Methodological and Theoretical Advances in the Social Assessment of Ecosystem Services

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ABSTRACT

This dissertation advances the methodological and theoretical foundations of the social assessment of ecosystem services, a growing research approach that uses survey and interview methods to examine how people perceive, prioritize, and relate to nature's contributions to human well-being. Responding to long-standing critiques of biophysical and economic assessments—including their limitations in capturing social diversity, cultural meaning, and policy relevance—this dissertation presents three empirical studies that improve how social values are captured and interpreted within ecosystem services research.

The first study offers a methodological contribution by demonstrating how the social assessment of ecosystem services can be used to compare expert and public stakeholder perspectives in the Portneuf River Watershed, Idaho. It introduces a structured framework for analyzing perceptions across four social dimensions: recognition, importance, perceived change over time, and the impacts of land-use on service delivery. The results reveal both alignment and divergence in stakeholder views, providing practical insights for participatory and inclusive environmental management.

The second study turns to theory, introducing a value-based model of preference formation. Using a survey across the contiguous United States, it explores how Schwartz's theory of basic human values predicts individual preferences for provisioning, regulating, and cultural ecosystem services. The findings show that self-transcendence and openness to change values are strongly associated with higher concern for

environmental services, offering theoretical clarity on why people value certain ecosystem services over others.

The third study integrates these methodological and theoretical insights into a local case study of the Tennessee River in East Tennessee. It examines how value orientations predict both ecosystem service preferences and policy solution preferences related to plastic pollution. Results show that individuals who prioritize self-transcendence values are more likely to support collective and regulatory policy solutions, highlighting the practical significance of linking values to policy preferences. Together, these three studies demonstrate that the social assessment of ecosystem services is a transferable, scalable, and policy-relevant approach.

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INTRODUCTION

Connected Systems of People and Nature

This In 1953, Eugene P. Odum published Fundamentals of Ecology, a work that laid the foundation for modern ecological thinking (Odum, 1953). His systems approach to ecology was groundbreaking, introducing the concept of homeostasis in ecosystems, wherein biological and chemical processes interact to maintain stability. By incorporating the first and second laws of thermodynamics, Odum demonstrated the holistic interconnections between organisms and their environment. He characterized ecosystem processes through key principles such as energy flow, material cycling, and ecological interactions. Among his many contributions—including the development of energy pyramids and trophic efficiency models—he was among the first to explicitly link human well-being to an inherent dependence on ecosystems and nature more broadly. This shift in thinking challenged the prevailing scholarly disconnect between ecological research and human society. Through his discussions on deforestation, industrialization, and urbanization, Odum warned of the dangers of resource overexploitation, arguing that human activities threatened to exceed ecological resilience, a concept he helped define. Odum's work emerged during a period of global environmental transformation, marked by unprecedented ecological degradation due to rapid industrial expansion, urbanization, and deforestation. During the mid-20th century, deforestation rates accelerated due to the growing demands of agriculture, particularly in tropical and temperate forests, where millions of hectares were cleared annually to support expanding populations and shifting economic structures. Simultaneously, industrialization surged, especially in the post-war

economies of Western Europe and the United States, leading to a sharp rise in fossil fuel consumption. As global populations grew, rapid urban expansion led to the large-scale conversion of natural landscapes into built environments, resulting in habitat destruction, pollution, and biodiversity loss. Odum recognized that these emerging environmental crises not only threatened ecological stability but also human well-being, as disruptions to natural systems would inevitably affect all aspects of society.

Odum's early attempts to link ecosystem processes with human well-being contributed to what can be (now) seen as a Kuhnian paradigm shift in ecological science, marking a departure from reductionist models toward an integrated, systems-based perspective. Aligning with Odum's ideas, Robert MacArthur's 1955 paper, Fluctuations of Animal Populations and a Measure of Community Stability, challenged simplistic predator-prey models and introduced the concept of food web complexity. MacArthur argued that the structure of food webs, particularly the diversity of energy flow pathways, is critical in determining the stability of ecological communities. His mathematical models demonstrated that ecosystem stability is directly correlated with species richness, as ecosystems with greater trophic connectivity are more resilient to perturbations. MacArthur's work not only advanced ecological modeling but also underscored the threats posed by human activities, particularly biodiversity loss, to the long-term stability of both ecosystems and human societies. Shortly after, Paul B. Sears expanded on MacArthur's concerns in his influential essay, The Process of Environmental Change, published as part of the book Man's Role in Changing the Face of the Earth (Wolf, 1957). Sears made explicit the growing fears about human-induced environmental change,

stating that humans were continuing to manipulate the environment to serve their immediate needs, neglecting the broader ecological principles that govern ecological stability. Drawing from the emerging concepts of ecological resilience and stability, Sears emphasized that unchecked human activities disrupt the balance of natural systems, suggesting that positive short-term outcomes would later give way to long-term consequences. His work reinforced Odum's warnings and helped to bridge the gap between ecological science and environmental policy, influencing early discussions on sustainability and conservation.

As these and other contributions mounted, it became evident that Odum's revolutionary ideas had established a new paradigm, ushering in a period of "normal science" in line with Kuhn's theory of scientific progress. Reflecting this philosophical shift, scholars from varied disciplines began integrating ecological concepts into their work. For instance, in his 1968 book, Ecology and Resource Management: A Quantitative Approach, economist Kenneth Watt applied Odum's systems approach to the field of resource management. While Watt's focus was primarily on resource optimization—such as maximizing crop yields while minimizing negative environmental impacts—he was among the first to explicitly consider the economic implications of human-nature interactions. Another significant contribution of Watt's work was his early incorporation of economic principles into ecological modeling, particularly in the areas of population regulation and resource use efficiency, which later influenced environmental policymaking. However, perhaps the most definitive reinforcement of this new paradigm was the rise of "human ecology" as an interdisciplinary science. John G. Bruhn's 1974

paper, Human Ecology: A Unifying Science? examined how various disciplines—including geography, anthropology, sociology, and psychology—had all, in their own ways, attempted to explore the interconnections between humans and the environment. Bruhn argued that, despite the fragmentation of research approaches and methodologies, human ecology had the potential to be a unifying science centered on a systems-based approach to studying human-environment relationships. By the 1970s, human ecology had begun influencing policy debates, conservation efforts, and early discussions on sustainability, further cementing Odum's legacy as a pivotal figure in modern ecological thought.

History and Development of the Ecosystem Service Concept

As the field of human ecology gained momentum, a related concept began to take shape: ecosystem services. In the late 1970s and early 1980s, scholars introduced the term ecosystem services to describe nature's beneficial functions. Westman (1977) was among the first to use the term, emphasizing that ecosystems provide valuable services to society—such as climate regulation, soil nutrient cycling, and freshwater provision—but that global markets lacked mechanisms to quantify these benefits effectively. A few years later, Ehrlich and Ehrlich (1981) further popularized the concept, making a utilitarian case for biodiversity conservation by highlighting how ecosystem services underpin human well-being. They also warned that biodiversity loss would weaken nature's ability to provide these essential functions. These early scholars saw ecosystem services as a useful framework for articulating and communicating nature's benefits in an accessible,

jargon-free manner. However, despite these contributions, the concept remained on the fringes of scholarly discourse for nearly 15 years.

That changed in 1997 when the concept gained widespread attention. In their seminal paper—now cited over 32,000 times—Costanza et al. (1997) sought to quantify the economic value of the world's ecosystem services. Like Westman (1977), they argued that ecosystems provide essential life-support functions. However, from their economic orientation, Costanza et al. (1997) argued that because these services fall outside traditional market valuations, their contributions to both global economic and social systems were consistently undervalued or entirely overlooked in policy decisions. By operationalizing ecosystem benefits as natural capital (that is, the monetary value of ecosystem services), Costanza et al. estimated the total annual value of global ecosystem services to range between $16 trillion and $54 trillion, with an average of $33 trillion per year. Perhaps the most striking aspect of this estimate—and the reason it catalyzed widespread interest in ecosystem services—was that it exceeded the total global gross national product (GNP) at the time, which stood at approximately $18 trillion. In other words, they argued that nature’s contributions to human well-being were more valuable than the entire global economy.

In producing their study, Costanza et al. (1997) also contributed to the classification of the world’s major ecosystem services, identifying 17 major categories and providing a foundational framework for subsequent research. At this time, scholarly interest in ecosystem service research was high in economic fields of study, however, the concept was rarely applied to environmental policy making. However, that all changed when the

ecosystem service concept appeared in the Millennium Ecosystem Assessment (MEA). Launched in 2001 and published in 2005, the MEA formalized the concept within international environmental policy community. Conducted under the auspices of the United Nations, the MEA assessed the state of the world's ecosystems, their capacity to support human well-being, and the consequences of their degradation. One of its most critical findings was that 60% of the world's ecosystems were either degraded or being used unsustainably, with land-use change playing a dominant role in this decline. By explicitly integrating ecosystem services into its framework, the MEA mainstreamed the idea that human well-being is inextricably linked to ecosystem health—an idea first articulated by Odum in 1953.

Building from Costanza et al. (1997), the MEA further refined the classification system, organizing ecosystem services into four broad categories: provisioning, regulating, supporting, and cultural services.

- Provisioning services encompass the tangible goods ecosystems provide, such as food, water, timber, and medicinal resources.
- Regulating services include ecological processes that maintain environmental stability, such as climate regulation, flood control, and water purification.
- Supporting services are those that underpin all other services by maintaining ecosystem functions, including nutrient cycling, soil formation, and photosynthesis.

- Cultural services encompass recreational, aesthetic, spiritual, and educational benefits derived from ecosystems, highlighting their role in shaping human culture and identity.

Aligning with Ehrlich and Ehrlich's (1981) utilitarian perspective, the MEA shifted the focus from conserving nature for its own sake to conserving ecosystems for human well-being. Arguably, this reframing presents a more compelling case for ecosystem protection to governments, businesses, and international organizations. The MEA's strength lay in its simplicity—it effectively communicated nature's complex benefits in an accessible way, free from technical jargon. This clarity has been recognized as key to mainstreaming ecosystem services in policy and decision-making (Gómez-Baggethun et al., 2010). By framing nature's contributions in economic and social terms, the concept gained traction across disciplines, making it easier for policymakers and stakeholders to integrate ecosystem services into environmental governance (Braat & de Groot, 2012). A meta-analysis of publication trends in ecosystem services research (McDonough et al., 2017) confirms that following the MEA's publication, there was a significant rise in ecosystem service research. Soon after, specialized academic journals emerged, including Ecological Economics, Ecosystem Services, PLoS One, and Acta Ecologica Sinica, reflecting the field's growing prominence. Moreover, the MEA's findings catalyzed major policy initiatives, most notably the establishment of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) in 2012. Created through collaboration among international bodies such as the United Nations Environment Programme (UNEP) and UNESCO, the IPBES sought to advance

ecosystem services research—and specifically improve how ecosystem service knowledge can be integrated into decision-making. Through a series of landmark global assessments, IPBES has played a pivotal role in shaping how ecosystem services are conceptualized and applied in policy. Notably, its work refined the MEA classification system, consolidating ecosystem services into three overarching groups while removing "supporting services" as a distinct category. Despite revisions to these categorizes, the definition of the ecosystem service concept has remained largely stable since its inceptions **(Table 1)**.

As ecosystem services research output expanded exponentially in the 2010s (McDonough et al., 2017), the field became increasingly diverse and specialized. Meta-analyses indicate that research moved beyond ecological and economic dimensions to incorporate policy considerations, reflecting a shift toward applied, decision-relevant studies (Takacs & O'Brien, 2023). This marked a critical turning point: ecosystem services transitioned from an abstract theoretical construct to a measurable and observable phenomenon. The concept was now recognized as both a research philosophy—capturing the fundamental interconnectedness of nature and human well-being—and an empirical framework for systematically assessing these relationships. Reflecting this shift, case study research, often described as place-based research, became the dominant methodological approach, emphasizing localized, context-specific applications of ecosystem service assessments.

Ecosystem Service Assessments

Ecosystem Service Assessments (ESA) involve the systematic identification, quantification, and evaluation of the benefits ecosystems provide to people.

Fundamentally, ESA operate under the assumption that ecosystem service knowledge can provide evidence-based insights to inform sustainable land-use planning, conservation policies, and ecosystem management. Aligning with the patterns of development of the ecosystem service concept, most ESA research orientates as either a (1) biophysical, or (2) an economic approach.

Biophysical assessments of ecosystem services involve the systematic measurement, mapping, and evaluation of the physical and ecological processes that sustain ecosystem functions (Vihenvaara et al., 2018). These assessments can rely on a combination of direct measurements, indirect measurements, and modeling approaches to understand the ecological characteristics of a landscape. Direct measurement methods involve field observations, where ecological characteristics such as vegetation cover, soil composition, or water quality are recorded through on-site data collection. Indirect measurement methods rely on remotely sensed data and spatial analysis to derive ecosystem service indicators. Techniques such as satellite imagery, allow researchers to estimate ecological functions quickly and across large spatial scales. Across both indirect or direct approaches, models can be used to integrate ecological, hydrological, and atmospheric data to simulate ecosystem processes and understand the likely delivery of ecosystem services (Lavorel et al., 2017). Notably, research often not only focuses on current level of deliver, but also uses models to consider how the effects of environmental changes, policy interventions, and land-use decisions may relate to the delivery of ecosystem services (Vihenvaara et al., 2018).

As first popularized by Costanza et al., (1997), economic ESA focus on quantifying the monetary value of services. As first described by Bateman et al., (2011) a fundamental aspect of economic assessment is distinguishing between ecosystem service stocks and flows. Ecosystem services are derived from ecological assets (stocks), which generate benefits (flows) over time and through interaction with human processes (this is sometimes referred to as co-production). To quantify the value of ecosystem services, economists use various valuation methods, with some of the most common described in **Table 2**.

Like biophysical assessments, economic methods must also account for spatial and temporal dimensions. In most studies, the economic value of ecosystem services is typically assessed on an annual basis to understand their contribution over time. To achieve a comprehensive total economic valuation, multiple economic methods are often combined. This is because different methods are suited to valuing different types of services, and no single method is universally applicable. For example, tangible services—those that provide marketable goods or products, such as timber, water, or food—are relatively straightforward to value using market comparison methods, as their market prices can be directly observed. However, some ecosystem services, particularly cultural services, are more challenging to value because they are intangible in that they lack direct market prices (termed market externalities). For example, services like recreational opportunities, aesthetic value, or spiritual benefits cannot be easily captured through market comparisons. In such cases, alternative methods, like the travel cost method, are necessary. The travel cost method, for instance, estimates the value of recreational

services by looking at how much people are willing to spend on travel and time to access natural areas. This helps quantify the value of ecosystem services that people may not pay for directly but still derive significant benefit from.

Critiques and the Emergence of the Social Assessment Approach

As ecosystem service assessments (ESA) became more widespread throughout the 2010s, several prominent critiques emerged in the literature. In this subsection, I briefly review these critiques and explore how they have contributed to the development of a new approach: the social assessment of ecosystem services.

One of the most pressing criticisms of ESA is their limited success in achieving their primary objective—informing decision-making. Saarikoski et al. (2018), in a meta-analysis of 22 case studies, argue that ESA rarely generate knowledge that can be effectively integrated by local decision-makers. Their findings suggest that while ESA may enhance conceptual understanding of socio-ecological linkages, increasing awareness of ecosystem service values among stakeholders, this rarely translates into concrete policy guidance. This critique is closely linked to the challenge of ecosystem service trade-offs, which occur when the enhancement or prioritization of one service leads to the reduction or degradation of another (Turkelboom et al., 2018). Because ecosystems provide multiple services simultaneously, shifts in land use, management decisions, or environmental conditions can disrupt this balance. These trade-offs may emerge in the immediate management of services, but they also manifest across different temporal scales (short-term vs. long-term impacts), spatial scales, and between private and public benefits (Portman, 2013). Notably, most ESA studies stop short of guiding

decision-makers through the complexities of these trade-offs, nor do they empirically assess how research insights translate into management outcomes (Baker et al., 2013). Beyond these applied critiques, scholars have also challenged the conceptual foundations of ESA. Melathopoulos and Stoner (2015), in Critique and Transformation: On the Hypothetical Nature of Ecosystem Service Value and Its Neo-Marxist, Liberal, and Pragmatist Criticisms, examine the limitations of ecosystem service valuation through a critical theory lens. Their neo-Marxist critique suggests that economic assessments reduce social and ecological relationships to market transactions, where conservation ideals are inherently juxtaposed to the implicit capitalist logics that environmental degradation drives economic gain. Their liberal critique asserts that both biophysical and economic assessments imposes a false objectivity on ecosystem service values, treating them as scientifically determined rather than socially constructed. In other words, they argue that these methods downplay the co-production of ecosystem services and the crucial pluralistic role that humans play. Finally, their pragmatist critique argues that economic approaches inform decision-making using value monism – the largely antiquated philosophical idea that there is only one fundamental value that guides all other values. Instead, they suggest that such complex socio-ecological decisions require a level of considered and deliberative thinking, which weights multiple pros and cons simultaneous—arguing against the uniform insights of economic analysis.

Similarly, Small et al. (2021) critiques ESA from a systems theory perspective, arguing that much of the research literature overemphasizes ecological components while downplaying the social and cultural dimensions that give ecosystem services value.

Though, perhaps the first explicit recognition of this issue came in the paper "Where are Cultural and Social in Ecosystem Services? A Framework for Constructive Engagement" by Chan et al. (2012). The authors argue that while ESA have successfully developed an approach for examining provisioning and regulating services, cultural ecosystem services remain inadequately integrated, largely due to their intangible nature and the difficulty of measuring them in monetary terms. To remedy this, the authors outline the need for more (social) participatory approaches and interdisciplinary methods, to better represent the diverse ways in which ecosystems contribute to human well-being. Their framework suggests that decision-making processes should account for trade-offs between material and nonmaterial benefits to ensure a more appropriate accounting for cultural values. This juncture, which occurred between 2012 and 2016, marked a concerted push amongst the scholarship to better capture cultural services using a social lens. Specifically, the scholarship developed the 'socio-cultural approach' to the valuation of ecosystem services, as a direct response to the critique that ESA often exclude the very stakeholder groups that they seek to support (Menzel et al., 2010). Iniesta-Arandia et al., (2014) first defined the socio-cultural approach as an ESA of social needs, perceptions and preferences. This approach acknowledges that stakeholders perceive and prioritize ecosystem services differently based on their backgrounds, occupations, and local knowledge, which is crucial to considering trade-offs in ecosystem services management. The socio-cultural approach exploded in popularity, and was iteratively refined by among the literature, often using face-to-face and online survey methods to capture stakeholder attitudes.

However, in 2015, Felipe-Lucia and colleagues argued that the socio-cultural approach had morphed into something unintended, principally due to conceptual misunderstandings and methodological inconsistencies (Felipe-Lucia et al., 2015). Fundamentally, they argue that scholars were mischaracterizing the socio-cultural approach as the totality of the (then emerging) social valuation approach. The social valuation approach seeks to capture social values across all service types (regulating, provisioning, and cultural), whereas the socio-cultural approach only examines cultural services. The authors contend that cultural ecosystem services had come to (inappropriately) dominate the social valuation discourse, leading to an overly narrow assessment. Second, Felipe-Lucia et al. criticize the blurring of lines between socio-cultural and economic valuation. They argue that many studies categorized as social assessments actually employ economic valuation techniques, such as contingent valuation and willingness-to-pay surveys, to capture social preferences. They suggest this is conflation undermines the original goal of the socio-cultural approach, which was to offer an alternative to economic valuation by focusing on collective meanings, relational values, and participatory methods rather than monetary metrics.

Social-Ecological Systems and Social Assessment

While ESA scholars grappled with the boundaries of the emerging social assessment approach, Social-Ecological Systems (SES) thinking became increasingly influential within the ecosystem services literature. In 2009, renowned political scientist Elinor Ostrom presented "A General Framework for Analyzing Sustainability of Social-Ecological Systems" (Ostrom, 2009). Her work described SES as complex,

interdependent systems where social and ecological components interact dynamically, and where various subsystems—such as resource users, governance structures, and ecological conditions—shape sustainability outcomes. Foundationally, her work critiqued traditional approaches to resource management, which assume that (governing) authorities must impose regulations to prevent overuse. In doing so, she popularized the notion of and discussions around the 'Tragedy of the Commons' (Ostrom, 2008), arguing that local communities, under the right conditions, are capable of self-organizing and managing resources in a sustainable fashion.

Like the ESA scholarship, Ostrom's SES thinking acknowledged that sustainability is shaped by trade-offs and feedback loops. In particular, Ostrom drew attention to the idea that management decisions that prioritize short-term gains can lead to long-term ecological degradation, while adaptive governance structures that foster cooperation and learning can enhance resilience. Ultimately, Ostrom considered the SES framework a diagnostic tool for understanding why some governance strategies succeed while others fail. However, for ESA scholars, Ostrom's ideas served as a catalyst for a renewed focus on social valuation, particularly in a way that aligned with Felipe-Lucia et al.'s (2015) call for a holistic social assessment. This perspective moved beyond socio-cultural valuation, advocating for an approach that integrates governance, institutional structures, and power dynamics into the evaluation of ecosystem services.

Contemporary social assessment scholarship is now growing rapidly (Castro-Díaz et al., 2022). Increasingly, studies employ methods such as in-depth interviews (Cáceres et al., 2015), surveys (Greeves et al., 2025; Castro et al., 2016), and focus groups (Slovák et al.,

2023) to examine how people perceive ecosystem services. Notably, in the decade since Felipe-Lucia et al. (2015) proposed A Framework for the Social Valuation of Ecosystem Services, a key shift has been the recognition that no case study population is homogeneous. Researchers increasingly emphasize the importance of assessing ecosystem service preferences by subpopulations. For example, socially meaningful distinctions can be made based on the roles different groups play within communities—such as participation in business, conservation, or management decision-making—ensuring that social assessments reflect the diversity of perspectives within a population. This approach not only improves the precision of preference measurements but also enables comparative analysis across stakeholder groups, enhancing the relevance of social assessments for decision-making in socio-ecological management.

The Contributions of this Multi-Part Dissertation

The overarching aim of this multi-part dissertation is to contribute to the methodological and theoretical advancement of the social valuation of ecosystem services.

The first research chapter introduces a novel methodology. Using a case study of the Portneuf River Watershed, I demonstrate how social assessments can be employed to examine provisioning, regulating, and cultural ecosystem services, both at the level of individual services and across broader ecosystem service categories. Building on emerging practices in the literature, I show how social assessments can capture multiple social dimensions of ecosystem services, including public recognition of services, perceptions of their relative importance, perceived changes in service provision over time, and the impacts of different land uses on these services. Together, these dimensions

provide a comprehensive understanding of how ecosystem service knowledge can inform sustainable land management. In line with Social-Ecological Systems (SES) thinking, I also illustrate how social assessments enable comparisons of stakeholder attitudes and perspectives toward ecosystem services. Finally, I discuss how survey design elements, such as photo-elicitation, can serve as effective tools for engaging diverse stakeholder groups, including those with limited familiarity with ecosystem service concepts.

The second research chapter addresses the application of theory in social assessment research. I begin by noting that social assessments typically focus on the social valuation of ecosystem services through the lens of preferences. However, preferences—defined as the extent to which certain services are valued over others—offer only a partial understanding of social valuation, as they reveal what people value but not why they value it (Schmitt et al., 2021). To address this gap, I incorporate Hausman's economic model of preference formation, which conceptualizes preferences as "subjective comparative evaluations" and distinguishes between partial and total evaluations. While current social assessment approaches primarily capture total evaluations, I argue that integrating Hausman's framework enables a more nuanced examination of the underlying factors shaping preferences. Building on this, I explore the relationship between people's core values, as outlined in Schwartz's Theory of Basic Human Values, and their ecosystem service preferences. By linking values to preference formation, this approach enhances the explanatory power of social assessments, offering deeper insights into why individuals prioritize certain services over others. This refined perspective strengthens the

utility of social assessments by providing a more structured and theoretically grounded framework for interpreting ecosystem service preferences in decision-making contexts. The third research chapter applies the methodological insights developed in the first chapter and the theoretical insights from the second chapter to a local case study of the Tennessee River in East Tennessee—one of the most polluted rivers in the United States. This chapter focuses on the general public, employing a survey-based methodology that combines ecosystem service preference rankings with Schwartz's Portrait Values Questionnaire (PVQ). By empirically testing the integration of value theory into social assessment research, this case study contributes methodologically by enhancing the scalability and transferability of preference-based analyses across diverse contexts. In addition, the chapter presents novel insights into the relationship between ecosystem service preferences and policy solution preferences, further strengthening the relevance of social assessments for informing decision-making in socio-ecological management.

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APPENDIX

Table 1 - Definitions of the ecosystem service concept.

Source	Definition
Daily (1997) Millennium Ecosystem Assessment (MEA, 2005) The benefits people obtain from ecosystems, categorized into provisioning, regulating, cultural, and supporting services.	Ecosystem services are the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life.
Costanza et al. (1997)	The benefits human populations derive, directly or indirectly, from ecosystem functions, valued in economic terms.
The Economics of Ecosystems and Biodiversity (TEEB, 2010)	The direct and indirect contributions of ecosystems to human well-being, making nature's values explicit for economic decision-making.
Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2019)	Nature’s contributions to people, emphasizing the diverse ways ecosystems support societies beyond economic valuation.

Table 2 - Methods for the economic valuation of ecosystem services.

Valuation Method	Description	Application	Reference
Market Comparison	Estimates the value of ecosystem services based on actual market transactions, using prices for goods and services that ecosystems provide.	Often used for valuing timber, fish, non-timber forest products, and water supply.	Taye et al., (2021)
Hedonic Price	Determines the value of ecosystem services by analyzing how environmental attributes (e.g., air quality, scenic views, proximity to parks) influence property prices.	Applied in real estate markets to assess the value of clean air, green spaces, and waterfront locations.	Hatan et al., (2021)
Travel Cost	Uses the cost of travel (e.g., transportation, time, entrance fees) to estimate the recreational value of ecosystems.	Commonly used to value national parks, beaches, and wildlife reserves.	Zhang et al., (2022)
Contingent Valuation	Surveys individuals to determine their willingness to pay (WTP) or willingness to accept (WTA) compensation for changes in ecosystem services.	Used for valuing non-market benefits like biodiversity, cultural landscapes, and conservation programs.	Perni et al., (2021)
Replacement Cost	Estimates the cost of replacing an ecosystem service with artificial alternatives (e.g., building water filtration plants to replace natural water purification by wetlands).	Applied in valuing flood control by wetlands, pollination by insects, and water purification by forests.	Yao et al., (2022)

CHAPTER I

SOCIAL VALUATION OF ECOSYSTEM SERVICES: A COMPARATIVE STAKEHOLDER ANALYSIS OF THE PORTNEUF RIVER WATERSHED, IDAHO

Authorship Statement

A version of this chapter was originally published by Scott B. Greeves, Rachel N. McGovern and Antonio Castro:

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I, Scott Greeves, was involved as the principal investigator in this project. I conceptualized the project, collected data, conducted analysis, and led the manuscript writing. Co-researchers Rachel McGovern and Antonio Castro were involved in parts of the writing and editing process.

Abstract

Ecosystem service assessments are diversifying from traditional biophysical and economic methodologies to incorporate a social assessment approach. This emerging approach uses surveys and interviews to explore how people relate to and prioritize ecosystem services, providing insights into the social feasibility, acceptance, and robustness of socio-ecological management strategies. Despite its promise, the social approach remains methodologically underdefined. To address this limitation, this case study presents a social assessment of ecosystem services within the Portneuf River Watershed, Idaho, focusing on a comparative assessment of expert and public stakeholder perspectives. The findings highlight the approach's utility in identifying (mis)matches between stakeholder perspectives across four key dimensions: (1) ecosystem service recognition, (2) ecosystem service importance, (3) ecosystem service change over time, and (4) the influence of land use on ecosystem service provision. These findings are

contextualized by examining factors such as stakeholder demographics, the environmental legacies of the study region, and the design of the survey, illustrating the potential of the social approach to inform socio-ecological management. Finally, we discuss methodological considerations for adapting our study design to other place-based contexts and highlight how case studies can contribute to broader networks of interconnected research.

Introduction

Ecosystem service assessments traditionally rely on biophysical and economic methods to examine ecosystem services within defined spatial contexts (Felipe-Lucia et al. 2015; Mengist and Soromessa. 2019). These assessments are conducted under the premise that ecosystem service assessments generate knowledge that informs decision-making and supports sustainable land management (Saarikoski et al. 2018). This premise stems from the utility of ecosystem service concepts in foregrounding and valuing the tangible connections between people and natural systems (Costanza et al. 1997). However, in practice, ecosystem service assessments have been criticized for failing to consider how specific ecosystem service knowledge can effectively be integrated into decision-making (Saarikoski et al. 2018). To address this challenge, ecosystem service assessments are diversifying from the established biophysical and economic approaches to include a social assessment component. While biophysical assessments measure ecological functions and properties in relation to services (Tiemann and Ring 2022) and economic assessments work to quantify the monetary value of services (Bateman et al. 2011; Huber and Finger 2020), social assessments use survey and interview methods to understand how people relate to and prioritize ecosystem services (Riechers et al. 2017; Bidegain et al. 2020). By gaining an understanding of people's knowledge of and preferences for ecosystem services, social assessments facilitate a comprehensive evaluation of the social feasibility, acceptance, and resilience of socio-ecological management options, ultimately supporting more informed and socially grounded approaches to sustainable ecosystem management (Felipe-Lucia et al. 2015).

However, as an emerging approach, social assessments of ecosystem services are poorly defined methodologically and underutilized within the research literature (Pingarroni et al. 2022). To date, many social assessments tend to focus narrowly on assessing cultural ecosystem services, erroneously omitting the assessment of regulating and provisioning services (Felipe-Lucia et al. 2015; McDonough et al. 2017). This tendency to focus on cultural services stems not from any theoretical grounding but from a persistent conflation between cultural ecosystem services and the socio-cultural valuation of ecosystem services (Scholte et al. 2015). Another point of methodological confusion is the inappropriate spillover of economic methods, particularly those relying on monetary valuation, into studies purporting to be social assessments (Felipe-Lucia et al. 2015). These challenges, combined with a lack of clearly established methodological norms, have resulted in excessive methodological pluralism among social assessments, making it difficult to derive scalable and transferable insights across multiple studies – an issue that also affects broader social-ecological (Cumming et al. 2020) and ecosystem service research (Balvanera et al. 2017; Norström et al. 2022).

In response to these challenges, researchers have emphasized the need for more robust and consistent data collection methods to better support global sustainability goals (Cumming et al. 2020; Norström et al. 2022). Addressing this need, the overarching goal of this study is to present a social assessment of ecosystem services that avoids the methodological pitfalls identified in the literature. Using a case study, we demonstrate how social assessments serve as powerful tools for examining provisioning, regulating, and cultural ecosystem services at both the individual service level and within broader

ecosystem service categories – provisioning, regulating, and cultural. Also, building on emerging practices in the literature, we highlight how social assessments can investigate multiple social dimensions of ecosystem services, including people's recognition of ecosystem services, perceptions of their relative importance, perceived changes in service provision over time, and the impacts of various land uses on these services. Together, these dimensions provide a comprehensive picture of how ecosystem service knowledge can inform sustainable land management.

A secondary objective of this study is to demonstrate how social assessments facilitate the comparison of stakeholder attitudes and perspectives on ecosystem services. Building on extensive evidence highlighting the value of stakeholder assessments in environmental decision-making and land management (e.g. Reed 2008; Reed et al. 2009; Bendtsen et al. 2021), recent research has shown the promise of integrating comparative stakeholder analysis into social assessments (Riechers et al. 2017; Quintas-Soriano et al. 2021). Given that stakeholder groups often hold diverse valuations and priorities for ecosystem services based on differences in knowledge, roles, motivations, and interests (Castro et al. 2011; Spangenberg et al. 2015; Quintas-Soriano et al. 2018), understanding these perspectives is important for evaluating the social feasibility and outcomes of policy options (Brugha and Varvasovszky 2000). Matches in stakeholder priorities within social assessments can signal support for policies that address shared ecosystem service priorities (Garard and Kowarsch 2017; Newig et al., 2018). Conversely, mismatches in priorities may indicate a higher likelihood of conflicting policy outcomes (De Pourcq et al. 2017). For instance, Riechers et al. (2017) used comparative stakeholder analysis to

study urban greenspace management in Berlin, finding mismatched priorities: experts valued creative design, while the public prioritized recreation. However, both groups similarly valued greenspaces for fostering awareness of nature. Understanding these stakeholder priorities is critical for evaluating potential policy trade-offs in ecosystem service supply and their varying impacts on stakeholder groups (King et al. 2015). Our case study, which spans 11 recognized cultural, provisioning, and regulating ecosystem services, compares expert and public stakeholder perceptions across four social dimensions of ecosystem services: (1) ecosystem service recognition, (2) ecosystem service importance, (3) ecosystem service change over time, and (4) the influence of land-use on ecosystem service provision. The findings highlight the effectiveness of this approach for comparing stakeholder perceptions at both the ecosystem service category level and the individual service level. We also discuss how survey design elements, such as photo-elicitation, are potentially useful tools for engaging stakeholder groups with varying levels of familiarity with ecosystem service concepts. Furthermore, we discuss how the results reflect the environmental legacies of the study region, consider the demographic characteristics of the stakeholder groups, and explore the transferability of this approach to other contexts.

Case study: the Portneuf River Watershed

The Portneuf River Watershed, located in southeastern Idaho, drains an area of approximately 3,440 km2. Sixty-three percent of the watershed is located within Bannock County, 33% in Caribou County, and 2.5% in Bingham County, with the remainder (1.5%) split between Power, Oneida, and Franklin counties (Natural Resource

Conservation Service Idaho 2007). The climate is semi-arid, with hot and dry summers and moderately long winters. Rangeland is the dominant land-use, covering 55.6% of the total watershed, with the remainder being comprised of agricultural land (22.3%), forest (17%), and urban development (4.2%). Elevation within the watershed, which is a locally important determinant of habitat distribution, ranges from 1255 to 3843 m above sea level. The most populous settlement in the area is Pocatello, which is home to approximately 79,000 residents. Within this city, 90.5% of the population is white, 1.0% is African American, 1.7% is Native American, 1.6% is Asian, 0.2% is Pacific Islander, 2.3% are composed of other racial groups, and 2.8% are composed of individuals identifying as two or more races. The City of Pocatello reports that the median household income per year is $47,132; 14% of the population has a high school degree, 28.3% has some college education, and 36.5% has a college degree.

Several key expert stakeholders are identifiable as they relate to the environmental management of the Portneuf Watershed. Management is highly departmentalized and collaborative, with eight key agencies involved in management, including federal (US Forest Service, US Bureau of Land Management, Portneuf Soil and Water Conservation District in the US Department of Agriculture), state (Department of Environmental Quality, Idaho Department of Fish and Game, Idaho Department of Transportation, Idaho Department of Water Resources), and local (City of Pocatello). The expert stakeholders and agencies were identified and selected based on their participation and membership in the Managing Idaho's Landscapes for Ecosystem Services (MILES) project, a statewide collaborative management research initiative (Program Overview | MILES [n. d.]).

Additionally, the study location includes the main campus of Idaho State University, which hosts numerous academics engaged in environmental management research and outreach, both through the MILES project and other related research programs.

The Portneuf River, which is a tributary of the Snake River, is the principal river in the watershed. It flows through many of the watershed's towns, including Pocatello. The river provides a crucial irrigation source for local agriculture but subsequently experiences an approximate 70% reduction in base flow during the summer months (Marcarelli et al. 2010). Responses to flooding of the Portneuf River during the mid-twentieth century resulted in the creation of concrete levees and channels, which have been cited as reducing river – community connections that are increasingly desired by local residents (Wu et al. 2017; Quintas-Soriano et al. 2018). The Portneuf River experiences reductions in water quality, in particular elevated levels of NO3-N and PO4-P, resulting from agriculture, industrial pollution, and animal grazing (Hopkins et al. 2011). Local political support for restoring the Portneuf River is tenuous, with agricultural and ranching interests concerned that restoration would impact their livelihoods (Lybecker et al. 2016). Furthermore, some local residents are apprehensive of river restoration activity because they fear it would involve the removal of flood control levees and channelization, leaving the community vulnerable to flooding (Lybecker et al. 2016). The management of the Portneuf River is overseen by a watershed partnership. This partnership represents a collaborative governance model that fosters socio-ecological management through cooperation between management agencies and public volunteers (Wu et al. 2017).

It is foreseeable that the Portneuf River Watershed will experience rapid land-use change, predominantly urban development, in the near future (Felt et al. 2018). Neighboring metropolitan areas within Idaho, including Boise, are among some of the fastest-growing cities in America, experiencing a 120% population increase between 1990 and 2015 (U.S. Census Bureau 2015). The likelihood of increased urban development in the Portneuf River Watershed has grown recently with the emergence of several projects in the area, including the Northgate development – planned to feature thousands of new homes and a shopping district – and the West Bench housing development, which aims to add hundreds of new homes (Evensen 2019; O'Connell 2019).

Methodology

Following previous research experience on ecosystem services valuation (Castro et al. 2016; Garcia-Llorente et al. 2012), we used a social assessment methodology to compare stakeholder perceptions across four dimensions of ecosystem services: (1) ecosystem service recognition; (2) ecosystem service importance; (3) ecosystem service change (over the last 10 years); and (4) land-use change impact on ecosystem services. These four components were adopted due to their unique utility in capturing a diversity of outlooks on ecosystem services, including the diversity of benefits people perceive (i.e. recognition), individual knowledge on the role of these benefits for wellbeing maintenance (i.e. importance), as well as people's perception regarding how the delivery of benefits has evolved (i.e. change) and how these benefits can be influenced by human activities (i.e. land use) (Castro et al. 2016; Cornell et al. 2019; García-Llorente et al. 2020; Quintas-Soriano et al. 2021). Based on a previous biophysical assessment of

ecosystem services in the study region (Quintas-Soriano et al. 2021), we identify 11 key ecosystem services to incorporate into our assessment and four land-use types. We delineated these 11 ecosystem services into three categories proposed by MEA (2025): provisioning services, regulating services, and cultural services.

Our study focused on two key stakeholder groups that are both central to the ongoing collaborative management of the study area: (1) experts and (2) the public (Wu et al. 2017). We define expert stakeholders as employees of federal (US Forest Service, US Bureau of Land Management, US Department of Agriculture), state (Department of Environmental Quality, Idaho Department of Fish and Game, Idaho Department of Transportation, Idaho Department of Water Resources), and local (City of Pocatello) agencies that are actively involved in local environmental management. Additionally, the expert group included academic researchers from Idaho State University whose work pertains to the management of ecosystems, landscapes, or human-environment interactions within the Portneuf River Watershed. We define the public stakeholders as members of the local public present within the study area. Broadly, our comparative stakeholder analysis sought to identify matches (shared perceptions) and mismatches (differing perceptions) of ecosystem services between the experts and the public. In total, our study sampled 28 expert stakeholders and 471 public stakeholders.

Survey tool

The survey tool consisted of three sections. Section one investigated local perceptions of ecosystem service as they relate to supporting and maintaining human well-being in the study region. Respondents were asked if they thought the Portneuf Watershed provided

‘Very Many’, ‘Many’, Few’, or ‘Very Little to No’ benefits. Next, respondents were asked to freely list any services and benefits that the Portneuf River Watershed provides. The free-listing technique was adopted because it provides unprompted, direct consultative responses that are not influenced by the listed options given, thus eliminating framing effects (Martín-López et al. 2012). Then, respondents were shown an ecosystem service resource panel and asked to rank the four most important ecosystem services, and indicate if each service had been increasing, decreasing, or stable in its level of provision in the last decade. The ecosystem service resource panel, which provided images and descriptions of locally important ecosystem services, was used to support photo elicitation.

Photo elicitation involves the use of visual aids during interviews and is grounded in the notion that images are more effective at evoking insights from experiences than written or spoken language (Carlsson 2001; Harper 2002). Additionally, in the context of our survey, the resource panels aided individuals in translating complex socio-ecological processes into more easily understandable benefits to human wellbeing. This was critical in removing jargon and reducing question complexity for individuals who may be unfamiliar with the ecosystem service concept. After ranking the four most important ecosystem services, we asked respondents to briefly describe why each ecosystem service was important and if the ecosystem service benefit had increased, declined, or remained steady in its level of provision over the last 10 years. The 10-year timeframe was adopted because it balances meaningful environmental change over time, while also reflecting the respondent’s recent experiences (Castro et al. 2016).

Section two of the survey investigated the perceived impacts of land-use change on ecosystem services in the study region. Endeavoring to further support photo elicitation, respondents were shown both a land-use resource panel, which depicted four prominent land-use types in the region (urban, agriculture, rangeland, and forest), and the ecosystem service resource panel. Using both panels, respondents were asked to consider how each of the four land-use types influenced ecosystem service provision. Specifically, for each of the four land-use types, respondents were asked to identify up to two ecosystem services that were positively affected and up to two ecosystem services that were negatively affected. Additionally, for each response, respondents were asked to provide a severity score on a scale from 1 to 10, with 10 indicating that the given land-use type was exerting the greatest possible effect on the selected ecosystem service. For land-use types perceived to exert a positive affect, a severity score of 10 denotes the greatest possible positive affect, suggesting the provision of the service is greatly supported by the land-use type. For land-use types perceived to exert a negative affect, a severity score of 10 denotes the greatest possible negative affect, suggesting the provision of the service is greatly reduced by the land-use type.

In the third section, we explored various demographic variables and factors associated with environmental behavior, including residency within the study site, participation in community affairs, engagement in local recreational activities, and political orientation.

Public Sample

In the summer of 2016, we recruited a convenience sample of members of the public from 14 locations within the study site. In total, 471 individual face-to-face surveys were

conducted at sites ranging from urban settings, recreational settings, a university campus, and outside shopping areas. These areas were chosen because they are freely accessible to all members of the public and have a large number of people present. At the beginning of each survey, participants were briefly informed about the nature of the survey, the voluntary nature of participation, and that participation would approximately require 15–20 minutes of their time. Additionally, respondents were told that participation was anonymous, for academic purposes only, and that responses to all questions were subjective, with no factually correct or incorrect answers. Participation was limited to adults aged 18+.

Expert sample

In the fall of 2019, we recruited an opportunity sample of 28 experts from within the Portneuf River Watershed. At the outset, we identified 45 pertinent MILES experts through their professional biographies and subsequently reached out to them via email, providing information about the study and extending invitations to participate. Participants were informed about the nature of the survey, the voluntary nature of participation, and that participation would typically require 15–20 minutes of their time. Respondents were told that participation was anonymous, for academic purposes only, and that responses to all questions were subjective, with no factually correct or incorrect answers.

Of the 45 experts contacted, 28 responded and were surveyed, representing a success rate of 62.2%. The sample was comprised of 14 academics from Idaho State University (located within the watershed) and 14 natural resource managers whose work pertains to

the Portneuf River Watershed. Of the 14 academics, nine were from the Department of Biological Sciences, two were from the Department of Sociology, two were from the Department of Geosciences, and one was a research administrator. Of the 14 natural resource managers, four were from federal agencies (US Forest Service, US Bureau of Land Management, Portneuf Soil and Water Conservation District in the US Department of Agriculture), seven were from state agencies (Department of Environmental Quality, Idaho Department of Fish and Game, Idaho Department of Transportation, Idaho Department of Water Resources), and three were from a local township agency (City of Pocatello). Face-to-face interviews with experts took place at their respective places of work.

Data analyses

Data that was manually recorded during face-to-face interviews was digitized. During this process, quantitative and categorical responses remained unchanged. Free-listed, qualitative responses regarding perceived contributions to human well-being were categorized into one of the 11 ecosystem services. For instance, ‘bike riding’ was categorized as ‘recreation’, and ‘for good air’ was categorized as ‘air quality’. Substantial efforts were made to categorize all qualitative responses logically; however, some ambiguous entries could not be assigned to any specific category and were therefore excluded.

To examine differences between the expert and public groups, we used the Wilcoxon rank-sum test (Aho 2014, 233). This test was employed to analyze survey responses across the four key areas of interest. First, we compared ecosystem service recognition

between the two groups, focusing on the number of ecosystem services identified and the types of services (provisioning, regulating, cultural) reported in both multiple-choice and free-listing contexts. Second, we examined ecosystem service importance by analyzing how respondents ranked individual ecosystem services and ecosystem service categories based on their perceived significance. Third, we assessed perceptions of ecosystem service change over time by comparing responses regarding whether services were perceived to have decreased, remained the same, or increased over the past decade. Finally, we evaluated perceptions of the impact of land-use changes, including urban development, natural forest, agricultural land, and rangeland, on ecosystem services. We adopted a graded method to define our certainty that the results differed from what would be expected by chance alone. In our study, we considered $p < 0.05$ significant and $p < 0.05$ and 0.1 marginally significant due to the limited sample size and associated limitations to the statistical power of our study (Gelman 2013). All data analyses were conducted in the statistical software package R Studio.

Results

The results of this study are presented at two discrete levels of analysis. The first is at the ecosystem service category level, which encompasses the three categories of provisioning, regulating, and cultural services. The provisioning category is comprised of the individual ecosystem services (1) 'food from agriculture', (2) 'freshwater provision', and (3) 'alternative energy'. The regulating category is comprised of the ecosystem services (1) 'habitat for species', (2) 'air quality', (3) 'water quality', (4) 'water regulation', and (5) 'climate regulation'. The cultural category is comprised of the

ecosystem services (1) ‘cultural heritage’, (2) ‘recreation’, and (3) ‘local identity’. The second level of analysis is conducted at the individual ecosystem level, which includes the 11 services named above.

Public sample description

Overall, considering the socio-demographic variables, the sampling technique provided a sample similar to the known population in the Portneuf River Watershed. About 55% of our respondents identified as male and 45% as female. The reported ethnic background of respondents was 75% white, 11% Latino or Hispanic, 9% Black or African American, 3% Indigenous American, and 2% Asian American. The political orientation was 41% moderate, 30% conservative, and 29% liberal. Almost 33% of the sample reported that they were active in community affairs, and 71% of the sample reported that government decisions do affect the Portneuf River Watershed.

Expert sample description

The expert sample was evenly split between academic and non-academic experts, with 14 experts in both categories (N = 28). However, when asked to self-report the ecosystem service and land-use type for which they held the most expertise, there was an uneven distribution of expertise **(Figure 1(a))**. A large proportion of experts reported that their expertise was related to ‘water quality’ and ‘habitat for species’, while no experts reported expertise on ‘air quality’, ‘alternative energy’, ‘cultural heritage’, or ‘food from agriculture’. Similarly, far more experts reported expertise in the land-use of ‘natural forest’ when compared to the other three land-uses **(Figure 1(b))**.

Ecosystem service recognition

When using a multiple-choice question regarding the importance of ecosystem services to human well-being, we found mismatching attitudes between the expert and public stakeholder groups. Specifically, the experts reported ecosystem services to be important when compared to the public group ($p < 0.05$) **(Figure 2)**. The overwhelming majority of experts (96%) reported that the watershed provides 'very many' contributions to human well-being, compared to just 49% in the public sample. Overall, the public reported a lower recognition of ecosystem service contributions, with the remainder of the public sample reporting 'many' (38%), 'few' (9.0%) and 'very little to none' (4%).

Similarly, when we assessed the ability of expert and public stakeholders to free-list ecosystem services, we found mismatching ecosystem service recognition between the groups. The expert group showed significantly higher recognition across all three ecosystem service categories compared to the public ($p \leq 0.05$) **(Figure 3)**. Experts reported more than twice the number of provisioning and cultural services and more than 11 times the number of regulating services compared to the public. Within just the expert group, there were no significant differences among the three ecosystem service categories ($p = 0.648$), indicating that the experts exhibited consistent reporting of provisioning, regulating, and cultural services. Conversely, we found the intra-group variability within the public group to be significant, indicating that they had inconsistent reporting across the three ecosystem service categories and were over five times less likely, on average, to cite regulating services compared to provisioning and cultural services ($p < 0.05$).

Ecosystem service importance

We found that when prompted to rank the most important ecosystem services, expert and public stakeholders held largely matching perceptions. At the ecosystem service category level, experts and the public did not significantly differ in their perceptions of ecosystem services for cultural and regulating services. However, we found that experts reported significantly higher importance for provision services compared to the public ($p \leq 0.05$) **(Figure 4)**. On the individual ecosystem service level, we found that only one ecosystem service differed significantly between the two groups. Experts reported that 'food from agriculture' was significantly more important when compared to the public ($p < 0.05$).

Ecosystem service change

Using a multiple-choice question, we asked expert and public stakeholders about their perceptions of ecosystem service change over the last 10 years; responses were limited to 'decreased', 'remained the same', 'increased', and 'don't know' **(Figure 5)**. We found largely mismatching perceptions between the two groups. At the ecosystem services category level, perceptions of both cultural and regulating services differed significantly between experts and the public ($p \leq 0.05$). However, we found no significant result in the provisioning services category. On the individual ecosystem service level, we found that experts perceived a significantly greater increase in the ecosystem service recreation, local identity, and water quality ($p \leq 0.05$). All other individual ecosystem services exhibited no significant differences between the two groups.

Ecosystem services and land-use change

We found that when prompted to consider the impacts of land-use change on ecosystem services, expert and public perceptions were generally matching across all four land-use types **(Figure 6)**. Specifically, we found that both groups perceived urban development to have a predominantly negative affect on ecosystem services, natural forest to have a predominantly positive affect on ecosystem services, and both agricultural land and rangeland to deliver trade-offs in ecosystem services.

However, we found a number of significant differences between public perceptions at the individual ecosystem service level. For urban land-use, experts perceived a significantly larger decline in the ecosystem services 'food from agriculture' and 'air quality' and a significantly smaller increase in local identity when compared to the public **(Figure 6(a))**. For agricultural land-use, experts perceived a significantly larger increase in the ecosystem services 'food from agriculture' and 'local identity', and a significantly larger decline in 'water quality' when compared to the public **(Figure 6(b))**. For the 'rangeland' land-use, the public perceived a significantly larger increase in the ecosystem services 'food from agriculture' and a significantly smaller decline in 'habitat for species' when compared to the experts **(Figure 6(c))**. For the 'natural forest' land-use, the public perceived a significantly greater increase in ecosystem services 'climate regulation', when compared to the experts **(Figure 6(d))**.

Discussion

This case study of the Portneuf River Watershed, Idaho, introduces a methodology for the social assessment of ecosystem services that addresses several key methodological

critiques raised in the literature. Specifically, it responds to calls for social assessments to move beyond a narrow focus on examining cultural services to also include provisioning and regulating services while avoiding the inappropriate use of economic valuation methods (Felipe-Lucia et al. 2015). Building on emerging best practices, our approach demonstrates how social assessments can encompass the examinations of several social dimensions of ecosystem services. In particular, we focus on the examination of (1) ecosystem service recognition, (2) ecosystem service importance, (3) ecosystem service change over time, and (4) the influence of land-use on ecosystem service provision. Furthermore, we illustrate how social assessments can effectively support comparative stakeholder analyses. In our case study, we compare the social dimensions of ecosystem services between expert and public stakeholder groups, emphasizing how matches (shared perceptions) and mismatches (differing perceptions) can potentially inform environmental management.

Our discussion is divided into two sections. The first section examines the findings of our case study, while the second addresses key methodological considerations.

Case study discussion

Our case study compared expert and public stakeholder perspectives across four dimensions of ecosystem services. Given the expected differences in knowledge types, roles, motivations, and interests between the expert and public stakeholders (Castro et al. 2011; Spangenberg et al. 2015; Quintas-Soriano et al. 2018), we anticipated the stakeholder perspectives to be largely mismatched. However, our analyses revealed a combination of both matching and mismatching perspectives. In this section, we discuss

these findings, considering factors such as the survey design, the demographic characteristics of the stakeholder groups, and the environmental legacies unique to the study region.

Our first finding highlights a notable mismatch in the recognition of ecosystem services between stakeholder groups, with experts demonstrating notably higher levels of recognition. In response to a free-listing question, experts identified more than twice as many provisioning and cultural services and 11 times as many regulating services compared to the public. While it is unsurprising that the experts demonstrate a higher overall recognition of ecosystem services, likely due to their deeper understanding of socio-ecological processes, this alone does not fully account for their disproportionately greater recognition of regulating services. A possible explanation is that regulating services are less tangible and more biophysically complex than provisioning and cultural services (Lewan and Söderqvist 2002; McInnes 2013; Thompson et al. 2016). For example, while the provision of fresh water is a visible, immediate concern for most, the processes regulating water quality often operate in the background and remain outside of the daily awareness of the public. Similarly, some cultural services, such as recreation, involve direct physical interaction, making them more easily recognized. This interpretation aligns with our parallel observation of low intra-group variability among experts, who consistently identified ecosystem services across provisioning, regulating, and cultural categories. In contrast, the public group exhibited high intra-group variability and were over five times less likely to cite regulating services than provisioning or

cultural services, reflecting a more fragmented and uneven understanding of ecosystem services.

Alternatively, the mismatch between expert and public recognition of regulating services may be linked to the differing demographic characteristics of the stakeholder groups (McMillan et al. 1997; Mildenberger and Leiserowitz 2017), particularly the significant political conservatism reported among the public sample compared to the expert sample. Cornell et al. (2019) found that within the Portneuf River Watershed, political conservatives were less likely than other political groups to express concerns about climate change. While not explicitly categorized as an ecosystem service, climate change arguably aligns more closely with regulating services, such as climate regulation, than with provisioning or cultural services. This alignment may partially explain the lower recognition of regulating services among the more politically conservative public sample. Additionally, given the relatively high level of politicization and polarization surrounding climate change – and, by continued logical extension, the regulating services associated with it – it is perhaps unsurprising that a more politically conservative public sample was less inclined to recognize regulating services. This stands in contrast to more tangible benefits, such as recreation or food derived from agriculture, which are often less politically charged (Steel et al. 2006; Jagers et al. 2018). Thus, both potential explanations for experts' heightened recognition of regulating services may offer promising opportunities while also posing potential practical challenges. If the mismatch stems from a knowledge gap, it presents an opportunity for decision-makers and experts to prioritize community outreach, education, and communication initiatives aimed at

increasing public awareness to foster greater alignment between stakeholder groups on policies that support and enhance regulating services. However, if the discrepancy is tied to demographic factors such as ideology, the public's lower recognition of regulating services may signal potential management and policy conflicts. In such cases, experts may prioritize safeguarding and conserving regulating services, while the public may disagree or struggle to understand why these services are emphasized as policy priorities. Conversely, unlike the discrepancies observed in ecosystem service recognition, our findings reveal that expert and public stakeholders hold largely matching perceptions regarding the relative importance of the assessed ecosystem services. When presented with 11 ecosystem services on a resource panel and asked to rank the four most important services to human well-being in the study region, expert and public perceptions differed significantly for only one of the 11 services analyzed. At first glance, this result may seem somewhat unintuitive, particularly given the previously discussed difference between expert and public recognition of regulating services. However, one possible explanation for the alignment in perceptions of ecosystem service importance lies in the use of the resource panel during the survey on ecosystem service importance but not for ecosystem service recognition. As outlined in the methodology section (3.1), the resource panel employed photo-elicitation – a technique designed to evoke insights from participants by visually representing ecosystem processes and their human benefits (Carlsson 2001; Harper 2002). This approach may have helped bridge the knowledge gap between experts and the public, contributing to a closer alignment in their reported perspectives. In fact, across four of the five regulating ecosystem services, the public

group reported a higher mean ranking score, though none of these differences were statistically significant compared to the expert group. This result suggests that, for the public, a lack of specific knowledge about ecosystem services – particularly in recognizing regulating services – may act as a barrier to accurately self-reporting their ecosystem service perceptions. In other words, while the public may fail to recognize the value of regulating services in unguided reporting scenarios, this does not necessarily indicate that they do not value them. By visually representing ecosystem processes and their benefits, these techniques may help mitigate the underreporting of regulating services among stakeholders with less specific knowledge.

We also utilized the resource panel to survey expert and public perceptions of how ecosystem service provision has changed over the past decade. Overall, we found that expert and public perceptions of ecosystem service change were largely matching. However, for the specific services of 'recreation', 'local identity', and 'water quality', the public perceived a more negative shift in provision compared to the experts. A likely explanation for this discrepancy lies in the environmental legacy of past conditions in the study area. Environmental legacies are significant because their effects can persist even after measurable environmental improvements occur (Pendleton et al. 2001). In the Portneuf River Watershed, the legacy of significant flooding and subsequent concrete channelization of the river in urban areas likely influences public attitudes toward water quality, recreational opportunities, and local identity (Hopkins et al. 2011; Wu et al. 2017). Conversely, experts' involvement in initiatives directly addressing these legacies, such as the Portneuf River Visioning project (City of Pocatello 2016, 2020) – which aims

to enhance access and support for recreational use of the Portneuf River – may contribute to their more optimistic perceptions of ecosystem service change (Quintas-Soriano et al. 2021). These contrasting experiences and contexts likely shape the differing perspectives on specific ecosystem services. This finding suggests that to better align public perceptions with their own, experts may need to enhance communication about the goals of ongoing projects. For instance, experts involved in the Portneuf River Visioning project could place greater emphasis on communicating the benefits of the de-channelization of the river while continuing to mitigate flood risk in those areas. Additionally, they could highlight the anticipated increase in recreational opportunities and how these changes could positively impact local identity.

Finally, we compared expert and public perceptions of how varying land-uses impact ecosystem service provision. To do this, we provided respondents with the land-use panel that depicted four common local land-use types to support their comprehension of each land-use, in addition to the ecosystem service resource panel. Here, the results show that expert and public stakeholders hold largely matching perceptions. Across all four land-uses, we found that expert and public perceptions matched for nearly three-quarters of the individual ecosystem services assessed. More specifically, we found that both groups expected urban development to have a predominantly negative impact on ecosystem services, agricultural land and rangeland to deliver trade-offs in ecosystem service delivery, and natural forests to have a predominantly positive impact on ecosystem services. These findings may provide practical insights for local policymakers. For example, the shared expectation among both groups that urban development would

negatively impact ecosystem services highlights a potential area of widespread local concern, particularly with projects like the Northgate development. This suggests there may be significant local interest in implementing measures to mitigate potential impacts.

Methodological considerations

The primary aim of this study was to develop a methodology for the social assessment of ecosystem services that addresses common methodological challenges identified in the literature. Additionally, we aimed to demonstrate how social assessments can facilitate the comparison of stakeholder perspectives across various dimensions of ecosystem services, thereby enhancing their applicability to sustainable and socially feasible decision-making processes. By presenting this methodology, we seek to reduce the excessive methodological pluralism in the field and promote the identification of broader trends among studies that adopt consistent approaches.

In considering the application of this methodology to other place-based contexts, several key factors should be evaluated. First, given the inherently contextual nature of place-based research, studies should carefully select the specific ecosystem services to be analyzed. The 11 services we assessed should not be treated as a default set; instead, they should reflect the principal ecosystem services present in the specific study region. In our case, these services were identified based on a prior biophysical assessment of the watershed. Where such assessments are unavailable, researchers may need to conduct biophysical evaluations to gain an adequate understanding of the ecosystem services relevant to the particular context. Similarly, our analysis focused on comparing perspectives from expert and public stakeholder groups. However, future studies may

involve different stakeholder groups, selected based on their relevance and contributions to socio-ecological decision-making in the specific study context. A wealth of environmental policy literature provides best practices for stakeholder analysis, which can guide the identification and inclusion of relevant groups (Colvin et al. 2016; Vogler et al. 2017; Lovrić 2019; Ihlo et al. [date unknown]). Importantly, our study was limited by the underrepresentation of the Shoshone-Bannock tribe, whose reservation lies within the study area. As a federally recognized sovereign nation located on the Fort Hall Reservation in southeastern Idaho, the Shoshone-Bannock tribe possesses invaluable traditional ecological knowledge. Indigenous populations in the United States, including the Shoshone-Bannock, are disproportionately affected by climate change and often excluded from environmental management and preservation discussions. Recognizing Indigenous communities as critical and impacted stakeholders is essential. While our opportunistic sampling strategy allowed for some representation of Indigenous voices in the public sample, future research should more intentionally engage with and incorporate Indigenous expertise in expert stakeholder analyses. Additionally, we did not collect detailed information about the specific identities or expertise levels of public participants (e.g. farmers, ranchers, etc.) regarding ecosystem services and their management. Future studies could benefit from investigating these factors. Specifically, examining intra-group variation within stakeholder categories may help identify whether certain sub-groups are disproportionately influencing observed matches or mismatches between stakeholders. Finally, research should consider how the interpretation of case-study findings can contribute to interconnected networks of place-based socio-ecological research. By

synthesizing insights across diverse contexts, these networks can inform the design of more comprehensive strategies to address complex environmental challenges (Balvanera et al. 2017). Our case study findings, for example, may be most applicable to other regions facing similar socio-ecological issues. Many of the challenges present in the Portneuf River Watershed, such as land-use change (Narducci et al. 2019) and issues related to water quantity and quality, are prevalent throughout the western US (Sabo et al. 2010). However, the spatial and temporal patterns of urbanization in small and mid-sized cities in Idaho are closely tied to their proximity to larger metropolitan areas, with urbanization rates increasing nearer to large cities (Felt et al. 2018). Given the location of our study site near the rapidly growing metropolitan areas of Boise and Salt Lake City, our findings may be particularly transferable to regions similarly positioned at moderate distances from major cities.

Conclusion

The findings of this study highlight the value of social assessments in examining multiple dimensions of ecosystem services while facilitating comparative stakeholder analysis. By identifying matches and mismatches in stakeholder perceptions, social assessments emerge as a powerful tool for generating ecosystem service knowledge that is directly applicable to socio-ecological management. The results highlight that while experts and the public share several priorities, significant mismatches – particularly in recognizing regulating services – may arise from differences in demographic characteristics, knowledge types, and contextual experiences. Similarly, mismatches in perceptions of ecosystem service have changed over the last decade, with the public reporting more

negative changes in recreation, local identity, and water quality likely reflect varying concerns shaped by environmental flooding legacies.

This study contributes a robust approach to social assessment that avoids the key methodological pitfalls identified in the literature. It demonstrates that social assessments can extend beyond cultural services to include regulating and provisioning services. Additionally, by utilizing survey tools that incorporate photo-elicitation techniques, the study underscores the value of visual aids in simplifying complex socio-ecological processes and reducing barriers to accurate reporting on ecosystem services, particularly for individuals less familiar with technical ecosystem service terminology. Furthermore, the study highlights the importance of tailoring social assessments to specific regional and stakeholder contexts to enhance the transferability of insights and better inform sustainable management practices in diverse socio-ecological systems.

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APPENDIX

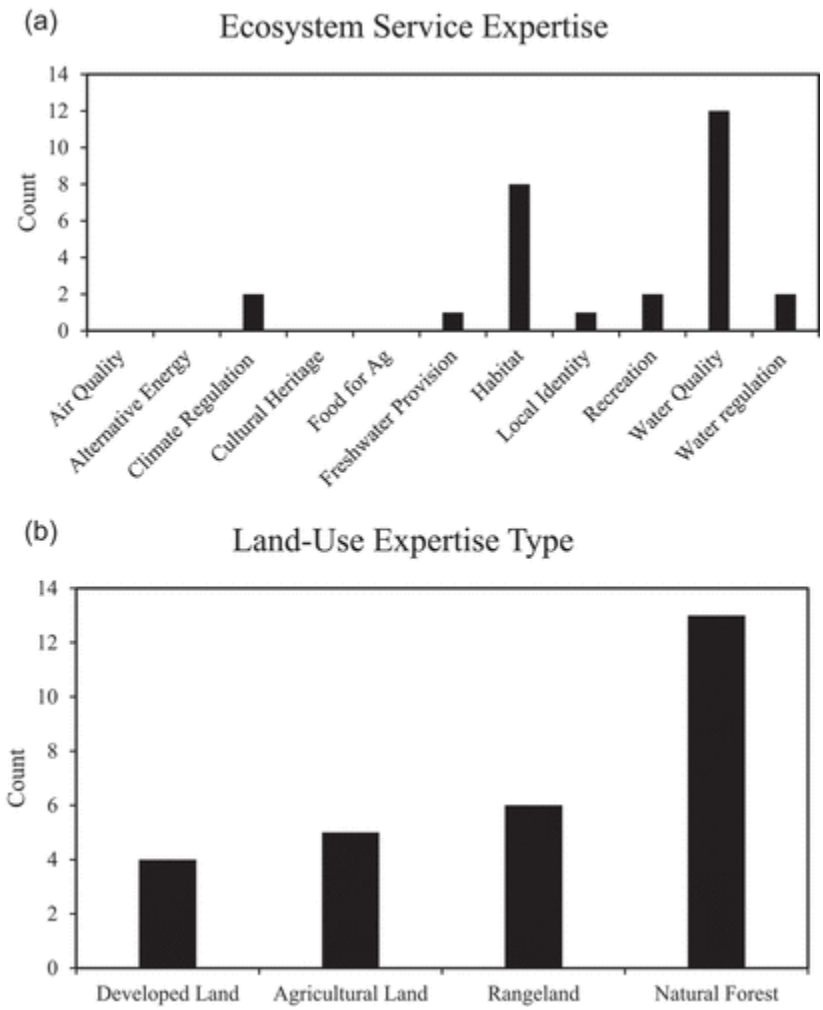


Figure 1. (a) Describes ecosystem service expertise as self-reported by the expert stakeholders. (b) Describes land-use type expertise as self-reported by the expert stakeholders.

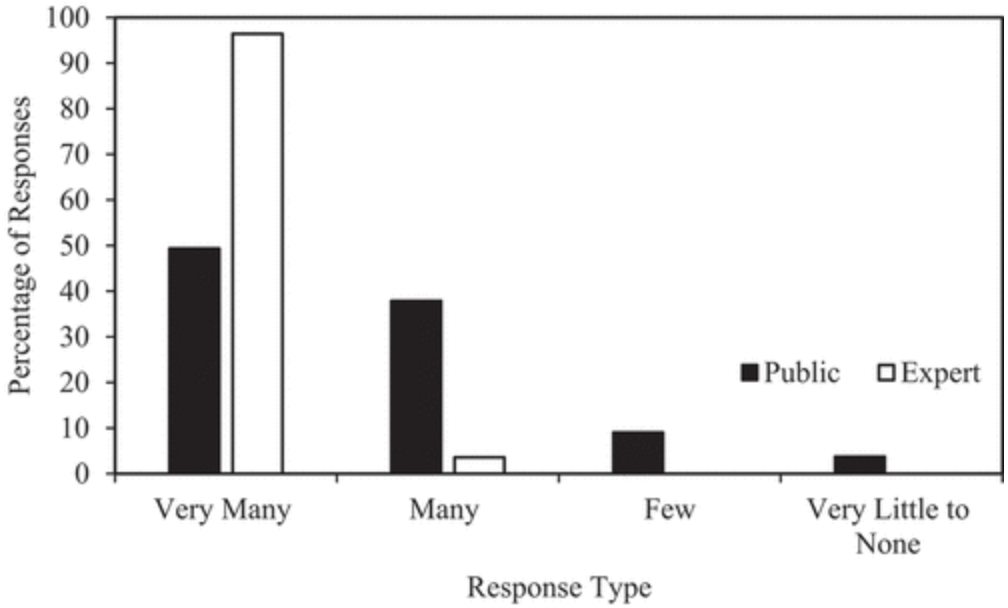


Figure 2. Percentage of respondents in each response category to the question 'do you think ecosystem services in the Portneuf River watershed provide contributions to human wellbeing in the region?' in both the public and expert groups. Public sample n = 451, expert sample n = 28.

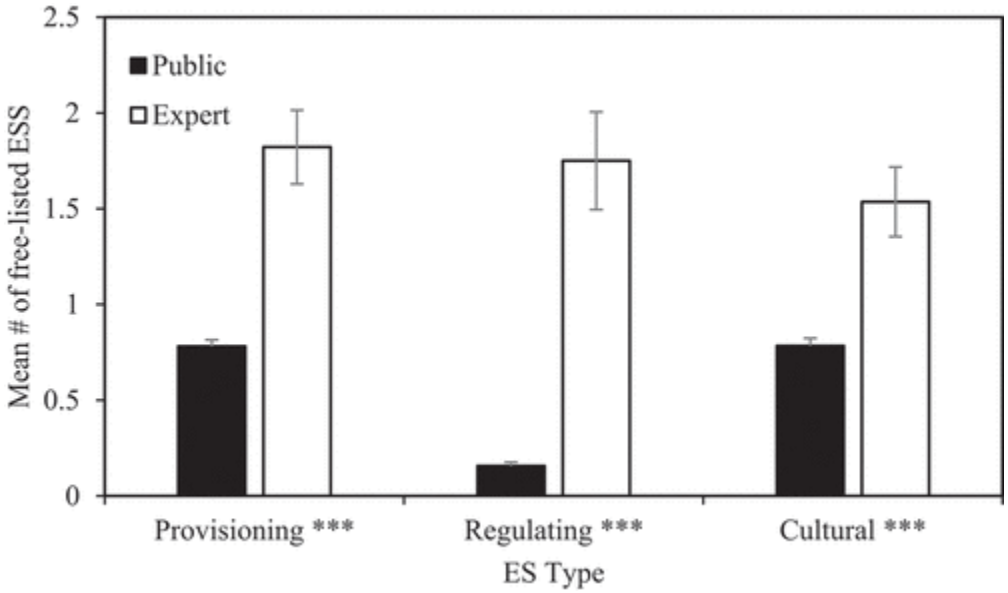


Figure 3. Mean number of free-listed ecosystem services per respondent, categorized into provisioning, regulating and cultural services. Public n = 1413 and expert n = 84. Wilcoxon rank-sum test was used to calculate statistical significance levels *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

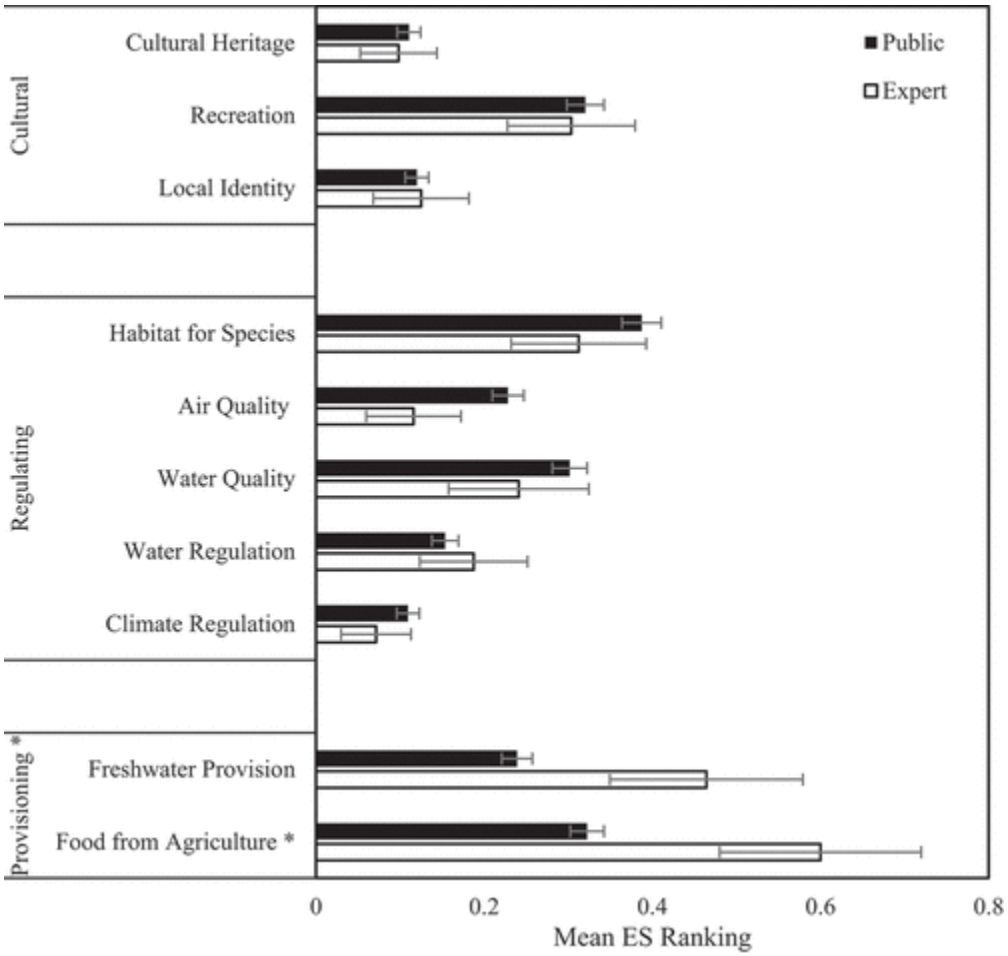


Figure 4. Mean perceived ecosystem service importance ranking for both public and expert groups, where the highest possible ranking is 4.0 and the lowest is 0.0. Each individual only ranks four of the 11 ecosystem services; the remaining seven ecosystem services are then ranked as zero. Public n = 1884, expert n = 112. Wilcoxon rank-sum test was used to calculate statistical significance levels * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

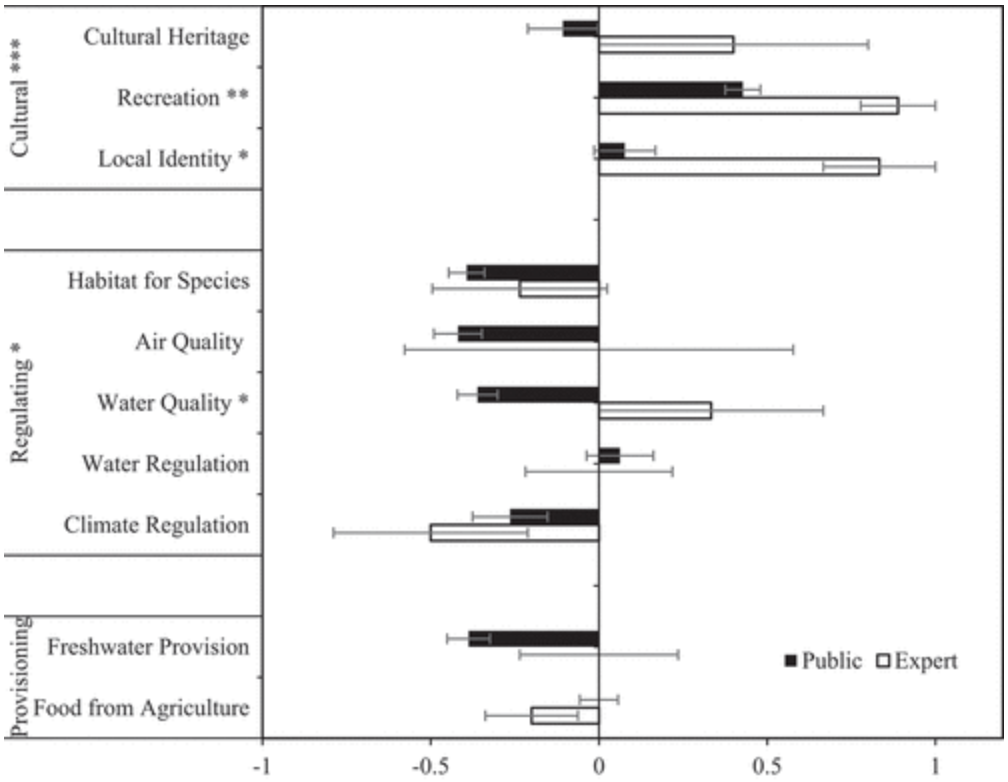


Figure 5. Mean perceived change in the provision of each ecosystem service over the last 10 years. Maximum possible increase = +1 and maximum possible decrease = −1. Public n = 1308 and expert n = 105. Wilcoxon rank-sum test was used to calculate statistical significance levels *p < 0.05, **p < 0.01, ***p < 0.001.

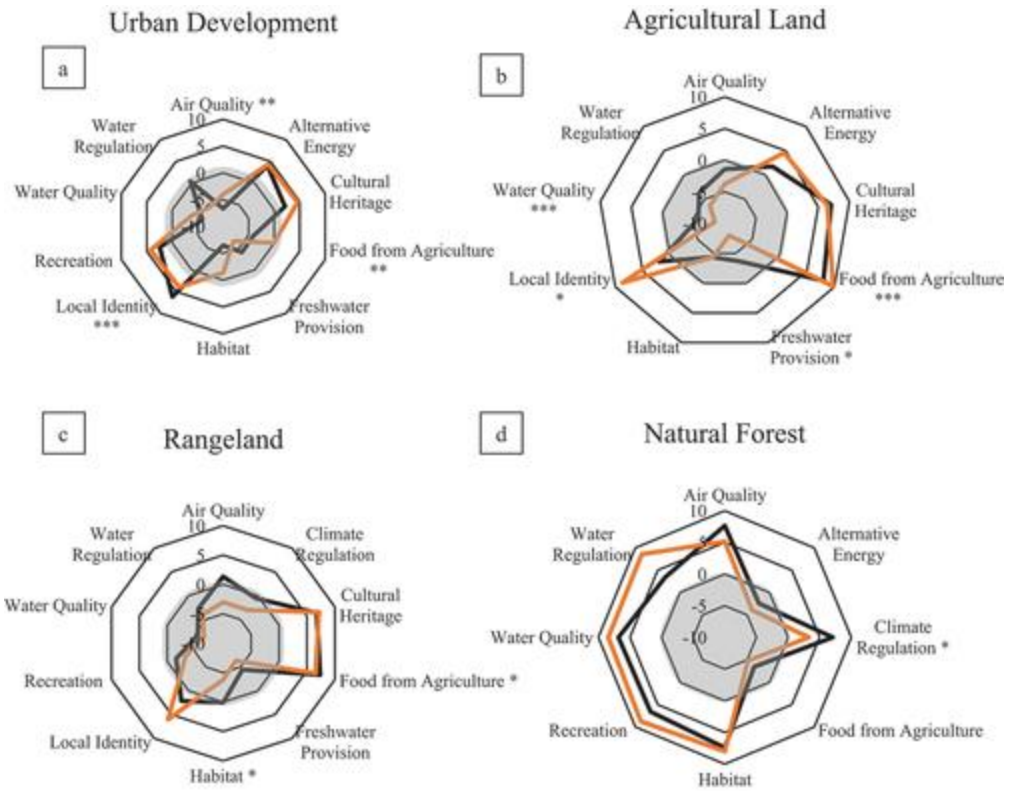


Figure 6. Mean perceived impacts on ecosystem services from four land-use types, (a) Urban development, (b) Agricultural land, (c) Rangeland and (d) Natural forest. Black solid line describes the public group and the solid orange line describes the expert group. Wilcoxon rank-sum test was used to calculate statistical significance levels *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

CHAPTER II

SOCIAL ASSESSMENT OF ECOSYSTEM SERVICES: THE ROLE OF VALUES IN PREFERENCE FORMATION

Authorship Statement

A version of this paper has been submitted to the Journal *AMBIO* and is currently awaiting an initial decision. Authors are:

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2. Rachel McGovern. University of Tennessee, U.S.A. Department of Political Science
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Rachel McGovern contributed to the conceptual basis of the research and contributed to the review of literature. Rebecca Burgee contributed to the data analysis and visualization.

Abstract

Alongside established biophysical and economic approaches, social approaches are increasingly used to study ecosystem services. These social assessments primarily focus on investigating people's preferences for ecosystem services, providing insights into social priorities. However, this emerging approach has been criticized for its limited examination of preferences—revealing what people value but not why they value it. To address this limitation, we adopt an interdisciplinary perspective, integrating an established economic model of preference formation with psychological insights to examine how core human values relate to ecosystem service preferences. Using a U.S. national survey (N=790), we identify a theoretically grounded relationship between values and ecosystem service preferences. By linking values to preference formation, this study strengthens the conceptual foundation of social assessments and enhances their applicability for socio-ecological management. Additionally, our findings challenge

conventional social assessment practices, particularly the reliance on biophysical landscape characteristics to contextualize preferences.

Introduction

Ecosystem service assessments, which seek to inform socio-ecological management, can be categorized into three approaches: (i) biophysical assessments, which map and model ecological functions in relation to the services they provide (Harrison et al., 2018; Tiemann & Ring, 2022); (ii) economic assessments, which estimate the monetary value of these services (Bateman et al., 2014; Häyhä & Franzese, 2014); and (iii) social assessments, which explore the human, social valuation of ecosystem services (Bidegain et al., 2020; Felipe-Lucia et al., 2015). Of these three approaches, biophysical and economic assessments are the most established and widely applied, whereas social assessments are still emerging, gaining traction in response to calls for more socially oriented ecosystem service research (Felipe-Lucia et al., 2015). Despite their relative infancy, social assessments have shown significant promise in capturing how people perceive and relate to ecosystem services, helping to align management strategies more effectively with social priorities (Meli et al., 2023).

Since their inception, social assessments have primarily explored the social valuation of ecosystem service through the lens of preferences. By examining preferences—as the extent to which certain services are valued over others—these assessments aim to communicate insights into how individuals, communities, and stakeholders, recognize and prioritize ecosystem services (Bernués et al., 2019; Castro et al., 2011; Martín-López et al., 2012). Applied to specific case study contexts, social assessments often present the ranking of ecosystem services based on their perceived contributions to human well-being, highlighting preferences both among individual services (e.g., climate regulation,

freshwater provision, and recreation) and across broader service categories (e.g., provisioning, regulating, and cultural services). Fundamentally, these case studies operate under the assumption that their findings can: (1) Inform socially responsive local management (Felipe-Lucia et al., 2015); and (2) contribute generalizable and transferable inferences to a wider network of interconnected place-based socio-ecological research (Balvanera et al., 2017).

However, critics argue that social assessments are struggling to meaningfully deliver on these objectives, primarily due to how they examine preferences. Preferences, as they are currently operationalized, provide only partial insights into social valuation—revealing what people value but not why they value it (Schmitt et al., 2021). As Schutter et al., (2021) observe, current social approaches "provide information about the intensity of preferring one ecosystem service over another, [but] they do not provide information about the reasons for these preferences," suggesting that preferences are "reason-blind" (Schutter et al., 2021, p. 4). And that without an understanding of the reasons (or the why) behind people's preferences, preferences alone cannot support the stated research objectives. Promisingly, however, adjacent literature demonstrates that preferences are not inherently reason blind (Angner, 2018; Hausman, 2011b); suggesting Schutter et al., (2021) critique is not fundamentally with preferences themselves but with how they have been operationalized within the social assessment literature. When analyzed from a different perspective, preferences can be better understood and effectively leveraged to achieve the stated objectives.

Despite Schutter et al., (2021) critique, most social assessments fail to explicitly define preferences nor offer much theoretical engagement with how they are formed or the rationale behind preference-based research. Though, based on their broad operationalization, we can infer that preferences are generally understood in social assessments as judgments about the degree to which certain services are valued over others. This conceptualization appears to closely align with an economic perspective, particularly as they treat preferences as comparative judgments of value (Angner, 2018). This is not surprising given the prominence of economic assessments in ecosystem service research and the spillover of economic valuation methods into studies that claim to present as a social assessment (Felipe-Lucia et al., 2015). This borrowed conceptualization of preferences from economics is not necessarily problematic on its own, but it becomes an issue in practice when concepts are applied with incomplete or inadequate accounting for what they constitute.

In economics, preference formation, which is described by Hausman's model (Hausman, 2011b), is widely understood as a process of "subjective comparative evaluations" (Angner, 2018, p. 660), which can either be partial or total. A partial evaluation reflects a judgment that x is better than y in a specific respect (Angner, 2018). Applied to social assessment, a partial evaluation could reveal, for example, an individual's preference for a regulating service over a provisioning service, specifically when considering their respective roles in providing protection against extreme weather events. However, in another partial evaluation, the same individual may prefer the provisioning service over the regulating service, in a separate respect, such as when considering food security.

Whereas, a total evaluation reflects the judgment that x is better than y all things considered—reflecting a combined deliberation among all partial evaluations (alongside other considerations), into a single, total evaluative preference **(Figure 7)**. The other considerations in this process reflect not specific criteria from which x can be comparatively evaluated against y, but rather factors that individuals bring to that deliberative process, such as contextual factors, affective responses, cognitive biases, and social influences (Angner, 2018). Thus, as Hausman (2011b) contends, total evaluations reflect the cognitive processing of the myriad of possible partial evaluations, alongside these other considerations, to arrive at a final preference. In social assessments, a total evaluation could, for instance, reveal an individual's overall, total preference for regulating services over provisioning services with respect to broadly supporting human-wellbeing.

Reconciling Hausman's model of preference formation with current approaches in social assessment research reveals that social assessments capture preferences at the point of total evaluation. For instance, studies most often challenge respondents to rank ecosystem services based on their overall contributions to human well-being (Castro et al., 2016; García-Llorente et al., 2020), requiring them to make a single, total judgment. Though Hausman's model suggests that these total evaluations are based on the sum of partial evaluation, alongside other considerations, these factors remain unexamined within the current social assessment approach. Thus, the lack of conceptual clarity in social assessments about what preferences are and how they should be evaluated likely underpins Schutter et al., (2021) critique that these assessments treat preferences as

"reason-blind," with the “reasons” being the unexamined partial evaluations and other considerations that contribute to total evaluations. In other words, while total evaluations provide a simple and efficient way to compare ecosystem services, their reliance on holistic judgments often obscures the deeper social and cognitive processes that shape preferences.

Based on Hausman’s conceptualization of preference formation, it is possible to consider how social assessments may differently examine preferences to gain an improved comprehension of their social foundations. Conceptually, the best approach would appear to be an examination of preferences at the level of partial evaluation. However, given the practical constraints of social assessment research, which often includes the assessment of many of ecosystem services using survey methods (Felipe-Lucia et al., 2015), it quickly becomes unfeasible to examine more than just a few partial evaluations. Instead, a more practically feasible alternative is to explore the other considerations, as conceptualized in Hausman’s model. Since these other considerations are not linked to any specific criteria for comparing one service to another, they can be assessed alongside the total evaluation, thereby offering an interpretive social lens.

In this regard, one promising candidate is the assessment of people’s core values. Building from the related work of Schutter et al., (2021), the rationale for focusing on values stems from what we already know about the nature of preferences. Preferences are not fixed; rather, they are shaped by an individual’s goals, cognitive constraints, and prior experiences and are often constructed at the moment of choice (Warren et al., 2011). They also shift over time in response to changing conditions (Nohrstedt et al., 2023) and

can be intransitive, particularly in complex decision-making environments where competing priorities create inconsistencies (Herweg, 2023). Values, on the other hand, offer a more stable foundation. They (1) are known to influence both preferences and behavior (Manfredo et al., 2021) and (2) function as deeply held beliefs about desirable end states or behaviors that transcend specific situations, guiding decision-making and shaping what people consider important in life (S. H. Schwartz, 2012; S. H. Schwartz & Cieciuch, 2022). Given these characteristics, we suggest values operate as other considerations within Hausman's model.

Indeed, Schutter et al., (2021) foundational work has established initial links between values and ecosystem service preferences. However, these links have not been examined within the framing of Hausman's model of preference formation, nor across diverse socio-ecological contexts. To address this gap, this study presents a U.S. national survey, which identifies significant relationships between people's values and their ecosystem service preferences. Using Schwartz theory of basic human values, we model the relationship between four high-order value dimensions (self-transcendence, self-enhancement, openness to change, and conservation) and 17 prominent ecosystem services, grouped into categorizes of provisioning, regulating, and cultural services. Our findings reveal how Schwartz's theorized structure of value relations, which describes the level of congruency among values, explains part of the formation of ecosystem service preferences. Our novel approach challenges an implicit assumption of social assessment research; that biophysical characteristics of a study region are the primary determinants of people's ecosystem service preferences. Finally, we outline how are findings support

the goals of social assessment, specifically in supporting socio-ecological management and in contributing generalizable findings to a network of place-based research.

Theoretical Framework: Schwartz Theory of Basic Human Values

Schwartz's Theory of Basic Human Values is a framework in psychology that describes the universal values that guide human behavior across cultures (S. H. Schwartz, 2012; S. H. Schwartz & Cieciuch, 2022). The theory has gained widespread recognition across disciplines for its ability to elucidate human decision-making processes (Fritzsche & Oz, 2007; Primc et al., 2021; Shaw et al., 2005). It identifies ten fundamental values that individuals prioritize to varying degrees, reflecting their deeply held principles about what is important in life (S. H. Schwartz, 2012). Schwartz's theory contends that values are intrinsically linked to emotions, informing actions and decisions in pursuit of goals that align with core beliefs (Sagiv & Schwartz, 2022). Through the lens of values, individuals evaluate both their own choices and those of others, with values extending beyond specific contexts. In essence, values shape our sense of what is desirable, good, or bad, establishing standards that guide how we navigate the world. The central assumption of the theory is that while all individuals hold multiple values, their relative importance differs from person to person. Thus, a value that is central to one individual may be less significant to another, highlighting the diversity in human priorities. In understanding the dynamics of multiple values, Schwartz's theory presents a structure of value relations **(Figure 8)**.

Schwartz's theory organizes the ten basic values into four higher-order constructs—self-transcendence, self-enhancement, openness to change, and conservation—which are

arranged in a circular structure. This structure reflects the relationships among values, showing areas of congruence and conflict in their underpinning motivations (S. H. Schwartz, 2012). Values positioned close together – congruence – share compatible motivations (e.g., self-transcendence and openness to change), whereas those further apart – conflict – represent conflicting motivations (e.g., self-transcendence and self-enhancement).

The four higher-order constructs and their associated values are:

1. Self-Transcendence prioritizes concern for others and the greater good. It includes universalism, which reflects appreciation for diversity, social justice, and environmental protection, and benevolence, which emphasizes concern for close relationships, kindness, and loyalty.
2. Conservation emphasizes stability, order, and respect for tradition. It includes security, which values safety, harmony, and social stability; conformity, which involves adherence to norms and social expectations; and tradition, which represents respect for customs, religion, and cultural heritage.
3. Self-Enhancement focuses on personal success, status, and control over resources. It includes power, which reflects a desire for authority, influence, and wealth, and achievement, which emphasizes success, competence, and social recognition.
4. Openness to Change encourages independence, creativity, and novelty-seeking. It includes self-direction, which values autonomy, curiosity, and

innovation, and stimulation, which reflects a pursuit of excitement, adventure, and new experiences.

Values and Preference Formation in Socio-Ecological Research

Value concepts have been widely applied in and valuable in environmental research as it has shown to aid in our understanding of how values influence attitudes toward nature, resource use, and policy preferences. Studies on climate change (Jones, 2011; McNeeley & Lazrus, 2014; O'Riordan & Jordan, 1999), environmental management (Billgren & Holmén, 2008; Buck, 1988), and sustainable development (Nedelko & Potocan, 2021; Sarid & Goldman, 2021; Shepherd et al., 2009), demonstrate that values influence risk perception, policy evaluation, and decision-making about environmental challenges (Ihemezie et al., 2021; Steynor et al., 2021). Research further suggests that value orientations correlate with environmental concern and behavior. Self-transcendence values (understood as universalism, benevolence), for example, are linked to greater environmental concern and pro-environmental actions, whereas self-enhancement values (understood as power, achievement) tend to correlate with lower environmental concern and a decrease in likelihood for an individual to engage with environmental actions (Primc et al., 2021).

Recognizing this, Schutter et al. (2021) were the first to propose that incorporating an examination of values could enhance the social valuation of ecosystem services. Their study conducted in the Seychelles, examine the relationships between people's values and their preferences for marine ecosystem services. Using a mixed-method approach, their study sought to examine the extent to people's values were expressed in their preferences,

seeking to disentangle the relationship between values and preferences. Broadly, the study found that respondents, who came from a relatively homogeneous cultural community, held low self-enhancement values and high self-transcendence and conservatism values. When asked to explain why they prioritized certain ecosystem services, respondents connected their preferences to these core values without being prompted about values explicitly. This suggests that preferences are not standalone choices but, indeed, are in fact influenced by value orientations. Based off these findings, the authors argue that by understanding the relationship between values and preferences, decision-makers are afforded a greater depth of insight regarding the reasons people have for holding certain preferences over other. Specifically, the authors contend that by incorporating value structures, decision-makers can design governance strategies that are more socially legitimate, culturally grounded, and less likely to face sociocultural opposition, resulting in more stable and effective socio-ecological management.

While Schutter et al. (2021) establish the initial links between values and ecosystem service preferences, their work stops short of explicitly addressing the role of values in preference formation. Instead, they treat preferences and values as separate, independent constructs, rather than situating them within an interconnected framework of preference formation. To address this gap, we draw on Hausman's (2011b) economic model of preference formation, which conceptualizes preferences as comparative evaluations that integrate multiple considerations. Hausman distinguishes between partial evaluations—judgments about specific evaluations—and total evaluations, which aggregate these judgments alongside other heuristic considerations. In this study, we propose that values

function as one such category of other considerations within Hausman's model, shaping how individuals weigh and integrate their partial evaluations. Importantly, we do not suggest that values are the sole other considerations in this process, as human decision-making is inherently complex. However, consistent with Schwartz's framework, which identifies values as foundational drivers of human behavior, we emphasize their central role in structuring preference evaluations.

Therefore, we broadly hypothesize a relationship between values, as described by Schwartz's theory of basic human values, and ecosystem service preferences. Specifically, we hypothesize that values will relate to preferences in a manner consistent with Schwartz's theorized structure of value relations:

1. H1: There is a relationship between values, as defined by Schwartz's theory of basic human values, and ecosystem service preferences.
2. H2: The relationship between values and ecosystem service preferences will align with Schwartz's theorized structure of value relations, where values that are theoretically compatible will be associated with similar preferences, while conflicting values will show opposing associations with preferences.

Methods

Survey development

To investigate the relationship between ecosystem service preferences and values, we designed a survey tool that integrates a social assessment of ecosystem service preferences with the Portrait Values Questionnaire (PVQ), a widely-used instrument for operationalizing Schwartz's theory of basic values (S. H. Schwartz & Cieciuch, 2022).

The survey assessed preferences for 17 ecosystem services identified as critical global contributors to human well-being, as emphasized in the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) 2019 Global Assessment Report (IPBES, 2019). These ecosystem service preferences were categorized into three sub-scales—regulating, provisioning, and cultural services. Preferences were measured by asking respondents to rate each ecosystem service on a 7-point Likert scale, with 1 representing "Not at all important" and 7 representing "Extremely important," based on the service's perceived contribution to human well-being.

Values were measured using the PVQ, developed by Schwartz et al., (2012). The PVQ was selected for its robust validation across a wide range of cultural contexts (Sagiv & Schwartz, 2022). This questionnaire consists of 57 statements that capture individuals' core life values, categorized into four higher-order dimensions: self-transcendence, self-enhancement, openness to change, and conservation. Respondents rated each statement on a 6-point Likert scale, where 1 represented "Not like me at all" and 6 represented "Very much like me." Subscales for each of the four high order value dimensions were scored by averaging responses to statements, as consistent with the PVQ protocol (S. Schwartz, 2016). Ecosystem service preferences and the four high-order value dimensions were scored by averaging responses to statements. All scales were tested for internal reliability using Cronbach's alpha coefficient, which measures the consistency of a set of survey items by quantifying the level of agreement on a standardized 0 to 1 scale.

A high Cronbach's alpha coefficient ($\alpha > 0.80$) indicates high agreement between survey items.

The survey also collected demographic information, including respondents' age (in years), length of current residence (in years), household income, highest level of education completed, gender, ethnicity (following U.S. Census categories), and zip code. Additionally, using respondents' zip codes, we categorized them by their ecological region of residence, referred to as "ecoregion." Ecoregions were defined according to the United States Environmental Protection Agency's Level 1 Ecoregion Map of North America (EPA, 2024), which groups regions based on shared ecological characteristics.

Data collection and analysis

A cross-sectional study design was employed, with data collected via an online survey hosted on the Qualtrics platform and drawing from the Qualtrics participant pool. Eligible participants were English-speaking individuals aged 18 or older, residing in the contiguous United States. A total of 790 respondents completed the survey, which took approximately 15 minutes to finish.

To examine the relationship between ecosystem service preferences and values, both simple and stepwise regression analyses were conducted. The ecosystem service preference subscales—regulating, provisioning, and cultural services—were used as dependent variables, while the four higher-order dimensions (self-transcendence, self-enhancement, openness to change, and conservation) and demographic variables served as independent variables. Simple regression models were used to predict each ecosystem service preference subscale based on individual dimensions. For the stepwise regression

models, inclusion and exclusion thresholds were set at $p < 0.05$ and $p > 0.10$, respectively.

Descriptive statistics were calculated for the individual ecosystem service preference statements, four higher-order dimensions, and ecosystem service preference subscales by ecoregion. A one-way analysis of variance (ANOVA) was used to evaluate differences in ecosystem service preference scales by ecoregions. Tukey's honestly significant difference adjustment was applied to post hoc tests. Data were evaluated for normality and equality of variance using the Shapiro-Wilk and Levene's equality of variance tests. All statistical assumptions were met for all models and analyzed using IBM SPSS (Version 29).

Results

Around half of respondents (56.5%) had an annual income less than $49,999, the majority had a high school diploma or GED (29.7%), the majority were female (68.4%), the majority were white (77.5%), and the majority fell into the eastern temperate forest ecoregion (64.7%). The average age of respondents was 53 years, and the average length of current residency was 32 years. **Table 3** further describes the demographic characteristics of the sample.

Ecosystem service preference scale and subscales were found to have good internal reliability (Cronbach's α: ecosystem service preferences = .952, regulating = .946, provisioning = .861, cultural = .814). Of the 17 ecosystem services examined, Food and Feed was scored on average as the most important, while Supporting Identities was scored on average as the least important, as shown in **Table 4**.

The four higher-order dimensions were found to have good internal reliability (Cronbach's α: self-transcendence = .905, self-enhancement = .862, openness to change = .854, conservation = .894). Of the four higher-order dimensions of Schwartz's theory of basic values, respondents reported the highest average score for self-transcendence and the lowest average score for self-enhancement, as shown in **Table 5**.

The results of the simple linear regression models found in **Figure 9** indicate that self-transcendence, openness to change, and conservation are positively associated with and consistently explain variation in each ecosystem service preference subscale, whereas self-enhancement has weak associations with little variation explained for the subscales. Upon testing all independent variables through stepwise regression, it was found that self-transcendence consistently maintained its significant positive association with each ecosystem service preference scale and subscales in the presence of other variables (see **Table 6**; Eqs. (1) to (4)). On the other hand, self-enhancement shows a negative association with ecosystem service preferences and regulating services in the presence of self-transcendence and openness to change (Eqs. (1), (2)). Openness to change maintained a positive association with ecosystem service preferences, provisioning, and cultural ser-vices in the presence of other independent variables (Eqs. (1), (3), (4)). Gender was the only demographic that showed an effect on cultural services; identifying more with male than female has a negative association with cultural services (Eq. (4)). Results of the one-way ANOVA found no differences in the ecosystem service preference scale and subscales between ecoregions. Ecosystem service preferences, regulating, and provisioning services had the highest average score for participants in the

marine west coast forest, while cultural services had the highest average score among participants from the great plains. Ecosystem service preferences, regulating, provisioning, and cultural services had the lowest average score among participants from the northern American deserts, northern forests, Mediterranean California, and northwestern forested mountains, respectively.

Discussion

In addition to established biophysical and economic approaches, social approaches are increasingly being utilized to study ecosystem services (Felipe-Lucia et al., 2015). These social assessments primarily focus on understanding ecosystem services through the lens of people's preferences, capturing the degree to which certain services are favored over others (Bernués et al., 2019; Castro et al., 2016; Martín-López et al., 2012). Despite initial promise, this approach has faced criticism. The primary critique is that social assessment research is "reason-blind," suggesting that while preferences reveal what ecosystem services are valued, they fail to explain why they are valued (Schutter et al., 2021). This critique extends that the current application of the social approach is too limited to effectively support the primary goals of social assessment—namely, informing local decision-making and generating generalizable insights for a broader network of place-based socio-ecological research. However, an established model of preference formation demonstrates that preferences are not inherently "reason-blind" when examined through a more conceptually and theoretically rigorous lens (Angner, 2018). Specifically, when considering Hausman's economic model of preference formation, we see that social assessments measure preferences as total subjective comparative evaluations—omitting

any deeper investigation into the additional ‘partial’ or ‘other considerations’ in the involved in preference formation. We argue that this limited examination of preferences gives rise to Schutter et al.’s (2021) "reason-blind" critique.

To address this limitation, this study explores ways to improve the effectiveness of social assessments in examining preferences. We recognize that the practical constraints of social assessment research—particularly the need to evaluate multiple ecosystem services—make it impractical to analyze every partial evaluation contributing to preference formation. However, building on Schutter et al.’s (2021) argument, we investigate how human core values, conceptualized as other considerations within Hausman’s model, can provide deeper insights into preference formation. Drawing from Schwartz’s theory of basic human values, which posits that values serve as stable and guiding principles in decision-making, we hypothesized that relate to the formation of ecosystem service preferences. Specifically, based on Schwartz’s theorized structure of value relations, we anticipate a corresponding structured relationship between values and ecosystem service preferences. To test this hypothesis, we conducted a U.S. national survey examining the relationship between the four higher-order value constructs—self-transcendence, self-enhancement, openness to change, and conservation—and preferences for 17 ecosystem services, categorized into regulating, provisioning, and cultural services.

Overall, our findings support the general hypothesis by identifying several relationships between values and ecosystem service preferences. Individuals who prioritized self-transcendence values—characterized by universalism and benevolence—tended to assign

high importance to regulating, provisioning, and cultural services, with the strongest preference for regulating services. Those who prioritized openness to change values—associated with self-direction and stimulation—favored provisioning and cultural services, particularly demonstrating a strong preference for cultural services. Conversely, individuals who prioritized self-enhancement values—defined by power and achievement—were less likely to prioritize regulating services. However, contrary to our hypothesis, we found no significant relationship between conservation values—characterized by security, conformity, and tradition—and any ecosystem service preference.

Beyond the general relationship hypothesis, we also hypothesized that values would relate to preferences in a manner consistent with Schwartz's structure of value relations. Specifically, we expected individuals with analogous values (e.g., self-transcendence and openness to change) to exhibit congruent preferences, while those with opposing values (e.g., self-transcendence and self-enhancement) would demonstrate contrasting preferences. Our findings largely support this hypothesis. For the opposing values of self-transcendence and self-enhancement, we observed contrasting preferences for regulating services. Individuals who prioritized self-transcendence values were more likely to assign high importance to regulating services, whereas those who prioritized self-enhancement values were less likely to do so. This finding aligns with Schwartz's theoretical framework. Self-transcendent values—such as universalism and benevolence—reflect a commitment to collective well-being and societal interests. Regulating services, such as climate and soil regulation, provide broad community benefits, making them more

appealing to individuals with a self-transcendent orientation. Conversely, individuals who emphasize self-enhancement values—centered on power and achievement—may perceive regulating services as less personally relevant, instead favoring provisioning services due to their direct and tangible benefits. Additionally, we identified two analogous value relationships consistent with Schwartz's theory. Individuals who prioritized both self-transcendence and openness to change consistently demonstrated strong preferences for provisioning and cultural services.

However, Schwartz's theorized structure of value relations does not fully explain all our findings. Not all opposing value orientations corresponded with opposing preferences, nor did all congruent value orientations align with congruent preferences. Nonetheless, we found no cases that directly contradicted our hypothesis—there were no instances where an opposing value orientation was linked to congruent preferences or vice versa. These results suggest that preferences can be partially understood through the lens of values, reinforcing our conceptualization of values as other considerations within Hausman's model of preference formation. Though, as other considerations that influence the sum of partial evaluations in forming total evaluations, values alone were unlikely to account for all observed variation. However, given the practical challenges of directly assessing partial evaluations in social assessment research, values offer a viable alternative. Unlike partial evaluations, values can be efficiently measured using well-established methods, such as the Portrait Value Questionnaire employed in this study. This tool, widely applied across disciplines, benefits from a strong theoretical foundation and has demonstrated validity in diverse cultural contexts (Sagiv & Schwartz, 2022).

While this study primarily highlights the utility of values, it also contributes to the broader discussion on best practices in social assessment research. To date, most social assessments interpret preferences through ad-hoc references to the biophysical characteristics of the study region, often linking them to prominent environmental challenges (Castro et al., 2014, 2016; Quintas-Soriano et al., 2018; Schmidt et al., 2016). For example, in a social assessment of a watershed in the south-central United States, Castro et al. (2016) argue that preferences for the service of 'water regulation' can be attributed to the variable water regime of the Kiamichi River, emphasizing the region's historical experiences with drought. This approach has some merit. In reference to Hausman's model of preference formation, it begins to incorporate partial evaluations—acknowledging that one service may be valued over another in response to specific environmental challenges. However, as we argue in this study, this approach is inherently incomplete. While some partial evaluations may be examined, the vast number of potential partial evaluations complicates the ability to draw meaningful inferences. Moreover, because these ad-hoc justifications are not explicitly tested within the assessments themselves, the conclusions drawn often rely on broader contextual interpretations rather than direct insights from the surveyed individuals. This limitation suggests that the reasoning behind preference formation is externally imposed rather than emerging from the respondents themselves. As a result, contextualization may be less compelling and risk overlooking valuable insights that could be gained by analyzing the demographics or characteristics of the surveyed population where these preferences manifest. Thus, while practical, this ad-hoc approach presents an inherent risk of

oversimplifying preference formation by implying a singular causal pathway—an assumption rarely supported in economics or social science (Hausman, 2011a; List, 2009).

In this regard, social assessments have arguably operated under an implicit theoretical assumption that the biophysical characteristics of a study region are the primary drivers of people's ecosystem service preferences. However, our study challenges this assumption with an additional, surprising, finding. In our national survey, we grouped respondents according to their ecoregion of residence using the EPA's Level 1 ecoregion map (EPA, 2024). Since these ecoregions are defined based on biophysical landscape characteristics, conventional thinking would suggest that residents within the same ecoregion should exhibit more similar ecosystem service preferences compared to those from different ecoregions. However, our results did not support this expectation. Instead, we found that across the eight major ecoregions of the contiguous United States, ecosystem service preferences remained largely stable, showing little variation by ecoregion. However, it is important to recognize that our analysis was conducted at a broad geographic scale, which is uncommon in social assessments (Felipe-Lucia et al., 2015). While we used the EPA's Level 1 ecoregion map, finer-scale ecoregions are delineated in Levels 2, 3, 4, and 5. Our decision to use the Level 1 classification was driven by limitations in sample size and opportunistic sampling strategies, which resulted in an overrepresentation of respondents from the Eastern Temperate Forest ecoregion. Future research should investigate this phenomenon using more precisely defined

ecoregions to determine whether biophysical characteristics influence preferences at finer spatial scales.

Moreover, as research practices evolve, social assessments are increasingly comparing stakeholder preferences (Quintas-Soriano et al., 2021; Riechers et al., 2017); we assert that examining values alongside preferences could further enhance and extend stakeholder-based ecosystem service assessments. Considering comparative stakeholder analysis, research based on related value theories demonstrates that stakeholder groups often share distinct value orientations. For instance, in Arkansas, research found that policy elites were primarily characterized by hierarchical and individualistic orientations. In contrast, the general public in Arkansas displayed a more egalitarian orientation (Tumlison & Song, 2019). Like preferences, values provide insight into how stakeholders may respond to policy or governance options. However, values may offer a more stable perspective on the belief orientations that influence decision making than preferences alone. While preferences capture specific ecosystem service perceptions at a particular moment in time, values reflect the broader belief systems which have shown to consistently influence decision making (Schutter et al., 2021). Since governance decisions rarely focus on a single ecosystem service, values offer a useful lens for evaluating policy options that complement preference-based insights. For instance, knowing that groups prioritizing self-transcendence values are more inclined to support regulating services, decision-makers can likely anticipate more favorable responses to policies promoting such services. Conversely, groups with self-enhancement values may be more likely to resist policies advancing regulating services. By accounting for these

enduring values, policies can be designed proactively to manage resource tensions and ensure stability, even as environmental conditions shift (Geva-May, 2002; Jones, 2011). This notion represents a logical expansion of the current practice of examining matches and mismatches between stakeholder preferences (Garau et al., 2020; Schmitt et al., 2021). By framing policies around value ideals rather than the technical language of ecosystem services—which requires an understanding of how socio-ecological processes deliver these services—decision-makers may also be able to achieve better communication outcomes and foster stronger public support for ecosystem management (Cornell et al., 2019; Jones, 2011). This not only builds governance resilience but also strengthens the connection between policies and the communities they aim to serve (Jones, 2011).

Finally, we suggest that by examining values alongside preferences, social assessments are better placed to identify generalizable trends among studies, contributing to the network of place-based socio-ecological research. This notion of supporting generalizability is not just a general goal of case-study research but also reflects the need for methodologies that foster an integrated network of place-based studies, as emphasized by the Programme on Ecosystem Change and Society (Cumming et al., 2020; Norström et al., 2022). As our conceptualization of preferences stems from Hausman's model, and our operationalization of values is derived from Schwartz's structure of value relations, we present a more theoretically grounded lens through which to understand preferences. Rather than considering the generalizability of findings from one context to another, based on an ad-hoc contextualization of preferences using the lens of each study's

respective biophysical characteristics, we present a set of variables (the four high-order value dimensions) that can be consistently investigated across studies. While we maintain that values will not explain the totality of variation in preferences, it represents a means to consider the human dimension of preference formation, which ultimately reflects the conceptual strengths of the social approach. That is, that the social assessments are most insightful when they directly examine the human component of how preferences are formed. With that said, we encourage future research to further develop and test additional considerations influencing preference formation. While we contend that values are important, there are surely numerous other factors that influence ecosystem service preferences remain underexplored. We recommend that future research continues to specifically examine the human and social dimensions that affect preference formation, ensuring that such studies are both theoretically grounded and conceptually robust and generalizable.

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APPENDIX

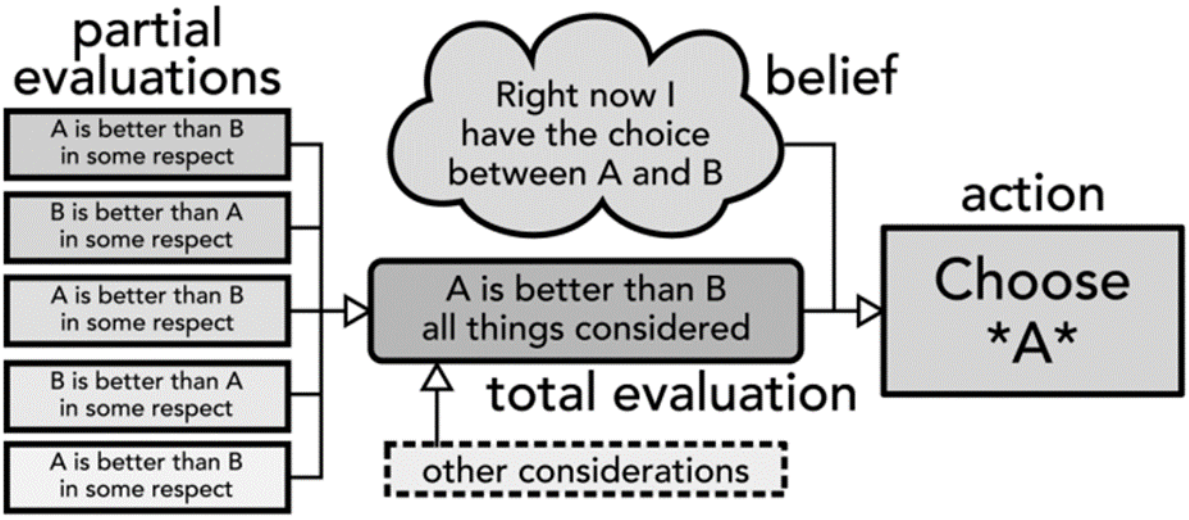


Figure 7. Hausman's model of preference formation, taken from Angner (2018).

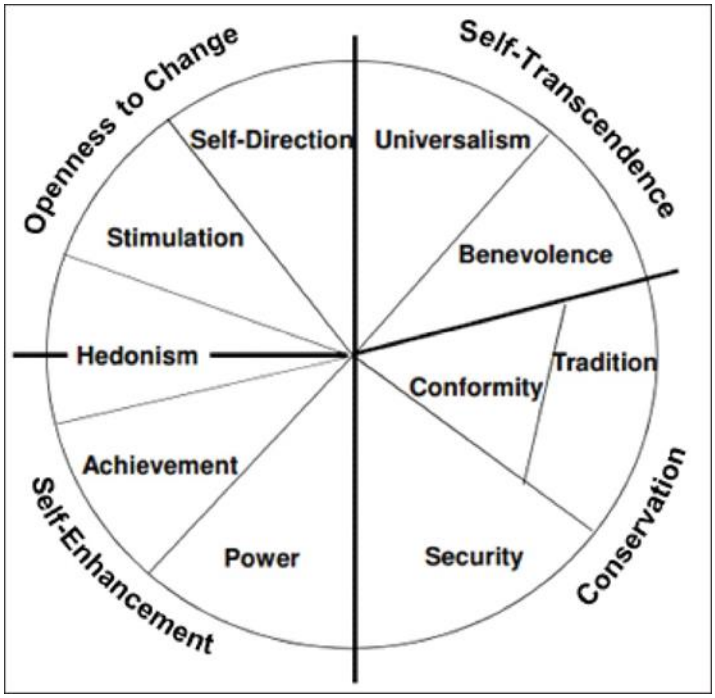


Figure 8. Schwartz's model of values, taken from Schwartz (2012).

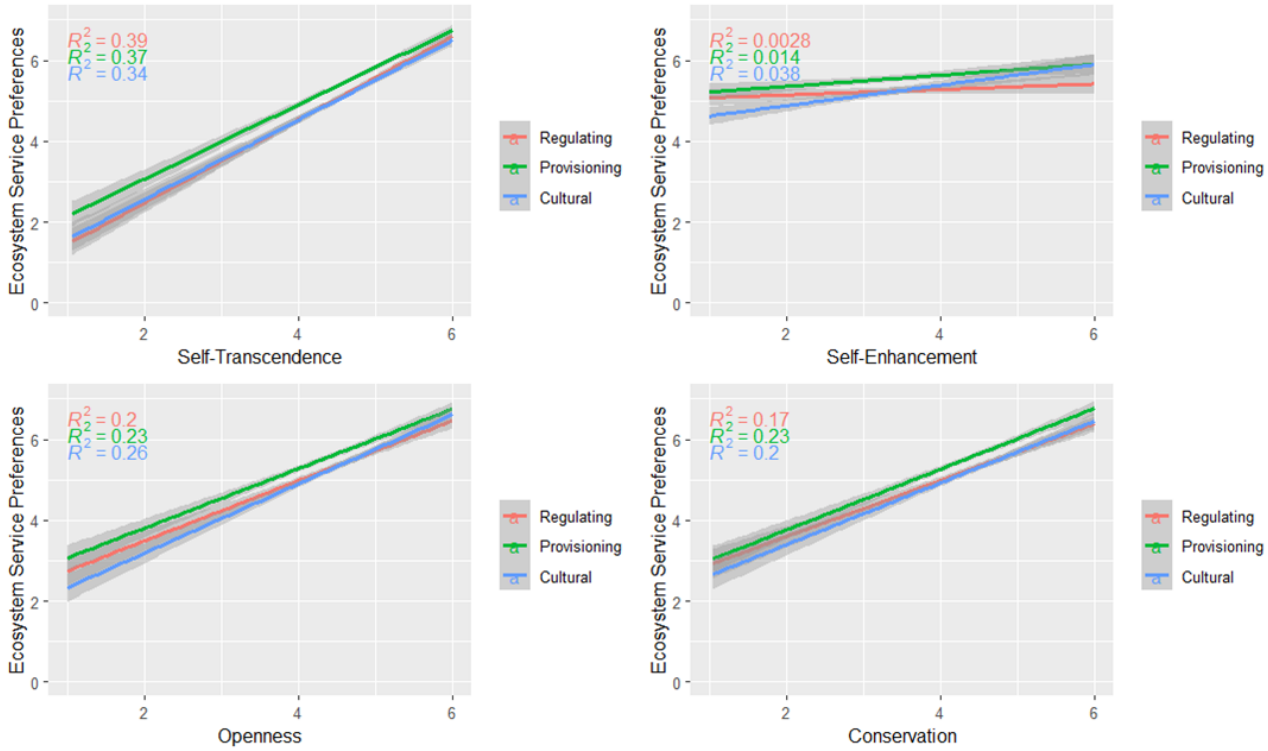


Figure 9. Simple regression models of the four higher-order value dimensions predicting ecosystem service preference subscales with corresponding R-square.

Table 3. Demographic characteristics of respondents.

Characteristic	*n* (%)
Income	
Less than $25,000	225 (28.5)
$25,000 - $49,999	221 (28.0)
$50,000 - $74,999	127 (16.1)
$75,000 - $99,999	95 (12.0)
$100,000 - $149,999	57 (7.2)
$150,000 or more	31(3.9)
Prefer not to say	34 (4.3)
Education	
Some high school or less	56 (7.1)
High school diploma or GED	234 (29.7)
Some college, but no degree	193 (24.5)
Associates or technical degree	107 (13.6)
Bachelor's degree	112 (14.2)
Graduate or professional degree	78 (9.9)
Prefer not to say	8 (1.0)
Gender	
Male	250 (31.6)
Female	540 (68.4)
Ethnicity	
White	612 (77.5)
Black of African American	118 (14.9)
American Indian or Alaska Native	14 (1.8)
Asian	14 (1.8)
Native Hawaiian or Pacific Islander	3 (0.4)
Other	29 (3.7)
Ecoregion	
Northern Forests	18 (2.4)
Northwestern Forested Mountains	19 (2.5)
Marine West Coast Forest	25 (3.3)
Eastern Temperate Forest	495 (64.7)
Great Plains	105 (13.7)
Northern American Deserts	36 (4.7)
Mediterranean California	51 (6.7)
Tropical Wet Forests	16 (2.1)

Table 4. Descriptive statistics of 17 ecosystem service preference statements.

Scale	Mean (± SD)
Ecosystem Service Preferences	5.29 ± 1.17
Regulating	5.23 ± 1.30
Habitat creation and maintenance	4.99 ± 1.54
Pollination and dispersal of seeds	5.12 ± 1.57
Regulation of air quality	5.40 ± 1.50
Regulation of climate	5.00 ± 1.78
Regulation of ocean acidification	5.10 ± 1.66
Regulation of freshwater quantity, location and timing	5.44 ± 1.57
Regulation of freshwater and coastal water quality	5.46 ± 1.52
Formation, protection and decontamination of soils and sediment	5.19 ± 1.53
Regulation of hazards and extreme events	5.39 ± 1.54
Regulation of detrimental organisms and biological processes	5.21 ± 1.54
Provisioning	5.53 ± 1.20
Energy	5.63 ± 1.43
Food and feed	5.93 ± 1.30
Materials and assistance	5.20 ± 1.42
Medicinal, biochemical and genetic resources	5.35 ± 1.51
Cultural	5.19 ± 1.33
Learning and inspiration	5.50 ± 1.44
Physical and psychological experiences	5.22 ± 1.45
Supporting identities	4.84 ± 1.75

Table 5. Descriptive statistics of the four higher-order dimensions of Schwartz's theory of basic values.

Dimension	Mean (± SD)
Self-Transcendence	4.67 ± 0.79
Self-Enhancement	3.23 ± 1.01
Openness to Change	4.34 ± 0.78
Conservation	4.35 ± 0.77

Table 6. Summary of stepwise regressions of independent variables that predict ecosystem service preference scale and subscales.

Model Equation Number	y_i	Variable	B	Standard Error	β	r^2	*t*	*p-value*
(1)	*Ecosystem Services Preferences*	Constant	0.573	0.199		0.466	2.874	0.004
		Self-Transcendence	0.888	0.057	0.601		15.468	0.000
		Self-Enhancement	-0.072	0.035	-0.062		-2.063	0.039
		Openness to Change	0.184	0.063	0.124		2.911	0.004
(2)	*Regulating*	Constant	0.578	0.232	0.641	0.400	2.494	0.013
		Self-Transcendence	1.052	0.047			22.434	0.000
		Self-Enhancement	-0.081	0.036	-0.063		-2.213	0.027
(3)	*Provisioning*	Constant	0.988	0.214	0.526	0.383	4.608	0.000
		Self-Transcendence	0.799	0.062	0.121		12.904	0.000
		Openness to Change	0.185	0.062			2.973	0.003
(4)	*Cultural*	Constant	0.355	0.243	0.446	0.373	1.462	0.144
		Self-Transcendence	0.748	0.069	0.192		10.848	0.000
		Openness to Change	0.323	0.069			4.664	0.000
		Gender	-0.288	0.082	-0.080		-2.771	0.006

CHAPTER III

VALUES AND ECOSYSTEM SERVICES PREFERENCES: A CASE STUDY EXAMINING THE TENNESSEE RIVER

Abstract

This chapter presents a case study of East Tennessee to examine how core human values influence ecosystem service preferences and policy solution preferences related to plastic pollution in the Tennessee River. Building on findings from a national survey (Chapter 3), this study investigates whether the value-preference relationships observed at a national scale are replicated in a localized context and whether these preferences inform support for specific policy interventions. Using data from 423 survey respondents across 33 counties in East Tennessee, the study finds that self-transcendence values consistently predict stronger preferences for regulating, provisioning, and cultural ecosystem services. Openness to change also positively predicts provisioning preferences, while self-enhancement is positively associated with cultural services. Conservation values, in contrast, show a negative relationship with regulating service preferences. Several demographic variables—including gender and income—also contribute to differences in ecosystem service preferences. Additionally, ecosystem service preferences and values help explain policy solution preferences: individuals who prioritize regulating and cultural services are more likely to support collective and regulatory policy solutions, and self-transcendence values positively predict support across all policy types. These findings reinforce the importance of incorporating value-based reasoning into social assessments and environmental policymaking, highlighting the utility of value-preference linkages for informing context-sensitive environmental governance.

Introduction

In chapter 3 of this dissertation, I highlight how the prevailing social approach—which involves surveying individuals' ecosystem service preferences—is frequently critiqued as being "reason-blind" (Schutter et al., 2021). This critique arises from the observation that, while current methods capture the intensity with which people prefer certain ecosystem services, they often fail to explain why these preferences are held. In other words, social assessments are not uncovering the deeper motivations behind why individuals prioritize specific ecosystem services. As a result, scholars face limitations when attempting to scale or transfer case-study findings—a key objective within the field (Norström et al., 2022). This limitation also restricts the capacity of researchers and practitioners to adapt policies and interventions across different contexts, as surface-level insights may overlook the deeper, context-specific factors that influence ecosystem service preferences.

To address this concern, I investigated the links between people's value orientations and their preferences for ecosystem services, arguing that values offer a theoretically robust and practically useful mechanism to interpret why people hold certain preferences. Using a national survey of 790 respondents across the contiguous lower 48 states, I establish empirical support for this relationship. The results show that individuals who prioritize self-transcendence values—those emphasizing concern for others and the collective good—consistently assign greater importance to regulating, provisioning, and cultural ecosystem services, with a particularly strong association with regulating services. Openness to change values, associated with independence and novelty-seeking, are

positively linked to preferences for provisioning and cultural services. In contrast, self-enhancement values, focused on personal success and control, are negatively associated with preferences for regulating services. Conservation values, however, showed no significant relationship with ecosystem service preferences. These findings underscore the explanatory role of values in shaping preference formation and offer a promising path for advancing social assessment research.

Given that most social assessments are applied within localized case study contexts (Felipe-Lucia et al., 2015), a natural next step for this research agenda is to reexamine these relationships within a similar case-study environment. Beyond simply demonstrating the practical application of the survey tools, this next step serves a broader purpose: to better understand how value-preference relationships may have applied implications for the development of socio-ecological management strategies. Moreover, within a case study context, there is scope to examine how value orientations relate to policy solution preferences, adding an additional layer of applied utility. Understanding this link not only enhances the explanatory power of social assessments but also equips decision-makers with actionable insights for designing policies that align more closely with the values and priorities of affected communities.

In this context, this final research chapter presents a case study centered in East Tennessee, USA, focusing on the issue of plastic pollution in the Tennessee River. The study assesses respondents' (1) value orientations, (2) ecosystem service preferences, and (3) policy solution preferences. The results show that, consistent with the national survey findings presented in Chapter 3, value orientations remain a significant predictor of

ecosystem service preferences. Self-transcendence and openness to change values were again positively associated with preferences for regulating, provisioning, and cultural services, while self-enhancement values exhibited a negative relationship with regulating services. However, unlike the national study, conservation values in this localized context were positively associated with provisioning service preferences, suggesting that local-particularities may modify the relationships between values and preferences. Moreover, the results show that individuals who prioritize regulating and cultural services are more likely to support collective and regulatory policy solutions, such as government-led clean-up programs and formal restrictions on plastic use. In contrast, those who place less emphasis on these services tend to prefer voluntary or market-based approaches. These findings demonstrate that ecosystem service preferences not only reflect individuals' value orientations but also inform how they evaluate concrete policy alternatives.

Case Study: East Tennessee

East Tennessee is one of the three Grand Divisions of Tennessee, as designated by the Tennessee State Department of General Services (Tennessee Department of General Services, 2024). It comprises the 33 counties of Anderson, Bledsoe, Blount, Bradley, Campbell, Carter, Claiborne, Cooke, Cumberland, Grainger, Greene, Hamblen, Hamilton, Hancock, Hawkins, Jefferson, Johnson, Knox, Loudon, Marion, McMinn, Meigs, Monroe, Morgan, Polk, Rhea, Roane, Scott, Sevier, Sullivan, Unicoi, Union, and Washington. The region is characterized by its diverse and complex landscapes, ranging from the Appalachian Mountains and the Great Smoky Mountains National Park in the

east to the Cumberland Plateau to the west. It is home to major population centers such as Knoxville, Chattanooga, and Johnson City.

Pollution of the Tennessee River

East Tennessee faces several environmental challenges, including land-use change, deforestation, and urban expansion (Drummond & Loveland, 2010; McGrath et al., 2004). However, among East Tennessee's most pressing environmental challenges is the degradation of the Tennessee River (Greeves, 2023). With its headwater in East Tennessee, the Tennessee River is among the most ecologically significant and biodiverse waterways in the United States, supporting 263 known fish species, 58 of which are endemic and others are designated as endangered, making it a key but vulnerable component of the Southeastern USA's globally recognized aquatic biodiversity hotspot (Elkins et al., 2019; Environment and Energy Study Institute, 2024; Tennessee Department of Environment and Conservation, 2024). Beyond its ecological value, the river plays a vital socio-economic role, facilitating commercial transport and generating nearly $12 billion annually through recreational activities managed largely by the Tennessee Valley Authority (Tennessee Valley Authority, 2017).

Despite its critical ecological and socio-economic roles, the Tennessee River faces serious and mounting pollution threats. The Tennessee Department of Environment and Conservation (TDEC) classifies large sections of the river as impaired due to pollutants such as E. coli, siltation, nutrients, metals, and organic chemicals, all posing risks to both ecosystems and public health (Tennessee Department of Environment and Conservation, 2024). More recently, plastic and microplastic pollution have emerged as alarming

concerns, with the river identified as one of the most plastic-polluted major rivers globally (Greeves, 2023; Tennessee Aquarium, 2018). Plastic contamination primarily stems from municipal waste, construction runoff, landfills, and notably, agricultural practices. Combined, these pollutants threaten the environmental health of the river and human wellbeing, from direct health risks associated with impaired water quality to diminished recreational access and aesthetic value.

The ecological richness and socio-economic importance of East Tennessee and the Tennessee River, make it an ideal context for examining how values, ecosystem service preferences, and policy solution preferences relate.

Methods

This study employed an online questionnaire to assess perceptions of ecosystem service preferences, core human values, and policy solution preferences related to plastic pollution in the Tennessee River. A total of 423 respondents completed the survey. Ethical approval for this research was granted by the University of Tennessee, Knoxville Institutional Review Board (UTK IRB-24-08472-XM).

Social sampling strategy

Using the Qualtrics participant recruitment service, the sample was drawn from residents of the 33 counties in East Tennessee as designated by the State of Tennessee. This region was selected due to its proximity to the headwaters of the Tennessee River in Knoxville. Participants were recruited through the Qualtrics participant panel, which provides incentives for survey participation. Data collection occurred over a two-week period in February 2025, resulting in 423 complete responses.

Questionnaire design

The survey consisted of four sections: (1) demographics, (2) ecosystem service preferences, (3) core values, and (4) policy solution preferences. Eligibility criteria required participants to be at least 18 years old and reside within one of the 33 East Tennessee counties. All respondents were informed of the voluntary nature of the study, the estimated completion time of approximately 15 minutes, the study's exclusive research purpose, and the focus on perceptions rather than factual knowledge.

The first section gathered demographic information, including education, gender, age, race, political affiliation, number of children, and household income. The second section measured perceptions of 17 ecosystem services, selected based on their designation as globally significant in the IPBES Global Assessment Report on Biodiversity and Ecosystem Services (2019). Respondents rated the importance of each service to human well-being using a seven-point Likert scale (1 = Not important at all, 7 = Extremely important). Following IPBES classifications, the 17 ecosystem services were grouped into three broader categories: regulating services, provisioning services, and cultural services (IPBES, 2019). The third section measured core human values using the 57-item Portrait Value Questionnaire (PVQ), based on Schwartz's Value Theory (S. H. Schwartz, 2012). Participants responded to each statement on a six-point Likert scale (1 = Not like me at all, 6 = Very much like me). Following the PVQ protocol (S. Schwartz, 2016), subscale scores were computed for the four higher-order value dimensions: self-transcendence, self-enhancement, openness to change, and conservation, by averaging the relevant item responses.

The fourth section evaluated support for policy solutions aimed at mitigating plastic and microplastic pollution in the Tennessee River. Eight hypothetical policies were developed based on Lowi's (1972) policy typology framework, comprising two policies each for distributive, regulatory, redistributive, and constituent typologies (Lowi, 1972). For example, a distributive policy read, "Local government provides financial incentives to local businesses to reduce plastic waste," while a regulatory policy stated, "Ban the sale of single-use plastics." Respondents rated their support for each policy using a five-point Likert scale (1 = No support, 5 = Full support) (see Appendix 1 for questionnaire description). For analysis, composite variables were created for each policy typology by averaging the two items within each policy topology category.

Data analysis

Survey data were downloaded and analyzed using IBM SPSS Statistics for Windows (Version 29.0; IBM Corp., 2023).

To examine the relationship between ecosystem service preferences and values, both simple and stepwise regression analyses were conducted. The ecosystem service preference subscales—regulating, provisioning, and cultural services—were used as dependent variables, while the four higher-order dimensions (self-transcendence, self-enhancement, openness to change, and conservation) and demographic variables served as independent variables. Simple regression models were used to predict each ecosystem service preference subscale based on individual dimensions. For the stepwise regression models, inclusion and exclusion thresholds were set at $p < 0.05$ and $p > 0.10$, respectively, and included all demographic variables.

To investigate the relationship between ecosystem service preferences and policy solution preferences, additional simple linear regression models were performed. The four policy support typologies—distributive, regulatory, redistributive, and constituent—served as dependent variables, while the ecosystem service preference subscales (regulating, provisioning, and cultural services) were used as independent variables.

Results

Sample description

The sample comprised 423 respondents residing in East Tennessee. The age distribution was 3.1% aged 18–24, 10.7% aged 25–34, 17.5% aged 35–44, 19.2% aged 45–54, 19.7% aged 55–64, and 29.9% aged 65 and older. In terms of gender, 67.8% identified as female, and 32.2% identified as male. The sample was predominantly White (92.9%), with smaller proportions identifying as Black (2.4%), Asian (1.2%), Native Hawaiian (0.2%), or another race (0.5%), while 0.7% preferred not to disclose their race and 2.1% were missing. Regarding educational attainment, 3.8% had some high school or less, 26.5% held a high school diploma or GED, 22.7% had some college but no degree, 18.0% had an associate degree, 19.9% held a bachelor's degree, 8.5% held a graduate degree, and 0.5% preferred not to answer. Household income varied, with 21.8% earning less than $25,000 annually, 28.9% earning between $25,000 and $49,999, 20.4% earning between $50,000 and $74,999, 12.6% earning between $75,000 and $99,999, 10.2% earning between $100,000 and $149,999, 4.5% earning $150,000 or more, and 1.7% preferring not to disclose their income. Lastly, the majority of respondents (74.6%)

reported having no children, 14.2% had one child, 6.4% had two children, 3.8% had three children, and less than 1% reported having four, six, or eight children.

Compared to Tennessee's general population, the sample displayed several notable differences. The sample was more heavily skewed toward White respondents (92.9%) than the state population, where approximately 77.6% identify as White (Data USA, 2024). Black or African American individuals were underrepresented in the sample (2.4%) relative to the state's 16.7% Black population. The sample also had a higher proportion of female respondents (67.8%) compared to the state, where the gender distribution is approximately balanced (51.2% female). In terms of age, the sample skewed older, with 29.9% aged 65 and older, whereas only about 17.1% of Tennessee's population falls into this age group. Educational attainment in the sample was similar to the state average with, 28.4% holding a bachelor's degree or higher, compared to approximately 28.7% statewide, but the sample had fewer respondents with less than a high school education (3.8% vs. 11.6% statewide). Household income levels were generally comparable, although the sample had slightly fewer individuals in the highest income brackets.

Ecosystem Service Preferences and Values

A series of three simple linear regressions were conducted to predict preferences for regulating, provisioning, and cultural ecosystem services from self-transcendence, self-enhancement, openness to change, and conservation values **(Table 7)**.

The regression predicting regulating ecosystem service preferences was statistically significant, $F(4, 417) = 53.62$, $p < .001$, explaining approximately 34.0% of the variance,

R^2 = .34, adjusted R^2 = .33. Self-transcendence was a significant positive predictor, B = 1.02, p < .001, such that higher self-transcendence was associated with stronger preferences for regulating services. Conservation was a significant negative predictor, B = -0.22, p = .015, indicating that higher conservation values were associated with weaker regulating preferences. Self-enhancement (B = 0.07, p = .284) and openness to change (B = 0.12, p = .237) were not significant predictors.

The regression predicting provisioning ecosystem service preferences was also statistically significant, F (4, 417) = 44.16, p < .001, accounting for approximately 29.8% of the variance, R^2 = .30, adjusted R^2 = .29. Self-transcendence positively predicted provisioning preferences, B = 0.81, p < .001, as did openness to change, B = 0.25, p = .020. Self-enhancement (B = 0.06, p = .356) and conservation (B = -0.15, p = .112) were not statistically significant.

The regression predicting cultural ecosystem service preferences was statistically significant, F (4, 417) = 47.27, p < .001, explaining approximately 31.2% of the variance, R^2 = .31, adjusted R^2 = .31. Both self-transcendence (B = 0.89, p < .001) and self-enhancement (B = 0.28, p < .001) were significant positive predictors. Openness to change (B = 0.10, p = .392) and conservation (B = -0.07, p = .480) were not significant.

To further explore this relationship, three stepwise linear regressions were performed to predict regulating, provisioning, and cultural ecosystem service preferences based on value orientations, and additional demographic variables **(Table 8)**.

The final stepwise regression model predicting regulating service preferences was statistically significant, F (2, 410) = 101.36, p < .001, explaining approximately 33.1% of

the variance in regulating ecosystem service preferences, $R^2 = .33$, adjusted $R^2 = .33$. Examination of the individual predictors showed that self-transcendence was a significant positive predictor, $B = 1.09$, $p < .001$, with higher self-transcendence scores associated with stronger preferences for regulating ecosystem services. Conservation also emerged as a negative predictor, $B = -0.18$, $p = .050$, suggesting that higher conservation values were associated with lower regulating preferences. Other variables considered (but excluded based on significance levels) include self-enhancement, openness to change, gender, education, age, race, political affiliation, and income.

The final stepwise regression model predicting provisioning ecosystem service preferences was also statistically significant, $F (3, 409) = 61.33$, $p < .001$, explaining approximately 31.0% of the variance in provisioning ecosystem service preferences, $R^2 = .31$, adjusted $R^2 = .31$. In the final model, self-transcendence was a significant positive predictor, $B = 0.73$, $p < .001$, with higher self-transcendence scores associated with stronger provisioning service preferences. Income was a significant negative predictor, $B = -0.12$, $p < .001$, suggesting that individuals with lower incomes expressed stronger preferences for provisioning ecosystem services. Openness to change was also a significant positive predictor, $B = 0.25$, $p = .011$.

The final stepwise regression model predicting cultural ecosystem service preferences was also statistically significant, $F (4, 408) = 55.76$, $p < .001$, explaining approximately 35.3% of the variance in cultural ecosystem service preferences, $R^2 = .35$, adjusted $R^2 = .35$. In the final model, self-transcendence was a significant positive predictor of cultural ecosystem service preferences, $B = 0.90$, $p < .001$, with higher self-transcendence scores

associated with stronger preferences for cultural services. Self-enhancement was also a significant positive predictor, $B = 0.29$, $p < .001$. Income was a significant negative predictor, $B = -0.15$, $p < .001$, suggesting that individuals with lower incomes placed greater importance on cultural ecosystem services. Gender was a significant positive predictor, $B = 0.32$, $p = .010$, indicating that women reported stronger preferences for cultural services than men. Other variables, including openness to change, conservation, education, age, race, and political affiliation, were not retained in the final model.

Ecosystem Service Preferences and Policy Solution Preferences

A series of linear regressions were conducted to examine whether core values predict support for distributive, regulatory, redistributive, and constituent policy solutions for plastic and microplastic pollution of the Tennessee River **(Table 9)**.

The regression model predicting distributive policy preferences was statistically significant, $F (4, 417) = 24.65$, $p < .001$, explaining 19.1% of the variance, $R^2 = .19$, adjusted $R^2 = .18$. Self-transcendence was a significant positive predictor, $B = 0.58$, $p < .001$, indicating that individuals with higher self-transcendence values were more likely to support distributive policies. Conservation was a significant negative predictor, $B = -0.21$, $p = .004$, suggesting that individuals with stronger conservation values were less supportive of distributive policies. Self-enhancement ($B = 0.02$, $p = .714$) and openness to change ($B = 0.08$, $p = .345$) were not significant.

The regression model for predicting regulatory policy preferences was also significant, $F (4, 417) = 21.37$, $p < .001$, accounting for approximately 17.0% of the variance, $R^2 = .17$, adjusted $R^2 = .16$. Self-transcendence was again a significant positive predictor, $B = 0.62$,

$p < .001$, while conservation was a significant negative predictor, $B = -0.22$, $p = .004$. Self-enhancement ($B = 0.08$, $p = .109$) and openness to change ($B = 0.01$, $p = .941$) were not significant.

The regression model for predicting redistributive policy preferences was statistically significant, $F(4, 417) = 18.40$, $p < .001$, explaining approximately 15.0% of the variance, $R^2 = .15$, adjusted $R^2 = .14$. Self-transcendence remained a significant positive predictor, $B = 0.67$, $p < .001$. Self-enhancement ($B = 0.04$, $p = .448$), openness to change ($B = -0.08$, $p = .439$), and conservation ($B = -0.14$, $p = .102$) were not significant predictors in this model.

The regression model for predicting constituent policy preferences was statistically significant, $F(4, 417) = 24.68$, $p < .001$, accounting for approximately 19.1% of the variance, $R^2 = .19$, adjusted $R^2 = .18$. Self-transcendence again positively predicted constituent policy preferences, $B = 0.59$, $p < .001$, while conservation negatively predicted preferences, $B = -0.16$, $p = .047$. Self-enhancement ($B = 0.00$, $p = .952$) and openness to change ($B = 0.13$, $p = .158$) were not significant.

Discussion

Relationship between values and ecosystem service preferences

In this chapter, I endeavored to examine how people's value orientations and ecosystem service preferences relate within the case study of East Tennessee. Overall, I found that self-transcendence values were the strongest and most consistent predictor across all three categories of ecosystem service preferences—regulating, provisioning, and cultural services. Specifically, I found that individuals who prioritize self-transcendence

(characterized by concern for others and the collective good) place broad importance on ecosystem services, with a strongest preference for regulating services. I also found self-enhancement values positively predicted preferences for cultural services, openness to change values to be positively associated with provisioning service preferences, and conservation values to be negatively associated with regulating service preferences. Beyond values, demographic factors also played a role, with income negatively associated with both provisioning and cultural preferences, and gender predicting cultural service preferences, with women expressing stronger preferences than men.

Overall, the findings of this case study largely mirror the findings of the national sample (presented in Chapter 2). In both studies, self-transcendence emerged as the most consistent and strongest positive predictor of ecosystem service preferences, significantly influencing each regulating, provisioning, and cultural services **(Table 10)**. Both studies also found that openness to change was positively associated with preferences for provisioning services, and that women consistently stronger preferences for cultural ecosystem services compared to men. Explanations and possible interpretations for these results are presented in Chapter 2.

However, several differences also emerged between the two studies. In the East Tennessee sample, self-enhancement positively predicted cultural service preferences, whereas in the national sample it negatively predicted regulating preferences. Additionally, while openness to change influenced both provisioning and cultural services nationally, it only predicted provisioning services in the East Tennessee case. Also, I found conservation values to be a negative predictor of regulating preferences in

the case study, while showing no significant relationship in the national sample. Finally, income was a significant negative predictor of provisioning and cultural preferences in East Tennessee, with lower-income respondents expressing stronger preferences for these services, whereas income was not a significant predictor in the national model.

In interpreting these findings, I suggest that certain relationships between values and ecosystem service preferences are relatively robust. For instance, the centrality of self-transcendence, and the role of openness to change for provisioning preferences. Similarly, among the demographic variables considered, the gendered pattern of stronger cultural service preferences among women emerged consistently, aligning with findings in related literature (Fortnam et al., 2019). However, other relationships appear more sensitive to factors external to this study. Underlying socio-economic, cultural, and ecological contexts may moderate the observed relationships, underscoring the need for future research to develop more sophisticated models that explicitly account for these contextual factors. Nonetheless, these findings provide initial empirical support for connections between values and preferences.

Relationship between values and policy solution preferences

This case study further examined the relationship between value orientations and policy solutions relating to plastic and microplastic pollution of the Tennessee River **(Table 9)**. The findings show that self-transcendence values consistently predicted stronger support for all policy types, while conservation values were negatively associated with support for distributive, regulatory, and constituent policies. Self-enhancement and openness to change values did not show consistent relationships with policy preferences. While the

models **(Table 9)** explain a relatively modest proportion of the variance in policy solution preferences (ranging from 14% to 18%), this is both expected and common in social science research. Writing about acceptable bounds of R-squared in empirical modeling for social science research, Ozili (2023) notes that "an R-squared that is between 0.10 and 0.50 (or between 10 percent and 50 percent when expressed in percentage) is acceptable in social science research only when some or most of the explanatory variables are statistically significant" (Ozili, 2023, p. 7). Indeed, contemporary applications of values as independent variables in other fields often yield similar levels of explained variance (Anglim & Marty, 2025; Molina-Sánchez et al., 2025). Furthermore, modest R-squared values are expected given that values are typically operationalized as independent variables, yet—as Schwartz emphasizes—they are relational constructs. Individuals hold multiple values simultaneously to varying degrees, meaning that potential interactions among values often remain unexamined in basic models (S. H. Schwartz, 2012). Notably, self-transcendence emerged as a particularly important value orientation, consistently predicting both ecosystem service preferences and policy solution preferences. Individuals who prioritized self-transcendence placed greater importance on regulating, provisioning, and cultural ecosystem services and simultaneously expressed stronger support for all types of plastic pollution policies, including distributive, regulatory, redistributive, and constituent approaches. This dual role of self-transcendence suggests that individuals who value the well-being of others and the collective good not only recognize the importance of ecosystem services but are also more likely to support policy actions to protect them. However, similar relationships did

not emerge for other value orientations to the same degree. As such, I suggest while self-transcendence has cross-cutting influences on both environmental attitudes and policy support, others values may play more discrete roles.

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APPENDIX

Table 7. Summary of simple linear regression models examining preferences for regulating, provisioning, and cultural ecosystem services from self-transcendence, self-enhancement, openness to change, and conservation values.

Predictor	**Regulating (β)**	**p**	**Provisioning (β)**	**p**	**Cultural (β)**	**p**
Self-Transcendence	.601	< .001	.479	< .001	.474	< .001
Self-Enhancement	.049	.284	.044	.356	.189	< .001
Openness to Change	.071	.237	.145	.020	.053	.392
Conservation	–.135	.015	–.091	.112	–.040	.480
R^2	.340		.298		.312	
Adjusted R^2	.333		.291		.305	
F (4, 417)	53.62	< .001	44.16	< .001	47.27	< .001

Table 8. Summary of stepwise regression models examining preferences for regulating, provisioning, cultural ecosystem services, and demographic variables from self-transcendence, self-enhancement, openness to change, and conservation values.

Predictor	Regulating (β)	p	Provisioning (β)	p	Cultural (β)	p
Self-Transcendence	.640	< .001	.433	< .001	.481	< .001
Conservation	–.106	.050	—	—	—	—
Income	—	—	–.137	< .001	–.158	< .001
Openness to Change	—	—	.143	.011	—	—
Self-Enhancement	—	—	—	—	.197	< .001
Gender	—	—	—	—	.104	.010
R^2	.331		.310		.353	
Adjusted R^2	.328		.305		.347	
F(df)	101.36 (2, 410)	< .001	61.33 (3, 409)	< .001	55.76 (4, 408)	< .001

Table 9. Summary of linear regressions models examine whether core values predict support for distributive, regulatory, redistributive, and constituent policy solutions for plastic and microplastic pollution of the Tennessee River.

Predictor	Distributive (β)	p	Regulatory (β)	p	Redistributive (β)	p	Constituent (β)	p
Self-Transcendence	.486	< .001	.487	< .001	.476	< .001	.439	< .001
Self-Enhancement	.019	.714	.083	.109	.040	.448	.003	.952
Openness to Change	.063	.345	.005	.941	–.053	.439	.094	.158
Conservation	–.177	.004	–.177	.004	–.103	.102	–.122	.047
R^2	.191		.170		.150		.191	
Adjusted R^2	.183		.162		.142		.184	
F (4, 417)	24.65	< .001	21.37	< .001	18.40	< .001	24.68	< .001

Table 10. Comparison of findings between East Tennessee case study and national sample.

Predictor	East Tennessee Case Study	National Sample
Self-Transcendence	Positive predictor for regulating, provisioning, and cultural services (strongest for regulating)	Positive predictor for regulating, provisioning, and cultural services (strongest for regulating)
Self-Enhancement	Positive predictor for cultural services only	Negative predictor for regulating services only; not significant for provisioning or cultural services
Openness to Change	Positive predictor for provisioning services only	Positive predictor for both provisioning and cultural services
Conservation	Negative predictor for regulating services	Not significant for any ecosystem service preferences
Income	Negative predictor for provisioning and cultural preferences (lower-income = stronger preferences)	Not significant for any ecosystem service preferences
Gender	Positive predictor for cultural preferences (women express stronger preferences)	Positive predictor for cultural preferences (women express stronger preferences)

CONCLUSION

This final dissertation chapter has three aims: First, it provides a concise summary of the preceding four chapters, while also making explicit the tangible connections between them. Second, to contextualize these contributions within the contemporary research literature regarding the social assessment of ecosystem services. Finally, this chapter outlines promising directions for future research, particularly as they relate to advancing socio-ecological research and improving the integration of social assessments into environmental management.

Introductory Chapter Summary

As a foundation, chapter 1 establishes the historical intellectual notion that humans are a part of—not aside from—natural systems. Early ecological theorists, such as Odum and MacArthur, emphasized the systemic and interconnected nature of ecosystems and highlighted the risks posed by human-induced environmental change (MacArthur, 1955; Odum, 1953). Their work paved the way for measuring empirical connections between nature and human-wellbeing, which reframed ecological functions as direct contributors to human well-being. This paradigm shift provided the groundwork for the development of the ecosystem service concept, which captures the direct and indirect benefits that people derive from nature (Baker et al., 2013).

Following the release of the Millennium Ecosystem Assessment (MEA) and the influential work of Costanza et al. (1997), the ecosystem service concept was popularized (Assessment, 2001; Costanza et al., 1997). The field quickly adopted the now-prominent typologies of regulating, provisioning, and cultural services. The chapter follows the

specialization of research field and the increasing interest in empirical assessments of ecosystem services, called ecosystem service assessments (ESA). It describes how these assessment approaches have diversified into three distinct methodological types—biophysical, economic, and social assessment approaches (Felipe-Lucia et al., 2015). Among these, this dissertation centers on the social assessment approach. While biophysical and economic assessments have matured into established methodologies, social assessments—those focused-on people's preferences and perceptions—remain underdeveloped (Felipe-Lucia et al., 2015). Chapter 1 highlights both the promise and the challenges of social assessments, including their potential to bridge gaps between ecological knowledge and socially grounded management, while also pointing-out their notable limitations. The most pressing of these limitations relates to the persistent critique that social assessments often lack a clear theoretical foundation for examining preferences, leading to findings that are difficult to generalize or apply across contexts (Schutter et al., 2021).

Overall, the first chapter works to emphasize this gap in the literature and allude to how the subsequent chapters may work to address it. As such, the overarching goal of this dissertation can be characterized as an attempt to develop the theoretical and methodological foundations of the social assessment of ecosystem services, with the ultimate goal being to improve their capacity to contribute meaningfully to socio-ecological management.

Chapter 1 Summary

In Chapter 1, the dissertation advances the social assessment of ecosystem services using a case study of the Portneuf River Watershed in southeastern Idaho. Principally, building from emerging but still niche methodological practices in the field, the study highlights how social assessment approaches are well-suited to facilitate a comparative analysis of preferences between distinct stakeholder groups. Specifically, this study investigates how two distinct stakeholder groups—environmental management experts and the general public—recognize, prioritize, and perceive changes in ecosystem services in the study region. By focusing on four key dimensions of ecosystem services that are present in the literature—recognition, importance, perceived temporal change, and land use impact—this chapter provides empirical insights into stakeholder perspectives that are often underrepresented in biophysical and economic assessments.

The findings show a mixed pattern of matches (shared perceptions) and mismatches (varying perceptions) between expert and public perspectives. A key mismatch was in the recognition of ecosystem services (when using a free-listing question type), especially regulating services, where experts demonstrated a much higher capacity to identify these services compared to the public. Experts identified more than twice the number of provisioning and cultural services and eleven times the number of regulating services, reflecting their technical familiarity and professional engagement with ecosystem processes. However, the results also demonstrated notable matches between the groups. When participants were prompted to rank the importance of ecosystem services using visual and descriptive cues, expert and public perceptions largely aligned. This suggests

that while public stakeholders may initially under-recognize certain services, particularly regulating ones, they do attribute importance to them once made salient, for example through photo-elicitation. This alignment highlights the potential of social assessment tools to bridge knowledge gaps and reveal otherwise hidden agreement between groups. Also, perceptions regarding the impacts of land-use change were similar between the two groups. Both experts and the public perceived urban development as predominantly detrimental to ecosystem services, natural forests as beneficial, and agriculture and rangelands as mixed, offering both positive and negative contributions depending on the service. This shared understanding has practical significance for policy development, indicating areas of common ground that could facilitate consensus-building in local environmental management.

Overall, Chapter 1 demonstrates the suitability of the social assessment approach for facilitating comparative stakeholder analysis. The accompanying discussion highlights the value of such assessments within the broader environmental literature, arguing that understanding stakeholder perceptions—both areas of alignment and divergence—is essential for designing policy interventions that are both feasible and socially acceptable. However, as an initial step, this chapter does not critically engage with the limitations inherent in preference-based analysis, capturing what people value but not why they value it. This limitation provides a clear rationale for the dissertation's progression to Chapter 2, which seeks to develop a theoretical explanation for the formation of ecosystem service preferences.

Chapter 2 Summary

Chapter 2 addresses a pressing theoretical critique of the social assessment approach that relates to measuring preferences. Identified and argued by Schutter et al (2021), the critique is that preferences alone do not explain why people hold particular ecosystem service preferences—only the intensity with which they prefer one service over another. This limitation reduces the practical usefulness of social assessments for informing management decisions and constrains the generalizability of case-study inferences (Schutter et al., 2021).

In response, Chapter 2 argues that the why can be better examined by integrating Hausman's economic model of preference formation with Schwartz's theory of basic human values (Hausman, 2011; Schwartz, 2012). This interdisciplinary approach conceptualizes preferences not as isolated judgments but as the outcome of structured deliberation, where values operate as key "other considerations" shaping how people evaluate ecosystem services. The chapter hypothesizes that core human values—self-transcendence, self-enhancement, openness to change, and conservation—systematically influence the formation of ecosystem service preferences.

Using data from a U.S. national survey (N=790), Chapter 2 examines these relationships. The results show demonstrate that values meaningfully explain variation in ecosystem service preferences, and in a fashion that is consistent with the theorized structure of value relation in Schwartz's theory of basic human values-- where congruent value orientations lead to similar ecosystem service preferences, and opposing value orientations lead to divergent ones. Individuals who prioritize self-transcendence and

openness to change consistently express stronger preferences for regulating and cultural services. Conversely, individuals who prioritize self-enhancement values are less likely to prioritize regulating services. The findings also challenge a common assumption within social assessments that local biophysical conditions primarily explain stakeholder preferences. The study finds no evidence that ecosystem service preferences vary across broad ecological regions (ecoregions). Instead, values, as stable constructs, offer a more promising explanation of preference formation across socio-ecological contexts.

By directly addressing Schutter et al.'s (2021) "reason-blind" critique, this chapter makes both theoretical and methodological contributions. It enhances the conceptual foundation of the social assessment approach and provides a more rigorous and generalizable framework for understanding preference formation. Practically, it equips decision-makers with insights that may improve the design of policies and interventions by anticipating how stakeholder values shape ecosystem service priorities. However, as Chapter 2 presents a national-level study—while most social assessments are conducted at local or regional scales—there remains a need to test this framework at finer levels of analysis (Norström et al., 2022). As such, Chapter 2 lays the foundation for Chapter 3, which applies the value–preference framework in a regional case study to examine how values shape stakeholder preferences regarding plastic pollution policy in East Tennessee.

Chapter 3 Summary

Chapter 3 represents an attempt to implement the value-preference framework examined in Chapter 2. Using a case study of East Tennessee, and a specific topical focus on plastic pollution of the Tennessee River, this chapter tests the framework's relevance and utility

in a local level context. Specifically, the study investigates the relationships between (1) value orientations, (2) ecosystem service preferences, and (3) policy solution preferences related to plastic pollution in the Tennessee River.

In further support for the hypothesized connection between values and preferences, the findings demonstrate that value orientations continue to explain variation in ecosystem service preferences. In fact, mirroring observed patterns in chapter 2, self-transcendence consistently emerged as the strongest and most robust predictor of ecosystem service preferences across regulating, provisioning, and cultural services. Openness to change positively influenced provisioning service preferences, while self-enhancement predicted cultural preferences. However, some differences were observed between the national survey (chapter 2) and the local case study (chapter 3). For instance, conservation values, which showed no significant relationship in the national study, negatively predicted regulating service preferences in East Tennessee.

With the goal of practical utility for decision-making in mind, this chapter expands beyond the scope of Chapter 2 by directly linking value orientations to policy solution preferences. The results show tangible connections between value orientations and policy preferences. Notably, self-transcendence emerged as important, positively predicting support for all four categories of policy solutions (distributive, regulatory, redistributive, and constituent policies) (Lowi, 1972).

Overall, chapter 3 shows that the value–preference framework offers explanatory power at both national and regional scales. While some relationships appear robust—particularly the role of self-transcendence—others are more sensitive to variables not

examined in the study. Thus, I suggest future models should attempt to examine additional variables, particularly those backed by related theory, to examine a greater portion of the variation. Ultimately, I hope that this dissertation presents a pathway for improving the social assessment approach.

Limitations

Several limitations in my research should be acknowledged. First, due to financial constraints, the national survey sample described in Chapter 2 did not employ a systematic sampling approach by ecoregion. Instead, a more cost-feasible (random) recruitment method was used, which resulted in an overrepresentation of participants from the Eastern Temperate Forest region (as this region is most densely populated). This sampling disparity limited the statistical power to evaluate the influence of ecoregion residence on ecosystem service preferences and value orientations, particularly in less represented ecological contexts. Future research using stratified sampling by ecoregion would provide a more robust basis for regional comparison. Second, as with any study employing an online survey and third-party participant recruitment tool, concerns remain regarding the quality and representativeness of the sample. While the online method facilitated a wide geographic reach, it may have excluded individuals without regular internet access or those less likely to engage in digital survey platforms. Therefore, the findings should be considered with caution, as they may not fully capture the views of the broader U.S. population or reflect the diversity of perspectives across all stakeholder groups.

In Chapter 3, the study design was further constrained by poor access to key stakeholder groups along the Tennessee River. While the initial research objective was to compare the preferences of river-related stakeholders—such as anglers, recreationists, and local conservation volunteers—with the general public, it was not feasible to reach (enough of) these small populations using an online sampling platform. As a result, the analysis relied solely on a general public sample. This limitation reduces the granularity of insight into how ecosystem service and policy preferences may vary among those most directly affected by riverine conditions. Future research may consider incorporating face-to-face sampling strategies (as we did in Chapter 1) or targeted outreach in stakeholder-specific venues to ensure better representation of these critical user groups.

Concluding Remarks

In writing this dissertation and engaging with the broader ecosystem services scholarship, it has become clear that the field has advanced rapidly over the past two decades. Given the concept's swift popularization and the parallel specialization of biophysical, economic, and social assessment approaches, it is perhaps unsurprising that methodological challenges persist. Moreover, considering the field's foundations in the natural sciences—and the fact that most scholars active in this area come from predominantly natural science backgrounds—the underrepresentation of interdisciplinary social science perspectives, particularly in relation to human psychology within social assessments, is understandable.

In this context, I feel there is significant scope for collaborative and interdisciplinary research aimed at developing more theoretically grounded approaches to ecosystem

service assessment. Moreover, across the social assessment literature and the ecosystem service literature more broadly, I strongly believe that research has an obligation to better consider (and support) the practical outcomes of studies—with particular regard to supporting decision-making. Too often, even well-executed research falls short of this goal, offering vague suggestion that are difficult to implement (Norström et al., 2022). This dissertation argues that values offer one promising mechanism to bridge this gap, providing explanatory leverage for both ecosystem service preferences and policy support.

Looking forward, I now hope to examine the role of values in other socio-ecological contexts. In particular, the observed links between value orientations and ecosystem service preferences suggest that values may also influence individuals' and groups' capacities to manage common-pool resources. Understanding these dynamics could offer meaningful contributions to both theory and practice in socio-ecological governance.

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