ABSTRACT

GALIK, CHRISTOPHER STEPHEN. Institutional Design and Decision-Maker Response: An Investigation of Environmental Policy and Research. (Under the direction of Erin O. Sills).

The development of effective environmental policy and the research to support it is both predicated on and informed by institutions. Institutions affect decision-maker behavior by influencing preferences, framing choices, and establishing expectations. This dissertation employs historical institutionalism as an overarching framework to unify the three essays contained within it. Each essay is concerned with a particular issue area within the field of environmental policy, but all three collectively explore how institutional context affects the behavior of decision-makers and the methods employed by policy scholars. Viewing these collected works through the lens of historical institutionalism provides insight into the mechanics perpetuating institutions in both policy and research. Having thus identified what perpetuates these institutions, one is better equipped to identify the changes necessary to better address today's pressing environmental challenges.

The first essay demonstrates how the literatures surrounding the analysis of property rights regimes in natural resource management are fragmented, leading to incomplete learning and a failure to capture (and therefore understand or model) key dynamics of a situation. The essay shows how institutional change can lead to new insights, new approaches, and increased innovation. It does so through a comparison of property rights frameworks across institutional theory, legal, and economic literatures. It discusses how frameworks can evolve over time to capture an increasing array of research questions, the incentives and constraints which contribute to the path dependency of individual lines of research, and how a failure to evolve may limit their applicability to important, emerging

natural resource management issues. The essay concludes with a case study applying a revised property rights framework applied to Reduced Emissions from Deforestation and Forest Degradation (REDD) programs.

The second essay investigates how distinct institutional contexts influence participant decision-making in different segments of the bioenergy market, suggesting that uniform national policies cannot capture the nuanced drivers affecting participant choice and therefore may fail to achieve broad-based producer response. To inform the development of policies best suited to encourage the participation of biomass producers, the essay explores the factors that have been found to be associated with biomass feedstock production decisions in the Southeastern and Midwestern U.S. Using social network analysis to assess the relationships between study variables across different user groups, feedstock types, and geographic areas, the essay shows that the factors used to investigate biomass market participation decisions vary across feedstock type and geographic region.

The third essay examines how institutions influence stakeholder participation in policy reform efforts, how participation can influence institutional design, and how institutional change could facilitate greater involvement from potentially under-served stakeholders. This essay employs a convergent mixed methods design and leverages a large data set of public comments and conservation plans to provide insight into efforts to reform implementation of the Endangered Species Act (ESA). Through an exploration of public participation in the development and implementation of policy, the essay illustrates how administrative reform processes could make use of multiple data sources both to draw in those not participating and to gain insights into necessary reforms. For stakeholder applicant and land use types with a greater instance of comment letter submission than plan

participation, the essay suggests that existing ESA policies may be ineffective in meeting stakeholder needs. For those applicant and land use types with greater instance of plan participation than comment submission, the essay suggests that valuable input on policy implementation is foregone so long as these users are underrepresented.

Institutional Design and Decision-Maker Response: An Investigation of Environmental Policy and Research

by
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BIOGRAPHY

Christopher Galik currently serves as a Senior Policy Associate in the Duke University Nicholas Institute for Environmental Policy Solutions. His work focuses on the development of state and federal renewable energy and climate policy, including the practical implications of offsets policy design, the intersection of biofuels and climate policy, and the potential use of domestic biomass resources for bioenergy. Past research includes the influence of project accounting on forest offset supply, the interaction between traditional land conservation programs and emerging biomass and carbon markets, and intersectoral competition for woody biomass in the Southeastern U.S. More recent work includes accounting structures to monitor emission reductions from avoided deforestation activities and evaluation of landowner incentives for at-risk species management. He has published multiple whitepapers, briefs, and online discussion papers, as well as several peer-reviewed articles in journals such as *Forest Ecology and Management*, *Journal of Environmental Management*, *Forest Science*, and others. Prior to joining the Institute, Christopher spent several years in Washington D.C. as a policy analyst, specializing in species conservation and federal forest management policy. He graduated from Vassar College with a Bachelor of Arts in biology (*cum laude*) and holds a Master of Environmental Management degree in resource economics and policy from the Nicholas School of the Environment, Duke University.

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CHAPTER 1 : INSTITUTIONS, ENVIRONMENTAL POLICY, AND RESEARCH: AN OVERVIEW

The following dissertation is comprised of three separate essays, each concerned with a singular issue area within the field of environmental policy. Each explores a unique environmental policy issue area and makes its own contribution to the broader literature by applying a novel methodological approach to address a specific and pressing contemporary policy question. This introductory chapter provides a discussion of what binds these essays together. It outlines the thematic linkages between the three essays, providing a brief overview of relevant theory and literature. It argues that greater attention to institutional design is necessary to both improve the development and implementation of environmental policy and to foster greater innovation among and within the academic community. It explores the use of innovative methodological approaches by which to explore the influence of institutional design in environmental research and policy, and concludes with a brief discussion of the relevance and importance of the research itself.

The Influence of Institutions on Decision-Maker Response

We are presently faced with a great variety of environmental issues in need of rapid and reasoned response. Ranging from global climate change, to loss of ecosystem biodiversity, to region-wide water shortages, the current suite of environmental challenges are termed by some to be distinctly “wicked” or even “super wicked” owing to the complex and conflicting evidence as to their cause, the presence of circularities, uncertainties, and

interdependencies in their potential solutions, and the lack or weakness of the central authority necessary to address them (Lazarus, 2009; Levin, Cashore, Bernstein, & Auld, 2009; Rittel & Webber, 1973).

The development of effective interventions to address these challenges, as well as the research to support them, is both predicated on and informed by the existence of institutions, defined to include "the formal or informal procedures, routines, norms, and conventions embedded in the organizational structure of the polity or political economy" (Hall & Taylor, 1996, p. 938). An important distinction here is between formal and informal institutions. As noted by Williamson (2009, p. 372), "informal institutions remain in the private realm, whereas formal constraints are centrally designed and enforced". North (1994) makes a similar distinction, separating formal constraints such as rules and laws from informal constraints like norms, conventions, and codes of conduct. Together, these formal and informal institutions affect decision-maker behavior by influencing preferences, framing choices, and establishing expectations (Hall & Taylor, 1996; Thelen, 1999). In this way, decision-making is not driven solely by institutions; rather, it is "easier for political actors to work with the grain of institutions than against it" (O'Riordan & Jordan, 1999, p. 83).

A subset of theoretical inquiry referred to as New Institutionalism (NI) provides a tractable approach for exploring the influence of institutions in environmental policy and research. An inherent strength of NI is that it "draws attention to the interplay between the regulatory system and the social system at large, providing insights for developing both regulation and the practices of environmental management" (Raitio, 2012, p. 309-310). As noted by Hall & Taylor (1996), NI lacks a universal definition but is instead comprised of

three variants: rational choice, historical, sociological. Each differs in the emphasis of approach, the model of the individual, and explanations for the origin and persistence of institutions. As a whole, however, NI generally holds that institutions influence the evolution of the policy and politics of a state or organization, and that the outcome is potentially inefficient due to symbolic action and the autonomy of institutions themselves (March & Olsen, 1984).

Within the broader field of NI, Historical Institutionalism (HI) has been touted for its "substantial appeal as a central organizing approach for explaining politics and policy" (Peters, Pierre, & King, 2005, p. 1282). It has been described as inductive, parsimonious, agreeable with real-world observations, and particularly amenable to comparative analysis (Deirmeier & Krehbiel, 2003; Hall & Taylor, 1996; Peters, et al., 2005; Thelen, 1999). Although rational choice and sociological institutionalism also provide viable approaches for exploring the influence of institutions in environmental policy and research, the role of HI as a bridge between these other variants (e.g., Hall & Taylor, 1996) positions it well to contribute to a broad understanding of these phenomena.

An area of emphasis of historical institutionalism is the effect of power asymmetries in the evolution of institutions, with those in positions of power better able to shape emerging institutions in times of change (Hall & Taylor, 1996). An additional area of emphasis is the inherent path dependency of institutions, or the influence of prior "institutional, economic, political, social, and cultural features" (Hall & Taylor, 1996; Thelen, 1999; Greif, 1998, p. 82). These "inherited" features affect both current and future preferences and constrain the opportunities presented to affected individuals (O'Riordan & Jordan, 1999, p. 83). Whether

through some combination of increasing returns, self-reinforcement, positive feedbacks, or lock-in (Page, 2006), incentives or constraints exist such that the evolution of institutions is influenced by those already or previously in place.

The literature contains multiple examples of environmental policy analysis through the lens of historical institutionalism. What these works have in common is that they each provide insight into the options and opportunities for redesign of planning processes and policy initiatives to address an array of environmental issues. For example, Raitio (2012) assesses collaborative forest management planning in Finland, finding that current planning processes reflect traditional power asymmetries present among actors. Mercier (2006) examines the factors that contributed to the U.S. failure to adopt greenhouse gas (GHG) reduction policy, linking the outcome to the path dependency of American institutions. Levin et al. (2009) build upon this theme, and utilize theories of path dependency to recommend a variety of policy and educational approaches to address climate change. Burns (2012) meanwhile employs a historical institutionalism perspective in her analysis of biotechnology policy in the E.U., with an emphasis on the role of exogenous shocks in the path dependency of regulatory regimes. Hoornbeek (2004) compares U.S. and E.U. water management, with a particular emphasis on the constitutional and organizational context that led to observed policy outputs and competencies.

Though less prevalent in the literature, historical institutionalism likewise provides a useful lens through which to view the conduct of scientific research. Those same incentives and constraints that affect the emergence of planning processes and policy initiatives also influence the creation of knowledge to inform said processes and initiatives. For example,

researcher behavior is influenced by "perceptual filters composed of preexisting beliefs" that determines how they will relate to the world around them (Sabatier & Weible, 2007, p. 194). The filters that affect decisions, these "moral or cognitive templates for interpretation and action" (Hall & Taylor, 1996, p. 939), may not always be fully appreciated by individual scholars. This implies that there will be multiple "truths" in knowledge creation (Ascher, Steelman, & Healy, 2010, p. 28), stemming naturally from a diversity of values and perceptions (e.g., Stone, 2002). Information generation and delivery within a given policy system thus "does not necessarily entail discovery of an 'objective' truth about a policy instrument, problem, or goal" (May, 1992, p. 351). This point is reinforced by van den Hove (2007), who notes "[t]he identification of the issue, the choice of relevant disciplines, methodologies, scales, variables, and boundaries, and the strategies to articulate them are elements of the scientific process which are in no way isolated from the socio-political context, as is quite obvious in the case of environmental issues" (p. 811-2).

An Examination of Environmental Policy and Research through an Institutional Lens

Viewing environmental policy and research through a lens of historical institutionalism provides a unifying approach to the essays below. Specifically, the dissertation separately explores the incidence and influence of path dependency and power asymmetries on emerging institutional design. Each individual essay takes the form of a single-case study (e.g., Yin, 1994) and highlights a different methodological approach for examining institutional design in environmental policy and research. The essays likewise explore how different institutional contexts affect the methods chosen to investigate the

questions asked. Apart from demonstrating the applicability and relevance of methodological pluralism in the study of institutions, the essays also lend insight into a specific environmental policy problem.

The first essay assesses how institutions influence research behavior and research findings through an examination of the competing property rights frameworks used to analyze natural resource management problems. These frameworks define the very essence of what can be considered property and how individuals may come to use, hold, manage, and/or exclude in the name of natural resource management. In re-evaluating Schlager and Ostrom's 1992 bundles framework alongside concepts drawn from other disciplines, this essay explores the ability of various property rights frameworks to fully capture the activities and phenomena relevant to analysis of Reduced Emissions from Deforestation and Forest Degradation (REDD) program activities. The essay demonstrates how revisions to dominant ontological frameworks shape how we conduct contemporary analysis and therefore understand applied natural resource problems. It also suggests how seminal works can behave like critical junctures as described in the historical institutionalism literature (Hall & Taylor, 1996; Ikenberry, 1994), establishing new branches of thought and influencing the direction of future contributions. The tools employed in the first essay reflect these tasks at hand, utilizing an interdisciplinary literature review and case studies to conduct a comparative analysis of the commonalities, differences, and relative strengths of competing property rights frameworks.

The second essay investigates how institutions influence market development by comparing drivers of bioenergy market participation across feedstock types, producer groups,

and geographic regions. It employs social network analysis to highlight the variety of factors affecting bioenergy market participation and to explore patterns of research findings both within and between market segments and user groups. In doing so, it suggests that structural and social constraints influence bioenergy market participation decisions, a finding with substantial policy and market development implications. Per North (1990), we can expect institutions to influence market development. Per Bowles (1998), we can likewise expect markets to influence institutions. A failure to fully reflect the institutional context of existing and emerging renewable energy markets risks the application of oversimplified, ineffective policy solutions (Ostrom, 2005; Seabright, 1993). Indeed, Bowles' discussion of market segmentation suggests that increased interaction with a subset of market actors could reinforce endogenous preferences within certain segments of the bioenergy market, necessitating carefully tailored policy approaches.

The third essay explores how institutions can affect public policy reform efforts. It compares public participation in regulatory rulemaking processes and related regulatory programs, employing a convergent mixed methods design to draw upon data from comment letters submitted to a 2012 advance notice of proposed rulemaking on voluntary conservation and data contained in a related federal database of approved conservation plans and agreements under Section 10 of the Endangered Species Act (ESA). The use of mixed methods provides a robust approach to investigate how regulatory reform may affect participation in the policy process. Unless roles are provided for less-represented stakeholders, asymmetries present in existing regulatory contexts are likely to be perpetuated

as those with greater power or representation are able to steer reform efforts to their advantage (Raitio, 2012).

The essays are followed by a short concluding chapter which summarizes the individual findings from each essay, as well as the collective contribution of the assembled works. As a whole, these essays offer insight into the influence of institutions on decision-maker response, the potential factors leading to the perpetuation of institutions in policy and research, and the possible implications of institutional change for the issue areas examined here. The dissertation closes with a short list of recommendations, further leveraging this work to better understand the options and opportunities for design of research, planning processes, and policy initiatives so as to address those “wicked” and “super wicked” problems that lie before us.

CHAPTER 2 : BUNDLES, DUTIES, AND RIGHTS: A REVISED FRAMEWORK FOR ANALYSIS OF NATURAL RESOURCE PROPERTY RIGHTS REGIMES.[1]

In their 1992 paper, Schlager and Ostrom presented a property rights framework characterized by nested, cumulative attributes. It has become arguably the most ubiquitous framework for analysis of natural resources and property rights. We revisit their contribution and discuss how the framework could evolve to address increasingly complex situations, with particular attention to institutional change. We devote increased attention to duties and liabilities associated with right allocation, tying the framework to a broader property rights literature. We conclude with an application to reducing emissions from deforestation and forest degradation (REDD+), illustrating how revisions to the framework facilitate contemporary institutional analysis.

Introduction

Property rights, defined as "a claim to a benefit stream that the state will agree to protect through the assignment of duty to others who may covet, or somehow interfere with, the benefit stream" (Bromley, 1991, p. 2), hold great importance in the study of natural resource management issues. As Kundhlande & Luckert (1998) write, they "are thought to affect the expansion of the market system, production and distribution of output, and affect incentives to efficiently manage resources" (p. 1). Over the past few decades, property scholars concerned with natural resource management have advanced several typologies

[1] This essay was coauthored with Pam Jagger, Assistant Professor in the Department of Public Policy, University of North Carolina at Chapel Hill. It will appear in the journal *Land Economics*, volume 91, no. 1 (2015).

suitable for conceptualizing formal property rights that broaden the more traditional classification of property as private, communal, or state owned. Kundhlande and Luckert (1998) categorize property rights on the basis of eleven individual factors (e.g., comprehensiveness, exclusiveness, use designation, duration, allotment type, size, transferability, fees, operational requirements, operational control, and security). Leach, Mearns, & Scoones (1999) focus instead on issues of endowments (the rights and resources in hand) versus entitlements (control over alternative commodities), with property rights being used to allocate the former. Ribot & Peluso (2003) meanwhile eschew focus on rights themselves but instead focus on the issue of resource access, or the ability to use a given resource.

In their review of the "diverse bundles of rights" held by various users of a given resource system, (Schlager & Ostrom, 1992, p. 249) identify five separate bundles: access, withdrawal, management, exclusion, and alienation. They further array these bundles across four classes of user: authorized user, claimant, proprietor, and owner. In doing so, they created a framework generally capable of capturing the diversity of property rights arrangements present in natural resource systems. It has since been applied to assess the role of property rights in determining sustainable outcomes, institutional formation, and institutional dynamics in, for instance, fisheries (Edwards, 1994; Sekhar, 2004), forests (Hayes, 2007; Hayes & Persha, 2010; A. M. Larson, Barry, & Dahal, 2010; Roy, Alam, & Gow, 2012), and irrigation systems (Meinzen-Dick & Bakker, 1999).

Comparative analysis of property rights systems is one area particularly well suited for the Schlager-Ostrom framework. Their 1992 paper features just such a comparative

analysis of Maine fisheries. Comparative analyses also feature prominently among the examples cited above. The issue explored here is whether the Schlager-Ostrom framework can be further adapted to better assess the process of institutional change itself. We also turn to the broader property rights literature and discuss how relevant contributions from legal, institutional, and economic scholarship can help inform a revised bundles framework. Placing the Schlager-Ostrom framework in the context of contributions from Honoré, Hohfeld, Bromley, and others, we present an example of what a modified framework could look like, as applied. We conclude with a brief case study making use of our amended property rights framework in the context of reducing emissions from deforestation and forest degradation (REDD+) activities.

The Continued Evolution of a Dominant Ontological Framework

The notion of rights as a separable bundle is a prevalent and long-running theme in the literature. Penner (1996) cites contributions from Hohfeld and Honoré as providing the basis for what he calls the "conventional formulation" of the separable bundle. Other notable contributions include Alchian & Demsetz (1972) who discuss a bundle typology in the context of the firm, and Eggertsson (1990) who discusses the partitioning of rights across multiple parties, with a focus on the role of the state and the economic outcomes of alternative allocations.

There are many benefits of a nested framework as operationalized by Schlager and Ostrom (1992). A primary advantage is that it aids in the disentanglement of a given property rights regime, thus allowing for detailed examination of both the resource and the users of

that resource (Hayes, 2007). By arraying rights in a nested and cumulative manner, it is possible to dissect property rights regimes to determine the bundles held by a given individual, to score those relative to a complete bundle, and to investigate the implications for any absences or changes over time (e.g., A. M. Larson, et al., 2010). The cumulative nature provides a way of understanding heterogeneity in property rights between and within individuals and communities of resource users, allowing for differentiation by socioeconomic status, ethnicity, gender, etc. It likewise allows for more meaningful exploration of the behavior and causal aspects of property rights endowments (e.g. is property rights regime "A" associated with higher productivity, higher equity, etc., than regime "B"?).

Despite its strengths, some have argued that a "bundles" framework, generally, and the Schlager-Ostrom framework, specifically, is an insufficient or inappropriate lens through which to view property rights and natural resource management issues (e.g., Bergstrøm, 2005; Penner, 1996; H. E. Smith, 2011). Even if one accepts the relevance and appropriateness of a bundles perspective, a practical concern with the Schlager-Ostrom framework is that the bundles defined therein may not adequately capture the full range of rights and resource conditions of relevance to contemporary natural resource management. Here, we explore how this issue can be rectified.

We begin with the argument that the issue of resource alteration, defined as the ability to change the goods and services provided by the resource, is a special case, and one that at present has a difficult time fitting cleanly in the existing Schlager-Ostrom framework. Next, we embark on a review of the broader literature on the subjects of ownership and the obligations associated with the allocation of each right bundle, including alteration. Although

it may not have been a priority given the focus of Schlager-Ostrom's original work, the framework nonetheless confuses notions of rights and powers, of duties and liabilities, and complicates the empirical analysis of complex and changing property rights systems. We attempt to address both issues below.

Increasing Resolution: The Addition of a Sixth Bundle

Schlager and Ostrom (1992) discuss five bundles of rights: access, withdrawal, management, exclusion, and alienation. As we revisit the framework, we ask whether it can be improved upon to better address situations of institutional change. In particular, we ask whether the original five bundles both fully capture and appropriately distinguish between important contextual differences encountered in contemporary natural resource management.

Included in Table 2-1 are the original five bundles and an additional sixth, alteration. We argue that alteration is a necessary distinction in the Schlager-Ostrom framework owing to the unique situation leading up to, and the far-reaching implications resulting from, a change in fundamental resource attributes. We emphasize that alteration is different than management which involves transformation of the resource by making improvements. Examples of management include establishing rules regarding the sustainable harvest of timber, making decisions about the length of time to fallow a parcel of land, or rotating the location of fishing sites to minimize depletion of the resource. Alteration on the other hand involves the complete transformation of the resource from its current state in ways that may be positive or negative depending on perspective and the outcome of interest, for example, clearing a forested stand for agriculture, planting trees on marginal pastureland, or

impounding a waterway and inundating associated low-lying areas in the name of hydroelectricity generation.

Table 2-1. Overview of revised rights bundles as defined in Schlager and Ostrom (1992, p. 250-1) and expanded upon here.

Right	**Description**
Access	"The right to enter a defined physical property"
Withdrawal	"The right to obtain the 'products' of a resource"
Management	"The right to regulate internal use patterns and transform the resource by making improvements"
Alteration	*The right to change the set of goods and services provided by a resource*
Exclusion	"The right to determine who will have an access right, and how that right may be transferred"
Alienation	"The right to sell or lease [some] or [all management, alteration,] and [exclusion] rights"

We argue that alteration is fundamentally different from management in that the former involves a change in the flow of goods and services associated with the resource, whereas the latter concerns the internal regulation and transformation within a particular resource. Unless "resource" is defined here to be so broad as to represent all available land uses, alteration and management are very different concepts with very different implications for rights holders.

If an additional bundle is to be useful in the context of the Schlager-Ostrom framework, it must somehow be set in the context of the other five bundles. But where does

alteration fall along the spectrum of various rights put forward some twenty years ago? A strength of the Schlager-Ostrom approach is that it allows for the arraying of different categories of rights, facilitating distinctions to be made among the different types of individuals and groups based solely on the rights they hold. These rights bundles are generally cumulative, meaning that they contain and build upon the preceding bundle.

We place alteration between management and exclusion (Table 2-2). Schlager and Ostrom (1992, p. 251) define management rights as conveying the authority to "regulate internal use patterns and transform the resource by making improvements". Alteration could at first be seen as a more extreme version of management. In terms of effects on rights holders, however, alteration and management are quite different. Management implies operation within a given resource system, further suggesting that options for use by those holding other levels of rights (proprietors and owners) may be preserved. Alteration, however, changes the very nature of the resource in question. This argues for alteration to be placed higher in the hierarchy, as fundamental changes in the resource can be seen as removing options from others in the array. For example, changing a given land use from one to another (from forest to agriculture, for example) not only affects the nature of the activities that may take place on that land, but also who may make use of that land and who may make decisions regarding that use. This becomes apparent in our application of the revised framework in the context of REDD+ below.

Table 2-2. Matrix of owner types and individual right bundles (adapted from Schlager and Ostrom, 1992, p. 252).

	Owner	**Proprietor**	**Claimant**	**Authorized User**
Access and Withdrawal	X	X	X	X
Management	X	X	X	
Alteration	*X*	*X*		
Exclusion	X	X		
Alienation	X			

Decisions over alteration may themselves be trumped by higher-order exclusion or alienation collective choice decisions. Without the collective choice rights of exclusion and alienation, alteration is thus best viewed as falling within the purview of a proprietor. But as the above text makes clear, the issue is not straightforward. Alteration is a complex phenomenon, and can affect all user types, regardless of where it is placed along Schlager and Ostrom's hierarchy. It is this complexity that warrants special attention to the issue and explicit discussion of the bundle separate and apart from the others previously identified.

We argue that the fundamental differences between management and alteration necessitate their separation. The addition of bundles should be undertaken with care, however. Experience with the empirical intractability of the original Schlager-Ostrom framework in applied field settings suggests that an even-more complex framework may be that much more empirically challenging. As Hohfeld (1913, p. 16) cautions, "too close an analysis might seem metaphysical rather than useful". Only in situations in which the

existing framework fails to capture and distinguish important differences in institutional or natural resource conditions, such as is argued here, is such refinement appropriate.

Anchoring to the Broader Literature: A Reference to Duties

There is a vast legal and institutional literature pertaining to duties, liabilities, and ownership. There is, however, little reference of this broader literature in Schlager and Ostrom (1992) or vice-versa. Envisioning how the Schlager-Ostrom framework may evolve to better capture situations of institutional change requires an examination of how its fundamental concepts fit into broader scholarly contexts.

It is of course impossible to do justice to the vast literatures of property rights and ownership in the space provided here. What follows is not a literature review per se, but rather a brief discussion of how the framework relates to seminal works of legal and institutional scholarship. The goal of this exercise is not to refute key assertions or to pass judgment on the appropriateness of one approach or another. Rather, we hope to simply draw a more coherent linkage between these oft-separated schools of thought, leveraging what is known in both to the study of contemporary natural resource problems while simultaneously motivating our suggested revisions to the framework.

Of particular relevance to this discussion are works by Wesley Hohfeld, Tony Honoré, and Daniel Bromley. Spanning nearly a century between them, their collective works have taught us much about ownership, property rights, property relations, and the incentives that are created by different property rights arrangements. Despite relevance to the Schlager-Ostrom framework, few if any works devote significant time to a discussion of the

linkages. Works by Bromley are cited within Schlager and Ostrom's 1992 paper, though these references reflect empirical findings rather than theoretical underpinnings. Others discuss the different works side-by-side but do not comment on their relationship (Veettil, Kjosavik, & Ashok, 2013). Works co-authored by Ostrom herself discuss the contributions of Hohfeld and Honoré to the study of property rights, but do not link that material back to the bundles framework (Cole & Ostrom, 2010; V. Ostrom & Ostrom, 1999). In particular, Cole and Ostrom (2010) briefly discuss Hohfeld, Honoré, and the Schlager-Ostrom framework, even going so far as to comment on the potential for overlap and divergence, but do not elaborate further.

Given the rarity of direct comparison, one could therefore suppose that Schlager and Ostrom (1992) has little to gain or to contribute to these other works. On the other hand, the repeated mention of them alongside one another implies connections. It seems to us that Hohfeld, Honoré, Bromley, and Schlager and Ostrom are not so much in disagreement, but are talking about different things. At the very least, they emphasize different parts of a related whole. Honoré outlines the elements of full ownership, Schlager and Ostrom focus on the arrangement of individual rights, and Hohfeld and Bromley teach much by way of the incentives that are transmitted between rights holders. We argue that, to be relevant to changing and increasingly complex natural resource management regimes, Schlager and Ostrom must somehow be placed in the context of these other works. The question, raised by the conspicuous absence of this in the literature, is how?

We begin with Honoré (1961), who sets out to articulate the incidents or elements of full ownership (rights to possess, use, manage, income, capital, security, incident of

transmissibility, absence of term, prohibition of harmful use, liability to execution, residuary character). The linkages between Honoré (1961) and Schlager and Ostrom (1992) are several and varied. In introducing the incidents of ownership, Honoré (1961, p. 113) explicitly mentions a bundles perspective, noting that "it is fashionable to speak of ownership as if it were just a bundle of rights, in which case at least two items in the list would have to be omitted". Two questions spring from this: 1) which of Honoré's incidents stand to be omitted, and 2) how could a Schlager-Ostrom nested bundles framework align with Honoré's remaining incidents? These two questions are themselves preceded by a more fundamental consideration, whether the Schlager-Ostrom framework could be viewed from the perspective of Honoré's incidents. Essentially, are they even compatible?

While it is theoretically possible to align incidents with their corresponding bundles, it does not follow that forcing all of one into the other is an appropriate exercise. Honoré and Schlager-Ostrom clearly set out to speak to different situations, with Honoré's focus on legal systems and Schlager and Ostrom's emphasis on common property regimes. Honoré's eleven incidents also provide a great deal more detail than the five bundles of the Schlager-Ostrom framework and speak to the larger institutional context within which rights are allocated. For example, incidents of security, transmissibility, absence of term, liability to execution, and residuary character all pertain to the durability and transfer of rights, aspects that are largely unaddressed in the Schlager-Ostrom framework. Another incident of particular interest is prohibition against harmful use, which could more appropriately be defined as a duty or responsibility and less as a right as elaborated upon by Schlager-Ostrom. A question explored below is whether a greater focus on such duties and responsibilities is an

appropriate exercise in the context of Schlager-Ostrom, and whether the inclusion of duties represents an improvement upon the original framework.

Beginning with Hohfeld (1913; 1917), scholars have devoted attention to the relationships between different classifications of legal relations, with rights and duties being of particular relevance. Hohfeld's work also advanced understanding of right structures and individual relationships. Hohfeld (1917) devotes significant effort to describing the important distinctions between the rights and duties held by individuals against other individuals ("in personam") and those held against multiple individuals ("in rem"). This distinction allowed for further analysis of the relationships between individuals, allowing for clearer articulation of the legal recourse for violation of rights (and claims), and therefore a more complete and critical evaluation of incentives. We believe this is a particularly salient contribution given the ubiquity of cases that have demonstrated property rights regimes where duties are not upheld.

The subject was furthered by Bromley (1989; 1991), who expanded Hohfeld's earlier paradigm and Demsetz's (1967) ownership classification scheme to examine the incentive structures put into place by various property rule arrangements. In his works, Bromley devotes significant time to explaining the differences between rights, duties, and privileges. He likewise describes the "triadic relationship" that rights create between an individual with the right, an object to which the right pertains, and all others who must respect that right, stating that "[r]ights can only exist when there is a social mechanism that gives duties and binds individuals to those duties" (1991, p. 15). This at once speaks to two issues, the role of enforcement and the presence of affirmative obligations or duties. Without diminishing the

critical role played by enforcement in property rights regimes, the focus at present is this notion of duties in the exercising of rights. As Bromley likewise notes, "[r]ights have no meaning without correlated duties and the management problem with open access regimes is that there are no duties on aspiring users to refrain from use" (1991, p. 2).

Hohfeld (1913, p. 9) provides a straightforward definition of duty which serves well the purposes of the present exercise: "that which one ought or ought not to do". Some property rights typologies treat duties as implicit or explicit characteristics of property rights (e.g., use designation and operational requirement characteristics as defined by Kundhlande and Luckert, 1998). For their part, Schlager and Ostrom (1992, 250) note the importance of clearly articulating the difference between rights and rules, specifically that "'rights' are the product of 'rules'". Citing Commons (1968), they briefly discuss the function of rules as specifying both rights and duties.

The question then moves to how duties are treated in the Schlager-Ostrom framework, how this relates to the above works by Hohfeld and Bromley, and how this affects the application of the framework to natural resource management issues with specific emphasis on institutional change. To narrow the field of analysis, we begin by applying the Schlager-Ostrom framework in the context of the Hohfeldian paradigm of correlated relations, limiting our evaluation on a subset of legal relations identified by Hohfeld and expanded upon by Bromley (1989; 1991). These are listed in Table 2-3. Static correlates refer to existing or established relationships, whereas dynamic correlates function in situations where new relationships may be created. Below, relations are apportioned to two hypothetically users, Alpha and Beta. In one situation, Alpha has a right, and Beta has the

correlated duty to observe that right. The situation could easily be reversed, where Beta has the right and Alpha is bound to observe the right. Alternatively, we could have a situation in which Alpha has the ability, or power, to develop a new relation with Beta, one that Beta is unable to stop (a liability).

Table 2-3. Selected static and dynamic correlate legal relations. Adapted from Bromley (1989; 1991) and Hohfeld (1913; 1917).

	Alpha	*Beta*
Static	Right	Duty
Dynamic	Power	Liability

Although both Schlager and Ostrom (1992) and Ostrom and Schlager (1996) describe rules as defining the allowable or required actions that accompany the exercising of a particular right, they devote a vast majority of their work to a discussion of rights. Apart from a lack of attention to correlated duties, Schlager and Ostrom also appear to conflate rights and powers. The Schlager-Ostrom framework splits their rights bundles into two separate categories – what they define as operational-level decisions and collective-choice decisions. As argued here, however, bundles defined by Schlager and Ostrom as collective-choice level rights are more appropriately defined as powers, or the authorization to alter relations between individuals, specifically the operational-level rights of access and withdrawal.

Viewing the Schlager-Ostrom framework in the context of both powers and rights, along with their correlates of liabilities and duties, the 5-bundle hierarchy introduced some

20 years ago expands significantly (Table 2-4). Seen in this expanded diagram are not only the original five bundles, but also the additional “alteration” bundle. We also see the correlated relationships for both rights (“duties”) and powers (“liabilities”). We argue that this expanded framework is necessary to fully appreciate the nuances and complexities of common property regime decision making.

In natural resource management policy formulation and implementation, formal property rights are enacted or reformed with the underlying assumption that rights will be realized at the operational level; that is, the duties and powers inherent in those rights will be recognized and internalized by resource users. Duties and powers apply to each of the property rights identified above. Our foray into duties and powers is particularly relevant for contemporary natural resource management issues that increasingly involve contractual agreements designed to guarantee a stock or flow of goods and services over a given time horizon. This focus on contracts and formalized obligations requires a clear understanding and documentation of the full suite of rights and responsibilities that characterize a given system.

Table 2-4. Revised Schlager-Ostrom framework, featuring both right bundles/correlated duties and powers/correlated liabilities. Also given are the implications of both holding and not holding a given right or power.

Right	**Duty**	
	Right Not Held	**Right Held**
Access	Do not access	Respect terms
Withdrawal	Do not obtain resource	Respect terms
Power	**Liability**	
	Power Not Held	**Power Held**
Management	Vulnerable to this and higher-order decisions	Vulnerable to higher-order decisions only
Alteration	Vulnerable to this and higher-order decisions	Vulnerable to higher-order decisions only
Exclusion	Vulnerable to this and higher-order decisions	Vulnerable to higher-order decisions only
Alienation	Vulnerable to alienation	Vulnerable to changes in formal (*de jure*) or informal (*de facto*) rule structures only

This added focus on the linkage between rights and responsibilities can be viewed in the context of another trend in natural resource policy, the increasing separation of goods and services (Beymer-Farris & Bassett, 2012). For example, a forest may no longer be viewed as just a forest but as a collection of land, trees, and carbon, each of which could be contracted for separately. The Schlager-Ostrom bundles framework does not have provision for

substantive alteration of the stock and flow of goods and services, aspects that have significant implications for fulfilling terms of medium to long run contracts. As such, both aspects of the revised bundles framework – an increased focus on responsibilities and the addition of alteration – are interrelated and serve to improve the application of the Schlager-Ostrom framework to contemporary natural resource policy issues. Below, we turn our attention to an application of the revised framework.

Applying the Revised Framework: The Example of REDD+

REDD+ is a mechanism to both enhance existing forest carbon stocks and reduce deforestation and forest degradation for the purpose of mitigating the effects of climate change. REDD+ is a particularly complex from a property rights perspective because it simultaneously operates at multiple scales and involves the consideration of rights to land, trees, carbon, and other forest related goods and services (e.g., Takacs, 2009). An advantage of placing REDD+ activities in the context of our revised property rights framework is the increased ease of evaluating the complex relations typifying common pool resources (CPR) management regimes simultaneously occurring in the context of these external policy drivers and contractual obligations. The focus of REDD+ on maintaining and improving forest condition benefits from our increased attention to alteration, while the role of obligations to maintain these conditions over time speaks to our focus on correlated responsibilities, making REDD+ an appropriate test case for our revised framework.

A Revised Framework and REDD+

The success of REDD+ hinges on the resolution of several oft-cited impediments. A primary hurdle to REDD+ is forest tenure. As Streck (2009, p. 154) defines it, tenure "determines who can use what resource, for how long and under what conditions". Unclear or "diluted" responsibilities can lead to deforestation (Streck 2009, p. 154), and secure tenure, along with the availability of appropriate economic incentives, and opportunities for participation in program design and implementation, are therefore viewed as being a necessary first step in local community engagement in REDD+ activities (Lawlor, Weinthal, & Olander, 2010).

The picture of REDD+ is further complicated in that implementation requires not only the resolution of existing rights, but also the assignment of new ones, specifically as they relate to carbon (Streck, 2009). On one hand, it can be difficult to assign clear property rights to ecological services due to their inherent interconnectedness and linkages to other services and systems (Costanza & Folke, 1996). For example, allocation of the benefits of carbon storage among multiple users is difficult in an environment characterized by unclear or shifting resource boundaries (Roncoli et al., 2007). The multiple attributes present in a forested system likewise complicate resolution of property rights. Much as the rights may be bundled, so too may be the resource itself. In a given forested area, one has land, trees, carbon, and countless other attributes. CPR regimes may also be characterized by what Kundhlande and Luckert (1998) refer to as "multiple tenures," or the allocation of one set of property rights for the land, another for specific goods or services coming from the forest itself (e.g., timber; nontimber forest products; carbon). The biophysical relationship between

carbon and these other attributes implies that the allocation of carbon property rights is dependent upon the allocation of property rights surrounding these other attributes. From a resource typology perspective, however, forest carbon storage possesses the attributes most likely to lead users to address both appropriation (e.g., allocation) and provision (e.g., management and protection) issues (Schlager, Blomquist, & Tang, 1994). The forest resource is stationary and the valued commodity, carbon, is bankable or capable of being stored. In and of themselves, these attributes would tend to facilitate the development of fixed rights to forest carbon.

The incentive to manage for the increased productivity and performance of a natural resource system is inherently tied to the ability of individuals or groups to capture the benefits of management and investment (Ostrom & Schlager, 1996). Of their five "bundles", alienation is highlighted as particularly important, as it allows managing individuals to "personally withdraw their share of the accumulated assets resulting from their prior investments in conservation or enhancement activities" (Ostrom & Schlager, 1996, p. 137). Ostrom and Schlager (1996) note that this assertion is largely borne out in the literature, but that other owner positions (e.g., proprietors) may also possess adequate incentives to make investments in the productivity and performance of a resource. Introducing alteration into the realm of proprietor (Table 2-2) complicates this assertion, as the potential exists for reconfiguration of rights through fundamental change of the underlying resource.

In the context of REDD+, our revised framework allows differentiation between those activities centering on the exercising of management (improved forest management and reduced degradation) and those centering on alteration (afforestation/reforestation and

avoided deforestation). For example, improved forest management and reduced degradation both require management powers to initiate activities. Alternatively, afforestation/reforestation activities require positive land use change to initiate (alteration from a non-forest use to forest), while avoided deforestation is predicated upon a lack of land use change (i.e., prevented alteration away from forest). We argue that it is the fundamental shift in resource attributes in each of these latter activities that necessitates a distinction between management and alteration.

As the incentives to invest in resource improvement vary by right holder position, maintenance of activities operating under a REDD+ regime would require not only management powers (in the case of improved forest management and reduced degradation) and alteration powers (in the case of afforestation/reforestation and avoided deforestation), but likely higher-order powers as well. Exclusion is of particular importance, as the ability to exclude activities detrimental to the provision of a service is a key element of payment for ecosystem services (PES) programs, generally (Sunderlin, Larson, & Cronkleton, 2009). In a broader context, these higher-order powers are important because they begin to speak to the long-term sustainability of increases in forest carbon storage and reductions in forest carbon emissions, the joint greenhouse gas (GHG) mitigation objectives of REDD+. The revised framework introduced here highlights the important distinctions between these rights and powers, allowing researchers and policymakers to focus on the connection between specific activities and the particulars of a given property rights regime in observing the effectiveness of REDD+ initiatives. The enhanced focus on correlated duties and liabilities likewise allows

for a greater investigation of the effect of permanence requirements that are likely to be imposed on individual REDD+ project activities.

The Example of Permanence

A unique attribute of terrestrial carbon storage is its inherent non-permanence, or the potential for stored carbon to be reemitted back to the atmosphere (Cooley, Galik, Holmes, Kousky, & Cooke, 2012). This presents an important distinction between carbon and other commodity markets, that the "use" or "extraction" of the resource comes with additional strings attached. There is an obligation to maintain that carbon long after it is sold.

Even in those analyses focusing on carbon storage on forest commons, the literature is generally silent on the issue of liability for loss and obligations to maintain storage (e.g., Chhatre & Agrawal, 2009), though notable exceptions do exist. Dutschke & Angelsen (2008), for example, identify non-permanence as an important concern in REDD, arguing that assignment of liability is a necessary precondition to ensure resulting credit fungibility in larger carbon markets. Palmer (2011) discusses the importance of assigning liability in the context of REDD+, and the link between it, property rights, and various institutional frameworks in determining reversal risk. Takacs (2009) meanwhile provides a discussion generally limited to the legal and tenure issues associated with REDD+, but presents a cautionary note that liability for underperformance and reversals are important to clearly delineate at the outset. Takacs (2009, p. 63) echoes the conflict present in other works on the subject, on one hand calling for clear delineation of both rights and responsibilities in either laws or contractual provisions so as to avoid future conflicts, but on the other noting that

“forest carbon ‘law’ should be pluralistic”, that it should “encompass local, informal legal arrangements”. The Forest Dialogue (2008) speaks to the inability of forest-dependent peoples to assume the risk (loosely defined) associated with carbon market participation. They argue, somewhat counter to Takacs (2009), that as of the date of the article “few countries have begun to address the property rights issues surrounding carbon sequestration, emissions, and trade” (The Forest Dialogue, 2008, p. 3-4), concluding with a call for clearly defined rights for the benefit of “the forest-dependent poor”.

Regardless of the policy structure through which REDD+ activities are to be implemented, it is likely that liability for carbon loss will need to be addressed somewhere, somehow. Under situations like the co-management framework reviewed by Palmer (2011), liability for carbon loss must be assigned so as to reduce deforestation and forest degradation incentives. If REDD+ activities are occurring as individual projects or if carbon reductions emerging from REDD+ are to be traded in some larger carbon market, the assignment of liability for reversal is of utmost importance (Dutschke & Angelsen, 2008; Streck, 2009).

Returning to the revised framework outlined in Table 2-4, the assignment of liability to affected groups and individuals is facilitated by first correctly distinguishing between powers and rights. As Schlager and Ostrom appropriately capture the important distinction between what they term operational and collective-choice decision making, the primary advantage of the revised framework in this regard is a simple correction of terminology. Literature outlining legal relations between parties has traditionally labeled the authorization to modify operational-level decisions as a power. In the context of liability for carbon reversal, this correction in terminology can help to unite what is at present a contract law-

centric discussion in the carbon market literature (e.g., MacKenzie, Ohndorf, & Palmer, 2012) and the literature on forest management, property rights, and tenure to which the Schlager-Ostrom framework is more directly applied. Turning to the correlate of power, the explicit recognition of the liability imposed by a lack of power can allow for an increased focus on the incentives to improve, transform, or alter a resource.

The greater contribution of the revised framework is on the issue of rights and their correlated duties. This is observable in the case of access and withdrawal rights in REDD+ activities, the decision levels where carbon sequestration is operationalized. Rights to receive some benefit for the increased carbon now stored in the forest arguably come with the duty not to withdraw other attributes that detrimentally affect carbon storage, a duty which, as explored below, may or may not be allocated through formal contract. The question is, in the case of carbon mitigation achieved through REDD+ activities, is this restriction better characterized as a modification of rights to these other attributes, or as an imposition of duties to the carbon buyer, larger carbon registry, or state or other entity providing benefits in exchange for carbon storage?

A focus on both rights and duties allows for exploration of this question. Returning to Hohfeld's analysis of in rem and in personam duties, we can imagine that the duty side of the equation in Table 2-4 above to be broken down by relation, ranging from obligations to individuals (e.g., funding entity, carbon benefit provider) or multiple individuals (e.g., community). A focus on correlated rights and duties facilitates this distinction to be observed (Figure 2-1). We argue that conceptualizing the framework in this manner allows for deeper

exploration into issues of forest carbon liability, itself an issue recognized for its complexity and multiple avenues for resolution under the auspices of REDD+ (Palmer, 2011).

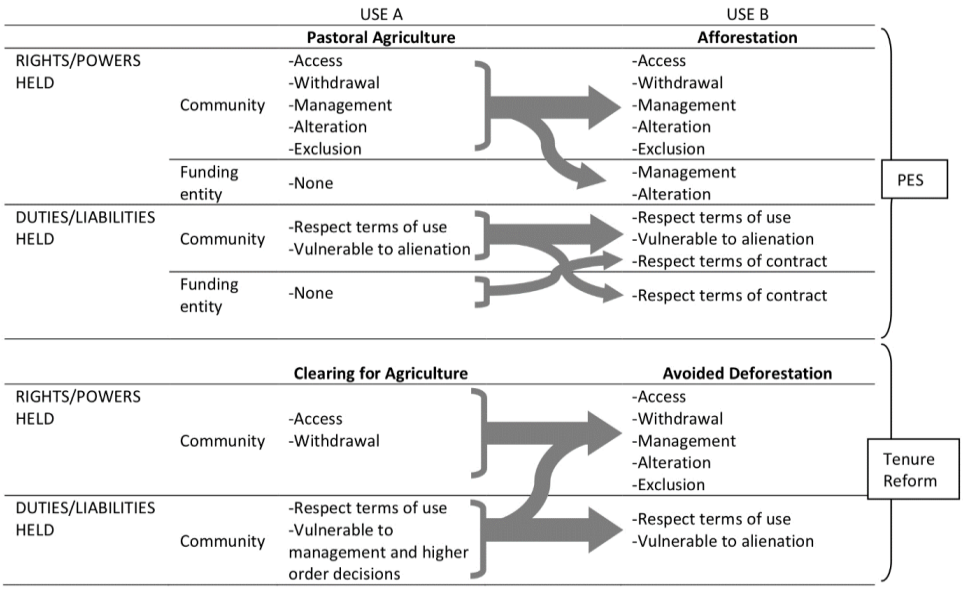

Figure 2-1. Overview of two hypothetical land use alterations taking place under the auspices of a REDD+ program.

Having isolated a particular relationship, we can now focus on the larger rule structures into which they are imbedded. These rule structures play a defining role in the exercising of both rights and duties, particularly through the provision and direction of incentives. Changing rule structures are themselves highlighted by the gray arrows in Figure 2-1, representing the allocation of rights and duties across land use and institutional contexts.

The first example in Figure 2-1 (pastoral agriculture to afforestation) represents a PES-type scheme, in which an outside entity purchases carbon credits for carbon stored. In this example, we see that the primary change in moving from Use A to Use B is the

allocation of additional powers to the entity purchasing the carbon credits yielded by the afforestation project. This represents an additional provision of what we could call in personam powers to the funding entity while preserving but slightly modifying the in rem allocation of rights and powers among the community itself. Note also the allocation of new duties to both the funding entity and the community as there is now a contractual obligation for the community to maintain the carbon and a contractual obligation for the funding entity to pay for this stored carbon. The second example (clearing for agriculture to avoided deforestation) is perhaps best seen in the context of tenure reform, in which additional powers are secured allowing for investments to be made to existing resources. Here, the primary change is the change of in rem management, alteration, and exclusion liabilities to powers. Community-defined terms-of-use remain, as does liability to state-imposed alienation decisions, but increased powers have been given to the community to make management, alteration, and exclusion decisions. It is these new powers that could dramatically alter the incentives to avoid conversion to agriculture in favor of maintained forest cover.

Streck (2009) makes the clear connection between payments under REDD+ and an associated loss of rights. The PES example detailed in Figure 2-1 gives credence to this claim. Here, the provision of some service (i.e., the storage of carbon) is paid for by some outside entity. In entering into such an agreement, the power to manage and alter land use is now partially contractually obligated to that entity so as to ensure the continued availability of that service. The tenure reform example is typified in research by Chhatre and Agrawal (2009), who find that greater rule-making autonomy can result in higher levels of carbon

storage. It also represents the recurrent theme in the literature calling tenure reform as a necessary prerequisite to reduced deforestation (e.g., Lawlor, et al., 2010; Sandbrook, Nelson, Adams, & Agrawal, 2010; Streck, 2009). Modifying the tenure reform example to include some direct payment for avoided carbon emissions (thus making it more akin to the PES example), we begin to approach a situation discussed by (Milne, 2012, p. 704) in which "local property rights were both recognized and taken away at the same time". In such a situation, we would retain both the branched arrows of the PES example indicating the transfer of powers and imposition of new duties and the transfer of liabilities to powers indicated in the tenure reform example.

The complex interplay of new duties and liabilities alongside the allocation of new rights and powers requires a framework capable of distinguishing between each. The revised framework presented here allows, for example, clearer distinction between carbon-related duties and those relating to access, withdrawal, and management of other resources (e.g., timber, water, minerals). It also allows for comparative analysis of multiple property rights regimes and their ultimate effect on the permanence of stored carbon. Larson, Barry, and Dahal (2010, p. 91), for example, argue that "the management portion of the bundle of rights is being spliced in ways that guarantee that the state will continue to play a central role in decision making". In the presence of such "splicing away," what are the observed differences specifically from a carbon storage perspective between reforms that splice management rights versus those that splice alteration? And are there observed differences in the permanence of carbon storage between the two?

Examination of a few early carbon storage projects can further reinforce the potential benefit of a revised framework. One such example is the Kariba REDD+ Project operating under the Verified Carbon Standard (VCS) (von Laer et al., 2012). The project began in July of 2011, and covers nearly 785,000 of woodland forest in northwest Zimbabwe. The land on which the project occurs falls across four separate provinces and is partially administered by Carbon Green Investment (CGI), the project proponent, and four local Rural District Councils (RDCs). The project consists of several activities intended to prevent additional deforestation and to improve degraded forest lands, including the promotion of sustainable agricultural techniques, fuelwood plantation establishment, fire management activities, monitoring and patrols, and the establishment of a community sustainable fund. Through a series of contracts, carbon revenue generated by the project is to be allocated among both CGI and the four RDCs, a formula for which is detailed in the project description document. The interactions between the rights to make use of forests, the rights to carbon finance proceeds, the obligations to further project objectives, and by extension, the implications of any future reversals are precisely the complex issues the revised framework are intended to address. With specific regard to alteration, identifying it as a separate bundle is useful to explore the implications of plantation establishment and other projects in which a change in land use could be expected. Indeed, preventing the area from being "cleared for non-sustainable alternative land-use scenarios" was a primary motivation in establishment of the project (von Laer et al., 2012, p. 4).

Contrast this to the Humbo Assisted Natural Regeneration Project in Ethiopia, registered under the Clean Development Mechanism in December 2009 (Biocarbon Fund,

2009). The revised framework introduced here is helpful in exploring the apportionment of responsibility for stock maintenance against the rights to future carbon revenue. The considerable effort devoted in project documents to clarify carbon rights, landholding rights, and the roles and responsibilities of key project stakeholders likewise speaks to the relevance of the revised framework (Biocarbon Fund, 2009, Annex 5). The value added by the alteration bundle is less clear in this example, however, as project documentation does not discuss project activities in fine enough detail to distinguish between management and alteration.

Conclusion

Having proposed a revision to Schlager and Ostrom's seminal framework, are there clear advantages to be gained in the application of the proposed modification? We argue that there are. By drawing attention to the correlates to rights and powers, the traditional focuses of analysis, we bridge the legal and institutions literature, and show how an increased focus on duties can yield increased insight into the relations that will define the incentives for GHG mitigation through the imposition of various rule structures. By adding a sixth bundle – alteration – we allow the framework to be more responsive to the nuances of resource management situations such as REDD+ other PES mechanisms that involve fundamental changes in the attributes of resources.

An inherent flaw in the revised framework is its increased complexity over the original. As noted above, this additional complexity may complicate application. Any discussion of correlated rights and duties should likewise bear in mind a cautionary note from

Bromley (1991, p. 50), however, that "instances of actual rights and correlated duties are best thought of as situations where the law is reasonably clear," implying that application of the revised framework discussed here could be difficult in situations of unclear or overlapping tenure systems. The true value of the revised framework will therefore be realized only with future application.

To that end, we envision several possible outlets. First and foremost, we believe that there is value in revisiting previous studies conducted using the original Schlager-Ostrom framework to evaluate the benefits of using the revised framework developed here. The examples reviewed here also largely relate to terrestrial land use change. Work should be devoted to examining the applicability of the revised framework to other natural resource contexts, for instance the explicit or implicit allocation of alteration powers in activities that affect water quantity, water quality, and/or fisheries directly. Multiple examples likewise exist in Western legal and policy contexts in which an increased attention to both rights and duties would be beneficial and provide further opportunity to explore alignment of Schlager-Ostrom with Honoré and other seminal works of property rights and ownership.

CHAPTER 3 : EXPLORING THE DETERMINANTS OF EMERGING BIOENERGY MARKET PARTICIPATION

Individual biomass producers will play a strong role in the emergence of robust and sustainable bioenergy markets. Research on what drives their participation, however, is substantial but fragmented. Despite a recognition of producer heterogeneity, there have also been few comparative analyses of drivers of bioenergy market participation across feedstock types, producer groups, and geographic regions. Through narrative review and network analysis, the following review of the bioenergy market participation literature generates both an increased appreciation of how bioenergy market participation is assessed in existing research and how social network analysis may be further employed as a tool for literature review. Across 41 studies selected for qualitative review and a subset of 22 selected for quantitative review, the analysis reaches two central conclusions. The first pertains to the findings of the literature itself, suggesting that a variety of non-production objectives, structural and social constraints, and market-related attributes influence bioenergy market participation decisions. A second conclusion is that the assessment of these factors varies significantly across the literature for both user group and feedstock type. Further examination of the individual variables within these segments of the literature, as well as of authorship patterns across them, suggests that this variation may rise from differences in the subject matter itself and not from differing perspectives of the researchers undertaking the work. Should disparities in the literature be reflective of actual socio-economic differences in their respective markets, policies or programs targeted to individual feedstock types or user groups may be more effective in encouraging participation than uniform national policy initiatives.

Introduction

Despite the strong role of individual biomass producers in emergence of a robust and sustainable bioenergy market, relatively little research exists on what drives their participation (Clancy, Breen, Moran, Thorne, & Wallace, 2011). And despite a recognition of a wide degree of producer heterogeneity (Tyndall, Berg, & Colletti, 2011), there have also been few comparative analyses of drivers of bioenergy market participation across different producer groups (Conrad, Bolding, Smith, & Aust, 2011; Markowski-Lindsay et al., 2012). These absences are all the more conspicuous in light of the large contributions bioenergy is projected to play in the U.S. and E.U. economies and the wide array of policies and incentives targeted to increasing their production and use (Vegh & Galik, 2014). Compilation of the lessons learned from the existing body of work is therefore a necessary and timely exercise.

Much of the research that describes aggregate bioenergy supply is generated from the use of economic models such as the Forest and Agricultural Sector Optimization Model with GHGs (FASOMGHG), the Global Trade Analysis Project (GTAP) model, POLYSYS, and others. These models have been used in recent years to assess a vast array of policies and environmental impacts (Baker, Murray, McCarl, Rose, & Schneck, 2011; Beach, Zhang, & McCarl, 2012; Birur, Hertel, & Tyner, 2008; Dicks et al., 2009; Keeney & Hertel, 2008; Murray et al., 2005). As powerful as these models are, they generally rely on a simplified model of producer participation, that of the profit maximizer. In the case of new or emerging markets like carbon offsets or bioenergy production, profit maximization may be a defensible assumption for larger landholdings or those that are managed for financial returns (G.C. &

Mehmood, 2012; Galik, Murray, & Mercer, 2013). As programs scale and a broader suite of producers are assessed for participation, however, models based on a singular assumption of profit maximization fail to incorporate the full range of objectives that may be managed for, and in doing so, may generate constrained, misleading, or otherwise incomplete results (Galik, et al., 2013; D. J. Smith, Schulman, Current, & Easter, 2011; Willock et al., 1999). In particular, they may tend to over-estimate participation rates and supply (Latta, Adams, Alig, & White, 2011).

A first step in addressing this is to develop a better sense of those factors that do influence producer decision making as it pertains to bioenergy market participation. Such a compilation is conducted here. The analysis first surveys the available literature for both identified drivers of and attributes associated with bioenergy participation. In addition to traditional economic measures such as feedstock price or willingness-to-pay, it also assesses factors such as demographic indicators (e.g., age, income, education), biophysical attributes (e.g., soil type, site productivity), and previous participation experience (e.g., conservation program participation, familiarity with easements). Next, social network analysis is employed to further explore trends in the literature with a particular emphasis on how identified factors may vary by region, feedstock, or user group. The analysis concludes with a summary of findings and recommendations for future model and policy development efforts.

Observing bioenergy market participation

Bioenergy market participation, defined here as "the direct generation of earnings from bioenergy market activities", may be observed differently across different parts of the bioenergy market supply chain. Specifically, market participation will mean different things for biomass producers, energy producers, and brokers, processers, and other intermediaries (Conrad, et al., 2011). The focus in this analysis is on bioenergy feedstock producers – farmers and foresters. But even within biomass producers, bioenergy market participation can be observed by way of several different behavioral changes, ordered here by the degree of commitment required or degree of risk exposure (Table 3-1).

Table 3-1. Bioenergy producer activities arrayed by degree of commitment or risk.

Activity	**Observable By**	**Commitment or Risk**
Change in Market	"willingness to sell to bioenergy refinery"	Lowest
Change in Contracting	"willingness to enter into long-term contract"	
Change in Feedstock Output	"number of acres of switchgrass planted"; "willingness to collect corn stover"	↓
Change in Cropping System/New Entrant	"willingness to establish miscanthus"	Highest

At the most basic level, bioenergy market participation can occur without substantive change in practice. This situation involves only a change "on paper", whereby there is a shift in feedstock spot or comparable over the counter (OTC) market but not change in product or terms (e.g., corn supplied to an ethanol refinery instead of a feedlot operation). Importantly,

this shift may or may not be known to the feedstock producer, depending on harvest arrangements and the presence of aggregators and other market intermediaries. Next, one could undertake a shift in type or terms of contracting to take advantage of bioenergy market opportunities (e.g., establishment of long-term contract to supply an ethanol refinery). Requiring additional levels of commitment are changes in feedstock output undertaken by existing farmers, measured in either a change in harvest scale (e.g., more acres planted) or an expansion of products harvested (e.g., harvesting stover for the first time). Finally come new entrants, or those individuals cultivating and/or harvesting for the express purpose of supplying biomass feedstock, thus requiring the purchase of new equipment and/or the establishment of new crops. These differences in commitment or exposure suggest that the factors underlying market participation may differ by feedstock. And as targeted feedstocks are not universal across space or industry, one could also expect to see differences in factors associated with market participation by region and user group, as well. These hypothesized differences form the theoretical basis of the following analysis.

Materials and Methods

Previous efforts to assess the factors contributing to particular land management decisions (Beach, Pattanayak, Yang, Murray, & Abt, 2005), social perceptions of new technologies (Brohmann et al., 2007), GHG and environmental effects (Guo & Gifford, 2002; Langanière, Angers, & Paré, 2010; Riffell, Verschuyl, Miller, & Wigley, 2011), and productivity (Miguez, Villamil, Long, & Bollero, 2008; D. Wang, LeBauer, & Dietze, 2010)

have employed meta-analytic approaches of varying complexity. These approaches range from simple vote counting to full statistical analysis of compiled results.

Owing to a suite of incentives that drive researchers to specialize in both discipline and methods (Poteete, Janssen, & Ostrom, 2010), the literature relevant to bioenergy market participation is fractured and wide-ranging. The varied subject matter and the range of both independent and dependent variables employed by the underlying literature complicates a formal meta-analysis. This analysis presents instead a narrative overview of the literature augmented by social network analysis (SNA). SNA is a powerful tool for assessing the way in which people or things are arrayed. It can be used to study the composition of networks as a whole or the strength and direction of ties between individuals within a given network. Although SNA has been commonly used to assess the ties between researchers via citation records (Li, Liao, & Yen, 2013; Otte & Rousseau, 2002), it has been applied to the findings literature itself much less frequently (van de Wijngaert, Bouwman, & Contractor, 2012).

SNA provides several benefits over a traditional descriptive or narrative literature review. In the present case, it can be used to graphically and quantitatively highlight trends ranging from "which are the variables most often used, and which variables are most often associated with each other?" to "do different relationships exist between variables in different regions or in studies on different bioenergy feedstock?". Collectively, this information can help refine understanding of the drivers of participation itself, as well as inform other research that depends on understanding these drivers.

The first stage of review and analysis consists of identification of cases or studies to review. Cases are selected from those returned from targeted Google Scholar searches,

described below. Google Scholar is used instead of traditional academic search engines (e.g., AGRICOLA, Web of Science) for two reasons. The first is to return the broadest sample of studies so as not to be limited by search provider subject areas. The second is that many of these studies exist only in the gray literature, whether in the form of unpublished conference papers, theses, dissertations, or whitepapers. Including these latter source categories requires an implicit assumption that the published and gray literatures are equivalent, at least in so far as they both provide an indication of the research being conducted.

Search terms are tailored by feedstock type. For dedicated energy crops, the assumption is that only those producers intending to participate in bioenergy markets will plant dedicated energy crops. In these cases, search terms consisted of "crop adoption" + [feedstock], where [feedstock] is one of four dedicated energy crops: switchgrass, miscanthus, hybrid willow, hybrid polar, or short rotation woody crop (SRWC). A similar search was conducted for corn stover and forest residues. Although these clearly are not dedicated energy crops, parsing out non-energy uses from the search returns is not necessary as it is unlikely that residues would be harvested *except for* bioenergy use. The search strategy is therefore straightforward: [residue] + willingness + harvest OR collect*, where [residue] is either corn stover or forest residue. The search strategy for multiple-use feedstock is more complicated, as it must differentiate the generation of earnings derived from the sale of feedstock for bioenergy purposes and that generated from sale to traditional commodity markets. To do so, the following search term is used: [feedstock] + willingness + sell OR

produce + bioenergy OR biofuel OR biopower, where [feedstock] is one of several feedstock types (corn, sugarcane, sweet sorghum, soy, and pulpwood).

Raw search statistics are included in Table 3-2. In addition to the studies returned from the targeted searches described above, the analysis also includes those studies identified through review of returned study reference lists or that were returned in searches for other feedstock (e.g., a corn stover study returned in a search for switchgrass). All identified studies are assessed for their contribution to the narrative review of the literature. Each study is also assessed for its relevance to the quantitative and network analysis components, translating in practice to the presence of a model associating market participation with other observable attributes. For comparative purposes, the analysis include studies from both the Southeast (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia) and Midwest (Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin).

Table 3-2. Search statistics. Search for each feedstock was conducted on date indicated. Conceptually-relevant studies included a model associating market participation with other observable attributes; geographic area includes studies conducted in both the Southeastern and Midwestern U.S. As studies often mention or examine multiple feedstocks, there is significant overlap between categories. Listed also are the numbers of studies identified by means other than the targeted Google Scholar search, such as from the reference list of previously returned studies or through the results of targeted searches for other feedstock.

Search	Gross Google Scholar returns	Conceptually- and geographically-relevant studies returned in targeted search	Conceptually- and geographically-relevant studies identified by other means	Total Studies Assessed
Dedicated				
Switchgrass (4/9/13)	45	7	6	13
Miscanthus (6/10/13)	30	1	3	4
Poplar (6/11/13)	32	1	1	2
Willow (6/11/13)	29	1	0	1
SRWC (6/10/13)	152	1	1	2
Residues				
Corn stover (4/9/13)	305	8	2	10
Forest residues (6/10/13)	336	4	0	4
Forest biomass (5/24/13)	786	11	3	14
Commodities/ Multiple-use				
Corn (6/13/13)	2510[a]	2	0	2
Soy (6/12/13)	669	0	1	1
Sugar cane (9/14/13)	927	0	1	1
Sweet sorghum (6/12/13)	160	1	0	1
Pulpwood (6/12/13)	329	12	0	12
Total Studies		**49**	**18**	**67**
Total Unique Studies				**41**
Total Unique Studies Assessed Quantitatively				**22**

[a] only the first 1,000 results were returned by Google Scholar in this search.

The quantitative analysis begins with each relevant study being coded into an Excel database. Each row represents a unique combination of feedstock, region, independent, and dependent variables within a given study. In a process called unification, variables are renamed when conceptually similar to variables employed by other studies. For example, dummy variables for farm location in North Illinois and North Iowa are both recoded as "Region". For studies including several different specifications of a single model (e.g., different combinations of variables) or that assess the performance of several different models (e.g., probit, two-part hurdle), each dependent-independent combination is recorded only once. For example, a hypothetical study exploring three alternative models of "Feedstock Production", in which "Region" was featured as an independent in each, "Education" featured in two, and "Farm Income" in one would yield just three Dependent-Independent records: "Feedstock Production-Region", "Feedstock Production-Education", and "Feedstock Production-Farm Income". Studies that assess similar models or specifications for different regions or feedstock are recorded separately (e.g., Iowa switchgrass v. Iowa miscanthus; Iowa switchgrass v. Tennessee switchgrass). Other descriptive data is recorded for each record, including the statistical relationship (significant or non-significant at p=0.05, NA, varies), the direction of the relationship (positive, negative, NA, varies), and multiple attributes pertaining to the underlying study (Table 3-3).

Table 3-3. Data collected for each combination of dependent and dependent variables

Variable	**Description**
CaseID	Unique record identifier
StudyID	Unique study identified
FullTitle	Title of Study
ShortTitle	Truncated title of study (first and last 9 characters)
Author (1 to *n*)	Name of study authors (unique column for each author)
Entity (1 to *n*)	Home entity for each author (unique column for each author)
Discipline (1 to *n*)	Primary discipline for each author (unique column for each author)
Year	Year of publication
Journal	Publication outlet
JournalDiscipline	Discipline of source publication
GeographicArea	Geographic area of study focus
TargetGroup	Study target group, profession, or population
PolicyContext	Policy context of study
EndUse	End use of feedstock
Methodology	Type of analysis employed
Feedstock	Study target feedstock
Dependent	Dependent variable
Independent	Independent variable
RelationDirection	Direction of Dependent-Independent relationship (+/-)
RelationSig	Significance of Dependent-Independent relationship (Y, N)

The search and unification process yielded 690 variable records. In recognition of the complexity of bioenergy market participation decisions, this analysis focuses solely on dependent-independent variable combinations yielded from multivariate analyses. Though model misspecification, including endogeneity and/or the omission of important independent variables, is a risk in each of the studies assessed here, the relationship between independent variables and the outcome of the dependent is better reflected in multivariate analyses than in bivariate owing to the influence of possible confounds in the latter. For this reason, several records were excluded that were assessed using only t-test or simple correlation. Also excluded are dependent variables that fail to address the fundamental issue of market

participation, such as dependents that address only market organization preference or co-op membership decision-making.

The market participation decisions expressed in Table 3-1 are explored by the literature in several different ways. Aggregating conceptually similar terms and arraying by the degree of information that is conveyed in subject response yields the following four dependents: Interest/Knowledge (stated awareness or willingness to engage in production of a given biomass feedstock); FeedstockProduction (intended or observed production of a given biomass feedstock); ShareConverted (amount of area dedicated to production of a given biomass feedstock); and WTA/WTP (price at which a given biomass feedstock production scenario would become favorable). Reducing the dataset to only those records containing one of these four dependents yields a final dataset size of 446 records extracted from 22 separate studies, a list of which may be found in Appendix A.

Having assembled the final dataset, the data is characterized using a variety of general summary statistics. The software packages UCINET 6.0 (Borgatti, Everett, & Freeman, 2002) and NetDraw 2.135 (Borgatti, 2002) are then used to format the dataset and generate figures representing the relationships between independent and dependent variables. These figures, called graphs, show general trends in the data, such as clustering, relative similarity, and number of occurrences. In NetDraw, graphs are plotted using an algorithm seeking to optimize three criteria simultaneously: 1.Equating point and path distance (i.e., placing more closely related points closer together than dissimilar ones); 2. Avoiding overlapping nodes; 3. Prioritizing equal-length lines to aid in interpretation (Borgatti, Everett, & Johnson, 2013).

Network graphs provide quick insight into the relative composition of a given network, but are augmented by quantitative analysis of network structure. Network density, or the total number of ties in a network relative to the total number of possible ties, is first calculated for each region, user group, and feedstock type. The analysis concludes with Quadratic Assignment Procedure (QAP) regression to assess the significance of several potential predictors of network structure. QAP regression generates multiple permutations of the dataset to generate a sampling distribution from which a test statistic may be derived, and is a tool often employed in network analysis (Lee, Feiock, & Lee, 2012; Moeliono, Gallemore, Santoso, Brockhaus, & Di Gregorio, 2014; Nagpaul, 2003; Tsai, 2002; Wey & Blumstein, 2010). To preserve network structure, the permutation procedure maintains the relationships present between data within any given row or column while eliminating any direct relationship between the dependent and independent variables. In doing so, QAP regression avoids violation of independence assumptions that would otherwise prohibit the use of ordinary least squares (OLS) regression (Krackhardt, 1988; Simpson, 2001).

The QAP regression in this analysis uses as its dependent variable the number of times the literature associates a particular dependent variable with a particular independent variable. Separate matrices representing these unique combinations are created for each region, targeted user, and feedstock category. Also included is a matrix noting whether a particular dependent-independent variable combination was found to have a statistically significant relationship ($p<0.05$). Note that variables in each of these categories are not mutually exclusive (i.e., a given dependent-independent variable combination may be found

in both Midwest and Southeast studies). The attributes of each matrix then serve as the independent variables in the QAP regression.

Synthesis of Literature: Who Is Likely to Participate?

The results of the literature review are presented below. Presented first is a narrative review of the literature, describing the key findings and trends emerging from recent works. Second, a subset of studies meeting all inclusion criteria is evaluated using network analysis. The section concludes with a brief discussion of findings and conclusions.

A Narrative Review of the Literature

Much of the literature on bioenergy market participation tends to be case-based, focusing on a singular region, a singular feedstock, or a singular user group. Taking a broader perspective across the literature, one theme that emerges is that, while important, profit is only one of several motivations behind feedstock production, specifically, and market participation, generally (Convery, Robson, Ottitsch, & Long, 2012; Rämö, Järvinen, Latvala, Toivonen, & Silvennoinen, 2009). Rather, actual production decisions are influenced by "by non-economic considerations, including values, beliefs, aesthetics, and extended benefits for family and community" (Rossi & Hinrichs, 2011, p. 1420). As Smith et al. (2011) likewise note, "[n]ew cropping systems require a significant investment of time, effort, and capital to implement. Even if expected returns are high, risks such as a loss of grain subsidies, drain tile damage, biomass price volatility and reconversion costs can keep farmers from participating." (p. 1). These latter categories do not so much refute the relevance of a profit-

based motivation framework, but rather argue for a more comprehensive view of what must go into profit estimation (e.g., costs attributable to risk and uncertainty).

Another theme that emerges is the uncertainty that still remains in the bioenergy market participation literature itself (Leitch, Lhotka, Stainback, & Stringer, 2013). As noted by Ostwald, Jonsson, Wibeck, & Asplund (2013), "[t]here is clearly a knowledge gap in our understanding of the various groups of motivational factors and how they are assessed by individual farmers" (p. 29). One reason for this uncertainty is that bioenergy markets may draw upon new products or entail new harvest practices, limiting the applicability of previous research on traditional forest and agricultural commodities (G.C. & Mehmood, 2012). And despite the attention in research and policy, the use of targeted survey techniques such as contingent valuation to assess the factors affecting supplier willingness to accept (WTA) decision-making remains relatively rare (Pancholy, Thomas, Solís, & Stratis, 2011).

Apart from these general themes, the literature provides insight into several broad and interrelated categories of factors associated with bioenergy market participation. The first category includes the non-production objectives of the landowners or managers themselves. For example, Pancholy, et al. (2011) note the role of aesthetics and non-agricultural investment objectives in influencing WTA payment for conversion of forests to corn production for ethanol. This also holds true for timber harvest activity in general (Gruchy, Grebner, Munn, Joshi, & Hussain, 2012). Joshi & Mehmood (2011) likewise report links between habitat management goals and willingness to supply biomass, while Hipple & Duffy (2002) find that compatibility with values and beliefs and aesthetic considerations influence the adoption of energy crops.

A second category of factors influencing bioenergy market participation includes structural and social factors that can be said to define producers and their operations. Demographically, younger landowners (Joshi & Mehmood, 2011; Lynes, Bergtold, Williams, & Fewell, 2012) and landowners with a higher education (Lynes, et al., 2012) are more likely to participate in bioenergy markets. Multiple economic, resource, and biophysical constraints also affect participation in biomass feedstock markets. Insufficient prices, time investments required, high equipment and fuel costs, asset possession costs associated with storage and delivery, land ownership/tenancy, debt/credit restrictions, farm size, existing cropping system, feedstock production restrictions, soil type, topography, location, other program participation, and concerns of being perceived by peers as too progressive (Alexander et al., 2012; Cope, McLafferty, & Rhoads, 2011; Dirkswager, Kilgore, Becker, Blinn, & Ek, 2011; Hipple & Duffy, 2002; J. A. Larson & English, 2009; J. A. Larson, English, & He, 2008; Tyndall, et al., 2011). Note that a vast majority of these are not unique to bioenergy feedstock production, but rather could apply to any number of other traditional markets.

The final category of factors influencing market participation includes attributes of market participation and of the market itself, in particular issues of uncertainty, risk, and contracting. Perceptions of biomass production as risky and as being associated with low profit margins are noted to impede participation (Lowenberg-DeBoer & López-Pereira, 1990; Rossi & Hinrichs, 2011). For dedicated energy crops like switchgrass, upfront costs, several years of scale-up, and concerns over production and price risk are all identified as potential barriers to participation (Alexander, et al., 2012; J. A. Larson & English, 2009; Villamil, Alexander, Silvis, & Gray, 2012). Lack of spot markets, along with uncertainty of production

and ultimate demand for feedstock, likewise impedes farmer conversion to bioenergy crops (Alexander, et al., 2012; C. Wang, 2011). Risk and uncertainty are further exacerbated by uncertainty and information shortages. General knowledge and information gaps present barriers to market participation (Joshi & Mehmood, 2011; Rämö, et al., 2009). Investments are also impeded by doubt over market potential (Rossi & Hinrichs, 2011) and a lack of policy clarity and certainty (Fiedling et al., 2012; Helby, Rosenqvist, & Roos, 2006).

This uncertainty reinforces the relevance of contracting. Paulrud & Laitila (2010) find that farmers place positive value on contacting approaches that reduced their market risk, while Bergtold, Fewell, & Williams (2011) find that insurance availability, similar to present crop insurance, is associated with farmer willingness to enter into production contracts. Inducing a shift in production can involve a significant risk premium to be included in payments and contracts will presumably reflect this (Alexander, et al., 2012). How risk reduction is achieved in individual contracts will vary to reflect the attributes of the contracted feedstock. The eased planting-to-harvest interval and multiple markets for sorghum imply that refineries may be able to offer less (i.e., no risk premium) to producers than dedicated energy crops (Alexander, et al., 2012). In corn stover markets, research finds that long term contracts (3-5 years) are preferable to short-term ones (1-2 years) from a risk management perspective (Tyndall, et al., 2011). Conversely, a survey of potential switchgrass growers in Kansas indicated that each year of contract length would increase the payment required by approximately $1 per acre (Fewell, Bergtold, & Williams, 2011).

These three categories are very much interrelated, and jointly influence bioenergy market participation decisions. Altman, Johnson, & Moon (2010) and Altman, Bergtold,

Sanders, & Johnson (2012) discuss the relationship between asset specificity and preference for market organization and contract format. Entities already owning equipment to harvest and transport biomass would tend to support the emergence of spot markets or short-term contracts, while those not possessing such specialized equipment would tend to prefer long-term contracts or even vertical supply chain integration (Altman, et al., 2010).

A Quantitative Review of the Literature

A first step in investigating hypothesized differences between feedstock, region, and user group, is to gauge which variables are assessed most often. The studies reviewed here contain a large number of independent variables in their exploration of bioenergy market participation drivers (Figure 3-1). Demographic variables are among those most-often cited (e.g., age, education, region), followed by structural or financial variables (e.g., area owned, income) and market preference and experience (e.g., harvest options, contract length). The list is shortened considerably when screening for only those independent variables that are significantly associated with the market participation dependent.

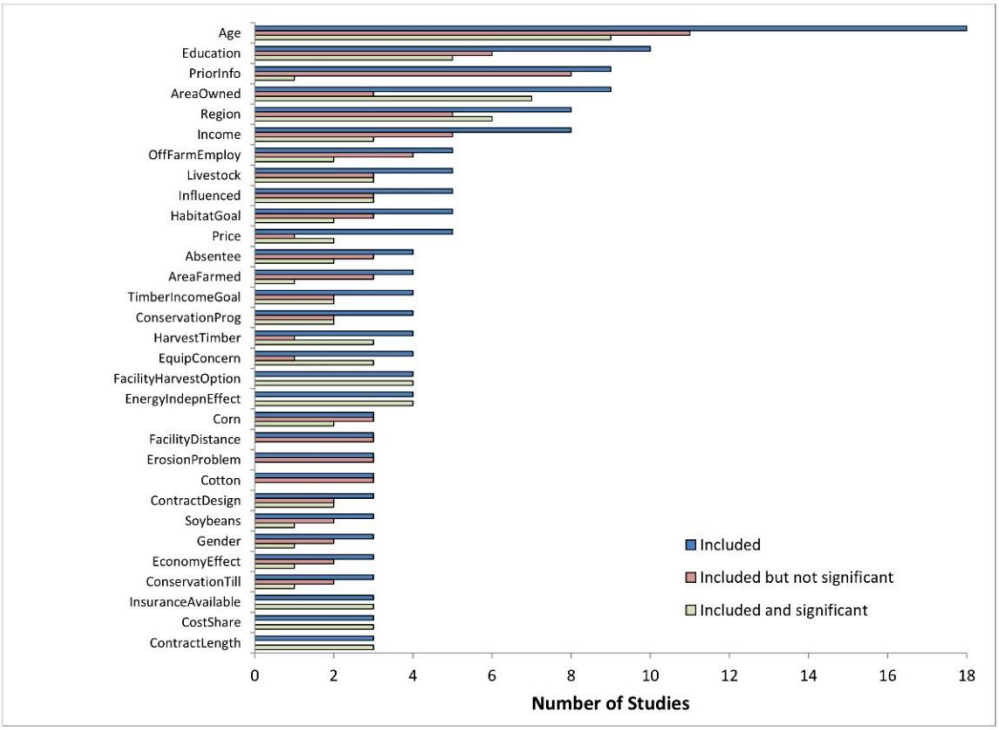

Figure 3-1. Comparison of the number of studies including a given independent variable, those including the variable but failing to find it significantly associated with the dependent, and those including it an finding a significant relationship with the dependent. Figure is limited to independent variables assessed by 3 or more studies.

Apart from simple significance, direction of effect is also important to gauge. For example, a variable found to be consistently significant but of inconsistent sign direction could suggest a spurious relationship. Figure 3-2 shows the average relationship between dependent variables and a subset of statistically significant independent variables occurring more than once in the surveyed literature. *Price*, *AreaOwned*, *FacilityHarvestOption* (purchasing facility offers harvesting services), *Education*, *EnergyIndepnEffect* (a belief that

bioenergy production contributes to energy independence) are the most common positively-associated independents, and *Age*, *ExistingCommodity* (growth of an existing commodity crop), and *ContractLength* are the most common negatively-associated independents. Generally speaking, the direction of association is what would be expected in each. These findings highlight the range of factors assessed in the literature and their consistency in both being significantly associated with a given dependent and the direction of that relationship. These results also support the narrative above in that, while important, pure profit motivations provide relevant but incomplete insight into bioenergy market participation decisions. Findings such as these can help to inform both future field research (e.g., survey development) and specification of economic models.

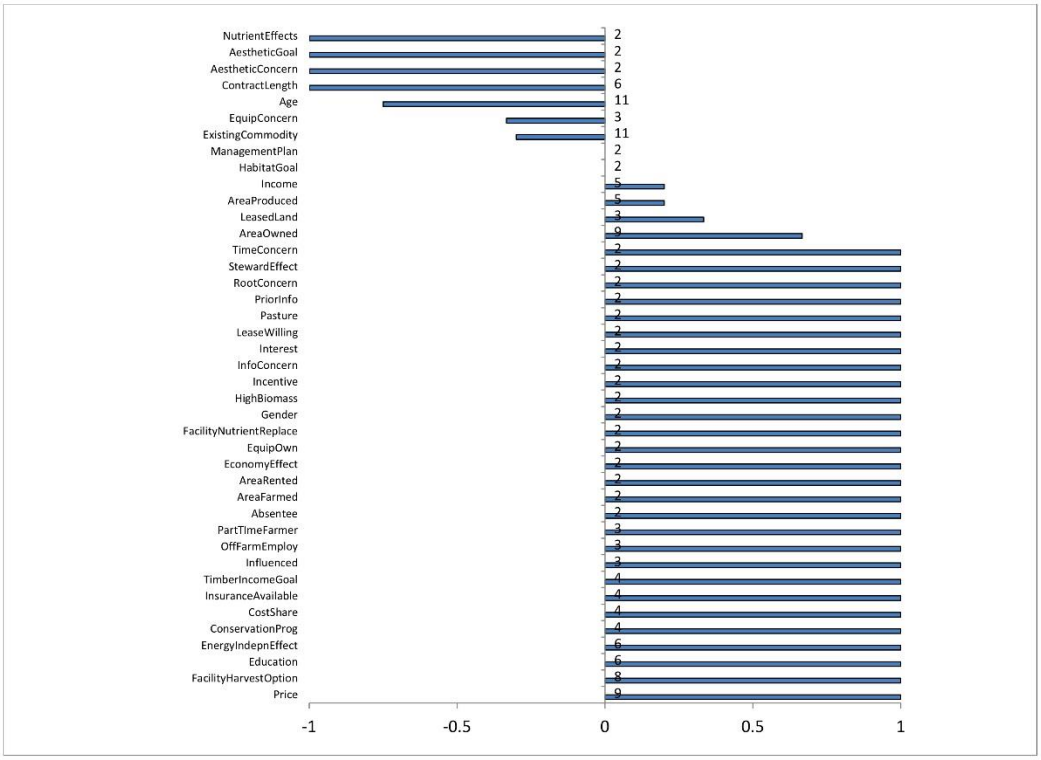

Figure 3-2. Average relationship direction of reoccurring statistically significant independent variables with respect to the dependent. “1” indicates that the independent is always positively associated with the dependent, and “-1” that the independent is always negatively associated with the dependent. Values in between indicate mixed findings in the literature. Frequency of occurrence is indicated by the data label next to each column. 15 records were removed for which direction was meaningless absent study context (e.g., “region”).

To directly assess the differences hypothesized above, the association between independent variables and their dependents across region, user group, and feedstock type is further explored using network analysis. Attribute data from identified studies are used to segment users (Farmers and Woodland Owners) and region (Southeast and Midwest). The same is done for feedstock type, which is categorized into Commodities (corn, pulpwood,

soybeans, sweet sorghum), Dedicated Crops (generic dedicated, perennial grasses, miscanthus, short rotation woody crops, switchgrass), and Residues (corn stover, generic agricultural residues, forest residues, forest biomass).

A network graph of the entire dataset is shown in Figure 3-3; graphs of each subgroup are contained in Appendix B. Comparison of the three feedstock graphs (Residues, Dedicated Crops, and Commodities) shows the large number of dependents evaluated in research pertaining to residues and dedicated crops relative to commodities. This partly reflects the relative number of studies examining each; four of the twenty-two identified studies assess commodities, six assess residues, and nine assess dedicated feedstocks. From this increased number of studies comes an increased number of independent variables posited to affect bioenergy market participation. Important to note, however, is the average number of unique independent variables assessed per study likewise increases across this same gradient, rising from 5.5 per study for commodities, to 10.5 for residues, and 11.4 for dedicated feedstocks. Similar patterns exist between Farmer and Woodland Owner user groups; as with feedstock, these patterns are partly a function of the number of studies returned. Region graphs (Southeast and Midwest) both contain multiple nodes and multiple ties, but the patterns of clustering appear subtly different between the two.

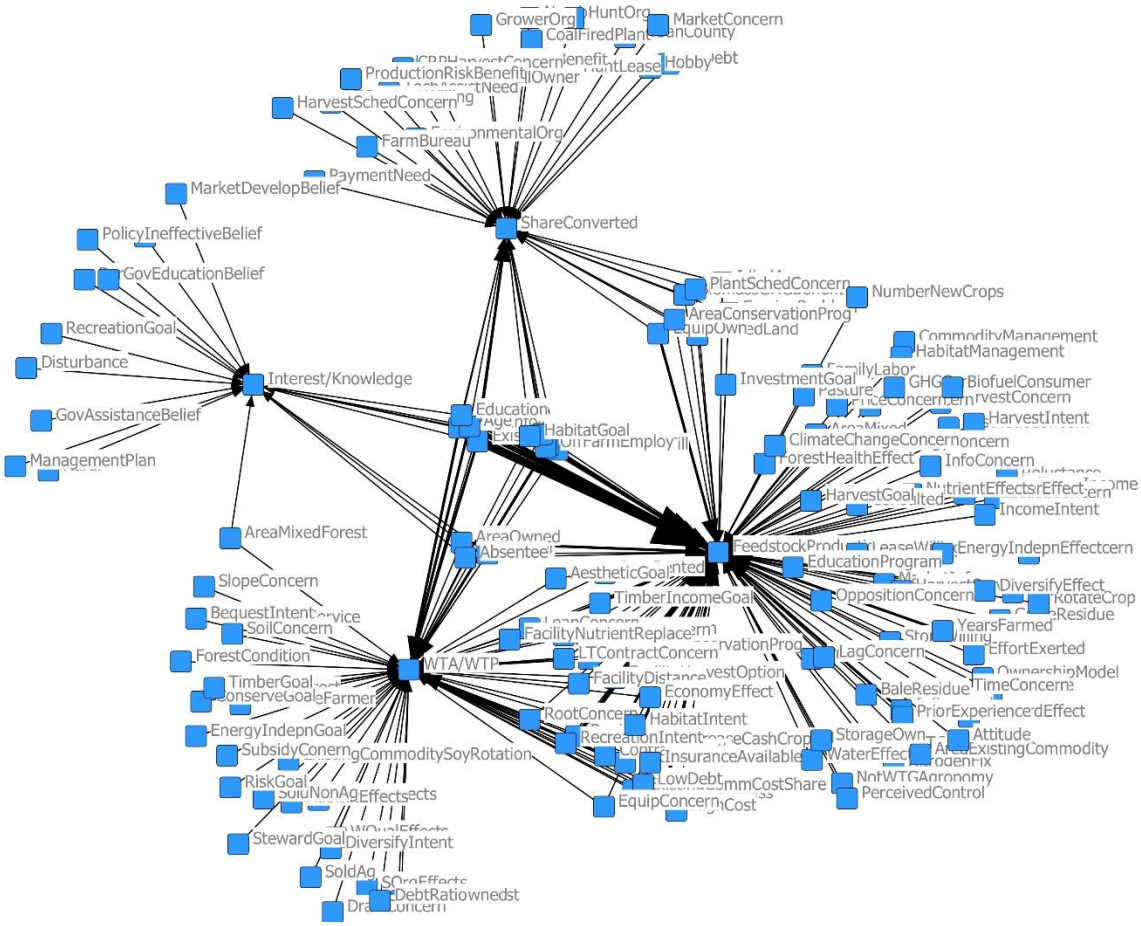

Figure 3-3. Network graph of entire dataset, with ties weighted by occurrence. Tie direction indicates variable type: out-degree ties represent independents, in-degree ties represent dependents.

Subtle differences likewise emerge when assessing network structure quantitatively through calculation of density, or the total number of ties in a network relative to the total number of possible ties. Density for each group and for the dataset as a whole is displayed in Table 3-4. Owing to the nature of this exercise and the data involved, the values are expected to be low. There is no interchange between dependent and independent variables, limiting ties between independents and between dependents. Calculated densities nonetheless provide

a quantitative interpretation of the visual patterns observable in the graphs. Of the feedstock categories assessed, research involving Commodities feature a greater number of dependents per independents assessed, or alternatively, fewer independents per each dependent or measure of participation. Residues and Dedicated tend to have a greater number of independents associated with each dependent. Similar distinctions can likewise be drawn between the farmer and woodland owner user groups. Returning to the graphs of these networks, there are actually a greater number of both dependents and independents in the farmer assessment, reflecting a wider variety of both measures of bioenergy market participation and of predictors expected to be associated with these measures.

Table 3-4. Network density for each category of interest (significant relationships only).

Category	**Group**	**Average Value**	**Standard Deviation**	**Average Weighted Degree**
Target User	Woodland Owner	0.033	0.212	1.372
	Farmer	0.03	0.284	2
Feedstock Type	Commodities	0.063	0.292	1.2
	Dedicated Crops	0.031	0.232	1.655
	Residues	0.058	0.303	1.4
Region	Southeast	0.027	0.192	1.444
	Midwest	0.036	0.325	2.018
Full Dataset	All	0.021	0.24	2.01

These quantitative metrics and visual comparisons of network structure suggest possible differences in the relationship between dependent and independent variables across various segments of the literature. These findings are confirmed through QAP regression analysis (Table 3-5). Although the model is significant (p=0.001), it explains very little

variation in the data (Adjusted R-Squared= 0.001). Among the variables assessed, one targeted user (Woodland Owners), and two feedstock categories (Commodities, Residues) were found to be significant. This lends further evidence to the finding that the bioenergy market participation literature may vary across feedstocks and users. Comparing authorship across these categories, an interesting trend emerges. No author overlap is seen across regions, and only one author out of 48 was identified as publishing research on both farmer and woodland owner user groups. Within feedstocks, five authors out of 48 published across feedstock categories, with three authors publishing research across all feedstock categories.

Table 3-5. QAP regression output on the influence of region, targeted user, and feedstock category on the number of times a particular dependent variable is associated with a particular independent. *** significant at p<0.01, ** significant at p<0.05, *significant at p<0.1.

Variable	**Standardized Coefficients**	**p-value**	
Intercept	0.0000	0.000	***
Region			
Midwest	-0.006	0.245	
Southeast	0.008	0.155	
Targeted User			
Farmer	0.008	0.168	
Woodland Owners	-0.014	0.031	**
Feedstock Category			
Commodities	-0.016	0.034	**
Residues	-0.011	0.038	**
Dedicated	-0.009	0.062	*
Significant	-0.006	0.207	

Conclusion

This analysis utilizes a variety of tools and approaches to assess the drivers of bioenergy market participation discussed in the available literature. Apart from providing a model for how future meta-analyses may be conducted, there are several conclusions that can be drawn from the analysis itself. The first set of conclusions pertains to the findings of the literature. The narrative analysis identifies a host of non-production objectives, structural and social constraints, and market-related attributes with the potential to influence bioenergy market participation decisions. Asset specificity, or the market or end-use flexibility of a given feedstock, emerges as a particularly important factor to consider. The quantitative analysis sheds further light on the drivers of bioenergy market participation, highlighting those independent and dependent variables most often assessed and most often found to be significantly associated. This latter category of statistically significant associations, particularly those with consistent directional associations, is particularly helpful in improving the representation of bioenergy market participation decision making in future modeling efforts.

A second conclusion relates to the primary hypothesis posed above, whether there exists a differential treatment of bioenergy market decision making in literature across feedstock, users, and geographic region. Using social network analysis to highlight trends in the literature, the analysis finds potential differences in network configuration and network density across these various subgroups, a finding confirmed through QAP regression analysis for two feedstock types (residues and commodities) and one user type (woodland owners). Overlap of individual authors across these categories suggests that these differences cannot

be attributed differing author networks alone. Rather, these differences may be a function of the variation in non-production objectives, structural and social constraints, and market-related attributes identified in the narrative review. This is particularly true in the case of feedstock type. Returning to Table 3-1, the findings are supportive of the original hypothesis, that the decision to implement activities of increasing risk or commitment are themselves functions of an increasing number of considerations. This is reflected in the increasing number of unique independent variables assessed per study for each feedstock category, averaging 5.5 per study for commodities (entailing a change in market, the lowest level of commitment or risk), to 10.5 for residues, and 11.4 for dedicated feedstocks (entailing a change in cropping system, the highest level of commitment or risk).

These findings also suggest that there may not be a single agreed-upon methodology or heuristic for assessing bioenergy market participation as a monolithic whole. Attempts to incorporate findings from this assessment into national bioenergy market participation modeling initiatives should bear this in mind. For example, the identified differences across the literature raise questions as to the most appropriate policy response to encourage the development of bioenergy markets. The necessity of public policy in supporting bioenergy market development is repeatedly referenced in the literature. Incentives and technical assistance may be needed in addition to viable feedstock prices (Gan, Jarrett, & Gaither, 2013). If the user group- and feedstock-specific differences found across the literature are indicative of fundamentally different socio-economic conditions in their respective markets, then policies specific to individual markets may be more effective in encouraging participation than uniform national policy initiatives. Such targeted policies are more capable

of recognizing important differences in feedstock production techniques, non-production objectives, and other attributes found here to be related to market participation decisions (Markowski-Lindsay, et al., 2012). Although recommendations on specific designs for such policies or programs are beyond the scope of this review, the greater number of considerations found here to be associated with dedicated feedstock production decision-making implies that policies targeted to their use should incorporate a broader array of incentives than, for example, those seeking to increase the production of residues or traditional commodities.

A related conclusion is that estimates based purely on pure profit-maximizing motive – especially one that takes a narrow interpretation of profit-maximization, excluding costs attributable to risk and uncertainty – are likely to overestimate participation in emerging bioenergy markets. Given the observed differences across user groups and feedstock types, the extent to which participation is overestimated remains difficult to estimate, however. Identification of the range of factors that can influence behavior is nonetheless a first step to increasing the accuracy and precision by which the aggregate effects of participation may be represented. It will likewise help to inform the design and delivery of policies intended to promote sustainable bioenergy market development. The preceding analysis is an attempt to establish this improved understanding, to better appreciate how bioenergy market participation is approached in the scientific literature and to document consistent findings and dissimilarities. In doing so, it demonstrates how social network analysis may be used as a tool for literature review and provides a model for how future reviews may be conducted. It likewise provides a knowledge base from which the potential effectiveness of policies to

encourage bioenergy market participation may be further assessed and opportunities to increase model representation of participation decisions may be further explored. Such analyses are ongoing, and are expected to be released as natural extensions of this work in the near future.

CHAPTER 4 : COMPARING PARTICIPATION IN THE REGULATORY PROCESS AND CONSERVATION AGREEMENTS UNDER THE ENDANGERED SPECIES ACT

Public participation plays an important role in the development and implementation of environmental policy. Given the inherent link between the participation process and the quality of the resulting decision, improving the incorporation of stakeholder perspectives and experiences can arguably lead to improved environmental decision-making. Recent efforts to make the Endangered Species Act (ESA) more conducive to voluntary and proactive conservation provide a unique opportunity to explore different forms of public participation in a regulatory reform process. Specifically, this analysis uses a convergent mixed methods design to develop a more complete understanding of stakeholder perspectives and experience with Section 10 plans and agreements, employing (1) public comment letters and (2) attributes derived from a federal database of approved Section 10 permits as the two sources of data. The analysis finds discrepancies in the patterns of comment letter submission and plan participation across types of applicants and land uses. The direction of these discrepancies likely reflects stakeholder needs relative to Section 10 program implementation. Greater incidence of comment letter submission relative to plan participation could reflect latent, unmet demand for policies or programs that better fit the needs or circumstances of particular types of applicants or land uses. Alternatively, greater incidence of plan participation suggests the existence of an underutilized source of input that could be tapped to improve regulatory reform efforts. Collectively, these findings suggest

that the composition of commenting organizations and the rate of response itself can be used as indications of reform potential and direction.

Introduction

Public participation, defined here as "direct participation by non-governmental actors in decision-making" (Mostert, 2003, p. 180), plays a critical role in environmental policy. Referred to by some as "unassailable good" (Steelman & Ascher, 1997, p. 73), public participation is argued to facilitate improved decision-making, reduce or resolve conflict, educate the public, and better incorporate public values into resulting policy (Beierle & Cayford, 2002; Fiorino, 1990; Koontz & Thomas, 2006). However, public participation also can be costly and time-consuming, lead to poor and/or inconsistent decision-making, elicit low-quality or limited response, and reinforce existing power asymmetries (Koontz & Thomas, 2006; Mostert, 2003; Peterson, Peterson, & Peterson, 2005). Public participation would therefore seem to possess the potential to both facilitate and hamper the development of sound policy solutions, a sentiment echoed on the first page of Beierle and Cayford's influential 2002 work: "Understanding the role of public participation is increasingly crucial for understanding how government makes and carries out environmental policy" (p. 1).

Characterized by a great degree of both breadth and depth, questions of who participates, why they participate, and the effect their participation has on policy development are particularly well-represented in the literature (Durocher & Fortin, 2011; Georgiou, 2002; Golden, 1998; Jorissen, Lybaert, Orens, & Tas, 2012; R. K. Larson & Herz, 2013; Scardina, Mortimer, & Dudley, 2007; West, 2005; J. W. Yackee & Yackee, 2006; S.

W. Yackee, 2006). But as noted by Beierle & Cayford, Koontz & Thomas, and others, the role of public participation in the policy process has changed over time. Once serving an oversight role to the managerial decisions made by federal agencies, public participation has since shifted to one characterized by popular democracy and collaboration – from accountability to development of policy itself (Beierle & Cayford, 2002; Koontz & Thomas, 2006).

As currently conceptualized, participation can be associated with the pursuit five separate social goals: incorporate public values into decisions; improve the substantive quality of decisions; resolve conflict among competing interests; build trust in institutions; and educate and inform the public (Beierle, 1999; Beierle & Cayford, 2002). The extent to which these goals are met is in large part a function of the process used to incorporate public input into decision-making. As noted by Reed (2008), "the quality of a decision is strongly dependant [sic] on the quality of the process that leads to it." (p. 2421). The linkage between public participation and policy development processes is likewise a complicated one. There are important differences between the outcome of participation processes and outcome of the implementation of resulting policy (Beierle & Cayford, 2002; Koontz & Thomas, 2006). This is because "public participation appears as only part of the machinery – perhaps only a small part – that turns ideas into action" (Beierle & Cayford, 2002, p. 56).

The pivotal role that participation can play in environmental policy decision-making, combined with remaining uncertainty as to the ultimate effect of participation on emerging policy, necessitates continued attention to the role of participation processes. This analysis uses evidence of participation, both in the regulatory process via a review of submitted

comment letters and in policy implementation via a federal database of approved permits, to explore both public demand for and potential response to reform efforts. Specifically, the analysis evaluates patterns of comment letter submission and participation in conservation plans and agreements under the Endangered Species Act (ESA or the Act). As public participation is itself identified as an important factor in determining the effectiveness of the ESA (Doremus, 1998), the analysis identifies domains where programs could better suit user needs and domains where increased public participation could be sought.

The Endangered Species Act and Section 10 Permitting

The ESA was passed into law in 1973 to "provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, [and] to provide a program for the conservation of such endangered species and threatened species" (Sec. 2(b)). To be listed under the ESA, a species must either be in danger of extinction throughout a significant portion of its range ("endangered") or is likely to become endangered in the near future ("threatened"). Species for which there exists sufficient information to list as threatened or endangered but for which listing is precluded by higher priority agency actions elsewhere are identified as a special class of species called "candidates". Candidate species receive no direct protection under the ESA, but are the subject of considerable planning and management attention given their potential to be listed in the near future.

To achieve its overarching goals, the ESA establishes a process by which the federal government may work towards the recovery of listed species. The ESA also establishes

restrictions on the "take" of listed species, specifically defined by the Act as "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (Sec. 3(19)) and interpreted more broadly to also include significant habitat modification and degradation (64 *Fed. Reg.* 60727; November 8, 1999). Section 10 of the ESA authorizes a "take" of a species in two situations. The first is authorized under Section 10(a)(1)(A) of the Act, and covers non-federal activities conducted to enhance the survival of a species (e.g., active restoration of habitat, captive breeding, reintroduction of extirpated species). The second is authorized under Section 10(a)(1)(B) of the ESA and addresses the "take" of species incidental to some other activity (e.g., residential construction). Owing to their varying objectives, permits issued pursuant to these authorizations are generally referred to as enhancement-of-survival permits (ESP) and incidental-take permits (ITP), respectively.

A variety of different plans or agreements may be developed using the authorizations granted by these two permitting approaches. Safe harbor agreements (SHAs) and candidate conservation agreements with assurances (CCAAs) are crafted in connection with ESPs issued under Section 10(a)(1)(A), while habitat conservation plans (HCPs) are required for the issuance of a ITPs under 10(a)(1)(B). There are important operational differences between these specific plans and agreements. HCPs are applicable to both listed and unlisted species. They define the extent of expected "take" and the mitigation and minimization measures that the permittee must employ. SHAs are applicable to the management of species already listed under the ESA. They facilitate proactive management of habitat by providing regulatory assurances that additional restrictions will not be put in place should management result in an increased presence of listed species. CCAAs pertain to the subset of unlisted

species which have attained "candidate" status, but provide similar regulatory assurances as SHAs should the species eventually be listed under the ESA.

Together, these broad Section 10 authorizations and planning processes provide the basis for many conservation activities undertaken by private landowners and state and local public entities. Non-federal landowners play an important role in the conservation of threatened and endangered species – U.S. Fish and Wildlife Service (FWS) statistics suggest that approximately one-half of listed species have at least four-fifths of their habitat occurring on private lands alone (USFWS, 2009). The ESA has historically been poorly equipped to engage these key constituencies, however, comprised as it is of a layered system of prohibitions, restrictions, and federal consultation obligations. As one of the few provisions of the Act designed specifically to facilitate the involvement of non-federal actors, Section 10 of the ESA has received a great deal of attention in both practice and in the literature (Doremus, 1998; Hood, 1998; Langpap & Kerkvliet, 2012; Langpap & Wu, 2004; Wilhere, 2009). Ongoing efforts to make the ESA more conducive to voluntary and proactive conservation are focusing renewed attention on Section 10 permitting processes (e.g., USFWS, 2011).

ESA Reform Efforts and the Role of Public Participation

On March 15, 2012, the Department of Interior released an advanced notice of proposed rulemaking (ANPRM) to "identify potential changes to our regulations that would create incentives for landowners and others to take voluntary conservation actions to benefit species that may be likely to become threatened or endangered species" (77 *Fed. Reg.* 15352;

March 15, 2012). This ANPRM provides a unique opportunity to evaluate public participation in environmental policy reform efforts for several reasons. The request for comment was open-ended, allowing significant latitude to comment on processes through which voluntary conservation could be achieved. This resulted in a large body of stakeholder comments about Section 10 plans, agreements, and processes. A great deal of information is likewise available on all approved plans and agreements under Section 10, accessible via a U.S. Fish and Wildlife Service-maintained website. While other recent regulatory reform initiatives provide opportunities to evaluate public comments on other components of the ESA (e.g., Section 7 consultations ["Interagency Cooperation; Incidental Take Statements", 78 *Fed. Reg.* 54437; September 4, 2013], critical habitat designations ["Implementing Changes to the Regulations for Designating Critical Habitat", 79 *Fed. Reg.* 27066; May 12, 2014]), the corresponding regulatory program participation data is either too scattered, diffuse, or difficult to acquire to allow for useful comparison to the comments submitted.

These circumstances create an opportunity to compare those expressing an interest in the regulatory reform processes (by submitting comment letters) and those potentially directly affected by the regulations (through their engagement in conservation plans or agreements). The primary research questions stem from this unique opportunity: Are there differences between the stakeholder groups that submit comment letters and those that participate in Section 10 plans and agreements? If so, are there discernible patterns in these differences? Finally, what do these patterns and differences suggest about stakeholder experience with existing plans and agreements under the ESA, and by extension, the opportunity for reform?

The following analysis combines two publicly available datasets to answer these research questions. It adopts a comparative, exploratory approach similar to the multiple case study analysis of U.S. Forest Service decision-making by Scardina, et al. (2007) but places greater emphasis on the patterns of stakeholder participation, thus approximating a simplified stakeholder analysis (see, e.g., Brugha & Varvasovszky, 2000; Reed et al., 2009; Varvasovszky & Brugha, 2000). Given the exploratory nature of this work, the scope of the stakeholder analysis is necessarily narrow, limited to secondary data and to a single policy issue – Section 10 of the ESA –operating at the national level. If one begins with West's (2005) observation that "organized groups will often submit comments on issues that affect them" (p. 662) and that stakeholder groups participating in conservation plans and agreements are fundamentally affected by regulatory reform efforts, the null hypothesis is that groups will comment in equal proportion to their participation. An exact match implies perfect representation, while a greater instance of commenting than participation could suggest an underserved, latent demand for new programs to address needs that are currently unmet. A greater instance of participation than commenting suggests an underutilized supply of input. If this experience could be tapped, it could be of great value to regulatory reform processes so as to better document what has worked and what could be improved.

Materials and Methods

This analysis employs a convergent mixed methods design to explore the patterns of organizations submitting comment letters versus those participating in conservation plans and agreements. Mixed methods are appropriate for research questions in which a single source

of data may be insufficient to yield adequate understanding of the problem at hand (Creswell & Clark, 2011). Here, qualitative and quantitative data are first collected and assessed in parallel and then merged and compared to address the primary research question. Qualitative data are derived from comment letters submitted to a single ANPRM on voluntary conservation initiatives under the ESA (77 *Fed. Reg*. 28347; May 14, 2012), and provide information on how commenting organizations view a wide variety of conservation programs under the Act. Quantitative data are derived from a U.S. Fish and Wildlife Service Conservation Plans and Agreements Database (http://ecos.fws.gov/conserv_plans/public.jsp; data downloaded on February 25, 2014), and feature metrics on approved plans and agreements, including project area, number of species covered, plan duration, as well as attribute data on location, organization type, and land use. The inherent connection between stakeholder policy perspective and stakeholder policy experience (e.g., Varvasovszky & Brugha, 2000) establishes a link between the two sets of data. Applicant and land use types in comment letters are thus assumed to be representative of those same applicant and land use types participating in conservation plans and agreements.

Comment Letter Data

The use of comment letters to assess stakeholder perspectives is a common technique used in the literature (Geiger, 1989; Saemann, 1999; Yen, Hirst, & Hopkins, 2007). Here, data are drawn from responses to the above referenced ANPRM. The request for comment was not limited to approval of a specific permit, related to a particular species or a particular geographic area, or pertaining to operational aspects of a particular permit type. Rather, it

requested input on a broad suite of changes to programs and regulations so as to create incentives for voluntary conservation action. As such, it prompted response on a variety of ESA programs, including permitting approaches under Section 10 under the Act. A total of 92 letters were submitted to the ANPRM during the comment period. Letters were downloaded from http://www.regulations.gov on February 7, 2014. The final assembled dataset includes 72 comment letters, a subset of the 92 submitted. This subset is limited to only those letters written by an attributable organization or interest (i.e., non-individual citizen) so as to appropriately classify each response and compare against plan participation data in a later portion of the project. Further examination of the excluded comment letters also found them to be generally shorter and more general than the letters attributable to a particular organization or citizen.

Comment letters were imported into NVivo 10 and coded. NVivo is a software program facilitating the cataloging, coding, and analysis of qualitative and mixed methods data (QSR International Pty Ltd., 2012). For each letter, the stated positions of each commenting organization was examined, particularly as it pertained to Section 10 permitting programs under the Act. Following the approach of Geiger (1989) and Saemann (1999), the coded text was used as the basis for the analysis, allowing for comparison of responses by applicant type, land use type, and stated positions of programs under the Act.

Data coded in each letter can be found in Table 4-1. ITPs and ESPs are used as a proxy for the general types of activities authorized and projects undertaken under each permit type. Although the content of the letters represent a wide degree of geographic diversity, the organizations submitting the letters were often based in Washington, D.C. Therefore,

commenting organization address was assumed to be an inaccurate measure of the location or spatial diversity of practices or experiences of commenting organizations. Applicant and land use types were selected to align with the plan participation dataset described below. When the land use or applicant type was obvious (e.g., energy exploration company = “Gas & Oil Production” and “Corporation”), comment-submitting organizations were simply coded to these types. “Other” applicant and land use types were used to account for both services (e.g., surveying, consulting, mitigation) and federal entities. The “NGO” applicant type was applied to conservation organizations only, while trade associations were coded to their majority or targeted membership. “Non-Commercial” land use types were applied to both conservation organizations as well as public entities, with public entities also being coded to their primary duty (e.g., recreation, forest management, water activities, etc.).

Once coded, themes were identified through the use of queries. Coding queries were used to assess frequency of text coded to particular law and policy provisions, while matrix queries were run to examine instances of coded law and policy references across organization type. To gauge consistency and replicability, 5 letters were selected at random and given to a colleague unaffiliated with the project to code, against which a coding comparison query was run. As a percentage of total records, this number was slightly below the percentage of cases examined for intercoder reliability by Beierle & Cayford (2002). Results from the coding query indicated fair to good agreement on a majority of coded nodes (Kappa value 0.40 to 0.75), with some nodes scoring poorly (< 0.40) and others scoring excellent (> 0.75). Average Kappa values for each double-coded letter was above 0.70 and above 0.60 for all coded nodes.

Table 4-1. Data collected from comment letter and plan participation datasets.

Variable/Attribute	**Comment Letter**	**Plan Participation**
Plan Type	*ITP, ESP*	*ITP, ESP*
Geographic Location	*Organization location*	*Lead FWS region*
Type of Applicant	*Commenting organization type*	*Applicant type*
Land Use(s)	*Commenting organization land use*	*Permitted land use*
Plan Delay	*Delay concerns indicated*	*Permit approval time*
Plan Complexity		*Plan acreage, plan duration, number species covered*
Plan Workability	*Cost, Lack of Assurances, Lack of Conservation Effectiveness, Consistency, or Eligibility concerns indicated*	
Plan Revision	*Indication of suggested reform (general or specific)*	

Plan Participation Data

The second portion of the analysis focuses on plan participation data derived from ESA Section 10 permit data in the U.S. FWS Conservation Plans and Agreements Database (USFWS, 2014). As with the comment letter data, specific plans and agreement types (e.g., HCPs, SHAs, CCAAs) are aggregated into their respective permit types (ITP, ESP). The complete dataset consists of 805 plans and agreements, including 693 ITPs, and 112 ESPs. Data extracted for each plan or agreement are indicated in Table 4-1.

Of the 805 total records, 205 were removed due to missing data. Also removed were an additional 36 records with a recorded plan size of "0" acres, 31 records with a permit duration of "0" years, 13 records in which the permit was recorded as approved before ever being noted in the *Federal Register* (thus resulting in a negative permitting time), and three records in which permit notice and approval were recorded as occurring on the same day (thus resulting in a permitting time of zero). Records were further limited to those approved under the current (Barack Obama) and previous (George W. Bush) presidential administrations so as to capture recent plan development and implementation experience. This reduces the final dataset to 378 records, of which 315 are ITPs and 63 are ESPs.

Results

Program Reference and Use by Applicant and Land Use Type

As seen in Figure 4-1, there is wide variation in the proportion of letters from each land use type found to reference ESPs or ITPs. Five out of six letters from Agricultural land uses were found to make reference to either permit type, with three out of six letters referencing either ESP or ITP permits. Eight out of 11 letters representing Gas and Oil land uses referenced ESPs while an identical proportion referenced ITPs, resulting in ten out of eleven referencing at least one permit type. Three out of four letters representing Residential Construction referenced either permit type. In referencing these various conservation programs, commenting organizations often cited both specific and unspecified workability concerns, such as delay, lack of assurances, cost, consistency of application, and conservation effectiveness. Applicant types show similar variability, with Local and Multiple

Jurisdictions citing ITPs more often than ESPs, while Corporations, State Agencies, and NGOs make greater reference to ESPs (Figure 4-2).

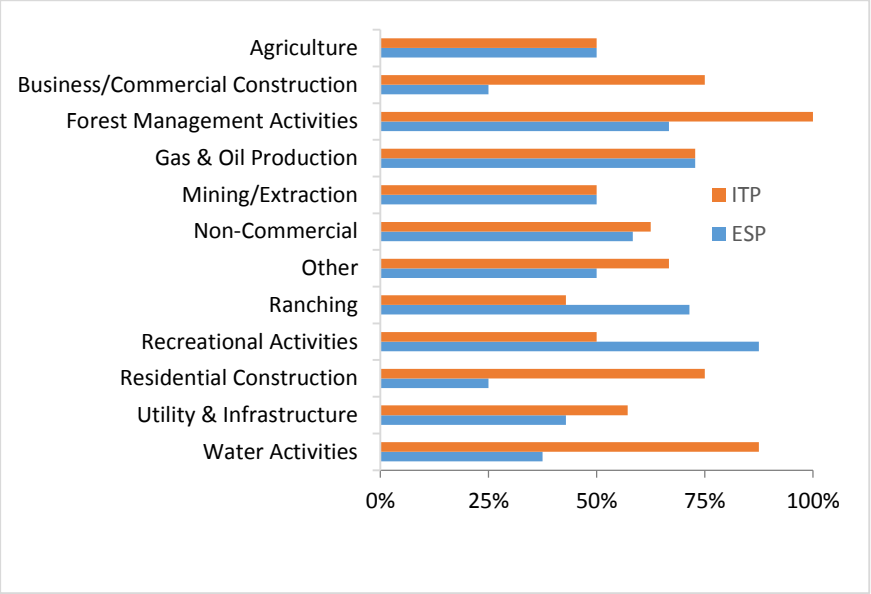

Figure 4-1. Percentage of comment letters in each land use type category referencing specific Section 10 provisions.

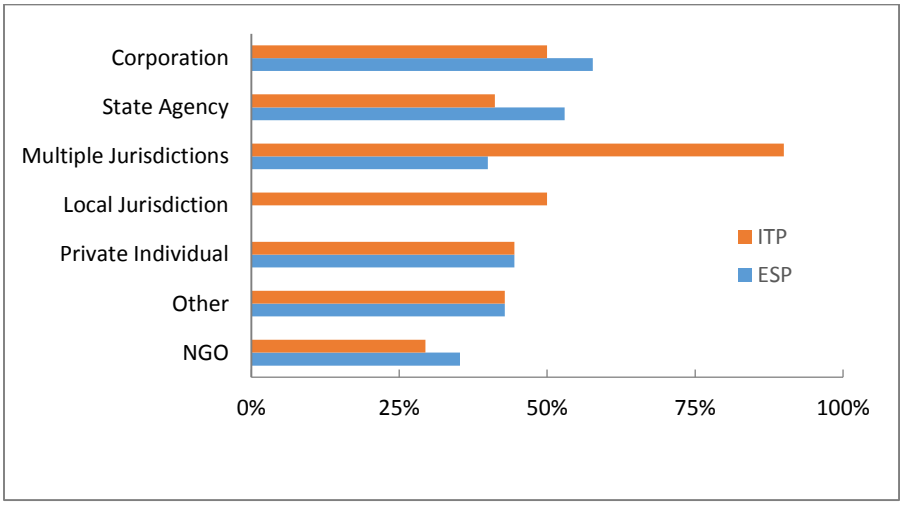

Figure 4-2. Percentage of comment letters in each applicant type category referencing specific Section 10 provisions.

Matrix queries indicate that patterns of stakeholder referencing of ESPs and ITPs likewise differ by land use type. For example, the analysis found Gas and Oil, Government, and NGO-affiliated organizations to relay the greatest number of workability concerns associated with ESPs, while Gas and Oil, Water Activities, and Residential Construction relayed the highest number of workability concerns with ITPs. Instances of suggested program revision were markedly different, with NGOs and Utility and Infrastructure having the greatest number of recorded mentions of requested reforms to ESP-related activities, and Utility and Infrastructure, Residential Construction, and Water Activities most often citing revision to ITP-related provisions.

The trends identified in the comment letter analysis suggest a divergence in the use of or attention paid to specific ESA provisions by different groups. This is apparent in differences in the programs mentioned and the issues expressed by commenting organizations. The trend is intuitive, as different land uses will generally encounter the ESA under different circumstances. For some (i.e., residential development and construction), the nature of their primary activity will tend to involve habitat disturbance and ITPs. For others (i.e., state wildlife agencies), primary involvement may be related to habitat management activities governed by ESPs.

As in the comment letter data, plan participation data indicate a variation in the use of ITPs and ESPs by applicant type (Figure 4-3). For example, Corporations are featured in a larger percentage of ITPs than in ESPs, while NGOs and State Agencies account for a greater percentage of ESP applications. The Private Individual category is fairly evenly split across plan and agreement types. A breakdown of land uses by conservation agreement type reveals

that Ranching, Agriculture, and Forest Management account for a larger percentage of ESPs than for ITPs, while plans involving Residential, Business/Commercial Construction account for a significantly larger percentage of ITPs (Figure 4-4). Gas and Oil production applicants are included in a higher proportion of ESPs than ITPs, as opposed to Utility and Infrastructure which show a higher rate of inclusion in ITPs.

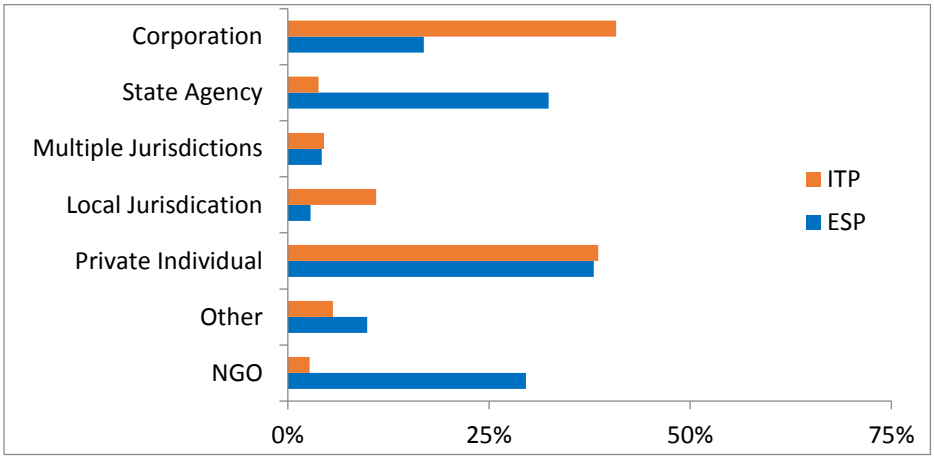

Figure 4-3. Percentage of each permit type featuring each applicant. Note: Totals for each permit type may exceed 100%, because each plan or agreement may contain more than one applicant type.

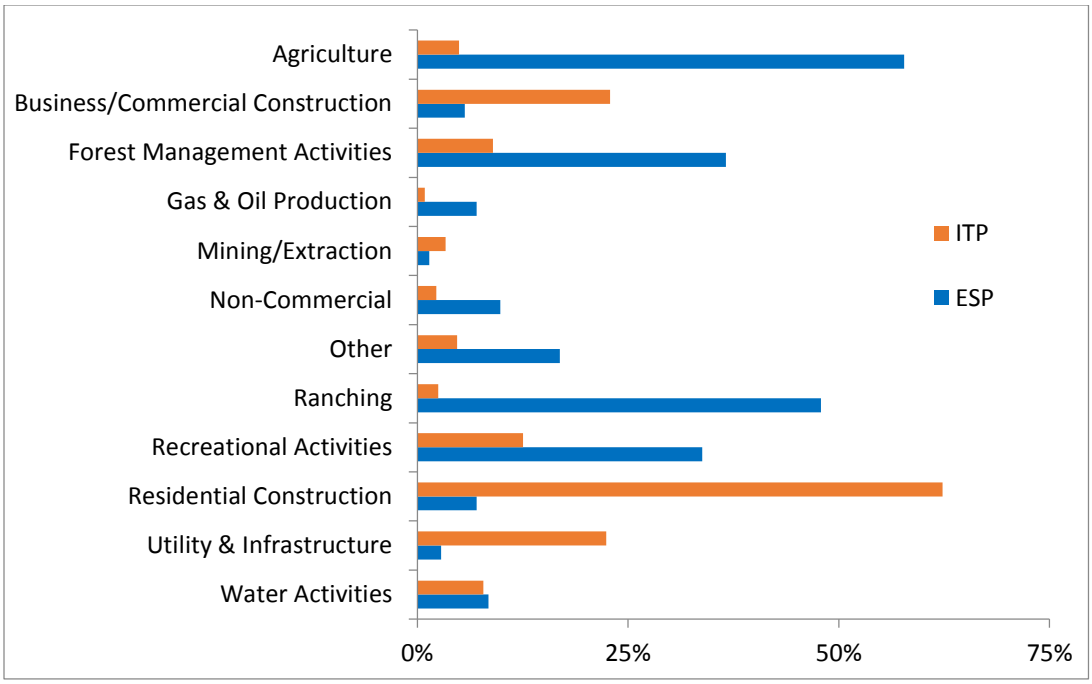

Figure 4-4. Percentage of each permit type featuring each land use. Note: Totals for each permit type may exceed 100%, because each plan or agreement may feature more than one land use type.

In comparing applicant types across comment letter and plan participation datasets, Private Individuals show similar patterns of plan reference and rate of use across datasets. Local Jurisdictions make greater reference and use of ITPs, while State Agencies and NGOs show a higher incidence of reference and use of ESPs. Magnitudes are not consistent across datasets for any applicant type except Private Individual. General patterns are difficult to discern in Corporations, Multiple Jurisdictions, and Other applicant types. Within land use type, Business/Commercial Construction, Residential Construction, and Utility & Infrastructure show similar patterns across datasets, making greater reference to and appearing in greater proportions of ITPs relative to ESPs, albeit at different magnitudes. Ranching and Recreational Activities show the opposite trend, making greater reference to

and use of ESPs relative to ITPs, again at different magnitudes in each dataset. No trends are apparent across datasets for Agriculture, Forest Management Activities, Gas & Oil Production, Mining/Extraction, Non-Commercial, Other, and Water Activities.

Comparison of Comment Letters and Plan Participation

The analysis next assesses mean response rate by applicant type and land use across datasets to investigate similarity in the mention and use of ITPs and ESPs. Results from a Shapiro-Wilk test of normality indicates that applicant type and land use data in both comment letter and plan participation datasets are not normally distributed, necessitating use of a nonparametric statistical test to assess differences across samples.

Table 4-2 indicates the mean response rate for applicant type and land use for both datasets, calculated as the average value per record where a value of 1 is assigned if a land use or applicant type is present in a given record and 0 if is not. Also presented are the results from a Mann-Whitney *U* test for differences. Results suggest that the relative occurrence of Other, Corporation, and Local Jurisdiction applicant types are not significantly different across comment letter and plan participation datasets. Relative occurrence in both datasets is likewise not significantly different for a variety of land uses, including Ranching, Agriculture, Utility & Infrastructure, Forest Management Activities, Other, Business/Commercial Construction, Recreational Activities, and Mining/Extraction.

Table 4-2. Mean response rate for individual applicant type and land uses (0=present, 1=present) across comment letter and plan participation datasets. Results of independent sample Mann-Whitney U tests are indicated, with * significant at <0.05, ** significant at <0.01, and *** significant at <0.001.

		Comment Letters	Plan Participation	Sig.
Applicant Type	NGO	0.22	0.07	***
	Other	0.08	0.07	
	Private Individual	0.14	0.42	***
	Local Jurisdiction	0.06	0.10	
	Multiple Jurisdictions	0.18	0.04	***
	State Agency	0.22	0.08	**
	Corporation	0.45	0.32	
Land Use	Gas & Oil Production	0.22	0.01	***
	Ranching	0.14	0.10	
	Agriculture	0.12	0.14	
	Utility &Infrastructure	0.14	0.16	
	Forest Management Activities	0.06	0.09	
	Non-Commercial	0.49	0.04	***
	Water Activities	0.16	0.08	*
	Other	0.12	0.06	
	Residential Construction	0.08	0.55	***
	Business/Commercial Construction	0.08	0.17	
	Recreational Activities	0.16	0.13	
	Mining/Extraction	0.04	0.02	

Discussion and Conclusion

This analysis seeks to generate an increased understanding of the role of public participation in environmental policy decision-making by comparing stakeholder attributes across comment letter and plan participation datasets. It suggests that both the relative number of submitted comment letters and their content may vary across applicant and land use types. The information expressed by comment letters is intuitive, with applicant and land use types most closely associated with habitat management being more often associated with

ESPs, while those more closely associated with habitat disturbance are associated with ITPs. Similar patterns are observable in the plan participation data.

Important differences are apparent in patterns of comment letter and plan participation (Table 4-2). NGO, Private Individual, Multiple Jurisdiction, and State Agency applicant types differ significantly across the datasets. Among land uses, Gas & Oil Production, Non-Commercial, Water Activities, and Residential Activities are likewise shown to differ across datasets. The remaining land uses and applicant types do not display significant differences in response rate across datasets. These findings both confirm and reject the central hypothesis in part -- that applicant and land use types will occur in equal proportion across comment letter and plan participation datasets.

The direction of observed differences is informative in that it provides a measure of stakeholder need relative to Section 10 program implementation. Those land use and applicant types with greater incidence of comment letter submission than plan participation could be suggestive of a latent, unmet demand for policies or programs that better fit their particular needs or circumstances. According to the analysis above, this includes the following applicant types and land uses: NGO, Multiple Jurisdiction, State Agency, Gas & Oil, Non-Commercial, and Water Activities. For these applicant types and land uses, the lower relative rates of plan participation suggest that existing Section 10 programs may be poorly suited to meet present needs. Alternatively, those applicant and land use types showing a greater incidence of participation than of comment letter submission (Private Individual, Residential Construction) suggest an underutilized supply of input which could be of great importance to regulatory reform efforts. These applicant and land use types could

represent an important storehouse of knowledge of plan and agreement implementation that is underrepresented in comment letter data.

An association between participation process and the quality of the resulting decision (e.g., Reed, 2008) implies that any information that improves the incorporation of stakeholder perspectives and experiences can ultimately lead to improved environmental policy decision-making. These findings provide such information, suggesting a mechanism by which the composition of commenting organizations and rate of response can itself be used as an indication of reform potential. The public participation literature suggests that the decision to participate in regulatory rulemakings is a function of multiple considerations (Durocher & Fortin, 2011; Georgiou, 2002). The choice either to submit or not submit a comment letter should therefore not be viewed lightly. Here, it is argued that the submission decision and content of comment letters can jointly help signal opportunities for reform, identifying those applicant and land use types for which additional policy options could be of use, as well as those from which additional feedback and insight should be sought.

As Doremus (1998) states, "[h]istory demonstrates that strong implementation of the ESA requires citizen prodding" (p. 712). Although her argument is framed in the role of citizen enforcement of species protection provisions of the Act, the important role of private landowners in species conservation nonetheless requires the assistance of the general public in stemming the tide of species decline. This implies that *successful* implementation of the ESA – conservation of the ecosystems on which species depend – will likewise require strong citizen participation in conservation programs. This further requires that the Act be

equipped with programs to facilitate their engagement. The approach and findings presented here may assist in those efforts.

Owing to the nature of the data used, this analysis is by default exploratory and the conclusions applicable only to this particular case. As Varvasovszky & Brugha (2000) caution, "[t]he environment, the context of the analysis, stakeholder interests, positions, alliances and influence change over time" (p. 344). Accordingly, validity and reliability are difficult to ascertain or guarantee. Potential sources of bias also exist. Only approved plans and agreements are present in the FWS database, inherently underrepresenting instances in which plan or agreement development ultimately proves unsuccessful. The self-reporting nature of the comment letters likewise holds the potential to bias the analysis, in particular if positions are intentionally misrepresented (e.g., Varvasovszky & Brugha, 2000).

It is likewise possible that the nodes selected for coding do not accurately capture commenting organization perspective, otherwise referred to as construct validity. This would be of greater concern if the analysis was seeking to examine inferred or latent support and concern with ESA provisions. Here, the intent is only to examine support or concern that is voiced directly, and the node structure is largely reflective of these stated positions. The fair-to-good agreement found in the coding comparison reinforces the appropriateness of the node structure and coding decisions. But with such an open-ended request for comment as the one reviewed here, the corresponding comments were wide ranging and oftentimes divergent. Only in keeping nodes general were themes able to be identified.

Future work should evaluate the specific plan participation history of those applicant and land use types found to be proportionally underrepresented in the plan participation

dataset. In particular, the participation experience of Multiple Jurisdiction and State Agency applicant types is of particular interest, given the outsized role these organization types may play in conservation planning. Gas & Oil, Non-Commercial, and Water Activity land uses should likewise be evaluated to examine the fit between existing Section 10 plans and agreements and the specific circumstances these land use types must navigate when interacting with the ESA. Finally, work should also apply the approach reviewed here to include a wider variety of rulemakings and participation data to determine whether observed patterns are consistent across other situations.

CHAPTER 5 : CONCLUSION

Apart from their contributions to their respective fields and issue areas, the preceding essays provide insight into the influence of institutions on decision-maker response and the methods potentially useful for investigating these phenomena. Upon reflection on the individual conclusions reached in each essay, what can these works collectively teach us about the influence of institutional design in environmental policy and research? Furthermore, what do these findings imply for environmental policy scholars and the broader policy and research community? These questions are addressed further below in a review of the conclusions from each essay.

Institutional Design and Policy-Relevant Research

The first essay shows that the literatures surrounding the analysis of property rights regimes in natural resource management are fragmented, leading to incomplete learning and a failure to capture (and therefore understand or model) key dynamics of a situation. Competing frameworks developed largely along disciplinary lines, building upon key works that came prior. This minimal cross-over exhibited among works cited potentially suggests a degree of path dependency and provides some support to the claim made in Chapter 1 that certain seminal works may themselves be seen as critical junctures in the development of scholarship. Referred to as “founder effects” elsewhere in the literature (e.g., Ascher et al., 2010), these institutional constraints can present barriers to our understanding of complex contemporary natural resource management issues.

Indeed, the dominance of a particular institution says nothing about its efficiency in capturing or addressing changing conditions (e.g., Greif, 1998). Property rights are conceptualized as comprising very different things depending on what strand of the literature one consults. Thus, an interdisciplinary and comparative approach such as the one employed here is necessary to evaluate the relative strengths and weaknesses of particular frameworks. Although Schlager and Ostrom's contributions have proven invaluable to institutional analysis of natural resource management issues, the argument here is simply that it could be improved upon by instating concepts present in other disciplines.

But making use of these broader concepts and literatures is generally impeded by established institutions within the research community. Lines of research and institutes of higher learning are both built upon themselves. The old adage of "standing on the shoulders of giants" is an appropriate, if loose, reflection of this. Formally, previous work will provide cues or starting points for future research efforts either by posing unanswered questions or by introducing findings or approaches to be replicated elsewhere. The content of formal academic training programs and established practices that promote field specialization transmit a variety of constraints and incentives that in turn influence the choice of methods in practice (Poteete, et al., 2010). This tendency has been recognized by scholars for several decades, as summarized neatly by Hubert & Schultz (1976): "the final selection of a statistical tool is guided either by tradition in the researcher's field or, at the other extreme, because one particular procedure happens to be in vogue" (p. 191).

If one accepts Poteete et al.'s (2010) proposition that "[m]ost periods of rapid theoretical development have occurred as a result of methodological and disciplinary cross-

fertilization" (p. 251), knowing what sustains a set perspective and/or approach allows for insight into how to elicit change and drive innovation. This information is particularly important for those entities with asymmetrical power to affect institutional change (e.g., Hall & Taylor, 1996), namely research funders and the policy audience itself. For example, the availability of new or novel funding mechanisms such as the National Science Foundation's Interdisciplinary Research and Education (INSPIRE) pilot could help to facilitate such cross-fertilization and innovation. Targeting of agency or other philanthropic opportunities to non-traditional partners could also increase the heterogeneity of perspectives taken and approaches applied. The Department of Defense, for instance, has shown a willingness to work with a wide array of disciplines and stakeholders in a quest to address its various research needs. Opportunities likely exist at other federal agencies or funders to replicate or build upon this.

Institutional Design and Market Development

The second essay explores how structural and social constraints influence bioenergy market participation decisions. The methods applied are again inherently comparative, employing social network analysis to assess the relationships between variables used by researchers to explain market participation. A finding of particular interest is the differentiated literature across feedstock type and geographic region. This finding has several interesting implications in light of the brief discussion of North (1990) and Bowles (1998) in Chapter 1. The interaction of markets and preferences implies the possibility of market segmentation, that individuals participating in certain market subsets – switchgrass

production, for example – may come to develop similar preferences as a result of their recurrent interactions and the unique pressures and opportunities created by the market itself. This possibility is not refuted by the findings in essay two.

The differences observed across feedstock type and geographic region also implies that that there could be distinct institutional contexts affecting participant decision-making across these subsets of the bioenergy market. If true, this likewise suggests that uniform national policies may fail to efficiently encourage broad-based response by failing to capture the nuances of drivers affecting participant choice. Simply, policy designed to encourage the development of new markets must reflect the institutions present. To appropriately design and target policies to encourage bioenergy market participation, it is important to know how decision making differs across feedstock production systems, and not simply that they do. The findings here suggest that those feedstock production systems characterized by the highest degree of risk or commitment are also associated with a greater number of factors potentially affecting decision making.

For those markets characterized by the highest degree of risk or commitment, policy will likely require use of a greater variety of instruments to encourage participation. Traditional tools like annual payments or grants could be effective in addressing economic concerns, such as the need to purchase additional equipment or the need to offset losses in the first few years of establishing perennial feedstock. Technical assistance could also help to address environmental concerns or help to incorporate feedstock production into existing management plans. Both sets of tools are commonplace in contemporary farm policy such as the Conservation Reserve Program (CRP) or Environmental Quality Incentives Program

(EQIP). Other factors associated with market participation decision-making is more difficult to address. Association of feedstock production with larger social or policy objectives such as the achievement of energy independence may be affected to some extent by education and outreach efforts. Recalling North (1990), however, such informal institutions may ultimately limit market development by influencing the preferences and constraining the choices available to potential participants.

Institutional Design and Policy Reform

The third essay provides insight into how administrative processes intended to redesign existing regulatory institutions can make use of multiple data sources to provide insight into who is participating and to suggest the direction of potential reforms. It specifically finds that certain applicant and land use types are represented in submitted comment letters in greater proportion than in related conservation agreements. For those applicant and land use types with a greater instance of comment letter submission than plan participation, the essay suggests that existing ESA programs and subsequent processes may be ineffective in meeting stakeholder needs. For those applicant and land use types with greater instance of plan participation than letter submission, the essay suggests that valuable input is foregone so long as these users are underrepresented.

To reach these conclusions, essay three employs a comparative approach across qualitative and quantitative sources of data. Content analysis is used to derive stakeholder policy perspective and attribute data from submitted comment letters, while a federally-maintained database on conservation plans and agreements yields summary statistics and

attribute data on plan participation. Absent a mixed methods approach, the analysis would paint an incomplete picture of who participates in ESA programs and reform efforts. Each source of data is capable of generating findings on absolute participation in a subset of the policy process, but neither is able to generate estimates of relative participation across both policy implementation and reform processes.

Essay three likewise provides insight into the influence of stakeholder participation on institutional design. The literature suggests that the evolution of institutions will be influenced by power asymmetries present in existing relationships (Hall & Taylor, 1996; Raitio, 2012), and that more powerful interests may seek to maintain the existing networks and decision-making structures that benefit them (Mostert, 2003; Peterson, et al., 2005). To help avoid the replication and propagation of existing asymmetries, the methods and findings introduced in essay three can help to target appropriate outreach strategies so as to ensure participation from affected but underrepresented groups in the design of formal regulatory institutions.

Institutional Design and Decision-Maker Response Revisited

The above essays each review a separate environmental policy problem and employ a different methodological approach. Together, they contribute to a greater understanding of institutional design, its influence on decision-maker behavior, and how we as scholars may investigate its implications. In the first essay, we observe path dependency in policy-relevant research. To help address the constraints and incentives that contribute to such an outcome, novel approaches for funding and collaboration may be necessary. The second essay

demonstrates how institutions may affect market participation decision-making and how these institutions vary by market segment. It provides insight into policy design, and argues that uniform policy approaches incapable of differentiating between diverse institutional contexts may fail to bring about the desired market response. The third essay describes how the reform of regulatory institutions may be informed by the relative contributions of different stakeholder groups, as well as how steps may be taken to avoid the perpetuation of existing power asymmetries.

The methodological approach developed in each essay also demonstrates how the choice of method can generate insight into institutional design. The comparative literature review and case studies in essay one draw out the conceptual differences and applicability of competing property rights frameworks. The social network analysis employed in essay two allows for comparison of the factors affecting bioenergy market participation decisions both within and between user group, geographic area, and feedstock category. The mixed methods design used in essay three develops a comprehensive picture of participation in a single conservation program and regulatory rulemaking under the ESA. All three essays make use of different tools but each is in some way comparative, thus allowing for the highlighting or isolation of important differences.

The works developed here represent a modest contribution to the field by proposing a different manner in viewing the issue. They demonstrate that the inherent interdisciplinarity of institutional theory and analysis is well suited to frame a broader examination of institutional design and decision-maker response. A particular advantage of viewing these collected works through the lens of historical institutionalism is that one can better draw

conclusions as to why observed institutions in both policy and research are perpetuated. Having thus identified what sustains these institutions, one is then better equipped to identify what can lead to change (Thelen, 1999). In research, institutional change can lead to new insights, new approaches, and increased innovation. In the development of nascent markets, institutional change can provide for the expansion of market opportunities and increased provision of renewable energy feedstock. In the revision of formal regulations, institutional change can increase the conservation tools available to under-served stakeholders. Better understanding and leveraging these mechanisms can bring better information to bear on the policy process while helping to develop more effective policy tools to address society's most pressing environmental challenges.

REFERENCES

Alchian, A. A., & Demsetz, H. (1972). Production, information costs, and economic organization. *The American Economic Review, 62*, 777-795.

Alexander, C., Ivanic, R., Rosch, S., Tyner, W., Wu, S. Y., & Yoder, J. R. (2012). Contract theory and implications for perennial energy crop contracting. *Energy Economics, 34*, 970-979.

Altman, I., Bergtold, J., Sanders, D. R., & Johnson, T. G. (2012). Market development of biomass industries. *Agribusiness, doi: 10.1002/agr.21318*.

Altman, I., Johnson, T. G., & Moon, W. (2010). Organizational preferences and producer characteristics in biomass supply chains. *Journal of Agribusiness, 28*, 151-162.

Ascher, W., Steelman, T. A., & Healy, R. G. (2010). *Knowledge and environmental Policy: Re-imagining the boundaries of science and politics*. Cambridge, MA: The MIT Press.

Baker, J., Murray, B., McCarl, B., Rose, S., & Schneck, J. (2011). *Greenhouse gas emissions and nitrogen use in U.S. agriculture: Historic trends, future projections, and biofuel policy impacts* (No. Report NI R 11-08). Durham, NC: Nicholas Institute for Environmental Policy Solutions, Duke University.

Beach, R. H., Pattanayak, S. K., Yang, J.-C., Murray, B. C., & Abt, R. C. (2005). Econometric studies of non-industrial private forest management: a review and synthesis. *Forest Policy and Economics, 7*, 261-281.

Beach, R. H., Zhang, Y. W., & McCarl, B. (2012). Modeling bioenergy, land use, and GHG emissions with FASOMGHG: Model overview and analysis of storage cost implications. *Climate Change Economics, 3*, 1250012 (1250034 p).

Beierle, T. C. (1999). Using social goals to evaluate public participation in environmental decisions. *Policy Studies Review, 16*, 75-103.

Beierle, T. C., & Cayford, J. (2002). *Democracy in practice: Public participation in environmental decisions*. Washington, D.C.: RFF Press.

Bergstrøm, C. (2005). *Claiming reindeer in Norway: towards a theory of the dynamics of property regime formation and change.* Norwegian University of Life Sciences, Ås, Norway.

Bergtold, J. S., Fewell, J., & Williams, J. (2011). *Farmers' willingness to grow sweet sorghum as a cellulosic bioenergy crop: A stated choice approach*. Paper presented at the Agricultural & Applied Economics Association AAEA & NAREA Joint Annual Meeting, Pittsburgh, Pennsylvania, July 24-26, 2011.

Beymer-Farris, B. A., & Bassett, T. J. (2012). The REDD menace: Resurgent protectionism in Tanzania's mangrove forests. *Global Environmental Change 22*, 332-341.

Biocarbon Fund. (2009). Humbo Ethiopia Assisted Natural Regeneration Project, Project Design Document Form for Afforestation and Reforestation Project Activities (CDM-AR-PDD) - Version 04. Retrieved April 1, 2013, from http://cdm.unfccc.int/Projects/DB/JACO1245724331.7/view

Birur, D., Hertel, T., & Tyner, W. (2008). *Impact of biofuel production on world agricultural markets: A computable general equilibrium analysis*. West Lafayette, IN: Department of Agricultural Economics, Purdue University.

Borgatti, S. P. (2002). Netdraw Network Visualization. Harvard, MA: Analytic Technologies.

Borgatti, S. P., Everett, M. G., & Freeman, L. C. (2002). Ucinet 6 for Windows: Software for social network analysis. Harvard, MA: Analytic Technologies.

Borgatti, S. P., Everett, M. G., & Johnson, J. C. (2013). *Analyzing social networks*. Los Angeles, CA: Sage.

Bowles, S. (1998). Endogenous preferences: The cultural consequences of markets and other economic institutions. *Journal of Economic Literature, 36*, 75-111.

Brohmann, B., Feenstra, Y., Heiskanen, E., Hodson, M., Mourik, R., Prasad, G., et al. (2007, June 20-22). *Factors influencing the societal acceptance of new, renewable and energy efficiency technologies: Meta-analysis of recent European projects.* Paper presented at the European Roundtable for Sustainable Consumption and Production, Basel, Switzerland.

Bromley, D. W. (1989). *Economic interests and institutions: The conceptual foundations of public policy*. Oxford, UK: Basil Blackwell.

Bromley, D. W. (1991). *Environment and the economy: Property rights and public policy*. Oxford, UK: Basil Blackwell.

Brugha, R., & Varvasovszky, Z. (2000). Stakeholder analysis: a review. *Health Policy and Planning*, *15*, 239-246.

Burns, C. (2012). An historical institutionalist analysis of EU biotechnology policy. *Journal of European Integration, 34*, 341-357.

Chhatre, A., & Agrawal, A. (2009). Trade-offs and synergies between carbon storage and livelihood benefits from forest commons. *Proceedings of the National Academy of Sciences of the United States of America, 106*, 17667-17670.

Clancy, D., Breen, J., Moran, B., Thorne, F., & Wallace, M. (2011). Examining the socio-economic factors affecting willingness to adopt bioenergy crops. *Journal of International Farm Management, 5*, 25-40.

Cole, D. H., & Ostrom, E. (2010). *The variety of property systems and rights in natural resources. Research Paper No. 2010-08-01*. Bloomington, IN: School of Public and Environmental Affairs, Indiana University.

Commons, J. R. (1968). *Legal foundations of capitalism*. Madison, WI: University of Wisconsin Press.

Conrad, J. L., Bolding, M. C., Smith, R. L., & Aust, W. M. (2011). Wood-energy market impact on competition, procurement practices, and profitability of landowners and forest products industry in the U.S. South. *Biomass and Bioenergy, 35*, 280-287.

Convery, I., Robson, D., Ottitsch, A., & Long, M. (2012). The willingness of farmers to engage with bioenergy and woody biomass production: A regional case study from Cumbria. *Energy Policy, 40*, 293-300.

Cooley, D. M., Galik, C. S., Holmes, T. P., Kousky, C., & Cooke, R. M. (2012). Managing dependencies in forest offset projects: toward a more complete evaluation of reversal risk. *Mitigation and Adaptation Strategies for Global Change, 17*, 17-24.

Cope, M. A., McLafferty, S., & Rhoads, B. L. (2011). Farmer attitudes toward production of perennial energy grasses in east central Illinois: Implications for community based decision making. *Annals of the Association of American Geographers, 101*, 852-862.

Costanza, R., & Folke, C. (1996). The structure and function of ecological systems. In S. S. Hanna, C. Folke & K.-G. Mäler (Eds.), *Rights to Nature: Ecological, Economic, Cultural, and Political principles of Institutions for the Environment* (pp. 11-34). Washington, D.C.: Island Press.

Creswell, J. W., & Clark, V. L. P. (2011). *Designing and conducting mixed methods research* (2nd ed.). Thousand Oaks, CA: Sage Publications, Inc.

Deirmeier, D., & Krehbiel, K. (2003). Institutionalism as methodology. *Journal of Theoretical Politics, 15*, 123-144.

Demsetz, H. (1967). Toward a theory of property rights. *The American Economic Review, 57*, 347-359.

Dicks, M. R., Campiche, J., Ugarte, D. D. L. T., Hellwinckel, C., Bryant, H. L., & Richardson, J. W. (2009). Land use implications of expanding biofuel demand. *Journal of Agricultural and Applied Economics, 41*, 435-453.

Dirkswager, A. L., Kilgore, M. A., Becker, D. R., Blinn, C., & Ek, A. (2011). Logging business practices and perspectives on harvesting forest residues for energy: a Minnesota case study. *Northern Journal of Applied Forestry, 28*, 41-46.

Doremus, H. (1998). Preserving citizen participation in the era of reinvention: the Endangered Species Act example. *Ecology Law Quarterly, 25*, 707-717.

Durocher, S., & Fortin, A. (2011). Practitioners' participation in the accounting standard-setting process. *Accounting and Business Research, 41*, 29-50.

Dutschke, M., & Angelsen, A. (2008). How do we ensure permanence and assign liability? In A. Angelsen (Ed.), *Moving Ahead with REDD: Issues, Options and Implications* (pp. 77-85). Bogor, Indonesia: CIFOR.

Edwards, S. F. (1994). Ownership of renewable ocean resources. *Marine Resource Economics, 9*, 253-273.

Eggertsson, T. (1990). *Economic behavior and institutions*. Cambridge, UK: Cambridge University Press.

Fewell, J., Bergtold, J., & Williams, J. (2011). *Farmers' willingness to grow switchgrass as a cellulosic bioenergy crop: A stated choice approach*. Paper presented at the Joint Annual Meeting of the Canadian Agricultural Economics Society & Western Agricultural Economics Association.

Fiedling, D., Cubbage, F., Peterson, M. N., Hazel, D., Gugelmann, B., & Moorman, C. (2012). Opinions of forest managers, loggers, and forest landowners in North Carolina regarding biomass harvesting guidelines. *International Journal of Forestry Research, 2012*, 15.

Fiorino, D. J. (1990). Citizen participation and environmental risk: A survey of institutional mechanisms. *Science, Technology, & Human Values, 15*, 226-243.

G.C., S., & Mehmood, S. R. (2012). Determinants of nonindustrial private forest landowner willingness to accept price offers for woody biomass. *Forest Policy and Economics, 25*, 47-55.

Galik, C. S., Murray, B. C., & Mercer, D. E. (2013). Where is the carbon? Carbon sequestration potential from private forestland in the Southern United States. *Journal of Forestry, 111*, 17-25.

Gan, J., Jarrett, A., & Gaither, C. J. (2013). Forest fuel reduction and biomass supply: Perspectives from Southern private landowners. *Journal of Sustainable Forestry, 32*, 28-40.

Geiger, M. A. (1989). The new audit report: An analysis of exposure draft comments. *Auditing: A Journal of Practice and Theory, 8*, 40-63.

Georgiou, G. (2002). Corporate non-participation in the ASB standard-setting process. *The European Accounting Review, 11*, 699-722.

Golden, M. M. (1998). Interest groups in the rule-making process: Who participates? Whose voices get heard? *Journal of Public Administration Research and Theory, 8*, 245-270.

Greif, A. (1998). Historical and comparative institutional analysis. *The American Economic Review, 88*, 80-84.

Gruchy, S. R., Grebner, D. L., Munn, I. A., Joshi, O., & Hussain, A. (2012). An assessment of nonindustrial private forest landowner willingness to harvest woody biomass in support of bioenergy production in Mississippi: A contingent rating approach. *Forest Policy and Economics, 15*, 140-145.

Guo, L. B., & Gifford, R. M. (2002). Soil carbon stocks and land use change: a meta analysis. *Global Change Biology, 8*, 345-360.

Hall, P. A., & Taylor, R. C. R. (1996). Political science and the three new institutionalisms. *Political Studies, 44*, 936-957.

Hayes, T. M. (2007). Does tenure matter? A comparative analysis of agricultural expansion in the Mosquitia Forest Corridor. *Human Ecology, 35*, 733-747.

Hayes, T. M., & Persha, L. (2010). Nesting local forestry initiatives: Revisiting community forest management in a REDD+ world. *Forest Policy and Economics, 12*, 545-553.

Helby, P., Rosenqvist, H., & Roos, A. (2006). Retreat from Salix—Swedish experience with energy crops in the 1990s. *Biomass and Bioenergy, 30*, 422-427.

Hipple, P., & Duffy, M. (2002). Farmers' motivations for adoption of switchgrass. In J. Janick & A. Whipkey (Eds.), *Trends in new crops and new uses* (pp. 252-266). Alexandria, VA: ASHS Press.

Hohfeld, W. N. (1913). Some fundamental legal conceptions as applied in judicial reasoning. *Yale Law Journal, 23*, 16-59.

Hohfeld, W. N. (1917). Fundamental legal conceptions as applied in judicial reasoning. *Yale Law Journal, 26*, 710-770.

Honoré, A. M. (1961). Ownership. In A. G. Guest (Ed.), *Oxford Essays in Jurisprudence* (pp. 107-147). Oxford, UK: Oxford University Press.

Hood, L. C. (1998). *Frayed safety nets: Conservation planning under the Endangered Species Act*. Washington, D.C.: Defenders of Wildlife.

Hoornbeek, J. A. (2004). Policy-making institutions and water policy outputs in the European Union and the United States: a comparative analysis. *Journal of European Public Policy, 11*, 461-496.

Hubert, L., & Schultz, J. (1976). Quadratic assignment as a general data analysis strategy. *British Journal of Mathematical and Statistical Psychology, 29*, 190-241.

Ikenberry, G. J. (1994). *History's heavy hand: Institutions and the politics of the state.* Paper presented at the New Perspectives on Institutions Conference, University of Maryland, College Park, Maryland, October, 1994.

Jorissen, A., Lybaert, N., Orens, R., & Tas, L. v. d. (2012). Formal participation in the IASB's due process of standard setting: A multi-issue/multi-period analysis. *European Accounting Review, 21*, 693-729.

Joshi, O., & Mehmood, S. R. (2011). Factors affecting nonindustrial private forest landowners' willingness to supply woody biomass for bioenergy. *Biomass and Bioenergy, 35*, 186-192.

Keeney, R., & Hertel, T. (2008). *The indirect land use impacts of U.S. biofuel policies: The importance of acreage, yield, and bilateral trade responses*. West Lafayette, Indiana Department of Agricultural Economics, Purdue University.

Koontz, T. M., & Thomas, C. W. (2006). What do we know and need to know about the environmental outcomes of collaborative management? *Public Administration Review, 66*, 111-121.

Krackhardt, D. (1988). Predicting with networks: Nonparametric multiple regression analysis of dyadic data. *Social Networks, 10*, 359-381.

Kundhlande, G., & Luckert, M. K. (1998). *Towards an analytical framework to assessing property rights to natural resources: A case study in the communal areas of Zimbabwe. Department of Rural Economy Staff Paper No. 98-05*. Edmonton, AB: Department of Rural Economy, University of Alberta.

Langanière, J., Angers, D. A., & Paré, D. (2010). Carbon accumulation in agricultural soils after afforestation: a meta-analysis. *Global Change Biology, 16*, 439-453.

Langpap, C., & Kerkvliet, J. (2012). Endangered species conservation on private land: Assessing the effectiveness of Habitat Conservation Plans. *Journal of Endangered Economics and Management, 64*, 1-15.

Langpap, C., & Wu, J. (2004). Voluntary conservation of endangered species: When does No Regulatory Assurance mean No Conservation? *Journal of Environmental Economics and Management, 47*, 435-457.

Larson, A. M., Barry, D., & Dahal, G. R. (2010). New rights for forest-based communities? Understanding processes of forest tenure reform. *International Forestry Review, 12*, 78-96.

Larson, J. A., & English, B. C. (2009). *Risk management for energy investments: Agricultural policy and extension recommendations*. Paper presented at the Farm Foundation. Transition to a Bioeconomy: The Role of Extension in Energy.

Larson, J. A., English, B. C., & He, L. (2008). *Economic analysis of farm-level supply of biomass feedstocks for energy production under alternative contract scenarios and risk*. Paper presented at the Proceedings of the Integration of Agricultural and Energy Systems Conference, Atlanta, Georgia, February 12-13, 2008.

Larson, R. K., & Herz, P. J. (2013). A multi-issue/multi-period analysis of the geographic diversity of IASB comment letter participation. *Accounting in Europe, 10*, 99-151.

Latta, G., Adams, D. M., Alig, R. J., & White, E. (2011). Simulated effects of mandatory versus voluntary participation in private forest carbon offset markets in the United States. *Journal of Forest Economics, 17*, 127-141.

Lawlor, K., Weinthal, E., & Olander, L. (2010). Institutions and policies to protect rural livelihoods in REDD+ regimes. *Global Environmental Politics, 10*, 1-11.

Lazarus, R. J. (2009). Super wicked problems and climate change: Restraining the present to liberate the future. *Cornell Law Review, 94*, 1153-1234.

Leach, M., Mearns, R., & Scoones, I. (1999). Environmental entitlements: Dynamics and institutions in community-based natural resource management. *World Development, 27*, 225-247.

Lee, I.-W., Feiock, R. C., & Lee, Y. (2012). Competitors and cooperators: A micro-level analysis of regional economic development collaboration networks. *Public Administration Review, 72*(2), 253-262.

Leitch, Z. J., Lhotka, J. M., Stainback, G. A., & Stringer, J. W. (2013). Private landowner intent to supply woody feedstock for bioenergy production. *Biomass and Bioenergy, 56*, 127-136.

Levin, K., Cashore, B., Bernstein, S., & Auld, G. (2009). *Playing it forward: Path dependency, progressive incrementalism, and the "super wicked" problem of global climate change*. Paper presented at the Climate Change: Global Risks, Challenges, and Decisions Congress. Copenhagen, Denmark. March 10-12, 2009.

Li, E. Y., Liao, C. H., & Yen, H. R. (2013). Co-authorship networks and research impact: A social capital perspective. *Research Policy, In Press, Corrected Proof*, 1-16.

Lowenberg-DeBoer, J., & López-Pereira, M. A. (1990). Risk assessment for herbaceous biomass crops: the case of perennial grasses. *Biomass and Bioenergy, 23*, 263-274.

Lynes, M. K., Bergtold, J. S., Williams, J. R., & Fewell, J. E. (2012). *Determining farmers' willingness-to-grow cellulosic biofuel feedstocks on agricultural land*. Paper presented at the Agricultural and Applied Economics Association AAEA Annual Conference, Seattle, Washington, August 12-14, 2012.

MacKenzie, I. A., Ohndorf, M., & Palmer, C. (2012). Enforcement-proof contracts with moral hazard in precaution: Ensuring 'permanence' in carbon sequestration. *Oxford Economic Papers, 64*, 350-374.

March, J. G., & Olsen, J. P. (1984). The New Institutionalism: Organizational factors in political life. *The American Political Science Review, 78*, 734-749.

Markowski-Lindsay, M., Stevens, T., Kittredge, D. B., Butler, B. J., Catanzaro, P., & Damery, D. (2012). Family forest owner preferences for biomass harvesting in Massachusetts. *Forest Policy and Economics, 14*, 127-135.

May, P. J. (1992). Policy learning and failure. *Journal of Public Policy, 12*, 331-354.

Meinzen-Dick, R., & Bakker, M. (1999). Irrigation systems as multiple-use commons: Water use in Kirindi Oya, Sri Lanka. *Agriculture and Human Values, 16*, 281-293.

Mercier, J. (2006). American hesitations to reduce greenhouse gas emissions: an institutional interpretation. *International Review of Administrative Sciences, 72*, 101-121.

Miguez, F. E., Villamil, M. B., Long, S. P., & Bollero, G. A. (2008). Meta-analysis of the effects of management factors on Miscanthus x giganteus growth and biomass production. *Agricultural and Forest Meteorology, 148*, 1280-1292.

Milne, S. (2012). Grounding forest carbon: Property relations and avoided deforestation in Cambodia. *Human Ecology, 40*, 693-706.

Moeliono, M., Gallemore, C., Santoso, L., Brockhaus, M., & Di Gregorio, M. (2014). Information networks and power: confronting the "wicked problem" of REDD+ in Indonesia. *Ecology and Society, 19*, 9.

Mostert, E. (2003). The challenge of public participation. *Water Policy, 5*, 179-197.

Murray, B. C., Sohngen, B. L., Sommer, A. J., Depro, B. M., Jones, K. M., McCarl, B. A., et al. (2005). *Greenhouse gas mitigation potential in U.S. forestry and agriculture. EPA-R-05-00*. Washington, D.C.: U.S. Environmental Protection Agency, Office of Atmospheric Programs.

Nagpaul, P. (2003). Exploring a pseudo-regression model of transnational cooperation in science. *Scientometrics, 56*, 403-416.

North, D. C. (1990). *Institutions, institutional change and economic performance*. Cambridge, UK: Cambridge University Press.

North, D. C. (1994). Economic performance through time. *The American Economic Review, 84*, 359-368.

O'Riordan, T., & Jordan, A. (1999). Institutions, climate change and cultural theory: towards a common analytical framework. *Global Environmental Change, 9*, 81-93.

Ostrom, E. (2005). *Understanding institutional diversity*. Princeton, NJ: Princeton University Press.

Ostrom, E., & Schlager, E. (1996). The formation of property rights. In S. S. Hanna, C. Folke & K.-G. Mäler (Eds.), *Rights to Nature: Ecological, Economic, Cultural, and*

Political principles of Institutions for the Environment (pp. 127-156). Washington, D.C.: Island Press.

Ostrom, V., & Ostrom, E. (1999). Legal and political conditions of water resource development. In M. D. McGinnis (Ed.), *Polycentric Governance and Development: Readings from the Workshop in Political Theory and Policy Analysis* (pp. 42-59). Ann Arbor, MI: University of Michigan Press.

Ostwald, M., Jonsson, A., Wibeck, V., & Asplund, T. (2013). Mapping energy crop cultivation and identifying motivational factors among Swedish farmers. *Biomass and Bioenergy, 50*, 25-34.

Otte, E., & Rousseau, R. (2002). Social network analysis: a powerful strategy, also for the information sciences. *Journal of Information Science, 28*, 441-453.

Page, S. E. (2006). Path dependence. *Quarterly Journal of Political Science, 1*, 87-115.

Palmer, C. (2011). Property rights and liability for deforestation under REDD+: Implications for 'permanence' in policy design. *Ecological Economics, 70*, 571-576.

Pancholy, N., Thomas, M. H., Solís, D., & Stratis, N. (2011). The impact of biofuels on the propensity of land-use conversion among non-industrial private forest landowners in Florida. *Forest Policy and Economics, 13*, 570-574.

Paulrud, S., & Laitila, T. (2010). Farmers' attitudes about growing energy crops: a choice experiment approach. *Biomass and Bioenergy, 34*, 1770-1779.

Penner, J. E. (1996). The 'bundle of rights' picture of property. *UCLA Law Review, 43*, 711-820.

Peters, B. G., Pierre, J., & King, D. S. (2005). The politics of path dependency: Political conflict in historical institutionalism. *The Journal of Politics, 67*, 1275-1300.

Peterson, M. N., Peterson, M. J., & Peterson, T. R. (2005). Conservation and the myth of consensus. *Conservation Biology, 19*, 762-767.

Poteete, A. R., Janssen, M. A., & Ostrom, E. (2010). *Working together: Collective action, the commons, and multiple methods in practice*. Princeton, NJ: Princeton University Press.

QSR International Pty Ltd. (2012). NVivo qualitative data analysis software (Version 10).

Raitio, K. (2012). New institutional approach to collaborative forest planning on public land: Methods for analysis and lessons for policy. *Land Use Policy, 29*, 309-316.

Rämö, A.-K., Järvinen, E., Latvala, T., Toivonen, R., & Silvennoinen, H. (2009). Interest in energy wood and energy crop production among Finnish non-industrial private forest owners. *Biomass and Bioenergy, 33*, 1251-1257.

Reed, M. S. (2008). Stakeholder participation for environmental management: A literature review. *Biological Conservation, 141*, 2417-2431.

Reed, M. S., Graves, A., Dandy, N., Posthumus, H., Hubacek, K., Morris, J., et al. (2009). Who's in and why? A typology of stakeholder analysis methods for natural resource management. *Journal of Environmental Management, 90*, 1933-1949.

Ribot, J. C., & Peluso, N. L. (2003). A theory of access. *Rural Sociology, 68*, 153-181.

Riffell, S., Verschuyl, J., Miller, D., & Wigley, T. B. (2011). A meta-analysis of bird and mammal response to short-rotation woody crops. *GCB Bioenergy, 3*, 313-321.

Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences, 4*, 155-169.

Roncoli, C., Jost, C., Perez, C., Moore, K., Ballo, A., Cissé, S., et al. (2007). Carbon sequestration from common property resources: Lessons from community-based sustainable pasture management in north-central Mali. *Agricultural Systems, 94*, 97-109.

Rossi, A. M., & Hinrichs, C. C. (2011). Hope and skepticism: Farmer and local community views on the socio-economic benefits of agricultural bioenergy. *Biomass and Bioenergy, 35*, 1418-1428.

Roy, A. K. D., Alam, K., & Gow, J. (2012). A review of the role of property rights and forest policies in the management of the Sundarbans Mangrove Forest in Bangladesh. *Forest Policy and Economics, 15*, 46-53.

Sabatier, P. A., & Weible, C. M. (2007). The Advocacy Coalition Framework. In P. A. Sabatier (Ed.), *Theories of the Policy Process* (pp. 189-220). Cambridge, MA: Westview Press.

Saemann, G. (1999). An examination of comment letters filed in the U.S. financial accounting standard-setting process by institutional interest groups. *Abacus 35*, 1-28.

Sandbrook, C., Nelson, F., Adams, W. A., & Agrawal, A. (2010). Carbon, forests and the REDD paradox. *Oryx 44*, 330-334.

Scardina, A. V., Mortimer, M. J., & Dudley, L. (2007). Getting past the who and how many to the how and why in USDA Forest Service public involvement processes. *Forest Policy and Economics, 9*, 883-902.

Schlager, E., Blomquist, W., & Tang, S. Y. (1994). Mobile flows, storage, and self-organized institutions for governing common-pool resources. *Land Economics, 70*, 294-317.

Schlager, E., & Ostrom, E. (1992). Property rights regimes and natural resources: A conceptual analysis. *Land Economics, 68*, 249-262.

Seabright, P. (1993). Managing local commons: Theoretical issues in incentive design. *Journal of Economic Perspectives, 7*, 113-134.

Sekhar, N. U. (2004). Fisheries in Chilika Lake: How community access and control impacts their management. *Journal of Environmental Management, 73*, 257-266.

Simpson, W. (2001). QAP -- The Quadratic Assignment Procedure. Harvard Business School, Working paper. Retrieved May 14, 2014, from http://fmwww.bc.edu/RePEc/nasug2001/simpson.pdf

Smith, D. J., Schulman, C., Current, D., & Easter, K. W. (2011). *Willingness of agricultural landowners to supply perennial energy crops*. Paper presented at the Agricultural & Applied Economics Association AAEA & NAREA Joint Annual Meeting, Pittsburgh, Pennsylvania, July 24-26, 2011.

Smith, H. E. (2011). Property is not just a bundle of rights. *Econ Journal Watch, 8*, 279-291.

Steelman, T. A., & Ascher, W. (1997). Public involvement methods in natural resource policy making: Advantages, disadvantages and trade-offs. *Policy Sciences, 30*, 71-90.

Stone, D. (2002). *Policy paradox: The art of political decision making* (Revised ed.). New York: W.W. Norton & Company.

Streck, C. (2009). Rights and REDD+: Legal and regulatory considerations. In A. Angelsen (Ed.), *Realizing REDD+: National Strategy and Policy Options* (pp. 151-162). Bogor, Indonesia: CIFOR.

Sunderlin, W. D., Larson, A. M., & Cronkleton, P. (2009). Forest tenure rights and REDD+: From inertia to policy solutions. In A. Angelsen (Ed.), *Realizing REDD+: National Strategy and Policy Options* (pp. 139-149). Bogor, Indonesia: CIFOR.

Takacs, D. (2009). *Forest carbon: Law + property rights*. Arlington, VA: Conservation International.

The Forest Dialogue. (2008). *Beyond REDD: The role of forests in climate change*: New Haven, CT.

Thelen, K. (1999). Historical institutionalism in comparative politics. *Annual Review of Political Science, 2*, 369-404.

Tsai, W. (2002). Social structure of "coopetition" within a multiunit organization: Coordination, competition, and intraorganizational knowledge sharing. *Organization Science, 13*, 179-190.

Tyndall, J. C., Berg, E. J., & Colletti, J. P. (2011). Corn stover as a biofuel feedstock in Iowa's bio-economy: an Iowa farmer survey. *Biomass and Bioenergy, 35*, 1485-1495.

U.S. Fish and Wildlife Service (USFWS). (2009). Our endangered species program and how it works with landowners. Retrieved April 17, 2014, from http://www.fws.gov/endangered/esa-library/pdf/landowners.pdf

U.S. Fish and Wildlife Service (USFWS). (2011). Endangered and threatened species: Preventing extinction…achieving recovery. Retrieved April 17, 2014, from https://www.fws.gov/endangered/improving_ESA/Readable.pdf

U.S. Fish and Wildlife Service (USFWS). (2014). Conservation plans and agreements database. Retrieved February 25, 2014, from http://ecos.fws.gov/conserv_plans/public.jsp

van de Wijngaert, L., Bouwman, H., & Contractor, N. (2012). A network approach toward literature review. *Quality & Quantity, DOI 10.1007/s11135-012-9791-3*, 1-21.

van den Hove, S. (2007). A Rationale for science–policy interfaces. *Futures, 39*, 807-826.

Varvasovszky, Z., & Brugha, R. (2000). How to do (or not to do)...A stakeholder analysis. *Health Policy and Planning, 15*, 338-345.

Veettil, P. C., Kjosavik, D. J., & Ashok, A. (2013). Valuing the 'bundle of land rights': On formalising indigenous people's (adivasis) land rights in Kerala, India. *Land Use Policy, 30*, 408-416.

Vegh, T., & Galik, C. S. (2014). *Bioenergy in the Southeast: Gap analysis and policy review. Draft report*. Durham, NC: Nicholas Institute for Environmental Policy Solutions, Duke University.

Villamil, M. B., Alexander, M., Silvis, A. H., & Gray, M. E. (2012). Producer perceptions and information needs regarding their adoption of bioenergy crops. *Renewable and Sustainable Energy Reviews, 16*, 2604-2612.

von Laer, Y., Reimer, F., Dannecker, C., Silber, T., Giraldo, V., & South Pole Carbon Asset Management Ltd. (2012). Kariba REDD+ Project. Retrieved April 1, 2013, from

https://vcsprojectdatabase2.apx.com/myModule/Interactive.asp?Tab=Projects&a=2&i=902&lat=-16.8184067184111&lon=28.7615526227228&bp=1

Wang, C. (2011). *How policy affects incentives and contract duration in biomass production*. Paper presented at the Agricultural & Applied Economics Association AAEA & NAREA Joint Annual Meeting, Pittsburgh, Pennsylvania, July 24-26, 2011.

Wang, D., LeBauer, D. S., & Dietze, M. C. (2010). A quantitative review comparing the yield of switchgrass in monocultures and mixtures in relation to climate and management factors. *GCB Bioenergy, 2*, 16-25.

West, W. (2005). Administrative rulemaking: An old and emerging literature. *Public Administration Review, 65*, 655-668.

Wey, T. W., & Blumstein, D. T. (2010). Social cohesion in yellow-bellied marmots is established through age and kin structuring. *Animal Behaviour, 79*, 1343-1352.

Wilhere, G. F. (2009). Three paradoxes of Habitat Conservation Plans. *Environmental Management, 44*, 1089-1098.

Williamson, C. R. (2009). Informal institutions rule: Institutional arrangements and economic performance. *Public Choice, 139*, 371-387.

Willock, J., Deary, I. J., Edwards-Jones, G., Gibson, G. J., McGregor, M. J., Sutherland, A., et al. (1999). The role of attitudes and objectives in farmer decision making: Business and environmentally-oriented behaviour in Scotland. *Journal of Agricultural Economics, 50*, 286-303.

Yackee, J. W., & Yackee, S. W. (2006). A bias towards business? Assessing interest group influence on the U.S. bureaucracy. *Journal of Politics, 68*, 128-139.

Yackee, S. W. (2006). Sweet-talking the fourth branch: The influence of interest group comments on federal agency rulemaking. *Journal of Public Administration Research and Theory*, *16*, 103-124.

Yen, A. C., Hirst, D. E., & Hopkins, P. E. (2007). A content analysis of the comprehensive income exposure draft comment letters. *Research in Accounting Regulation*, *19*, 53-79.

Yin, R. K. (1994). *Case study research: Design and methods* (2nd ed.). Thousand Oaks, CA: Sage Publications, Inc.

APPENDICES

Appendix A - Subset of studies used in the social network analysis of the literature

Anand, M. (2010). Essays on the profitability of winter farming enterprises. A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy. Auburn University, Auburn, Alabama.

Becker, D. R., Eryilmaz, D., Klapperich, J. J., & Kilgore, M. A. (2013). Social availability of residual woody biomass from nonindustrial private woodland owners in Minnesota and Wisconsin. *Biomass and Bioenergy*, *56*, 82-91.

Becker, D. R., Klapperich, J. J., Domke, G. M., Kilgore, M. A., D'Amato, A. W., Current, D. A., et al. (2010). 2010 outlook for forest biomass availability in Minnesota: Physical, environmental, economic, and social availability. Staff Paper Series No. 211. St. Paul, Minnesota: Department of Forest Resources, College of Food, Agricultural and Natural Resource Sciences, University of Minnesota.

Bergtold, J. S., Fewell, J., & Williams, J. (2011). Farmers' willingness to grow sweet sorghum as a cellulosic bioenergy crop: A stated choice approach. Paper presented at the Agricultural & Applied Economics Association AAEA & NAREA Joint Annual Meeting, Pittsburgh, Pennsylvania, July 24-26, 2011.

Bergtold, J. S., Fewell, J., & Williams, J. (no date). Farmers' willingness to produce alternative cellulosic biofuel feedstocks in Kansas using stated choice experiments. Manhattan, Kansas: Kansas State University.

Fewell, J., Bergtold, J., & Williams, J. (2011). Farmers' willingness to grow switchgrass as a cellulosic bioenergy crop: A stated choice approach. Paper presented at the Joint Annual

Meeting of the Canadian Agricultural Economics Society & Western Agricultural Economics Association.

Fox, J. E. (2010). Intent to continue growing switchgrass as a dedicated energy crop: A case study of switchgrass producers in East Tennessee. A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science. University of Tennessee, Knoxville, Tennessee.

G.C., S., & Mehmood, S. R. (2012). Determinants of nonindustrial private forest landowner willingness to accept price offers for woody biomass. *Forest Policy and Economics*, *25*, 47-55.

Gan, J., Jarrett, A., & Gaither, C. J. (2013). Forest fuel reduction and biomass supply: Perspectives from southern private landowners. *Journal of Sustainable Forestry*, *32*, 28-40.

Gedikoglu, H. (2012). Impact of off-farm employment on farmers' willingness to grow switchgrass and miscanthus. Paper presented at the Southern Agricultural Economics Association Annual Meeting, Birmingham, Alabama.

Gruchy, S. R., Grebner, D. L., Munn, I. A., Joshi, O., & Hussain, A. (2012). An assessment of nonindustrial private forest landowner willingness to harvest woody biomass in support of bioenergy production in Mississippi: A contingent rating approach. *Forest Policy and Economics*, *15*, 140-145.

Jensen, K., Clark, C. D., Ellis, P., English, B., Menard, J., Walsh, M., et al. (2007). Farmer willingness to grow switchgrass for energy production. *Biomass and Bioenergy*, *31*, 773-778.

Joshi, O., Grebner, D. L., Hussain, A., & Grado, S. C. (2013). Landowner knowledge and willingness to supply woody biomass for wood-based bioenergy: Sample selection approach. *Journal of Forest Economics*, *19*, 97-109.

Joshi, O., & Mehmood, S. R. (2011). Factors affecting nonindustrial private forest landowners' willingness to supply woody biomass for bioenergy. *Biomass and Bioenergy*, *35*, 186-192.

Leitch, Z. J., Lhotka, J. M., Stainback, G. A., & Stringer, J. W. (2013). Private landowner intent to supply woody feedstock for bioenergy production. *Biomass and Bioenergy*, *56*, 127-136.

Lu, W. (2008). Corn stover as a biofuel feedstock in Iowa: an analysis of farmer interest, concerns and price. A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science. Iowa State University, Ames, Iowa.

Lynes, M. K., Bergtold, J. S., Williams, J. R., & Fewell, J. E. (2012). Determining farmers' willingness-to-grow cellulosic biofuel feedstocks on agricultural land. Paper presented at the Agricultural and Applied Economics Association AAEA Annual Conference, Seattle, Washington, August 12-14, 2012.

Pancholy, N., Thomas, M. H., Solís, D., & Stratis, N. (2011). The impact of biofuels on the propensity of land-use conversion among non-industrial private forest landowners in Florida. *Forest Policy and Economics*, *13*, 570-574.

Qualls, D. J., Jensen, K. L., Clark, C. D., English, B. C., Larson, J. A., & Yen, S. T. (2012). Analysis of factors affecting willingness to produce switchgrass in the southeastern United States. *Biomass and Bioenergy*, *39*, 159-167.

Schulman, C. (2012). Minnesota landowners' habitus and interest in perennial energy crops. A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science. University of Minnesota, St. Paul, Minnesota.

Smith, D. J., Schulman, C., Current, D., & Easter, K. W. (2011). Willingness of agricultural landowners to supply perennial energy crops. Paper presented at the Agricultural & Applied Economics Association AAEA & NAREA Joint Annual Meeting, Pittsburgh, Pennsylvania, July 24-26, 2011.

Villamil, M. B., Alexander, M., Silvis, A. H., & Gray, M. E. (2012). Producer perceptions and information needs regarding their adoption of bioenergy crops. *Renewable and Sustainable Energy Reviews*, *16*, 2604-2612.

Appendix B - Network graphs for dataset subgroups

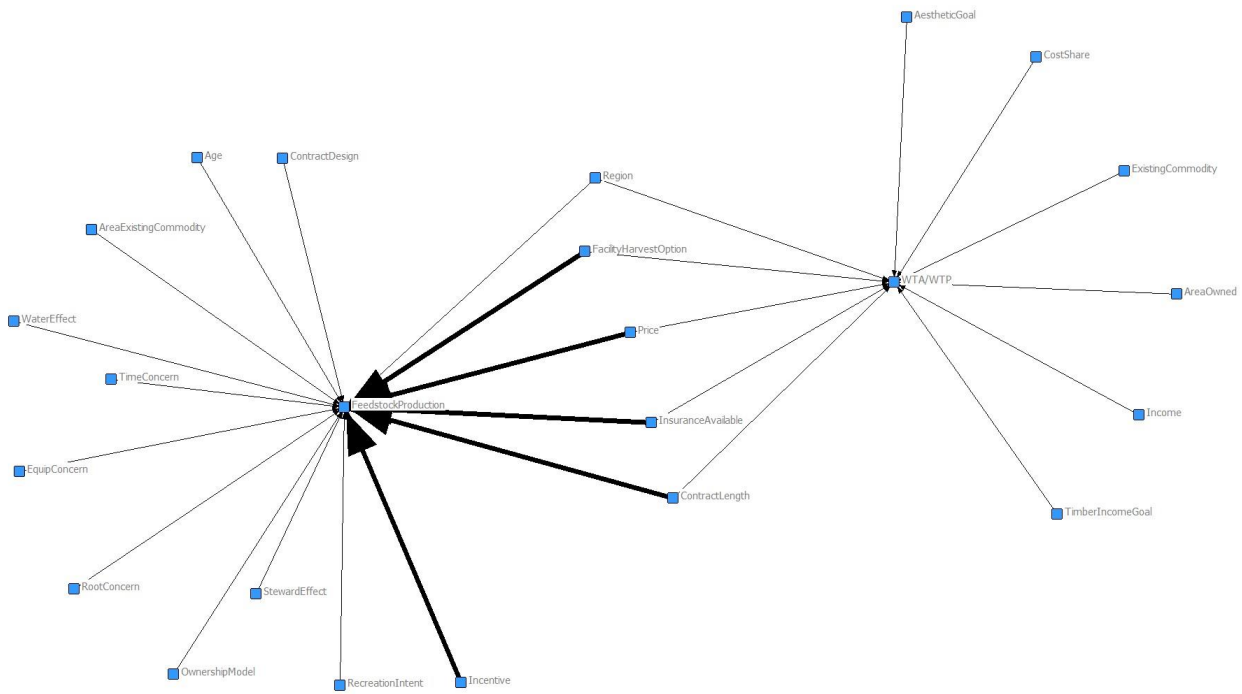

Figure B1. Network graph of commodity feedstocks, with ties weighted by occurrence. Tie direction indicates variable type: out-degree ties represent independents, in-degree ties represent dependents.

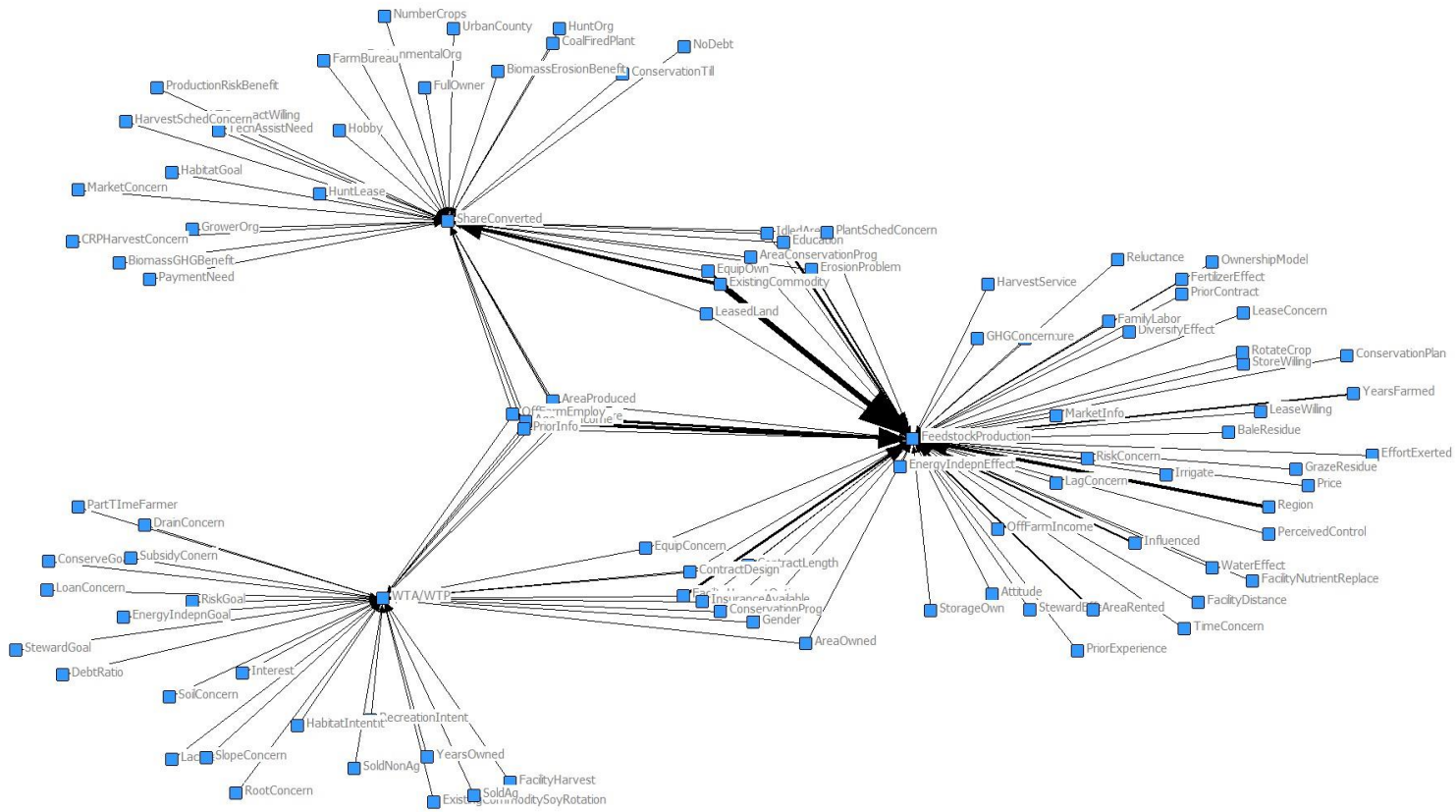

Figure B2. Network graph of dedicated feedstocks, with ties weighted by occurrence. Tie direction indicates variable type: out-degree ties represent independents, in-degree ties represent dependents.

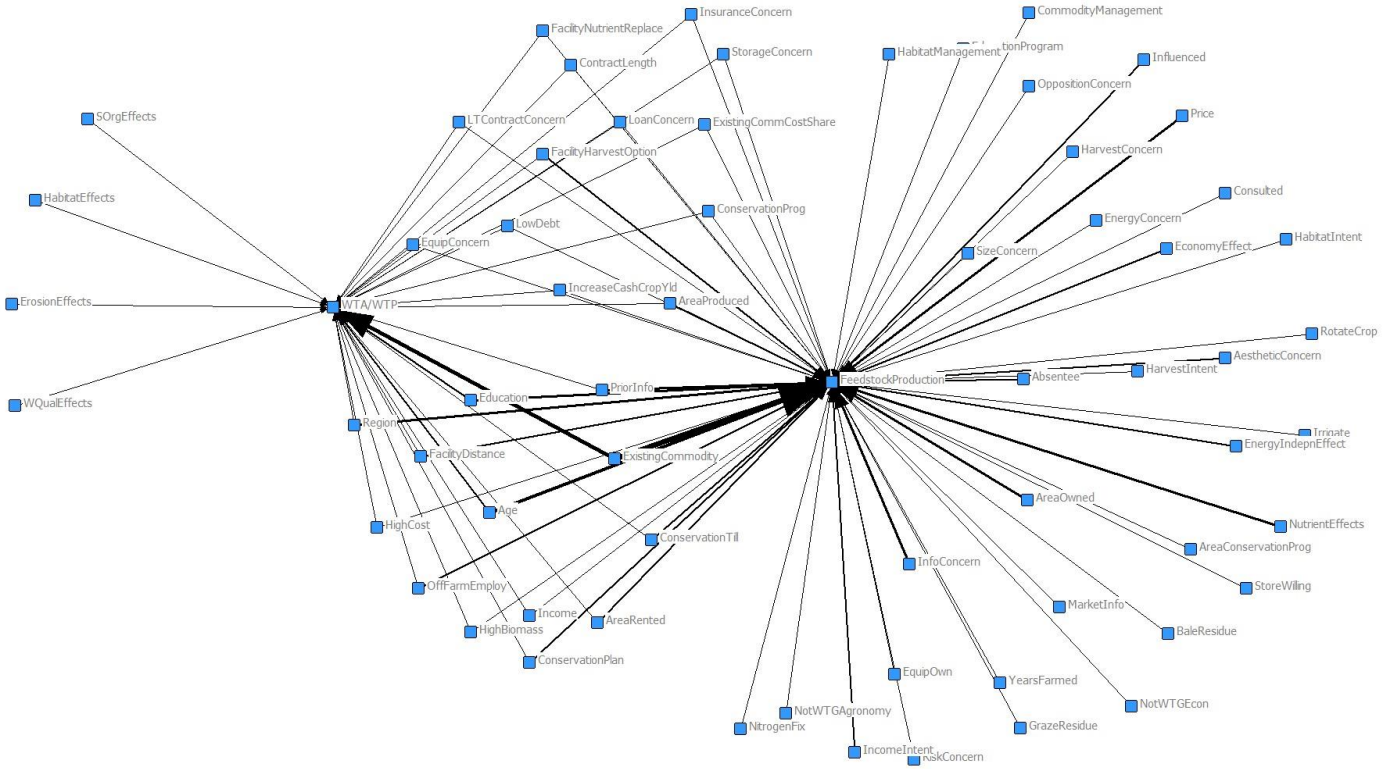

Figure B3. Network graph of residue feedstocks, with ties weighted by occurrence. Tie direction indicates variable type: out-degree ties represent independents, in-degree ties represent dependents.

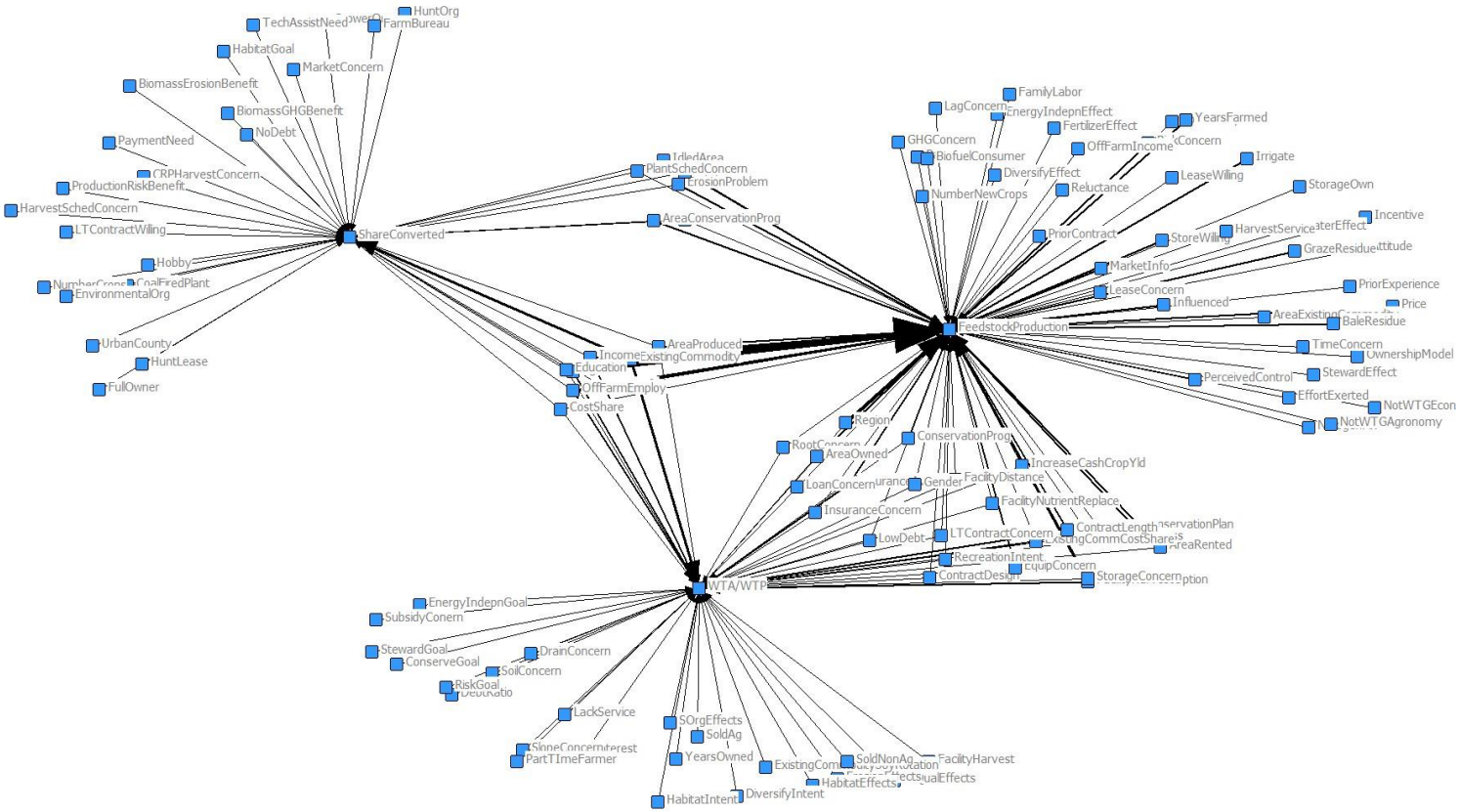

Figure B4. Network graph of farmer user group, with ties weighted by occurrence. Tie direction indicates variable type: out-degree ties represent independents, in-degree ties represent dependents.

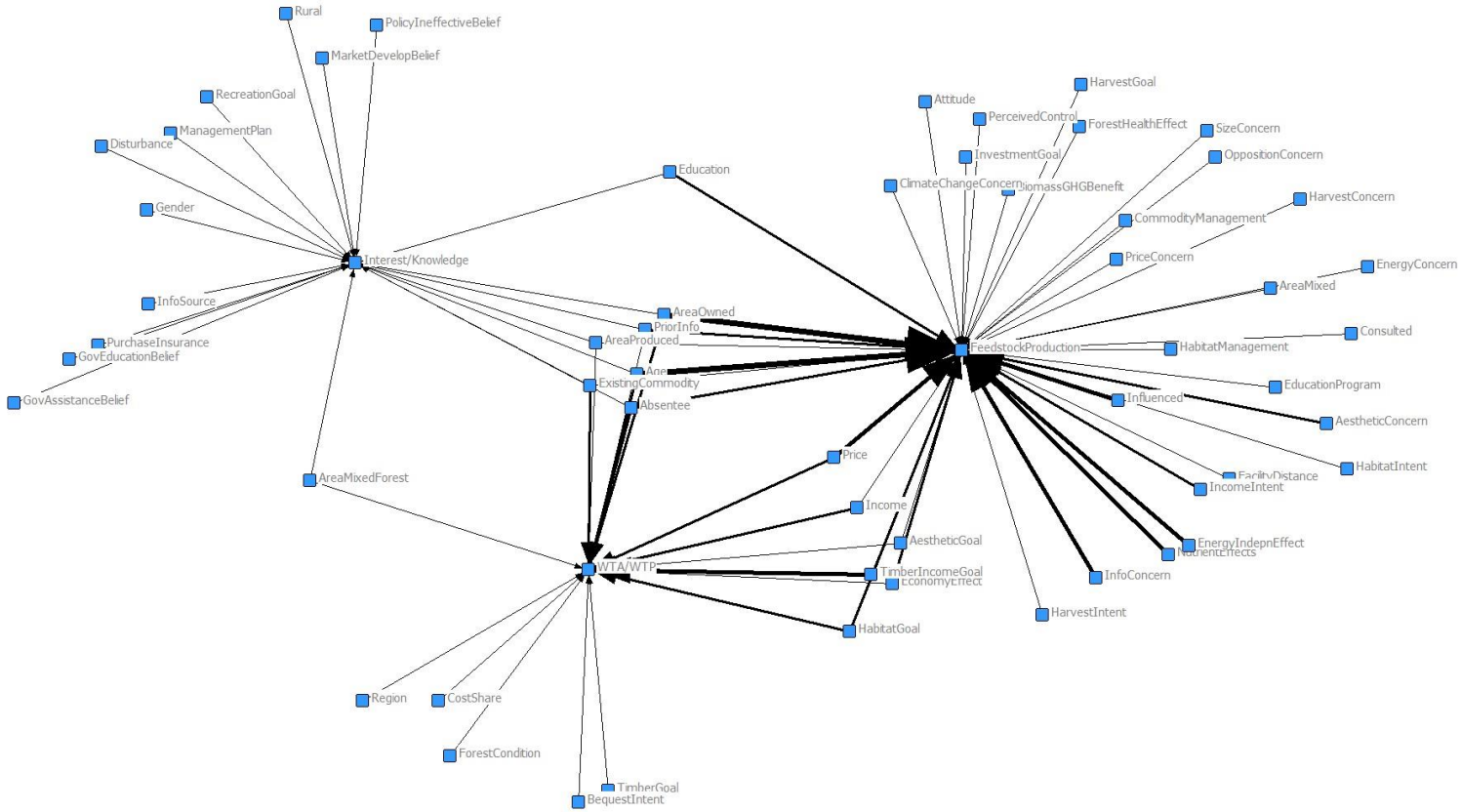

Figure B5. Network graph of woodland owner user group, with ties weighted by occurrence. Tie direction indicates variable type: out-degree ties represent independents, in-degree ties represent dependents.

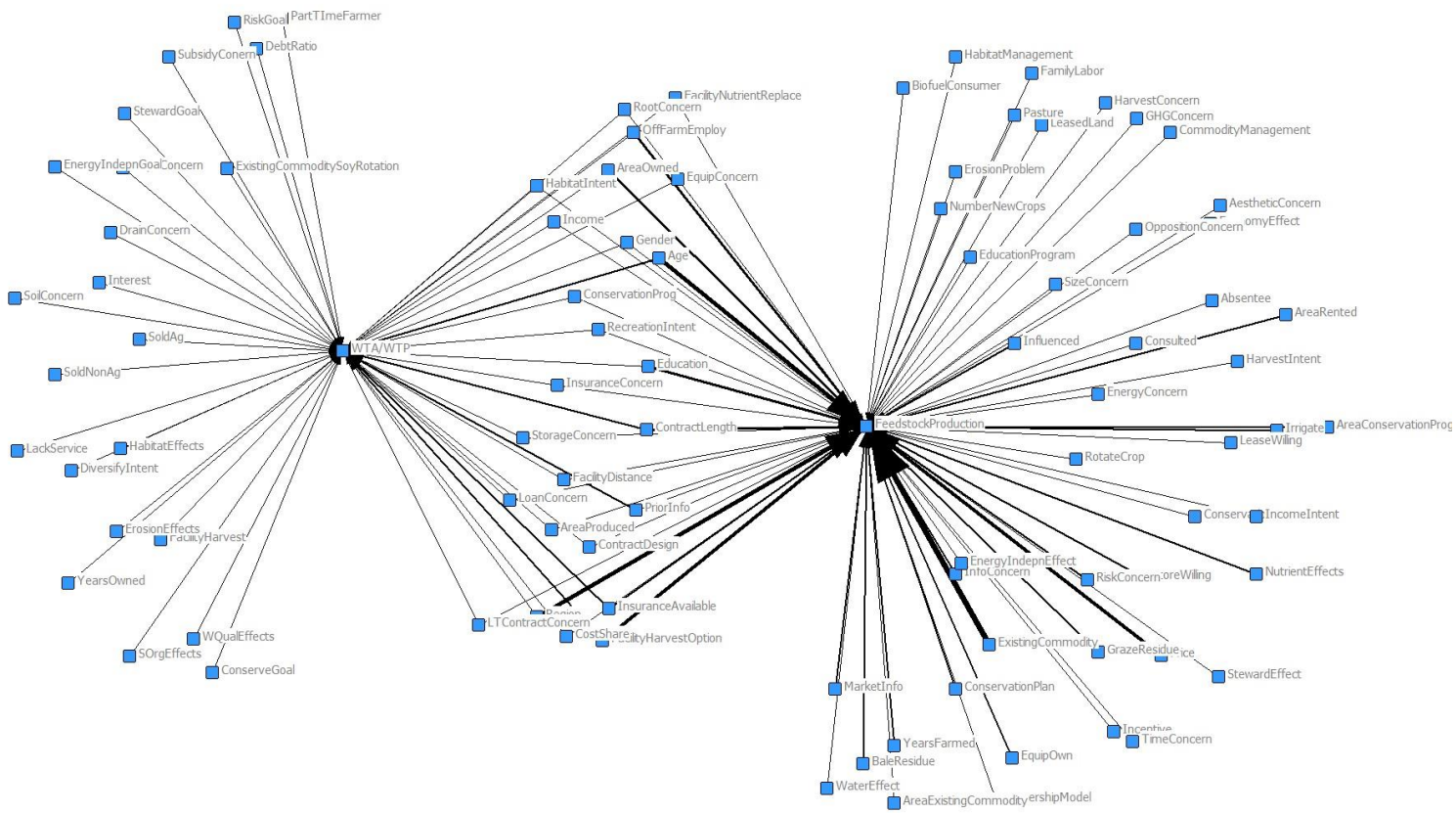

Figure B6. Network graph of the Midwest region, with ties weighted by occurrence. Tie direction indicates variable type: out-degree ties represent independents, in-degree ties represent dependents.

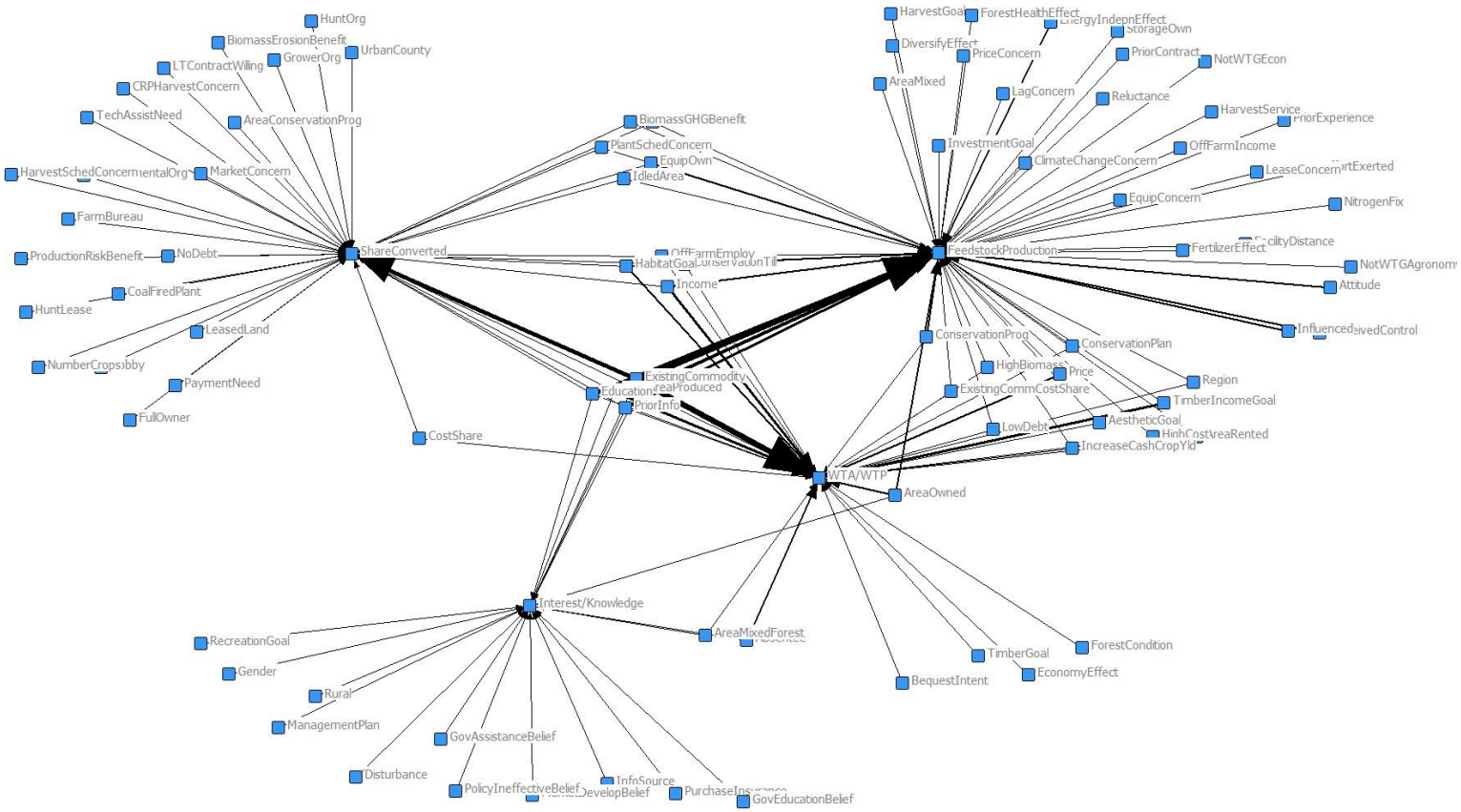

Figure B7. Network graph for the Southeast region, with ties weighted by occurrence. Tie direction indicates variable type: out-degree ties represent independents, in-degree ties represent dependents.

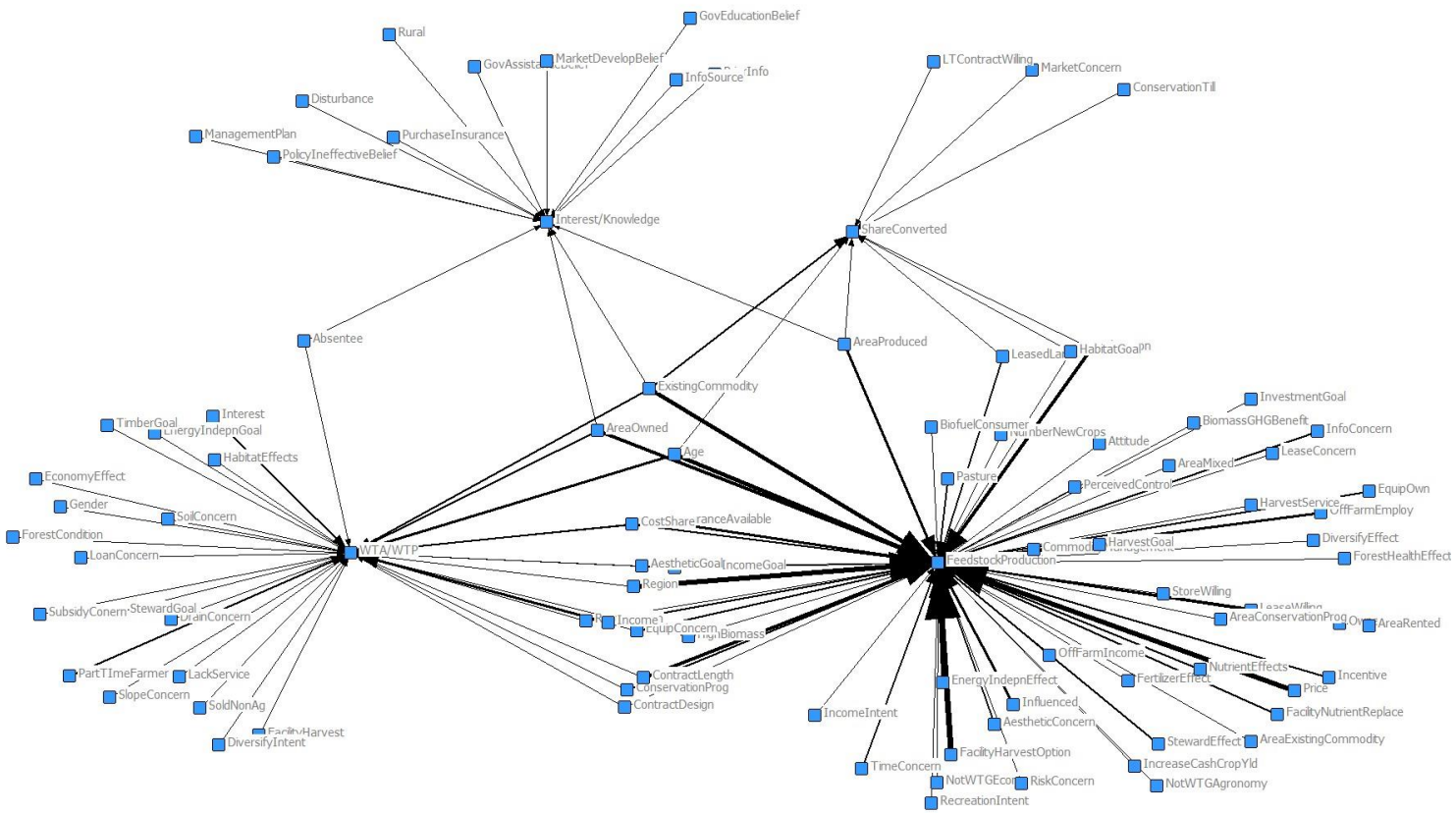

Figure B8. Network graph of variables with a statistically significant relationship, with ties weighted by occurrence. Tie direction indicates variable type: out-degree ties represent independents, in-degree ties represent dependents.