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This research analyzes how family forest owners conceptualize biodiversity in one high-conservation value area of oak woodland in the Willamette Valley of Western Oregon. Oregon white oak (*Quercus garyanna*) woodland, one of the most biologically diverse ecotypes in the state of Oregon, is in decline. Much of the oak ecotype occurs on the lands of family forest owners. Understanding owners' conceptions of biodiversity is important for the conservation of this important resource. Theories from sociology, social psychology, and policy analysis argue that information about people's knowledge and beliefs is important for understanding and influencing their behavior. This research explores the mental and biophysical terrains of owners' relationships with biodiversity. Through interdisciplinary methods – including concept mapping, in-depth interviews, property mapping and field reconnaissance – it explores the meanings that people give to biodiversity on their family properties. Findings indicate that 1) owners are knowledgeable about the key elements of biodiversity, and 2) their use of this knowledge in management reflects their beliefs about human relationships with nature and external market constraints.

KEYWORDS: biodiversity conservation, family forest owners, nonindustrial private forests, oak woodland.

Mental and Biophysical Terrains of Biodiversity: Conservation of Oak Woodland on Family Forests

by
Alexandra Paige Fischer

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I. Introduction

The Oregon white oak (*Quercus garyanna*) ecotype, one of the most biologically diverse ecotypes in the state of Oregon (Thysell and Carey, 2001; Hagar and Stern, 2001; Staniford, 2002), is in decline (Oregon Biodiversity Project, 1998). Much of the oak woodlands occur on the lands of family forest owners.[1] Understanding how family forest owners conceptualize biodiversity – their knowledge, beliefs and behavior – can help planners and policy-makers tailor conservation efforts to the people who will determine the fate of this important ecotype.

Family forest owners hold complicated views on oak woodland, as illustrated in the following comment by Donald Farmer[2], a semi-retired owner of 39 acres of forestland.

> I would hate to see the oaks disappear...Maybe on my south hillside here where I have a lot of oaks I should just let them grow. The oaks tend to grow up and not shade like the maples do. Douglas fir grows right up through them...I like the diversity. I certainly would not clean out all the oaks. I mean, 3 or 4 big logs, I might sell those for a good price, but the main thing is to leave other oaks coming along so that in 50 years there's another big stand.

At the same time that family forest owners value oak woodland for its beauty and manage their forests for biodiversity, they do not especially promote oak

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[1] A subset of "non-industrial private forest owners," which are individuals and families that own forestland yet do not own processing infrastructure (Birch 1996).
[2] All names are pseudonyms. Se Appendix A for profiles of informants.

woodland as part of their management approaches. The ways in which the forest owners conceptualize biodiversity – that is, formulate knowledge and beliefs and imbue meaning to biodiversity – influence their decisions to foster some species and structures at the expense of others. Ultimately, the forest owners' conceptions of biodiversity affect the biophysical conditions of oak woodland.

Understanding family forest owners' conceptions of biodiversity is important for the conservation of oak woodland. Theories on social construction of nature suggest close interaction between peoples' ideas about the environment and the biophysical nature of the environment itself (Greider and Garkovich, 1994); the environment is at once social construct and scientific fact (Buttel et al., 2002). Theories from social psychology and policy studies argue that anticipating and influencing people's behavior requires information on their beliefs and motivations (Schneider and Ingram, 1990 and 1993; Azjen and Fishbein, 1980).

This research explores the mental and biophysical terrains of people's relationships with biodiversity. I attempt to understand how family forest owners in a random sample conceptualize biodiversity in one high-conservation value area of oak woodland in the Willamette Valley of Western Oregon. Through interdisciplinary methods – including concept mapping, in-depth interviews, property mapping and field reconnaissance – I enrich the definitions that people give to biodiversity with symbolic and biophysical evidence of the meanings upon which they operate.

The goals of my research are to understand:

1. How family forest owners conceptualize biodiversity,
2. How family forest owners' conceptions of biodiversity influence the biophysical landscape of their forests,
3. What my findings imply for oak woodland conservation policy.

When I set out to do my research, my objectives and questions were as follows:

Objective 1. Document family forest owners' stated attitudes, knowledge and management behavior regarding biodiversity.

1.1 What do family forest owners know and believe about biodiversity?

1.2 How do family forest owners describe the role of biodiversity in their forestry practices and objectives?

1.3 Are family forest owners' conceptions of biodiversity influenced by information about and interactions with biodiversity?

1.4 Do family forest owners' views on biodiversity differ depending on ownership context?

1.5 What constrains family forest owners' interest in and efforts to promote biodiversity through management?

Objective 2. Explore relationships between family forest owners' knowledge, attitudes and behavior as evident in actual biodiversity conditions.

2.1. What conditions for biodiversity, including such biophysical characteristics as plant species composition and forest habitat structures, can be identified on family forest ownerships?

2.2. What general management practices can be identified on family forest ownerships?

2.3. How do the conditions for biodiversity on family forestlands relate to family forest owners' knowledge and beliefs regarding biodiversity?

2.4. How do family forest owners' conceptions translate into on-the-ground practices?

Objective 3. Understand how family forest owners view biodiversity management practices and policies.

3.1. What kinds of biodiversity management practices do family forest owners find to be acceptable?

3.2. What influences family forest owners' views on the acceptability of management practices?

3.3. What constraints and incentives affect family forest owner willingness to implement biodiversity management practices on their properties?

3.4. What kinds of policies or programs do family forest owners view as potentially most useful for promoting biodiversity management practices on their lands?

3.5. What constraints and incentives affect family forest owners' responses to biodiversity conservation policies?

Objective 4. Evaluate the appropriateness of biodiversity conservation policy for family forestlands.

4.1. What aspects of family forest owner knowledge, beliefs and behavior regarding biodiversity might be factors in the effectiveness of policy?

4.2. What constraints and incentives for family forest owners to manage biodiversity might be factors in the effectiveness of policy?

4.2. Based on the findings about family forest owner knowledge, beliefs and behavior regarding biodiversity, what policy tools might affect biodiversity management on family forests?

4.3. Based on the findings about how family forest owners determine the acceptability of management practices and policies, what policy tools might be most effective for encouraging biodiversity management on family forests?

Shortly after beginning my research I decided to focus on objectives one and two in a first stage of my research, postponing work on objectives three and four for a later time. However, I continued to pursue all three goals. From my findings on objectives one and two, I draw implications for conservation policy and ideas for research on objectives three and four, which I will pursue in a Ph.D. program.

What follows is a review of the literature on biodiversity, oak woodlands, family forests and relevant social theories (chapter 2); an overview of my methods (chapter 3), a presentation and discussion of my results (chapter 4), and a conclusion, which includes a discussion of policy implications and a proposed agenda for further research.

2. Literature review

2.1. Meanings of biodiversity

Biodiversity is a well-studied concept but it is also contested, lacking any universal agreement on what it is and how to manage for it. Like the terms "sustainability," "nature" and "health," biodiversity is imbued with both scientific data and social values. Definitions range from the genetic variation within species (Hedrick and Miller, 1992; Millar, 1999) to the variety of species in specific locations (alpha diversity), the variety of species across environmental gradients (beta diversity) and the variety of species within landscapes (gamma diversity) (Whittaker, 1972). Even broader definitions include the variety in ecosystem structures and processes (Spies and Turner, 1999; Franklin, 1988) and the variety of all life across all levels of organization (Wilson, 1998). Eloquently put by Takacs in his 1996 analysis of the term,

> The complexity of the biodiversity concept does not only mirror the natural world it supposedly represents; it is that plus the complexity of human interactions with the natural world, the inextricable skein of my values and its value, of my inability to separate my concept of a thing from the thing itself (1996: 341).

While high biodiversity is often a goal in conservation, scientists have been unable to identify the threshold of species loss beyond which ecosystems will no longer function properly (Simberloff, 1999). In addition, biodiversity is relative to spatial and temporal scale (Spies and Turner, 1999; Lindermayer and Franklin, 2002). Ecosystems of different types and sizes naturally have more, less or different biodiversity. Since ecosystems are always in flux, the natural amount of biodiversity is somewhere in a natural range of variability (Aplet and Keeton, 1999), the measurement and application of which scientists also contest. In this very confusion, according to Yearly (2002), biodiversity bears signs of its own construction. Instead of having a systematic definition and application, the meaning of biodiversity depends on one's perspective.

For the purpose of this study, I use the term biodiversity to refer to the diversity in species compositions, structural conditions and functions (Franklin, 1998) at multiple spatial scales, including landscape, ecosystem, population and genetic-levels (Noss, 1993).

2.2. Biodiversity of the Oregon white oak ecotype

The Oregon white oak ecotype is an especially interesting ecotype for the consideration of human-environment relationships because it evolved with human, primarily Native American, use of prescribed fire (Agee, 1990). Oregon white oak is unique in that it can establish itself on sites that are marginal for other species and it can endure frequent, low intensity fires (Agee, 1993). For 5000 years before European settlement the fires that tribes such as the Kalapuya set for hunting and foraging kept invasive trees and shrubs at bay (Boyd, 1999). As a result, Oregon white oak became established as an ecotone of solitary trees and open stands between prairie and conifer forests (Ryan and Carey, 1995).

2.2.1. Species diversity

Oregon white oak woodlands contain high levels of species diversity compared to other forest systems in the Northwest (Thysel and Carey, 2001; Hagar and Stern, 2001; Staniford, 2002). Species diversity refers to the variety of species that are represented in a system. This number can reflect the sheer number of different species, a characteristic called richness, or it can reflect the relative abundance of the different species, a characteristic called evenness (Peet, 1974; Hunter, 1999). Oak woodlands in the Willamette Valley occur in four compositional types: a xeric type with poisonoak (*Rhus diversiloba)* in the understory, a xeric type with bitter cherry (*Prunus emarginata)* and snowberry (*Symphocarpus alba)* in the understory, a mesic type with serviceberry (*Amelanchier alnifolia)* and snowberry *(Symphocarpus alba)* in the understory and a mesic type with hazel (*Corylus cornuta)* and swordfern (*Polystichum munitum)* in the understory (Thilenius, 1968). Oak woodland compositions include such threatened and endangered species as golden paintbrush (*Castilleja levisecta*), Kincaid's lupine (*Lupinus sulphureus var. kincaidii*), Bradshaw's lomatium (*Lomatium bradshawii*) and the Columbia white-tailed deer *(Odocoileus virginianus leucurus)* (Thysell and Carey, 2001; Steele et al. 2002; Van Lear and Brose, 2002).

Oak woodland supports large numbers of cavity nesting fauna (Gumtow-Farrior and Gumtow-Farrior, 1997) including the Western gray squirrel (*Scurius* *griseus*), big brown bat (*Eptesicus fiscus*), white-breasted nuthatch (*Sitta carolinensis*), red fox (*Vulpes vulpes*), several species of woodpecker including pileated woodpecker (Dryocopus pileatus) and acorn woodpecker (*Melanerpes formicivorous*), and several species of cavity-nesting ducks including the wood duck (*Aix sponsa*) (Ryan and Carey 1995).

2.2.2. Structural diversity

Oak woodlands are structurally diverse. Structural diversity, or complexity, refers to the composition and spatial arrangement of various layers of live and dead material, including standing live plants, standing dead trees, and downed dead trees and wood, and gaps (Lindenmayer and Franklin, 2002). The standing live plants layer comprises further strata including the tree layer, shrub layer and herb layer. The presence and absence of these layers reflect stages in stand development. In temperate conifer forests, these stages include stand initiation, stem exclusion, understory re-initiation and old growth (Brokaw and Lent, 1999). In oak woodland, herbaceous plants and shrubs form an understory beneath open stands of heavily branched, wide canopied oaks.

Under a normal regime of frequent, low intensity fires, solitary oaks regenerate under existing oaks. Under normal conditions, acorn production starts at about 20 years of age, increases until 60 or 80 years of age and then levels off (Agee, 1993). Only when fire is suppressed do regenerating oaks form thickets, as in a stem exclusion phase. Such trees have low reproduction and high mortality rates when compared to stands of low-density, open-grown trees with mushroom-shaped crowns (Peter and Harrington, 2002.)

Open-grown oak stands provide more complex structures such as larger, fuller crowns and larger, more abundant branches than closed-canopy oak stands. These open-form trees provide more cavities than closed-form trees (Gumtow-Farrior and Gumtow-Farrior, 1991). Larger diameter oaks are associated with greater abundance of cavity-nesters than smaller diameter trees (Hagar and Stern, 2001). The Western gray squirrel uses cavities for nesting and rearing in trees that are greater than 5" DBH (Thysell and Carey, 2001). Pileated woodpecker and acorn woodpeckers create their own cavities in sound wood while other species such as Lewis' woodpecker use pre-existing cavities or create their own cavities in decaying wood. As a result both sound and decaying wood, including dead branches and down wood, is necessary (Gumtow-Farrior and Gumtow-Farrior, 1991). Landscape-level habitat features are also important for oak woodland-associated species. For example, the Western gray squirrel is usually found in oak communities that are greater than 5 acres in size and less than .6km from water (Thysell and Carey, 2001).

2.2.3. Spatial and temporal Scale

The biodiversity of the Oregon white oak ecotype varies over spatial and temporal scales. Spatial and temporal scales are important factors in biodiversity, as the composition, structure and function of ecological systems vary over space and time (Spies and Turner, 1999). The biodiversity of one forest may result from processes that occur at different times or different places such as disturbance and succession. A species that is rare in one forest may be common within the larger area and vice versa. Due to the influence of a variety of disturbances and changes in climate and weather over space and time, forests within the same ecotypes are not all the same. Instead, they have a "range of variability" (Aplet and Keeton, 1999).

The Oregon white oak is diverse in different ways at different spatial scales. While the ecotype is highly diverse at the species level, at the structural level the ecotype assumes only three main forms: open-grown, open form oaks; oak woodlands; and, in the absence of fire, oak thickets. At the landscape scale, the species comprises mosaics of oak savanna and oak woodland that border coniferous forest on upland edges and treeless prairie (Agee, 1990). This spatial arrangement is the result of the species' ability to establish itself on both dry and seasonally wet sites of poor rocky soils along valley margins (Agee, 1993). These sites are physiologically marginal for the establishment and growth of trees that would normally out-compete it (Agee, 1990).

The extent of the Oregon white oak ecotype varies over temporal scales. The ecotype is relatively young. The modern species assemblages of the Oregon white oak ecotype developed over the last 5000 years (Agee, 1993). Currently, the geographic range of Oregon white oak in Oregon runs from the foothills of the Coast Range to the foothills of the Cascades from the state's northern border with Washington to the southern-most end of the Willamette Valley. In the west, the geographic range of the Oregon white oak extends from Vancouver Island, BC. to Los Angeles County, California. However, the Oregon white oak ecotype is rapidly declining. The woodlands have declined between 50-90% in all regions in which they were historically common (Oregon Biodiversity Project 1998). In Oregon, they have decreased from more than 1,000,000 acres (Ryan and Carey, 1995) to between 61,580 and 172,192 acres (Atterbury Consultants, Inc. 1992; Klock et al., 1998). The primary causes of this decline are alteration of the historic fire regime, which allows Douglas-fir to encroach and out-compete the oak, and conversion to non-native forest uses, including agriculture, Douglas-fir plantations, Christmas tree farms, vineyards and suburban development (Agee, 1993; Tveten and Fonda, 1999).

2.3. Family forest owners

Ninety-eight per cent of Oregon white oak woodlands in Western Oregon are found on private land (Oregon Biodiversity Project, 1998). In the Willamette Valley, where 96% of the land is in private hands (Oregon Biodiversity Project, 1998), almost all private forestlands are family forestlands. Private forestlands are home to more than 50% of federally-listed threatened and endangered species (Irland, 1994).

The management objectives of family forest owners are diverse, ranging from wildlife habitat, views and recreation to long-term investment and timber income (Bliss and Martin, 1989; Clawson 1989; Johnson et al., 1997; Huntsinger and Fortmann, 1990). Several studies have found that family forest owners rate amenity objectives such as wildlife, views and recreation as having value equal to or greater than timber production (Jones et al., 1995; Brunson et al., 1996). Numerous variables affect these objectives including ownership size (Huntsinger and Fortmann, 1990; Sampson and DeCoster, 1997), length of tenure, age, income level and residence on the property (Ostrom, 1985). Parcel size usually declines with focus on timber income (Sampson and DeCoster, 1997; Rosen and Kaiser, 1998; Bourke and Luloff 1994; Huntsinger and Fortmann, 1990.)

2.4. Social theory

Several social theories inform the rationale and approach of this research. Social construction of nature theory from environmental sociology calls for analysis of the meanings that people give to complex concepts such as biodiversity (Buttel and Taylor, 1992; Hannigan, 1995; Greider and Garkovich, 1994.) Assumption-based policy analysis (Schneider and Ingram, 1990 and 1983) provides a theoretical framework for analyzing the social constructions and behavioral assumptions upon which policy tools rely. The Theory of Reasoned Action from social psychology (Azjen and Fishbein, 1980) proposes that beliefs and behavioral intentions are important in understanding and predicting human behavior. Cognitive dissonance theory (Festinger, 1957), also from social psychology, calls for investigation of the contradictions in what people say and do.

2.4.1. Social construction of nature

Social construction of nature theory is useful for understanding how family forest owners conceptualize biodiversity. Environmental sociology postulates that there are interactions between the conceptual and material manifestations of peoples' ideas about the environment (Dunlap, 1997; Gramling and Freudenburg, 1996; Kroll-Smith, 1994). The constructionist approach within environmental sociology recognizes that the ways people conceptualize environmental phenomena affect what is commonly accepted as the nature of these phenomena (Greider and Garkovich, 1994). Constructionism on the whole rejects objective facts and distinctions between human and material worlds; instead, society gives meaning to the things that exist in the world and these meanings reflect specific times and places (Berger and Luckmann, 1967).

> A social constructionist approach...recognizes the extent to which environmental problems and solutions are end-products of a dynamic social process of definition, negotiation and legitimation both in public and private settings (Hannigan, 1995: 31).

This subjective, contextual approach makes it possible to obtain valid understandings of peoples' conceptions and behavior (Maloney and Ward 1973; Fischer, 2000).

While environmental sociologists agree that the constructionist perspective is important, they debate what form the theory should take (Buttel and Taylor, 1992; Gramling and Freudenburg, 1996). Strict constructionism receives criticism because it treats environmental problems primarily as social constructions, thereby denying their biophysical significance and exempting society from responsibility for them (Dunlap 1997; Buttel et al. 2002; Soulé and Lease, 1995). Strict constructionism is a reaction to what lies on the opposite end of the spectrum: the biological deterministic view that the environment shapes society (Benton, 1994).

In its more moderate forms, social constructionism acknowledges the existence of environmental problems outside human experience at the same time that it examines their socio-cultural dimensions (Gramling and Freudenburg, 1996; Kroll-Smith et al., 2000). Moderate constructionists argue that analyzing the social construction of environmental issues does not undermine legitimate perceptions and claims about environmental problems when one considers that both valid and invalid claims are socially constructed (Hannigan, 1995). Some moderate constructionists argue that instead of focusing on uncovering causal links between biophysical and social phenomena, constructionism should approach environmental issues as “landscapes” that society symbolically creates and contests through the dynamics of perception and power (Greider and Garkovitch (1994).

The ways that social groups construct meanings for things, such as biodiversity, can be understood, in part, through examination of individual conceptions. Conceptualization is the process of coming to agreement about the meaning of terms. Conceptions are the resultant cognitive constructs. They serve as the underlying organizing frames of the concepts for which society shares definitions (Searle, 1995). In this study, I use the term "conception" to refer to the bundle of knowledge, beliefs, values and attitudes that, to different extents, influence people's behavior.

Knowledge is the sum or range of what has been perceived, discovered, learned and, as the constructionists would argue, negotiated (Fischer, 2000). "Ordinary" or "local" knowledge describes practical knowledge and belief gained through experience (Lindblom and Cohen, 1979). "Scientific" knowledge, on the other hand, is knowledge and belief that a technical community has submitted to the rigors of testing for proof and agreed upon as valid. Beliefs are incontrovertible personal "truths" (Pajares, 1992). They are taken-for-granted presumptions about the self, physical, and social reality (Rokeach, 1968). Beliefs have stronger affective and evaluative components than knowledge; they influence judgments about a course of action. In this study, I choose to focus on beliefs instead of values and attitudes because beliefs comprise values and attitudes. Beliefs are the products of basic values (Rokeach, 1968; Stern et al., 1995). As representations of fundamental social and biological needs, basic values are widely shared in society and vary little among people (Fulton et al., 1996). Beliefs elicit attitudes, which, in turn, elicit behavior (Futon et al., 1996; Stern et al., 1995; Ajzen and Fishbein 1980. However, beliefs are more strongly linked to behaviors than are their intermediaries, attitudes.

2.4.2. Assumption-based policy analysis

Social constructionism is relevant to policy (Fischer, 2000; Schroedel and Jordan, 1998; Schneider and Ingram, 1993). When rationalizing their policy approaches, policy-makers rely on social constructions about the identity of their target groups and assumptions about their behavioral motivations (Schneider and Ingram, 1990, 1993). In other words, policy-makers design policy with expectations of how target groups will react based on cultural characterizations, or stereotypes, of these groups. They make assumptions about the groups' knowledge, beliefs and values and what might motivate them to engage in the behaviors that the policies are trying to affect.

For example, authority tools assume people are motivated to obey laws and regulations. Incentive tools assume that individuals are "utility maximizers" and have adequate information, decision-making skill and opportunity to make choices that will lead them to tangible payoffs. Capacity tools assume that people lack necessary information, skills or other resources to make decisions but would welcome assistance if available. Symbolic and hortatory tools assume people are motivated by beliefs and values that can be manipulated. Finally, learning tools assume that people don't know what needs to be done but would be able to select appropriate tools through learning and cooperative experiences. Schneider and Ingram (1990, 1993) suggest that policy-making, in order to be effective, should analyze and test the validity of the social constructions and behavioral assumptions upon which policies rely.

2.4.3. Theory of Reasoned Action

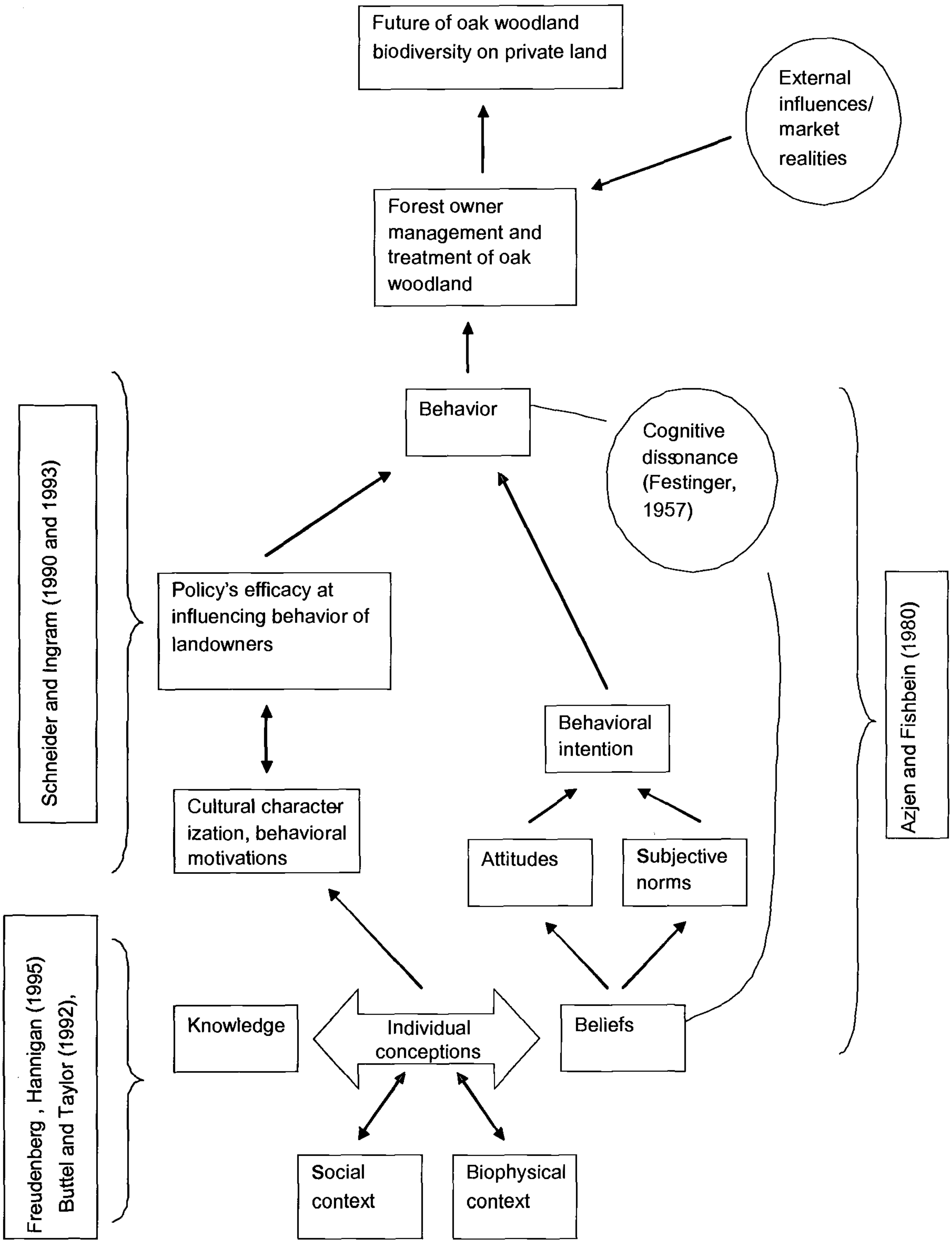
Valid understanding of people's beliefs is especially important in policy-making. The Theory of Reasoned Action (Azjen and Fishbein, 1980) postulates that people's beliefs determine their behavioral intentions and, ultimately, their behavior. People's beliefs about a phenomenon and the consequences of their behavior toward that phenomenon, in addition to the opinions that other significant people might have about their behavior, form their attitudes and subjective norms. These attitudes and subjective norms, in turn, form their intentions and determine their behavior. Identifying people's beliefs is relatively simple according the Theory of Reasoned Action. When asked to describe the essential aspects of a thing's character, qualities and attributes, a person will list their salient beliefs about the thing.

2.4.4. Theory of Cognitive Dissonance

In order to fully understand people's beliefs, one must understand the contradictions that often exist between people's beliefs and behaviors. Cognitive dissonance theory (Festinger, 1957) is useful for analyzing the relationship between family forest owners' stated beliefs about oak woodland biodiversity and their apparent behaviors. Cognitive dissonance theory argues that people, in order to reduce contradiction between their attitudes and actions, will change their views on a subject and accommodate behaviors that are more difficult to change. When people do contradict themselves, they do so for a reason. In the process of contradicting themselves, people—motivated by below-the-surface goals—are asserting knowledge and value claims (Potter and Wetherell, 1987). Applying cognitive dissonance theory makes possible to learn from the variability that exists between what people say and what they do (Egan and Jones, 1993; Gilbert and Malay, 1984).

The theoretical perspectives that inform this research, from the fields of environmental sociology, social psychology and policy studies, provide justification and guidance for this research. Together they suggest an approach for gathering qualitative data on people conceptions of biodiversity, especially on the connection between knowledge, beliefs and behavior, in order to inform biodiversity conservation. I combine these theories into a framework, depicted in Figure 1, to illustrate why information about people's conceptions of biodiversity is important for planners and policy-makers in order for them to promote conservation behavior. In the framework, social and biophysical contexts influence how landowners conceptualize biodiversity. Conceptions comprise knowledge and beliefs. Policies rely on assumptions about the knowledge, beliefs, motivations and abilities of the people whose behavior they seek to change; they rely on social constructions of their target groups. The effectiveness of policy depends on the validity of these social constructions. Accurate understanding of people's beliefs is especially important, since beliefs determine the attitudes and subjective norms that influence people's behavioral intentions. However, predicting behavior from beliefs is not straightforward because people often change their beliefs to bring reduce dissonance with their behavior. Beliefs must be examined in relation to behavior. In order to encourage and reward management practices that conserve biodiversity by private landowners, policy makers must have a comprehensive understanding of how members of their target groups conceptualize the phenomena that the policies seek to influence. They must also recognize constraints that outside forces, such as markets, impose on their target groups. The future of an at-risk ecotype, such as the Oregon white oak ecotype, on private land may rely on policy-makers understanding how the owners conceptualize their ecotype's biodiversity.

Figure 1. Theoretical Framework. Relationships between landowners' conceptions and the success of conservation policy.



3. Methods

This research employs a multidisciplinary approach to understanding family forest owners' conceptions of biodiversity. For rich, comprehensive data, I triangulated in my collection of qualitative information on knowledge, beliefs and behavior. I used in-depth interviews and concept mapping to gain an initial understanding of the forest owners' knowledge and beliefs. Then I looked to biophysical conditions, through property mapping and field reconnaissance, for evidence of behavior. Biophysical data provides additional insight into the forest owners' knowledge and beliefs. Table 1 presents an overview of these methods. I conducted this research in the fall of 2002. I maintain the confidentiality of my informants through the use of pseudonyms.

Table 1. Methods. Description of methods used.

#	Method	Purpose	Analysis
1	Concept mapping	To understand the forest owners' conceptions, the structure and content of their knowledge and beliefs.	Structural comparison and concept count.
2	Open-ended interviewing[1]	To understand how the forest owners articulate their knowledge and beliefs using their own language and logic.	Coding and organizing quotations into themes using Atlas TI.
3	Property mapping	To relate the forest owners' conceptions to physical places and management decisions.	Visual assessment, qualitative documentation of biophysical evidence of behavior toward biodiversity.
4	Field reconnaissance	To clarify and enrich meanings of the forest owners' conceptions by referencing actual biophysical conditions. To provide context to discussion of management objectives, constraints and policies.	Visual assessment, qualitative documentation of biophysical evidence of behavior toward biodiversity.

[1]Most of my analysis revolved around the information collected through this method.

3.1. Study area

My study area is located in the Oregon white oak ecotype along the hilly margin between the Willamette Valley and the Oregon Coast Range in Benton County, Oregon. This area corresponds to the boundaries of the Western Muddy Creek Watershed, which covers 125 square miles (32,000 hectares) between 443115N 1231804W and 441722N 1232223W (USGS, 2000). Figure 2 shows the location of the watershed. I chose the area for its large proportion of Oregon white oak

Figure 2. Location of Western Muddy Creek Watershed. (Hulse et al., 2000).

woodland and family forestland and because several conservation efforts have identified it as a high conservation value and priority area (Oregon Biodiversity Project, 2002; Oregon Department of Forestry, 2001). Figure 3 shows the extent of oak woodland on non-industrial private forestland in the watershed and in the Willamette Valley. Figure 4 shows the extent of oak woodland in the watershed.

Approximately 3000 residents live within the Muddy Creek watershed, a sub-basin of the Mary's River watershed. Eighty-eight percent of the watershed is privately owned. The remainder is under the ownership of the Bureau of Land Management and the US Fish and Wildlife Service. Three percent of the Muddy Creek watershed is zoned "Rural Residential," 42% is zoned "Exclusive Farm Use," 35% is zoned "Primary Forest" and 13% is zoned "Secondary Forest." The Finley National Wildlife Refuge comprises 7% of the watershed (Hulse et al., 2000). Non-industrial private forest owners own 50% of the land area (Mary's River Watershed Council, 2002).

Elevations within the watershed rise from 200 feet near the Willamette River on the east side of the watershed to 2,000 feet in the Coast Range on the west side. Average annual rainfall is 40-60 inches. Grass seed fields and hay fields dominate the lower elevations of the watershed while Christmas trees, vineyards and non-industrial and industrial timberlands comprise the mid-elevations, and industrial timberlands comprise the upper elevations.

Figure 3. Distribution of Oak Woodland. Distribution of oak woodland on non-industrial private forestlands (Atterbury Consultants, Inc., 1992).

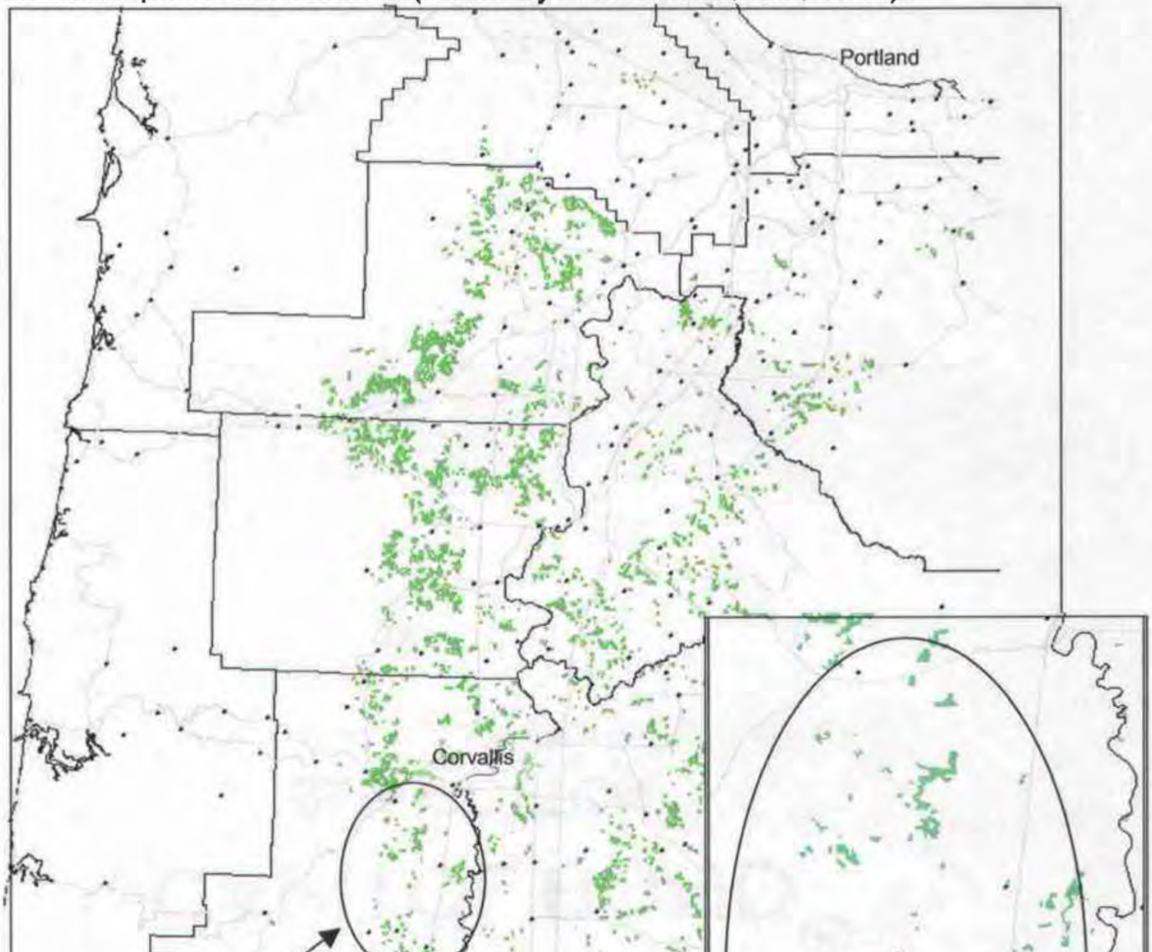
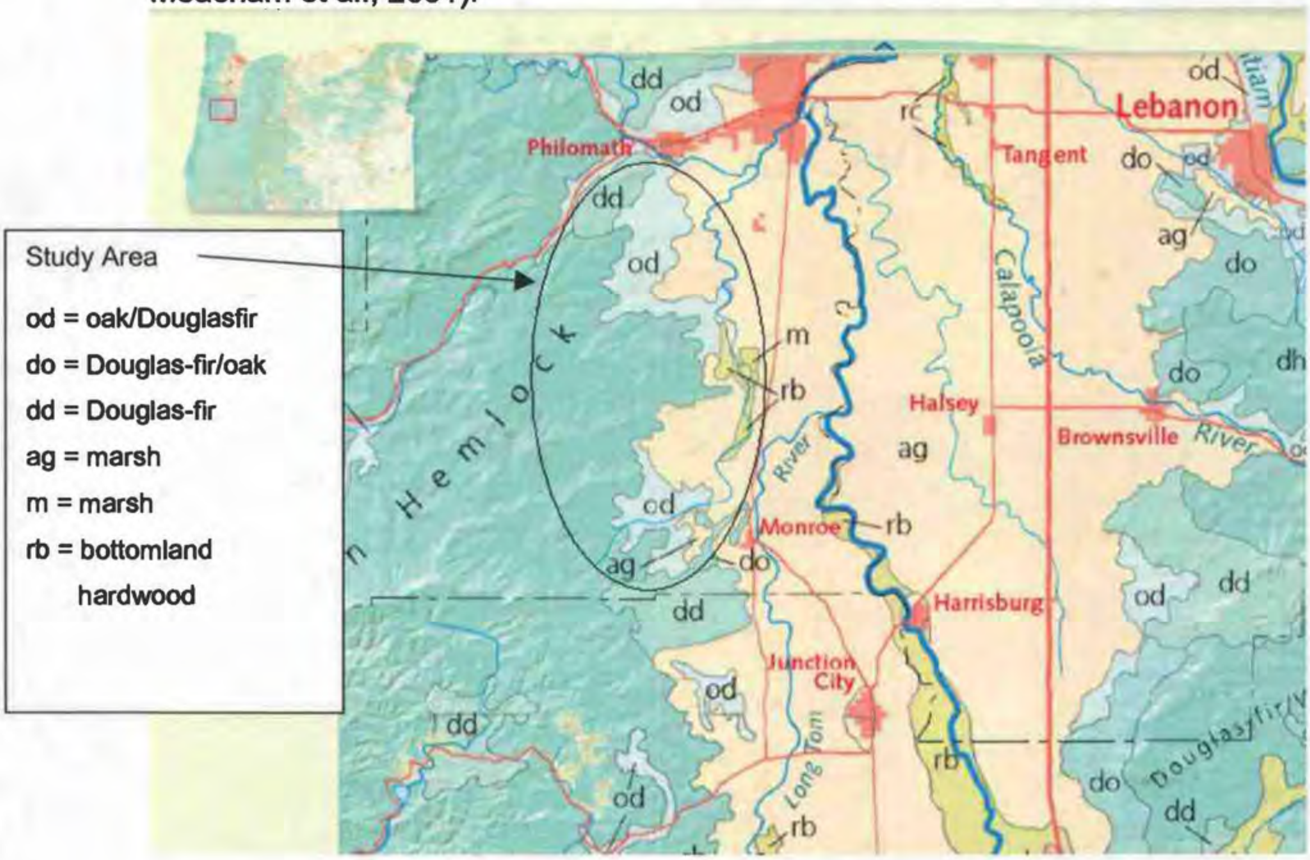


Figure 4. Vegetation of the Western Muddy Creek Watershed. (Adapted from Meacham et al., 2001).



Several small communities, including Alpine and Bellfountain, are located in the watershed (Hulse et al., 2000).

The current vegetative cover differs greatly from the landscape at the time of European settlement, around 1850. The forest types in the study area are currently more extensive and less complex, with less diverse species compositions, than in previous times (Hulse et al., 2000). Prior to Euro-American settlement mixed conifer-oak woodlands and oak savanna comprised more than half of the watershed. Wet and dry prairie dominated the eastern half in the lower elevations, Douglas-fir and Western Hemlock forest dominated the higher elevation foothills along the Western edge, and oak woodland and savanna served as the ecotone between the prairie and forestlands. Riparian forest and swamps abounded along the stream channels and in low-lying areas with saturated soils (Csuti et al., 1997; Hulse et al., 2000).

3.2. Sample

I identified forest owners through a proportional stratified random sample of individual- and family-owned parcels. The sample population was the non-industrial private (or "family") forest ownerships in Western Oregon and the sample frame was the non-industrial private ownerships that are zoned for forestry and located in valley fringe quads in Benton County. Table 2 presents the breakdown of the population and sample strata. The parcels are zoned for

Table 2. Proportional Stratified Random Sample. A proportional stratified random sampling strategy based on parcel size.

Ownership size class (acres)	Number of ownerships	Percent of total ownerships	Number in stratified sample	Completed
10 - 19	44	21%	2	2
20 - 39	59	28%	3	2*
40 - 79	51	24%	2	2
80 - 1999	60	28%	3	4*
Total	214	100%	10	10

*Completed numbers do not match anticipated numbers because at some of the interviews I learned that forest owners' parcel sizes differed from the records I used in my sampling strategy.

forest use and located in the 15 USGS quads where Oregon white oak is represented in Benton County, which also correspond to the Western Muddy Creek Watershed. I chose to base the proportional strata on parcel size because numerous studies associate management styles and motivations with ownership size (Hunsinger and Fortmann, 1990; Sampson and DeCoster, 1997). I wanted to generate a sample that was representative of the ownership composition of the study area. However, I do not seek to test theories that correlate specific parcel sizes with landowner characteristics.

My sample comprises 10 forest-owning individuals and families. Table 3 provides information about the notable characteristics of the sample. Of the 16 people that I contacted, 10 agreed to interviews for the times that I suggested. Nineteen people that I called either didn't respond nor had non-working numbers. I determined the sample size through theoretical saturation, the technique of capping sample size when the collection of additional units of data yields proportionally smaller units of findings, or when the researcher begins to hear the same information repeated by numerous informants (Strauss, 1987; Lincoln and Guba, 1985). In my case, I stopped increasing the sample size by selecting additional landowners from the parcel size strata when additional codes no longer surfaced in additional interviews.

Table 3. Sample Characteristics. Percent of forest owners displaying notable characteristics.

Characteristic	% of land - owners
Gender	
Male individuals	60%
Female individuals	10%
Mixed couples	30%
Highest educational level attained	
Grade school	10%
High school	20%
College	50%
Master's degree	10%
Ph.D.	30%
Income dependence	
Timber	30%
Combination timber and outside work	30%
Outside jobs	30%
Origin	
Locally born and raised	60%
Emigrated from other states	40%
Ownership sizes	
< 19 acres	20%
20 - 39 acres	30%
40 - 79 acres	20%
80 - 1000 acres	30%

3.3. Data collection and analysis

I arranged to meet the landowners on their properties and told them I wanted to learn about their land management practices through an informal interview and a tour of their property. I began each interview with a concept mapping exercise. Concept mapping is useful for understanding the structure and content of a person's knowledge, including their assumptions, beliefs and misconceptions about the world, and the context of their views (Austin, 1994). With as few prompts as possible, I encouraged the interviewees to describe their forests and management approaches for about an hour. Meanwhile, I recorded key concepts on small pieces of paper. I then asked the landowners to arrange the concepts on large pieces of blank paper in any way that made sense to them. The resultant maps shed light not only on the details of what people know about a topic and how they know it, but also how this knowledge impacts behavior (Kearney and Kaplan, 1997). Figure 5 presents an example of a concept map created by one of my informants. The maps help to reveal the forest owners' knowledge about biodiversity, the logic that influences their land management decisions, and the language that they use to describe biodiversity.

Next, I presented the forest owners with an aerial photo of their property. I asked them to indicate, by drawing on the photo, areas of special significance and areas under different management approaches. Participatory mapping through the use of aerial photos stimulates and helps to direct discussion toward common reference points or characteristics of a landscape (Mahler, 2000). The property mapping exercise gave us more detail on how people view and treat their forests by allowing the landowner to relate concepts to physical places and tangible management decisions. The maps also provide biophysical information on the properties and management practices that can be analyzed as part of the proposed field reconnaissance component of the methodology.

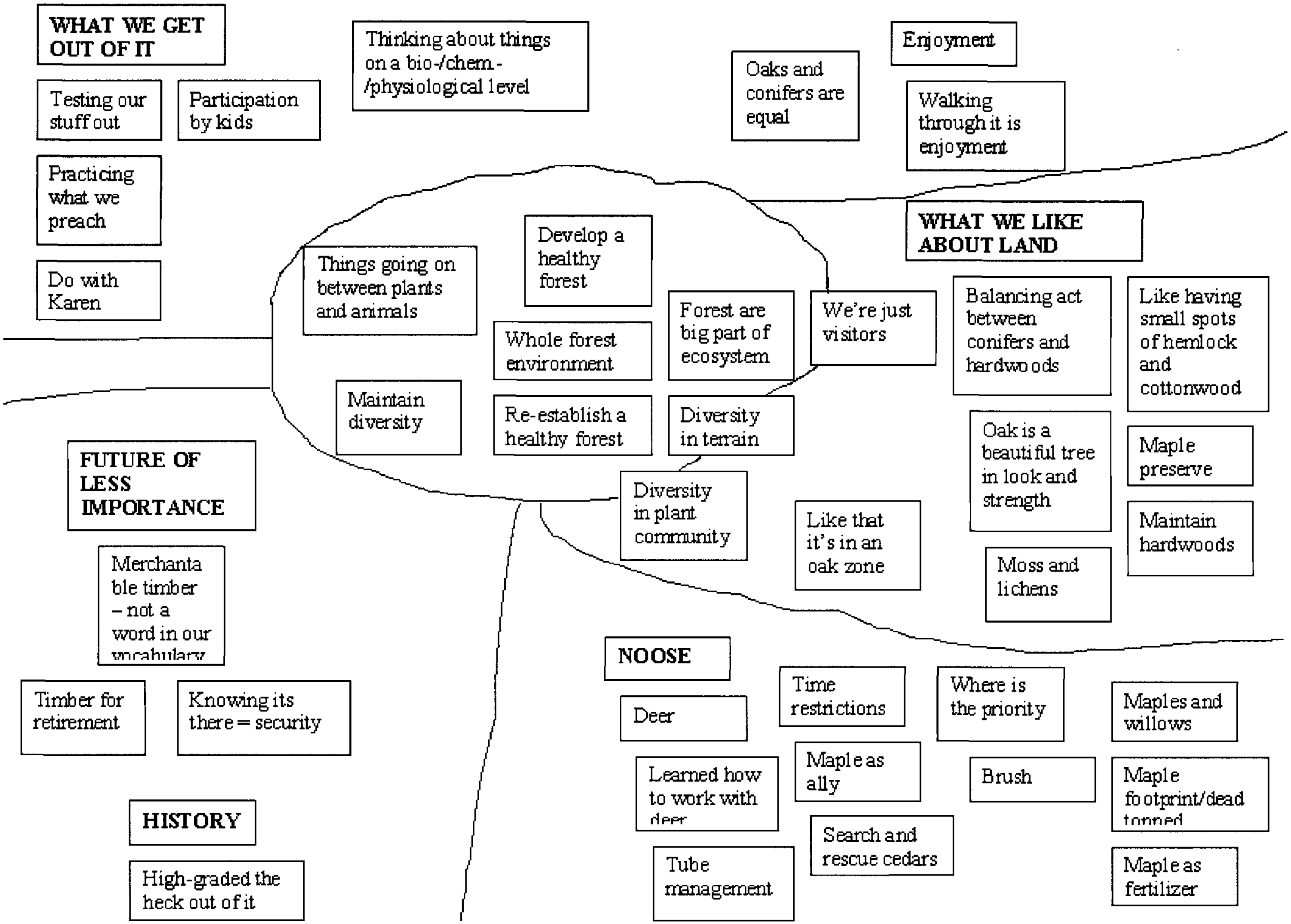


Figure 5. Example of a Concept Map.

Building on the ideas that people put forth in the concept and landscape mapping exercises, I then conducted semi-structured interviews of open-ended questions. I conducted the interviews while the forest owners led us on a tour of the property to demonstrate some of their ideas and management practices in the field. During the interviews, I prompted the forest owners to further articulate the knowledge and views on biodiversity that they had brought up during the concept mapping exercises. I avoided contentious terms such as "biodiversity" itself, "stewardship" and "conservation." Instead I employed, as much as possible, the forest owners' own terms.

Finally, I asked the forest owners to take us to sites on their properties that exemplify important aspects of their forests and management approaches. I viewed several sites per ownership. The sites ranged from the areas around individual trees and habitat structures to stands of trees. At the sites, I recorded data on the biophysical conditions that I saw, including species composition, stand structure and habitat components. The form I used to collect this information can be found in appendix B. I used this biophysical information to enrich my understanding of the forest owners' conceptions of biodiversity. Augmenting social data with biophysical data can reveal what people mean by the terms and concepts that they use and how they operationalize these meaning in their management practices (Schauman, 2000).

I tape recorded and transcribed verbatim all of my interactions with the forest owners. I analyzed the data from the mapping exercises and interviews through the use of the coding and theme-building software Atlas-TI. The software makes it possible to tag phrases and ideas in the transcripts with codes and link the codes via interpretive memos, themes and broader networks of themes (Weitzman and Miles, 1995).

To analyze the transcripts I used a qualitative protocol for coding and building theory. To describe this protocol, I use terms from the qualitative analysis method, grounded theory (Strauss, 1987). In my first review of the transcripts I coded my data with 80 "open codes," including in vivo and scientific code names relating to biodiversity. Open-coding produces provisional concepts that open up the inquiry (Strauss, 1987). I then went through the transcripts a second time using axial coding to refine and relate my codes to each other via memos. Axial coding reveals relationships in the data that can be used to build or test theory (Charmaz, 2001). After studying the transcripts a third time, I networked these open and axial codes into 3 families of 37 codes that had explanatory power regarding family forest owners' conceptions of biodiversity. Finally, I went through the transcripts again selectively re-coding the data with these 3 families of codes in mind.

I stopped coding the transcripts when I reached theoretical saturation and was unable to uncover new codes or expand existing codes. At this point, I began building micro-level theories on how the family forest owners in my sample conceive of biodiversity, which I will present in the following results and discussion section. Figure 6 depicts my coding framework; how I grouped open codes under axial codes, and axial codes in code families, in order to address my research questions.

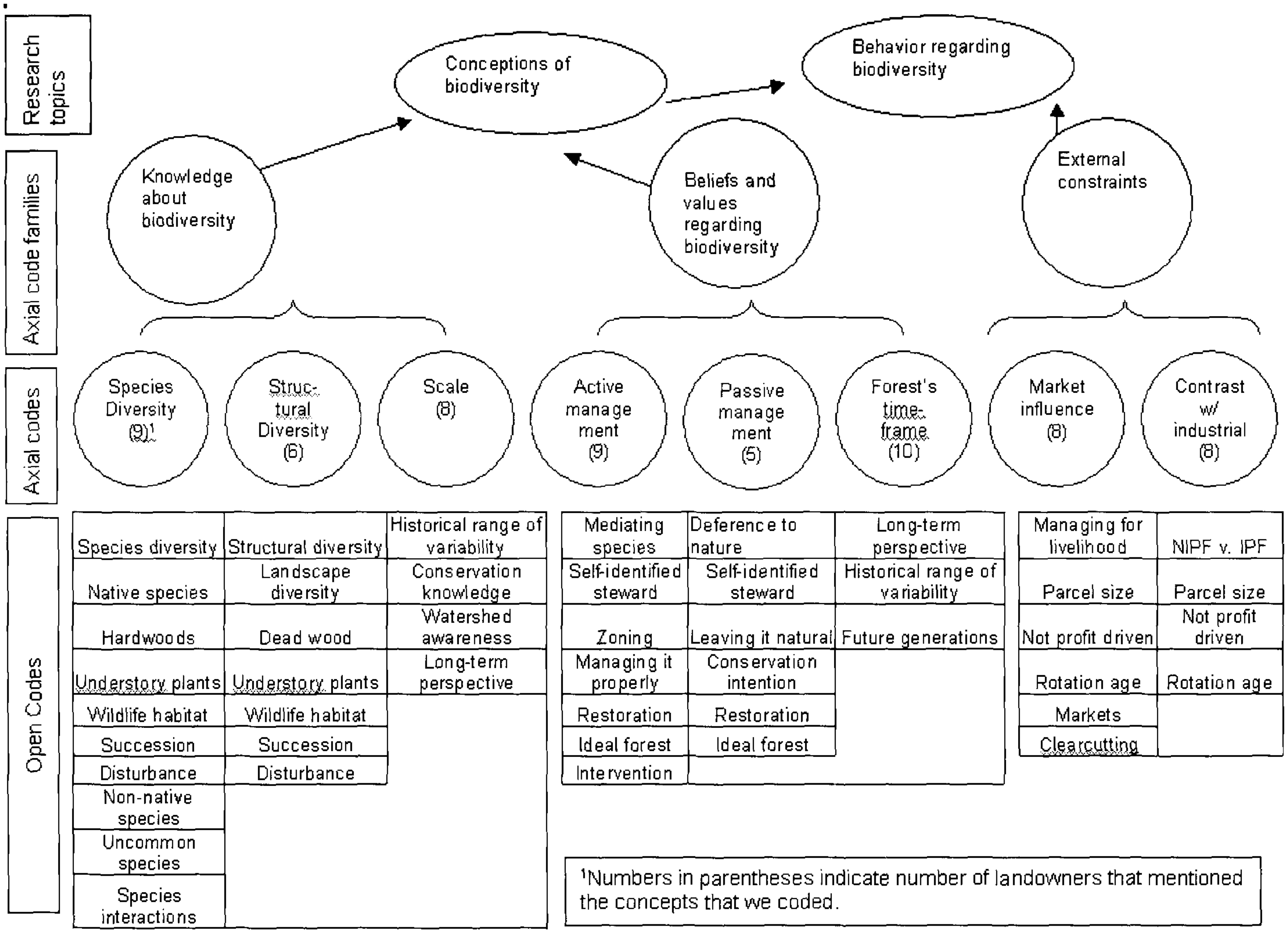


Figure 6. Coding Framework. Relationships between open codes, axial codes, code families and research.

4. Results and discussion

My analysis yields 3 insights into how the family forest owners in the sample conceptualize biodiversity. It also raises questions about how these conceptions might influence the forest owners' management approaches. First, the forest owners' knowledge about biodiversity plays a role in their decisions regarding species choice, promotion of certain structural conditions, and timeframe for management. Second, the owners' beliefs about the relationship between humans and nature influence how they view and manage for biodiversity. Third, timber markets, dominated by private industrial forest companies, constrain the owners' abilities to manage their forests in the ways that they want. Together these categories of information – knowledge, beliefs, and external constraints – inform how the forest owners conceptualize biodiversity.

4.1. Knowledge of diversity

In this study, I am interested in understanding the scope of family forest owners' knowledge about biodiversity and how it relates to the accepted scientific knowledge. But because I view knowledge from the constructionist perspective as subjective and discursive, I am more concerned with how people frame their knowledge, how they reach a point at which they think they know something, and why they see things as they do. From the definitions of diversity that the forest owners volunteered, as well as their explanations of these definitions, which I prompted, it is clear that the owners are knowledgeable about biodiversity. In some cases, their knowledge corresponds with scientific knowledge about diversity.

Donald Farmer displays the kind of knowledge that I recognized in many of the forest owners as he emphasizes the importance of diversity in his approach to forest management.

> I'd like to see a few trees left even when I do almost a clearcut just because I think it's good to have a little diversity. I like the madrones and I like the chinquapins; I like diversity in that way. Then I like diversity [when] I've got a few pretty big trees and I've got young trees all in the same stand. I know that's not traditional...I think having a diverse stand probably helps with soil conservation. You don't have much run off and soil erosion and so forth if you have some big trees intermixed with the little ones.

Like other owners, Donald acknowledges the role of species diversity (madrones and chinquapins mixed in with Douglas-fir) and structural diversity (big trees mixed with small ones) in maintaining healthy forest functions. Many of the owners also recognize that while diversity in species and structures is important, forests' compositional and structural attributes vary over different spatial and temporal scales.

The following subsections will explain the forest owners' knowledge of these three main elements of diversity – species, structures and scale – elements that reoccur not only in my interviews, but also in the scientific literature. This information is important for several reasons. First and most relevant to this study, understanding people's knowledge about biodiversity helps us interpret the meanings they operate on, the foundations of their management decisions. Second, information about people's knowledge about biodiversity can help policy makers and planners design conservation initiatives for biodiversity that take into account people's existing knowledge and capacities. Finally, understanding the perceptions held by stakeholder groups about such concepts as biodiversity can help to reduce conflict in their conservation. In the case of oak woodland biodiversity, mutual recognition by landowners, natural resource agents and policy-makers of each other's definitions for biodiversity could increase the efficacy of programs that encourage conservation of specific species and structures.

4.1.1. Species diversity

Most of the forest owners that I interviewed recognize and promote species diversity. Figure 6 presents the open and axial codes and code families that relate to biodiversity and the number of forest owners that mentioned these codes. Nine of the forest owners mentioned species diversity during the interviews (see Figure 6). Table 4 presents the biophysical conditions that I noted during the field reconnaissance. I corroborated what the owners' said about biodiversity with what I saw of their forests during the reconnaissance. The forest owners associate species diversity with forest naturalness and health, a theme I also visit in the next section on beliefs. Many of the owners foster diversity by encouraging the growth of non-commercial shrub and tree species

Table 4. Existing Forest Conditions. Conditions of forests on properties.

Condition	Rounds	Harten	Stohl	Johnson	Hollis	Garvey	Farmer	Schultz	Hallard	Parsons
Multiple species on all portions of property	X	X	X							
Multiple species on some portions of property				X	X	X	X	X	X	
Multiple age classes on all portions of property	X	X	X							
Multiple age classes on some portions of property				X	X	X	X			
Even-aged stands with many hardwoods				X	X	X				
Even-aged with some hardwoods							X	X	X	
Even-aged stand with very few hardwoods										X
Hardwoods throughout property	X	X	X	X	X	X				
Pure oak stands on some portions of property	X	X		X						
Reserves on some portions of property	X	X	X	X	X	X		X	X	
Habitat structures on some portions of property	X	X	X	X	X	X	X	X	X	

on their property, a practice that can take growing space and light away from the primary cash crop, Douglas-fir. Dale Hollis describes his appreciation for mixed species,

> A very good mixed forest [with] variety of ages and variety in hardwoods, is more appealing than many acres of trees all the same age. I usually consider that maple is not very valuable but visually it is valuable to people to have a mixed forest, and perhaps habitat-wise also.

Dale encourages the growth of hardwoods such as maple primarily for aesthetic reasons, but he also suspects that a mixture of species was important for wildlife. In his opinion, monocultural tree plantations are unappealing. Like some of the other forest owners, his aesthetic appreciation of forests depends on them appearing as natural as possible.

The forest owners find diverse tree species aesthetically pleasing and they value the wildlife that such a mixed forest attracts. Dan Garvey explains his decision to leave hardwoods in his forest for habitat despite pressure from forest managers to remove them.

> I make my living on wood products and I believe there's a middle of the road to make the environmentalist happy and to make the loggers happy. You just use common sense and say, 'OK, leave some of the hardwoods.' Who gives a shit? Are they going to choke out my brand new stand of 'corn' coming up that's gotta be theirs? Who cares! No, they won't. Will they die, fall and break a few trees? Yea, they probably will. But they make that little difference that you need right in the time where there isn't any other things standing up so the birds and all those things have something to go land in.

Dan recognizes that diversity in tree species, especially hardwoods, is important for birds. While one of his objectives for forestry is financial investment, his takes the welfare of birds into consideration. Like Dale, Dan distinguishes his approach to forestry from the agricultural model that he associates with industrial timber management. He disapproves of monocultural plantations for excluding wildlife. Unlike stereotypical environmentalists, Dan views his forest as a resource for timber. Unlike stereotypical loggers, Dan is willing to sacrifice growing space for his commercial crop of trees in order to protect birds.

One-half of the forest owners specifically mention the importance of oak for wildlife and diversity. For example, Kyle Johnson argues that the deer in the area have larger racks due to the high quality forage provided by the Oregon white oaks. Mary Harten associates oaks with moss and lichen diversity. Several of the forest owners say that it is because of the oaks' value for wildlife and increasing rarity, that they choose to preserve them. On three of the ownerships I saw intact stands of Oregon white oak (see Table 4), which the families said they set aside. The Hartens choose not to underplant the oaks with conifers on 20-30% of their 160-acre property. Adhering to their policy to "stay out of the hardwood spots," the Hartens leave this portion of their property "natural." If they had time, they would remove the firs and take out the suppressed oaks. The Rounds set aside the majority of their 14-acre property in oak woodland for the purpose of conservation.

Other forest owners do not see value in oak. For example, when asked about his personal policy on oaks, Bud Parsons replies,

> Get rid of them if you can. The thing about oaks is that the fir will grow up through them. Maple will just kill out the fir. I don't care for oak mainly because of the value. If I had a choice of hardwood it would be alder. Oak doesn't have the value, and the quality in this area isn't very good either.

Bud doesn't dislike the oaks as much as he does the maples, since Douglas-fir can grow up, unhindered, through the oak canopy. The problem with oak, in Bud's view, is that it doesn't pay for itself. While Bud won't spend time and money eliminating the oaks, he will cut them down if they impede his efforts to grow Douglas-fir, and he certainly won't promote them.

On several of the ownerships, I saw stands of multiple conifer species (see Table 4), which the owners said they promote. Cultivated conifer species that I saw include Western red cedar, ponderosa pine, sequoia and grand fir. When asked why they plant other conifer species, many of the forest owners explain that they like them because of their beauty and uniqueness. Dale Hollis explains,

> The replanting with something other than Douglas-fir would have been unheard of 40 years ago. I planted cedar because I love cedar. I don't cut the cedar on my place. It's a beautiful tree and not very common.

Similarly, Keith Harten explains that he and his wife plant cedar in response to what they consider the routine and indiscriminant over-planting of Douglas-fir in Oregon.

> I used to plant trees when I was in school. No matter what was there, they planted Douglas-fir. There'd be these beautiful spots that should have been something else but they'd plant Doug-fir. I can remember planting Douglas-fir in standing water. That got me thinking, 'why in the hell aren't I planting cedars?'...It's the balance, the needs of Doug-fir are different from the needs of cedar and I've got such a diversity of land and drainage that I needed something besides Doug-fir, and I like cedars.

Keith and Mary Harten plant conifer species besides Douglas-fir because they visualize a healthy forest as trees of many species and ages. They know that different species are associated with different sites within ecosystems. Both Keith and Mary Harten and Dale Hollis counter the agricultural model of forestry that they think is so common in Western Oregon with what they consider to be a more ecological model, planting species in sites to which they think they are well-suited.

At the same time that the forest owners value diverse species and safeguard them during logging, they are also resigned to losing them to the process of stand development. For example, Kyle Johnson expresses appreciation of oaks for their beauty and the forage they provide to the deer he hunts. When asked about the future of his stand of centuries-old oaks, on which young Douglas-fir trees are encroaching from all sides, he laments, "Well, they're going to die. Can't regenerate under a canopy that dense." He makes no mention of keeping back the Douglas-fir to let the oaks grow, even though the stand, located behind his house, is not for production. At other sites around his property, he refers to his family's decisions to keep the madrones because they are uncommon. While Kyle recognizes the wildlife value of hardwoods such as oak and madrone, in management he defers to Douglas-fir. Later in my visit, Kyle also mentions that oak and madrone make nice firewood. The importance he places on hardwoods for wildlife –already secondary to the importance he places on Douglas-fir – competes with the importance he places on hardwoods as fuel. How this competition plays out in management is unclear; many forest owners do not fall standing oaks for firewood but use oaks that have already fallen due to wind or rot. However, in the fallen oaks' place they may plant Douglas–fir.

Some of the forest owners promote plant species diversity by planting trees that are from other ecotypes. For example, the Hartens plant cedar in the name of diversity. When asked to describe her management approach Mary Harten said,

> I look at it as a whole forest environment, not just the trees. I try to maintain the diversity in plants that's there now as I introduce trees…all the hardwoods - We're trying to maintain that part of the forest as I re-introduce the conifers.

While the Hartens value the diversity in species that are native to their immediate ecotype, they also treat the concept of diversity as inclusive of species from other ecotypes, not only cedar but also redwood (*Sequoia sempervirens*), a species native to California, and dawn redwood (*Sequoia spp.*), a species native to China. They describe parts of their property as an arboretum.

Similarly, the forest owners recognize wildlife common to edge habitats around the state beyond the oak woodland ecotype. Edges are the transitional areas in managed forests between closed-canopy stands and clearcuts (Matlack and Litvaitis, 1999). The species that the forest owners mention include generalists and edge specialists. Generalists are species such as deer and turkeys that can adapt to many different ecological conditions including edges. Edge specialists are species such as pileated woodpeckers, bluebirds and coyotes that thrive at the intersections between open areas and forests (Matlack and Litvaitis, 1999). Table 5 presents a comparison between the species that various studies have shown to be associated with oak woodland, and the species that the forest owners mentioned in my interviews. This table illustrates that while the forest owners express appreciation for diversity, and indeed mention many species in their discussions, few of the species they mention are oak woodland-associated species.

Table 5. Comparative Species List. Species associated with the Oregon white oak ecotype and species mentioned by forest owners.

Species associated with oak woodland	**Species mentioned (unprompted) by forest owners**	**% of owners that mentioned species**	**% of total species mentioned by forest owners**
Plants (Chappell et al., 2001; Stein, 1990; Thysell and Carey, 2001)			45%
Oregon white oak	Oak	90%	
Ponderosa pine	Ponderosa	80%	
Western red cedar	Cedar	80%	
Madrone	Madrone	70%	
Trailing blackberry	Blackberry	40%	
Grand fir	True fir, Grand fir	30%	
Snowberry	Snowberry	30%	
Brackenfern		20%	
Oregon ash	Ash	10%	
Ocean spray	Ocean spray	10%	
Baldhip rose	Rose	10%	
Poison oak		10%	
Hazel	Hazel	10%	
Oval-leaved viburnum		10%	
Salal		10%	
Incense cedar			
Serviceberry			
Indian plum			
Wedgeleafed ceanothus			
Huckleberry (V. ovatum)			
Piper's barberry			
Fescue (occidentalis)			
Melica subulata			
Longhair sedge			
Camas			
Galium aparine			
Swordfern			
Golden Indian paintbrush			
Columbian whitetop aster			
Small flower wakerobin			
Torrey's pea			
Kincaid's lupine			
Wayside aster			

Table 5. Comparative Species List (continued).

	Douglas-fir	10%	
	Big-leaf maple	80%	
	Alder	60%	
	Cherry	50%	
	Yew	30%	
	Chinquapin	30%	
	Vine maple	30%	
	Western hemlock	20%	
	Redwood	20%	
	Hawthorne	20%	
	Willow	20%	
	Maidenhair fern	20%	
	Cascara	20%	
	Elderberry	20%	
	Iris	20%	
	Orchid, Ladyslipper	20%	
	Thistle	20%	
	Western white pine	10%	
	Port orford	10%	
	Dawn redwood	10%	
	Cottonwood	10%	
	Dogwood	10%	
	Wild iris	10%	
	Shooting star	10%	
	Wild holly	10%	
	Mint	10%	
	Lamb's tongue	10%	
	Skunk cabbage	10%	
	Scots broom	10%	
Birds (Hagar and Stern, 2001; Brown, 1985)			21%
Woodpecker, acorn, Lewis', downy	Woodpecker, black and white, downy, pileated, red-headed	40%	
Hawk, cooper's, red-shouldered, red-tailed, rough-legged	Red-tailed hawks	30%	
Owl, common barn, Western screech, great horned, long-eared, Northern saw-whet	Owls, great-horned, short-eared	30%	
Bluebird, western	Westerm bluebirds	30%	
Jay, scrub	Jay, Oregon, stellar	20%	
Wild turkey	Turkey	20%	

Table 5. Comparative Species List (continued).

Heron, great blue	Herons	10%
Duck, wood		10%
Grouse, ruffed		10%
Nuthatch, white-breasted		10%
Robin, American		10%
Merganser, hooded, common		
Vulture, turkey		
Kite, back-shouldered		
Kestrel, American		
Falcon, prairie		
Turkey, wild		
Bobwhite, northern		
Quail, California, mountain		
Pigeon, band-tailed		
Dove, mourning		
Nighthawk, common		
Poorwill, common		
Swift, Vaux's		
Hummingbird, Anna's, Rufous, Allen's		
Flicker, Northern		
wood pewee, Western		
Flycatcher, ash-throated, Western		
Swallow, tree, Violet-green, cliff, barn		
Crown, American		
Raven, common		
Chickadee, black-capped		
Titmouse, plain		
Bushtit		
Wren, Bewicks, housem		
Kinglet, golden-crowned, ruby-crowned		
Gnatcatcher, Blue-gray		
Wrenitt		
Shrike, Loggerhead		
Vireo, Hutton's, Warbling		
Warbler, Yellow-rumbed, black-throated gray		

Table 5. Comparative Species List (continued).

Tananger, western		
Grosbeak, black-headed		
Lazuli bunting		
Towhee, Rufous-sided, brown		
Sparrow, chipping, lark, fox, sing, golden-crowned		
Junco, dark-eyed		
Blackbird, Brewer's		
Cowbird, Brown-headed		
Oriole, Northern		
Finch, purple, house		
Goldfinch, lesser, American		
Mammals (Brown, 1985)		
Deer, mule, Columbian white-tailed	Deer	90%
Elk	Elk	40%
Raccoon	Raccoon	40%
Coyote	Coyote	20%
Vole, California and creeping	Vole	20%
Skunk, Striped and Spotted	Skunk	10%
Squirrel, western gray, California ground	Squirrel	10%
Bat, pallid, big brown, silver-haired and hoary, Brazilian free-tailed	Bats	
Fox, red and gray	Fox	
Masked shrew		
Coast mole		
Myotis, California, little brown, fringed, long-legged, Yuma		
Ringtail		
Townsend's chipmonk		
Gopher, Camas pocket, Northern pocket		
Heerman's kangaroo rat		
Dusky-footed woodrat		
Deer mouse		
Pacific jumping mouse		
Black-tailed jackrabbit		
Brush rabbit		
	Beaver	10%
	Bear	20%
	Bobcat	60%
	Cougar	50%
	Flying squirrel	20%
	Lynx	10%
	Mink	10%
	Rabbit	30%
	Porcupine	20%

Amphibians and Reptiles (Brown, 1985)			30%
Salamander, Northwestern, Long-toed	Salamanders	20%	
Snake, sharptail, ringneck, gopher, Western aquatic garter, Western terrestrial garter, Common garter	Snake, rattle, rubber boa	10%	
Newt, rough-skinned	Newts	10%	
Ensatina			
Toad, Western			
Treefrog, Pacific			
Turtle, painted, Western pond			
Lizard, Northern aligator, Southern alligator, Western fence			
Skink, Western			
Racer			
Other			n/a
Valley silverspot butterfly			
Mardon skipper butterfly			
	Mushrooms, chantrelles	20%	
	Trout	10%	
	Moss	10%	
	Lichen	10%	

The forest owners are equally divided in their attitudes toward rare species. While almost all the forest owners express appreciation for unique flora and fauna, few mention rare species, especially those that are associated with oak woodland. The Rounds, who want to reintroduce rare plants that might be missing from their piece of oak woodland, are an exception.

> If someone has a compelling reason to put in some native species that are endangered or that they're trying to reintroduce, I'd love to have people come plant them here, I'd help them out.

Others are concerned about the consequences of finding or promoting rare species. They fear the effects of environmental regulations on their abilities to manage. For example, when asked whether he knew of other unique species of birds or animals, beside the deer with large racks, Kyle Johnson answers hesitantly, "Hmm? Oh, you mean like spotted owls? No owls. And even if I do, I don't, you understand." The forest owners temper their enthusiasm for diverse species with concern for the perceived consequences of endangered species regulations.

4.1.2. Structural diversity

The forest owners that I interviewed acknowledge the importance of different forest structures and structural conditions for providing wildlife habitat and other forest functions (Table 4). For example, Dale Hollis explains his view that a forest without structural diversity is unnatural,

> Acres and acres and acres of all the same size seems unnatural. You don't say that about your alfalfa field or your potato field but when it's about your forest now that doesn't look right, it seems the same age, man has had a touch there.

In his mind, promoting structural diversity distinguishes his more "natural" approach to forestry from industrial forestry's agricultural model.

I noted large, woody habitat structures on 9 of the ownerships (see Table 4). Many of the forest owners said they retained these structures, such as snags, broken-topped trees and downed logs, for wildlife purposes. While they recognize the value of dead and decaying wood for wildlife, their opinions on snags and downed logs differ. Most of the forest owners say see snags as positive features of their forests. Incidentally, the Oregon Forest Practices Act, in many cases, requires retention of snags; the owners may have no choice but to like snags. Many of the forest owners voluntarily point out cavities that woodpeckers have created in conifer snags and in broken-topped hardwoods. However, when asked how they feel about downed logs, they generally characterize them as wood that they should have salvaged but instead wasted. This view illustrates the competing values that the forest owners have for their forests; they value them for wildlife habitat and other natural functions and, due to their utilitarian perspective on forests, they do not see that management interventions necessarily compromise these functions. For this reason, the forest owners are happy to conserve large woody habitat structures up to the point at which they could be more useful as extracted products from the system.

Many of the forest owners mention the species that are found in the herbaceous layer of their forests, the first live structural layer, which is characterized by grasses and forbs (see Table 5). Diversity in stand structure allows light to reach the forest floor. While the light fosters the growth of weedy plants such as blackberry, poison oak and Scots broom, which are the bane of timber owners, it also makes possible the growth of the herbaceous plants that the owners like, such as wild iris, orchids, lambs tongue and shooting star. Dale Hollis refers to the family's appreciation for these understory plants.

> Mom was the kind of person that would go in where they were going to log and get any of the little lady-slipper bulbs and transplant them to other places in the woods.

The forest owners maintain stands of live trees of mixed ages and sizes (Table 4). However, their opinions differ greatly about which stages of forest development are more advantageous to wildlife and the ecosystem. Some of the landowners associate diversity of young trees with forest health. For example, Dale Hallard states emphatically that he would never allow his trees to become giants.

> When things are ripe they ought to be harvested. I don't think I'll ever see anything that's ripe on this ground.

Dale values regenerating clearcuts for the forage they provide to wildlife. Looking out over his 40-acre replanted clearcut of several age classes of young Douglas-fir seedlings intermixed with vine maple, cherry, ocean spray and thistles, he says,

> This is my idea of ideal. Plenty of feed for the animals, plenty of cover. Feed for your deer, your rabbits, your cougar: wildlife feed.

He comments on allowing trees to grow until maturity:

> That's exactly the opposite of what is good for the animals. If you didn't harvest this forever again, the feed value for wildlife would be gone in 15 years. It would grow big tall timber and salal and that's all.

The kind of structural diversity that Dale Hallard values is an assortment of shrubs and trees of different ages and sizes all in the early stand initiation stage.

Other forest owners prefer forests in the understory reinitiation and old growth stages. When asked about the dozens of giant Douglas-firs, hemlocks and cedars that Dale Hollis and his mother Estelle have on their property, Dale shares his family's commitment to keeping old trees around,

> We're not going to touch them. In fact, We're taking the approach that anything over 200 years I'll just leave because you can't replace them very quickly...Beauty, it's just not worth cutting.

For Dale, the value of a big, old tree is greater live than dead. Even though they depend on timber for their income, Dale and Estelle have an informal policy to set aside these hundreds-of-years-old trees out of respect. Similarly, Lynn Stohl says her management objective is to turn her forest into old growth of the kind that one finds in the dense, decadent Western-hemlock forests of the Cascade foothills.

Some of the forest owners' notions of structural diversity extend beyond diversity in the sizes and ages of live and dead woody plants to diversity in landscape forms. For example, some forest owners apply a mosaic of management practices to their lands; for example, mixing stands of mixed species and age classes, with stands of even-aged Douglas-fir and reserves throughout their properties (see Table 4). John Schultz and the Hollises designate reserves around legacy structures such as old conifer and maple trees, the Hartens and the Rounds leave meadows open to attract birds and to maintain a nice view, the Hollises and the Hartens maintain different stands of mixed tree species and sizes in different places around their properties, and the Hartens and the Rounds even set aside oak groves.

Not one of the forest owners attempts to create the kind of structural diversity that is characteristic of oak woodland, namely patchwork mosaics of open oak stands and solitary oak trees. This may be due, in part, to the difficulty of promoting oak woodland structures, which historically resulted from frequent, low-intensity fire. However, it is possible to mimic the processes that lead to characteristic structure by clearing understory shrubs and Douglas-firs to release oaks, and reducing tree density to promote mushroom-canopied oaks. In light of the time and energy that family forest owners expend on their forests, often without the likelihood of financial reward, it is possible that they could engage in restoration activities. Perhaps the family forest owners do not value oaks enough to make them the focus of their management attention.

4.1.3. Spatial and temporal Scale

The forest owners that I interviewed are aware that forest systems are variable; their species compositions and structural conditions change over time and space. However, the forest owners have separate and somewhat contradictory understandings of the roles of temporal and spatial scale on this variability. They are well aware of the changes their forests have undergone over the course of stand development and as a result of different management practices. But they do not factor spatial context into their perspectives and management practices.

The forest owners I interviewed do not view their forests in the context of the landscape beyond their property boundaries. When asked how the conditions of their forests might compare to others nearby, the Hartens, the Rounds, Dale Hollis and Lynn Stohl acknowledge that their forests contain elements that are rare in the larger spatial context, such as oak woodland and old growth stands. The majority, however, say they know little about their neighbors' forests, and prefer to mind their own business, as if the forests that are beyond their influence are irrelevant.

The forest owners are well aware of temporal scale, on the other hand. They evaluate the current conditions of their forests in relation to the other potential conditions their forests could have assumed. Seven of the landowners come from families that have lived on forestlands and farms for generations (see appendix A). Some have heard stories from their grandparents, seen pictures from the old days and witnessed first hand the changes that have occurred on their own forests. All are well aware that oak woodland was the original forest cover type, upon which Douglas-fir has only recently encroached. For example, Dale Hollis and his mother Estelle look out on the valley in which they had both grown up. The north slopes are a mixture of Douglas-fir and hardwood forest at least a century old. The south slopes are pastureland against a backdrop of 60 year-old Douglas-fir. "Mom has pictures looking out this way taken in the early '30s and there are no fir trees back here," notes Dale. Estelle points to a stand of oaks. "My brothers hung the engines from their cars on those oaks to work on them. That means that 70 years ago the branches were big enough to support an engine." Dale comments,

> It's a rare opportunity to see an area change over a lifetime. People talk about, 'oh, I should return these acres around Corvallis to what they used to be.' Then I should plant oak trees, because they were all oak trees. People don't realize that some hundreds of years ago they were oak grove after oak grove.

Even the forest owners that did not grow up in the area are able to reflect on what their lands may have looked like in the past. Donald Farmer who moved to Oregon from the Midwest where he grew up on a farm, explains,

> A hundred years ago most of this area was pasture. It's just been in the last 60 or 70 years that people have planted it and grown Doug-fir. Doug-fir is not native so it wouldn't have been here at the time of [European settlement]. It would have been the oaks and the maples. Ponderosa pine is the only native to this area as far as evergreens go.

Donald is aware that the site where his Douglas-fir forest now stands used to be oak woodland. Although the boundary of the Western hemlock ecotype, which includes Douglas-fir, is just a few miles west of his property, he considers Douglas-fir to be a non-native species. He clearly distinguishes the ecotype in which his land is located from other ecotypes. Yet, he is growing a Douglas-fir forest.

Landowners are also knowledgeable about why the ecotype changed. Dale Hallard explains,

> This land was not nearly as timbered as it is now. It was a lot of open hills. They had a lot of fire. They deliberately burned parts of it. All of the Coast Range and Willamette Valley, none of it had as much timber as it does now. It was all more open. They were patchy hills, from the fires from the Indian times...I think it would be its more natural state if you deliberately burned it.

In addition to being aware of the general changes that forests undergo over time, the forest owners are familiar with specific changes that occur in forest composition, structure and function as a result of stand development. Dan Garvey enjoys the orchids and other flowers that grow on the floor of his forest. However, he usually keeps them a secret because he fears that the government might institute protections for orchids that would restrict his management practices. He argues that the only reason the orchids grow on his property is that he has created a conifer forest for them to grow in. The stand where the orchids grow is in the stem-exclusion phase, yet the trees are spaced far enough apart to let light penetrate the canopy and reach the forest floor.

> The truth is, they [the orchids] are only there when the forest is at a certain age and they weren't there a hundred years ago, because there wasn't even a tree standing on this hillside and it's not as though they've been there forever and you're taking their life away. They come back and they come and go and they have their way of surviving.

With their knowledge of the different past and present conditions of their forests, the forest owners recognize that change is inherent to the nature of forests. When asked to describe what his ideal forest would look like, John Schultz answers,

> The forest isn't static, so the vision of an ideal forest doesn't make any sense. It's the evolution of it. Is it working right? [Even if you think] it is, maybe in five years you realize 'I should have done something just a little bit different somewhere else.'

John sees the future of a forest not in terms of a pre-determined stage on a linear trajectory toward succession but as a combination of latent responses to various processes, including management interventions and disturbances. He perceives a role for himself in influencing his future forest, a topic that I will discuss in detail in the next section. But, in his view, one cannot predict the effects of these processes.

In their recognition of nature as variable and unpredictable, the forest owners are able to look beyond the short-term impacts of their management practices on biodiversity, an idea that I will consider in more detail in the following section. Many of the forest owners say that cutting trees is painful until they look at in perspective. Harvesting results in a temporary state of barrenness and then nature takes over, filling the harvest areas with different compositions of plants and animals as the structure of the forest changes over the course of its development. In the words of Dan Garvey,

> These trees are planted as if they are a harvestable crop...I want my kids to understand that the most fun in my life was actually when I got to do the logging and watch the regrowth and see that kind of cycle...It was a little bit of sadness, 'oh, the poor trees,' but that was just the first winter, and after that it's green already and then things started popping up and growing. It's so apparent that it's just the process of life and you can't deny it.

Like John Schultz, Dan Garvey not only recognizes the dynamic nature of forests and biodiversity, but also perceives a place for people in shaping the forest's future. Dan's desire to pass this perspective on forests onto his children indicates its importance.

The forest owners' knowledge that forests change over time and space, and can take on any number of potential conditions, gives them a framework for evaluating their forests. Some landowners feel strongly that their forest practices should be judged in relation the original conditions of the land. In the words of Dale Hallard,

> I've lived here for 50 years and I really take care of what I have...You can just look when I go out...there's more trees than there's ever been. I'm of the mind that every time you see a tree you should cut it down. Now that may sound foolish to you but there's so many more trees today than there was years ago.

Dale Hallard is aware that the area where his land is located used to be oak woodland, that any amount of conifer trees is more than what originally grew there. He feels that people should form their opinions about logging in relation to the historical conditions of an area. Why should it be a crime to cut a tree when the only reason the tree is there is that someone planted it for the purpose of cutting it? Dan Garvey provides a relativist perspective similar to Dale Hallard's.

> We're looking at it as if this is the natural state and it has always been like this on the hillside. The more natural state to this is of an open, non-forested hillside with rose bushes and grasses and hardwoods and oaks...We try to look at it in our lifetime as if it's always been all firs, but it's just because it has a dense crop of firs on it right now. It's the first time it's ever had it.

Clearly, scale plays a role in the forest owners' ideas about their forests. While the owners do not view their forests and management practices so much in terms of spatial scale, they are well aware of the temporal scale. The owners' knowledge of the changes their forest have undergone over time provides them with a view of forests as unpredictable and resilient. They view change and variability as essential features of forest systems. This perspective makes it possible for them to look beyond the short-term impacts of logging to view forests in light of other potential past and future states.

4.1.4. Discussion: Social construction of biodiversity knowledge

The forest owners that I interviewed are clearly knowledgeable about biodiversity. Although the forest owners may not use the term "biodiversity" to define their knowledge, they explain biodiversity when describing their forest systems and management practices. They address what the scientific literature considers to be the main elements of biodiversity: variety in species and structures, and variability at different scales. However, the forest owners' knowledge of biodiversity does diverge from the scientific literature on some points, especially on spatial scale, or context. I propose that the family forest owners' knowledge, including their contextual frames for looking at forests, is related to their beliefs and the external constraints under which they operate. This discussion will analyze the ways in which the forest owners' knowledge differs from the scientific literature and how these variations may be related to the forest owners' beliefs about human relationships with nature and their biophysical and socio-environment (which I will discuss in further depth in the following chapters). I will also relate my findings to the theories I introduced in my literature review and suggest implications for biodiversity conservation.

I found the knowledge held by the forest owners in my sample to be similar, in many ways, to the knowledge of conservation biologists as evident in the scientific literature. My findings on the complexity and sophistication of the forest owners' knowledge are surprising considering other research on the subject. Several recent studies on biodiversity find the general public, and specifically land-based communities, to lack basic knowledge about biodiversity (Hunter and Brehm, 2003; Mankin et al., 1999; Kellert, 1993; Kellert and Berry, 1987). A recent study of people in a rural area near public lands in Utah found low levels of knowledge about biodiversity (Hunter and Brehm, 2003). Asked about the meaning of biodiversity, informants responded "That's too big for me..."diversity" of course means spread out, I guess "bio" would mean biological type stuff?" and "I'm assuming you're talking about the plant and animal kingdom. Does it mean you have your little area and in the area there's the diversity of animals and people and the land and water and of those sorts of things?"

Where my forest owners' definitions differ from the scientific literature is on the subject of spatial scale, or context, the most nuanced of biodiversity's underlying elements. Spatial scale is one of the most important considerations in biodiversity conservation (Hunter, 1999; Whittaker, 1960). Species richness alone is only meaningful in a designated area (Burton et al., 1992). It is most useful when combined with evenness (Peet, 1974). Adding more species to an ecosystem will increase diversity, but it may also compromise the system's uniqueness by altering the delicate balance that pre-existing species have with their habitat. It may render its composition and structure as generic as any other system that has been altered. Increasing local or "alpha" diversity by introducing new species ultimately reduces global, or "gamma" diversity" (Hunter, 1999).

The forest owners in my sample do not restrict their treatment of species diversity, structural diversity and scale to the Oregon white oak ecotype in which their lands are located. Even the forest owners whose primary goals include forest health do not favor species that are characteristic of oak woodland in their management practices. For example, the Hartens are aware, from the remnant stands of oak and the rocky soils on their property, that the original condition of their land is oak woodland. Yet Keith and Mary are planting Western red cedar and other conifer species that are not native to the Oregon white oak ecotype on 70-80% of their land. In the language of conservation biology, the forest owners – by creating conditions that support common species and marginalize ecotype-associated ones – promote generic species richness at the expense of evenness. Hunter (1999) attributes this approach to biodiversity to a failure to consider local biodiversity in a global perspective. Instead of adding more species indiscriminately to a system, we should consider the status of a wide array of ecosystems. Then we should a) maintain the biodiversity of ecosystems that are already in good condition and b) restore the biodiversity of ecosystems that have been degraded.

The kinds of structural diversity that the forest owners recognize - the stand initiation, stem exclusion and old growth stages - are not limited to the Oregon white oak ecotype. Instead, they are more characteristic of both early successional conifer forests, which are well represented in Western Oregon, and late-successional conifer forests, which have never existed in the Oregon white oak ecotype. For example, Dale Hallard views his early successional forest of young Douglas-fir saplings and brush as the best possible conditions for diverse species of wildlife. Lynn Stohl, on the other hand, in describing her ideal forest, references the mixed hemlock-fir climax forest, an ecotype that she correctly recognizes as underrepresented in Oregon, but which is not indigenous to her ecological zone. Like the other forest owners, Dale and Lynn's enthusiasm for promoting forest health belies their contextual understanding.

The forest owners are knowledgeable about diversity but rely on a general interpretation of the concept. They acknowledge the importance of species and structural diversity, but not the species that are associated with oak woodland. What is missing from the forest owners' knowledge of biodiversity, when compared with the scientific literature, is grounding in spatial context. While they view species and structural diversity as indicators of forest health, which some of them strive for in management, they promote a kind of diversity that conservation biologists would consider out of place in their ecotype. The spatial context that the owners operate within does not conform to the boundaries of their immediate ecotype. Instead, the oak woodland and Western hemlock ecotypes bleed into one another. Integrating species and structures from ecotypes does not pose problems to the owners' ideas of good forestry or biodiversity. It simply reveals the compromise, which I will discuss later, that owners must reach between their multiple and competing objectives: income generation, conservation and recreation.

While conservation biologists would likely think that the family forest owners, by mixing ecotypes, are compromising the integrity of their forests' biodiversity, they are not necessarily contradicting core community ecology principles. Conservation biologists recognize that much variability and blurring occurs at the edges of ecological communities, that ecosystems are not so much evolving along well defined, linear pathways toward climax as they are evolving in dynamic equilibrium (Spies and Turner, 1999) or non-equilibrium (Reice, 1994). In other words, the differences between the forest owners' and conservation biologists' understandings of biodiversity are ambiguous; considering how flexible accepted meanings for biodiversity are, it would be difficult to delegitimize the forest owners' meanings.

My analysis of the forest owners' treatment of biodiversity in the interviews raises many questions about how they conceptualize biodiversity and how these conceptions might influence their management approaches. Why does the owners' knowledge differ from the scientific literature on some points and not on others? Obviously, I cannot assume that conservation would be a top priority for these owners. Yet even the owners that do list forest health and wildlife habitat at the top of their lists of priorities still transform their oak woodlands into mixed-conifer stands and justify their behavior with forest health and diversity arguments. Why do they promote the biodiversity of conifer forest over that of oak woodland even though they appreciate hardwoods, know that oak woodland is their ecotype, and manage for amenity values in addition to timber income? Why do the forest owners think so exclusively about the forests within their property boundaries, and not make themselves aware of the conditions of the forests that surround them? I propose four related hypotheses to answer these questions, which I will develop further in later sections.

My first hypothesis is that the forest owners' views on biodiversity are, in part, a product of their socio-economic and biophysical environment. A core postulate of environmental sociology is that social and biophysical worlds are connected by a web of cause and effect (Buttel et al., 2002). Constructionism suggests that people frame their knowledge and beliefs in relation to and in reaction to the world in which they live; what they see around them defines the possibilities for their actions, as much as these surroundings are a product of their actions (Gramling and Freudenberg, 1996). In the biophysical and socio-economic landscape that surrounds the family forest owners in my study area, what is possible is production conifer forestry. The socio-economic conditions of the region impose constraints on how the owners can manage their lands. In turn, these conditions produce a biophysical environment increasingly dominated by young conifer plantations. Working within these possibilities, the owners develop and implement their knowledge of biodiversity.

Although the area in which the forest owners live was originally oak woodland, the forested landscape of the eastern Coast Range foothills has largely become mixed conifer–Douglas-fir plantations. This change in forest type is partially the result of a wood products economy, dominated by industrial producers, that prefers Douglas-fir in logs of a specific diameter from trees of a specific age class. These preferences are part of the larger global economic trends that favor raw products that are versatile enough to be in widespread use and demand, allowing for economy-of-scale production (Johnson et al., 1998). Indeed, for owners of family forests to achieve any financial goals for timber, they must grow commercial species on a commercial scale. It is also possible that the forest owners see commercial timber production as their only option. State extension foresters and family forest interest groups may advocate for management in the form of Douglas-fir in plantations (Best and Wayburn, 2001; Sampson and DeCoster, 1997). Both the Hartens and the Rounds referred to the pressure they felt from small woodland interest groups and extension foresters to homogenize their forests by reducing hardwoods and controlling brush to establish Douglas-fir, as will be discussed later.

Examining the family forest owners' knowledge of biodiversity reveals their appreciation for its components – species diversity, structural diversity, and scale. In the forest owners' implementation of their knowledge, they adapt and conform their appreciation of biodiversity's elements to their environment. Their environment is characterized by young conifer plantations, a reflection of a socio-economic system that values production conifer forests.

However, the forest owners clearly distinguish their management practices from those of industrial forest owners. They argue that their appreciation for diversity makes them different from industrial owners, and more responsible, as I will demonstrate in the following sections. If they really value diversity and stewardship, why wouldn't they steward the biodiversity of oak woodland, which they know is the original condition of their lands? My second hypothesis is that the forest owners' efforts to reduce conflict between their beliefs about biodiversity and the behaviors that they see as possible produce the phenomenon that Festinger (1957) termed cognitive dissonance. In order to smooth out tension between their beliefs and the world around them, the owners make do with beliefs that are contradictory to their behavior, or they outright alter their beliefs. For example, the owners appreciate diversity in species at the same time that they need to produce timber efficiently. To reduce dissonance between their diversity ideals and production goals, they come to see diversity in the very forest systems that efficiently produce timber. As a result of a compulsion to bring belief, which can be changed, in line with behavior, which is less easily changed, many of the owners promote a kind of biodiversity that they know is not ecologically appropriate to their area.

In many cases, the forest owners exercise different, and sometimes contradictory, beliefs about biodiversity in different sites around their properties. For example, at the same time that they defend the ecological soundness of their conifer production forests, the forest owners also designate oak woodland reserves on sites that are unsuitable for Douglas-fir, legacy hardwood stands in riparian buffers where the Forest Practices Act prohibits harvest, and stands of mixed species and age classes in their viewsheds. The owners manage according to a list of different, and to some extent, competing priorities. In offering up rationales that support these different management practices, they expose differing sets of beliefs about biodiversity and their relationships to it. In this way, they can accommodate their different management priorities without outright contradiction.

A third hypothesis is that the forest owners' conceptions of biodiversity are related to their beliefs about what is "natural" and their beliefs and values about human relationships with nature, ideas that will be developed further in the next section. The forest owners in my sample see a place for themselves in their forest systems. Most of the owners do not think that management interferes with the naturalness of their forests. By including a role for humans in natural systems, the owners can reduce conflict between their knowledge that oak woodland was the historical condition of their forests and their knowledge that their management practices are converting oak woodland to conifer forest. If a managed forest of variable species and structures that changes over time is natural, then biodiversity can easily mean species and structural diversity that is transferable from ecotype to ecotype.

Finally, I propose a hypothesis that may explain the family forest owners' conceptions of biodiversity's spatial scale. The limitation of forest owners' views on biodiversity to their own property boundaries is, in part, a product of our nation's land tenure system, which encourages autonomy and adherence to property lines (Brunson, 1998; Jacobs, 1998). Land tenure, as the written and unwritten rules by which people exert claims on resources (Geisler and Salamon, 1993: 529), is a reflection of society's beliefs, values and relations (Fortmann, 1996). The owners see themselves as responsible for and able to affect only their own property. Other people's forests are not only none of their business, but they are also outside of their purview, as are the conditions of forests in the larger region. Control over one's private property is linked to their identity, autonomy and motivations to manage their land (Bliss and Martin, 1989). With a perspective on forest biodiversity that focuses on the private parcel, it is not surprising that the forest owners do not situate their views on biodiversity within a large-scale spatial context.

4.2. Beliefs regarding human relationships with nature

The family forest owners' beliefs regarding the relationship between humans and nature influence their conceptions of biodiversity. These values manifest in the forest owners' approaches to treating the species and structures that make up biodiversity and in the temporal scales that they choose to think and operate within.

The forest owners' management approaches range from active to passive, with each owner occupying different, and sometimes multiple, points along the spectrum depending on the context. Some owners manage their production stands more intensively than the stands they set aside for wildlife and views. Others manage both production and reserve stands with the same intensity. Still others see themselves as not managing at all. All the forest owners value the naturalness of their forests. Their management approaches correspond with their beliefs on the degree to which human involvement in biodiversity can still produce natural forest systems.

I broadly categorize the forest owner's beliefs about their role in their forest systems into two code categories, "active management" and "passive management" (see Figure 6). Active management describes tinkering with forest systems to get the right balance in species composition and structures, a management approach which reflects the active role that can humans play in nature. Several of the forest owners describes this approach as a "balancing-act." Passive management describes not meddling with the parts of the system that are already in a desired state, especially when the task of changing the natural trajectory of species composition and structural conditions is too daunting. Two of the forest owners refer to this approach as "letting nature win." My categories correspond in some ways to other categories that social scientists have used to describe human relationships with nature; for instance, instrumental and intrinsic (Bengston, 1994), and anthropocentric and biocentric (Steele et al., 1994; McFarlane and Boxall, 2000).

The forest owners operate within a time frame that they consider to be more appropriate to the life of a forest than the time frame that most humans operate within, the span of their own lives. While this long-term perspective has been well documented among family foresters in relation to other concepts such as ecosystem management (Creighton et al., 2002; Rickenbach et al., 1998), this research reveals the connection between this perspective and the forest owners' conceptions of biodiversity. The forest owners not only plan for future generations, making decisions that will have results long after they are gone, but they relate their long-term perspectives to the temporal scales on which forest systems function. In other words, they adapt their management time frames to the time frames of biodiversity.

4.2.1. "Balancing act": Active management of biodiversity

Most of the family forest owners in my sample play an active role in forest management (see Figure 6). In order to achieve their objectives for their forests – be they timber, wildlife habitat or a nice view – they tinker with species composition, forest structure and function. They associate this tinkering approach with stewardship and differentiate it from the approach taken by industrial forest owners. In actively managing their forests, mediating the relationships between species and promoting certain structures over others, the forest owners maintain what they view to be the correct balance of biodiversity and steward the naturalness of their forests. They clearly see a role for themselves in their forest systems. In fact, it is the very intensity of their management practices that allows them to care for their forests.

Dale Hallard holds the most extreme of the forest owners' views on the need to intervene in biodiversity in order to protect it. He describes how he "rescues the forest from the brush:"

> The first few years are critical. If you don't control the brush and berries you will never have anything...You've just got to physically cut or spray or do whatever's necessary to free the ground...The priority is to make sure the replantings survive from being smothered by the brush.

Dale Hallard's objectives for his forest include stewarding the land that he loves, ("I manage it because I love that land and I want to take care of it...I don't want those trees to die,") as well as generating income, ("Well that's why you have anything, is to make a living.") Dale grows a Douglas-fir forest on most of his land. It is not surprising that he is concerned about brush. Brush is a well-documented hindrance to the regeneration of Douglas-fir seedlings. However, there is some controversy among foresters over whether brush should be controlled or left alone (Savill et al., 1997). There is some debate whether the increased growth that results from eliminating brush is worth the time and money required to eliminate it. Not all family forest owners eliminate brush. Dale himself expresses appreciation for the wildlife feed and habitat that a diversity of brush species provides, as mentioned in the previous section. Yet Dale thinks that at certain stages in forest development, the forest – in order to survive – needs human intervention. The brush must be eliminated in order for the seedlings to become established. When the seedlings are above the brush and free to grow, the brush can be allowed to grow again. In order to achieve his multiple objectives for his forest, producing Douglas-fir and stewarding the land, he must balance out the relations between the commercially-valuable tree species and the species that provide for biodiversity.

Mary and Keith Harten also see a role for themselves in managing species compositions and structural conditions. Mary explains how she and Keith save the existing hardwoods and big trees as they introduce young conifers.

> It's kind of a balancing act of trying to hold one back while the other one gets up…I keep my trees away from the existing big trees because they're healthy and they got here first.

Mary and Keith also talk about leaving dead-topped maples for the woodpeckers instead of clearing them to release Douglas-fir: "If I see an owl, or if a pileated [woodpecker] likes that spot, I'll leave it even if it's shading trees." Mary and Keith are planting conifers in their mixed hardwood forest, a former oak woodland. They value and defer to the trees that were on the property when they purchased it, acknowledging that they do not have license to eliminate things in nature that precede them. At the same time, their goals for their forest include increasing the number of trees and diversifying species. They see a place for themselves in their forest systems, in mediating relationships between existing and introduced species and structures. As long as they do not deny the existing trees and shrubs the light and space they need to grow and their functions of providing habitat, they do not see conflict in modifying their forest system to accommodate species that they want to introduce.

The forest owners feel that playing an active role in their forests – intervening in and balancing out species and structural relations – allows them to do a better job of management than landowners who do not tailor their practices to each stand. They frequently contrast their fine-grain approach to the economy-of-scale approach used by industrial forestry to cultivate expansive even-aged crops of a single species, Douglas-fir. They attribute their ability to take this active role to several factors, including the small size of their parcels relative to industrial parcels and their residence either on or in close proximity to their lands. Bud Parsons argues that having a small-sized property and the skills to manage it enables him to be creative and adaptive.

> Me, being small enough to be able to tinker with it instead of having to go in and say 'I'm going to clearcut this forty, I'm going to plant this forty.' I can kind of play with it and adjust it as I go. It's just more of a hands-on approach. Not a lot of people have the opportunity to actually do the work. They may have the ground and they just send somebody in to do it. It's totally different, doing it yourself on your own property.

In Bud Parson's view, playing an active role in his forest system allows him to experiment with different management practices, develop an intimate knowledge of his forest, and adapt his practices as he goes to meet the needs of his forest.

Mary and Keith Harten take this active role a step further, arguing that living on their parcels and in their forests allows them to do a better job of management. Mary explains,

> People wouldn't be able to do this kind of management. It's too intense. You've got to be able to jump on it and go do it. If I had to travel to 6 different parcels around the county and manage those, it's just not the same intensity.

In Mary and Keith's perspective, the more that they are physically part of the forest system, the more intensively they can manage it, and the better they can balance the needs of the existing and introduced species and structures.

Through this "balancing act" approach to management, the forest owners carve out roles for themselves in the ecosystems of which they feel a part. Out of concern for the welfare of their forests, they feel compelled to intervene in species composition and structural conditions. This active management approach reflects a view of nature that imbeds humans in biodiversity. It translates into a landscape that is neither "settlement," such as farm or tree plantation, nor wilderness, but both these things: a human-inclusive ecosystem. The forest owners believe that they can best manage the species and structures that comprise biodiversity by making a place for themselves in the system. They do not view themselves as needing to be outside the system in order to protect biodiversity. Instead, biodiversity is all the better for the role they play in managing it.

4.2.2. "Letting the forest win": Passive management of biodiversity

At the same time that the forest owners intervene in biodiversity, they are also willing to let nature be at times. Several of the forest owners mention situations in which they decide not to intervene in nature, and describe a general management philosophy of setting aside some or all of their parcels to nature's devices (see Figure 6). In the approach of "letting the forest win" or "letting it be natural" the forest owners acknowledge that they do not have control over nature. When encroaching blackberries or widening big leaf maple crowns are not detrimental to the species or structures that they value, they are willing to let nature follow its course, especially when there is little that they can do to change the situation. This hands-off approach reflects the belief that sometimes humans should let nature be, that nature is better off on its own and doesn't need human intervention. At times, forest owners may also favor this approach when the activity – clearing blackberries, for example – requires too much work, costs too much money or yields too little value.

For example, Lynn Stohl describes her struggle with the forest over light.

> I love the trees but they're blocking out the sun, which I also love. I am constantly going back and forth between whether I want the forest up there or the sun down here. So far the forest is winning.

While Lynn is managing her forest for a good view in addition to conservation purposes, she questions how much she should require of the forest to satisfy her own aesthetic needs. She does not want to live in the shade. At the same time, she does not feel comfortable cutting down or thinning the stands near her house to allow light in. She takes the approach of letting nature run its course as long as she can tolerate it.

Dan Garvey describes a similar relationship with the blackberries that are taking over many open spaces in his young Douglas-fir stand, "They're fine. They're not hurting anything. I don't have this drive that I have to go and manicure it all and kill these things." While Dan would like his Douglas-fir trees to grow vigorously, he does not want this growth at the expense of any other living things, even blackberries, the bane of many forest owners in Western Oregon. Unlike Dale Hallard he does not feel compelled to keep down all the brush in order to release his seedlings. He defers to nature and expects the species to work things out.

Many of the family forest owners say it is important to them to leave some parts of their forests natural. Richard and Debbie Rounds leave the majority of their 14 acre, south-facing oak woodland as they found it when they purchased the property.

> When we first got here we didn't have much of an understanding of what it is that we should do. We thought we were going to be required to pull the oak and put in Douglas-fir...[Then we learned] 'oh no, my word, this is oak savannah and its endangered.' There's so much of the valley that is being altered, trying to use a neutral term, that we have a concern about how much is left natural.

Richard and Debbie are some of the few forest owners that preserve their oak woodland. They see their oak woodland as native and in danger of disappearing. They cut a mile-long trail through their forest for the purpose of viewing it, and declare all land off the path off-limits. When asked what they think of the exotic species of English hawthorn tree that is invading the understory of their woodland, they simply anslr, "We don't do anything off the path." Richard and Debbie share the belief that nature is better left alone, and that any intervention by humans compromises the naturalness of a forest system. While they are willing to adapt their policy of not intervening in the oak woodland in order to develop a path, they are not willing to go so far as to remove the hawthorns that are, arguably, a greater threat to oak woodland than human intervention.

Lynn Stohl also believes that nature is better off, and her forest is more natural, without human involvement in the forest.

> Forest management is planned human intervention in the forest pattern and I practice very little of it. My goal is that in 200 years it will be old growth. That's my management approach.

Lynn is promoting a Douglas-fir forest on her 19-acre property. In Lynn's view, there are too few trees in the world. The ideal state for any forest is late successional conifer forest, a state that she believes her forest will achieve if she leaves it alone. Lynn's property is located in a canyon, spanning the north slope, on which Douglas-fir might have grown historically, as well as the south slope, where oak woodland most likely grew. While it is debatable whether her forest was, or could ever be, the kind of old growth forest she envisions, Lynn clearly sees management as antithetical to a forest's ideal state of old growth. She sees no place for humans in a forest that is natural. Leaving her forest alone allows it to be as natural as it can be.

The forest owners' approaches to managing their forests reflect their views on their relationship to nature and their role in biodiversity. The "balancing act" to maintain some existing species and structures as they introduce new ones reflects a view that humans are a part of nature and that nature benefits from human intervention. The resignation to "let the forest win" or "leave it natural" reflects a view that not all natural processes should be controlled or denied, especially when they do not significantly impede progress toward management goals. Instead, humans should defer to nature, at least when it is convenient, and acknowledge that nature does better when left on its own.

4.2.3. Managing on the timescale of a forest

All the forest owners in my sample view their forests in a long-term timeframe (see Figure 6). Not only do they judge the impacts of their management practices in relation to the range of possible conditions their forests could assume over time, as explained in my discussion of temporal scale in the section on knowledge, but they set their management schedules according to the lifespan of a forest. They are willing to make investments in their forests, the rewards of which they will never see. I argue that the forest owners, with their knowledge of the temporal scale of biodiversity, realize that forests cannot be managed within the lifespan of a human. Instead, they believe they must look at things in terms of the lifespan of a forest.

Most of the forest owners emphasize that forestry is a long-term endeavor when describing their management approaches. When asked to define what he means by "proper management," Bud Parsons explains,

> It's a way that I have to plan carefully because it's not a short-term thing. You can't go out and imagine that tree there to be a hundred years old. It's a long-term basis, so it takes a lot of planning.

In Bud's forest, nature dictates the timeframe. Working within this timeframe, Bud takes care when making his decisions, since every mistake will take decades to correct. While industrial forest owners are doing what they can to grow trees faster and cut trees earlier in order to produce more wood from their lands, Bud takes a slower approach, one that he feels is more in tune with the patterns of growth of his forest.

Many of the forest owners are, like Bud, concerned about the long-term impacts of their management decisions. Richard Rounds and his wife, Debbie, also view their forest on its own temporal terms. When asked about his approach to management, Richard explains that one of his main concerns about his decisions is:

> What are the long-term ramifications of it? We bought the property when we were about 50 and quite likely the most we'll be here is 40 years and it's been here a long, long time. We're a little blip on the time scale and so we'd like to have whatever we do make sense for the long term for the good of things.

With the knowledge that their lifespan is just part of a forest's lifespan, they try to view their management decisions on the forest's terms. For this reason, they choose to set aside their own financial wants and not to convert their 14 acres to Douglas-fir, instead leaving it as oak woodland.

Most of the forest owners acknowledge that they will never benefit directly from the efforts they are making to manage their forests. Dale Hallard makes this clear when asked about his planned schedule for thinning and harvesting, "Anybody that's into timber knows that it's a long process. Like I say, I'll probably never see anything harvested around here. I may live long enough to see it thinned."

Kyle Johnson makes a similar comment when asked why he is thinning his forests to promote the growth of large diameter trees at the same time that he complains of there being no market for big trees, "Well, actually, I don't really look at it that way. I don't know that I will actually ever cut this. This will probably be here for the kids."

Kyle and Dale express an idea that perplexed us in my research. Why do the forest owners dedicate time and energy to their forests with the knowledge that they will never directly benefit financially? The owners suggest that they are investing for the benefit of their offspring. But why choose forestry, which requires much labor and follows a long return cycle, as opposed to other investments, such as stocks and bonds? Clearly, they enjoy forestry as a hobby, and appreciate other benefits forests provide, such as views, recreational opportunities and wildlife habitat. But there must be something else in forestry that makes it worth their while to plan their investments beyond the terms of their own lives and along the terms of the life of a tree.

Asked why he is able to make decisions that will yield benefits primarily to the next generation, Dale Hollis suggests that growing up in a family that has lived on the land for generations helped him see things with a long-term perspective. In his view, this perspective differentiates him and other land-based people from the general public.

> I wonder if that isn't why it's harder for the general public to relate to forestry, because it's a long-term type thing. You're going to do things that you won't see the result of in your day and that's awkward for people. They want to see something right now but that's not the way it happens with trees....If you haven't seen it, you've heard it, you've heard your parents or grandparents describe what it was, or you've seen where they've logged and now it's a beautiful forest again.

The forest owners' long-term perspective enables them to think about the future ramifications of their decisions. It also enables them to make management plans that extend beyond their own lifespan and into that of the next generation. This temporal scale may be what enables them to consider the range of variability in forest conditions that I mentioned earlier. It also may enable them to consider the effects of their management on various stages of species composition and structural conditions that make up biodiversity. I argue that the family forest owners are able to look beyond their own life-spans, at least when it is convenient, to consider the effects of their actions in terms of the timeframe that nature follows. At other times, economic constraints may impose more immediate concerns. In this way they live their lives on multiple timescales, and they manage their forests on the temporal terms of biodiversity.

4.2.4. Discussion: Beliefs that humans are part of nature

The family forest owners in my sample generally see themselves as part of their forest systems, at least in some management contexts. They see a role for themselves in assembling species compositions and structural conditions, mediating relationships between species, structures and forest functions, and setting aside some areas as reserve zones where they do not make any management interventions. The owners see a place for themselves in their forests, and feel that their forests are better off because of their physical presence and intensive management approach. Furthermore, the forest owners design the timeframes of their management plans along the lifespan of a forest. They consider their management actions in terms of a forest's life, not just their own. These perceptions reveal an underlying recognition by the forest owners that they are part of a larger system with multiple temporal scales.

In their perceptions of the close relationship between humans and nature, that humans are indeed a part of nature, the forest owners exhibit awareness of and consideration for the underlying elements of biodiversity. They perceive their forests to be not just the stand of trees that they see before them, but an ever-changing assemblage of different species and structures that assume different compositions and conditions over time. They do not see management as an interruption to the course that forests follow in their evolution, but as a helpful, guiding force. They see a role for themselves in species diversity and structural diversity, in biodiversity itself. This perspective may be very different than that of conservation biologists and other supporters of the biodiversity concept, whose interests in biodiversity stem from concern over disappearing species and the belief that every species is indispensable. Such perspectives often justify reserve strategies for conservation, which limit human intervention for the good of biodiversity. With the perspective that biodiversity is something to be managed intensively, not something to be set aside, the family forest owners in my sample may be amenable to conserving biodiversity on their properties.

4.3. Economic Realities

Regardless of what the family forest owners know about biodiversity and believe about their relationship to it, the realities of the market may constrain the extent to which they can implement their knowledge and beliefs in management. As I stated in the introduction to this section, the forest owners' conceptions of biodiversity may be, in part, a reflection of their biophysical and socio-economic environment, or what is possible in this environment. The forest owners in my sample indicate that the demands of the market influence their choices about species compositions and structural conditions. Their efforts to define themselves and their management approaches in contrast to those of industrial forestry signify that they are subject to these influences. This subsection addresses the underlying socio-economic forces that are at work in the meanings that the forest owners give to biodiversity. Understanding external constraints, such as market forces, on the owners' management practices may help explain some of the contradictions that one might see between what the owners say they know and appreciate about biodiversity and what they actually do on their lands.

4.3.1. Market constraints

Many of the forest owners explain, with regret, that the market is increasingly dictating the terms of their management practices (see Figure 6). The preferences of the industrial timber companies and the wider market are determining the species that they grow and the times at which they harvest. At times they even blame the timber market for undermining their ability to manage the in the ways they want.

Like the other forest owners, Bud takes pride in his ability to manage his forest in a way that is appropriate for the conditions of the land. He explains the long-term nature of forestry and the need for the patience to wait for a tree to grow to maturity, which may take 100 years, more than a lifetime. Yet he admits that he feels conflict between his management ideals and making a living. According to Bud,

> The hard decisions are the need for money, because you don't want to cut the trees, you really hate to do that. I don't care who you are, you like looking at the big, old trees. You don't want to let that tree get so big that it's no good any more, but you don't want to cut it unless you have to, but sometimes the old world dictates what you have to do.

In an ideal world, Bud wouldn't cut his trees. In a more realistic world, he would let them grow until maturity and cut them before rot starts developing in the wood. In the world of the current timber sector, he cuts his trees before their time, before he feels it is necessary. He attributes his dilemma to the diminishing returns on large logs. This trend that may be due to increasing substitution by steel and engineered wood products, which do not require large logs, as well as the market's anticipation of reduced availability of large logs (Wagner et al., 2003; Størdal and Adams, In progress). The market economy imposes limits on what he can do to manage along the timeframe of a forest.

Dale Hollis makes a similar observation about the compromises he must make to stay afloat in the timber business. He acknowledges how the market constrains forest owners' management approaches. From Dale's description of what makes a healthy forest and good management, one would expect to see a forest of multiple species and age classes, as close in appearance to what one would find in a nature preserve as possible. Yet on the north slopes of his property, beyond the view from his house, Dale is managing even-aged stands of Douglas-fir, plantation-style. While Dale would rather manage a forest of mixed species and ages, he believes that he must generate some income by growing Douglas-fir, a species that cannot regenerate well in a mixed forest because it requires full sun.

> You have to log to generate income to live on, but you don't like to. It's not something you take joy in seeing, the change, so that makes you do things a little differently. You can't go in and plant Douglas-fir in the shade of all these huge giants, it won't grow. So then you're faced with clearcutting. You may have selective logged this year but maybe 30 years down the road or 40 years you're going to need to either selective log once more or if you want new trees you're going to have to clearcut and plant, especially on the north slopes because you can't get enough sun for the trees to grow.

While Dale expresses knowledge and appreciation for species and structural diversity, he does not stay true to his beliefs about biodiversity in his management practices across his entire ownership. Does such inconsistency compromise the integrity of the forest owners' beliefs? Or does it reveal the world of complex, opposing forces in which they live and attempt to manage as best they can? I argue that Dale, like the other forest owners, do exhibit dissonance in the relationship between their beliefs and behaviors. The external pressure that timber markets impose may help to explain this dissonance.

4.3.2. Identity politics

Many of the forest owners specifically distinguish their management objectives and values from those of the industrial forest owners that dominate the timber market (see Figure 6). It is as if they define what they are by what they are not. Dan Garvey emphasizes the difference in the ways he views biodiversity and his family treats hardwoods compared to the industrial timber company that had a contract to harvest some of his timber when he and his wife inherited their property. The timber company wanted to clearcut the land, but Dan and his family wanted to keep the hardwoods in tact for wildlife, specifically birdlife.

> We were happy to see all the use those things got...all the white oaks and all the madrone and all the maple...I left as many as I could, even if I got chided a little bit by the loggers, telling us I should cut those down, 'they're gonna die' and all that. I said, 'OK, fine, then they'll die'...Under their own contracts...clearcut means level to the ground everywhere, but if you say 'don't take the hardwoods,' it makes it kind of a problem because they have to fall them a bit differently. But it was a weak argument to use. We are just small landowners. How much did I sacrifice in 60 years because there is this maple tree taking a little bit of room?

Dan recognizes why industrial forest owners cut the hardwoods when harvesting Douglas-fir, in order to make the process more efficient. He also realizes that if he and his family were to grow a Douglas-fir plantation, the hardwoods might eventually die for lack of light. Yet Dan has different priorities for his forest than industrial forest owners. Like most of the family forest owners in my sample, Dan isn't driven by growing as much Douglas-fir as possible as fast as possible. He doesn't intend to grow a densely stocked plantation. Instead, he plans to grow a forest, for which the planting of fewer Douglas-fir to allow for other species, in his view, is a very small sacrifice. Dan's story reveals the pressure that he and other forest owners feel to manage their forests in ways that are contradictory to their knowledge and beliefs about biodiversity. As a result, the owners assert the aspects of their identity that they feel are unique, specifically their holistic approach to forestry, to distinguish themselves from an identity with which they do not want to be associated.

Bud Parsons articulates how his tailored approach, while better for the land, marginalizes him in the marketplace. He laments how the scale of his operation is not as economical as it needs to be in order to compete with the large forest management operations, which he terms "the big people."

> The thing about the big people is that the bigger they are, they can harvest that timber so much cheaper than I can. They run the little guy out. I have the versatility to go in and manage the small guys they don't want to mess with. Yes, it's more expensive for me to do it. It's a matter of being able to be there when the people want and do it. The big people can't and the little people don't want them there because they're just in there to get in and get out. I won't say they're not there to take care of the property but they don't have the time to take care of it like the people want. Every old logger, of course, wants the big bucks and wants the big harvest. But the small guy is where you get into the managing part of it rather than the timber harvesting.

Bud makes it clear that he chooses to manage his property differently from the industrial model because the land, which he values for reasons besides timber, deserves better. In fact, he argues that is it precisely because he is not managing according to the industrial model, that he can tailor his practices to the needs of the land. He generalizes family forest owners as valuing a kind of intensive, site-specific approach to management. Yet he suggests that his decision to follow this approach makes him less competitive.

Dale Hallard criticizes the industrial model more directly for not taking the health of the forest into account. He paints a negative picture of industrial forestry as greedily growing tree after tree with no concern for wildlife habitat or other forest functions. His describes an increasingly high-yield agricultural model of forestry against which family forest owners must compete.

> Weyerhaeuser plantations are ruining a lot of country because it's just like field after field after field of corn with nothing in it. Before, Weyerhaeuser would take a few trees here and replant there. What I'm talking about is selective logging. Now they cut it down and replant...Sure it's producing lots of timber, but not in the way that I like. In eastern Oregon, Weyerhaeuser has mile and mile of these plantations and there's no feed at all for the animals in these plantations. They've got more timber than you can imagine. They're doing it all wrong. You should be taking small patches and doing it so that it isn't all the same age.

Dale depicts the typical industrial timber plantation as a field of trees, not a forest. According to Dale, in such plantations trees are planted so close together that brush, which wildlife need for shelter and forage, cannot grow. In portraying industrial forestry is such a negative light, Dale distinguishes his own practices from those that do not take biodiversity into account.

John Schultz comments specifically about the practice of growing trees on shorter rotations, which he disapproves of because of their effects on wildlife, "There's much more frequent entry. Their 35-40 year rotation...is just too short. It's just a little harder on the land." Due to various shifts in timber markets and processing technologies, consumers no longer pay premiums on large logs from older trees. As a result, industrial forest owners are reducing the harvest age from around 80 years to around 40 years. This practice not only limits the time that forest systems have to re-establish themselves but it also increases the frequency at which land owners harvest, pile slash, burn and prepare sites for the next generation of trees (Wagner et al., 2003). While John takes an intensive approach to forestry, and sees management intervention as compatible with forest health, he believes there is a limit to this intervention. Entering the forest for such invasive activities as harvesting and site preparation more than once every 60 to 100 years compromises the forest system. In John's view, the fewer entries, the better. Rotation age is something that distinguishes family forest owners from industrial owners. Historically, this is true. Yet, current trend data show that family forest owners are managing along shorter and shorter rotations (Lettman, personal communication, January 30, 2002; Wagner et al., 2003).

Almost all the forest owners mention the pressure they feel they are under to grow trees on shorter rotations. When asked why he planned to harvest his trees at 40 years of age, Dale Hallard explains,

> It's not very effective [to grow older trees]. It costs more to log than you get out of them. Now they're penalizing us for large logs. The mills are all set up for their laser crews and can only take a certain diameter. That's because they shut down all these small mills, they only want small logs, they don't want anything bigger than these. There's nobody that wants to cut them. [The landowners are] harvesting not by what they would have normally done, but what the market demands.

Kyle Johnson also attributes his harvest decisions to the market. He and his family decided to convert some of their mature stands of Douglas-fir to young trees so they could have a chance at harvesting them when they're younger and more valuable. Kyle admits that he and his family have already logged earlier than they wanted to and used the harvest technique of clear-cutting instead of selectively logging, which they prefer. Still, he attempts to minimize the significance of his decisions.

> The only clearcuts I've done has been this one, and that one down below, and the one over here, and that one over there. Like I said, I had some really big trees and there really wasn't a lot of market. I mean they were really nice trees but you're not getting money for bigger trees these days. And you might as well cut them and replant. I didn't take them all out. I just took a pocket.

Some forest owners describe the pressure they are under to adopt plantation practices as insidious and pervasive. The Rounds decline invitations to join family forest interest groups such as the Oregon Small Woodlands Association (OSWA) because they think these groups, with their focus on

Douglas-fir monocultural plantations, are beholden to the timber industry. The Hartens claim that they have to defend their forest practices when extension workers and program agents come to review their management plans.

> Well, the first thing that comes to my mind when the state forestry guy comes out here and wants to know what my objective is, I always try to tell him that we're not looking for maximum productivity or a certain number of year turn around, that we're trying to reestablish a healthy forest.

In order to qualify the Hartens for reforestation assistance, they say forestry field agents encourage them to clear away minimum amounts of brush and increase their seedling counts to 400 trees per acre. In essence, they direct the Hartens toward plantation forestry.

4.3.3. Discussion

Wider market forces may explain some of the contradictions in family forest owners' knowledge and beliefs about biodiversity and their management practices. While the forest owners in my sample express knowledge and appreciation for mixed forests and active, adaptive management, they function within an increasingly competitive market that does not value diversity, and even seems to be devaluing large trees. The forest owners compromise their beliefs about biodiversity and their management ideals in order to survive in a market that is dominated by industrial, plantation-style forestry. Even the Hartens, who claim to prioritize restoration of forest health, plant dense designs of cedar and other conifer seedlings that will eventually shade out the remaining oaks on their land. Whether their actions are the result of external market forces, or ignorance of locally characteristic forest health conditions, it is clear that they feel pressure to conform to a conifer plantation model. The influence of the socio-economic environment is evident in the family forest owners' reflections on their management decisions regarding species choice, rotation age and harvest technique. The pressure that the forest owners feel they are under to adapt to this environment is clear in their persistent assertions of their identities. They assert their identity by contrasting it with that of industrial forestry.

5. Conclusion

In this research, I approach the challenge of conserving the at-risk Oregon white oak ecotype, much of which occurs on family forestlands, by understanding how and why family forest owners view and treat biodiversity on their lands. I strive to understand how family forest owners conceptualize biodiversity: their knowledge, beliefs and the motivations behind their behaviors. In doing so, I analyze the potential for encouraging family forest owners to conserve the biodiversity of the oak woodland.

Environmental sociologists argue that the social and biophysical worlds are connected, that each world informs, without actually determining, the other. Social constructionists suggest that in order to understand why people act in the world in the ways that they do, we must understand the meanings that they give to things. Theories from social psychology and policy studies complement this constructionist message. These theories argue that in order to understand and influence behavior, we must understand the forces behind their behavior: their beliefs and motivations. In order to tailor policies to specific populations, we must analyze and verify the social constructions upon which we base policy. Furthermore, we must look beyond apparent contradictions in what people say and do, and analyze the source of the cognitive dissonance that people come to accept.

My study makes several contributions to the fields of biodiversity conservation and environmental sociology. It illuminates the meanings that people attribute to biodiversity and the implications of these meanings for conservation policy. It also offers a unique methodological framework for the study of human-environment interactions. Finally, it suggests questions and topics for further research in the area of human-environment interactions and conservation policy.

5.1. Meanings of biodiversity

This research reveals that the family forest owners in my sample are knowledgeable of the main elements of biodiversity. They recognize and value species diversity, structural diversity and the multiple temporal scales of forest systems. Yet, while they are aware that they live in an area that was historically oak woodland, they do not focus their management practices on this ecotype. Instead, they promote mixtures of hardwoods and conifers, primarily Douglas-fir, revealing their interest in biodiversity *per se*. They maintain these mixtures mostly in younger age classes and homogenous structural conditions, and sometimes they harvest them using the very even-aged techniques of which they disapprove.

Conservation biologists might contest my treatment of the forest owners' knowledge as true to biodiversity, accusing me of appropriating and pauperizing the term. I approach the idea of biodiversity as complex, contested and politicized, similar to Tacaks' analysis of conservation biology's construction of biodiversity.

> The term biodiversity is a tool for a zealous defense of a particular social construction of nature that recognizes, analyzes, and rues this furious destruction of life on Earth. When they deploy the term, biologists aim to change science, conservation, cultural habits, human values, my idea about nature, and, ultimately nature itself…Their factual, political, emotional, aesthetic, ethical, and spiritual feelings about the natural world are embodied in the concept of biodiversity; so packaged, biodiversity is used to shape public perceptions of, feelings about, and actions toward that world…By altering my mental configurations of nature, biologists seek to alter the geographical configuration of nature (1995: 1-2).

While the forest owners in my sample do not openly rue "the furious destruction of life on Earth," they are concerned about the loss of species and habitat. And they do address what conservation biologists have identified as the main components of biodiversity. The meanings that the forest owners give to biodiversity reflect other aspects of their lives that may or may not resonate with conservation biologists. Their interpretations of biodiversity are contingent on the traditions they carry on as people who make a living on the land. They manage their forests for multiple objectives including timber, habitat and recreation. The meanings that they attribute to biodiversity must be compatible with the context of their lives.

Understanding the meanings that family forest owners give to biodiversity and how they are different from the meanings that other groups of people use can shed light on the challenges and opportunities that our society faces in conserving our environment. This constructionist approach has its roots in post-modern social theory. For example, cultural reflexivity theory (Bourdieu, 1992) proposes that the ideological presuppositions of a society determine, in part, the interpretation and understanding that can be achieved by that society. In the case of biodiversity, a society's view on the essence of nature – the extent to which components of natural system are indispensable – and the role of humans in relation to nature, all determine society's willingness to define biodiversity as something of which humans are or are not a part.

A risk inherent to the social constructionist approach is that, in focusing so much on how people construct the meaning of biodiversity, we deny the concept of biodiversity of having any basis in reality. This concern about constructionism stems from Douglas and Wildavsky's Risk and Culture (1982), which portrays environmental problems as manufactured by sect-like environmentalists (Hannigan, 2002). For example, the family forest owners in my sample rationalize the ways they change their lands away from original conditions with the knowledge that change is inherent to forest ecosystems. Critics of constructionism warn against deconstructing the concept of biodiversity. "Loose talk about all change being 'natural,' while true, is meaningless. We must pick and choose, consistent with ethical reasoning. We cannot know which changes are vital and which are deadly" (Worster, 1995). "The idea that all changes are equivalent, that the loss of virginity is absolute, is a dangerous oversimplification" (Soulé, 1995).

I deal with concern about constructionist's exemptionalist tendencies by paying special attention to the multiple forms of knowledge and belief about biodiversity, the interactions between people's knowledge and beliefs, and the positions or context from which they approach biodiversity. Furthermore, I refer to biophysical context as an additional vantage point for analyzing the forest owners' conceptions. I do not attempt to discount the validity of the biodiversity concept by illustrating how family forest owners conceptualize it. Instead, I try to understand the circumstances and positions from which they interact with the world, including the natural world on their land. I recognize that social and biophysical worlds interact, and that both must be acknowledged and understood.

Diverse social, natural and ideological strands go into the making of knowledge that, in turn, influence the choices that people make (Taylor, 1992). "The processes by which society develops reality, knowledge and meaning can be observed in the connections between the micro-realities of such social groups as family, friends, co-workers, and the macro-realities of our social institutions, including government, economy, education" (Berger and Luckmann, 1966). I attempt to understand biodiversity and its conservation opportunities primarily by studying the connections between the "micro-realities" of family forest owners. In addition, I interpret the connections between the "micro-realities" and "macro-realities" that might affect understandings of biodiversity and conservation opportunities, including the economy and the environment. I study, in detail, what the forest owners say about biodiversity and how they manage their lands. Then I trace their knowledge and beliefs to the wider system of beliefs about human relationships with nature and land tenure, and the external constraints imposed by the timber sector.

In these connections, I see how the family forest owners construct the meanings that they attribute to biodiversity and the beliefs and values that influence these meanings. These meanings reveal the parameters within which they live and manage. I see evidence of the forest owners' reactions to larger forces; evidence of the land tenure system in their spatial perspectives, evidence of increasing environmental regulation in their choices to retain or eliminate certain habitat elements, evidence of the importance that the region places on Douglas-fir in their beliefs about ideal forest conditions, and evidence of the economy's preference for small diameter Douglas-fir logs in their choices about species and structural conditions. With this information, I can proceed with designing and analyzing policies with consideration of their appropriateness for the landownership groups that they target.

5.2. Policy Implications

Understanding how family forest owners and other landowners conceptualize biodiversity has important policy implications. Policies and programs rely on social constructions and assumptions about the behavioral motivations of the groups they target. In order for biodiversity conservation efforts to be successful, the social constructions and behavioral assumptions upon which they rely must be accurate (Schneider and Ingram, 1990 and 1992). Knowledge about people's beliefs and behavioral intentions is essential for predicting and influencing their behavior (Azjen and Fishbein, 1980). In order to encourage and reward landowners for conservation, policy-makers and planners need information on the ownership group's knowledge and beliefs.

Information about landowners' conceptions about biodiversity can also enlighten stakeholders such as conservation biologists, agency field staff and policy-makers and planners about possibilities for conservation of important ecotypes. It can provide them with the context and empathy for effectively reaching out to a crucial group such as family forest owners; how to design programs appropriately for an ownership group based on what the group already knows and what already motivates its members. Comparative information about these stakeholders' conceptions of biodiversity may also play a role in identifying information gaps and resolving potential conflicts.

While I find that the family forest owners in my sample have a basis of knowledge as well as a set of beliefs and values that are relevant for biodiversity conservation, significant differences may exist in the ways forest owners and other stakeholders conceptualize biodiversity. The differences have the potential to alienate forest owners from the very land ethic that they hold dear. A July 2003 newsletter of the Oregon Small Woodland Association (OSWA), an interest group for family forestland owners, exemplifies this risk. In the issue, the Secretary of the Baker County chapter of OSWA, Carmelita Holland, writes a diatribe on environmental terrorists who, among other things, "bring pressure on the Board of Forestry to incorporate such terms as 'Biodiversity' and 'Ecosystem Management' into any timber management program." Ms. Holland claims that that such "terminology, as it is being interpreted, is the preservationist's dream." While she acknowledges that terms are interpreted, she associates "biodiversity" with an agenda by environmentalists to sabotage natural resource industries and private property rights. The politicization of language, fueled by more fundamental social conflicts, has the potential divide would-be partners, such as family forest owners and conservation biologists, in efforts to conserve at-risk ecotypes. For this reason, it is important to recognize, understand and resolve differences in the ways that stakeholders conceptualize biodiversity.

The forest owners' hold knowledge and beliefs about the elements of biodiversity that are crucial for its conservation. They are interested in multiple species and age classes, the core of biodiversity management. They may be receptive to diversifying their species and structures. They are willing to integrate non-traditional species and structural conditions into their forest compositions. They may be willing to plant oak or thin competing conifers to release oaks. They manage intensively, tailoring their management actions to their land based on a detailed understanding of it, yet along long-term timeframes. They may be willing to develop and implement small-scale conservation plans independently. They plan according to the future of the forest and the needs of generations to come. They may be receptive to long-term management plans and conservation arrangements. Their multifaceted management approaches reveal that they are not motivated by timber income alone.

Furthermore, the forest owners seem to resent regulation and resist participation in forestry interest groups and programs. Only two of my forest owners had ever participated in a government program. Both of them received assistance for reforestation. When asked why they do not take advantage of government programs that offer technical and financial assistance, many explained that they like to maintain their privacy and autonomy, and dislike the paperwork that such programs involve. The owners in my sample may not be receptive to regulatory mechanisms or financial incentives for biodiversity conservation. They may not be interested in participating in formal programs.

The spatial context in which they view their forests reveals a focus on discrete ownerships, not other contexts such as watersheds or bioregions. They may not be inclined to participate in watershed programs or other community approaches to conservation.

While family forest owners conceptualize biodiversity in similar ways to the scientific literature, their conceptions are fundamentally different from those of conservation biologists. Conservation biologists have traditionally focused on large ecological reserves as strategies for conserving biodiversity (Lindenmayer and Franklin, 2002), an approach that reveals the belief that, in some cases, nature is better off without human intervention. While reserves are very important for conserving at-risk and rapidly disappearing ecotypes and species that are very sensitive to anthropogenic disturbances, they are not always practical. For the Oregon white oak ecotype, which is by and large found on private land, reserves are not viable. Furthermore, the owners of these lands, if my study has any merit, believe that their forests are better off because of their interventions.

In the case of oak woodland, where private landowners must implement or participate in conservation efforts if they are to occur at all, conservation biologists may benefit from understanding how landowners conceptualize biodiversity. Awareness of the landowners' existing knowledge and potential to integrate biodiversity conservation into their existing management approaches may be useful to conservation biologists. With this information, they can make recommendations to planners for incorporating and building on landowners' existing knowledge and practices.

In the Oregon white oak ecotype, active participation by landowners can be complementary to ecosystem health, because humans have historically maintained it with fire. By taking in account the wealth of human knowledge and capacity within an ecological system, conservation biologists may recognize the relevance of one of their very own tenants to conservation, that biodiversity is dependent on scale; biodiversity can have multiple meanings and applications depending on the context. In private, managed landscapes, biodiversity must be negotiated within the context of the landowners' multiple objectives and rich, multifaceted knowledge and belief systems.

Field workers from wildlife, conservation and planning agencies may also benefit from understanding family forest owners' knowledge and beliefs about biodiversity and the external constraints on their management choices. Like conservation biologists, they will be better able to tailor their outreach efforts to landowners if they understand the landowners' points of view. For example, the department of forestry field agents, described in section 4.3.2, could have better assisted the Hartens in achieving their goal of restoring forest health if they had recognized the difference in how the Hartens and Department of Forestry personnel conceptualize forest health. Instead of assuming that all forest owners share the same timber production goals and advising the Hartens on seedling species and densities, they could have helped the Hartens understand potential indicators of forest health for their area. In this way, they could have directed the Hartens toward oak restoration instead of conifer plantation guidelines. Field staff must be aware of the multitude of potential objectives and definitions that landowners have for ecological conditions. They should be able to tap landowners' interests in conservation and restoration.

Finally, understanding how landowners such as family forest owners conceptualize biodiversity can help policy-makers and planners design programs that harness people's existing knowledge, values and motivations. For example, should a program harness the existing motivations of a target group through education, encourage conservation through financial incentives, enforce conservation through regulatory measures, or promote conservation through hortatory or symbolic encouragement (Schneider and Ingram, 1990)? With this information they can identify when landowners need education and information about how to tailor conservation to specific ecosystems such as oak woodland. Few biodiversity conservation policies and programs engage family forest owners, (Best and Wayburne, 2001) and even fewer address oak woodland's decline (Huntsinger and Fortmann, 1990.) The public policies and programs that do serve family forest owners promote reforestation, forest stocking, water quality and game fish and wildlife (Best and Wayburn, 2001; Sampson and DeCoster, 1997). Common policy mechanisms include financial incentives, recognition awards and educational opportunities. In focusing on such tangible pay-offs, they make assumptions about human behavior, as I described in the literature review section (Schneider and Ingram, 1990).

For family forest owners in the Oregon white oak ecotype of Benton County, I find an interest in and capacity for engaging in biodiversity conservation, which could be harnessed for the conservation of oak woodland with the right policy measures. At the same time, I caution that policy-makers and planners must be aware of the wider external constraints, such as market pressures from industrial timber sector, with which family forest owners must contend. Without intervention, these constraints may influence forest owners to homogenize their practices, potentially compromising species and structural diversity and their tailor-made ways that make them suitable as managers of biodiversity.

5.3. Methodology

While other studies have taken a constructionist approach to biodiversity (Takacs, 1996; Yearley, 2002) none have integrated social and natural science methods. The research techniques that I use in this study are in their early stage of development, having been applied to one small sample. However, the richness of the findings indicates that the combined methods of concept mapping, interviewing, property mapping and field reconnaissance demonstrate potential.

Traditional tools such as surveys and attitudinal studies do not adequately help us understand why people think and act as they do (Mishler, 1994; Gilbert and Mulkay, 1984) particularly in relation to complex and ill-defined natural resource concepts such as biodiversity. Given the politicized nature of such conservation biology terms including "unique species," "conservation" and "biodiversity" itself, and the forest owners' sensitivity to these terms, it is unlikely that surveys or attitudinal studies would have been able to evoke straightforward answers about their knowledge and views on biodiversity.

My approach of combining concept mapping with in-depth interviewing allows us to understand not only what people say on a surface level, but also the underlying contextual meanings. Open-ended interviews are useful for studying the meaning of certain phenomena to the participants and the motivations that underlie a person's actions (Robson, 2002). Combined with concept mapping, interviews reveal the context of and influences on peoples' conceptions of complex phenomena such as biodiversity (Kearney and Kaplan, 1997). Property mapping and field reconnaissance allow the researcher to further enrich those meanings with information about behavior (Schauman, 2000).

5.4. Limitations and opportunities for Further Research

In this final section, I review my efforts and their limitations and outline an agenda for future research (see Figure 7). The main limitation of my research, as well as one of its most interesting attributes, is my treatment of biodiversity. At the same time that I attempt to understand how the family forest owners conceptualize the controversial idea of biodiversity, I avoid using the term itself. As a result, none of the owners use the term "biodiversity" and few explicitly address the concept. This approach leaves me with no choice but to infer whether what the owners say is relevant to biodiversity. In other words, I deconstruct what they say about their forests and then re-construct their ideas into "biodiversity" concepts.

How can I be sure that what they are really talking about is biodiversity? In my opinion, this is impossible, and irrelevant, because I do not identify an objective standard against which to compare the owners' ideas about biodiversity. Instead, I treat the owners' views on biodiversity as one of many subjective meanings that people give to the term depending on the context. By separating out the strands of the owners' statements that relate to commonly-accepted categories of biodiversity meanings (species diversity, structural diversity and scale), I can demonstrate how they talk about and treat biodiversity in their everyday lives. It is my hope that this iterative, subjective process

Figure 7. Proposed Research Agenda.

1. How can biophysical data be better used to enrich understandings of peoples' conceptions of and relationships with the environment?
    a. *Enrich data on conceptions and management approaches.*
        i. Build biophysical component into interpretations of social data.
        ii. Incorporate participatory elements in biophysical data collection.
    b. *Quantify evidence of conceptions and management in biophysical conditions.*
        i. Incorporate classification method for silvicultural practices.
        ii. Incorporate classification method for composition, structure and function.
        iii. Incorporate ecotype-associated species inventory.
2. How can data on conceptions and management approaches be used to test the social constructions and assumptions about human behavior and motivations upon which policies are built?
    a. *Analyze policies for the validity of their assumptions.*
        i. Isolate assumptions of conservation policies and programs.
        ii. Compare assumptions against my data.
    b. *Understand how family forest owners and policy makers view biodiversity management practices and policies.*
        i. Incorporate questions about practices and policies in interview protocol.
        ii. Conduct tours for family forest owners and policy makers to biodiversity demonstration sites.
        iii. Conduct focus groups with family forest owners and policy makers.
    c. *Make recommendations for refining and reforming existing policy and informing future policy.*

provides insight into the rich and complex meanings about the natural world upon which people operate as they manage their lands.

When I began my research, my goals were to understand:

1. How family forest owners conceptualize biodiversity,
2. How their conceptions influence and are reflected in the biophysical landscape of their forests, and
3. The implications of my findings for oak woodland conservation policy.

I made progress toward these goals, despite some limitations that I will explain.

My first objective was to document how family forest owners conceptualize biodiversity. I pursued the following questions:

1.1. What do family forest owners know and believe about biodiversity?

1.2. How do family forest owners describe the role of biodiversity in their forestry practices and objectives?

1.3. Are family forest owners' conceptions of biodiversity influenced by information about and interactions with biodiversity?

1.4. Do family forest owners' views on biodiversity differ depending on ownership context?

1.5. What constrains family forest owners' interest in and efforts to promote biodiversity through management?

Concept mapping and in-depth interviewing allowed me to uncover detailed information about the family forest owners' knowledge and beliefs about biodiversity (question 1.1). I was able to obtain rich descriptions of the role of biodiversity in their forestry practices and objectives (1.2). I found that by not using the contentious term "biodiversity", I was able to unearth the most valid information about the forest owners' conceptions of biodiversity – the information that they volunteered, using their own terms and rationales, and in their own contexts. I also was able to identify some of the factors that constrained and piqued their interest in management for biodiversity (1.5).

I did not pursue question 1.3., as planned, through the used of a participatory biodiversity inventory with the forest owner. I decided against introducing information about biodiversity that would interfere with the forest owners' abilities to articulate their views on their forests in a straightforward manner. I realized immediately upon beginning my interviews the degree to which biodiversity would be associated with other politicized environmental terms. The influence of information about and interaction with biodiversity might be better examined through a pre-test\post-test design in the context of a different research proposal, for example, a study of the influence of introduced knowledge on attitudes and beliefs. Finally, I did not reach any conclusions about the association between ownership context and conceptions of biodiversity. My sample, which was not designed for statistical analysis, did not reveal any patterns between ownership size and conceptions of biodiversity. Also, because my ownerships are all located in the same general area, I did not look for any associations between ownership location and conceptions of biodiversity.

My second objective was to explore relationships between family forest owners' conceptions of biodiversity and actual biodiversity conditions. I pursued the following questions:

2.1. What conditions for biodiversity, including such biophysical characteristics as plant species composition and forest habitat structures, can be identified on family forest ownerships?
2.2. What general management practices can be identified on family forest ownerships?
2.3. How do the conditions for biodiversity on family forestlands relate to family forest owners' knowledge and beliefs regarding biodiversity?
2.4. How do family forest owners' conceptions translate into on-the-ground practices?

My method of referring to aerial photos, maps and sites around the ownerships during the interviews enabled me to identify biophysical characteristics of biodiversity on the ownerships. I could compare what people said about their knowledge, beliefs and management practices to actual forest conditions. I was able to better understand what people mean by the concepts they used in the interviews, such as "a mixed forest" and "wildlife habitat," because I had on-the-ground examples to refer to. Recording biophysical information about the properties also allowed me to compare the forest owners' ideas and examples of biodiversity with the scientific literature on biodiversity in the Oregon white oak ecotype. In this way, I was able to address all three questions under objective two.

However, two things limited my results from objective two: the practical difficulty of recording detailed biophysical data while conducting an interview and the theoretical difficulty of inventorying biodiversity. Originally, I hoped to collect detailed data, with the help of the forest owners, about species composition, stand structure and oak woodland biodiversity indicators. I decided this task would be too time-consuming and distracting during the interviews. In addition, my review of the literature revealed much controversy about the usefulness of biodiversity indicators and methods for characterizing biodiversity. I decided that characterizing biodiversity in any rigorous, quantifiable way was beyond the scope of my research at this point. Instead, I recorded general, descriptive information about the forest conditions that I encountered for the purpose of enhancing my understandings of the forest owners' conceptions. A future agenda for this research should include a protocol for recording data on key forest species and structures for the purpose of generating quantifiable data on management practices and oak woodland biodiversity on family forest ownerships. I believe that this information could be useful in demonstrating the extent to which forest owners imprint their conceptions of biodiversity onto their lands through management.

My third and fourth objectives address the policy implications of my research. While I considered these objectives during this study, I decided to pursue them more formally as part of a future research agenda at the Ph.D. level.

Objective three, which remains largely unstudied, is to understand how family forest owners view biodiversity management practices and policies through the following questions:

3.1. What kinds of biodiversity management practices do family forest owners find to be acceptable?

3.2. What influences family forest owners' views on the acceptability of management practices?

3.3. What constraints and incentives affect family forest owner willingness to implement biodiversity management practices on their properties?

3.4. What kinds of policies or programs do family forest owners view as potentially most useful for promoting biodiversity management practices on their lands?

3.5. What constraints and incentives affect family forest owners' responses to biodiversity conservation policies?

Answering questions 3.1 – 3.5 entails exposing the forest owners to demonstration sites of biodiversity management practices, assessing their processes for judging acceptability of these practices, and analyzing data from focus groups in which the forest owners discuss practices, programs and policies regarding biodiversity. I feel that it would be very useful to obtain detailed, qualitative information about forest owners' views on biodiversity conservation practices and policies. However, it may be challenging to identify demonstration sites of biodiversity management especially in the Oregon white oak ecotype. While there are several oak woodland restoration projects in the area, these sites do not show practices that integrate oak woodland restoration with the management practices for timber production that many family forest owners favor.

Objective 4 is to evaluate the appropriateness of biodiversity conservation policy for family forest owners. I pose the following questions:

4.1. What aspects of family forest owner knowledge, beliefs and behavior regarding biodiversity might be factors in the effectiveness of policy?
4.2. What constraints and incentives for family forest owners to manage biodiversity might be factors in the effectiveness of policy?
4.3. Based on the findings about family forest owner knowledge, beliefs and behavior regarding biodiversity, what policy tools might affect biodiversity management on family forests?
4.4. Based on the findings about how family forest owners determine the acceptability of management practices and policies, what policy tools might be most effective for encouraging biodiversity management on family forests?

With the kinds of information about family forest owners' conceptions of biodiversity that I found in my research, I am poised to address question 4.1 – 4.3. From the forest owners' knowledge, belief systems and time-frames for management, I could infer, to some degree, the appropriateness of different conservation practices and policies, as discussed in the subsection on policy implications (5.2). Further interviews and focus groups could help us better understand their views on policy. Enlarging the sample size by interviewing or surveying more forest owners from different areas could enable us to make statistical inferences to the population of forest owners in the Oregon white oak ecotype. A comprehensive assessment and analysis of existing and proposed conservation policies would allow us to apply my findings on forest owners' conceptions of biodiversity and views on biodiversity policies and practices to policy recommendations.

In conclusion, my research provides a rich, multifaceted picture of family forest owners' conceptions of biodiversity in the Oregon white oak ecotype, their knowledge, beliefs and management behavior. However, the potential remains to make this research more relevant to environmental sociology's core postulate, that the social and biophysical worlds are connected, and to the argument within policy studies that social constructions and assumptions must be analyzed.

The next steps for this study are to expand the sample and refine the data collection tools. I plan to expand the sample to include family forest owners in other areas in Western Oregon where oak woodland is present. Including additional study areas within the Oregon white oak ecotype will help to eliminate the influence of unique cultural, political and economic characteristics of the Benton county sample while keeping the natural resource characteristics somewhat the same. I also intend to improve my data collection tools by refining my field reconnaissance protocol for comparing and linking mental and physical information about biodiversity.

The protocol will include aerial photo interpretation for gathering course-grain information on the compositional and structural aspects of the forests. The protocol will also include an oak woodland-specific inventory method for collecting fine-grain information on forest practices and characteristics. I will collect data categorically for statistical analysis on oak number, diameter, crown quality and stand density as well as key oak woodland-associated species. The biophysical information collected through the field reconnaissance protocol will be useful for assessing the extent to which landowners are managing for quality oak woodland habitat. It will provide a reference for what people say about biodiversity and a physical reflection of what they mean, ultimately helping to provide more insight into the mental and physical terrain of family forest owners' conceptions of biodiversity.

Finally, I will inventory conservation policies and programs that target family forest owners, identify the social constructions and assumption up which they rely, and compare them with my findings. I will also conduct tours to biodiversity demonstration sites and focus groups for discussion of biodiversity conservation practices and policies. With the resulting information, I can make recommendations for biodiversity conservation policy based on the forest owners' conceptions of biodiversity, their stated views on biodiversity practices and policies, and my conclusions on their inclinations, capabilities and motivations to manage for biodiversity in the Oregon white oak ecotype.

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Appendices

Appendix A. Profiles of forest owners interviewed.

Pseudonym of main interviewee/s	Main source of income	Highest educational level attained	Origin	Land-related Heritage	Parcel size (acres)	Total acreage owned
Bud Parsons	Timber	High school	local	Third generation forestland owner	364	365
Dale Hallard	Retired (formerly grazing, timber and construction)	High school	local	Second generation forestland owner	40	300+
Dale Hollis	Timber	College	local	Second generation forestland owner	800	800
Dan Garvey	Wood processing engineer	College	local	Wife, third generation forestland owner	24	24
Donald Farmer	Scientific research	Ph.D.	Midwest	At least second generation land owner	39	39
John Schultz	Timber	M.S.	local	First generation forestland owner	90	470
Keith/Mary Harten	Environ-mental consulting/ organic farming	Ph.D./college	Midwest/ Born in Oregon and grew up in Southeast	First generation forestland owner	160	160
Kyle Johnson	Timber/Elementary school teacher	College	local	Wife, third generation forestland owner	260	260
Lynn Stohl	Unclear	College	East Coast	First generation forestland owner	19	19
Richard/Debbie Rounds	Scientific research	Ph.D./Ph.D.	Midwest/Southest	First generation forestland owner	14	14

Appendix B. Biophysical Inventory Form: Data collected in field reconnaissance.

INVENTORY SHEET	Date ________	Ownership____________________
Category	**Subcategory**	**Presence/absence and description (evidence, number, size (DBH), percent cover, proportion of area)**
SITE INFORMATION	Parcel location	
	Parcel size	
	Elevation	
	Aspect	
	Slope	
	Biophysical Aspect	
MANAGEMENT PRACTICES	Oak woodland	
	Mixed hardwood species	
	Mixed conifer species	
	Mixed structural conditions	
	Douglas-fir plantation	
	Rotation age	
	Reserves (view, recreation, wildlife…)	
LANDSCAPE ELEMENTS	Closed areas	
	Open areas	
	Wet areas	
	Variability	
	Evidence of fire	
HABITAT ELEMENTS	Standing live	
	Standing dead	
	Wolf trees	
	Logs	
	Streams	
	Cavities	

SPECIES	*Q. garryana*	
Q. garryana-associated	*Amelanchier alnifolia*	
	Acer macrophyllum	
	Alnus rubra	
	Arbutus menziesii	
	Fraxinus latifolia	
	Polystichum munitum	
	Populus balsamifera	
	Rhamnus purshiana	
	Cornus nuttallii	
	Corylus cornutta	
	Prunus emarginata	
	Pinus ponderosa	
	Rhus diversiloba	
	Symphocarpus albus	
	Thuja plicata	
	Acorn woodpecker	
	Pileated woodpecker	
At risk	*Aster vialus* (wayside aster)	
	Castilleja levisecta (golden paintbrush)	
	Cimicfuga elata (tall bugbane)	
	Delphinium leucophaeum	
	Erigeron decumbens (Willamette daisy)	
	Delphinium oreganum (Willamette Valley larkspur)	
	Lupinus oreganus var. kincaidii	
	Western pond turtle	
	western gray squirrel	
	white breasted nuthatch	
Seral stage		
Early		
Mid	white breasted nuthatch	
Late		
Exotic invasives	*Cytisus scoparius* (broom)	
	Brachypodium sylvaticum	