Collaborative Interface Modeling of Fuel Wood Harvesting Practices: Residential NIPF Landowners of the Jefferson National Forest Wildland/Urban Interface, Montgomery County, Virginia

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ABSTRACT

Residential non-industrial private forest (NIPF) owners within the Wildland/Urban interface are an increasingly important forest owner demographic. An increase in rural residential land use is fragmenting historically large contiguous forestlands. Consequently resource management has become decentralized.

NIPF-landowners, as the new land managers, must now be capable of creating resilient forest ecosystems at the landscape scale. To overcome this issue landowners and resource managers at all levels of decision-making (including landowners) must come to understand how social structures such as psychology, organizations, institutions, and culture are linked to behavior and the physical world.

Collaborative Interface Modeling (CIM) has been created in response to an information gap that exists between the social and natural sciences at the site scale. CIM reveals the causal linkages between land use decisions and their effects allowin landowners to more closely trace and investigate their management policies, behaviors, and feelings as well as the consequences of those behaviors.

A demonstration of the CIM process with residential forest landowners is conducted to evaluate the process and detect possible implications of encroaching development on the Jefferson National Forest in Montgomery County, Virginia. A focus on fuel wood collection was established because it has been noted as a potential source o negative impact. Possible implications and improvements to the CIM process are also noted.

To my friends & family…Shalom.

I am at two with nature
-Woody Allen

I would like to acknowledge the landowners who generously provided their time and interest to this project. Without them there would have been nothing. Thanks to Britt Boucher for making me feel that there is room for humanity in business. And also a great thanks to my committee for their efforts and commitment in helping me see this project through to the end. I appreciate all you have and have not done for me.

Thank you.

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INTRODUCTION

The task of forest management has grown more complex. Forest resources are no serving many functions that landowners once considered fringe but now are consider integral, i.e. aesthetics, recreation, biodiversity, sustainability (Boyce1995). This issue has become particularly relevant to the management of Non-Industrial Private Forest (NIPF). An increase in rural residential land use is fragmenting historically large contiguous forestlands. Consequently resource management has become decentralized.

NIPF-landowners, as the new land managers, must now be capable of both defining elusive terms such as sustainability or biodiversity and charting a course towards their achievement at the landscape scale. Furthermore, achieving these goals means doing so across property boundaries while meeting diverse land use goals, within increasingl tighter time/ monetary budgets, overcoming large learning curves, and doing so with minimal support for new residential owners.

To overcome these issues landowners need to understand of themselves, bot personally and socially, in the context of ecological dynamics. Resource managers at all levels of decision-making (including landowners) must come to understand how social structures such as psychology, organizations, institutions, and culture are linked to behavior and the physical world. By understanding those connections we can develop more integrated forms of management.

One emerging management scheme, the Adaptive Ecosystems Approach (AEA), represents a perceptual shift from natural and social systems as separate entities to one where they are seen as one interrelated entity (Boyle 1998). Land management therefore can then be described in terms of collaboration between the biological context of our social systems and the social systems themselves. The goal of adaptive ecosystems management is to realize and make operational this perceptual shift, this new paradigm.

Within the context of the Adaptive Ecosystems Approach (AEA) I propose a process, identified as Collaborative Interface-Modeling (CIM). The objective of CIM is to reveal linkages between decision-making processes and biophysical resources at the smalles scale of resource management, the site scale. The site scale of management is important to understand because of the direct impact of decisions on resources.

Landscape Architects (or other landscape professionals) facilitate this process by using a collaborative (or participatory) social science investigation to build a diagrammatic model depicting the causality of site level interactions between decision rules and physical systems.

The purpose of CIM is to help participants evaluate their role as ecological agents by tracing their management policies, behaviors, and feelings to the consequences of those behaviors. CIM therefore, helps to make sustainable resource usage relevant to each person.

As an extension of larger land planning goals (watershed, conservation area, regional resources) CIM can be integrated into landscape design projects to build a sense of community (social capital) and hopefully foster positive environmental change. With wide implementation landowners may use the information gathered during a CIM project to foster better communication with other resource managers including other landowners and local regulators. Researchers may utilize CIM as a new source of information for detecting generalizable linkages between social and ecological processes (i.e. values, actions/behaviors, motivations, attitudes).

The CIM process is demonstrated with three case studies of residential NIPF owners adjacent to the Jefferson National Forest in Montgomery County Virginia. The demonstration focuses on the decision processes of NIPF residential landowners during fuel wood collection.

THEORY

NIPF Owners. Who are they? What do they want?

Non-industrial private forest (NIPF) owners have been drawing considerable research attention for the past 30 years (Cordell ed. 1995 p.160). Recent attention has focused on a shift in forestland holdings away from large tract size and economically driven ownership towards smaller parcel sizes and non-timber land values (Hull, Robertson, and Buhyoff unpublished; Broussard 2001; Kluender and Walkingstick 2000; U.S. Dept. of Agriculture 1998; DeYoung 2001). This section summarizes this research and attempts to understand what the demographic shift in NIPF owners could mean for the resilience of both public and private lands.

In the United States today over 90% of all landowners now own less than 100 acres, and most holdings are less than 10 acres (Hull, Robertson, and Buhyoff unpublished). As part of that parcelization in land ownership there has been a 20% increase in the number of NIPF owners in the last 15-20 years. The total number of NIPF owners now exceeds 10 million landholders and equates to over 93 million hectare of forestland (DeYoung 2001). This figure is significant when considering that the bulk of timber extraction still occurs on large tracts of NIPF lands. For instance, 87% of the harvest of hardwoods in Indiana, Missouri, and Tennessee in 1997 came from NIPF lands (Broussard 2001). Other influencing factors such as urbanization, land-use changes, and habita fragmentation are also affecting forestlands. There was a total of about 4.7 million acres of forestland converted to devel pment between 1992 and 1997(Broussard 2001).

Although private owners dominate the landownership patterns in the United States, conservation efforts have historically taken place on public land. In recent years however, with the acknowledgement of the importance of NIPF owners, more effort has been made to target NIPF owners for conservation programs. The research related to these programs has focused on the changing demographics of NIPFs, understanding the reasons NIPF owners choose to own forestland, andowner attitudes toward stewardship, and landowner management knowledge.

Kluender and Walkingstick (2000), U.S. Dept. of Agriculture (1998), DeYoung (2001) found similar demographic profile shifts among NIPF owners across varied geographic areas. NIPF owners in general tend to be older, wealthier, and better educated than ever before.

Studies also report a shift from NIPF owners owning land as a source of income towards non-economic valuation of the land. Non-economic reasons for owning forestland include: recreation, aesthetic enjoyment, preserving nature, wildlife viewing, building one's own house, watching things grow, living simply, escaping the "rat race" o civilization, living in a healthy place, walking on their land, and having privacy (Hull, Robertson, and Buhyoff unpublished; Kluender and Walkingstick 2000; U.S. Dept. o Agriculture 1998; DeYoung 2001).

Owners show a wide variety of opinions pertaining to management of their lands. Hands-off management (let nature take its course), activel plant new trees, cooperative management among landowners, cut down dead trees, maintain trails and views, improve wildlife habitat, improve forest health, increase privacy, kill vines in trees, and contro pests (even if doing so involves pruning or removing trees and applying pesticides) were noted as management activities taking place on NIPF properties (DeYoung 2001; Hull, Robertson, and Buhyoff unpublished).

What does it all mean?

As a consequence of large parcels being subdivided the usage of those parcels has become more diverse. Large contiguous tracts of forest are being fragmented and mixed with houses, commercial properties, industrial parks, and expanded agricultural lands (Broussard 2001). The fragmentation of forestlands can seriously redu ce the resilience o forests both to natural and anthropogenic disturbances (Forman and Godron 1986). More specifically, ragmentation means a fragmentation of land management styles, increased edge (more edge effects), possible pollution, increased likelihood of invasive plants and animals, fire suppression, and reduced biodiversity (from over harvesting and habita alteration) (Plessis 1995; Lindsay, Gillum, and Meyer 2001; Hull, Johnson, and Nespeca 2000; Forman and Godron 1986 p.108-111; Shafer 1999; Broussard 2001; Dramstad, Olsen, and Forman 1996 p.19, 27, 35, 41).

Within the shift in NIPF ownership a significant trend is occurring toward non-farm residential land use. This trend represents an increasingly important area of interest. Impacts from residential land use can be directly attributed to activities involving recreational, yard waste disposal, and landscape design (Matlack 1993; Plessis 1995; Lindsay, Gillum, and Meyer 2001; Fry 1997). The impacts from these activities are defined as ‘sociological edge effects’ (Matlack 1993). Sociological edge effects occur along parcel boundaries, and roads. Specific activities that have been associated with sociological impacts include fire wood (fuel wood) harvesting, campsites, hacked or carved trees, ree houses, children’s huts, lawn extensions, pruned limbs, yard waste piles (lawn clippings, leaf piles, Christmas trees, etc.), dumps (e.g. old appliances, cars, building materials, etc.), and footpaths (Matlack 1993). This list, however limited in breadth, conveys the myriad of activities may influence ecology at the site scale. Sociological edge effects are evidenced by changes in under-story composition and structure such as forest floor clearing or compaction, trampling, weakening of trees, increased insect damage, and/or a reduction in nesting sites (Matlack 1993; Plessis 1995; Lindsay, Gillum, and Meyer 2001).

While newer NIPF owners cite a less economic angle to their ownership they are not averse to harvesting some timber from their lands (U.S. Dept. of Agriculture 1998). Parcel size does affect timber harvesting however. Owners of smaller parcel sizes are less likely to harvest timber (U.S. Dept. of Agriculture 1998; Kauneckis and Novac 2000). Persons that do not own land specifically for timber production tend hold smaller parcels. Kluender and Walkingstick (2000) support this by finding by stating that the majority of owners (excluding those owning land exclusively for timber who they call "Timber Managers") had no interest in harvesting timber. Non-harvesting property owners are called, Resident Conservationists", "Affluent Weekenders", and "Poor Rural Residents") (p.156). The increase in non-timber producing owners with small land holdings may be resulting in a positive trend related an overall increase in forest cover as suggested b Kauneckis and Novac (2000).

New residents moving from the city to the country bring with them expectations o receiving the same level of public services they had in the city. They may also bring misconceptions and a lack of understanding about the forest resource they are moving into (USDA Forest Service 2000). The new NIPF owners, having little or no history wit land management, a do-it-yourself attitude towards forest management (U.S. Dept. of Agriculture 1998), and a general distrust of professional foresters (Hull, Robertson, and Buhyoff unpublished) are thought to be lacking important knowledge that can help formulate good forest management decisions. As a result, this growing market i expected to have some negative impacts on local landscapes. Understanding the demographic profile of NIPF owners is only the first step toward determining the exten to which negative impacts may be occurring.

Due to the potential impacts that can occur at larger scales NIPF owners are now being called upon to pickup where traditionally only professionals once worked. Among other factors the reduction in parcel size and a shift away from large-scale timber extraction have meant that professional foresters have not been marketing to small parcel owners because they are not seen as profitable (Hull, Robertson, and Buhyoff unpublished). This has left an information gap. There is a need to provide landowners a way to ask credible and specific questions about landscape processes, seek information, and test best management practices specific to their property. Three major sources o information used by landowners to make decisions about how to manage their land include friends and neighbors, service providers, and extension a gents (Jenkins 2002).

Several new forms of information and management styles are emerging such as forest cooperatives, information clearinghouses, conservancies, and 'alternative' foresters. However, most NIPF owners still prefer to manage their land b themselves or with as little outside help as possible (Jenkins 2002). This uncoordinated land management can disrupt ecological processes operating at large spatial and tempora scales– e.g., wildlife habitat, biodiversity, and water flow (Hull, Johnson, and Nespeca 2000).

Because resource management has become decentralized understanding the decision-making processes of individuals and the aggregate effects of those processes is becoming increasingly important for protecting the resilience of local landscapes. A new system of management is needed to meet the new conditions of land ownership.

Beyond that, the task of forest management has grown more complex. Forest resources are being asked to serve multiple functions that once were fringe issues but are now integral, namely aesthetics, recreation, biodiversity, and sustainability (Boyce1995). Therefore, the new system of management must be capable of both defining elusive terms such as sustainability and biodiversity as well as charting a course towards their achievement. Resource managers (and by implication landowners) must be aware of the connections between the function of natural systems, values, beliefs, and attitudes that define these terms. A more integrated form of management is needed to mee t these diverse goals within increasingly tighter monetary budgets, shorter time periods, a large learning curve, and little cross boundary support.

The Adaptive Ecosystems Approach (AEA)

The traditional (reductionist) approach, as seen by advocates of the ecosystems approach, is too "deductive" (purely rational, "lacking psychological models and indigenous knowledge"), "narrowly focused" (temporal, spatial, and organizationally), gives only a "snapshot" characterization of problems (non-dynamic descriptions, linear), emphasizes the "analysis of parts" (models lack important relationships), seeks to "eliminate uncertainty" to provide "unambiguous" answers and a high degree o generalizability (overlooks "irreducible uncertainty" and therefore overextends predictive power), and perpetuates "fragmented management" (solutions are applied to many, "often inappropriate, scales") (Jensen and Bourgeron 2001 p.462; Boyle 1998; Berkes and Folke 1998 preface; Costanza 2001 p. 5, 7, 9, 11, 20, 25; Capra 1996 chapter one; Allen and Starr 1982; Johnson and Hill 2002 p.177, 308, 336; Holling 2001). The Adaptive Ecosystems Approach (AEA) is not a flat rejection of the 'reductionist' problem solving strategy but rather it has been formulated by exposing its shortcomings and proposes a new expanded definition of environmental problems. The ecosystems approach is a re-formulation and extension of critical problem solving. To affect a shift from non-sustainable practices to highly sustainable practices it is necessary to redefine ourselves in the context of ecological dynamics. Our mental models, behaviors, and physical world are linked to one another. The Adaptive Ecosystems Approach (AEA) is emerging as a new perspective (or management paradigm) to achieve more integrated natural resource management plans.

The AEA is a flexible assessment and planning process that takes into consideration changing biological and social contexts, the principle of irreducible uncertainty, and the need to include stakeholders in the decision making process (Boyle, 1998). By recognizing that uncertainty cannot be fully resolved AEA sees ecologica assessment and planning as an iterative learning process. This perspective helps planners form a broader definition of ecological scenarios (problems) to better cope with ecological 'surprises' (Walker et al. 2002)

AEA differs from other problem strategies by embracing the incomplete knowledge of ecological conditions (Jensen and Bourgeron 2001 p.462). This includes the resource manager's knowledge. Furthermore, management does not focus specifically on physical resources but takes a broader focus to include the social context of the resource including economics, institutional controls, and stakeholder values (Jensen and Bourgeron 2001 p.21, Boyle 1998, Berkes and Folke 1998 chapter one; Costanza 2001 chapters one and two; Kibert, Sendzimir, and Guy 2002 chapter 3; Boyce 1995 chapters one and two; Naveh and Lieberman 1994 p.68).

Systems modeling and non-linear mathematics are two central tools used to increase our understanding of the complex relationships and behaviors that ecosystems are composed of (Capra 1996 p84, 85). Additionally, social science has begun to play a larger role in ecological planning and design (Johnson and Hill 2002 p.124, 232). Its newfound importance stems from our need to define how societal systems and biologica systems interact and the necessity to collect social data.

Operationalizing the AEA

AEA is not a comprehensive set of tools. Rather AEA is just that, an approach. T he tools used to conduct a project under AEA are the same tools used for current land planning, with a few exceptions. GIS, landscape ecology, statistics, aesthetic judgments and/or any other tool may be used to perform an AE project. AEA proposes a wa to employ those tools that generates the true differences. As AEA has evolved it has gained its own set of unique tools too. Dynamic modeling, various participatory social science techniques for integrating people into the ecological context, and non-linear mathematics represent three major developments (Walters, C.J., et al. 2000). A complete description of the tools of AEA is not available because of the context-specific nature of each project.

AEA projects do carry with them organizational similarities however. Several articles have been published that identify key organizational characteristics of the AE (Jensen and Bourgeron 2001; Lal, Lim-Applegate, and Scoccimarro 2001; Walker et al. 2002; Boyle 1998). After reviewing these articles several steps (phases) were seen to be common to each project: *Problem Identification, Context Identification and Model Building, Assessment, Action, and Adaptation.*

Problem Identification provides both the impetus for starting the project b identifying a conflic between social systems, socia -resource systems, and/or between resources and identifying the desired state of the system. Stakeholders both define and direct the *Problem Identification* process. Stakeholder input is critical in every phase o the AEA process.

Context Identification and Model Building identifies both the physical and social context of the*Problem.* This includes defining the boundaries of the *Problem,* defining relationships between resources, between scales, and between social organizations and resources. A model of the context is helpful for understanding the complexities of the relationships.

The model should capture how the actual system behaves. That is, it should try to capture how people actually behave and how resources are actuall responding and changing, not how we assume things are happening (Sterman 2000 p.141). Data needs, units of measure, assumptions, and stakeholder buy-in are also addressed in this step (Sterman 2000 p.179; Costanza 2001 p.21).

After defining the context and relationships within the project context an *Assessment* of ecosystem behavior is established. Also, management alternatives (or pathways for management success) are formulated guided by the desired state of the *Problem* context. To formulate and evaluate management scenarios decision support systems (DSS) have been advocated to provide guidance to stakeholders (Jensen and Bourgeron 2001; Lal, Lim-Applegate, and Scoccimarro 2001; Walker et al. 2002; Boyle 1998).

Tradeoffs are a necessity in management. However, the selection of an alternative in the *Action* phase should be based on its ability to prevent the system from moving to an ‘undesired configuration’ after a disturbance and to nurture ‘adaptive capacity’ (Walker et al. 2002).

The *Adaptation* phase gives AEA its flexibility to cope with system ‘surprises’, and is central to the AEA (Lal, Lim-Applegate, and Scoccimarro 2001). *Adaptation* is focused on stakeholder learning. Four main areas are evaluated during the *Adaptation* phase: evaluation of programs and services, evaluation of social policy (performance evaluation), political learning (becoming better policy makers and negotiators) (Lal, Lim-Applegate, and Scoccimarro 2001). Lal, Lim-Applegate, and Scoccimarro (2001) also specifically call out a fourth area, resource users as key learners. By having users actively observing and analyzing the cause-effect relationships of their resource interactions they will be able to input new knowledge into the decision making process.

These steps are not considered to be exclusive and must be developed in an iterative way such that a step may be returned to and developed further as the project continues (Jensen and Bourgeron 2001; Lal, Lim-Applegate, and Scoccimarro 2001; Walker et al. 2002; Boyle 1998).

Dynamic Modeling

System modeling is used for three key functions within the AEA: 1) it improves communication and helps build consensus among stakeholders (e.g. by clarifying problems, uncovering assumptions, and to formulate alternatives); 2) it facilita es the screening of management or policy options to eliminate unworkable solutions (helping participants make effective choices) and; 3) it identifies critical knowledge (information/ data) gaps (Lynam, et al. 2002; Costanza 2001 p.21). Costanza (2001) differentiates four (4) model types based on their purpose: 1) Hi -generality conceptual models, 2) High-precision analytical models, 3) high-realism impact analysis models, and 4) Moderate-generality and moderate-precision indicator models. The type of m del that may need to be built depends on the purpose of the project (Costanza 2001 p.25; Sterman 2000 p.85).

A main tenant of the AEA is consensus building. For model building this means a stakeholder involvement model (Lynam et al 2002). Its incorporati n into any project is viewed as critical to generating more realistic models of resource usage (Lynam et a 2002). Drawing connections between resource usage decisions, actions, and results is paramount to facilitating the learning process, a key component of the AEA (Costanza 2001 p.27; Brock 1999).

Dynamic simulation computer programs built using graphical programming languages such as STELLA™ or VENSIM™ are currently being used to model socio-ecological systems (SES) (Walters, C. J., et al. 2000). GIS (geographical information systems) are also being interfaced with these dynamic simulation programs (Crews-Meyer and Walsh 2002; Waddell 2000; Andrusd et al. 2002). Graphical output to the modeling allows resource decision makers to evaluate current and future usage policies.

One prime difference between McHargian type modeling (e.g. Arcview™) of land planning and AEA modeling (e.g. UrbanSim™) is the shift from 'snapshot' planning to one of dynamic planning, where the context of the social-ecological system (SES) is a dynamic and evolving process (Waddell 2000). McHargian modeling represents a static view of the consequences within a management decision, whereas, AEA modeling is capable of modeling the dynamic relationships that form and change through time. The goal of dynamic modeling (even at the conceptual level) is to reveal dynamic trends between variables and more clearly see the relationships of non-spatial data to physica planning (Costanza 2001 p.21).

The inclusion of non-spatial data is implicit to understanding the social impact of management decisions. The perceptual shift from biophysical and social systems as separate entities to one where they are seen as one interrelated entity implies that w cannot control nature but rather that our social systems are nested inside and are theref re dependent upon the context of the biophysical model (Boyle, 1998). Once we embrace this new understanding we lose our long held belief that our social systems are in some way removed from biological processes and we can begin to see land management as collaboration between the biological context of our social systems and the social systems themselves. The goal of adaptive ecosystems management is to realize and make operational this perceptual shift, this new paradigm.

<u>Integrating the Social into the Ecological</u>

Social science can be seen to have two main components within the context of AEA. Firstly, one of the main precepts of this approach is the focus on humans as decisio makers who realize the implications of their behaviors. To this end, it is necessary to "include public involvement in decision-making" (including formulating policies and strategies) and "stress resource decision making at all levels of planning into the process" (Endter-Wada et al. 1998 p. 892). Secondly social analysis is used to "integrate social considerations into the science of understanding ecosystems and their management" (Endter-Wada et al. 1998 p. 891).

Most research emphasis has been put on the first component of social analysis, public involvement in decision-making. Data collected from this component typicall pertains to the ways in which people relate to resources including their values, beliefs, and preferences regarding resource use and management. These types of studies have served to build support for management decisions, build coalitions of managers and landowners, reduce resource conflicts, and reduce the distrust of resource managers. Programs centered on collaborative learning, local decision-making partnerships, and co-management between managers and ocal groups help to achieve sustained public involvement in resource management (Endter-Wada et al. 1998; Chambers 1994; Kapoor 2001; Ostrom 1999).

The second component of social information, the incorporation of humans into ecological systems, canno be conveyed as succinctly. Due to underlying issues, including the view that humans are external to ecosystem processes and the need to maintain scientific data manageability, contributions from social science have been minimized or disassociated from ecological research (Capra 1982; Endter-Wada et a 1998; Davis 1996 p. 417). This is to say that, "most researchers have pursued answers to fundamental questions about pattern and process in the ecological and human world from within the boundaries of one discipline or another, neglecting the feedbacks that cross between ecological and social systems." (Grove, Kuby, and Redman 2000 p.1). historical lack of communication, a common theoretical ground, and disparate units o measure between natural and socia sciences have all prevented integrating knowledge gained in each professional camp. However, there is now movement toward collaboration in these professions for incorporating human decision-making and interactions as a focus of ecosystem analyses (Davis 1996 p. 417; Grove, Kuby, and Redman 2000; Walker et al. 2002,).

There are several examples of AEA projects that have integrated a wide variety of sociological data (Berkes and Folke 1998; Jensen and Bourgeron 2001 p. 445-511; Costanza 2001 p.189-191; Crews-Meyer and Walsh 2002; Lal, Lim-Applegate, and Scoccimarro 2001; Walters et al. 2000; Castro et al. 2001). However, there have been as many social science approaches as have been projects. This diversity appears to be a function of the size and complex ity of each project's objectives, availability of expertise and funding, and lack of existing standards for conducting social science at various scales of analysis. Adaptive management requires that analysis and management processes place less emphasis on exercising control in social systems (regulatory statutes) and more emphasis on generating meaning and enabling responsive action (social learning). Depending on circumstances (such as scale, research problem, diversity of stakeholders, etc.), some social science information sources will be deemed critical while others will be less useful or inapplicable[1] (Lovell, Mandondo, and Moriarty 2002; Carroll and Pearson 2000; Hostetler 1999; Jensen and Bourgeron 2001 p.119; Lal, Lim-Applegate, and Scoccimarro 2001; Boyle 1998).

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[1] Jensen (2001 chapter 9) offers an overview of data integration challenges for ecological assessments.

The Individual in the Model

The contributions of social science to ecosystem management range from macro-level analyses of general social, cultural, political, and economic values, behaviors, and trends down to micro-level analyses of individual and group attitudes, values, and behaviors. Micro-level analyses are important to conservation decision-making and behavior because they provide insight regarding economic decisions, aesthetic preferences, and ecologically based values and bias processes.

Social values and meanings of resources shape both large scale and site scale decision-making. These biases have their roots in cultural traditions and individual or group experiences (Kaza 1996 p.57). Sustainability (as a set of long term ecological goals) itself cannot be defined solely on ecological terms but must also include a chosen set of preferred conditions, a socially derived concept. As noted by Bruce Hull in Restoring Nature, "ecological theory suggests that many alternative environmental conditions are equally possible, equally natural, and equally healthy for any given place at any given point in time." (Gobster and Hull 2000 p.98). Some environmenta conditions may be favorable to human existence while others may not. Revealing how people are explicitly or implicitly choosing the 'nature' they are surrounded by is needed to define acceptable sustainability goals and measurements.

At small scales, including the scale of the individual person, any researc performed solely 'on' rather than 'with' stakeholders is not a sufficient source of data for understanding how management actions relate to social systems. Rather an ongoing, process-oriented, assessment approach is needed (Endter-Wada et a 1998). Site-specific projects may build on findings from broader scale pilots, but must collect sets of social scientific data applicable to that scale. To that end, highly detailed information about attitudes, values, and behaviors are needed to achieve the appropriate level of complexity in ecosystem models (Endter-Wada et al. 1998).

Unfortunately, data collected thus far has focused on overarching, 'coarse grained' social assessments of existing conditions, societal needs, and the effects o humans on the landscape, with little attention to addr essing site-specific issues (Endter-Wada et al. 1998). And when data was collected at a site level the projects focused on the effects of humans on the land instead of the causal linkages at the root of those effects (Endter-Wada et al. 1998). This has left an apparent gap in the knowledge concerning social science's role in ecosystem management. ecently, 'interfacing' (as termed b Kay in Kibert, Sendzimir, and Guy 2002 p.90) has been cited in the literature as being an area of rich opportunity for investigation (Ashley, Evans, and James 2000; Tonn and MacGregor Technical Report NCEDR/98-18, p. 41, 49, and 65; Hull, Robertson, and Buhyoff unpublished; Cordell 1995; Erickson, Ryan, and De Young 2001; Matlack 1993; Grove, Kuby, and Redman 2000; Shindler 1999; Hostetler 1999; Schrader 1995; Stynes and Stokowski 1996 p.443)

<u>Managers (Landowners) as decision makers</u>

Resource management has become decentralized and landowners are now known to be important players in the land management framework. Understanding the decision-making processes of individuals and the aggregate effects of those processes is becoming increasingly important for protecting biodiversity and the resilience of the landscape. This section presents a theoretical grounding for the investigation of manager's decision-making processes.

A significant amount of investigation has been done into the motivations and values carried by NIPF owners (Rey 1996). These studies yield a great deal of insight into the intentions of management actions. Motivation studies can be useful in drawing conclusions about general feelings about management objectives and aid in identifying who is adopting management practices. However, even the best intentions don't always yield the desired results. Kauneckis and Novac (2000) illustrates this by identifying that while landowner's preferences were found to be linked to forest cover changes the direction of that change was not determined by the intention to conserve forest cover. It was equally likely that landowners who intended to conserve forest cover experienced a net loss or gain. No correlation could be drawn between the intended land cover change and the actual direction of that change. Therefore, motivations are not a predictor o actual land conservation. Restated, the decision to conserve the land may be 'intendedly rational' (internally consistent with the understanding of the systems structure) but not be capable of fulfilling the desired effect (Sterman 2000 p 603). By this notion it can be assumed tha motivations only represent one facet of the decision-making process.

more detailed analysis is needed to distinguish when conservation motivations result in positive or negative outcomes. By understanding the decision-making process (and by implication the plans and policies of landowners) the correlation between intention and desired effect can be realized.

Several theories have been presented that explain how humans make decisions. From the perspective of the AEA a 'good' decision-making theory must be capable o capturing both the generation of policies and their evolution (i.e. how learning happens). It is the idea of continual learning that underlies the adaptive approach and implies a constructivist decisi -making model. One such theory is called the Self-Regulation Model (SRM).

The SRM, as proposed by Byrnes (1998), "…captures the basic thrust of how all of the components of decision-making interrelate." The term 'sel -regulation' refers to the theory's assumption that decision makers utilize a goal directed process that results in beneficial (successful) adaptation of both goal seeking and goal achievement strategies (Byrnes 1998).

The SRM is composed of three (3) phases (Figure 1). These phases are called Generation, Evaluation, Learning, and Moderating Factors. The first three describe the evolution of a decision while the fourth describes factors that inhibit successful decision-making.

The Generation phase describes how signals (or cues) from the environment or internal sources are perceived and interpreted, a goal is determined, and options for reaching the goal are formed. Evaluation refers to the weighing of options and the selection of a 'best' option. During the Learning phase the 'best' option is implemented and the consequences of the decision are judged. The Learning phase improves the information that feeds the decision making process and improves the likelihood o successful decisions in the future. The first three (3) phases are not linear but rather require a great dea of jumping back and fourth from phase to phase is often necessary to arrive at a satisfactory decision.

Associated with all three phases are a list of human attributes that inhibits the generation of options, evaluation of options, and learning from choices known as Moderating Factors. Moderating factors include: memory limitations, inadequate knowledge, lack of calibration, heuristics and biases, encoding processes, emotions, stress, psychoactive substances, and dimensions of personality (Byrnes 1998).

By understanding the decision-making process of cue interpretation, goal formation and associated behavior rules we can more closely examine the unique circumstances tha yield successful conservation decisions. Furthermore, by exposing the decision-making process it may become practical as a tool in the formulation, selection, and evaluation of management options.

This position is implicated in the work of Carl Stienitz who's framework for landscape design best integrates decision-making as a basis for finding design solutions. He clearly defines decision-making as a process of data, information, and cultura knowledge (Johnson and Hill eds. 2002 p.233)

A PROPOSA

Collaborative Interface Modeling

By drawing on the information collected throughout this report (i.e. dynamic modeling, social science research methods, and the SRM) this section proposes a process to investigate the 'interfacing' of site scale socio-ecological interactions. I will refer to this process as 'collaborative interface-modeling' (CIM).

CIM is designed as a collaborative process between an outside facilitator and a landowner. The purpose of the CIM is to use a collaborative (or participatory) socia science investigation to build a diagrammatic model that represents a property owner's decision rules and their link to the ecology of their property, thus exposing the causality of site level interactions. Representing decision processes diagrammatically allows the landowner to more closely trace and investigate their management policies, behaviors, and feelings as well as the consequences of those behaviors.

The organization of the CIM has been adapted from the first two phases of the *Adaptive Decision Making Process* (ADMP) (Lal, Lim-Applegate, and Scoccimarro 2002). This adaptation was done to clarify complex data collection and assessment tasks. The ADMP itself was chosen because it closely parallels the self-regulation model of decision-making. The ADMP itself is composed of four phases:

1. *Sub-System Identification (Problem and Context Identification),*
2. *Reflection (Model Building),*
3. *Action (Assessment and Action), and*
4. *Adaptive Learning (Adaptation).*

CIM collects and organizes information that can be integrated into a full ADMP project. The scope of the CIM is limited to allowing landowners to examine more closely how they are thinking about activities on their properties and elucidate how what they think (and how they act) 'feeds back' through the ecology of their property both directl and indirectly. It is intended to help landowner's inquire into the interrelationships between themselves and their property and inspire them to question their land use policies. CIM is not intended to be a complete model of the decision process or a complete ecological model. Since learning is a contin uous iterative process CIM models will evolve and change as new information becomes available or relevant.

The participatory nature of CIM can help make environmental issues relevant to each person and help create unique, learning based solutions to sus ainability problems, a meaningful form of 'ecological design' (Kapoor 2001; Bragg 1996; Chambers 1994; Allen et al. 1997; Vabi 1996; Clitheroe, Stokols, and Zmuidzinas 1998; Boyle 1998). This approach can empower landowners by enabling them to participate and change their 'policies' if they don't like the long-term result of their actions (Kapoor 2001; Chambers 1994; Diduck 1999). As an extension of larger land planning goals (i.e. watershed, conservation area, regional resources), landscape design can be u tilized as a tool in providing new 'system structures' and hopefully positive environmental change.

Several Landscape Architects and firms now advocate this position. Examples include Carl Steinitz's Camp Pendleton project, the work of Jones& Jones, and John Lyle's book Design for Human Ecosystem .

The CIM Process

A clear understanding of the underlying management issues and genera agreement on the desired outcome are critical to any decision-making process that attempts to choose a path for developmen and management. The CIM helps to define the *Problem* and understand the basic dynamic relationships within the *Problem.* It is hoped that CIM may serve as the first step towards better land management policies.

PHASE I: Problem and Context Identification

To understand the context of the *Problem* it is necessary to identify all parties (stakeholders) associated with the *Problem* (including managers at all institutional levels), and understand the linkages between the stakeholders. It is also important to understand the biophysical context (forest ecology) of the study area. The following activities are performed during Phase I:

<u>Identify key resource owners</u>

- Using GIS data (parcel, tax, DOQQs, and zoning layers) to identify...
  - All parcels associated with the study area
  - Characterize landcover of study group parcels

<u>Identify managers at all levels of governance</u>

- Identify the systems of governance that encompass the *Problem.* Be sure to include stakeholders at all scales of resource decision-making.

<u>Existing patterns of decision-making</u>

- Identify and map inter-agency and formal/informal relationships.
  - Understand the channels of communication between landowners and other managers
  - Identify sources of information (formal and informal) used to make decisions about land use

<u>Research the physical resource system (focus on dynamic relationships)</u>

- Conduct a literature review to gain an understanding of the system
- Employ the help of ‘experts’ as advisors during collaborative system identification. It is important that they do not act as ‘experts’ but rather point landowners toward useful resources.

PHASE II: Model Building (to be performed with the landowner)

The goals of this phase are to:

- Define the nature and scope of the *Problem*;
- Establish a common vision for the goal for the system;
- Identify the 'decision cues' (*) used in the formulation of the decision rules;
- Identify the decision rules themselves, and;
- Develop a narrative of the system's dynamics and a causal diagram for the landowner property. The information generated during Phase I, as well as indigenous knowledge (landowner's firsthand knowledge of their land), is used to formulate causa relationships and system structure

(*) For this modeling exercise it is important to reveal the cues and processes that landowners are using to develop management decisions. These cues are often implicit to decision-making and therefore landowners may not be able to readily disclose their actua decision-making process. In order to determine decision rules and cues as they actually are used ethnographic techniques from the social sciences will be employed. The techniques to be used include:

- Cognitive mapping (concept mapping)
- Semi-structured interviewing
- and a Property Walk

Phase II is carried out by meeting with the selected landowner several times (as necessary), documenting the meetings via voice recordings, documenting the property and possible impacts from management actions via photographs, GIS, and hand-drawn maps. From the analysis of these data collections a diagram of the social ecological system (SES) as it is known can be generated.

As mentioned above, the CIM represents only the first two phases of the ADMP. 'Assessment' of the CIM model is needed to determine if action is required to better mee land use goals. If action is required then management options would need to be created and the best option implemented. The final step 'Adaptation' (which includes model validation) would be used to monitor the progress of the new policy. The ADMP (including the CIM) would then begin again, as a continual, iterative, learning process.

Collaborative Interface Modeling of Fuel Wood Harvesting Practices: Residential NIPF Landowners of the Jefferson National Forest Wildland/ Urban Interface, Montgomery County, Virginia

INTRODUCTION

The Jefferson National Forest in Montgomery County, Virginia provides an excellent case study for examining residential land management along the urban-wildland interface. Over the past 20 years increased residential development has been occurring along the Jefferson National Forest (JNF) boundary. This development can have negative impacts on the JNF via fragmentation of land management styles, increased edge (more edge effects), possible pollution, increased likelihood of invasive plants and animals, fire suppression, and reduced biodiversity (from over harvesting and habita alteration) (Plessis 1995; Lindsay, Gillum, and Meyer 2001; Hull, Johnson, and Nespeca 2000; Forman and Godron 1986 p.108-111; Shafer 1999; Broussard 2001).

One common activity having possible negative consequences is the harvesting o firewood or fuel wood from residential properties bordering the JNF. Fuel wood harvesting has been shown to have negative impacts on forest resources. Plessis (1995) demonstrated that unchecked fuel wood harvesting leads to depletion in nesting sites for small mammals and birds. As a result local extinctions are occurring at the study sites.

Extension service documents state that fuel wood harvesting is beneficial for woodlots. Although, it can have negative impacts for the stand if improperly done (North Carolina Cooperative Extension Service 1995; Hinkel 1989; Oklahoma Cooperative Extension Service F-9439; Oklahoma Cooperative Extension Service F-9440). The success of fuelwood harvesting does not appear to be clearly defined. One fuel wood management guide describes properly culling fuel wood from a woodlot as requiring 'good judgment and proper planning' (Oklahoma Cooperative Extension Service F-9440). Subjective measures of post harvest conditions must be clearly defined and the dynamics of harvesting must be understood to accomplish a landowner's objectives and protect the resilience of forest resources.

Within the context of the Adaptive Ecosystems Approach (AEA) I propose a process, identified as Collaborative Interface-Modeling (CIM) to help landowners understand how they manage their property can have an effect on the landscape. The CIM uses dynamic modeling to understand how a landowner's decision-making processes and the biophysical processes of their property relate. Landscape Architects and other land planning professionals can play an important role as the facilitator of this process.

The AEA and the proposed CIM both advocate that landowners (the new resource managers) are capable of defining and charting a course toward achieving elusive terms such as sustainability and biodiversity. With the help of facilitators landowners can make connections between their values, beliefs and attitudes and the function of natural systems. Information to be used in the CIM process must be derived from the scale of the individual to be representative of the land management decisions taking place on any one landowner's property. Therefore landowners must provide the detail necessary to define sustainable land use at the site scale. A clear understanding of the underlying management issues and general agreement on the desired outcome are critical to an decision-making process that attempts to choose a path for development and management. The CIM helps to define the *Problem* and understand the basic dynamic relationships within the *Problem.* It is hoped that CIM may serve as the first step towards better land management policies.

METHODS

CIM is divided into two phases. Phase I identifies the physical and social context of the project. Phase I also identifies project participants for Phase II. Phase II works with the selected landowners via various interviewing techniques to build a qualitative dynamic model of the landowner's decision-making process and its feedback through the environment. For this project landowners are then asked to evaluate their models and report on their completeness and usefulness.

PHASE I

Physical Context

The physical context was defined from oth a *resource inventory* perspective and a *systems* perspective. That is to say that landcover and forest resources were identified and characterized by their occurrence and their expected change over time under curren management.

The *resource inventory* was conducted by using GIS (ArcView 3.2), the Revised Jefferson National Forest (JNF) Draft Environmental Impact Statement (DEIS), and the JNF Draft Revised Land and Resource Management Plan (LRMP). ArcView data was clipped to the Montgomery County boun dary and projected to NAD UTM 1983. Data was collected for analysis from various sources, including:

- *Landcover data* – Species occurrence and associated land use types (The Virginia Gap Analysis Project through the Department of Fisheries and Wildlife Scie nces at Virginia Tech);
- *Land use*– Current parcel boundaries, roads, water features, landowner identification information, and building locations (Montgomery County Parks and Planning Office);
- *Jefferson National Forest data*– forest ownership boundaries, quadrangle identification, and management area identification (The U.S. National Forest Service);
- *Digital Elevation Map (DEM) data*– used to create elevation, slope, and aspec maps (the GIS data depot, www.gisdatadepot.com); and
- *Digital Orthophoto Quarter Quadrangle (DOQQ)*– color aerial photographs (Virginia Economic Development Partnership through Radford University).

Forest ecology was used as a basis for understanding the complex interactions o forest resources (i.e. the physical system's dynamics). Textbooks, journal articles, the JNF-DEIS, JNF-LRMP, and interviews with resource specialists were used to gather information about stand level resource dynamics. A causal loop diagram was constructed to understand the dynamics of coarse woody debris(CWD) recruitment and decomposition. An emphasis was given to understanding CWD dynamics because CWD was found to be the primary source of fuel wood on the study sites.

Both the concept map and the causal loop diagram were drafted using Vensim© PLE32 v.4.0d from Ventana Systems, Inc. Vensim© is a dynamic modeling software platform capable of modeling both qualitative and quantitative relationships.

Social Context

Four main goals define the social context of the project:

1) Identify land management decis on makers at all levels of governance.

2) Summarize the existing patterns of resource decision-making.

3) Summarize the management of Jefferson National Forest in Montgomery County Virginia along the Urban/Wildland Interface management designation.

4) Identify project participants (residential NIPF landowners as near to the JNF Urban/Wildland Interface as possible).

Resource management professionals were interviewed in a snowball style interview process to reveal all relevant decision makers. Information from these interviews was used to create an organizational chart depicting the existing patterns of information flowing towards the landowners (Figure 6). It was assumed that understanding the flow of information to the landowners was important to understanding how landowners are generating fuel wood management techniques. The Jefferson National Forest (JNF) Plan-Alternative I -Draft was used to summarize the management goals of JNF along the Urban/Wildland Interface.

Project candidates were selected using a convenience sampling procedure. Study area residents were initially identified using a snowball interviewing process (candidates were gathered from references and asked to provide additional candidates in an iterative fashion). Potential project participants were identified and assigned priority based on their proximity to JNF. After generating an arbitrary short list of nine (9) candidates a letter of introduction was sent to potential participants.

The introductory letter provided a summary of the project, a synopsis of the expectations and responsibilities of participants, and the researcher's contact information. After a one-week waiting period potential candidates were contacted and asked if the would be interested in participating. From the list of interested candidates three projec participants were selected based on their proximity to JNF. No selection preference was given to landowners beyond their proximity to JNF, their self-identification as residential NIPF owners, and the indication th at they actively collect fuel wood from their property.

PHASE II

Phase II reveals and records the decision-making processes of three (3) landowners. Each participant was asked to engage in three data collection exercises: a semi-structured interview, a property walk, and a concept mapping session. All exercises were performed at a location of the landowner's choosing and at a time determined by the landowner/ participant.

The Virginia Tech Internal Review Board (IRB) approval of this research was sought and received. To protect the anonymity of the three landowners each participan received a name code (Harvey, Diane, and Elizabeth). These codes are used to protect landowner's individual identity when presenting the results of the study. All records pertaining to each case were coded with the corresponding name code.

Due to the subtle nature of decision-making processes it was necessary to make audio recordings of the data collection exercises. Additionally, photographs of the participants' property were taken. All recordings and photos were made digitally with a handheld recording device or camera. The subjects were informed of the recording, starts, stops, and archiving procedures.

Each participant's name code and a date/time stamp code the recordings. All recordings were made, analyzed, and stored by the primary researcher. After publication of the research all identifying information was destroyed except aerial photographs and maps necessary to communicate study site locations.

Three data collection techniques (interview, property walk, and concept mapping) were chosen to capture the logic and spatial patterns present on each property. Each exercise was used to access a slightly different aspect of the decision-making process. The total time required varied with each participant but an average time of one hour was required to complete each exercise.

The self-regulation model (SRM) of decisio -making was consulted in the development of data collection tasks. Specific attention was given to detemining the environmental and internal cues used to define goals. Additionally, questions sought to reveal the forces acting to form the participant's 'Strategy for Option Evaluation' and 'Evaluation of Option Outcome' (Figure 1). Since decision -making is a highly complex task the SRM served only as a general guide. Specific questions and language were determined using qualitative research methods.

<u>Sem -Structured Interview</u>

The semi-structured interview was used to access landowner motivations, attitudes, and values engendered in owning property. Moreover, questions were used t construct the landowner's sociological frame of reference. The SRM sees this frame o reference as influencing the selection of a best option, during the evaluation phase, from among the possible formulated options.

Question phrasing was formulated using a phenomenological interview style. Phenomenological interviewing uses open-ended questions that allow interviewees to interpret interview questions and use a narrative answer form (Wengraf 2001). This style of questioning was found to be appropriate because social norms and values tend to be hard to articulate if asked about them directly. Using open-ended questions allow values to be embedded in answers. It is then the interpretation of the answers by the interviewer that articulates the mental model (including frames of reference) of the interviewee. The semi-structured interview allowed for answers of the written questions to be probed further for more details of the frame of reference. Specifically, ten interview questions were formulated and used to ascertain the following information.

1) What does the landowner value in owning this specific piece of land and where do these values derive from? *(Interview Questions # 1, 2, 3 and 10)*

2) What is required for the property to be a desirable place and where does tha desirability derive from *(Interview Questions # 4, 5, and 6)*

3) How is 'fuel wood' defined and how does it relate to the rest of the site? (*Interview Questions # 7, 8, and 9)*

Interview Questions:

1) Tell me about your history with the property, beginning with your decision to move from your previous residence.

2) Do you have long-term goals for the use of your property? If so, please describe your goals.

3) You mentioned that you had chosen this property because you wanted to ___. In what other ways do you use the property

4) In what ways have you changed the property as a result of your desired uses Please explain why these changes were made? (Or, if no changes have been made, why you have taken this approach?)

5) Since first seeing the property how has it changed?

6) Are the changes you are making to the property enabling you to meet your goals? How do you measure "success" in meeting your goals?

7) Do you burn wood that you've collected from your property

8) Tell me about a specific experience that you've had while collecting firewood. Please, describe the experience, as it happened.

9) Do you feel that you have to balance wood collection with other goals and uses? If so, how do you do that? If not, why not?

10) Is there anything else you would like to discuss regarding the use of your property? (Are there any other issues or concerns you face during the year?)

Property Walk

From the SRM decision-makers are seen to react to internal and environmental cues, form goals from those cues, and take action to achieve those goals. Options are formed, weighed, and selected based on their ability to successfully fulfill the goal. When the best option is acted upon it becomes a decision rule. Decision rules are then tested in the Learning Phase of the SRM. Successful rules are retained for further use. It is assumed that fuel wood collection follows decision rules. These decision rules are complex and are not directly accessible to decision makers. Rather than asking directly about decision rules, it is often more effective to observe people's behavior and decipher rules from what they do, how they communicate ideas, and how they respond to various aspects of their property.

A property walk is a mobile interview in which the researcher walks with the landowner through the fuel wood collection process. Particular attention is paid by the researcher to environmental cues used to define fuel wood, wood preferences, and impacts to he natural resources of the property (Sevilla and Jordan 1996).

A property walk is conducted by having both the researcher and the landowner take the opportunity to ask questions about resources and discuss how they are used while actually observing the situation in question. The participant and researcher together not significant boundaries, usage patterns, resource occurrences, and other significant issues arising along the walk.

The walk need not follow a straight line; it may be more interesting to purposefully orient the walk to take in places of particular interest such as a sacred grove or private orchard. It is useful to look for signs or otherwise discover that resources are being used (cut branches, children or adults collecting fruits) or tha there are controls on resources (e.g. fences, thorn pickets around trees, signs of spiritual uses of areas or resources) (Sevilla and Jordan 1996).

Property walks can be helpful in focusing on such issues as where resources are located, how and by whom they are used, how much pressure exists on specific resources, what the rules of access are, and whether there are conflicts with other site goals.

Property walks were recorded using a handheld voice recorder. Transcripts of the conversation were made noting specific conversational topic points. The information was then used to inform the CIM model

Concept Mapping

Concept mapping is a technique used to help individuals (or groups) to organize complex and diverse ideas into an understandable and coherent framework (Trochim 1989). It is a process that involves a series of structured and discrete steps to arrive at a pictorial representation, in the form of a map or diagram, of the interrelationships am ideas. Concept mapping was applied here to help landowners depict the various ideas, materials, and cues used to generate fuel wood for their property (Appendix A). Thi process was instrumental in depicting the logic used to interact with wood as a resource.

The process was guided by a facilitator (the researcher), whose job it was to lead a participant through the various steps in the process. The participant was asked to generate responses to a focal question, organize the thoughts, and interpret the results.

Landowners were asked, “Why do you collect wood the way that you do?” The facilitator then recorded statements in a brainstorming session. The landowner was then asked to organize the statements and define what the underlying order appeared to be. Landowners were then asked to draw on a sheet of paper (12”x18”) a concept map depicting the organization of how fuel wood is selected and collected. These maps served as the basis for the fuel wood collection diagrams (Figures 8, 9, and 10).

Fuel Wood Collection Diagrams

Data collected from the semi-structured interview, property walk, and concept mapping exercises were used to form an understanding of fuel wood collection decision-making in both depth and breadth. The semi-structured interview was used to reveal the frame of reference of the landowner while the property walk and concept map were used to reveal the decision cues and rules.

Data collection was aimed at determining both the criteria used to select wood (i.e. defining ‘fuel wood’) and the rules that establish the rate of harvest o the selected wood. In this respect, CIM models are composed of three interconnected modules: a selection module, a harvest rate module, and a natural process module.

The selection and rate modules were developed from the information gathered during the data collection exercises. Raw interview responses were converted into a more usable format by transcribing quotes containing idiosyncratic speech (e.g. “giving it back to nature”) and factual information (e.g. consider pet fence a contradiction to “giving back”). An attempt was made to preserve the response information as it was reported; interpretive statements were not included in the transcription.

The transcription of the interview data (semi-structured interview and property walk) and the concept map were then interpreted to extract selection and harvest rate determinants. Statements containing ‘evidence of intention’ formed the basis for data interpretation. ‘Evidence of intention’ is defined as statements that represent the conscious or unconscious inclusion or exclusion of internal or environmental cues. In essence, ‘evidence of intention’ is a statement that reflects the selection of decision cues and rules of behavior. For example, the statement that, the “less grunt work” the better, implies a preference to minimize the manpower needed to collect fuel wood.

Only comments rendered during an interview were interpreted. No intentions were assumed unless evidence was present in the interview materials. By design the interview style (using open-ended questions and a phenomenological data collection strategy) allows landowners to convey what they feel is the most important information without influence from predetermined survey responses or efforts to please the interviewer. Statements were classified as part of the selection module if they seemed to represent a determining factor in how wood in the forest was regrouped as 'possible fue wood' or 'non-fuel wood'. Statements were classified as part of the harvest rate module if they were felt to represent a determining factor of how much wood was collected fro the 'possible fuel wood' group.

The natural process module relied on the landowner's definition of fuel wood. I wood was collected from CWD sources then the natural process module was developed to represent the dynamic recruitment and decomposition process of CWD. If wood was collected from standing live trees then the natural process module was developed to represent the dynamic opening and closing process of the forest canopy (determined to be a general guide to stand successional state). The natural process module in either case (or a combination of the two) was developed from the understanding of forest ecology gathered in Phase I.

All three modules combined form a complete CIM model. CIM models were created with the assumption that decision-making is very complex and always evolving. CIM models created for this study are knowingly incomplete and were created with the assumption that models are not capable of capturing the entire decision-making process. Furthermore, natural process modeling in this context was formulated at the stand level to represent stand level linkage of fuel wood harvesting to the productivity of the forest. The dynamics represented are, like decision-making, highly complex. Therefore, CIM models were created with the intention of forming a foundation model that could be used as a basis for refinement.

CIM is intended to be an iterative learning process. The addition of new information and the reformulati n of the foundation model are fundamental to advancing the understanding of decisio -making feedbacks between people and the environment.

CIM Evaluations

Each landowner was presented their respective CIM model. Each variable within the model was explained and the decision-making process revealed. Expected outcomes and conclusions drawn from the CIM models were also explained. After answering any questions landowner's were then asked to evaluate the CIM process including their model. Landowner's were asked the following questions. Any additional comments given by the landowner concerning the CIM process were also listed.

Evaluation Questions:

1. Do you feel that the model correctly depicts your fuel wood collection practice

2. Do you feel that you benefited from the CIM process?

3. What did you learn from the project? Or, what had you hoped to learn but did not?

4. How could the project be done differently? Do you have any suggestions?

5. Do you plan to use the findings from this project? If so, how

FINDINGS and MODELING CONCLUSIONS

Three landowners were asked to participate in this CIM demonstration project. The three landowners represent very different ideas about fuel wood, its definition, use, and longevity of the resource.

PHASE I

Findings from Phase I describe the decision-making context of fuel wood collection at the study site.

Social Context

Many different people care about the forests in Montgomery County. Each o these 'stakeholders' acts on the best information available to them to ac hieve their professional and social (personal, familial, and/or interest group) goals. The information each stakeholder uses to form goals and make decisions is often particular to their professional or educational background. Socio-political involvement may also be a significant factor in goal setting and decision-making. It is assumed that no one person or profession is capable of acting alone to protect the forest as a resource. Each stakeholder, it could be said, is linked to the others via some decision-making web of interactions. Some interactions are adversarial while others are cooperative. The cumulative effect o these interactions and by implication the effect of all decisions is the actual managemen of the forestland.

Landowners in the social setting of Montgomery County are part of a hierarchy o decision makers that ultimately dictates the management of the forests along the Wildland/Urban interface. In the broadest sense of the term the interface includes an large stand of forest that adjoins suburban developments. Montgomery County is an excellent example of this situation. The majority of the county is still forested bu pressure is mounting to subdivide large parcels and develop land. The major portions o parcel subdivisions are occurring along transportation corridors (Figure 2). However, rural large lot housing is also a salient form of expansion into forestland. One such large -lot neighborhood is Preston Forest.

Developed in the early 1990's Preston Forest was developed to be large residential lots (+3 acres) with septic drain fields and well water. The developmen serves an excellent laboratory for studying the Wildland/Urban Interface for two reasons. Firstly, the development extends up to the property boundary with JNF, actually utilizing an old Forest Service fire road as a residential roadbed. Secondly, JNF has recognized the unique situation that it poses and has responded by creating a Wildland/ Urban Interface management designation along its border in Montgomery Co unty.

The Preston Forest neighborhood served as the study area for this CIM project (Figure 4). Three landowners were selected from this neighborhood to participate in the CIM project (Figure 5). Each of them received a codename (Harvey, Diane, and Eliza eth) and their properties are described below (see Physical Context).

The Wildland/Urban Interface management designation points directly to the increased risk of wildfires to encroaching residential developments. The primary focus of the management is to create a "defensible space". This means reducing the fuel load of the forest through clear cutting, thinning, and prescribed fires (U.S. Dept. of Agriculture 2003b p3-35).

The JNF has recognized that these management activities will have an impact on local residents. Therefore, as part of the designation's objectives it has included an education component to help property owner's along the Interface recognize the importance of reducing fuel loads as well as promoting a "long-term ecological aesthetic." (U.S. Dept. of Agriculture 2003b p 3-35). Ninety percent of the wildfires are human-caused (U.S. Dept. of Agriculture 2003 p 1-3). The JNF seeks to have a cooperative relationship with boundary landowners seeks input and feedback to its policies. The management of the Interface is expected to have shor -term aesthetic impacts but over the life of the policy will provide sustained improved views.

While Landscape Architects are not the primary service providers by any means, all landscape professionals working in this area will also need education to properl facilitate the maximum benefit of the JNF policy. Landscape professionals working in collaboration with the JNF will be capable of reinforcing the "ecological aesthetic" education effort and can help make creating defensible space desirable, and alleviate cross-boundary conflicts.

Landowners in Preston Forest are, generally speaking, both the "land management administrators" and the "field technicians". Administration requires information to set policies in place. Understanding where landowners are obtaining information from can help other land managers see themselves as part of the management hierarchy. diagram was created depicting the flow of information that landowners receive as the seek management options (Figure 6).

A brief survey of information sources was collected for Montgomery County and uncovered six (6) major sources of information landowners turn to when making management policy, they include: Regulations/Regulators, Service Providers, Non-Government Organizations (NGOs), VPI Extension Service, Virginia Department of Forestry (VDOF), and other landowners (Virginia Forest Landowner Update, Jenkins 2002, Boucher 2003, and Powers 2003). Of these information sources, informal associations among landowners were found to be the most utilized information source (Jenkins 2002).

VPI's Extension Service plays an important role for landowners. Extension provides a touchstone for accessing other sources of information. When a landowner contacts the extension office with a question an extension officer may handoff the landowner to one of the other information sources, thereby serving as a surrogate information filter for the landowner. This activity helps to administer the management o lands by directing landowners to 'preferred' service providers or 'preferred' services.

It was found that Extension Service personnel often hand landowners off to the VDOF for further assistance (Jenkins 2002). The VDOF, as part of a larger bureaucratic system, gains input from other departmental agencies and from within its own structure.

Residential NIPF owners tend to own small parcels and are therefore not regulated under VDOF regulations. Since they exist outside of the VDOF jurisdiction they are not regulat ed to erosion, aesthetic, or water quality standards that apply to larger forested parcels (Powers 2003). Residential NIPF owners are regulated at the local leve via town and county zoning codes (Powers 2003). At least one land developer has enacted a site-level set of covenants to protect the residential forest. However, upon further investigation, it was found that many landowners tend not to follow the covenants in full.

Service providers and NGOs both provide information directly to landowners and offer options for management practices. However, service providers differ from NGOs because they offer information with the implication that they are trying to maximize their business opportunities and profits. The effect of this may be that good management information is not offered in lieu of profit-oriented information, thus skewing the landowner's possible management options away from 'best management practices' (Boucher 2003).

Physical Context

Historically, agriculture and forestry have dominated he land use in the county. However, the population of Montgomery County, Virginia has been steadily increasing over the last 20 years at a rate of about 10,000 new residents per decade (Montgomery County 2000)

As the total population continues to rise the demand for buildable land has also increased. This increase in land prices has shifted land use from a focus on agriculture and forestry to a focus on residential building. Lands historically thought not to be economically viable have found a market due to the increased demand for residentia sites. The land use trends follow a national trend of urban sprawl with developmen occurring along established transportation corridors. With the increase in the housing stock parcel sizes have decreased to accommodate the new development. The decreasing parcel size is associated with an increase in landscape fragmentation. The result is a loss of forest cover predominantly on smaller parcels less than 50 acres (Figure 2).

Currently, the majority of land in Montgomery County is still classified as forestland (65%). While agriculture (26%) and urban land use (9%) comprise the remaining 35% of the landscape (V -GAP 1999) (Figure 3). The forest cover is expected to decrease as the result of continued population expansion.

Montane Dry Deciduous Forest Complex and Montane Mesic Deciduous Forest Complex dominate the forest cover in Montgomery County (VA-GAP 1999). These species complexes contain predominantly oak species (*Quercus -alba, rubra, velutina, prinus, stellata, falcata*) but also contain a variable mix of hickories (*Carya spp. -ovata, cordiformis, and glabra*), Tulip Poplar (*Liriodendron tulipifera),* and Sugar Maple (*Acer saccahrum)* on steep, Sout -facing slopes, convex areas, and at higher elevations (VA -

GAP 1999). Concave landforms on lower grades, and more northerly aspects tend to have a variable mix containing more Red Maple (*Acer rubrum),* Black Locus *(Robinia pseudoacacia),* Sweet Gu *(Liquidambar styraciflua),* Black Tupelo *(Nyssa sylvatica),* Birch *(Betula spp. -alleghaniensis, lenta, nigra*), Magnolia (*Magnolia spp. -acuminata, fraseri*), and American Beech *(Fagus grandifolia)* (VA-GAP 1999). Predominant pine species include *Pinus spp. -strobus, echinata, virginiana, and taeda* (US Dept of Agriculture 2003 p*3-48*). Table Mountain pine (Pinus pungens) is also found in the area, typically located on convex, south to west slopes of steep spur ridges, narrow rock crests, and cliff tops (US Dept of Agriculture 2003 p*3-48).*

These species complexes are also representative of the Jefferson National Forest. Approximately 76% of all JNF lands are classified as oak or oak-pine forest (US Dept of Agriculture 2003 p3-48). The New River Ranger District monitors the Jefferson National Forest (JNF) land existing within the boundary of Montgomery County. This portion of the JNF is approximately 25,000 acres; approximately 3.5% of JNF land in Virginia.

Approximately 93% of JNF oak and oak-pine forests are classified as being in mid- to late-successional stage or older han 40 years (US Dept of Agriculture 2003 p*3-49)*. This percentage, while slightly above normal, is consistent with other Southern Appalachian forestlands. The skewed age distribution may be due to disturbance suppression. Thinning and prescribed fire have not been utilized as a primary management tool. Oak and oak-pine forests are somewhat disturbance dependent and may not perpetuate themselves if disturbance is absent. Fire has historically played a major role in establishing and maintaining the plant communities of the Appalachian Mountains. However, the JNF DEIS notes that little forest restoration is needed in areas of oak and oak pine since these forest types are quite plentiful, well distributed, and generally occupies appropriate sites" (US Dept of Agriculture 2003 p*3-50).* Table Mountain pine communities however are being threatened due to fire suppression (US Dept of Agriculture 2003 p3-96).

An effect of the skewed age distribution has been an elevated hard mast and den sites for late success onal stage dependent animals. However, early successional stage dependent animals have declined. A revised forest management plan recently adopted b the JNF proposes the utilization of thinning and prescribed fire to redistribute the age classes and improve early successional stage habitat.

Long-term, widespread fire suppression may be causing some stands of Table Mountain pine to succeed to closed, mixed oak-pine forest (US Dept of Agriculture 2003 p 3-96). Major insect pests include the gypsy moth, southern pine beetle, and hemlock woolly adelgid. Major disease problems include oak decline, dogwood anthracnose, and shoestring root rot. It was noted that increased edge effects are likely within 200 feet o the JNF boundary. Additionally, invasive biota is seen as a major threat to the long-term management of the JNF. There are currently 30 species of invasive plants listed by the JNF (US Dept of Agriculture 2003 p3-103).

Of particular interest is the management designation Wildland/Urban Interface. This management designation occurs along the southern boundary of the JNF in Montgomery County where the JNF abuts residential developments and applies to approximately 3,900 acres (1% of JNF land) (U.S. Dept. of Agriculture (b) p3-35) (Figure 4). The purpose of the designation is to minimize the risk of wildfires to encroaching residential developments. The primary focus of the management is to create a “defensible space” which primarily means reducing the fuel load of the forest through clear cutting, thinning, and prescribed fires (U.S. Dept. of Agriculture (b) p3-35).

The fuel load to be reduced is composed of dead woody material (e.g., standing dead trees, fallen trees, limbs, and large root masses) known as Coarse Woody Debris (CWD) (Van Lear 1993, Tietje et al. 2002). Residents near the Wildland/ Urban Interface use this wood as a primary source for fuel wood.

Understanding the recruitment and decomposition of CWD is an importan component of the ecological setting. CWD is important to the productivity of the forest. It serves as sites for seed germination, long-term storage of moisture and nutrients, and as critical habitat for many species. As CWD decomposes it also promotes good soil texture (Van Lear 1993, Hunter 1990 p.163, Tietje et al. 2002, Kimmins1997 p. 61,62).

When seen as a subsystem of the forest inputs and outputs of the CWD stock can be recognized. Understanding what regulates the input and output from the system wil help to regulate the stock volume. In more practical terms, C WD volumes can be monitored and altered to achieve the goals of the JNF management objective or the goals of private landowners.

Mechanical disturbances and fire damage trees and add to the CWD stock. Disturbances include wind, lightening, insect infesta ions, disease, ice storms, competition, and human caused damage and timber harvesting (Van Lear 1993, Tietje e al. 2002). Decay, fire, and harvesting are ways that the CWD stock is reduced (output). Fire has the potential to increase, decrease, or transform the CWD stock. Increases occur by weakening or killing trees and/or limbs, decreases occur when complete combustion eliminates a piece of CWD, and transformation refers to the incomplete combustion of a piece of CWD; essentially aiding decomposition (Van Lear 1993).

Wood that is not consumed by fire or harvested returns its nutrients to the forest floor where other organisms take them up or they are released to the atmosphere. Once wood dies it begins its decomposition by being attacked by microbes and fungi. As the wood structure is broken down other mechanisms come to aid in decomposition such as mechanical fragmentation, boring animals, chemical reactions. The final products o decomposition are CO_2, humus, and fine woody debris (Van Lear 1993) . The decomposition of all litter fall is regulated by many factors including moisture, temperature, pH, exposure to oxygen, relative abundance of biologically and chemically active soil matrix, and the composition of the litter itself Kimmins1997 p. 55). The rate of decomposition tends to increase closer to the equator (with higher temperatures and humidity), as soil texture improves, at moderate elevations, and on northerly slopes (Kimmins 1997 p.55, Van Lear 1993).

From this assessment it is assumed that as decomposition increases the productivity of the stand will increase in response. In turn, improved stand productivity will supply the forest with more CWD via increased disturbances (as defined above) thus becoming a reinforcing loop. Other issues in forest ecology (e.g. succession, land use change, etc.) can obviously offset this reinforcing loop because forests can neither have infinite productivity nor an infinite CWD load. These topics will not be addressed as par of this study.

For the purposes of this study a causal loop diagram has been constructed to depict the dynamics of CWD (Figure 7). In this diagram CWD harvest and wildfire are also represented due to their applicability to the landowners in this study. Harvest is a form of land management, a form of negative feedback (or a behavior that curbs the reinforcing CWD loop). Fire as depicted in the diagram is also a negative feedback referring to the possible effects of high intensity wildfires due to fire suppression and an exaggerated CWD stock.

Three landowners were selected to participate in this study. Each of the participants was given a codename (Harvey, Diane, and Elizabeth). The following is a brief description of their properties.

'Harvey': This 5-acre property is located along the ridgeline of Brush Mountain and is separated from JNF by a paved residential road. The property slopes to the south at less than 16%. Hardwoods dominate the property, with a few white pines planted by the previous landowners. Fruit trees are also found onsite, which were planted as a hobby by the current landowner. Much of the property was heavily disturbed in the early 1990's when an ice storm damaged a significant portion of the property's trees. Currently some portions of the property remain open but generally the forest has reestablished itself. A stand of even aged trees approximately 3-inches in diameter occupies the center portion of the property. Small-scale "farming" is a major use of the property. Fruit trees, berries, vines, and mushrooms are grown onsite (Figure 8).

'Diane': At 22-acres this property is the largest of the three cases and is bounded almost entirely by other forestland with the exception of the paved residential road servicing the property. A wide range of ecological niches occurs on-site. The site overlooks a valley and extends over the valley to another ridge. Hardwoods dominate the uplands with pines occupying the southwest slope of the valley. Rhododendrons dominate the lower slopes and floor of the va lley where a small stream flows year round. Valley walls average a slope of less than 25% while portions reach a maximum of 33%. The landowner has buil a road capable of supporting a tractor extending from the residence to the drain field. The drain field is located on the far ridge (Figure 9).

'Elizabeth': This 8-acre property represents the most northeasterly parcel of the Preston Forest neighborhood. Except for an abandoned fire road that runs between 'Elizabeth' and the JNF this parcel represents the closest neighbor to JNF. The fire road is the flattest part of the property with slopes less than 8%. The majority of the property slopes between 16% and 25%. The entire site is dominated by hardwood species although a few white pines have been p lanted near the driveway (Figure 10).

PHASE II

Phase II presents the CIM models developed in collaboration with each landowner ('Harvey', 'Diane', and 'Elizabeth') (Appendix A). In addition, Phase II also presents conclusions of system behavior based on the findings from each landowner's CIM model. These conclusions represent the feedback dynamics expected to occur due to the landowner's selection rule and harvest rate.

'Harvey' Findings

Having lived in cities for several years 'Harvey' moved to Presto n Forest looking to fulfill dual goals of having a vacation house and an "every-day" home. Wood being collected on the 'Harvey' property was identified by the landowner as a "hobby". Although the primary source of heating on the property is fuel wood (e timated at 70-80%) onsite fuel wood is expected to provide only 20% of the total annual inventory. Offsite sources provide the bulk of annual inventory. Onsite sources are used when available but offsite sources are used when onsite sources are not readily available.

Due to a major ice storm that hit southwestern Virginia in March 1994 a significant portion of the trees on the property were damaged. Wood was salvaged from this even and stockpiled prior to the arrival of the current resident (4-6 cords were salvaged). This stockpile has been used to heat the home since 1997 (the arrival of the current resident). Recently this stockpile has run low. Harvesting by the current resident has supplemented the original inventory. The bulk of the current residents' harvesting has been associated with land clearing for small scale farming operations including fruit trees and berries. This source of wood has also reached its climax because farming activities have reached their desired level or spatial distribution. In the future, wood from off-site sources will be purchased and supplemented with on-site wood. Future on-site sources will compose a smaller percentage of the total annual inventory than historical conditions (20% versus 100%). The following is a narrative of the current collection procedures. The CIM model depicts these procedures (in blue, Figure 8).

Wood from 'Harvey' is used for two goals: 1) to provide home heating, and 2) for mulch to be used for 'small scale farming'. The dominance of goa -1 versus goal-2 is indeterminate. While goa -1 appears to be the dominant wood usage this investigation has not determined if mulch production would stop if fuel wood collection were to stop. For the purposes of this discussion goal-1 (fuel wood) is expected to remain the dominan goal over the ownership of the property. This assumption is based on relative wood volumes collected for each goal per period of time.

Fuel wood used on 'Harvey' comes both from onsite and offsite sources. Fuel wood collected onsite will be defined as 'hobby wood'. Offsite sources of fuel wood will be defined as 'delivered wood'.

Potential 'hobby wood' is identified via the perception of at least one of the 'conditions for collection', as defined by the landowner. Those condi ions include:

a) "Does the tree block light to my fruit trees?"
b) "Does the tree block the view from the house", and
c) "Is the tree damaged?" (Included in this definition are: 'has the tree fallen down in an area that interferes with other site activities', 'is it standing and damaged', is the tree included in a firebreak area').

After defining potential 'hobby wood' the actual collection of individual candidates is governed by a 'harvest selection' rule. This rule weighs 'hobby wood' candidates against floating goals of 'inventory', 'emotional significance', and 'positive effect on other goals'.

Floating goals are goals that change based on the perceived state of the system. Decisions made using floating goals reference the perceived state of the system relative the actual state of the system. For example, the goal of 'emotional significance' of a tre fluctuates by observing the perceived guilt associated with cutting down verses the expected guilt associated with cutting down a tree. The goal is met whe n perceived guilt does not exceed the expected guilt associated with cutting down a tree. Therefore it could be said that cutting the tree down is not emotionally significant. It was decided floating goals were necessary to communicate the landowner's fluctuating feelings toward the removal of a tree. One day the landowner mentioned that he felt the need to remove a tree but the next day felt they should leave it. This "floating" goal expresses that feature of the decision-making rule. The state of each floating goal is based on the following, as mentioned by the landowner:

'Inventory'--- *inventory level relative to usage rate;*
'Emotional Significance'--- *the perceived guilt associated with the harvest of a tree, and the determination of whether the collection of fuel wood would "heat you twice" (physical activity and heat), and;*
'Positive effect on other goals'--- *the perceived state of the view, perceived effectiveness of the firebreak, and on 'farming activities'.*

Wood is selected for harvest when 'inventory' is low, when 'emotional significance' is low, and when 'positive effect to other goals' is high. Otherwise, wood is collected from offsite via 'delivered wood'. 'Hobby wood' is preferred to 'delivered wood' and is expended before seeking 'delivered wood'.

Fuel wood collection is carried out via two major stocking procedures: 'roundup events' and 'delivered wood'. 'Delivered wood' is expected to be the dominant stocking procedure with 'roundup events' supplementing annual inventory. 'Roundup events' occur on an as needed basis (determined by the 'hobby wood' rule).

After selecting a piece of wood for harvest (via the 'hobby wood' rule) severa steps are employed to turn the selected wood into harvested fuel wood inventory. Firstly, the selected tree is cut down using a gas-powered chainsaw; making sure to guide the tree away from other trees and plantings (to prevent damage). The tree is then cut up into logs for the wood stove. An SUV is driven onto the property via previously existing paths. (The paths were created by the previous owner and are used by the current owner. When questioned whether he might create paths if none were present 'Harvey' responded by saying that he would not). Logs are loaded into the SUV and driven via the pa ths to the staging area. The logs are then off loaded. As many trips as necessary are made using the SUV to haul logs to the staging area until either the inventory becomes full or all the wood has been transported (whichever comes first). Logs are then split, stacked, and added to the inventory. A smaller cue of fuel wood is gathered from the staging area once a week to be used in the wood stove. The cue is stored at the house entrance closes to the wood stove.

A chipper is rented as needed to chip all non-fuel wood material (<4-inch) and brush. The chip piles are created at the site of the tree felling. Piles of chips are treated with nutrients (nitrogen) and allowed to compost. As the chips decompose they are added as mulch to plantings associat d with the farming activities, as deemed necessary.

‘Harvey’ Modeling Conclusions

Three major conclusions were drawn from the collection techniques (as noted in red, Figure 8). 1) Future harvests can be expected to derive primarily from ‘damaged trees’; 2) A significant one-time harvest event can be expected when existing even aged trees block the view; and 3) ‘Hobby wood’ collection will be inhibited over time.

1) **Future harvests can be expected to derive primarily from ‘damaged trees’.**

With farming activities believed to be at a maximum, the harvesting of trees to provide sunlight to plantings is not expected. Tree growth is expected to block the view from the house over time. However, the most significant remaining source of ‘hobby wood’ is expected to be wood from damaged trees due to natural mortality and disturbance events.

2) A significant one-time harvest event can be expected when existing even-aged trees block the view.

Harvesting activities performed by the previous owner has left an even aged stand of young trees (<4-inch) inline with the view from the house. Without additional management this stand is expected to grow in height as a single unit. This growth pattern would lead to a blockage of the view if left unmitigated. When the view becomes blocked a mass harvesting will need to be performed to reopen the view yielding a significant onetime ‘hobby wood’ harvest and leaving an unplanted slope. Mitigating harvest patterns should be examined to relieve this growth pattern.

3) ‘Hobby wood’ collection will be inhibited over time.

Barring an increase in farming or a significant disturbance event ‘hobby wood’ collection is expected to decline over time. This is expected because perceived guilt associated with harvesting trees is expected to increase as the significance of existing trees grows, the perceived significance of “heats you twice” declines as ‘delivered wood’ becomes the norm and adjusts the floating goal. Additionally, as other site activities become more established (i.e. the fire break a nd fruit trees and berries) the fewer positive effects will be found from harvesting.

Current linkages to the environment (fuel wood specific)
View retention
Shade cast by existing trees
Fire hazard level (moisture content and proximity to the house)
Farming practices
Individual tree health

Possible linkages to the sustained collection of fuel wood include the following:
Damaged tree recruitment rate
Management techniques to resolve the even-aged stand

‘Diane’ Findings

Diane expressed childhood memories of having forest and his association with the forestry profession as reasons for owning the land. Fuel wood collection on the ‘Diane’ property was found to be the most intensive of the three landowners. The collection techniques seen at ‘Diane’ involve the use of a tractor, employing outside help, and are considered imperative to household operation, as fuel wood is the primary heat source. The following is a narrative of the collection procedure. The CIM model depicts these procedures (in blue, Figure 9).

Two major uses of wood on ‘Diane’s’ property are fuel wood for home heating (wood w/ dia. >4-inch) and wood for bonfires (wood w/ dia. < 4-inch). Fuel wood collection is the primary goal of wood collection. Bonfire wood is a secondary goa achieved through the collection of fuel wood. Fuel wood selection follows a prescribed 'Opportunity Preference' or weighted additive decision rule.

Points are awarded to dead wood (sole source of fuel wood) found on the property based on its 'opportunity for collection'. The landowner does not actually award points. This convention was only used to communicate the logic of the selection procedure. 'Opportunity' is divided into three categories: high, medium, and low. These categories are scored on their preference of ease of access, species selection, timing, and aesthetic goal achievement.

A high score of one (1) is awarded to wood for each of these categories when wood is easily accessed (<50-feet into the forest), is either oak or hickory, or is collected during the spring of early fall (when labor is most available). Annual fuel wood collection is primarily carried out during the spring and fall. An effort is made to have the annual supply prepared for use by Thanksgiving.

Medium scores are awarded a value of half (0.5). Medium opportunities exist when wood is between 50'-100' into the forest, is either maple or birch, and the opportunity occurs during summer.

Low scores are awarded when access to wood is difficult (> 100-feet), wood is of non-preferred species (pine, poplar, gum), or is to be collected during the of -season (winter). Low scores are given a preference value of one-quarter (0.25).

Aesthetic goal achievement is given a score of one (1) if collection of the wood does not detract from the perceived view from the house or utilizes an "ugly" tree; otherwise a score of zero is awarded (0).

Wood is collected when its preference score is highest among all possible preference scores. In the event of a tie the possible options are re-weighed. A heavier weight is then given to access, as access was mentioned by the owner to be the "wors part" of collecting wood.

To gain further access to wood stocks a road was constructed through the property. Careful attention was given to the construction of the road to protect the view from the house and prevent unnecessary weakening or killing of trees as well as erosion prevention (cross sloping and planting ground cover on the road).

Wood found on “another” site (off-site) and used on-site is considered to have a ‘perfect score’ (4). Wood from other sites is used to supplement the onsite wood collection when shortfalls in stacked inventory occur. This supplementation procedure is a function of prevailing weather conditions and therefore if it occurs, it occurslate into the annual usage cycle.

Fuel wood collection is carried out via three major stocking procedures: ‘weekend events’, ‘personal events’, and ‘wood from other sites’. ‘Weekend events’ utilize outside help (the owner’s three sons) to collect the bu lk of the annual fuel wood stock. ‘Personal events’ are performed on an as-need basis to supplement ‘weekend event’ collections, gathering the remainder of the required annual stock. ‘Personal events’ are seen as a quality of life benefit and were noted to be “good honest work” and tied directly with the larger goal of owning the property, or “pride in owning land”.

‘Wood from other sites’ is considered a secondary supplement to the ‘weekend events’. The wood collected from ‘other site’ events is of very low volume and is only gathered during times when the collected inventory is low and the owner’s time is at a premium. ‘Wood from other sites’ is therefore important but its impact on onsite wood collection strategies is considered to be negligible.

For ‘weekend events’ and ‘personal events’ the fuel wood collection procedure is the same. After selecting a piece of wood for harvest (via the Opportunity Preference rule) several steps are employed to turn the selected wood into harvested fuel wood stock. Firstly, a tractor hauling a large wheeled cart is driven to the collection site via the collection road. Then, if necessary, the tractor is used to haul the tree closer to the road to reduce carrying distance to the cart. The tree is then cut to 22” lengths (the width of the woodstove) using a gas-powered chainsaw. These rounds are then loaded onto the cart and driven to the staging area. Wood rounds are then offloaded and stacked. This process is repeated until the inventory of fuel wood has met the desired level. Once a year an industrial wood splitter is rented to split the major portion of the annual inventor of wood rounds. After that, any additional splitting is done by hand. ‘Wood from other sites’ is brought in whole and split by hand onsite and added to the staging area inventory. After splitting, wood is restacked at the staging area. A smaller cue of fuel wood is gathered from the staging area once a week to be used in the wood stove. The cue is stored at the house entrance closest to the wood stove.

<u>'Diane' Modeling Conclusions</u>

Four major conclusions were drawn from the collection techniques (as noted in red, Figure 9). 1) Road access is the limiting factor in collecting fuel wood. 2) As high preference options decline, management of the stand will intensify. 3) As labor becomes less available (due to the life choices of the sons) collection of the annual inventory wil be affected. 4) Although fuel wood is the primary heating source the longevity of its collection has not been examined.

1) Road access is the limiting factor in collecting fuel wood.

The 'Diane' property encompasses 22 acres of forestland. To increase the acreage available to fuel wood harvesting a road was constructed that bisects the property (from the house to the drain field). This action increased the wood available for collection in two ways: 1) disturbing trees to install the road and 2) making access to standing dead trees and CWD within 100 ft of the road. In total, the current road allows access (<100') to approximately 8 of the 22 acres, less than 37% of the total acreage. As fuel wood is harvested along the road 'high' quality wood sources will be depleted overtime and result in more low quality opportunities. The increase in low quality opportunities will r esult in increased time spent collecting fuel wood both by the reduced heating power of the low quality species (meaning more wood collection for the same BTUs) and more hauling to gather wood farther from the road.

2) As high preference options decline, management of the stand will intensify.

The owner, after reflecting on his collection techniques, mentioned that he was thinking of installing another road "along the creek". Further questioning revealed tha he was also open to thinning the forest to achieve the heating goals. This has lead to the conclusion that over time management on 'Diane' will increase. Propagation of trees is not expected to be done via plantings.

3) As labor becomes less available collection of the annual inventory will be affected.

Low and medium access opportunities can be justified with the extra manpower associated with 'weekend events'. Manpower was also found to be important in the volume of wood collected because collection involves carrying 22-inch long cuts of wood from the collection site to a tractor for transport to the staging area. The duration o 'weekend events' is all day versus 'personal events' and 'wood from other sites', which typically last 1-3 hours. As high preference wood is used up more labor will be needed to maintain annual inventories.

However, labor is expected to become scarcer due to life changing events (i.e. marriage, travel, personal obligations) of the labor pool (less help from the owner's sons). Therefore, as 'weekend events' become ore important they will concurrently become less frequent thus failing to achieve the necessary annual inventory more often over time. As the goal is not expected to change significantly alternate policies will need to be explored.

4) Although fuel wood is the primary heating source the longevity of its collection has not been examined

Due to time scale of the goal and the other three conclusions mentioned there is expected to be a general decline in the procurement opportunities of wood and productivity of 'Diane's' stand to produce CWD. This conclusion does not presume t predict the long-term dynamics of the stand only that current polices do not consider current trends. Sustainability has not been addressed in the comments from my interviews with the owner.

Current linkages to the environment (fuel wood specific)
View creation and retention
Weather
Species preferences
Technology used to collect wood

Possible linkages to the sustained collection of fuel wood include the following:
CWD recruitment rates (species dependent)
Road Impacts
Potential weaknesses created by building roads that could increase CWD recruitmen
Available help to harvest wood

<u>'Elizabeth' Findings</u>

'Elizabeth' stated that living next to a forest as a child was a reason for wanting to own the current residence. Fuel wood collection on the 'Elizabeth' property is performed with the perspective that 'less human interaction is better for the forest'. Techniques used to collect fuel wood reflect this attitude by using only wood that is not being used by wildlife, minimizing collected CWD volume, and reducing the total heating requiremen for the house. The following is a narrative of the collection procedure. The CIM model depicts these procedures (as noted in blue, Figure 10).

There is only one major use of wood on 'Elizabeth's' property – fuel wood. Fuel wood is the secondary heat source on 'Elizabeth'; space heaters are the primary sources of heat. Additionally, inside temperatures are allowed to drop significantly (<55 degr ees) before fuel wood is used.

Fuel wood for 'Elizabeth' is derived both from on-site and off-site sources. Although onsite wood collection comprises the majority of wood used (short and medium length fire durations). Wood collected onsite is defined here as 'handy wood'. Of -site wood is collected infrequently and is used to create a stock of long burning logs. Therefore off-site wood will be referred to as 'log wood'.

Only dead wood (standing and fallen) is used for fuel wood on the 'Elizabeth' property. Furthermore, an important linkage exists between fuel wood collection and 'habitat protection' (another major goal of the property). To balance 'habitat protection' with fuel wood CWD is pre-screened to remove potential candidates that are visibly being used by birds, small mammals, or insects.

Individual candidates for fuel wood follow a prescribed 'easy-does-it' additive decision rule. Selection criteria include: proximity to observer, accessibility, species, manpower, and state of wood decomposition. Points are awarded to CWD in the these categories as follows:

Proximity is a floating goal. Wood is collected as close to the observer as possible until the desired volume of wood has been collected. As the observer proceeds from the house into the forest several potential candidates may be observed but those closest to the house will be deemed more suitable than others. If a candidate is deemed 'close' it is awarded a score of (1); otherwise, a score of zero (0) is awarded.

Accessibility is awarded points based on slope. A score of one (1) is awarded if CWD is present on flat or gently sloping grade. A score of zero (0) is given if CWD is present on a steep grade (perceived to be inaccessible). A majority of the property is steep. Therefore, onl a small portion of the property is being used for fuel wood collection. Furthermore it is not expected that 'accessibility' policy will change in the future as long as 'manpower' requirements remain low.

Species of wood preference noted during the interview are reflected here. complete list of species preferences has not been made; hence this is only a partial ranking. Oak was noted as being the most preferred and receives a score of one (1). CWD derived from oak is the most common occurrence within th is forest type. A score of half (0.5) is awarded to cedar. Pine was the least preferred species and receives a score of zero (0); it is "passed by" if found in the forest.

'Manpower' is a floating goal and is dependent on the technology being used during wood selection (i.e. hand-carry, handsaw, chain saw) and expected fire duration. All potential candidates are judged as to their potential to achieve the heating objectives with the least amount of 'manpower' (energy expended). For example, using only my hands I want to collect enough wood for a 1-hour fire. To achieve this goal I could expend the energy to collect 100 small branches, 10 medium sized branches, or 1 large log. The goal is achieved when the perceived 'manpower' necessary does not exceed he expected 'manpower'. Therefore, from experience (expected 'manpower'), 10 medium sized branches are selected (perceived 'manpower') to achieve my 1-hour fire with the least amount of 'manpower' (energy expended). Those candidates deemed to meet this goal are scored one (1) point; otherwise zero (0) points are awarded.

The 'state of wood decomposition' is a floating goal being dependent on the state of all available CWD. Candidates are evaluated on their degree of rot and evaluated against other potential candidates. Since CWD is prevalent in this area a very low degree of rot is the goal of this criterion. Candidates deemed to meet this goal are scored one (1) point; otherwise zero (0) points are awarded.

Wood is collected when its preference score is highest among all possible preference scores. In the event of a tie the possible options are re-weighed. A heavier weight is given to proximity, as proximity was mentioned to be of particular interest when collecting wood.

Fuel wood collection is carried out via three major stocking procedures: 'long term', 'event', and 'inventory'. A large stockpile of fuel wood is not kept; rather an 'on-demand' rule is used to govern CWD collection procedures. This 'on-demand' rule selects between 'event' and 'inventory' collection procedures based on their ability to produce heat for an expected duration. Small stockpiles of various wood sizes may exis as perceived fire duration is sometimes underestimated. Also, a small stockpile of 'log wood' is kept due to its slow usage rate, and large 'manpower' requirement (associated with 'long term' collection).

After selecting a piece of wood for harvest (via the 'easy -does-it' preference rule) several steps are employed to turn the selected wood into harvested fuel wood. F or 'long term' collection Jefferson National Forest (JNF) land is accessed along an unimproved fire road. A collection permit is acquired from JNF before beginning collection. 'Long term' collection typically occurs once every 12 to 18 months and is usually conducted in October. Involved with 'long term' collection events are several families. A truck is utilized to collect more wood and larger log diameters. The truck is driven along the road until a preferred CWD candidate is observed. Then chainsaws are used to cut logs into rounds the length of the chainsaw blade. Cut wood is then loaded into the truck and the process is repeated until the truck is full. The total load is divided among the participants' and dropped at the staging are for splitting , sorting, and stacking.

Typical fires burned at 'Elizabeth' tend to be of short duration (<8hours). A fire utilizing 'log wood' is perceived to burn for durations longer than their expected necessity. Therefore, 'log wood' is used least, being used typically during periods o extended heating.

'Event' and 'inventory' comprise the majority of fuel wood collected for use on 'Elizabeth'. 'Event' collection occurs when a tree falls into the driveway, walkway, or onto the house, or when a short-term stockpile is to be created during high 'on-demand' periods. 'Event' collection typically takes 1-2 hours to complete utilizing one or two people (the owners) to collect the downed wood. Stocks from this procedure are shorter lived (less than one month) than those of 'long term' (one year). A chainsaw or handsaw and a wheelbarrow are used to cut and transport the downed wood to a staging area located near the house.

'Inventory' is the most common stocking procedure and collects the larges percentage of wood used per year. When short-burn fires are needed (less then eigh hours) 'inventory' is used to collect the necessary wood. Because of the shor -burn nature associated with 'inventory' procedures the diameter of wood tends to be smal (<5-inches). Using a handsaw and either hand-carry or a wheelbarrow is used to collec and transport wood to a staging area. Associated with 'inventory' is the collection o pinecones, wood scraps, and lumber pieces used for kindling. These items are collected using the 'on-demand' rule.

All wood is brought to the staging area to be processed. At the staging area wood from 'long term' and 'event' procedures is split, sorted into various sizes, and stacked. small cue of split wood is kept nearer the door closest to the wood-burning stove. After collection 'inventory' wood is cut into rounds (small enough to fit into the wood stove) and used immediately.

<u>'Elizabeth' Modeling Conclusions</u>

Three (3) major conclusions were drawn from the collection techniques (as noted in red, Figure 10): 1) 'Manpower' is expected to grow as wood is collected nearer the house, 2) Small diameter CWD is being used faster than large diameter CWD, 3) CWD recruitment is expected to exceed CWD harvesting.

1) 'Manpower' is expected to grow as wood is collected nearer the house.

As the goal of proximity is to collect CWD that is close to the observer and the observer proceeds from the house into the forest it can be expected that CWD will be collected as close to the house as possible. However, as CWD is collected using this policy the distance between the house and 'proximal' CWD is expected to increase over time. An increased travel distance translates into increased manpower required to collec an equal volume of fuel wood overtime.

2) Small diameter CWD is being used faster than large diameter CWD.

'Inventory' collection is the primary collection procedure and utilizes small diameter (<5-inches) CWD. Therefore small diameter wood is expected to be utilized at a faster rate than CWD >5-inches. This may cause travel distance (to locate ‘handy wood’) to increase. A corresponding increase in ‘manpower’ is expected in order to collect the same diameter CWD.

3) CWD recruitment is expected to exceed CWD harvesting.

Current harvesting policies in place on ‘Elizabeth’ are expected to utilize as little CWD as possible to achieve the heating goal of the household. Recruitment rates o CWD are expected to add more CWD to the forest than will be extracted yearly. Curren policies may add to wildfire intensity during an event. It should be noted that this conclusion does not expect that one property will significantly add to the intensity of wildfire or that current policies will harm the property ecologically. Only an aggregated increase in fuel over several properties would be expected to add significant intensity to wildfire. This conclusion is only meant to reflect this property’s potential as part of a larger aggregate. Furthermore, in the absence of wildfire, species associated with CWD usage will be expected to increase while wildfire dependent species will decrease (due to natural mortality).

Current linkages to the environment (fuel wood specific)
Weather
Species preferences
Technology used to collect wood

Possible linkages to the sustained collection of fuel wood include the following:
CWD recruitment rate as modified by current collection policies
‘Proximity’ preference

LANDOWNER CIM-EVALUATION

After CIM models were presented to the landowners, questions regarding the layout and content of the model were answered. Landowner’s were then asked five questions addressing the accuracy and usefulness of the CIM process. Any additiona comments given by the landowner concerning the CIM process were also listed. The following is a summary of the landowner’s sentiments (see transcripts in Appendix A).

Do you feel that the model correctly depicts your fuel wood collection practice?

All three participants felt that the model correctly depicted their fuel wood collection practice. However, one of the three andowners felt that his model should have included his efforts to provide for wildlife. This issue (wildlife) was not addressed in his data collection interviews as part of his fuel wood collection practice and was therefore not included in his model. While restrictive, this rule of thumb was used to retain the clarity of the interview direction and highlight the need for iterative modeling.

Other comments included statements that reflected satisfaction such as “makes sense to me” and “…looks like you’ve covered it well.” These statements should not be misconstrued to mean that the full depth and breadth of fuel wood decision-making was revealed. Rather all information that *was* collected was accurately represented. As one landowner pointed out “You’d just about have to do a year long case study…” to get all the information.

Do you feel you benefited from the CIM process?

Each landowner felt differently about the benefits of their experience. One landowner did feel that he benefited from the experience, one landowner said he benefited because he felt the CIM process did not invalidate his management strategies, and the third landowner said he did not feel any benefit from the process. Overall the feelings of benefit from the CIM process, as it was carr ed out, were subtle at best. discussion of increasing the benefit to landowners can be found in the Conclusions section of this paper.

What did you learn from the project? Or, what had you hoped to learn but did not?

Two of the three landowners mentioned that they had no preconceived expectations from the project. Simply they were “trying to help a graduate student”. The third landowner was hoping to learn more about the ecological effects of his harvesting practices. Two of the landowners stated that they enjoyed the project as a menta exercise and found themselves questioning their fuel wood selection criteria. The third landowner was disappointed that the model was not capable of predicting the future impacts on the environment with any certainty. No landowner expressed that they felt they had gained any ecological knowledge. This may be a consequence of the phrasing of this question or a true lack of useful information. Possible improvements to the predictive power of the CIM and education usefulness are addressed in the Conclusions.

How could the project be done differently? Do you have any suggestions?

All three landowners felt that the process methodology was good. Comments included "I think you've nailed some salient things" and, "It was good, it worked." Each landowner did offer suggestions for improvement. One landowner felt that some additional preparation on his part could have made the process more useful. One landowner felt that the data collection was too time consuming to be used at any commercial scale noting that facilitators would get burned out quickly. And the third landowner felt that the whole process was conducted in haste. Stating: "it just went too fast", the landowner offered that to be done with greater breadth and depth would take much more observation of collection practices and interviewing.

Do you plan to use the findings from this project? If so, how?

When asked if they were going to use the findings of the CIM model in any way each landowner responded in a different way. One landowner flatly stated that he was not going to change what he was doing because he was not influenced by the conclusions of the CIM process. The other two landowners felt more contemplative about their models. They mentioned that they were going to re-read the information and think more about their habits although no major policy changes were expected. 'Harvey' mentioned specifically that he was "haunted" by the question of what the association of his farming activities were to the forest. Improving the relevance and predictive power of the CIM process could help to better evaluate policies and facilitate implementation of the CIM conclusions. These points are addressed in the Conclusions.

PROJECT CONCLUSIONS

The CIM project was proposed as a process that allows landowners to more closely trace and investigate their management policies, behaviors, and feelings as well as the consequences of those behaviors. CIM was created in response to an information gap between the social and natural sciences at the site scale. This information gap cites a need to reveal the causal linkages between land use decisions and their effects. The CIM project was organized around the principles of the AEA and utilized theory, data collection, analysis, and representation from both the natural and social sciences. This project was conducted as a demonstration of the CIM process.

Three landowners were selected to participate in this project. These landowners serve as three case studies representing the diverse perceptions, behaviors, and decisio -making processes of residential NIPF owners within the Wildland/Urban interface. The Interface serves as an important area of demonstration because several important issues converge in an emerging land use trend.

These forest owners are the new managers of the forest. They make decisions that affect the aesthetics, productivity, and ultimately the sustainability of the forest. The importance of this study site is increased when considering the implications o encroaching development on public lands, the Jefferson National Forest. Resourc decisions on neighboring properties may pose the potential to affect the general resilience of the Jefferson National Forest.

Fuel wood collection has been cited as a potentia source of negative impact if collection policies are not carried out with consideration of impacts on the resilience o the forest. The demonstration of the CIM has focused on this issue. However, the CIM process is designed to be used in any site scale resource decision-making context

Coarse-woody debris (CWD) was cited as a major source of wildfire fuel and a primary source of residential fuel wood. The Jefferson National Forest prioritized clearing CWD from lands adjacent to the Preston Forest neighborhood and created a “defensible space” management designation to protect Preston Forest and other Interface neighborhoods. Residents of Preston Forest have given much less emphasis to clearing CWD.

Using the CIM to investigate the CWD resource issues it was found that residents see CWD primarily as a source of fuel and less so as a fire hazard. Even participants who mentioned wildfire as a concern did not refer to their use of CWD as part of a larger goal of reducing high-intensity wildfire risk. This difference in perspectives between JNF and Preston Forest residents will need to be addressed if JNF educational efforts are to succeed. Cross-boundary support of the JNF management can significantly improve the designations ability to reduce destruction from wildfires. But without directly addressing the difference in motivations (perspective) landowners will not “buy” into the JNF plan.

Landscape professionals can play a role in contributing to the success of the JNF Interface management designation. By examining the decision-making processes these professionals may help to design aesthetically acceptable "defensible space". Influencing landowners to better protect their investments is a difficult task. Education and incentives are seen as avenues of gaining buy-in (Johnson and Hill 2002 p.). Information garnered from the CIM can point to areas of needed education and possible creative incentives landowners may readily accept.

As it was proposed however, the CIM the impact of fuel wood collection on the forest proved to be beyond the capabilities of the CIM. Although feedback structures were revealed by the CIM the effect of fuel wood harvesting on the forest was not conclusive. Without predictive power the CIM cannot influence landowner motivation and therefore does not create an incentive to change CWD management. However, the impact o current CWD management actions can however be speculated upon.

The state of the CWD stock is a function of the disturbances (including harvesting), decomposition rates, and stand productivity. The forest age, type, area, determine the forest structure and in turn help determine the natural mortality disturbances of trees adding to the CWD stock. One study points to the long-term trend of CWD generation as a U-shaped curve. Stands produce the most CWD just after a disturbance and at the late stage succession (Van Lear 1993). The forest associated with the JNF and Preston Forest interface is estimated to be in earl -mid-successional state. This puts CWD generation in the descending trend of the first arm of the U and thus at the end of the first high CW production curve. Therefore, unless management policies change CWD production is expected to decrease.

Furthermore, The volume of fuel wood harvested from any one property proved to be relatively low compared to the total volume of wood available in the forest. The majorit of wood being collected was dead standing and downed trees. From the literature, these trees make up only about 5-10% of the forests total nutrition (Hunter 1990). The nutrients being removed from the forest are a very low percentage of the total nutritional load. Changes in habitat composition were not addressed during this study. Further research could be done by interested landowners to determine if their practices are positively or negatively impacting species of interest.

While wildfire fuel loads may be being reduced over one or two sites further study is required. The reduction over one or two sites cannot predict the impact o the reduction over the entire Preston Forest neighborhood. It is expected that if an improved CIM project (including a quantitative modeling program) were conducted at the scale of the entire neighborhood a risk analysis could be carried out. The CIM wo uld benefit planners and regulators by providing both the traditional wildfire risk analysis but also the expected trends of resource stocks and therefore more accurate predictions of future risks based on current management actions. The full ADMP process could help to generate design solutions, an opportunity for landscape professionals.

Residents would also gain from the experience of a neighborhood wide CIM project by fostering a sense of community. Community building can help to sustain improved landscape management by shifting policies from reactionary to proactive, collaborative efforts, that extend across property lines and management boundaries– such as the JNF property (Johnson and Hill eds. 2002 p. 253). Citizen participation can also alleviate top-down styles of land management such as those imposed by developers and state regulators. Top-down management policies have often been criticized for failing to gain citizen buy-in and creating animosity among residents toward the management agency. A lack of buy-in was noted as none of the three participants abided by the developer's covenants completely.

The CIM process was capable of accurately revealing and communicating decision-making processes, making it possible to more closely examine he implications of curren management actions. Self-reflection was seen as the most successful concept of the CIM process. The interviews and evaluations captured the self-reflective thought necessary for a learning based management scheme. Participants stated that they valued the ability of the CIM to help them "think through" their fuel wood collection process. As a result new information can now be used to evaluate their personal fuel wood collection strategies. For example, 'Diane' noted that he would be thinking of ways to overcome his imminent 'labor' shortfall. Sel -reflection can be thought of as a correlate to the 'Adaptation' phase of the AEA. This phase is considered integral to establishing sustainable resource management. However, sel -reflection and policy evaluation alone did not warrant policy changes.

Each of the three landowners felt that their actions had no direct implications for the resilience of the forest. However, two of the three landowners were noted as trying to shape the structure of the forest. 'Elizabeth' took a "hands-off" approach to managemen stating that they were "trying to return the property back to nature". 'Harvey' also was actively shaping his property by planting fruit trees and berry species that "may add to the biodiversity of the forest". 'Diane' did not project any long-term vision for the forest and simply stated that education and experience were enough to predict that no harm was being done to the resilience of the forest. All three used their experience with fuel wood collection and written information to form opinions on what impacts could be expected from their actions and future conditions of the forest although no analytical analysis was performed in any case.

To be carried forward many improvement need to be made to the CIM as it was proposed. Landowners will adopt policies that reflect the importance of wildfire fuel removal only come when the *Problem* is deemed relevant to the participant, learning is focused on solving that problem, and thesolutions arrived at are self-generated (Voege and Wagner 1997). For this study landowners were asked about their fuel wood collection. The issue of CWD management was brought to the project by the researcher. If residents had been allowed to arrive a his *Problem* on their own buy-in for the projec would be expected to increase. This aspect of the project failed to create a relevan project for the landowner. The researcher justified the fuel wood issue to create a unified theme for the case studies. In future implementation of the CIM landowners should be allowed to choose their *Problem.* This is expected to increase the likelihood o participation, information gathering, and solution building.

Also, for this project the research for understanding the physical system was conducted by the researcher to minimize the workload on the participants, as time constraints prevented a longer research period. Landowner's are expected to learn more and increase solution options building.

Furthermore, without a more quantitative approach the CIM will not be able to assess the state and expected trends of a resource in enough detail to be deemed beneficial to landowners. Applying a quantitative element with the CIM process can help represent the importance of landowner participation in CWD management and thus improve buy-in.

By further developing the CIM process it may find some utility as an analysis tool in several related areas. Research being done to improve natural resource- decision support systems, collaborative design experiences, capacity building sessions, and awareness training are all possible applications. With improvements the CIM could serve to further our personal understanding of our linkages to the world around us.

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FIGURES

APPENDIX A

Field Data Transcripts

'Harvey' Field Data Collection Transcript

1) Used to live in CO, before moving to VT in 1997,
   Before kids, thinking about kids
   Selected property from a picture, "liked the idea of living in the woods. Although it was a little bit scary at first."
   Wanted to live "a little bit out", mostly lived in big cities
   Sees it as a combo house-vacation house
   VT offered a unique situation of 5acres close to town for a reasonable price
   Also appealing because it was a good site for fruit tree hobby, got interested exotic temperate fruit trees, relaxing
   Noted the ice storm (previous to moving in) had knock down many trees, opening up the view
   Used wood from the ice storm to heat house, about 4 cords of wood was present property when they moved in (stacked), and another 6 cords lying on the ground uncut

2) If staying long term in that house ("real possibility") would like to "replace about half the trees on the property with fruit trees" native for the most part to the US
   And the view
   And fire wood

3) Walk around
   Bird feeder, bat house, owl house, 10 bluebird houses,
   Fishpond
   Fruit trees maturity
   Make firebreaks
   Sees evergreens as a fire hazard as c ose to their house as they are
   "Just have fun with the place"
   Would like to install solar and wind mill (doesn't think he's allowed)
   Has installed sky lights
   Agreed that he "does his homework"

4) Needed room for fruit trees. (Noted on move in that he could have probably only pu in 4 trees for full sun half the day
   Noted some trees need shade in early stages
   Firebreak has been an ongoing process
   Doesn't feel that his time spent will be return in property value
   Built pond
   Paved drive
   Put in drain tiles for two cisterns (for the deer and watering plants) and (fish pond)

5)

6) Maintaining the view is “pretty obvious”
Success in heating measured by if they are warm or not, and having a good stock o usable wood
Downstairs is 80-90 degrees and upstairs is
Without fans it would be worse
Thinking of getting a new stove, knew its history (1986 catalytic), new stove will increase efficiency (described how it works), also noted the radon issue

DICOTOMY QUESTION
“Like to leave it better than you find it”
3400sq ft house
“it’s the American way”

7) cut up most of the available wood
used for the last three years
70-80% heating from wood stove in basemen
in the future 20% of fuel will come from property
Secondary heating propane gas logs and a heat pump (thinking of getting a new heat pump)
Notes two book authors as source of current interest in energy usage Campbell and Daniel Jurgeon (the prize), “we are at a turning point”, 10hrs a week looking into alt energy, grew up interested in alt energy

8) Large oak got hit by lightening
“Blew the bark…skinned the tree”
Caused $2000 damage to the house
Him and a friend were cutting the tree…tree started falling the wrong way
Got a come along, and cranked the tree “towards myself”
“We were scared…scared stiff”
But it came down and everything was fine
Drives SUV on property to collect wood, pull railroad ties
Paths used to collect wood were already there, if they were not there he would not have created them or drive the SUV out there
Brings his son on wood collection trips

9) Yes. “We want trees, so you don’t want to go too far”
“Use the wood for a useful purpose”
Wood chips used for mulch around fruit trees
“If you want to have fruit trees you’ve got to have a place to put them”
Fruit trees detract from the rura -ness in the short te m but when they “come in” they’ll be ok, noted again that they trees are ‘native’ (“but at least their native” to the US)
Estimates the “whole area was clearcut 20-40 year ago” based on the look of the trees
Thinks he’s cut more wood than he was supposed to
Doesn’t really obey the covenants, knows approximately what they are though

10) I don't feel good about cutting a few of these trees
"I'm trying to do something positive here"

Balance the money input vs. the benefits?
Doesn't see a quality of life improvement from the investments, but he enjoys i
"No rational reason to do it. I wanted to do it."
Isn't inclined to listen to others…
"I don't think people have a clue about what's good and bad…"
Doesn't think more information would help make better decisions

Why do you feel there are no benefits
"Doing it for my own benefit"
"The bigger battles have to be fought and won at a higher level"

Thank you.

Property Walk

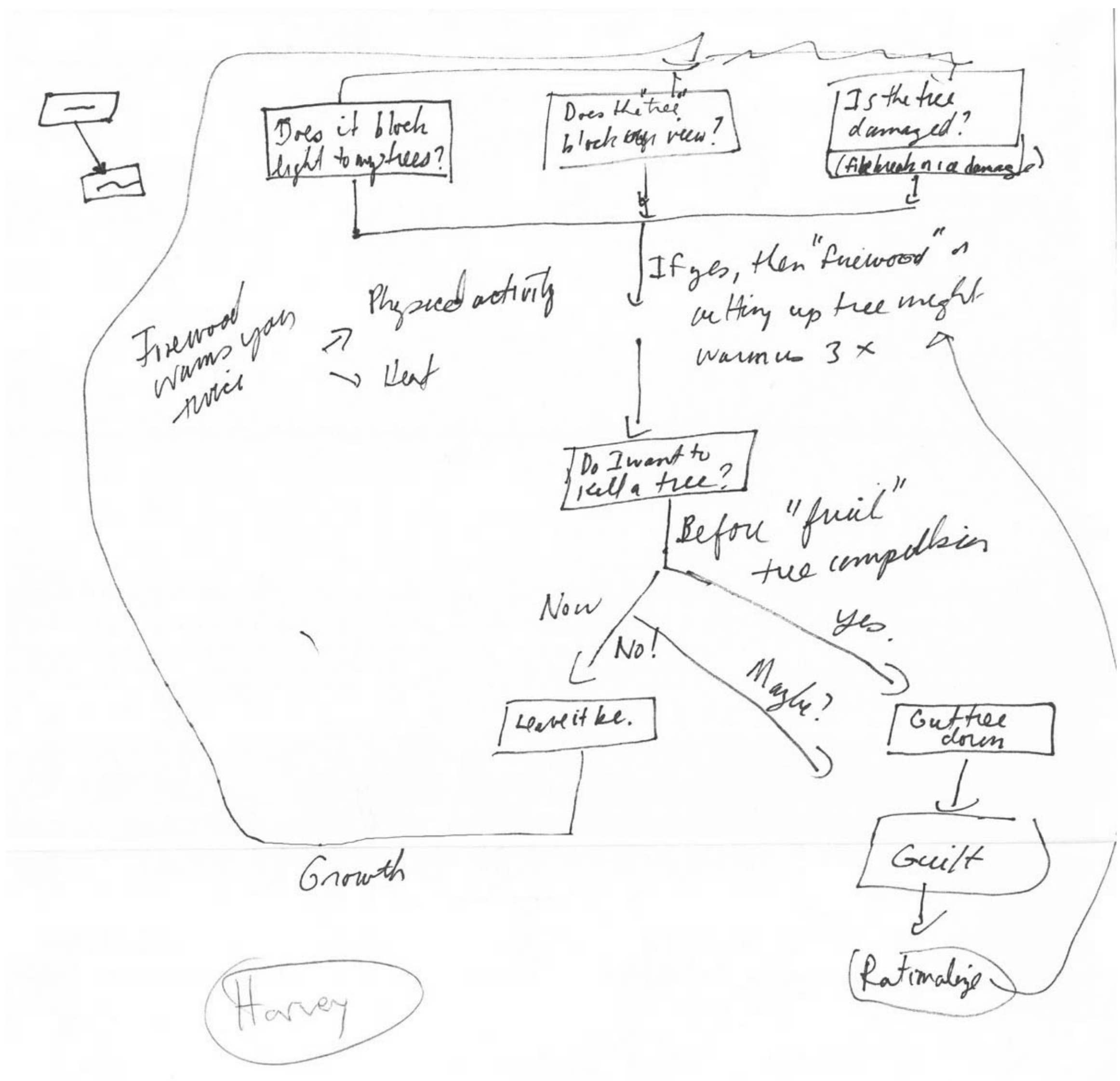
Growing shitake mushrooms (10lbs/yr)
Ornemental bamboo on property corner, understands it spreading potential (plans on maintaining it)
Used old 4-6" x 6' limbs as posts to grow Clematis up
Planted evergreens along road as windbreak but deer ate them, won't be replanting
Ponds hold 4000gallons (?
Small fruit trees (1.5 ft tall), Painted to prevent sun scalding
Painting was recommended on Persimmon but painted all fruit trees
Wildflowers planted (40 trials. Experimenting with species that deer won't eat)
Only foxglove and mustard sp have worked
Trees cut to advantage fruit trees (cut trees were small at first <6") now trees are ~8-12"

Procedure
Cut tree down using gas chainsaw
Cut it up into logs for fire
Drive Ford explorer onto property, collect wood
Drive through paths on property, back up explorer to storage area and unload
Rent a wood chipper and chip at felling location all undesired wood
Nutrients are applied to chip piles and maintained to yield mulch for fruit trees
When property was bought former owner made piles of brush, new owner is converting piles to mulch, "get some use out of it", "make it look tidier", kids play on mulch
Also, sees brush pile as a fire hazard
Believes that a large swath of trees were removed after an ice storm, former owner hired someone to cut 'half broken' trees down ("to finish the job off"), those trees were then left in place to ro
New owner has been collecting this downed wood as primary fuel wood source (source exhausted this year)
Clearing spots for fruit trees is secondary wood source (source minimized because current level of fruit trees is "enough")
Tertiary source of wood is to buy supply (currently not used but will be starting nex year)
At leach field: owner cut trees down to put persimmon trees "at down slope of leach field"
Some would exists cut up at a felling site not loaded and moved to stock ar ea, will be collected this year to burn
Dug leech field up because it was clogged up
No kindling kept on hand
Center of property lacks trees over 4" and under stor
Hasn't decided what to do with the middle of the property yet but has considered planting more fruit trees (sees potential for planting advantage)
Some trees he cut last fall remain intact lying on the ground to be cut up for this year
Doesn't have a 'curing procedure'
Wants to get a new stove, sees efficiency as the main reason he used as much wood as he did

Removed rocks from forest to use on the ponds
Planted blueberries on rock pile and learned over three years that blueberries don't like rock and improved soils, now they are doing better
Plans on eating and drying fruit, beyond that he doesn't care what happens to fruit
Mentioned owl and bat houses (told story about owl)
Dumps ash beside deck just outside room with wood burning stove
Stores a week supply on deck next to woodstove roo
Interior fencing is wood; inside that fence is a "carpet o f wildflowers"
Only uses a portion of the property, the unused part is not used at all, doesn't know the property boundary line on that part.
Sees burning wood as a hobby "no economic advantage"
"I'd like to see this vision come into fruition"
"What I do in the center is a mystery to me"
Fruit trees grow to 20' high; part of their selection was that they wouldn't interfere the view from the house
"I like living in the forest" was the stated reason for living on current property vs. a plot of better suited agricultural land "The only reason this got started…" because of the poor condition of the property at the time of purchase. (Large section of downed trees, smal DBH trees in center of property, trails) opened opportunity where otherwise one wouldn't have existed before
Believes that all things planted in this "garden" property "could conceivably be part o the natural forest"
Sees interior fence as not being part of the forest the rest is or could be
View dictated location of what got developed for landscaping and farming, also fung shui
Played a role in defining the view ("axis of the universe")
"I didn't want to impose too much on the forest"
Property faces directly south, passive solar
"I didn't mess with the center stuff…"
The view has been degraded because the center trees are growing up
16" Pullman chainsaw, on his second one—burned up first one, improper size. Bought same one because he had all the chains and tools alread
Wood splits nice…
Would buy pre-split if they were the same cos
"Definitely the cool factor" that influences the decisions about what to plant, what to buy
Cost plays a factor in getting the coolness wants cool for he wants
Mushrooms, solar, windmill (if he could), are other things that possess coolness

Farming species (doesn't think he'll be feeding the deer with fruit or fruit tree leaves after trees mature)(added "I'll probably be proven wrong")
Persimmon fenced to ward off deer
Melon tree fenced to ward off deer
Kiwi (climate appropriate variety) fenced to ward off deer (3 years to maturity- to yield fruits)
Blackberry fenced to ward off deer
Paw paws (8yrs to maturity) fenced to ward off deer "deer aren't supposed to eat" -once established
Gooseberry (area not clear, needs cover) fenced to ward off deer
Jostaberries (area not clear, needs cover) fenced to ward off deer
Current berries
Heart nut tree
Cherry tree
Blueberries (15 varieties) (believes blueberries "grow wild here" know he has high bush and local natives are lowbush) "deer aren't supposed to eat", sees yield of blueberries in 3 years will be "more than 3-4 families can eat"
Figs
Grapes
Asian pears
Apples

'Harvey' Concept Map



'Diane' Field Data Collection Transcript

1) Has Master's,
   Discovered property by driving around with realtor,
   1990
   Built the house on the lot
   South facing lot, oriented the house on the lot
   Lifestyle decision
      My family growing up had woods behind the house
      Favorite places, secret places
      Don't want to worry about opinions of others
      Have some land
   Knowledge of streams co nnection downstrea

2) Pride of Ownership of land
   Family entertainmen

3) Walk in woods
   Parties
   The creek
   Look out from deck
   'Neat ecologically'
   Rhododendron
   South facing species

4) Built a road
   Drain field
   Culvert
   Improved view
      Minimize hacking away at all trees to accomplish goa
      Cut understory for view
      Selected specific trees for removal (crowns were in the way)
   Selected species for fall color by improving their growing conditions
      Sassafras
      Maples
      Scarlet oak
      Serviceberr
      Dogwoods
   Cuts down balckgum, dislikes them
   Cub-scout path (kept open by dogs and deer)
   Drain easemen
   Initial cutting from lot clearing was left to rot onsite (2-3 year supply of firewood)
   Would like to build bridge across creek

5) Blow down (from ice storm), poplar (12-20 DBH)
   Hemlock disease
      Wooly-Adelged
      Saved 'important' ones, ones that he could (time, money)

6) Changes have met goals. Measures success by ease of access.
   Pleasure of use from improvement

7) Yes.
   Initial cut was too much wood to salvage.
   Collected wood fro neighbors when they built their driveway.
   Running out again.
   So now…supplements with easily collected wood from work (Forester).
   Downed wood only now.
   Close enough to reach it. Farm tractor.
   Uses wood for heating (primary source).
      Ceiling fans
      Feels he needs backup, so he can leave house without feezing pipes.
      Bon-fire twice a year
         Small limbs and branches
         Left over x-mas trees

8) Made felling a large chestnut tree a party even
   Take my sons on fir wood collection trips
   'Good honest work', feels good

WILDLIFE QUESTION
   Too many deer
   Planted road,
   Bird feeders
   Dreams to have know measurement points (2-3 /acre) to measure stand qualities

9) improving views were seen as independent to fire wood
   more comes down than " I can get to"

10) Wildfires are a concer
   Thinks a neighborhood fire prevention policy would be good
   Would like to do more vegetative management, design ideas
   Hemlock trees were part of the design of the house siting
   Looks to friends and other experts for help on issues
   Feels well connected, friends, extension agents, foresters

'Diane' Concept Map

'Elizabeth' Field Data Collection Transcript

1) Moved from DC to VT.
   Considered capital gains tax policy in choosing new property. Wanted to build bu found land is harder to find than an al eady built, also considered two year limit of tax polic
   This property specifically because of view (Mrs)
   (Mr) likes proximity to woods (JNF) for walking, view, potential to meet tax code with additions to house (screened porch, 21 trees planted, remove la wn area)
   Moved into house in 1994
   Mentioned houses 'quirks'

2) "give it back to nature"

3) Mentioned wood collection
   "Darwinian landscapers"

4) have made it a goal to remove lawn (nasty, dirty),
   consider pet fence a contradiction to "giving back" but then re-considered dog interactions with deer as maybe an improvement of fence
   allowed septic field to be overrun with groundcover, planted seed where bare ground showed up (vetch)
   mentioned wood collection, permit from JNF, "Darwinian landscapers", "were not even hobby gardeners", tried to move mountain laurel and rhododendron but they died
   planted white pines

5) Property changed itself slowly creeping in

6) Time spent maintaining property (lawn mower used less)
   Old lawn areas are turning to moss, have actively tried to propagate moss
   Letting paved driveway deteriorate and replace with gravel as holes form, consider it less "invasive", "we don't know what we're doing", gravel is much cheaper.
   Spend as little time as possible outside using property
   Spend more time manipulating the house to better fit them rather than landscape

7) Yes. And also comes from JNF. Primarily use wood from their property but use JNF fire road to collect a load of wood, see a downed tree along the road and cut it up and haul it off
   Wood from their property, standing dead wood marked with orange tape, downed wood is easier
   "More wood than we can use"
   Keep the house cool " pretty nippy", (>55 degrees), use electric base board to tak "edge off"
   Wood stove is secondary heat source, baseboard to primary with space heater
   Moved original woodstove from basement to upstairs (hired someone to do this)
   Prefer to be cool over hot

8) (Mrs) wanted to tell story about rattle snakes (acknowledged that it wasn't a firewood story) "love copperhead stories"
"Wood stor es don't come to mind"
"Sometimes wood gathering can be a social activity", went with guys with kids, their still using wood from years back, feels other families use cords of wood
Story—a tree fell and they wood chainsaw parts of it and wheel barrow it in
Typically downed trees, mostly downed trees
(Mrs) askes (Mr) to share first chainsaw stor
One time a "german guy" got clocked by a block of wood
(Mrs) was impressed with (Mr) use of chainsaw, never used one before this property, liked his mindfulness o fumes, safety, considered a "necessary evil"
Safety is a major concern with saw use, don't enjoy noisy things
Mostly use Swedish handsaws
Splitting wood is fun, use wood granade because splitting is easier
Used to split wood in former house but not chainsa w

WILDLIFE QUESTION

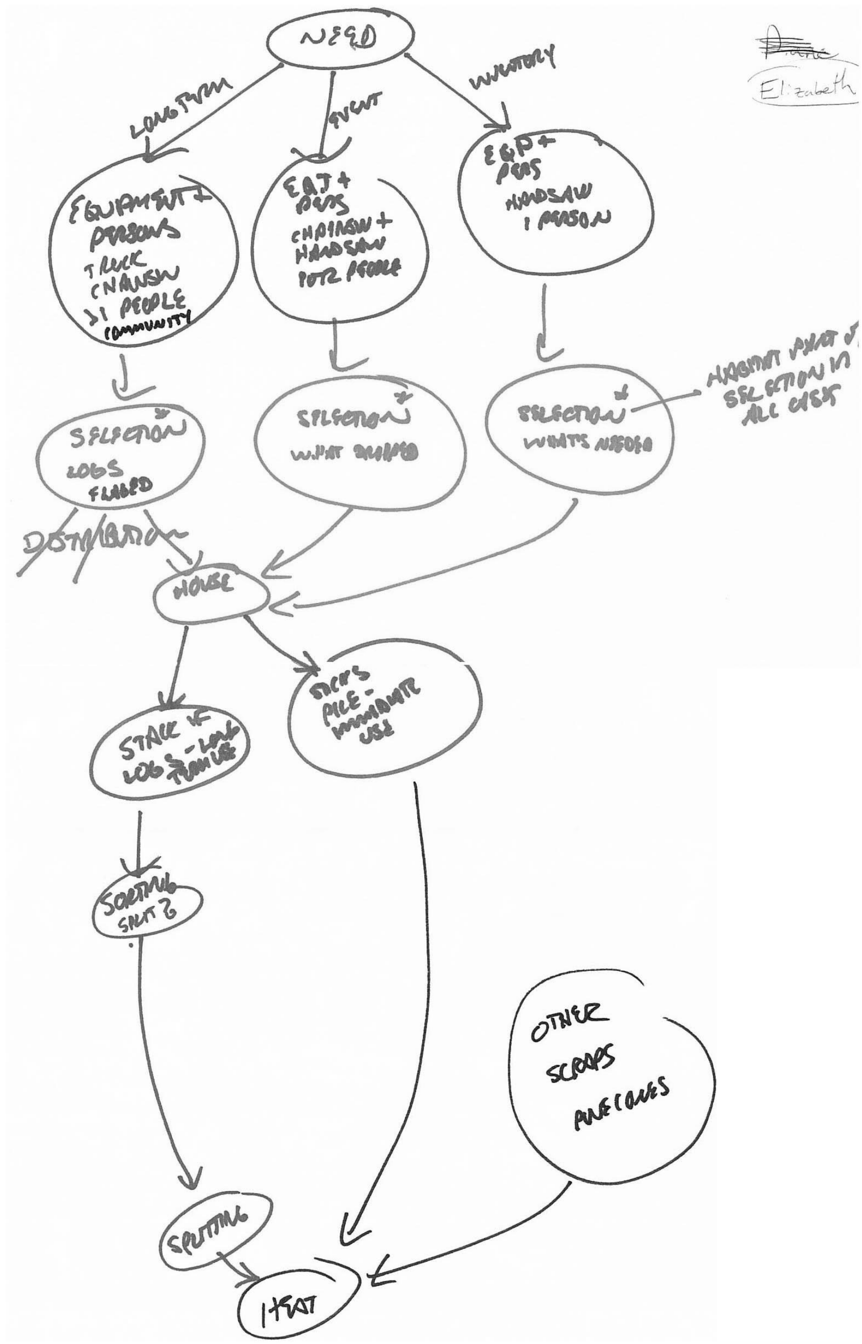
"people want to kill venomous snakes", they don't kill wildlife, they were here first, deer, controlled hunting "never agree to", " don't want to live where guns are being fired", hunting is ok, it's the bad apples that ruin the bunch, uses 'starving to death over winter' as measure of overpopulation, deer and car traffic is a problem, prefer birth control might be a viable option 'if overpopulation is a real thing' 'people' talk about reintroduction of foxes, wolves.

9) No. they "realize were taking nutrients out of the forest", don't feel they know what species would improve the forest, stay away from trees with woodpecker holes
Compost pile is a feeder for birds and deer, also have a few bird feeders

10) (Mrs) "I don't think in terms of how I use the property", "I use it to not use it" (Mr), AEP power line issue,
Uncontrolled- controlled burns
Forest service tells people to "denude" the forest of trees. Fire wouldn't deter the from living there, "hope it doesn't happen". It's a reason to pull things away from the house.
Mostly use the fire road to walk verse the property. (Mrs) uses trekking poles. "I' not a meanderer through the property" but does love the view through the windows, "Marvel at the privilege I have to live here"
(Mr) looking out windows is nice but its not a replacement for going out and doing

PROPERTY WALK
On the aerial map they could see significant figures
Drain field, driveway (used to be fire road), pine trees they've planted, fenced dog area,
Collect wood on the property uphill from the driveway/old fire road
Noted former lawn area
Dog-fenced area, used fence covenant to design fencing
Showed me a downed tree that they've "gnawed on" for a while
Estimated ½ cord of wood in last year
Noted 'orange tape' tree (marked during leaf out)---most easily taken tree, noted use o wheelbarrow
No forethought into tree diameter, whatever is easiest, prefer smaller to larger ---"less grunt work"
Wanted to show me the woodpile
Showed me staging area, "normal haul", use a smaller bin to carry kindling upstairs
Noted "German guy" trip when referencing one specific piece, also referenced wood type, cedar, and its preference as a firewood—poor, due to 'creosote' levels in wood, sticks to the chimney, referred to product to help alleviate danger of chimney fires
Prefers oak to other species, but uses what's easiest to get to
Has wondered about ash as a fire hazard but never noted any real threat
Told story about a tree that was hit by lightening very close to the house, the tree is still there not used as firewood
Bare patches from dog paths is not seen as a problem because it's the dogs' area
Noted the wood cue
"Its hard to get enough coals to get a warming fire"
Tool shed
14"-16" bladed chainsaw, splitter, owns a log jack but abandoned it because it wasn' easy to use
Wheelbarrow had a flat tire, usually fills it as full as they can get it
1 wheelbarrow load in a day during cold weather (24hrs)
To the collection site…
Noted the $15 collection fee if collecting fr m the JNF
Showed trees they planted, white pines, redbud, old lawn areas (have watched it convert back to forest)
Noted property boundary signs used by JNF
Showed "typical" fallen and dead trees
Pass by pines, habitat trees (woodpecker holes, insect sites), too rotten, quality to burn
Quality is "doesn't crumble", hard wood
Most dead trees are 'oaks', "see a lot of them"
Rock wall (psychological boundary) installed because JNF travelers would use their lane
Showed rain gauge owned by 'weather service', knew what it was for and how it worked
Very offended by trash left by others
Knew property boundary

'Elizabeth' Concept Map



APPENDIX B

Curriculum Vitae

Jonah M. Fogel

304 Giles Rd., Unit 2
Blacksburg, VA, 24060
jonah_fogel@hotmail.com

Education: **Virginia Polytechnic Institute (Virginia Tech)** Blacksburg, V
Master's of Landscape Architecture
Expected Graduation: May 2003, GPA: 3.41

Western Michigan University Kalamazoo, MI
Bachelor of Science in Hydrogeolog
Graduation: April 1998, Major GPA: 3.21

Professional Experience:

June 2002- **Haile Landscape Design** Blacksburg, V
Sept 2002 Landscaper
Landscape installation and maintenance

Aug. 2001- **Community Development and Assistance Cente** Blacksburg, V
Feb. 2002 Project Landscape Architect
Organize and perform site analysis and documentation for 'trailways' program. Conduct precedent survey and design development. Generate report and perform presentations on project findings. Generate final 'trailways' design and conduct TE -21 funding search.

June 2001- **Kalamazoo Nature Center** Kalamazoo, MI
Volunteer Technician
Assisted field biologist in conducting vascular plant survey. Additional experience with GIS and data processing for Michigan State Avian Inventory.

Dec. 1999- **Materials Testing Consultants (MTC)** Grand Rapids, MI
Aug. 2000 Environmental Specialist
Coordinate and perform environmental and construction field activities, draft and prepare technical documents and drawings including bid documents and investigative reports, oversee subcontractors, act as a site safety officer.

Aug. 1998- **Earth Tech** Grand Rapids, MI
Oct.1999 Staff Hydrogeologist
Coordinate and perform field activities, write and prepare technica documents, oversee subcontractors, act as a site safety officer. Other roles included CTO coordinator, and Core Skills development team participant.

Teaching Experience:

Jan. 1998- **Western Michigan University** Kalamazoo, MI
May 1998 Lab Instructor- Geol. 100 (Earth Science)
Taught lab material, reviewed lecture material, administered quizzes, and calculated grades

Research Experience:

Reviewer for Dr. Bruce Hull and Dr. David Robertson, Virginia Tech Forestry Department

- R. Bruce Hull, David P. Robertson, Gregory J. Buhyoff, **Boutique Forestry: An Emerging Area of Forestry Practice,** Journal of Forestry, submitted July 2002

Statistical and Computer Experience:

JMP 4.0 (statistical), AutoCAD, Vensim (systems modeling),
ArcView 3.2, Photoshop, Pagemaker, Dreamweaver 4.0 (Web publishing),
Adobe Flash MX (Web graphics), Microsoft Office

Awards: W.A. Tarr award for leadership and meritorious work in Sigma Gamma Epsilon

Affiliations Member of American Society of Landscape Architects- Virginia Tech Student Chapter
Landscape Architecture Department Representative of the Graduate Student Assembly