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This study estimates a range of opportunity costs associated with three land management alternatives for a site in the Oregon Coast Range. A 35,000 acre site was selected which includes a mix of federal and private land ownership and provides significant biological resources. The first alternative examines a plan for federal agencies to maximize present net worth of the timber on all forested acres. The second alternative describes a federal plan to protect old-growth dependent species. The third alternative examines a biologist's plan to protect all current species as well as restore extirpated species to the region.

For the first alternative, results show significant economic benefits associated with a timber harvest schedule that maximizes the present net worth of timber on federal land. For the second alternative, the results show significant opportunity costs associated with forgone timber harvests on federal land. For the third alternative, the results show significant opportunity costs associated with forgone timber harvests and lost opportunities for recreation. Although the forgone value of timber comprises the majority of the opportunity costs, the forgone value of recreation contributes to a substantial portion of opportunity costs. The recreation values range from 10 to 29 percent of total opportunity cost estimates.

An Opportunity Cost Approach to Land Preservation in the Oregon Coast Range

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

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An Opportunity Cost Approach To Land Preservation In The Oregon Coast Range

Chapter 1
Introduction and Justification

In recent years, two key factors have led to proposals to manage large land areas. First, regulatory provisions have required public land managers to develop plans that protect natural resources and the habitat of individual species. Second, public concern over the loss of biological diversity has prompted private organizations, along with state and local governments, to propose new alternatives to manage public and private land.

Several arguments have been put forth in favor of preserving large land areas (Wilson,1988; Ledec and Goodland, 1988; Nations, 1988; Dixon and Sherman, 1990; Nash, 1973). For example, large areas of undeveloped land may provide the following social benefits:

- Maintain atmospheric quality
- Control and ameliorate climate
- Regulate freshwater supplies
- Reduce erosion and alleviate the impact of floods
- Generate and maintain soils
- Dispose of household sewage and waste that industry and agriculture produce
- Control pests and diseases
- Pollinate crops and wild plants
- Contribute to medical research
- Provide recreation benefits associated with wilderness values

Others argue that society should preserve land for intrinsic reasons--spiritual, ethical, or moral respect for nature (Ehrenfeld, 1988). Proponents of environmental ethics espouse a more ecocentric rather than anthropocentric view and argue that plants and animals have a right to exist, independent of their value to humans. (Taylor, 1986; Stevens et al. 1991b).

The U.S. Congress passed the International Environmental Protection Act of 1983 which legally recognized the concept of biological diversity (Cairns and Lackey, 1992). The Environmental Protection Agency's Science Advisory Board recently asserted that natural ecosystems form a vital link to human health and welfare (USEPA, 1990). Although recognition of the threat to biological diversity seems fairly recent, for some scientists the concern over species loss dates back to at least 1864 (Marsh, 1864).

In recent times, public concern centered on the loss of large, popular animals such as bears, eagles, elephants, and whales. While the public's concern did evolve to include species of plants, butterflies, and reptiles, throughout the 1970s the primary focus remained on the large, popular species. In the 1980s, the public's concern shifted from protection of individual species to protection of specific land areas such as tropical rain forests, the Florida Everglades, Alaskan tundra, and the old-growth forests in the U.S. Pacific Northwest (Cairns and Lackey, 1992).

Management of Federal Forest Land

In an attempt to protect public forest land and maintain a stable supply of timber (ideals strongly associated with Gifford Pinchot, the first chief of the USDA Forest Service in 1905), public forest managers adopted a maximum sustained-yield policy. This policy attempted to ensure that federal agencies harvest timber at the maximum potential biological yield and, through time, maintain the volume of timber harvests. Maximum sustained-yield describes a level of timber volume that remains constant, or increases over time, and does not decrease.

Although the Multiple-Use and Sustained-Yield Act of 1960 and the National Forest Management Act of 1976 did expand single-use timber harvest goals to include non-timber resources (e.g., recreation and amenity values), timber continued to be managed in accordance with previous policies (Bowes and Krutilla, 1989). Many parties have challenged the legality of Forest Service practices under these acts (Coggins and Wilkinson, 1986). Later, laws such as the National Environmental Policy Act of 1969 and the Endangered Species Act (ESA) of 1979 added new legal requirements for the management of federal forest land. In 1989, as a result of the failure to develop a suitable management strategy to protect the northern spotted owl as required by the ESA, federal courts essentially halted the harvest of timber from federal land in Oregon, Washington, and Northern California (FEMAT, 1993).

The focus of federal land managers has shifted from concern for a single threatened species, to concern for several threatened species within the same ecosystem, and most recently to concern over the impact on all species within an ecosystem. To manage federal forest land within a framework that can address these new concerns, federal agencies have adopted the concept of ecosystem management. This new philosophy attempts to balance the need to conserve biological diversity with the need to provide commodities such as timber and grazing land (FEMAT,1993). Under the goals of ecosystem management, federal agencies attempt to meet legally mandated biological objectives and minimize the negative socioeconomic impact on local communities and regions.

The Oregon Coast Range

In the late 1800's, lumber companies began to harvest trees in Oregon's Coast Range. These companies clearcut and burned forests and usually did not replant after the harvest. To these early logging companies, the supply of timber seemed inexhaustible (FEMAT, 1993).

In 1945, changes in technology, improvements in transportation, and excess demand led to increased timber harvests. By this time, most federal and private lands were managed using European forest practices which included clearcuts, removal of snags and logs, slash burns, and replanting harvested areas with a single species. In an attempt to produce high yields of timber, these forests were harvested and replanted at relatively short intervals (i.e., 40-80 years). As a result of timber production and fire control, the forests of the Oregon Coast Range now consist mainly of clearcuts, thinned stands, and young plantations interspersed with natural (unmanaged) stands (FEMAT, 1993).

Wildfires and windstorms, which kill only some of the trees in a stand, occurred frequently in the Oregon Coast Range; as a result, many of the natural (unmanaged) forests in the Oregon Coast Range consist of mixed-age stands with patches of old-growth trees (FEMAT, 1993). Older forests in the Oregon Coast Range are highly fragmented, especially on BLM lands, which are intermixed with private lands in a checkerboard pattern of alternate square-mile sections[1] (FEMAT, 1993).

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1 Under the Oregon and California Railroad Act (1866), the federal government granted alternate square mile sections of land to railroad companies that attempted to build a route from Oregon to California. In 1917, these railroad companies forfeited much of the land which was returned to the federal government. The Bureau of Land Management took over management of these lands when the organization was formed in 1946.

In the recent decade, the public has expressed concern over the preservation of old-growth forests in the Oregon Coast Range area. Kellogg (1992) estimates that 96 percent of the coastal forests in Oregon have been logged. The Oregon Coast Range has been identified as an area of concern for the survival of threatened and endangered species such as the northern spotted owl, marbled murrelet, and some anadromous fish stocks (FEMAT, 1993). The Oregon Natural Heritage Data Base (1989) lists 30 animal species and 34 plant species within the Oregon Coast Range as endangered, threatened, of concern, or limited in abundance throughout their range (Noss, 1993).

Historically, timber production has been the primary use of coast range land. Now hunters as well as fisherman, campers, hikers, and mountain bikers use timber roads to reach recreational areas. Many view the Oregon Coast Range as a prime recreational site that attracts new residents as well as tourists to the region. For this reason, the concern over land use in the Oregon Coast Range also involves issues related to outdoor recreation.

Problem Statement

Plans to protect and enhance biological diversity may conflict with other social objectives and could require society to forgo significant economic opportunities. Conflicts between commodity production and protection of biological diversity have arisen within the Forest Service, Bureau of Land Management, Army Corps of Engineers, National Marine Fisheries Service, and Fish and Wildlife Service (Cairns and Lackey, 1992). These agencies need to consider the forgone opportunities associated with any plan to manage public resources.

Plans to protect and enhance biological diversity tend to restrict and limit human activity and development within large land areas. Some argue that the costs associated with such plans, particularly those that include large carnivores, may be too high a burden for society to bear (Mann and Plummer, 1993). With regard to the opportunity costs of these plans, research is limited. To enable such plans to become politically viable, proponents will need to consider the opportunity costs.

Objective

With regard to three alternative proposals to manage land within the Oregon Coast Range, this study will estimate the opportunity cost -- what society would forgo under each plan. The analysis will take as a given that society benefits from land use plans that attempt to protect biological resources and will then ask the empirical question, "What is the opportunity cost?" This project will provide an example of a method to estimate opportunity costs and it will attempt to stimulate further research in areas related to socioeconomic costs associated with proposals to conserve biological diversity.

Organization of the Thesis

Chapter Two provides a literature review. Chapter Three outlines the details of two plans to conserve biodiversity-- one private and one federal. Chapter Four details the procedure and analysis used to estimate the opportunity costs under the various proposals. Chapter Five summarizes the results of the study, identifies concerns for decision makers, and provides recommendations for further research.

Chapter 2
Literature Review

This literature review summarizes methods which estimate the opportunity costs of land designated as a biological reserve. The opportunity costs of a biological reserve are the benefits that society would forgo once the reserve is established. The opportunity cost of protecting a land area depends on the alternative uses the plan restricts.

Opportunity Cost Literature

A variety of studies attempt to measure the opportunity costs of forgone activities associated with land designated as wilderness. The Wilderness Act of 1964 prohibits development such as buildings, roads, dams, and timber harvests within designated areas (Walsh *et al*, 1984). Tyre (1975) estimates the average costs of outdoor recreation on national forest land in the southeastern United States. He considers timber production and recreation as mutually exclusive and includes the forgone value of timber and timber growth as opportunity costs associated with recreation. Within four proposed New England wilderness sites, Guildin (1980) estimates the costs associated with forgone timber harvests, the purchase of private land, and annual costs to protect (i.e., suppress insects and fire) and manage the wilderness areas.

Under provisions of the National Environmental Policy Act of 1969, the Forest Service devised a method to determine the forgone timber value associated with including roadless and undeveloped areas into the National Wilderness Preservation System (Milton, 1975). Other governmental studies examine the opportunity costs associated with wilderness areas (ORRRC 1962; USDA 1978).

Still other researchers combine biological data with economic models. To determine the trade-offs between opportunity costs and levels of individual species protection, Montgomery and Brown (1992) use biological data on the northern spotted owl and link the probability of owl survival with different levels of acreage requirements. The authors then estimate a marginal cost curve that relates the opportunity costs of forgone timber harvests to the probabilities of survival. Hyde (1989) examines the opportunity costs associated with two alternative plans to protect the current population of red-cockaded woodpecker in North Carolina's Croatan National Forest. Researchers at Resources for the Future, the Bonneville Power Administration, and Northwest regional planners have analyzed the trade-offs between the biological effectiveness and the annual costs of alternatives proposed to protect the number of salmon stocks in the Columbia River (Wernstedt *et al*, 1992). All of these studies provide examples of methods that combine biological data with economic costs.

Other researchers have explicitly examined the opportunity costs of land-use restrictions intended to reduce the impact of development within specific areas. Batie and Mabbs-Zeno (1985) estimate the opportunity cost of prohibiting recreational development in Virginia's Eastern Shore wetlands. Parsons and Wu (1991) estimate the opportunity cost of land-use controls that limit residential and commercial development along the coast of Maryland's Chesapeake Bay. Both of these studies present methods that rely on price information, specifically with regard to the local real estate market.

Timber Harvest Literature

With regard to land managed for timber production, forgone timber harvests will significantly contribute opportunity costs associated with plans to protect species. To estimate the opportunity cost of forgone timber harvest, the price of timber becomes a key factor in the estimates. This literature review will examine research that adds insight to changes in the price of timber and related changes in the level timber harvests.

In an attempt to evaluate the short-run behavior of national forest timber harvests, Adams et al (1991) develop a harvest model in which timber harvests are a function of the price of timber. In the past researchers have considered the harvest of timber from national forests as fixed and insensitive to price (Adams and Haynes, 1989; Berck, 1979). This research has not considered that, once sold, federal timber may remain uncut and under contract; as a result, the decision to harvest federal timber may vary with current market conditions.

Although annual changes in the sales volume of national forest timber has been modest, data on the volume of harvests suggest that timber harvests from national forest land are sensitive to price changes. Actual harvests are characterized by volatile cycles similar to those experienced by the lumber and plywood industries (Adams *et al* , 1991). During periods of rising prices, the share of timber harvested from national forests tends to rise relative to the share from private forest lands. Conversely, during periods of price decline, the share of timber harvested from national forests tends to fall. These findings suggest that, compared to timber harvests from private land, national forest timber harvests are more sensitive to price changes. In fact, the authors conclude that national forest timber may provide a supply buffer to protect against major fluctuations in the market price of timber (Adams *et al*, 1991).

In general, research on timber prices provide mixed results. Washburn and Binkley (1990) show that southern pine stumpage prices follow a random walk. Others suggest that timber prices follow some stochastic process (Norstrom, 1975; Brazee and Mendelsohn, 1988).

Outdoor Recreation Literature

Another body of literature examines changes in the demand for outdoor recreation. Since some biological reserve proposals restrict or limit certain types of recreation, opportunity cost estimates may need to consider the value of lost recreational opportunities through time. This section of the literature review will focus on the research related to the specific outdoor recreation that applies to this study. The review will then examine research that links outdoor recreation with roads.

Several studies estimate changes in the demand for recreation associated with various demographic characteristics (Murdock *et al*,1991; Hof and Kaiser 1983). Krutilla and Fisher (1975) compare the benefits of recreation with the benefits of development for three alternative plans to build a hydropower facility on the Snake River. The authors take into account the growth in demand for recreation over time as a function of the increase in population, income, and changing tastes (Krutilla and Fisher, 1975). Bergstrom and Cordell (1991) developed a model to predict recreational trips, by activity, taken by a region or population. The authors concluded that population size is a strong predictor for the total number of trips taken by a community (Bergstrom and Cordell, 1991). To predict the future demand for recreation, several governmental studies use population change as a key determinant (USDI BLM, 1992; English *et al* , 1993; OSPRD, 1991).

Researchers estimate consumer surplus values for specific recreational activities. Deer and elk hunting are two recreational activities that are relevant to this study. The Forest Ecosystem Management Assessment Team estimates the value per visit for a hunting day to be $39.08 (FEMAT, 1993). This estimate does not vary between season restrictions (i.e. rifle or archery) or between the types of harvest (i.e. elk and deer). Intuition and other research suggests that hunting value should depend on the restrictions and type of harvest.

Nickerson (1990) examined the changes in hunting demand associated with changes in a variety of management regulations. For example, he found that a restriction which allows only primitive (muzzleloader) hunting reduced the demand for both elk and deer permits by 70 percent.

In a review of hunting valuation studies in the West, Bolon (1994) found elk hunting values of $7 to $82 per hunter day with an average of $45. Specifically with regard to a study of the economic value of elk to hunters in the Blue Mountains of Oregon, Bolon (1994) found a per day value range of $39 to $78. Luzar, Hotvedt, and Gan (1992) estimated the total consumer surplus per deer hunting trip in Louisiana to be $24.70. In comparison, Donnelly and Nelson (1986) estimated a consumer surplus range of $19.18 to $30.71 per deer hunting day in Idaho. Sorg and Nelson (1986) estimated a consumer surplus range of $22.24 to $35.18 per elk hunting day in Idaho. Loomis et al (1989) found an average consumer surplus of $68.73 for deer hunting in California. Hays (1988) used contingent valuation studies to estimate the net economic value for deer hunting in each state and reported a net economic value of $30. Results from these and other similar studies indicate that the consumer surplus estimates are highly sensitive to reasonable changes in the opportunity cost of time and vehicle operating costs (Luzar *et al* , 1992; Hotvedt and Luzar, 1989). Such variation in results suggests that, for estimates of total willingness-to-pay for deer and elk hunting, a range of economic value may be more appropriate than a single value.

This section will now examine outdoor recreation and roads. The Forest Service and Bureau of Land Management (BLM) classify all land into six recreational categories: primitive, semiprimitive nonmotorized, semiprimitive motorized, roaded natural, roaded modified and rural. These classifications take into account the natural setting, acres of allocation, and quality of experience associated with a recreation visit (Swanson and Loomis, 1995). In a report prepared for the Forest Service, Swanson and Loomis (1995) estimated the number of visits and dollar value for each of the general classifications of recreation in the range of the northern spotted owl. They found that most visits took place in the roaded natural category (79.7 million visits) and the least in primitive (3.9 million visits). Overall, 94 percent of the visits occurred within one of the motorized classifications (Swanson and Loomis, 1995). The authors then projected future increases in recreation use by the year 2000. Wildlife observation and backpacking were recreational activities identified as two of the 10 fastest growing over the next 50 years (Swanson and Loomis, 1995). Given the projected growth in activities, the Oregon State Parks and Recreation Department (1991) forecasts the number of acres needed for each land classification. They found that under current management, recreation demand will exceed supply in primitive, semiprimitive nonmotorized, and semiprimitive motorized categories (OSPRD, 1991).

In comparison, based on the 1988 Statewide Comprehensive Outdoor Recreation Plan for Oregon, the BLM estimated that nonmotorized travel visits accounted for just 16 percent of total recreation visits within the Salem District (USDI BLM, 1994). Similarly, the 1986-87 Pacific Northwest Outdoor Recreation Study, indicated that 79% of the participation rates occurred in activities that involved some type of motorized recreation (Hospordarsky *et al* , 1988).

Benefits of Biological Diversity

Although the focus of this analysis remains on opportunity costs, a wide body of literature does attempt to evaluate the benefits of biological resources. This section will briefly review some of this work and highlight the controversial issues that surround any attempt to examine benefits.

Economists find it difficult to place values on the benefits associated with biological diversity. Bishop (1978) defines two types of uncertainty: "natural uncertainty" which refers to uncertainty with regard to knowledge about the characteristics of species that may provide some potential use to humans (supply side) and "social uncertainty" which refers to uncertainty with regard to the future human demand for biological resources (demand side). With respect to biological diversity, uncertainty exists on both the supply and demand side (Dixon and Sherman, 1990). In most cases, scientists cannot even establish a link between specific land management actions and levels of environmental services (Rosenthal and Nelson, 1992).

Individuals and society may benefit from biological diversity even though no direct use occurs. Krutilla (1967) proposed the idea that individuals may value natural resources even though they have no desire to actually use it or travel to see it. Weisbrod (1964) argued that individuals may be willing to pay to retain the option for future use. Individuals may also be willing to pay to bequest biological resources to future generations. In recent years, many economists have formalized methods to measure these types of nonuse values (Brown, 1984; Smith, 1993; Loomis, 1988; Madariaga and McConnell, 1987).

However, the extent to which economists should value the non-use benefits remains a subject for debate within the profession. Gregory (1986) summarizes evidence that shows many of the methods used to value public goods violate the axioms of utility theory. Kopp (1992) recognizes all nonuse values as values that arise from the nature of public goods and argues that economists should value public goods within the same theoretical structure as private goods. Kahneman and Knetsch (1992) argue that surveys may ask people to choose between an ordinary good and a moral principle. Rosenthal and Nelson (1992) argue that economists should not employ formal methods to measure values related to cultural symbolism and social ideology. With regard to the relationship between humans and nature, some believe that social conflicts are the result of fundamental moral or religious differences (Nash, 1973; Nash, 1989; Dennis, 1987).

Other issues spark debate within the profession. For example, why not include non-use values associated with all goods and services (Castle and Berrens, 1993)? Also, can any method fairly measure benefits across generations? Pearce (1983) argues that policy makers have little incentive to consider the potential costs imposed on future generations from irreversible decisions. Also, since market information does not exist for most types of biological benefits, economic results are highly uncertain and the design of the studies have a high likelihood of influencing the results (Castle and Berrens, 1993).

Uncertainties aside, economists do attempt to measure the economic value associated with protection of biological diversity. To measure the value individuals place on old-growth for protection of the northern spotted owl, Hagen et al (1992) surveyed a sample of U.S. households. To determine an estimate of willingness to pay to double Columbia

River salmon runs, Olsen et al (1991) surveyed households in the Columbia River Basin. Walsh (1990) surveyed households in Colorado to determine their willingness to pay maintain 13.6 million acres of wilderness.

Although these studies elicit the economic value individuals place on a single species or specific land area, such models do not provide a clear theoretical framework from which economists can address the economic benefits associated with plans to protect a collection of species Stevens et al (1991b.) investigate the economic value individuals are willing to pay to protect endangered species. They found that these values were highly sensitive to whether the species were evaluated separately or as part of an aggregate. As a result of such uncertainty, the authors conclude that policy makers should not use estimates of economic benefits to make decisions with regard to endangered species (Stevens *et al* , 1991a,b).

The Safe Minimum Standard Approach

An alternative strategy would be to adopt management guidelines that protect the resource unless the opportunity costs are exceedingly high. Ciriacy-Wantrup (1952) formalized such an approach with the concept of the safe minimum standard (SMS). A SMS avoids the critical point at which it becomes uneconomical to halt or reverse the impacts of development. With a SMS one attempts to discover the best set of actions at any given time and remain receptive to change and new information. Although opportunity cost estimates are needed to evaluate options within a SMS approach, information is also needed on critical biological thresholds. Essentially, the SMS approach combines opportunity cost estimates with measures of biological stability (Castle and Berrens, 1993). Once the analysis is complete, the political process must decide whether to bear the opportunity costs.

Discount Rate Literature

For a project with costs incurred years into the future, the choice of discount rate will have a substantial impact on the results (Robinson, 1990). Any discussion of opportunity costs would be incomplete without some consideration of the appropriate discount rate. A discount rate is needed to compare the value of future costs with those of the present. In effect, a positive discount rate will reduce the present value of future costs and benefits. This section will briefly describe some of the literature that focuses on the appropriate discount rate.

There is no consensus on a single "correct" discount rate, or whether discounting is even appropriate (Bojo et al. 1990; Costanza *et al* , 1991; Norgaard and Howarth, 1991). A number of economists argue that a positive discount rate is incompatible with long-term sustainability of biological diversity (Gowdy, 1993; Hueting, 1991; Norgaard and Howarth, 1991). Conservationists sometimes prefer lower discount rates because a low rate favors the management of slow growing trees, the protection of biological diversity, and the conservation of exhaustible resources (Norgaard and Howarth, 1991). On the other hand, with regard to projects with negative environmental consequences, conservationists often argue for higher discount rates. Specifically, with regard to water projects, many argue that low discount rates artificially inflate the value of future benefits (Reisner, 1986).

Solow (1974) argues that the discount rate choice implicitly implies a decision about the intergenerational distribution of wealth. Perrings (1991) argues for a zero discount rate because a positive discount rate weights the needs of the present generation higher than the those of the future generation. He also points out that a positive discount rate tends to reduce the impact of uncertainty for decisions with long time horizons (Perrings, 1991).

To justify a discount rate, economists use two general arguments (Robinson, 1990). First, some economists contend that public investments should yield the same rate of return as investments in the private sector and argue for a discount rate that reflects the market rate of return (Summers, 1992). In contrast, others argue that the discount rate should reflect the consumer rate of time preference without any concern for issues related to opportunity cost (Bradford, 1975; Arrow,1966). Such a rate would be lower than the market rate or any other measure of the rate of return on private investments (Lind, 1982).

Chapter 3
Land Management Plans

This study will examine two alternative plans to protect species in the Oregon Coast Range. Each plan prescribes different management actions and alternatives. Following a description of each plan, Table 1 summarizes the major similarities and differences.

A Federal Plan to Protect Species

To develop management alternatives that could meet the current legal requirements and minimize the economic impact on communities, the Clinton Administration Commissioned the Forest Ecosystem Management Assessment Team (FEMAT). The team consisted of scientists and technical experts from a variety of public agencies and disciplines. The team developed and analyzed ten options that comprised various combinations of reserves and management practices. For each of the ten options, the team evaluated conditions expected to maintain the habitat for the marbled murrelet and the northern spotted owl. The team also considered the impact on over 1,000 plant and animal species thought to require similar habitat conditions (FEMAT, 1993).

Each of the options contains reserve areas in which timber harvests are prohibited or severely restricted. The reserves consist of two types: Late-Successional Reserves and Riparian Reserves. Both types of reserve acres consist of older aged forests in their natural condition (i.e., stands not managed for timber production) and younger stands that were managed to produce timber. Late-Successional Reserves were developed to accommodate the habitat needs of the northern spotted owl and expanded to include the habitat needs of other old-growth dependent species. Riparian Reserves were developed to accommodate the habitat needs for fish as well as other aquatic and riparian dependent terrestrial species (FEMAT, 1993).

The study will now focus on the details of Option Nine, the option which President Clinton chose to implement. In general, Option Nine limits timber harvests to treatments that enhance the old-growth characteristics of young stands, hazardous tree removal, and the limited salvage of dead trees within late-successional reserves. Under Option Nine, all timber harvests within the Reserves need to accelerate the development of late-successional forest conditions. As a result, federal agencies cannot continue to clearcut and regenerate timber within these reserves (FEMAT, 1993).

In general, the Forest Service and Bureau of Land Management will manage roads to provide a wide range of developed and dispersed recreation and attempt to meet any projected increase in the demand for recreation. Both agencies will maintain and enhance existing recreational areas and provide additional wildlife viewing areas and scenic roadways. They plan to locate new recreational developments in areas which do not degrade the habitat of or contribute to any adverse effects on late-successional species. If dispersed or developed recreation conflicts with the Late-Successional Reserve objectives, the agencies plan to use adjustment measures such as education, use limits, and traffic control devices. Off-road vehicle use will be managed in a way that protects natural resources and minimizes conflict among users. In addition, the BLM plans to improve wildlife and fish habitat to enhance hunting and fishing opportunities and increase the economic returns generated from these activities (USDI BLM, 1994; FEMAT, 1993).

Oregon Coast Range Conservation Plan

The Oregon Coast Range Conservation Plan (OCRCP) stems from a case study performed for the Coast Range Association by Reed Noss, a private conservation biologist. The goals of the plan are consistent with The Wildlands Project, a long range project to restore native species and wildness throughout North America (Noss, 1993). The OCRCP attempts to preserve or restore all ecosystems and species native to the Oregon Coast which include some extirpated species such as fisher, wolverine, wolf, and grizzly bear. The plan establishes a general reserve class for specific land areas and, within each general reserve class, proposes a variety of guidelines that restrict human activities.

The OCRCP establishes three general classes for reserves. Class I reserves represent highest priority areas that require immediate and strict protection. The total area covered by 31 class I reserves covers 1.25 million acres, or 23.4 percent of the Coast Range Bioregion. The estimated total area covered by the class II reserves encompasses 1.4 million acres, or 26.2 percent of the Bioregion. Multiple-use zones comprise another 25% of the Bioregion. The ownership of this land is a mix of federal, state and private land with much of the private forest land owned by timber companies. Reserves were established based on biological data such as occurrences of rare species, spotted owl locations, amount and density of old-growth forest, connectivity, and watershed values.

Although more extensive trails for hiking, and mountain biking are permitted in class II reserves, the guidelines that apply to class I and class II reserves are essentially the same. Within both class I and class II reserves, the plan requires no logging in natural forests and no other timber cutting except thinning designed to restore plantations to their natural age structure. The OCRCP does not permit any salvage logging in either class I or class II reserves (Noss, 1993).

Within both class I and class II reserves, the OCRCP also requires the prompt closure of all roads, except major highways and other roads necessary to access private property or to conduct restoration activities. Essentially, the plan would not permit roads to remain open for motorized recreational use. The long term goal is to revegetate many roadbeds and reduce overall road density to well below 0.5 miles/square mile (Noss, 1992). The following additional restrictions also apply to both class I and class II reserves:

- No new road construction or re-construction
- No grazing of domestic livestock
- No mining, mineral, oil, or gas exploration
- No off-road vehicles or other motorized equipment

To enact other guidelines of the plan will require a long time horizon- perhaps between 100-200 years. Before any restrictions are placed on private land, state and federal agencies need to acquire the land or arrange conservation easements. Land managers must also attempt to eliminate exotic species and, after road density is reduced and private land acquired, reintroduce extirpated species (e.g., wolves, and grizzly bears).

Table 1 summarizes the major differences between the FEMAT-Option Nine Plan and the OCRCP.

Table 1

Summary of Major Differences Between Plans

	FEMAT-Option Nine Plan	Oregon Coast Range Conservation Plan
Federal Land	Timber Harvests Severly Restricted	Timber Harvests Severly Restricted
Private Land	No Impact	Timber Harvests Severly Restricted
Recreation	Seeks to maintian and enhance all types of recreational opportunities	Would severly restrict all types of recreation that depend on roads
Species Goals	Seeks to protect the habitat of and maintain viable populations of existing species	Seeks to protect and maintain existing species as well as reintroduce extirpated species

Chapter 4
Analysis and Results

Famework for Analysis

A theoretical framework provides a foundation from which to evaluate opportunity costs. We can describe the opportunity cost of land preservation as a function of the management practice, population growth rate, discount rate, per capita consumer surplus estimates, and the length of the planning horizon. Mathematically, we can express this relationship as

$$OC = f(M, P, D, CS, L) \quad (1)$$

where:

OC = Opportunity cost

M = Management Restrictions

P = Population Growth Rate

D = Discount Rate

CS = Per Capita Consumer Surplus Estimate

L = Length of Planning Horizon

As the management restrictions, the rate of population growth, the per capita consumer surplus estimates, and the length of the planning horizon increase, the opportunity costs should increase as well. As the discount rate increases, the opportunity costs should decrease because future values are more heavily discounted.

The relationships between these variables can be expressed as the following partial derivatives:

$$\frac{\partial OC}{\partial M} > 0 \qquad (2)$$

$$\frac{\partial OC}{\partial P} > 0 \qquad (3)$$

$$\frac{\partial OC}{\partial D} < 0 \qquad (4)$$

$$\frac{\partial OC}{\partial CS} > 0 \qquad (5)$$

$$\frac{\partial OC}{\partial L} > 0 \qquad (6)$$

Description of Land Area

As delineated in the OCRCP, within the boundaries of Marys Peak/Grass Mountain Reserve, this analysis will estimate the opportunity cost associated with three alternative land use plans. Although the boundaries are estimates, the site consists of approximately 35,152 acres of land with 77% owned by the federal government and 23% owned by private timber companies. The site contains approximately 33,400 acres of forested land which private owners and federal agencies could conceivably manage to produce timber. A small amount of forested land timber within the site-585 acres- is managed exclusively for recreation by the Siuslaw National Forest.

Table 2 presents the total forested acres by ownership and ten-year age class. The table does not include non-forested acres such as meadows, rock, administrative sites, and acres managed exclusively for recreation.

Table 2

Forest Acres by Ownership and Age Class

Ownership	Age Class (Years)	Forest Acres (unit = 1 acre)
Federal	0	1,078
Federal	10	1,895
Federal	20	2,190
Federal	30	1,619
Federal	40	1,657
Federal	50	2,180
Federal	60	2,039
Federal	70	1,132
Federal	80	2,574
Federal	90	2,594
Federal	100	2,419
Federal	110	1,458
Federal	120	769
Federal	130	854
Federal	140	271
Federal	150	91
Federal	160	3
Federal	200	631
Total Federal		25,454
Private	0	1,400
Private	10	1,600
Private	20	1,340
Private	30	1,230
Private	40	490
Private	50	540
Private	60	510
Private	70	280
Private	80	500
Private	110	50
Total Private		7,940
Total Forest Acres		33,394

Out of the 31 sites proposed, the OCRCP ranked this land as the fourth highest priority site. The ranking method was used as a proxy to measure biodiversity value. Thus, relative to other land in the Oregon Coast Range, the plan's ranking method suggests a high biological value for land contained within the Marys Peak/Grass Mountain Reserve. The FEMAT-Option Nine Plan classifies all the federal land within the Marys Peak/Grass Mountain Reserve as a Late-Successional Reserve. This classification, which suggests that the land exhibits old-growth characteristics and provides habitat for many old-growth species, adds further evidence in support of the reserve's high biological value.

The Discount Rate

To convert future monetary costs to the present time period, this analysis will use two discount rates. First, a discount rate of 7-3/4 percent will represent the opportunity cost of funds to the federal government. Federal agencies currently use this discount rate to evaluate the economic impacts of water and land projects. Second, a discount of 3 percent will represent the long-term real rate of return on investment. The Bonneville Power Administration (BPA) uses this rate to evaluate water projects.

The formula for present net worth can be expressed as

$$PV = \sum_{t=0}^{n} \frac{y_t}{(1+r)^t} \qquad (7)$$

where

PV= Present Value

Y_t = Revenue minus Cost in year t

r = Discount Rate

n = Length of Time Horizon

The Length of the Time Horizon

For each of the alternative land use proposals, this analysis will examine two time horizons. First, a sixty year period was chosen because the optimal harvest age for Douglas fir is roughly sixty years. Thus, in sixty years all forest acres could be harvested at least once. We hypothesize that including time periods longer than sixty years will have no significant impact on the conclusions. With future values discounted, the first sixty years should account for most of the present value associated with forgone timber harvests. For periods beyond sixty years, most of the data in the analysis become highly uncertain and, due to discounting, we expect that these opportunity costs will be practically irrelevant.

Second, the analysis will examine a two-hundred year period. With the two-hundred year period we can examine the economic significance of opportunity costs beyond sixty years. Under certain assumptions with regard to recreation changes and population growth, consideration of time periods greater than sixty years could significantly impact the opportunity cost estimates. The point of evaluating the proposal over a two-hundred year period is to determine whether time periods beyond sixty years affect the relative differences between the proposals. Although in theory, an infinite time horizon should apply to an opportunity cost analysis, we felt an infinite horizon was, practically speaking, irrelevant for decision makers.

Harvest Yield Estimates

To obtain yield estimates for Douglas-fir, this analysis uses the Douglas Fir Simulator program version 1.0 (DFSIM). Douglas-fir comprises the majority of the standing timber within the Salem District of the BLM (USDI BLM, 1993). The timber within the Marys

Peak/Grass Mountain Area, which is located in the Salem District, should also reflect similar homogeneity among species. Throughout this analysis, timber growth is based on the Douglas-fir yields in thousand board feet (MBF). The yields are based on Douglas-fir trees planted to 250 trees per acre and no commercial thinning. Table 3 shows the yields by age class that were generated through DFSIM.

Table 3

Yield Table by 10-Year Age Class

Age (Years)	Yield (MBF)
10	0.00
20	0.00
30	0.00
40	16.74
50	31.31
60	46.47
70	61.29
80	75.17
90	86.99
100	97.04
110	105.82
120	113.59
130	120.51
140	126.70
150	132.24
160	137.20
170	141.65
180	145.62
190	149.16
200	152.31

Harvest Schedule Model

To estimate forgone timber value, this analysis will use the Harvest-New Forestry (NF) program. The Harvest-NF program can simulate a variety of harvest schedules for an all-aged forest (Barber,1994). The calculations in this analysis are based on ten year age class intervals with yield and volume data in MBF. The analysis uses a constant stumpage price of $450 per MBF and a regeneration cost of $300 dollars per acre. These values represent rough approximations of current market conditions. Although large changes in timber harvest volume may influence the stumpage price, this analysis will consider a perfectly competitive market (i.e. quantity harvested does not influence price). The Harvest-NF program generates a harvest summary table that shows annual volume harvested, growth, inventory volume, price, revenue, cost, and discounted net revenue. The total discounted net revenue for the entire harvest period will represent the total economic value associated with timber production.

Within the Harvest-NF program, the minimum harvest age reflects the age of financial maturity. The age of financial maturity occurs when the growth rate of timber equals the discount rate. The following formula can be used to determine the annual growth rate:

$$\sqrt[10]{\frac{V_t}{V_{t-1}}} - 1 \qquad \textbf{(8)}$$

where:

V_t = Yield by 10-Year Age Class in MBF

When the annual growth rate of timber falls below the discount rate, the timber has reached the age of financial maturity. This is the point at which a land owner who maximizes present net worth will harvest the timber. At a 3 percent discount rate, the age of financial maturity occurs between 60 and 70 years. At a 7-3/4 percent discount rate the age of financial maturity occurs between 40 and 50 years. With the higher discount rate, the land owner finds it more profitable to harvest the timber earlier and invest the funds in a project that earns a higher return. With regard to a schedule that harvests timber at the age of financial maturity, this analysis uses a 60 and 40 year minimum harvest age for the 3 and 7-3/4 percent discount rates respectively.

Land Management Alternatives

The opportunity cost associated with any land use plan will depend on the forgone benefits of both commodities and recreational activities. For the Marys Peak/Grass Mountain Area, this study will evaluate opportunity costs under the following three land management alternatives:

- Maximize Financial Return of Federal Timber
- FEMAT-Option Nine Plan
- Oregon Coast Range Conservation Plan

The analysis will now evaluate the opportunity costs associated with three land use alternatives two of which attempt to protect biological diversity. This analysis will evaluate each of these alternatives against the federal policy to maximize a sustained-yield of timber. Due to its historical precedent, this mandate seems to be the most appropriate benchmark from which to compare the other alternatives.

Maximize Financial Return of Federal Timber

Critics of the maximum sustained-yield policy point out that a constant or increasing volume of timber through time sacrifices the potential returns that managers could earn by harvesting more timber earlier and investing the proceeds at the market rate of interest

(Bowes and Krutilla, 1989). To estimate the present value of a plan to maximize the present net worth of timber on federal land, this analysis will simulate a scenario in which federal agencies harvest all timber at the age of financial maturity.

With a harvest schedule that maximizes present net worth, timber revenue becomes more valuable in earlier periods; as a result, relative to the non-declining even flow baseline scenario, timber is harvested much faster in the early periods. In addition, this harvest schedule will harvest and regenerate timber in cycles, thus, the volume of standing timber will significantly vary throughout the cycle. The volume of standing timber will impact the extent to which a land manager can produce other social or ecological forest services (Bowes and Krutilla, 1989).

Table 4 shows the net present value of timber associated with a harvest schedule that maximizes the present net worth of timber on federal land. To estimate the opportunity cost associated with this harvest schedule, the net present value of timber with a schedule in which timber is harvested at the age of financial maturity is subtracted from the net present value of timber with a non-declining even flow harvest schedule. The difference represents the opportunity cost associated with the alternative to maximize the financial return of timber on federal land. Over a sixty year period, with a 3 percent rate of interest, the opportunity cost is approximately negative $297 million dollars. With a discount rate of 7-3/4 percent rate, the opportunity cost decreases slightly to approximately negative $309 million dollars. Table 5 shows these opportunity cost estimates evaluated at both discount rates for each time period.

Table 4

Economic Benefits Associated with a Harvest Schedule that Maximizes the Present Net Worth of Timber on Federal Land

Discount Rate %	Discounted Net Revenue - 60 Year Period (Dollars)	Discounted Net Revenue- 200 Year Period (Dollars)
3	572,819,600	644,921,900
7-3/4	436,224,800	436,676,500

Table 5

Opportunity Cost Estimates of Alternative to Maximize Present Net Worth of Federal Timber

Discount Rate %	Opportunity Cost - 60 Year Period (Dollars)	Opportunity Cost- 200 Year Period (Dollars)
3	(297,048,400)	(313,619,700)
7-3/4	(309,184,000)	(308,175,100)

Although time horizons and discount rates do significantly impact the present value of discounted net revenue associated with federal timber harvests, these variables have a minor impact on the relative differences. As a result, for each scenario, the opportunity cost estimates associated with the maximize present net worth of federal timber alternative are roughly $300 million. Alternatively, one could view these negative opportunity cost estimates positively-- as the present value of the loss associated with a non-declining even-flow harvest schedule constraint.

FEMAT-Option Nine Plan

The FEMAT-Option Nine Plan classifies all the federal land within the Marys Peak/Grass Mountain Area as a late-successional reserve. The management guidelines that apply to this type of reserve preclude federal agencies from harvesting timber to regenerate forests (i.e. no clearcut logging can take place). The net present value of timber with a non-declining even flow harvest schedule will represent the opportunity cost associated with the FEMAT-Option Nine Plan. Since the FEMAT- Option Nine Plan does not apply to private land and does not diminish and could even enhance recreational opportunities, no opportunity cost will be associated with private land or recreation.

Although the FEMAT-Option Nine Plan does allow for some salvage logging on land classified as late-successional reserves, these provisions are unlikely to generate much economic value. The BLM limits the salvage of dead trees in late-successional reserves to areas where disturbance exceeds ten acres in size and canopy closure has been reduced to less than 40 percent. Very few areas are likely to meet this criteria. In addition, the BLM will not remove standing live trees, including those injured, or snags that are likely to persist until late-successional forest conditions are reestablished (USDI BLM, 1994). Due to these restrictions, very little salvage logging seems likely to occur within late-successional reserves. The analysis will not consider the economic impact of salvage logging.

Evaluated at two discount rates for two time horizons, Table 6 shows the opportunity cost estimates associated with the FEMAT-Option Nine Plan.

Table 6

Opportunity Cost Estimates for FEMAT-Option Nine

Discount Rate %	Opportunity Cost- 60 Year Period (Dollars)	Opportunity Cost- 200 Year Period (Dollars)
3	275,771,200	331,302,200
7-3/4	127,040,800	128,501,400

Oregon Coast Range Conservation Plan

The present value of timber harvested under a non-declining even flow harvest schedule will reflect the opportunity cost of forgone timber harvests associated with the OCRCP. Thus, with respect to federal land, the opportunity cost estimates associated with the FEMAT- Option Nine Plan will also apply to the OCRCP. Under the OCRCP, all private land would be acquired or easements attained that would restrict timber production. Thus, the opportunity cost estimates for the OCRCP will also include the forgone value of timber located on private land. Without the OCRCP, private land owners could maximize the present net worth of timber and harvest trees at the age of financial maturity. The opportunity cost estimates associated with the OCRCP will reflect this assumption and provide the discounted net revenue that private land owners would need to forgo with the plan. For two discount rates and two time horizons, Table 7 combines the opportunity cost estimates associated with federal land with those associated with private land and shows the total opportunity cost estimates of forgone timber harvests associated with the OCRCP.

Table 7

Opportunity Cost of Forgone Timber Harvests for the Oregon Coast Range Conservation Plan

Discount Rate 3 %				
Forgone Activity	Opportunity Cost-60 Year Period (Dollars)	Percent of Total	Opportunity Cost-200 Year Period (Dollars)	Percent of Total
Timber Harvests (Federal Land)	275,771,200	79	331,302,200	80
Timber Harvests (Private Land)	71,157,300	21	82,487,100	20
Total	346,928,500	100	413,789,300	100

Discount Rate 7-3/4 %				
Forgone Activity	Opportunity Cost-60 Year Period (Dollars)	Percent of Total	Opportunity Cost-200 Year Period (Dollars)	Percent of Total
Timber Harvests (Federal Land)	127,040,800	77	128,501,200	77
Timber Harvests (Private Land)	38,729,100	23	38,909,600	23
Total	165,769,900	100	167,410,800	100

The OCRCP would also require the prompt closure of most roads within the reserve. These road closures will result in the loss of motorized recreation and, due to restricted access, may reduce many non-motorized forms as well. Within the Marys Peak/Grass Mountain Area, most of the recreation occurs around a developed site at the top of Marys Peak. Other more dispersed recreation such as hunting occurs along roads and within undeveloped forest lands. This analysis will estimate the opportunity cost associated with the road closures proposed in the OCRCP.

Impact of Population Growth

Research shows that as the population of a region grows, the demand for outdoor recreation tends to increase as well (Bergstrom and Cordell, 1991; Clawson, 1985; Kelly, 1987; U.S. Department of Interior, 1986; Murdock et al., 1991). Within the Marys Peak/Grass Mountain Area the future demand for recreation should depend on the nearby population. This analysis will consider the demand for recreation a function of the population of two counties--Linn and Benton-- in which residents live within easy driving distance to Marys Peak.

Changes in income could also affect recreational demand. With a higher income, a person may visit a site more often and could be willing to pay more per visit. There is no easy way to predict the extent to which income elasticity will affect each (Porter, 1990). Further research is needed to establish a relationship between income and recreation. This analysis will not consider the impact of income on visitor days.

Table 8 summarizes the population growth for both Linn and Benton County from 1980-1994 (CPRC, 1991). For the weighted average of the two counties combined, the data shows a population growth rate of .61 percent per year. The Center for Population Research and Census (CPRC) projects that the combined population of Linn and Benton county will equal 209,455 in the year 2010 (CPRC, 1993). This projection is consistent with an annual population growth rate of 1.25 percent and based on historical trends which the CPRC characterizes as conservative (i.e. projections are based on the past) (CPRC, 1993). Although population growth rates at this level and higher are more characteristic of the trends in recent years the CPRC does not predict that the projected rates will sustain themselves for periods as long as sixty years. This analysis will consider the impact of a .61 percent population growth rate as well as faster population growth rates of 1.25 and 2 percent per year. These higher rates of population growth will provide an upper bound estimate and establish the extent to which opportunity cost estimates change with large changes in population over time.

Table 8

Population Change for Linn and Benton County: 1980-1994

County	Population-1980 Census	Population-1994 Estimate	Average Percent Change 1980-1994
Benton	68,211	75,400	.72
Linn	89,495	96,300	.54
Total Pop.	157,706	171,700	.61

For the two-hundred year time horizon, the analysis will project positive population growth rates for the first sixty years and a zero rate of population growth thereafter. When population growth of 1.25 and 2 percent are projected for two-hundred years, the total population for Linn and Benton county exceeds any reasonable estimate of the capacity for the area[2]. Table 9 shows the total population for Linn and Benton counties with constant growth rates for sixty years.

[2] Over a two-hundred year period, a population growth rate of 1.25% results in a population of over 2 million people for Linn and Benton county. A population growth rate of 2%, results in a population of well over 8 million.

Table 9

Population Projections for Linn and Benton County

Annual Rate of Population Growth (percent)	Total Population in 60 years
.61	247,309
1.25	361,803
2.00	563,353

To predict changes in the demand for recreation due to population growth (population elasticity for recreational demand), the analysis will assume a constant population elasticity for recreational demand of one. This suggests that the percentage change in recreational visitor days equals the percentage change in population. In other words, everyone is equally likely to go on a visit.

Marys Peak Visits

Visits to the top of Marys Peak are a major recreational activity within the Marys Peak/Grass Mountain Area. A paved road provides motorists with easy access to the highest peak in the Oregon Coast Range. The site offers year round opportunities for activities such as picnicking, sightseeing, photography, walking, and day hiking. Sledding is also popular when the peak receives snow in the winter months. Although data does not track recreational visits by activity, this analysis will consider sightseeing as the primary recreational activity that motivates people to visit the top of Marys Peak. Given the scenic views from the top of Marys Peak, sightseeing seems likely to occur on the majority of visits.

In a 1991 environmental assessment, the Siuslaw National Forest Service estimated that over 90,000 people annually visit Marys Peak (USDA, 1990). Based on Forest Service data collected with mechanical road counters, approximately 42,613 vehicles visited Marys Peak in 1994. With an average of three persons per vehicle, an estimated 127,839 visitor days occurred in 1994. Studies provide support that three persons per vehicle provides a reasonable estimate. In a report prepared for the Oregon Tourism Division, Davidson-Peterson Associates, Inc. found that on average in-state visitors have 3.1 people in their travel party (OTD, 1995). In a study to estimate future outdoor recreation consumption in the Pacific Northwest, Hospodarsky (1989) found an average group size of 2.4 for both picnicking and sightseeing. To project Marys Peak visitor days for years into the future, this analysis will use 127,839 as a base figure.

This analysis will consider consumer surplus the appropriate monetary measure for which to estimate the economic losses that individuals experience as a result of road closures[3]. In terms of recreational visits, consumer surplus represents how much additional value a person would be willing to pay to visit a site rather than being forced to do without the visit. Based on data from a nationwide survey, Bergstrom and Cordell (1991) estimated the consumer surplus value for sightseeing as $14.23. The consumer surplus estimates for pleasure driving, picnicking, day hiking, photography, range from $9.65 to $12.31. For an estimate of the consumer surplus associated with a visitor day at Marys Peak, this analysis will use $14.23 as a middle estimate, $19.23 as a high estimate, and $9.23 as a low estimate. Given the uncertainty regarding the opportunity cost of time, a wide range of consumer surplus estimates seems appropriate.

3 Economists developed the concept of consumer surplus to represent the value of a welfare gain or loss an individual experiances as a result of a change in price (Nicholson, 1992).

Due to the steep, rugged terrain and the duration of time required for a nonmotorized journey, road closures would likely result in the loss of most visits to the top of Marys Peak. This analysis will estimate the opportunity cost associated with a loss in motorized access to Marys Peak. Given a population elasticity for recreational demand of one and a range of population growth rates and consumer surplus estimates, Appendix B shows opportunity costs associated with forgone visits to Marys Peak. Next, the analysis will examine the economic value for deer and elk hunting within the Marys Peak/Grass Mountain Area.

Deer and Elk Hunting

This analysis will estimate the opportunity cost of forgone hunting associated with the OCRCP. With regard to hunting, this analysis will make a key assumption. Since most of the land in the Alsea Wildlife Unit would fall into other OCRCP reserves with the same restrictions, this analysis will assume no substitution possibilities exist (i.e., hunters who cannot hunt in the Marys Peak/Grass Mountain Area also cannot hunt in other nearby areas).

To manage wildlife, the state of Oregon's Department of Fish and Wildlife (ODFW) divides the state up into Wildlife Units. The Marys Peak/Grass Mountain Area is contained within the boundaries of the Alsea Wildlife Unit. The Alsea Wildlife Unit consists of 1,240,960 acres of land of which 42 percent, or 521,203 acres, constitute public land. The Marys Peak/Grass Mountain Area comprises 5.2 percent of total public acres within the Alsea Wildlife Unit. If dispersed hunting recreation is spread evenly across the public Alsea land, then 5.2 percent of the hunting visits in the Alsea unit or 7,236 hunter days should occur within the Marys Peak/Grass Mountain Area.

Since the OCRCP would still permit hunters to travel by foot or by horseback, even with road closures, some economic value for hunting could remain. To account for this possibility, we will estimate that road closures contribute to an 80 percent loss of the annual hunting days. Data which shows over 80 percent of recreational visitor days occur on land classified as suitable for motorized transportation provides some support for this estimate; however, this data does include many other types of outdoor recreation besides hunting (FEMAT, 1993; Hospordarsky et al., 1988). For 1994, this analysis will estimate that 5,789 hunter days occurred in the Marys Peak/Grass Mountain Area. This estimate will be used as a base from which to project changes in hunting days.

Table 10 shows the total deer and elk hunter days in the Alsea unit, hunter day estimates for the Marys Peak/Grass Mountain area, and an estimate of the annual loss of hunting in the reserve for 1993. This annual loss reflects consumer surplus estimates of $30.00 and $45.00 for the value deer and elk hunter days respectively. Current literature provides support for these estimates (FEMAT, 1993; Luzar *et al*, 1992; Loomis *et al*, 1989). The weighted average per capita consumer surplus of $32.45 reflects the higher number of deer hunting relative to elk hunting days in the area. This analysis will use $32.45 as a mid range estimate, $42.45 for a high, and $22.45 for a low per capita consumer surplus estimate of the economic value for a hunting day in the Marys Peak/Grass Mountain Area.

Table 10

1994 Deer and Elk Seasons-Hunter Days and Economic Values

Season	Hunter Days Alsea Unit	Hunter Days (5.2% of Alsea Unit)	Hunter Days (80% of Estimate)	Value per Day (Dollars)	Estimated Annual Loss (Dollars)
Elk	22,759	1,184	947	45.00	42,615
Deer	116,371	6,052	4,842	30.00	145,260
Total	139,130	7,236	5,789	32.45 *	187,853

Given a population elasticity for recreational demand of one and a range of population growth rates and consumer surplus estimates, Appendix A shows opportunity costs associated with forgone hunting days in the Marys Peak/Grass Mountain Area.

Opportunity Cost Estimates for OCRCP

Table 11 combines the opportunity cost estimates for the value of forgone visits to Marys Peak with the estimates for the value of forgone hunting days. As a percent of the total opportunity costs associated with the OCRCP, forgone visits to Marys Peak comprise between 9 and 26 percent of total opportunity costs while the value of forgone hunting days comprise between 1 to 3 percent of the total. Thus, the majority of the recreation losses are associated with the closure of one road that would eliminate reasonable access to one particular site.

* Average value weighted by deer and elk hunting days.

Table 12 combines the recreation losses with the losses associated with the forgone timber harvests and shows the range of total opportunity costs associated with the OCRCP. Table 12 also shows that losses associated with forgone recreation comprise between 10 to 29 percent of the total opportunity cost estimates. Appendix B provides a summary of the opportunity cost estimates for each time horizon, discount rate, population growth rate, consumer surplus estimate.

Table 11

Opportunity Cost Estimates for the Value of Forgone Recreation Associated with the Oregon Coast Range Conservation Plan

Discount Rate (percent)	Visits to Marys Peak (Dollars)	Percent of Total	Hunting in Marys Peak/Grass Mountain (Dollars)	Percent of Total
3	37,548,958-151,706,386	9.7-26.1	4,135,735-15,165,001	1.1-2.6
7-3/4	16,265,860-42,073,229	8.9-19.7	1,791,562-4,205,760	1-2

Table 12

Range of Total Opportunity Costs Associated with the Oregon Coast Range Plan

Discount Rate (percent)	Opportunity Costs- 60 Year Period (Dollars)	Forgone Recreation (Percent of Total)	Opportunity Costs- 200 Year Period (Dollars)	Forgone Recreation (Percent of Total)
3	388,613,193- 466,959,095	10.8-25.7	465,645,120- 580,660,687	11.1-28.7
7-3/4	183,827,322- 210,870,628	9.8-21.4	185,724,273- 213,689,989	9.9-21.7

Relative to the FEMAT-Option Nine Plan, Table 13 shows the additional cost of the OCRCP as a range of estimates and as a percent of the total opportunity costs. The OCRCP increases the opportunity cost estimates between 41 to 75 percent. Table 14 shows the increase in opportunity costs associated with forgone recreation and the percent of total opportunity costs associated with forgone recreation. Relative to the FEMAT-Option Nine Plan, recreational losses comprise 14 to 50 percent of the increase in opportunity costs associated with the OCRCP.

Table 13

Range of Opportunity Costs Associated with the Oregon Coast Range Plan Relative to the FEMAT-Option Nine Plan

Discount Rate (percent)	Opportunity Costs- 60 Year Period (Dollars)	Percent of Increase	Opportunity Costs- 200 Year Period (Dollars)	Percent of Increase
3	112,841,993- 191,187,890	41-69	134,342,920- 249,358,487	41-75
7-3/4	56,786,522- 83,829,828	44-66	57,222,873- 85,188,589	44-66

Table 14

Range of Opportunity Costs for the Value of Forgone Recreation Associated with the Oregon Coast Range Plan Relative to the FEMAT-Option Nine Plan

Discount Rate (percent)	Opportunity Costs of Forgone Recreation- 60 Year Period (Dollars)	Percent of Increase	Opportunity Costs of Forgone Recreation- 200 Year Period (Dollars)	Percent of Increase
3	41,684,693- 120,030,590	15-44	51,855,820- 166,871,387	16-50
7-3/4	18,057,422- 45,100,728	14-36	18,313,273- 46,278,989	14-36

Chapter Five will now summarize these results and discuss policy implications along with areas for further research.

Chapter 5
Conclusions and Policy Implications

The results show that relative to the baseline non-declining even-flow timber harvest schedule, the Maximize Financial Return of Federal Timber alternative does significantly reduce opportunity costs; in fact, the results show a positive economic benefit. The opportunity cost estimates range from negative $297 million to just over negative $313 million. For the FEMAT-Option Nine Plan, the opportunity cost estimates range from approximately $127 million to just over $331 million. For the OCRCP, the opportunity cost estimates range from approximately $184 million to over $580 million.

Uncertainty with regard to the rate of population growth tends to widen the range of opportunity cost estimates for the OCRCP. From a policy makers perspective, the population growth rate of .61 percent seems the most appropriate for a period as long as sixty years. However, given this rate of population growth, the opportunity cost estimates for the OCRCP still range from $184 million to over $520 million.

Table 15 provides a summary of the opportunity costs associated with each alternative. The opportunity cost associated with the OCRCP reflects a population growth rate of .61 percent and the mid range per capita consumer surplus estimates.

Table 15

Opportunity Cost Overview by Proposal

Proposal	3 percent		7-3/4 percent	
	60 year period	200 year period	60 year period	200 year period
Maximize Financial Return on Federal Land	(297,048,400)	(313,619,700)	(309,184,000)	(308,175,100)
FEMAT-Option Nine Plan	275,771,200	331,302,200	127,040,800	128,501,400
Oregon Coast Range Conservation Plan	410,796,105	493,240,694	193,436,754	195,996,731

A policy maker may also choose to examine the opportunity cost of the OCRCP relative to FEMAT-Option Nine Plan. Since the forgone value associated with federal timber remains the same in both alternatives, the additional cost associated with the OCRCP consists of the value of forgone private timber along with the value of forgone recreation. The analysis shows that, depending on the scenario, the OCRCP adds between 41 to 75 percent to the total opportunity cost estimates. These results suggest that relative to the FEMAT-Option Nine Plan, the OCRCP significantly increases the total opportunity costs. From a policy makers perspective, a substantial amount of additional benefits would be needed to justify implementing the OCRCP.

For the FEMAT-Option Nine Plan, all of the opportunity costs are associated with forgone timber harvests. With regard to the OCRCP, the opportunity costs also include forgone recreation. The recreation estimates range from approximately 10 to 29 percent of the total opportunity costs for the plan. These results suggest the potential for a range of distribution impacts. The individuals that bear the costs associated with forgone timber harvests are not necessarily the same people that bear the costs associated with lost recreation. Policy makers will need to consider the extent to which a small group of individuals bear the cost and address the potential disparity between those who bear the costs and those who receive the benefits. If a small segment of society bears a large portion of the costs, should society compensate the losers? With regard to the OCRCP, an uneven distribution of costs may occur among outdoor recreational participants (i.e. primitive users would benefit while users of roads would suffer the loss). Policy makers will need to consider the distribution of losses associated with each land management alternative.

Additional Policy Implications

With regard to a decision to implement a particular plan to protect species, opportunity costs are only one factor for policy makers to consider. A policy maker should also consider the social benefits of these alternative plans. Although under most circumstances the benefits will not be easy to quantify, a decision maker will still need to assess the importance of these benefits relative to other social concerns and goals.

Policy makers should also consider the extent to which opportunity costs will reduce the probability that some irreversible loss will occur. Most likely, society will view an irreversible loss differently than a loss that is easy to reverse. If significant opportunity costs are associated with very small changes in the probability of a loss, then society does not seem likely to benefit from the additional cost. Although information on critical biological thresholds and probability estimates will not always exist, policy makers will need to work with the "experts" to gain some sense of where these estimates may lie.

Areas for Future Research

The long standing policy of a non-declining even-flow harvest schedule has not been justified on economic grounds. Future research could attempt to measure the impact that a harvest schedule that maximizes present net worth of timber would have on aesthetic, amenity, and non-use values. In other words, an evaluation of the benefits associated with the non-declining even-flow constraint provides a subject for further research.

Further research needs to examine the potential price impact of large decreases in the supply of commodities such as timber. For example, a substantial rise in the price of timber could induce suppliers from other regions or countries to harvest even more timber. Large scale management plans could inadvertently trade an increase in the likelihood of survival of species in one region for country for a decrease in the likelihood of survival in another area. For example, could a small increase in the probability of survival for some Pacific Northwestern species result in large decreases in the probability of survival for species in the rain forests of Brazil? When land management restrictions induce external changes in the production of commodities, research is needed to determine the global impact on biological diversity?

Further research is needed to determine the economic impact of road closures on recreation. Are the biological damages caused by the roads themselves or by specific activities of individuals who use the roads? Would restrictions on certain types of roads achieve biological objectives? For example, do the acres designated as roaded natural pose the same threat as those acres designated as semiprimitive motorized? How would limited or concentrated road restrictions impact biological diversity? If roads were closed, to what extent would people shift to non-motorized forms of transportation? Do the management options that enhance the value of recreation conflict with the goals to conserve species?

What are the impacts of these options for biological diversity? Further research is needed to consider each of these issues.

Additional research is also needed on the potential for changes in consumer surplus when no substitute sites are available. For example, with regard to the OCRCP, would closure of all the roads increase the consumer surplus estimates because alternative sites are overcrowded or unavailable? Also, will the transition of timber lands to old-growth reserves induce a shift in the demand for recreation or change the value of consumer surplus estimates? Studies are needed to determine to what extent are people are willing to pay for changes in the quality of recreational sites and extent to which those changes will induce additional demand.

A policy maker could decide that the opportunity costs are too high for the entire project, but still remain open to converting a smaller portion of the land area. Research is needed to determine the extent to which society can achieve goals to protect species with partial implementation of a plan. For example, could land managers achieve the species conservation objectives in the OCRCP and still allow the road to Marys Peak to remain open? If a budget constraint limited to 50,000 acres the extent to which managers could implement the OCRCP, which acres would provide the most biological benefits? How much of the species conservation objectives would managers forgo with this type of limited approach? These are all issues that policy makers will need to consider with any plan to manage land.

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Appendices

Appendix A
Recreation Estimates

Table 16

Estimates of the Economic Value of Forgone Visits to Marys Peak

Discount Rate 3% 60-Year Period			
Population Growth	Consumer Surplus High Estimate $19.23	Consumer Surplus Middle Estimate $14.23	Consumer Surplus Low Estimate $9.23
0.61%	78,230,387	57,889,672	37,548,958
1.25%	90,744,607	67,150,066	43,555,524
2.00%	109,122,409	80,749,448	52,376,486

Discount Rate 3% 200-Year Period			
Population Growth	Consumer Surplus High Estimate ($19.23)	Consumer Surplus Middle Estimate ($14.23)	Consumer Surplus Low Estimate ($9.23)
0.61%	97,318,714	72,014,836	46,710,959
1.25%	118,476,922	86,671,690	56,866,458
2.00%	151,706,386	112,261,148	72,815,910

Discount Rate 7-3/4% 60-Year Period			
Population Growth	Consumer Surplus High Estimate $19.23	Consumer Surplus Middle Estimate $14.23	Consumer Surplus Low Estimate $9.23
0.61%	33,888,677	25,077,269	16,265,860
1.25%	36,891,048	27,298,992	17,706,936
2.00%	41,002,047	30,341,088	19,680,129

Discount Rate 7-3/4% 200-Year Period			
Population Growth	Consumer Surplus High Estimate ($19.23)	Consumer Surplus Middle Estimate ($14.23)	Consumer Surplus Low Estimate ($9.23)
0.61%	34,368,836	25,432,581	16,496,327
1.25%	37,588,643	27,815,205	18,041,767
2.00%	42,073,229	31,133,752	20,194,275

Table 17

Opportunity Cost Estimates of Forgone Hunting

Discount Rate 3% 60-Year Period			
Population Growth	Consumer Surplus High Estimate ($42.45)	Consumer Surplus Middle Estimate ($32.45)	Consumer Surplus Low Estimate ($22.45)
0.61%	7,820,132	5,977,933	4,135,735
1.25%	9,071,089	6,934,201	4,797,313
2.00%	10,908,186	8,338,531	5,768,876

Discount Rate 3% 200-Year Period			
Population Growth	Consumer Surplus High Estimate ($42.45)	Consumer Surplus Middle Estimate ($32.45)	Consumer Surplus Low Estimate ($22.45)
0.61%	9,728,255	7,436,558	5,144,861
1.25%	11,843,290	9,053,351	6,263,412
2.00%	15,165,001	11,592,563	8,020,124

Discount Rate 7-3/4% 60-Year Period			
Population Growth	Consumer Surplus High Estimate ($42.45)	Consumer Surplus Middle Estimate ($32.45)	Consumer Surplus Low Estimate ($22.45)
0.61%	3,387,609	2,589,585	1,791,562
1.25%	3,687,734	2,819,010	1,950,286
2.00%	4,098,681	3,133,150	2,167,618

Discount Rate 7-3/4% 200-Year Period			
Population Growth	Consumer Surplus High Estimate ($42.45)	Consumer Surplus Middle Estimate ($32.45)	Consumer Surplus Low Estimate ($22.45)
0.61%	3,435,607	2,626,276	1,816,946
1.25%	3,757,468	2,872,316	1,987,165
2.00%	4,205,760	3,215,003	2,224,247

Appendix B
Opportunity Cost Estimates

Table 18

Opportunity Cost Estimates: Oregon Coast Range Conservation Plan

	Discount Rate 3% 60-Year Period Population Growth .61%		
Forgone Activity	High Estimate	Middle Estimate	Low Estimate
Timber Harvests (Federal Lands)	275,771,200	275,771,200	275,771,200
Timber Harvests (Private Land)	71,157,300	71,157,300	71,157,300
,Hunting	7,820,132	5,977,933	4,135,735
Visits to Mary's Peak	78,230,387	57,889,672	37,548,958
Total	$432,979,019	$410,796,105	$388,613,193
	Discount Rate 3% 200-Year Period Population Growth .61%		
Forgone Activity	High Estimate	Middle Estimate	Low Estimate
Timber Harvests (Federal Lands)	331,302,200	331,302,200	331,302,200
Timber Harvests (Private Land)	82,487,100	82,487,100	82,487,100
Hunting	9,728,255	7,436,558	5,144,861
Visits to Mary's Peak	97,318,714	72,014,836	46,710,959
Total	$520,836,269	$493,240,694	$465,645,120

	Discount Rate 3% 60-Year Period Population Growth 1.25%		
Forgone Activity	High Estimate	Middle Estimate	Low Estimate
Timber Harvests (Federal Lands)	275,771,200	275,771,200	275,771,200
Timber Harvests (Private Land)	71,157,300	71,157,300	71,157,300
Hunting	9,071,089	6,934,201	4,797,313
Visits to Mary's Peak	90,744,607	67,150,066	43,555,524
Total	$446,744,196	$421,012,767	$395,281,337
	Discount Rate 3% 200-Year Period Population Growth 1.25%		
Forgone Activity	High Estimate	Middle Estimate	Low Estimate
Timber Harvests (Federal Lands)	331,302,200	331,302,200	331,302,200
Timber Harvests (Private Land)	82,487,100	82,487,100	82,487,100
Hunting	11,843,290	9,053,351	6,263,412
Visits to Mary's Peak	118,476,922	86,671,690	56,866,458
Total	$544,109,512	$509,514,341	$476,919,170

	Discount Rate 3% 60-Year Period Population Growth 2%		
Forgone Activity	High Estimate	Middle Estimate	Low Estimate
Timber Harvests (Federal Lands)	275,771,200	275,771,200	275,771,200
Timber Harvests (Private Land)	71,157,300	71,157,300	71,157,300
Hunting	10,908,186	8,338,531	5,768,876
Visits to Mary's Peak	109,122,409	80,749,448	52,376,486
Total	$466,959,095	$436,016,479	$405,073,862

	Discount Rate 3% 200-Year Period Population Growth 2%		
Forgone Activity	High Estimate	Middle Estimate	Low Estimate
Timber Harvests (Federal Lands)	331,302,200	331,302,200	331,302,200
Timber Harvests (Private Land)	82,487,100	82,487,100	82,487,100
Hunting	15,165,001	11,592,563	8,020,124
Visits to Mary's Peak	151,706,386	152,017,150	72,815,910
Total	$580,660,687	$537,643,011	$494,625,334

	Discount Rate 7-3/4% 60-Year Period Population Growth .61%		
Forgone Activity	High Estimate	Middle Estimate	Low Estimate
Timber Harvests (Federal Lands)	127,040,800	127,040,800	127,040,800
Timber Harvests (Private Land)	38,729,100	38,729,100	38,729,100
Hunting	3,387,609	2,589,585	1,791,562
Visits to Mary's Peak	33,888,677	25,077,269	16,265,860
Total	$203,046,186	$193,436,754	$183,827,322
	Discount Rate 7-3/4% 200-Year Period Population Growth .61%		
Forgone Activity	High Estimate	Middle Estimate	Low Estimate
Timber Harvests (Federal Lands)	128,501,400	128,501,400	128,501,400
Timber Harvests (Private Land)	38,909,600	38,909,600	38,909,600
Hunting	3,435,607	2,626,276	1,816,946
Visits to Mary's Peak	34,368,836	25,432,581	16,496,327
Total	$205,742,617	$195,996,731	$186,628,949

	Discount Rate 7-3/4% 60-Year Period Population Growth 1.25%		
Forgone Activity	High Estimate	Middle Estimate	Low Estimate
Timber Harvests (Federal Lands)	127,040,800	127,040,800	127,040,800
Timber Harvests (Private Land)	38,729,100	38,729,100	38,729,100
Hunting	3,687,734	2,819,010	1,950,286
Visits to Mary's Peak	36,891,048	27,298,992	17,706,936
Total	$206,348,682	$195,887,902	$185,427,122
	Discount Rate 7-3/4% 200-Year Period Population Growth 1.25%		
Forgone Activity	High Estimate	Middle Estimate	Low Estimate
Timber Harvests (Federal Lands)	128,501,400	128,501,400	128,501,400
Timber Harvests (Private Land)	38,909,600	38,909,600	38,909,600
Hunting	3,757,468	2,872,316	1,987,165
Visits to Mary's Peak	37,588,643	27,815,205	18,041,767
Total	$208,757,111	$198,098,521	$187,439,932

	Discount Rate 7-3/4% 60-Year Period Population Growth 2%		
Forgone Activity	High Estimate	Middle Estimate	Low Estimate
Timber Harvests (Federal Lands)	127,040,800	127,040,800	127,040,800
Timber Harvests (Private Land)	38,729,100	38,729,100	38,729,100
Hunting	4,098,681	3,133,150	2,167,618
Visits to Mary's Peak	41,002,047	30,341,088	19,680,129
Total	$210,870,628	$199,244,138	$187,617,647
	Discount Rate 7-3/4% 200-Year Period Population Growth 2%		
Forgone Activity	High Estimate	Middle Estimate	Low Estimate
Timber Harvests (Federal Lands)	128,501,400	128,501,400	128,501,400
Timber Harvests (Private Land)	38,909,600	38,909,600	38,909,600
Hunting	4,205,760	3,215,003	2,224,247
Visits to Mary's Peak	42,073,229	31,133,752	20,194,275
Total	$213,689,989	$201,759,755	$189,829,522