

Opportunity Costs of Spotted Owl Management Options for British Columbia

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On estime qu'il y a moins que 100 paires des chouettes tachetées du Nord au Canada. Tous ces chouettes tachetées sont dans le sud-ouest de la Colombie-Britannique. En 1986, la chouette tachetée fut classé espèce en danger. Un programme de recouvrement, comprenant six options de gestion, fut développé afin de stabiliser la population des chouettes tachetées et ayant comme but éventuel l'amélioration du statut de l'espèce. Et article a pour objectif de présenter les estimations des coûts d'opportunité des diverses options visant à augmenter la population des chouettes tachetées. Le principal coût d'opportunité est la coupe de bois dans la région peuplée des chouettes tachetées, à laquelle on renonce. Nous rapportons les estimations des coûts d'opportunité au niveau agrégé et au niveau des ménages. Cet article décrit aussi quelques uns des bénéfices qui peuvent découler de la protection d'espèces on voie de disparition et discute de quelques problèmes associés à la mesure de ces valeurs.

It is estimated that there are fewer than 100 pairs of northern spotted owls in Canada all located in the southwestern mainland of British Columbia. In 1986, the spotted owl was designated as an endangered species. A recovery plan was developed setting out six management options to stabilize spotted owl populations and eventually lead to an improvement in the status of the species. The purpose of the present paper is to report estimates of the opportunity costs of the options for recovering the owl populations. The primary opportunity costs of the recovery options would be the foregone timber harvests in the area inhabited by spotted owls. Aggregate and annual household opportunity cost estimates are reported. The paper also describes some of the benefits that can arise from the protection of endangered species and discusses some problems in measuring these values.

BACKGROUND AND INTRODUCTION

It is estimated that there are fewer than 100 pairs of northern spotted owls in Canada. All known Canadian owl pairs are located in the southwestern mainland of British Columbia. This area represents

the northern extension of the owl's habitat which is mainly located in the US Pacific Northwest but which also extends south into Northern California. The spotted owl populations of British Columbia are associated with dispersed patches of late successional and old growth coniferous forests. Studies

indicate that spotted owl populations appear to be declining throughout North America. Loss of habitat has been identified as the main threat to the survival of the owl throughout its range (Thomas *et al.* 1990).

In 1986, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated the spotted owl as endangered in Canada. This means spotted owls are felt to be threatened with imminent extinction throughout all or most of their range in Canada. In 1990, the Canadian Spotted Owl Recovery Team (SORT) was established to develop a recovery plan setting out options that would stabilize owl populations and eventually lead to an improvement in the status of the owl. SORT is composed of representatives from the British Columbia Ministries of Environment, Lands and Parks and Forests, Canadian Wildlife Service, academia, forest industry, and an environmental non-government organization.

The purpose of this paper is to present estimates of the opportunity costs of the options to recover spotted owl populations to complement SORT's biological assessment. The primary opportunity cost of protecting spotted owls is the value of the timber harvest that would be foregone with each of the management options. The paper presents estimates of the aggregate and annual household opportunity costs of the foregone timber harvests as the chances of the owl's survival are improved. The measures of opportunity costs show the increasing sacrifice that society has to make to increase the probability of the spotted owl's survival. Further, the opportunity cost analysis provides a basis for comparing the costs of protecting spotted owls to the costs of protecting other species or initiating other public policies. In order to judge whether a public policy such as options for the recovery of endangered species is worthwhile, it is desirable to know the full set of benefits and costs of the policy. While the paper identifies a number of benefits associated with the protection of endangered species, estimating their magnitude is, in most cases, problematic being incomplete and imprecise.

The following section describes the six management options proposed for the recovery of spotted owls in British Columbia. The third section describes the estimates of the opportunity costs of the foregone timber harvest associated with each spotted owl management option. This includes a sensitivity analysis that shows the effect of changes in the discount rate, timber prices, and harvesting costs on estimates of opportunity costs. The opportunity costs are presented as aggregate measures as well as the annual costs to British Columbia households. This is followed by a description of some of the benefits that arise from protecting endangered species and the difficulties in obtaining full and accurate measures of these benefits. An alternative framework to benefit-cost assessment of endangered species is discussed and evaluated. The paper concludes with a summary of the findings and discussion of their uses.

OPTIONS FOR SPOTTED OWL RECOVERY IN BRITISH COLUMBIA

SORT's recovery plan report presented six options for long-term spotted owl management (Dunbar and Blackburn 1994). The six options are listed and described in Table 1. They range from maximum to minimum protection of spotted owls. Four of the six options are based on a system of proposed Spotted Owl Conservation Areas (SOCAs). SOCAs are areas that range in size from 6,000 hectares to 37,000 hectares and are large enough to support multiple breeding pairs of spotted owls. SOCAs were designed to maintain critical habitat for the spotted owl and reverse the trend of habitat loss. The number and distribution of SOCAs and the amount of timber harvesting to be allowed in them vary across the different options. Of the 332,400 hectare total area contained within the 21 proposed SOCAs, 35 percent would be within already established parks, 42 percent would be in the currently inoperable forest land base and 23 percent would be from the economically operable portion of the harvestable land base. Some of the options provide protection according to activity centres. A spotted owl activity

TABLE 1
Options for Spotted Owl Recovery

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- 1. Full Protection Option:** No timber harvesting permitted which degrades or destroys suitable owl habitat within all forested habitats throughout the entire documented range of the bird in the province.
 - 2. Full SOCA Protection Option:** Timber harvesting prohibited which degrades or destroys suitable owl habitat in all SOCAs throughout the entire documented range of the bird in the province.
 - 3. Sasquatch SOCA and 67% Activity Centre Protection Option:** No timber harvesting which degrades or destroys suitable owl habitat in all SOCAs within the Sasquatch Range and the retention of a minimum 67% owl habitat in each 3,200 ha. activity centre within all remaining SOCAs throughout the documented range of the bird in the Province (outside the Sasquatch Range). (The Sasquatch Range is the area bounded in the west by the Capilano River, in the north by Golden Ears and Sasquatch Provincial Parks, in the east by Sowaqua Creek, and in the south by the international border with the United States.)
 - 4. 67% Activity Centre Protection Option:** Retention of a minimum 67% suitable owl habitat in each 3,200 ha. activity centre within all SOCAs throughout the entire documented range of the bird in the province.
 - 5. Sasquatch SOCA Protection Option:** Timber harvesting prohibited which degrades or destroys suitable owl habitat in all SOCAs within the Sasquatch Range. No spotted owl management beyond existing parks and protected areas outside the Sasquatch Range.
 - 6. Base Case Option:** No spotted owl management beyond existing parks and protected areas.
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centre represents the home range of a known spotted owl site usually supporting a pair of owls. For administrative purposes these centres are set at an area of 3,200 hectares.

A panel of six independent experts was recruited by SORT to assess and rank the six options according to the five status categories of the Committee on the Status of Endangered Wildlife in Canada. Panelists were asked to give their best judgement for each option in answering the question: Given the likely condition of habitat under a specific option, what will be the status of the spotted owl in 100 years? Table 2 lists the six options and the overall ranking of each option by the panel of experts along with the definitions of the COSEWIC status categories. For the options that have two rankings, the first is most likely, but the second still has a fairly high probability of occurring.

Each increase in the amount of owl habitat protected that increases the probability of the owl's

survival entails an additional cost to society. The alternative or opportunity cost of protecting owl habitat is the value of the land in its next best use. That is, if the land is preserved, it is unavailable for other uses incompatible with owl habitat. The value of the foregone use of the land is the cost of owl habitat protection. Currently, there are plans to log much of the area that is spotted owl habitat. Given the incompatibility of logging and owl habitat protection, increasing the probability of owl survival requires a reduction in the amount of logging. The value of the reduced timber harvest is the opportunity cost of increasing the probability of the spotted owl's survival.

There may be some non-timber costs associated with the foregone harvests. For example, there are wildlife species that benefit from some types of timber harvesting. Also, a second growth forest may be more visually pleasing and provide more recreational opportunities than a dense, decaying old growth forest. However, no attempt is made here to

TABLE 2
Probable Status Rankings of Spotted Owl Options

Option 1 (Full Protection Option)	de-list
Option 2 (Full SOCA Protection Option)	vulnerable
Option 3 (Sasquatch SOCA and 67% Activity Centre Option)	threatened
Option 4 (67% Activity Centre Protection Option)	threatened/endangered
Option 5 (Sasquatch SOCA Protection Option)	endangered/threatened
Option 6 (Base Case Option)	endangered/extirpated

Five Status Categories of COSEWIC

De-listed	A species not at risk
Vulnerable	A species particularly at risk because of low or declining numbers, small range, or some other reason, but not a threatened species.
Threatened	A species likely to become endangered in Canada if factors affecting its vulnerability are not reversed.
Endangered	A species threatened with imminent extinction or extirpation throughout all or a significant portion of its range in Canada.
Extirpated	A species no longer existing in the wild in Canada, but occurring elsewhere.

estimate the non-timber costs of the foregone harvests. The following section describes the calculations of the opportunity costs of the foregone timber harvests for each of the options that improve the status of spotted owls. In a similar exercise, Montgomery and Brown (1992) and Montgomery, Brown and Adams (1994) estimate the marginal cost of increasing the amount of protected spotted owl habitat in the US Pacific Northwest.

TIMBER HARVESTING OPPORTUNITY COSTS

The Value of Forest Land

The value of forest land devoted to timber production is the maximum amount that someone would

be willing to pay for the land if it was devoted to producing an infinite series of rotations of identical growing regimes. The maximum amount someone would be willing to pay for the land is equal to the net present value of the infinite series of forest rotations. This net present value is known as the site value which is the capitalized value of the net income of producing timber. The site value is the appropriate measure for the valuation of private forests. However, the public forest lands of British Columbia are managed to achieve multiple use objectives. For provincial forest lands not designated as wilderness areas, these objectives as set out in the *Forest Act* (British Columbia Forest Act, 1979. R.S.B.C. Chap.140) include:

- timber production and utilization;

- forage production for the grazing of livestock and wildlife;
- forest and wilderness-related recreation; and
- water, fisheries and wildlife resource purposes.

Non-timber management objectives typically withdraw forest land from timber production or place constraints on the time and place in which harvests can occur. These constraints may extend the rotation age for the site well past its economic rotation age. It is assumed that timber production and utilization are the only multiple-use objectives which are affected by the spotted owl options and that all other uses of public forests are compatible with the spotted owl recovery plan. As a result, only foregone timber harvesting opportunities are addressed in the following.

The approach taken to estimate foregone timber values is to treat the management area as a whole and value the flow of harvest revenue and costs. Forecasts of future timber harvests are made for each of the spotted owl management options. For each time period, an estimate is made of the value of timber harvested and from this is subtracted the estimated harvest costs. The net value derived during each period is then discounted back to a present value. The present values are summed across all time periods to yield a net present value of the flow of timber harvests over time. This can be expressed as:

$$(1) \quad NPV_a = \sum_{i=0}^n (R_i - C_i) / (1+r)^i$$

where NPV_a = net present value of the flow of timber harvests under management option a,

R_i = timber harvest revenue received in period i ,

C_i = harvest cost, including silviculture costs of regeneration, incurred in period i ,

r = social discount rate, and

n = planning period over which options are assessed.

Timber Supply Analysis

Timber supply analysis is the process of predicting future harvests. Among the factors that affect timber supply are the inventory of operable forest land and the growth and yield of stands contained in the inventory. Timber supply is also directly linked to the forest management practices applied to the land. These practices reflect the management objectives, priorities, and constraints being placed on the forest land base by society. Some of these practices are designed to enhance timber production such as basic silviculture obligations. However, many of the forest management practices are designed to protect some forest management objective other than timber production.

The effects of land withdrawals on the long-term timber supply were simulated for options two through five over a 400-year period (Industrial Forestry Services Ltd. 1994a and b). Option six which called for no spotted owl management beyond existing parks and protected areas was treated as a base case since it would not result in any land withdrawal from the timber supply area. Option one which would allow no timber harvesting that degrades or destroys suitable owl habitat would lead to a total cessation of timber harvesting in the management area. Once the inventory, growth and yield estimates, and management practices are specified, simulation is done using a computer model that produces harvest forecasts and tracks changes to the forest inventory. The computer model selects areas ready for harvest while ensuring that none of the various management practices are violated.

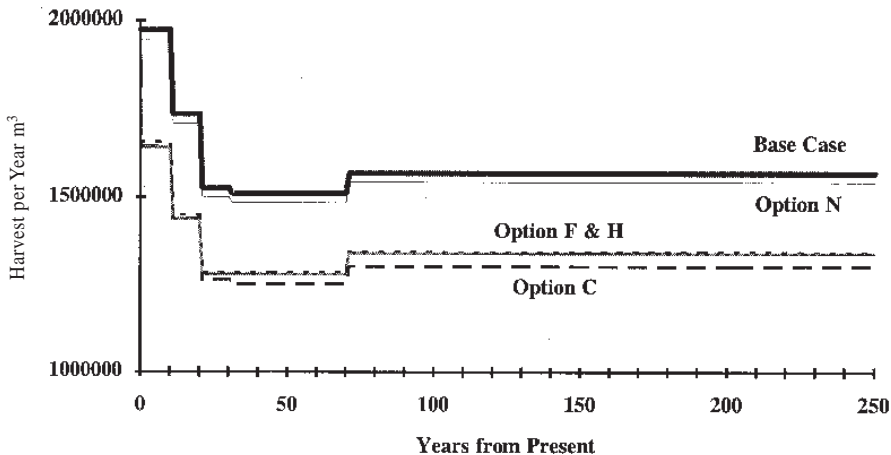
Table 3 and Figure 1 show the timber supply analyses for the spotted owl management options (Industrial Forestry Services Ltd. 1994a, 1994b). Industrial Forestry Service's forecasts were prepared for the spotted owl management plan and should not

TABLE 3
Harvest Forecasts for Spotted Owl Management Options (annual harvest levels in thousands of cubic metres)

Years from Present	Management Option				
	Base	2	3	4	5
0-10	1,975.2	1,643.1	1,641.0	1,654.0	1,943.8
11-20	1,734.1	1,440.1	1,438.8	1,450.2	1,706.4
21-30	1,525.5	1,267.2	1,282.8	1,285.3	1,501.2
31-70	1,511.0	1,253.4	1,282.8	1,285.3	1,485.0
71-400	1,569.0	1,303.9	1,341.9	1,344.4	1,543.0

Source: Industrial Forestry Services Ltd. (1994a and b).

FIGURE 1
Impacts of the Spotted Owl Management Options on Timber Supply



be confused with the timber supply analysis prepared by the Ministry of Forests as part of the determination of the allowable annual cut for each timber supply area in the province. All options show harvest levels dropping sharply over the next three decades to the long-term sustainable harvest level in the

management area. The dip below the long-term harvest level is due to an imbalance in the age-class distribution of the inventory and the minimum harvest ages. There are insufficient stocks of mature timber available to sustain harvest levels until the immature stands reach the minimum harvest age.

Net Value of Future Harvests

In a perfectly competitive market for timber on the stump, comparable stands could provide the information necessary to determine the value of the standing timber in the spotted owl management area. However, since perfectly competitive markets do not exist, the common practice is to determine the stand's conversion value. The conversion value of a stand is calculated by following the timber until it enters a market transaction and then determining the selling price. From this value is subtracted all the costs of converting the timber into the market product. The value remaining after subtracting the costs is the net value of harvesting the stand.

In the coast region of British Columbia, timber end product values are derived from log transactions on the Vancouver Log Market. Logs on this market are sold by grades that reflect the value of the timber contained in the logs. Data on invoiced (f.o.b.) market values are collected for prime, domestic, arm's-length sales on the coast. Monthly average market values by species and grade are then developed from this data. The costs of harvesting and transporting logs to market are determined by the Ministry of Forest's Revenue Branch through comprehensive surveys of logging operations on the coast as part of the provincial timber appraisal system. Cost data collected include wages, benefits, overtime, depreciation, fuel supplies, repair and maintenance, moving assistance, freight, applicable licences, insurance, etc. From this data predictive

equations and averages are developed for each logging phase, which can be used to estimate the cost of harvesting a specific site.

Table 4 presents the weighted average timber values and harvest costs over the period 1992-94 in constant 1994 dollars for the Chilliwack and Squamish Forest Districts which fall in the management area for spotted owls. The average timber values and costs were estimated from quarterly mean sales values and harvest costs prepared by the Revenue Branch for each forest district in the province. The weights used were the volume harvested in each year in the two forest districts affected by the spotted owl management plan. The three-year averages are used as the initial values of the expected revenues and costs for each cubic metre of timber harvested in the future. Using three-year averages dampens short-term price fluctuations.

Potential Changes in Timber Values and Harvest Costs

Future timber values and harvest costs are unlikely to remain at their current levels. However, the direction of the change in values and costs and their effects on net values is difficult to predict. Factors that could affect future values and costs include the transition from primarily old-growth timber to second-growth timber, declining stocks of timber resources worldwide, increasing world demand for forest products due to increasing population and income levels, technological change in both timber harvesting and processing, changes in the prices of

TABLE 4
Average 1992-1994 Timber Values and Harvest Costs for Chilliwack and Squamish Forest Districts (constant 1994 \$/m³)

	<i>Chilliwack Forest District</i>		<i>Squamish Forest District</i>	
	<i>Timber Value</i>	<i>Harvest Cost</i>	<i>Timber Value</i>	<i>Harvest Cost</i>
Average 1992-94	\$80.53	\$55.51	\$85.81	\$57.63

substitute products, the development of substitute products and changes to forest management practices. The volume of timber that would be affected by any of the spotted owl management options is insufficient to have any effects on either British Columbia or world prices or costs regardless of the option selected.

Forecasts of future scarcity of timber have led many observers to predict that timber resources will experience real price increases with respect to other commodities over time. Projections of future timber price increases are provided by Sedjo and Lyon (1990) and Dykstra and Kallio (1987) based on models of world timber supply and demand. Sedjo and Lyon predict real increases in the price of timber of between 0.2 percent and 1.2 percent per year over the period 1988-2000. Dykstra and Kallio predict annual increases in the real price of conifer sawlogs of between 0.3 percent and 5.9 percent depending upon the geographical region over the period 1980 to 2000.

In a study for Forestry Canada, H.A. Simons and Cortex Consulting Inc. (1993) found that over the last 25 years the real price of coastal logs had increased at an average rate of 0.3 percent per year. They also forecast the real price increases for four timber species to the year 2040. Their forecasts of the individual species average real log price increases were converted to an all species average real price increase. The weights used in calculating the average were the relative total value contributed by each species. This results in an average real price increase of 0.34 percent per year. This is assumed to be the rate at which real prices increase over the first 50 years for the calculation of the opportunity cost of the foregone timber harvest. This gives an accumulated increase of 18.5 percent over the period. After those 50 years, real prices are assumed to remain unchanged.

A factor that may increase harvesting costs in the future is the recent introduction of a Forest Practices Code (*Forest Practices Code of British*

Columbia 1994. S.B.C. Chap. 41). This will place more stringent requirements on logging practices such as road construction standards, choice of harvesting methods, and soil compaction standards. The code will bring together in a single document all current harvesting regulations, standards and guidelines, add new requirements, and provide tougher enforcement of all the code's provisions. The additional requirements plus fuller enforcement of current requirements should, to some extent, increase future harvest costs. The extent of the increase for individual operators will depend on their current compliance with existing standards. Operators who in the past were not in full compliance with existing standards are likely to face sharp increases in harvesting costs. It would appear reasonable to include some adjustment of harvesting costs for potential impacts of the code. While the impact will vary by operator, it was felt that a \$5/m³ cost increase phased in linearly over a five year period would be a reasonable approximation of the code's impact on operating costs.

Opportunity Costs of Timber Harvest Reductions

The net present values of timber harvest reductions were calculated using a discount rate of 4 percent estimated by Heaps and Pratt (1989). The estimate of the discount rate was based on the measurement of the social opportunity cost of capital in British Columbia's forest sector. The opportunity costs for each option were found as the difference in net present values of harvest with no recovery plans and harvests with each of the recovery plans in effect. The first row of Table 5 shows the opportunity costs of timber reductions given the initial set of assumptions described above. The opportunity cost declines from one (full protection option) through two, three and four to five (Sasquatch SOCA protection option). The opportunity cost is much higher for the full protection option than the other options because it would require timber harvesting to cease completely in the management area. The opportunity costs of options two, three, and four are similar since they entail roughly the same reductions in timber

TABLE 5
 Opportunity Costs of Timber Harvesting Reductions Compared to Base Case
 (net present values, \$ million)

<i>Scenario</i>	<i>Spotted Owl Recovery Plan Option</i>				
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>
Initial Case	1,223.0	207.4	198.0	192.8	19.3
Discount rate 2%	2,527.7	429.0	394.5	386.8	40.4
Discount rate 6%	815.3	138.1	134.5	130.5	12.7
Timber value +\$10/m ³	1,703.8	288.7	276.1	268.8	27.1
Timber value -\$10/m ³	742.2	126.1	119.8	116.9	11.5
Harvest cost +\$10/m ³	774.2	131.5	124.8	121.8	12.0
Harvest cost -\$10/m ³	1,671.9	283.3	271.1	236.9	26.6
Code costs +\$5/m ³	1,026.8	174.2	166.1	161.9	16.1
Code costs -\$5/m ³	1,419.3	240.6	229.8	223.8	22.5
Price decrease -1%/year	529.6	89.6	89.4	86.3	8.0
Price decrease -0.5%/year	848.3	143.7	139.4	135.3	13.2
Price increase +0.5%/year	1,665.8	282.7	266.9	260.6	26.5
Price increase +1.0%/year	2,191.5	372.0	348.4	340.8	35.2
No price or cost change	1,157.9	196.2	189.0	183.7	18.2

harvesting as one another — as seen in Figure 1. The Sasquatch SOCA protection option (number five) has a much lower opportunity cost since it requires a relatively small reduction in timber harvesting.

The estimated opportunity costs of the foregone timber harvest are dependent on the assumptions made about the discount rate, initial timber harvest values and costs, and expected changes in timber harvest values and costs. In order to test the sensitivity of the estimated opportunity costs to each of these assumptions, each parameter value was varied in turn while the remaining assumptions were unchanged. Estimates were made for discount rates of 2 percent and 6 percent and harvest values and

costs that were \$10 above and below the initial values. Real price increases that were 0.5 percent and 1.0 percent above and below the initial 0.34 percent increase were also tested. Changes in costs due to the Forest Practices Code implementation of \$5 higher and lower than the initial assumption were considered. Finally, an estimate was made with no price or cost increases. The estimates of the opportunity costs of the foregone timber harvests are shown in lines two through 14 of Table 5 for the alternative assumptions.

Changes in the discount rate have the greatest effect on the estimates of opportunity costs. A reduction in the discount rate has a larger

TABLE 6
Opportunity Costs of Household (1994 Dollars)

<i>Option</i>	<i>Total Household Opportunity Cost (\$/household)</i>	<i>Annual Household Opportunity Cost (\$/household/year)</i>	<i>Incremental Annual Opportunity Cost (\$/household/year)</i>
1	\$890.60	\$35.60	\$29.60
2	151.00	6.00	0.20
3	144.20	5.80	0.20
4	140.40	5.60	5.00
5	14.00	0.60	0.60
6	0.00	0.00	0.00

impact than an increase in the rate. The effect of a \$10/m³ increase (decrease) in initial timber values has virtually the same impact as a \$10/m³ decrease (increase) in initial harvest costs. Real price increases had a significant impact on the opportunity cost estimate when an increase of 1 percent was assumed. These experiments show the sensitivity of the estimates to changes in the initial assumptions.

The total opportunity costs for the initial case given in Table 5 are expressed as opportunity costs per household in Table 6. The total opportunity costs per household were found by dividing the total opportunity costs of each option by the estimated 1,373,167 households in British Columbia in 1994. The annual value per household was then found by multiplying the total opportunity cost per household by a capital recovery factor. The resulting annual value represents the cost British Columbia households would have to be willing to incur each year for the next 400 years if that spotted owl option was implemented. The final column of the table shows the additional cost per year for each household in the province of moving from one option to the next option.

In the first column of Table 6, the opportunity cost per household of option five (Sasquatch SOCA

protection option) is relatively low whereas the cost of option one (full protection option) is quite high. The opportunity costs of options two, three, and four are fairly close together. This is because all three options would reduce the timber supply by about 17 percent. The second column of the table shows how much, on average, it would cost provincial households annually to implement each of the options. The final column of the table shows the additional cost of progressing from the base-case option six and from one option to the next and finally to option one. There is a fairly large cost increase in introducing option four. However, the change from option five to four improves the likely status of the owl from endangered to threatened. Subsequent moves from option four to options three and two are relatively cheap. The probable status of the owl improves from threatened for options four and three to vulnerable for option two.

BENEFITS OF SPOTTED OWL PRESERVATION

While a number of different types of economic benefits can be identified with the preservation of endangered species, a full and accurate estimate of their magnitude is usually problematic. Of these benefits, perhaps the most important is the value that

individuals place on knowing that endangered species are being preserved and will be available for present and future generations. Individuals as stewards of the environment value protecting natural assets for the sake of knowing they exist, maintaining the possibility of future use and passing these resources on in undiminished abundance and variety. This type of economic value is referred to as a non-use or preservation value. Some endangered species, depending upon their numbers and accessibility, may provide opportunities for people to watch them in their natural habitats. This is a so-called use value where sighting or actual contact is made with the species.

Studies that have attempted to determine the preservation or non-use values of endangered species have used an approach known as the Contingent Valuation Method (CVM). Since most environmental assets, including endangered species, are not exchanged in markets, no prices exist to indicate the value people place on them. As a result, it is necessary to use non-market approaches, such as the CVM, to value environmental assets. The CVM is a survey technique that elicits values respondents place on non-market goods contingent on hypothetical markets. The CVM attempts to determine the maximum price respondents would be willing to pay to maintain or increase the amount of an asset or the value of compensation they would have to receive for a reduction or loss of the asset.

In the United States, the northern spotted owl is a threatened species under the *Endangered Species Act*. There are roughly 4,000 known pairs of spotted owls in the old growth forests west of the Cascades in Washington, Oregon, and Northern California. A couple of studies have attempted, using the CVM, to determine the values associated with spotted owls as part of the evaluation of options to preserve owl habitat in the Pacific Northwest. Rubin, Helfand and Loomis (1991) in 1987 surveyed a random sample of 1,200 Washington state households to determine the value they place on preserving spotted owls. They found the average household was

willing to pay \$56.10 per year. (All values reported in this section are expressed in 1994 Canadian dollars.) This gives an estimated total annual willingness to pay of \$100.9 million for all Washington state households. Rubin *et al.* extrapolated their estimates to include Oregon, California, and the rest of the United States. They estimate that households in the Pacific Northwest would pay \$526 million per year to assure the preservation of spotted owls while other US households would pay \$1,858 million annually for a total of \$2,384 million. This compares to an estimated cost of between \$564 and \$1,771 million for owl protection.

Hagen, Vincent and Welle (1992) also undertook a CVM study of how much people would be willing to pay to protect spotted owls. Their scenario included informing respondents of the probable costs of protecting spotted owls based on the conservation strategy for the Pacific Northwest. The questionnaire was sent to a random sample of 1,000 households across the United States. After a number of adjustments of the data, the best estimate of the average household willingness to pay was \$121.50 per year. Even the lowest estimate of the annual value households place on protecting spotted owls was sufficient to cover the costs of the conservation strategy.

Studies, such as Hagen *et al.* and Rubin *et al.* use a benefit-cost framework to compare the benefit measures derived from CVM surveys to the costs of protecting the species. The question may arise of whether the household preservation values found for the US spotted owl CVM studies could be compared to the annual household opportunity costs shown in Table 6 to give an indication of the efficiency of the options for protecting spotted owls. However, the applicability of these studies to the British Columbia situation is questionable. This is because of potential differences in the way British Columbians value environmental assets and the differences in the nature and magnitude of the spotted owl issue between British Columbia and the Pacific Northwest. Further, while the CVM is a commonly

employed technique, its accuracy, especially in measuring preservation values, has been questioned (Diamond and Hausman 1993, 1994). Also, there is a wider range of values associated with protecting spotted owls and other endangered species than is estimated by the CVM studies.

The preservation of old growth forests required for spotted owl habitat provides benefits beyond spotted owl preservation alone. Benefits arise from the preservation of other plant, animal, and fish species also dependent on this habitat for survival. For example, there are approximately 71 vertebrate species and vascular plant species that occupy the old growth forests of southwestern British Columbia within the range of the spotted owl. Of those species that have been inventoried in the area, 23 are considered at risk. This includes three species that are vulnerable in Canada and the marbled murrelet that has a threatened status. The elimination of unique ecosystems has greater costs for society than the loss of spotted owls alone.

There is a high degree of uncertainty surrounding the future usefulness and value of endangered species. The preservation of endangered species provides benefits in that it maintains the diversity of the gene pool. While the usefulness of the genetic stock of many species is unknown, research continues to find new drugs and discover improved strains of plants and animals. The broader the gene pool that can be sampled, the greater the potential opportunities for future advances in medical and other sciences. For example, it is estimated that about half of the world's drugs are derived from plant and animal materials with about 3,000 species worldwide having anti-cancer properties (Frisvold and Condon 1994). The protection of spotted owls provides time to gather additional information about the usefulness of the species and eliminate some of the uncertainty associated with it. The risk premium that would be paid for the opportunity to obtain additional information about a resource whose extinction is irreversible is known as the quasi-option value (Arrow and Fisher 1974).

The options to protect spotted owls raise important equity issues. Much of the cost of preserving endangered species is borne by the present generation while much of the uncertainty of extinction and future values are borne by generations to come. Since there are no markets that allow willful transactions between the present and future generations, it is not possible to adequately measure future generations' well-being. The costs to future generations of restoring or replacing species that are in jeopardy or eliminated may be much greater than the costs to the present generation of protecting and enhancing existing populations. A second type of equity issue that frequently arises in protecting endangered species involves identifying the groups of people that bear the costs and receive the benefits of the adopted policy. For example, the costs of preserving spotted owl habitat would fall largely on the residents of the southwest region of British Columbia whereas the benefits of preservation would accrue to residents throughout British Columbia and Canada.

As an alternative to the use of benefit-cost analysis to assess options to protect endangered species, Bishop (1978, 1980); Randall (1988); and Castle and Berrens (1993) describe the use of the Safe Minimum Standard (SMS). The SMS recommends that extinction be prevented unless the social cost of doing so is unacceptably high or other social objectives take priority. The SMS requires maintaining sufficient habitat and population to assure survival. It focuses attention on the social cost to the present generation of avoiding extinction with the burden of proof assigned to the case against maintaining the SMS. As Bishop (1993) points out, the SMS does not mean that all species would be saved. Rather, it would prevent the extinction of those species that could be saved without unacceptably high costs or sacrifices of other social goals. The goal of the SMS is to save some species that would otherwise be lost, thereby increasing the options to future generations for a sustainable economy.

In the case of spotted owls, the SMS provides little or no guidance as to whether the opportunity

costs shown in Table 5 are unacceptably high or not. This is compounded by the fact that costs tend to be localized while the benefits are more widespread. Further, with several species endangered in British Columbia, the SMS provides little direction in choosing among them. In some cases, due to uncertainty, the wrong species will be saved while beneficial species are lost. Further, the SMS does not ensure the optimal number of species are preserved.

SUMMARY

Among some of the questions that arise in evaluating species protection are what species should be protected, and for species that are to be protected what level of protection should be provided. One framework that can be used to assess such choices is benefit-cost analysis. However, questions about species preservation often involve important intergeneration and interregional equity issues which cannot be accommodated in a benefit-cost framework. Also, while "ballpark" estimates of some of the benefits of species preservation can be obtained using non-market valuation techniques, the value of benefits from reduced uncertainty and the preservation of ecosystems are much more difficult to measure. An alternative that has been suggested to benefit-cost analysis of endangered species protection is the Safe Minimum Standard. The Safe Minimum Standard recommends that extinction be prevented unless the social cost of doing so is unacceptably high or other social objectives take priority. The SMS is difficult to operationalize since it provides no criteria for deciding when costs are unacceptably high. Further, judging solely on the basis of costs some species that provide exceptionally large benefits may go unprotected if their protection involves relatively high costs.

The recovery and protection of endangered species frequently require that some activities inimical to the species must be reduced or curtailed. Options suggested by the Spotted Owl Recovery Team for protecting spotted owls would entail reductions in

the volume of timber that could be harvested in the management area. This paper has presented estimates of the opportunity costs of the foregone timber harvests for each of the management options. The value of the foregone timber harvest was estimated as the annual value of the timber on the Vancouver Log Market less the costs of harvesting and transporting the logs to market over a 400-year period. The annual values were discounted using the social opportunity cost of capital to give net present values of the foregone timber harvest. Sensitivity analysis showed that the estimates varied most with changes in the discount rate but were also sensitive to harvest costs and timber prices.

The full protection option was estimated to entail opportunity costs of over \$1.2 billion during the 400-year planning period. While the three options provide lower levels of protection each have opportunity costs of about \$200 million dollars. Expressed on an annual basis, the full protection option would cost each British Columbia household over \$35 while the next three levels of protection cost households between \$5.60 and \$6.00. A movement from option four to option three and to option two, providing full protection to SOCAs rather than 67 percent of activity centres, would cost each British Columbia household an additional 40¢ each year while improving the status of spotted owls from threatened/endangered to vulnerable. The information on the opportunity costs of the different options for recovering spotted owls provides the basis for deciding whether society can afford to protect spotted owls or whether it should make sacrifices for some other endangered species or on competing policies. If spotted owls are to be protected, the opportunity costs provide estimates of the sacrifices for different probabilities of recovery.

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