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Wildfire, timber salvage, and the economics of expediency

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Abstract

Administrative planning rules and legal challenges can have significant economic impacts on timber salvage programs on public lands. This paper examines the costs of the delay in salvage caused by planning rules and the costs associated with the volume reductions forced by legal challenges in one case study. The fires on the Bitterroot National Forest in the northern Rocky Mountains in the United States burned 124,250 ha in the summer of 2000, killing valuable timber. A proposal to salvage about 15% of the burned area, containing 0.8 million m^3 (176 million board feet) of the damaged timber, was challenged in court, resulting in a mediation plan salvage amount of 0.27 million m^3 (60 million board feet). Administrative planning requirements also delayed the initiation of salvage to 2003. Because timber decays following death and damage, the costs of delay can be quantified. We evaluate the costs of both reducing the salvage volume due to the litigation and the losses due to decay from the administrative delay. Simulations show that the court settlement plan created through legal challenge resulted in an $8.5 million loss to the U.S. treasury and an $8.8 million (65%) loss in net welfare under the base case market assumptions. The delay in salvaging the agreed upon salvage amount from 2001 to 2002 reduced revenues from salvage to the U.S. treasury by $1.5 million (25%) and potential welfare benefits by the same amount, under base case assumptions of market sensitivities to prices.

Keywords: Timber salvage; Welfare; Legal challenge; Lawsuit; Stumpage; Wildfire; Catastrophe; Timber market

1. Introduction

Wildfire provides a dramatic expression of the interaction between man and nature in a forested landscape, raising a number of basic questions regarding forest management, policy, protection, and restoration. In the summer of 2000, these questions were again brought to national prominence after fires in the northern Rocky mountains in the United States burned more forest area there than at any time since the catastrophic fires of 1910. The largest and most damaging of these fires occurred on the Bitterroot National Forest in western Montana where 124,240 ha burned and damage to adjacent private property, including houses, and private land (over 20,230 ha burned) was widespread. Proposals by the Forest Service to restore and reduce the flammability of forests drew considerable public debate and litigation.

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The most controversial element of the Bitterroot proposal was a plan to salvage 0.8 million m^3 (176 million board feet) of damaged timber. Challenges to salvage harvesting raised important questions regarding the role of salvage in the reduction of fuels and the optimal design of salvage activities following a large fire.

This paper uses the Bitterroot National Forest case to examine salvage harvest strategies available to the government and the economic effects they may generate. When a salvage harvest is large in the context of the local market it can influence market-clearing prices, thereby affecting the decisions and welfare of other timber producers and of timber consumers. We estimate these market effects for the Bitterroot case study considering the effects of short-run increases in harvesting along with potential long-run harvest reductions linked to substantial losses of standing forest inventories on both public and private lands. Our findings suggest a structure for evaluating future salvage operations.

We also examine how the time interval between burning and salvage harvesting influences the economic effects and viability of the salvage efforts and how procedural requirements may affect this interval and therefore the flow of benefits. For public land, the length of this interval is largely determined by the administrative rules governing planning and environmental assessment as well as by administrative appeal procedures and litigation that may follow a decision. The consequences of delay are largely determined by the process of decay in the dead trees—i.e., salvage options are foreclosed as harvesting is delayed. Nearly 2 years transpired between the fire and the date at which salvage harvesting commenced on the Bitterroot National Forest, with the planning process alone requiring 15 months for completion. Agency efforts to expedite implementation of the resulting fire recovery plan were controversial and led to litigation.[1] A mediated settlement eventually reduced salvage harvests by about two-thirds (to 0.27 million m^3) and resulted in further delay.

In this paper, we first examine the effects of government salvage operations from a theoretical economic perspective and then estimate the economic effects that would have resulted from both the original Bitterroot National Forest fire recovery plan and the mediated settlement plan. The analysis considers the interaction of government and private timber producers in the marketplace, costs imposed on private producers, and benefits accruing both to the treasury through revenues and to consumers from the increased availability of timber products. We also address the intertemporal effects of harvest strategies and estimate the costs of delay related to administrative procedures and public challenges to the recovery plan. Salvage harvests provide a case where the length of the decision process may be mapped to real irretrievable costs. By computing these costs, we provide some insights into the general debate regarding the effects of what has been described as “process gridlock” in public land management in the United States. We close with some general observations on the implications of these findings for the design of future salvage operations.

2. Economic effects of timber salvage

Natural catastrophes that generate large quantities of dead or damaged timber yield a complex of economic effects (Holmes, 1991; Prestemon and Holmes, 2000). If damages are large enough, then the resulting sale of damaged timber can yield market-scale effects that affect all market participants. For example, salvage sales may shift supply outward so prices fall and producers of undamaged timber suffer losses compared to the no-salvage case. Depressed timber prices yield benefits to consumers of timber products—i.e., consumer surplus increases over the no-salvage case. In the long run, countervailing effects may arise: an initial decrease in timber prices may be followed by a period of higher prices due to losses of standing inventory and contracted supply. This has positive effects on producers of undamaged timber and

[1] In an attempt to expedite timber salvage, the Chief of the Forest Service requested that the USDA Undersecretary for Natural Resources approve the project rather than decision officers lower in the line (e.g., Forest Supervisor, Regional Forester, or the Chief himself). The undersecretary’s approval of the project precluded administrative appeals that would have been coupled with automatic stays of action. The plan and the approval by the Undersecretary were challenged by lawsuits filed by seven environmental groups in U.S. District Court.

reduces consumer benefits (Prestemon and Holmes, 2000).

Timber salvage activities by private landowners can generally be predicted based on optimizing behavior (see Holmes, 1991, for the case of insect damage, Prestemon and Holmes, 2000, for the case of hurricane damage). Optimal salvage harvests from public lands are more difficult to predict because the objective function is difficult to define and is heavily influenced by the activities of competing interest groups and a body of natural resource law. Public forests are managed for a complex of competing objectives that go far beyond timber economics. Government actions are also often guided by their distributive consequences—i.e., the distribution of costs and benefits among different groups of consumers and producers. Here we examine the economic efficiency calculus of government salvage activities, assuming that nontimber objectives are imposed on decision makers through constraints on the maximum quantity of timber and types of trees that could be salvaged without compromising non-timber objectives for the land (e.g., not wildlife snags).[2] We discuss distributional considerations in our conclusions.

Setting aside distributional concerns for the moment, government action motivated by efficiency gains would seek to maximize the net public welfare—i.e., the sum of net producer surplus (public and private) and consumer surplus. The mechanics of these welfare effects can be generally described using Fig. 1. Timber supply with an undamaged inventory (I_0) is defined by $S_0(P,I_0)$, where P is timber price. The damages caused by the fire are reflected in a reduced inventory (I_1) that shifts supply inward to $S_1(P,I_1)$. Salvaged timber (V_t) is imposed on the market without regard to cost (hence, the vertical line in Fig. 1) and total supply is defined by $S_T(V,P,I_1)$ which is the horizontal sum of salvage (V_t) and shifted

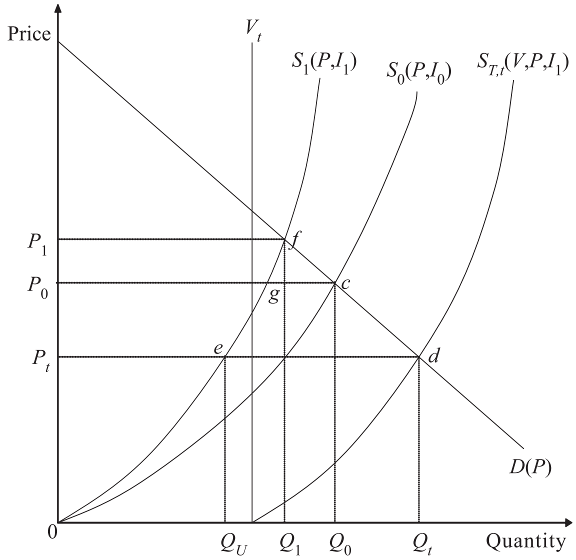

Fig. 1. The effect of wildfire on timber markets. Demand for timber is defined as $D(P)$. The supply of undamaged timber is shifted (S_0 shifts to S_1) due to reduction in available inventory (I_0 reduced to I_1). Salvage harvested at quantity V_t results in total supply defined by $S_{T,t}$ with market clearing price P_t and quantity Q_t.

supply (S_1).[3] Consumer surplus, the area above the price line and below the demand curve, $D(P)$, is enhanced because price falls while output expands (in Fig. 1, consumer surplus rises by the value of the polygon P_tP_1fd). Producer surplus for undamaged timber, the area below the price line and above the supply curve, is unambiguously reduced because harvest of undamaged timber falls ($Q_t - V_t = Q_u < Q_1$) and price falls as well (in Fig. 1, producer surplus falls by the amount P_tP_1fe).

For this single period case then, the efficient solution for the government producer is a salvage level that maximizes total economic surplus, defined as the sum of changes in consumer and producer surpluses, as described above, plus the revenue

[2] While this decision model would be inappropriate in the more familiar context of long range planning–i.e., it does not allow for explicit trade-off analysis between timber and nontimber resources–it may be an accurate description of the decision process used to address an emergency situation. A timber salvage program must be developed in concert with direction laid out in the Forest Plan and would be integrated with other burned area recovery goals such as reducing fuels, improving watersheds, and reforesting burned land.

[3] This figure, consistent with other research (e.g., Holmes, 1991), shows a perfectly inelastic salvage volume that intersects the horizontal axis where price equals zero. This is clearly an abstraction, where the curve could be drawn as very elastic at very low salvage volumes—a few easy stands could be salvaged even with near-zero stumpage prices) and then quickly becoming inelastic. Stumpage price is the net of delivered price and the costs of removal and transport. If the timber is worthless in a few years, gaining no value, then as long as it could be salvaged at a nonzero price, it will be.

generated by the salvage sale net of costs to prepare the sale. To assist with later exposition, we introduce the variable E to represent the effort expended to prepare the sale (measured in dollars). V is now a function of E and the objective for the government producer is to select E to maximize economic surplus:

$$\text{Max } ES_E = \Delta CS[V(E)] + \Delta PS[V(E)] + p_t V(E) - E \tag{1}$$

When the problem is extended to a multiple-period model, time enters the decision calculus in two important ways. Effort would be spread over a finite time period (T) and all terms are discounted to define the present value of economic surplus (PVES). In addition, the effectiveness of effort (E) is determined by the time since the wildfire occurred. That is, since damaged timber decays over time, $V(E)$ declines over time with E constant. In the parlance of forest management, the rate of decay is reflected in the degrade factor, or proportion of salvaged volume that is useable. The degrade factor, $k(t)$, is a function of the time since the wildfire (k is at a maximum at t=0 and declines to zero over time) so that $V(E,t)$=$V(E)$*k_t. The intertemporal objective function is defined as:

$$\text{Max } PVES_E = \sum_{t=0}^{T} \{\Delta CS_t[V(E_t,t)] + \Delta PS_t[V(E_t,t)] + p_t V(E_t,t) - E_t\} e^{-rt} \tag{2}$$

where r is the discount rate.

3. Methods

Our analysis is based on characterizing ex ante shifts in, and equilibrium with respect to, demand and supply relationships shown in Fig. 1. We parameterize supply and demand using theory and estimates from the existing literature. For both demand and supply functions, we apply constant elasticity functional forms:

$$D(P) = Q = a_0 P^{a_1} \tag{3}$$

$$S(P,I) = Q = b_0 P^{b_1} I^{b_2} \tag{4}$$

Parameters a_1 and b_1 were set to estimates of price elasticities found in econometric studies of timber markets in USDA Forest Service Region 1, Montana and northern Idaho. Based on Adams and Haynes' (1996, p. 23) estimates of supply elasticities by owner group for the northern Rockies and weighting by the inventory shares of nonindustrial and industrial producers (Smith et al., 2001, p. 104), we calculated an aggregate supply elasticity of +0.21.[4] We set the price elasticity of demand at −0.5, generally consistent with several timber market studies (see Abt and Ahn, 2003, for a review). The elasticity of supply with respect to inventory was set to unity based on theory and empirical evidence (e.g., Binkley, 1987). Parameters a_0 and b_0 were calculated by substituting observed values of P and Q for the year prior to the fires into Eqs.(3) and (4).

The effects of salvage harvests on the market-clearing price and quantity of timber were calculated by specifying the salvage volume $V(E)k_t$ (the green equivalent of the salvaged timber), and solving the equilibrium condition for price:

$$a_0 P^{a_1} = b_0 P^{b_1} I^{b_2} + V(E)k. \tag{5}$$

Q is then defined by substituting equilibrium price into either the supply or the demand function. The degrade factor (k)[5] was provided by resource managers on the Bitterroot N.F. and was determined, after weighting different degrade factors by volumes in various species groups, as 0.87 (implying that salvage wood was valued at 87% of green wood of the same

[4] We have subsumed the very small amount of planned public timber harvests into the "other" supply. As a result, the public supply is implicitly assumed to be price responsive (consistent with Adams et al., 1991) and as inelastic as private sector timber. Also implied here is that green harvests on Federal lands in the region are assumed to be unaffected by the salvage effort. While this is an abstraction, the effect of this assumption is small, relative to the market price and welfare effects of salvage, in the long run. Further, reductions in green harvests during salvage operations could be made up by national forests after salvage is completed, resulting in those years in a market level price reduction and similar effects on non-participant producer and consumer welfare as during salvage, although the impacts would be delayed (and hence discounted).

[5] The degrade factor used here is equivalent to the inverse of the salvage discount factor described by Holmes (1991) and Prestemon and Holmes (2000).

volume) for 2001, 0.64 for 2002, 0.50 for 2003, and 0.22 for 2004.[6] This weighting did not account for adjustments in harvest costs, compared to harvest costs for green timber.

With supply and demand specified and a price and quantity solution for a salvage scenario, consumer and producer surplus effects were calculated. For each solution, the consumer surplus is defined by the area under the demand curve above the price in the range from the intercept with the vertical axis (Q=0; Fig. 1) to the equilibrium quantity (Q_t). Producer surplus is the area between the equilibrium price line and the supply curve from Q=0 to Q=Q_t. For expositional clarity, we use inverse supply and demand functions (price is a function of quantity) here:

$$CS = \int_0^Q D^{-1}(q)\mathrm{d}q - PQ \tag{6}$$

$$PS = PQ - \int_0^Q S^{-1}(q)\mathrm{d}q \tag{7}$$

A description of data and assumptions used to calculate price, quantity, and welfare effects is contained in Table 1.

Table 1
Data and assumptions used in this analysis

Parameter or variable	Base case	High	Low	Source of base
Discount rate (%)	6	9	3	assumed
Stumpage supply elasticity with respect to stumpage price	0.21	0.8	0.1	Adams and Haynes (1996), Smith et al. (2001)
Stumpage supply elasticity with respect to stumpage inventory	1	1	1	assumed
Stumpage demand elasticity with respect to stumpage price	−0.5	−0.1	−1	Abt and Ahn (2003)
Degrade factors				National Forest managers
Fire-killed total volume (million m^3)	7.13			National Forest managers
Regional inventory volume (million m^3)	2059			Smith et al. (2001)
Annual regional harvest volume (million m^3)	8.44			Smith et al. (2001)
Softwood stumpage price (\$/m^3)	29.74			assumed

3.1. Scenarios

In August and September of 2000, wildfires burned more than 120,000 ha in western Montana and northern Idaho (Fig. 2). Roughly 7.1 million m^3 of timber–primarily Douglas fir, ponderosa pine, and western larch–was burned on the national forest (USDA Forest Service, 2000). While a series of emergency restoration and soil stabilization projects commenced almost immediately, a plan for completing long-term activities required thorough interdisciplinary analysis, an environmental impact statement, and extensive pubic involvement and review. The Record of Decision for the Bitterroot Fire Recovery Plan was released on December 17, 2001–fifteen months after the fires–and specified a salvage harvest of 0.8 million m^3, beginning in 2002.

The responsible official for the Record of Decision was not a Forest Service line officer but was the Undersecretary of Agriculture for Natural Resources and the Environment. This unusual arrangement was designed to expedite the implementation of the plan—the Undersecretary's decision could not be appealed "up the line" within the Forest Service. Seven environmental groups challenged the Fire Recovery Plan and the approval by the Undersecretary in U.S. District Court on December 18, 2001. A preliminary injunction stopped implementation and found that the approval by the Undersecretary rather than by Forest Service line officer circumvented an appeals process prescribed by Congress. A mediated resolution of the case, signed February 7, 2002, reduced salvage harvesting to 0.27 million m^3 and stopped government challenges to the preliminary injunction. Salvage harvests were allowed on a total of 5,950 ha—about 5% of the burned area.[7]

[6] These figures, based on local knowledge, are comparable to those by Lowell et al. (1992) for Douglas fir and ponderosa pine, based on analyses across the West. Potential reasons for any differences between them are that fire severity, climate, and pest conditions in western Montana are different from those generally comprising the analyses reported by the cited authors.

[7] The Wilderness Society, American Wildlands, and Pacific Rivers Council vs. M. Rey, R. Richardson, and United States Forest Service; Joint Motion to Dismiss, CV 01-220-M-DWM, filed February 7, 2002, United States District Court, District of Montana, Missoula Division.

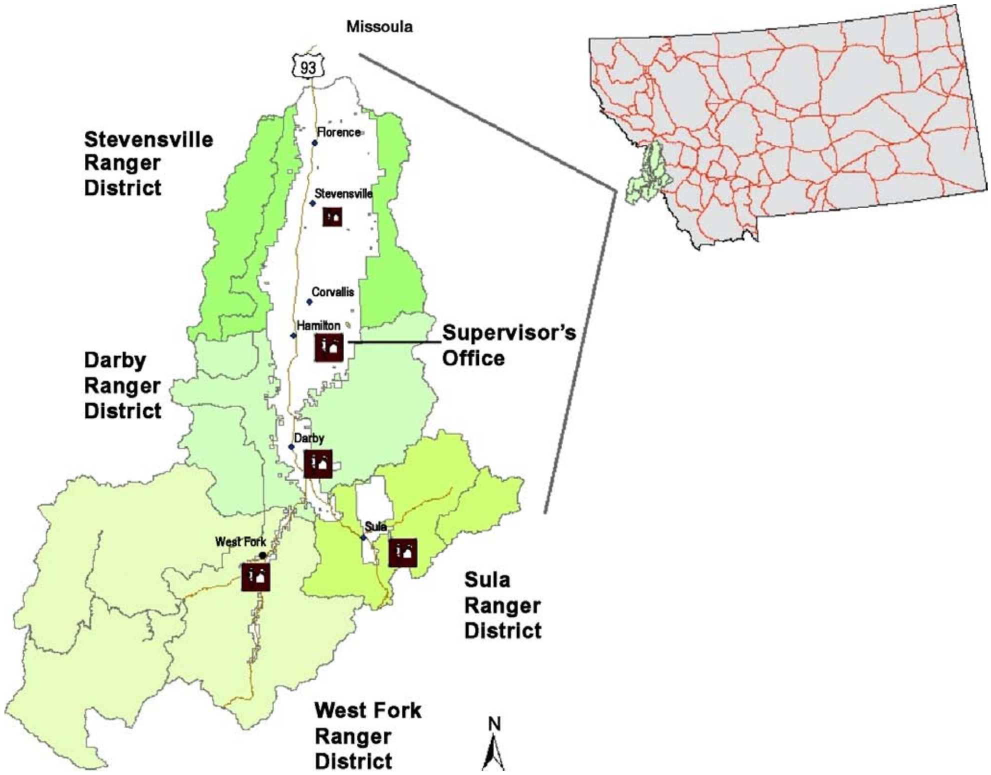

Fig. 2. Location of the Bitterroot National Forest in western Montana and northern Idaho.

To evaluate the economic effects of the salvage harvests and the costs of various aspects of the decision making process, we estimate price, quantity, and welfare outcomes for the following seven scenarios: (1) a counterfactual scenario of no salvage harvests (labeled no salvage); (2) salvage harvesting at levels initially set in the fire recovery plan (labeled BSRP), starting in three alternative years, (a) 2001, (b) 2002, or (c) 2003; and (3) salvage harvesting at levels determined through litigation and mediation (labeled Court), starting in (a) 2001, (b) 2002, or (c) 2003. All economic values are discounted to a common comparison year, 2001, and are expressed in 2001 dollars. The three starting years represent the actual schedule of timber harvests (2002), expedited decisions (2001), and further delays in the process (2003).

Comparing the effects of the various scenarios allows us to estimate the costs of the delay related to analysis and litigation. A comparison of the economic effects of the salvage reduction, moving from (2b) to (3b), gauges the welfare impacts of the court decision. Comparisons across start years quantify the welfare impact of delays. Delays have a secondary impact of putting welfare benefits (and costs) off to the future; when discounted to a similar base year, future economic effects appear diminished.

The counterfactual timber economic impacts of the wildfires are quantified in the no-salvage scenario (1). These impacts, as outlined graphically in Fig. 1, involve a loss in timber inventory, which is valued as the economic surplus provided by timber production foregone by that portion of the lost inventory until it grows back. The inventory is allowed to grow back, and the regrowth rate is set at the average annual rate of net growth of softwood for the Intermountain Rockies. This growth rate was determined as the net softwood growth in growing stock recorded for 1996 (the average annual rate from 1986 to 1996) (Smith et al., 2001, p. 144), 54.1 million m^3 (1912 million ft^3), divided by the softwood growing stock volume for that region in 1997 (Smith et al., 2001, p. 134), or 3201 million m^3 (113,118 million ft^3): 0.0169. The economic surplus lost is identical across all scenarios and calculated as the 1986–1996 average quantity provided per unit of inventory and the period's average stumpage price for sawtimber stumpage, \$29.74/m^3 (\$135/mbf).

Salvage harvests are assumed to be spread over 2 years. Conversations with National Forest managers suggest that the Forest would have had difficulty preparing all sales for harvest during the first year.

The economic consequences of all scenarios are dependent upon our initial assumptions regarding the responsiveness of private (non-National Forest) supply and demand to timber prices. These assumptions were varied in sensitivity analyses that were applied in the no-salvage scenario; similar sensitivity analyses are available for salvage scenarios. The choice of a discount rate also affects the economic impacts of reduced timber inventory in the region and it influences the economic comparisons across scenarios. We therefore conducted a sensitivity analysis on the discount rate. Base case assumptions and sensitivity analysis (low and high) values for elasticities and the discount rate are shown in Table 1. Finally, if capacities in the region were insufficient to handle large increases in timber production from salvage, then the price consequences might be large. Solidwood production capacities in Idaho and Montana, however, able to receive up to 26.8 million m^3 of timber annually, are far in excess of current production plus considered salvage volumes (Spelter and Alderman, 2003).

4. Results

4.1. No-salvage scenario

The no-salvage scenario describes the economic effects of wildfire without a federal response. The fires killed valuable timber (worth \$8.9 million) and create higher prices received by owners of undamaged timber due to the reduced inventory. Consumer welfare losses are \$15.3 million, undamaged producer gains total \$15.2 million, and the net effect is a market loss of about \$8.9 million (Table 2). The gains by owners of undamaged timber (which just offset consumer losses) are an example of the wealth transfers that occur as a result of catastrophic losses—not everyone loses from a damaging event.

Table 2
Sensitivity analysis of the timber market welfare effects (2001 \$ million) of timber losses on the Bitterroot National Forest due to the 2000 wildfire with no salvage harvests

	Discounted consumer surplus change	Discounted value of timber lost	Effects on undamaged producers	Total discounted surplus
Base case values	−15.3	−8.9	15.2	−8.9
Low discount rate	−22.0	−12.8	21.9	−12.9
High discount rate	−11.6	−6.8	11.5	−6.8
Low supply elasticity	−18.0	−9.8	17.9	−9.8
High supply elasticity	−8.3	−6.0	8.3	−6.0
Low demand elasticity	−35.3	−8.9	35.2	−9.0
High demand elasticity	−8.9	−8.9	8.9	−8.9

Effects are shown for the base case and for alternative discount rates and elasticities.

Sensitivity analyses on the discount rate and on elasticities do not change the calculus of the event, whose overall impact includes a rearrangement of wealth. When a higher discount rate is applied, the consumer losses and producer gains still balance (about \$11.5 million change hands), but the economic value of the lost inventory is slightly reduced (\$6.8 million) as the negative economic impact of the killing of inventory on future harvests is discounted more heavily. At lower discount rates, about \$22 million in welfare changes hands between consumers and undamaged producers, while the economic value of killed inventory rises to \$12.8 million. Under alternative supply and demand elasticity assumptions, total economic losses range from \$6.0 million under a less inelastic supply to \$9.8 million with a more inelastic supply. The effects of varying the demand elasticity from −0.1 to −1 fall between those ranges. The factor that varies more widely is the amount of welfare changing hands between undamaged producers and consumers. The range in that value is from \$8.9 million (elastic demand) to \$35.3 million (more inelastic demand).

Table 3
Changes in welfare effects (2001 $ million) resulting from alternative salvage plans by producer and consumer group

Salvage plan	Discounted consumer surplus change	Effects on undamaged producers	Value of salvage removed	Total discounted surplus
BSRP-2001 Start	24.4	−24.0	17.2	17.6
BSRP-2002 Start	17.5	−17.2	13.1	13.4
BSRP-2003 Start	10.5	−10.4	8.4	8.5
Court-2001 Start	8.4	−8.4	6.1	6.1
Court-2002 Start	6.0	−6.0	4.6	4.6
Court-2003 Start	3.6	−3.6	2.9	2.9

The no-salvage scenario is the point of comparison.

4.2. Salvage scenarios

All salvage harvest scenarios result in gains in total surplus (Table 3). Salvage harvests result in net gains to timber consumers and losses to owners of undamaged timber when compared to the no salvage alternative. For all scenarios, these two effects are similar in magnitude so that the total discounted surplus (welfare effects) is approximately equal to the discounted value of salvage removed.

Simulations of the salvage harvests prescribed by the recovery plan (labeled BSRP-2002) lead to a $13.4 million gain in total discounted surplus compared with the no salvage case (Table 3). This more than offsets the total loss from the fires ($8.9 million) and results in a net increase in total discounted welfare of $4.4 million (Table 4). Salvage harvests reduce surplus for owners of undamaged timber by about $17.2 million, thus shifting the net effects from a net gain of 15.2 million (Table 2) to a net loss of $2 million ($15.2 million minus $17.2 million; Table 4). The effect of the salvage plan on consumers similarly offsets the timber welfare losses resulting from the fires.

The salvage harvests defined by the mediated settlement from the U.S. District Court (labeled Court-2002) resulted in a gain of $4.6 million in total economic surplus compared with the no-salvage scenario. These gains would mitigate about one half of the timber market losses due to the fires ($8.9 million), reducing the overall net losses to $4.3 million (Table 4). Consumer losses and gains to producers of undamaged timber would both be offset by about $6.0 million under this scenario.

The timber-related economic implications of the court settlement are defined by comparing the recovery plan scenario (BSRP-2002) with the mediated plan (Court-2002). The settlement reduced potential salvage revenues to the US Treasury by $8.5 million ($13.1–4.6 million, Table 3). The settlement also resulted in a redistribution of welfare from the consumers of timber (loss of $11.5 million, Table 4) to the producers of undamaged timber (gain of $11.2 million). The court settlement reduced total discounted surplus by $8.8 million, or 65% (from $13.4 million to $4.6 million, Table 3).

The timber-related economic effects of delays caused by administrative planning requirements can be estimated by comparing the recovery plan scenario (BSRP-2002) with a scenario that expedited the salvage harvest prescribed by the recovery plan (BSRP-2001). This defines a case where plans would have been finalized and put in place after 6 months of preparation rather than the observed planning period of 15 months. Expedited planning would have increased total discounted surplus by 32% (from $13.4 million to $17.6 million, Table 3). This scenario would have put

Table 4
Timber market welfare effects (2001 $ million) of the Bitterroot Fires mitigated by differing levels of management intervention: (a) no salvage harvests, (b) harvests prescribed by the Bitterroot Recovery Plan, and (c) salvage harvests prescribed by the court settlement

Salvage plan	Discounted consumer surplus change	Effects on undamaged producers	Value of salvage removed	Value of timber loss	Total discounted surplus
No salvage	−15.3	15.2	0.0	−8.9	−8.9
Original plan (BSRP-2002)	2.2	−2.0	13.1	−8.9	4.4
Mediated plan (Court-2002)	−9.3	9.2	4.6	−8.9	−4.3

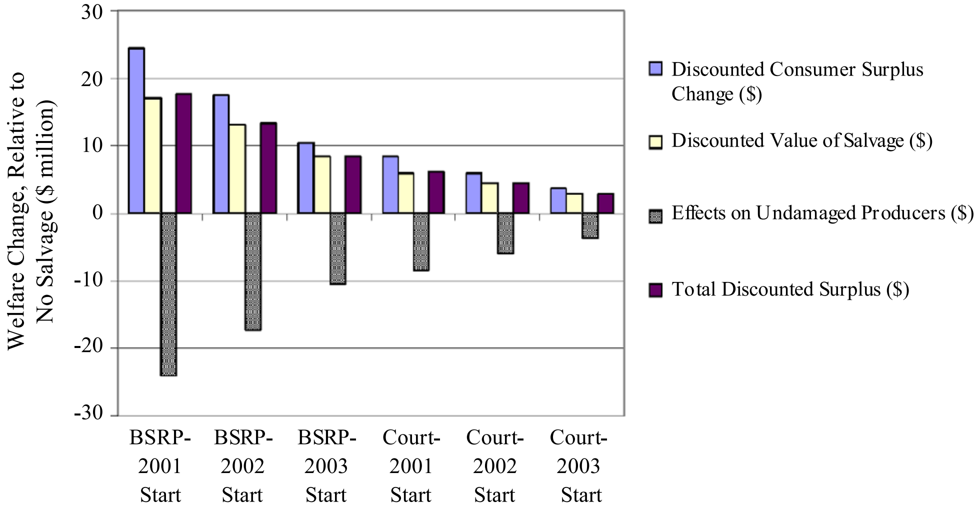

Fig. 3. Welfare impact (in constant 2001 dollars) by market group under alternative scenarios, applying a discount rate of 6% and base case elasticities of timber supply and demand with respect to price.

enough timber on the market to switch the direction of welfare redistribution so that consumers would have been net gainers (+$6.9 million) and producers of undamaged timber would have lost economic surplus (−$8.8 million). The total cost of shifting the beginning of the salvage harvest program from 2001 to 2002 (i.e., extending the planning period a year) is $4.2 million.

The recovery plan could only have been implemented in 2002 as planned with expedited approval within the Forest Service. Therefore the timber-related economic effects of the expedited approval process—i.e., for the case where the challenge to departmental approval of the project had not been sustained by the courts—can be estimated by comparing the recovery plan scenario (BSRP-2002) with the same plan delayed by 1 year (BSRP-2003).[8] The returns to the expedited plan would have been $4.9 million (from $8.5 million to 13.4 million or 58%). Timber consumers would have gained about $7.0 million with an expedited decision.

5. Discussion and conclusions

The results of this analysis demonstrate that wildfires can have substantial timber market impacts, even in areas where timber values are relatively low. The Bitterroot fires of 2000 resulted in a net timber market loss of $8.9 million. The indirect effects resulting from increased prices and long-term inventory changes would have cost timber consumers about $15.3 million.

Our findings indicate that salvage harvests can play an important role in mitigating the timber-related economic impacts of fire. We have shown that even by salvaging a small share of lost timber, volume removed from less than 5% of the burned area, the economic gains are substantial. In the case of the Bitterroot, the court-mediated salvage plan released enough wood to the market to compensate for at least half of the timber market surplus lost from the damage to the entire forest. If the BSRP as originally planned had been implemented in an expedited fashion (BSRP-2001), the value of salvage would have exceeded the discounted value of surplus of timber lost forest-wide by $8.3 million, at base case elasticities and the 6% discount rate (Fig. 3).

We have shown that the effects of delaying salvage following a catastrophic wildfire can be substantial, increasing losses or reducing potential gains by millions of dollars. Salvage following catastrophic fire can actually increase temporarily the aggregate size of the timber market: the volume, even damaged, enters the market far earlier than it would have, resulting in larger economic surplus accrued than in a counterfactual, no-fire and no-salvage, case. The

[8] We are therefore assuming that administrative appeals would have taken 1 year to complete.

delay in salvage activity is not benign for the market. Consumers and producers of timber could incur either large net losses or large net gains, depending on the outcome of planning and court decisions. Salvage is also a double-edged sword, serving to reduce economic windfalls or even create losses for owners of undamaged timber following a forest-based catastrophe such as a fire. The net timber market costs of such delays, however, should be a paramount consideration when managers and policy makers consider the explicit benefits of the delay—e.g., better planning and sale preparation, more attention to environmentally sensitive issues such as threatened and endangered species and water quality. In other words, if the BSRP or the mediated settlement could have been completed in time for summer of 2001 timber harvesting on the Bitterroot, the market as a whole would have been larger by $1 million to $4.2 million. If expedited planning and analysis would have cost $1 million more than the observed rate, then, the U.S. economy would have been at least no worse off and might have been better off. Clearly, a generalization follows: the larger the timber value at stake, the greater the potential net timber market benefits of expedited planning and analysis.

We learned, also, that the court-agreed settlement cost about $8.8 million, or about $1.3 million for each 10% reduction in salvage compared to the BSRP. When courts and interested parties are considering an agreement such as this, the net environmental benefits of reducing the salvage harvests should be balanced against the potential market costs of salvage volume limits such as those observed. For the case at hand, this would suggest comparing the $8.8 million costs of not salvaging 10% of the burned area (about 12,000 ha) with the resulting environmental benefits. It is incumbent upon resource economists, biologists, and other resource professionals to assess these trade-offs when considering salvage actions following large wildfires and other catastrophic events on public forests.[9]

The passage of the National Forest Management Act (NFMA) in 1976 established strong roles for public appeal and judicial review in Forest Service decision making (Wilkinson and Anderson, 1987).[10] In addition to providing detailed guidance on technical planning of national forest management, the NFMA opened up the technical basis of decision to judicial scrutiny, and the courts have demonstrated a willingness to evaluate the adequacy of the science behind long-range forest plans and specific forest management projects. For example, the same court that found in favor of plaintiffs in the Bitterroot case has issued injunctions in salvage timber sales on two other National Forests in Montana affected by the 2000 wildfire season. On the Lolo National Forest, sales were halted based on a challenge regarding the adequacy of water-quality evaluations conducted by the State of Montana. On the Kootenai National Forest, sales were halted based on a finding that the old-growth inventory was inadequate.[11]

Unlike the Bitterroot case, where an expedited decision process was attempted (and rejected by a court), these two forests worked through the administrative appeals process as designed and issued contracts for the salvage sales. Subsequent lawsuits halted harvesting operations, causing damages to the private firms who were awarded these contracts. Logging and wood products firms as well as other

[9] A full cost–benefit analysis of the timber and non-timber trade-offs inherent in burned area recovery alternatives is complicated by the fact that multiple, interconnected ecosystem services are provided by forests, flows of ecosystem benefits have temporal and spatial dimensions, and some ecosystem processes (such as future fires) are stochastic.

[10] According to Wilkinson and Anderson (1987), prior to the NFMA, Congress had chosen to defer to the judgment of the agency with regard to natural resource management decisions. Controversies on the Monongahela and Bitterroot National Forests led to a substantial loss of agency autonomy regarding these decisions and a high degree of specificity regarding requirements for decision analyses. The courts' interpretation can therefore be brought to bear on compliance with these specific regulations via the Administrative Procedures Act.

[11] Specifically, court order enjoins the U.S. Forest Service from completing salvage harvesting and restoration activities until sediment Total Maximum Daily Load (TMDL) estimates are made by the State (Sierra Club, and Alliance for the Wild Rockies, vs. D.L.R. Austin and the United States Forest Service; Order CV 03-22-M-DWM, filed April 30, 2003, US District Court, District of Montana, Missoula Division). In the Kootenai case, the U.S. Forest Service is enjoined from completing timber sales until resolving deficiencies in its monitoring of old-growth area and indicator species (The Ecology Center, and The Lands Council, vs. B. Castenada, B. Powell, and United States Forest Service; Order 02-200-M-DWM, filed June 27, 2003, US District Court, District of Montana, Missoula Division).

entities–including large state forests and private landowners in western Montana–are generally affected by USFS actions (and inaction) and must plan their activities in response to USFS plans (Wear, 2003). While we could not estimate the economic impacts of this aspect of market interactions, the unpredictability of USFS salvage harvests likely leads to additional economic losses for the private sector. Put another way, predictable salvage harvest by the Forest Service allows other producers to make the best choices regarding how their timber will be managed, perhaps especially in case of salvage harvesting.

Administrative appeals and judicial reviews as allowed by legislation governing public forest management in the United States allows affected parties to challenge and delay decisions at several junctures. In the context of long-range planning, this process might be viewed as appropriately deliberative, given the magnitude of the resource values involved, and the opportunity costs of delays may be small in comparison to these values. In the context of salvage harvesting, costs of delays are structurally dissimilar to cases where delays affect harvests of green timber. Here the decay of dead timber and therefore the rapid depreciation of standing timber values argue strongly for expedited analysis. Given current arrangements, those who seek to forestall harvests have a strategic advantage over others in the decision process because the delay costs can rise quickly with time and hence can sometimes foreclose management options.

Options for expediting the decision-making process are limited, given current law. One feasible approach might be to incorporate strategies for responding to potential catastrophic forest damages in long-range plans, in effect, planning for emergency responses in the future. With adequate specificity for ecological provinces, site conditions, resource values, and markets, these strategies could be given careful deliberation and review ahead of time and then provide the foundation for expedited analysis on the occasion of a major fire event. Of course, the politically charged rule-making process may preclude development of yet another type of planning process for the national forests. While fires are stochastic events, history indicates that salvage decisions are faced by the U.S. Forest Service in at least one region of the United States in most years. Our results indicate that resource values can be strongly affected by the timing of these decisions. These values, coupled with the potential role of salvage harvests in mitigating the fire's net damages, create an argument for a careful but expeditious assessment of alternative management responses.

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