

**Timber Harvest, Landscape Preservation,  
and Local Economic Vitality in Montana**

A Paper Prepared for the  
Pacific Northwest Regional Economic Conference  
Tacoma, WA  
May 19-21, 2004

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May 17, 2004 Draft

## 1. The Contribution of Forestlands to Local Economic Vitality

Natural forests can provide two broad sets of economically valuable goods and services.:

- a. Commercially valuable goods and services, including timber, minerals, livestock forage, and commercial recreation.
- b. Environmental services including non-commercial recreation opportunities, wildlife habitat including fisheries, scenic beauty, water quality, climate stabilization, etc.

There often can be conflicts between the pursuit or protection of these two sets of economically valuable goods and services. Pursuing one set may limit or degrade the other.

In evaluating the tradeoff between these two sets of goods and services, economists would usually focus on the potential contributions each could make to citizen well being. Benefit-cost analysis, for instance, would take that point of view. However, in many discussions of the appropriate management of public forest lands, the tradeoff between commercial timber harvest and preserving natural forest values is presented in the context of the determinants of local economic vitality, including job, income, and population growth. Instead of focusing directly on the economic values at issue, the focus, instead, is on various measures of local economic activity.

In the management of state forest lands in Montana, the conflict between these two different sets of economic values is particularly troublesome. The Montana constitution requires that state forestlands be managed “for the support of education and for the attainment of other worthy objects helpful to the well-being of the people of this state. The Montana Department of Natural Resources and Conservation has held that this requires forest management to maximize the flow of revenues into a public school trust account. This interpretation has supported what environmental critics have labeled a “clear-cutting for kids” policy. These environmental critics, besides pointing to the constitutional language about “the attainment of other worthy objects helpful to the well-being of the people of this state,” have also argued that preserving the natural forest qualities of at least some of these state forestlands can support schools financially. Protecting the natural amenities those forests provide, they have argued, can lead to amenity-supported economic development that will build the local economy and its ability to support schools and other public services. Note that the focus is not directly on the economic values at stake but on the different impacts on local economic activity.

This paper presents an empirical analysis of these two alternative ways in which management of natural forests could support schools and the local economy, through commercial timber harvest or through protection of natural forest values.

## 2. Economic Analysis of the Impact of Forest Management on Local Economies

The way in which commercial timber harvest can affect local economic vitality through employment and earnings is well known. The economic base model, while incomplete as a full model of the local economy, emphasizes this type of local economic stimulus: The harvest and processing of wood fiber leads to employment and its related income that circulates through the local economy stimulating locally-oriented economic activity. The result is higher levels of local employment, aggregate earnings, and population.

Over the last half-century, the important role of local amenities in supporting economic vitality has received increasing attention by economists. Local amenities include all site-specific qualities that make an area more or less attractive to potential residents. These include the quality of local public services and the character and level of the taxes that support them, cultural attributes, and a broad range of environmental qualities including climate, congestion, crime, air and water quality, recreation opportunities, etc. Local cost of living may also be treated as an amenity or disamenity. Such amenities have been used to explain important changes in the nation's economic geography including the move from center cities to suburbs, from the Frost Belt to the Sun Belt, and the "resettlement" of various regions of the nation including the South and the Mountain West as well as the "unsettling" of the Great Plains.

These two sets of economic forces suggest that local economic vitality can be modeled by focusing on how some local characteristics directly support job creation because they boost firm productivity or reduce production costs. Other local characteristics attract residents who, by providing a labor supply and markets for goods, also support job creation. In this dynamic view of the economy, people follow jobs that are created locally because particular sites are good for certain types of businesses. At the same time, jobs also follow people as they move to where they perceive the balance between local amenities and economic opportunity to be most attractive. (Roback 1982 and 1988)

## 3. Previous Analysis of the Impact of Protected Landscapes on Local Economies

Duffy-Deno (1997) used a simultaneous equation disequilibrium model of population and employment change in 250 non-urban counties in the eight-state Mountain West to study the impact of wilderness protection. He found no evidence that the existence of federal wilderness was directly or indirectly associated with population or employment growth between 1980 and 1990. In addition, he found no empirical evidence that natural resource industry employment in counties was adversely affected by the existence of federal wilderness. In fact, one of his estimated models found a significant positive impact of wilderness on natural resource employment. He also found evidence that National Forest wilderness was associated with population growth and that federal wilderness stimulated employment growth outside of the natural resource industries. These latter results, however, may have been tied to particular model specifications.

A recent University of Maine analysis of migration patterns in the seven-state Northern Forest region of the United States found a positive impact of public lands dedicated to

conservation on in-migration (Lewis and Plantinga (2002). In that study, however, National Forest lands, along with National Parks and state parks and wildlife refuges, were classified as “conservation lands” because most types of commercial and residential development could not take place on them. The study looked at rural forested counties in northern Maine, Vermont, New Hampshire, New York, Michigan, Wisconsin, and Minnesota. It sought to determine the impact of higher densities of public conservation lands on in-migration and employment in these rural forested counties. The focus was on the years 1990-1997, when timber harvests on federal lands declined dramatically as conservation objectives increasingly limited commodity production. The study found that, in general, jobs were following people rather than people following jobs. In addition, the more of a county that was publicly-owned land managed for conservation objectives, the higher was the rate of in-migration. Such enhanced in-migration then had an indirect impact on employment that was similar in size.

That University of Maine analysis of the impact of public conservation lands also sought to determine if more restrictive protection had positive or negative impacts on local economic vitality. The more restrictive preservation category included federally designated Wilderness Areas as well as National and State Parks. There are no large National Parks in this Northern Forest area. The preservation lands category was dominated by Adirondack State Park in New York and the Boundary Waters Canoe Area Wilderness in Minnesota. The study found that the presence of such more restricted-use public lands had no significant impact on county economies, either positive or negative. Since conservation public lands had a significant impact but the preservation component of those lands did not, it appears that the less restricted public lands were responsible for the positive impact. As the study pointed out, however, much of the preservation restrictions were adopted many decades ago (for Adirondack State Park, over a century ago) but the study was focused on the 1990s. Thus the positive (or negative) impact of the restrictions may have been experienced many years earlier. Finally, the period of the study’s focus, the 1990s, was a period during which timber harvests on National Forests fell towards zero and those public lands were managed more for wildlife, recreation, and other environmental values, similar to the way a preservation area would be managed. Despite this, the presence of those lands had a positive impact on local economic vitality.

Paul Lorah has statistically analyzed the relationship between protected landscapes and local economies for all of the counties of the western states (Lorah 2000 and Lorah and Southwick 2003). That correlation analysis showed that higher percentages of county land protected by National Park, National Monument, and National Wilderness System status were associated with higher rates of employment growth between 1969 and 1997. Even when only the more rural (non-metropolitan) counties in the West were considered, those counties with more than ten percent of their land in National Parks, Monuments, and Wilderness saw job growth 1.85 times the average for western non-metropolitan counties; income grew 1.43 times faster. The correlation between the amount of National Park, Monument, and Wilderness within 50 miles of a rural western county’s center was positively correlated with both income and employment growth for both the 1969-1997 and 1990-1997 periods. Finally, unprotected wildlands that have yet to face roaded development also appeared to attract economic activity. The acreage of US Forest

Service inventoried roadless areas within 50 miles of a county's center was also positively correlated with employment and income growth. The strength of that correlation increased as the analysis shifted from all counties to just the non-metropolitan counties (that is, no cities larger than 50,000) to the purely rural counties (that is, no cities greater than 2,500) of the western states.

#### 4. Modeling Population Changes

Although in popular economic discussions population is often assumed to be dictated by the employment opportunities in an area, this type of "economic base" analysis is incomplete since it focuses solely on how the demand for labor draws people to an area while ignoring the role that the supply of labor plays in drawing economic activity to an area. From an economic point of view, not only may people follow jobs, but jobs may also follow people because people represent a supply of labor and a market for goods. Causation, potentially, runs both directions simultaneously. The relative importance of the two causal connections can only be determined empirically and is likely to vary from one region to another and over time. We follow Carlino and Mills (1987) in modeling this relationship.

In this simultaneous equation context, local population is determined by the totality of employment opportunities in an area and the site-specific characteristics of an area that either attract or repel potential residents, the amenities and disamenities associated with the area.

$$(1) \quad \text{Pop} = f(E_T, \mathbf{A})$$

where Pop is population,  $E_T$  is total employment, and  $\mathbf{A}$  is a vector of site specific amenities and disamenities. These amenities might include characteristics of the local natural environment (air and water quality, climate, outdoor recreation opportunities, scenic beauty, etc.) and the social environment (crime rates, congestion, quality of public services, local tax burdens, etc.)

Total local employment is broken into two components. One part is assumed to be exogenously determined by local site-specific resources such as fertile agricultural land, mineral deposits, commercially valuable timber, a military base, etc. This is labeled exogenous employment,  $E_X$ . The other part of employment,  $E_N$ , is endogenously determined either as a result of the spill-over effects of the exogenous employment or by the size of the local population.

$$(2) \quad E_T = E_X + E_N$$

$$(3) \quad E_N = g(\text{Pop}, Y_X, \mathbf{C})$$

where  $Y_X$  is the earnings in the exogenous sectors that circulate within the local economy, and  $\mathbf{C}$  is a vector of local characteristics that determine the costs and productivity of firms operating in this location. The local cost characteristics might

include local natural resources, local tax burdens, the quality of public services, the quality of the workforce, local wage levels, transportation and communication infrastructure, local utility costs, etc.

Although this equation system, ideally, should be estimated simultaneously, the impact of the exogenous variables on population can be estimated by deriving a reduced form version of the population equation:

$$(4) \quad \text{Pop} = a + bY_X + cA + dC$$

In this reduced form earnings in the exogenous sectors are used not only to represent the income “injected” into the local economy but also the level of exogenous employment. Successful estimation of this reduced form equation should provide an accurate indication of how timber harvests affect local economic vitality as measured by population through the impact of the harvest on the local economic base and its amenity and disamenity effects. Since the system is over-identified, the coefficients associated with the simultaneous equation system [equations (1) through (3)] cannot be determined from such reduced form estimates, but the impact of forestland management decisions as summarized in equation (4) can be determined.

Given that our focus is on the role of a particular amenity (landscapes protected against timber harvest and other commercial development) and a particular disamenity (the damage done by commercial timber harvest) in a single state, Montana, many of the other local amenities and the cost characteristics are likely to be similar. At the very least, they are unlikely to vary as much as they would in a national or multi-state regional context. For instance, tax levels and climate can be expected to be more similar within a state than across the nation. In some of the empirical work that follows, we estimate Equation (4) in a change format. As a result, county characteristics that did not change over the 1990-2000 time period are eliminated from the equation, possibly justifying the small number of amenity and cost variables included in our estimation. When we estimate Equation (4), however, using the size of the dependent and independent variables, we implicitly are assuming that the relevant amenities and cost characteristics are identical across Montana counties except for differences in protected landscapes, intensity of timber harvest, and trade center status. This, of course, is a rather heroic assumption.

## 5. Variables and Data Sources

We use county level data for all of Montana’s fifty-six counties in a cross-sectional analysis. Population levels between 1990 and 2000 were regressed on measures of the exogenous earnings, the intensity of timber harvest, and the density of protected landscapes.

*Exogenous Earnings:* Land-based economic activities such as farming, ranching, mineral extraction, and logging are not drawn to a particular area by the existence of a local labor force but by the natural resource endowment of the area. The same is also the case with military bases and the federal employment that is associated with managing

local public lands. We use BEA Regional Economic Information System data on industry earnings in agriculture, agricultural services, mining, manufacturing, railroad, and federal military and civilian employment to measure these exogenous sources of income. Manufacturing is used to approximate lumber and wood products, paper mills, metal smelting, petroleum refining, agricultural product processing, etc., the manufacturing associated with land-based economic activities. Since it also includes some locally oriented activities such as newspaper publishing, there is some error involved in this approximation, but disclosure problems prevent access to the detailed industry-level data in the more rural counties. Railroad activity in Montana is primarily associated with the land-based economic activities and traffic simply crossing the state and therefore is largely exogenous.

Another external source of income flowing into a county is non-employment income such as federal transfer payments (mostly related to retirement) and investment income (dividends, interest, and rent). Besides supporting a larger local economy and population, these are also influenced by the size of the existing population. To avoid that simultaneity problem, we measure non-employment income as a percentage of total personal income. This data also comes from the BEA Regional Economic Information System.

From a local economic base point of view, trade center activities that serve a larger geographic area beyond a particular county could also be included as exogenous earnings. In addition, trade center status may affect the costs faces by firms. We use the location coefficient for retail trade sales per capita relative to the state as a whole to measure this. It seems likely that population level influences this variable since larger counties, with a more developed commercial infrastructure, are more likely to become retail trade centers. For that reason this variable may not be entirely exogenous.

*Protected Landscapes Measure:* The amenities of protected landscapes were represented by the acreage of federally classified national Wilderness, National Park, National Monument, and officially recognized roadless areas within a 50 mile radius of the geographic centroid of each county. The roadless area acreage was established as part of the Clinton Administration's roadless area initiative.

*The Disamenity Associated with Logging:* Commercial logging, especially clear cutting large areas, has significant environmental impacts including water pollution, loss of fisheries, damage to scenic beauty, reduced recreation potential, and loss of wildlife habitat. We measure the intensity of logging by using the harvest per square mile of county land area. Timber harvest data in Montana is reported by the Bureau of Business and Economic Research at the University of Montana (Keegan et al. 2001).

## 6. Empirical Results

We estimate Equation (4) above as:

$$(5) \quad \text{Pop} = a + bY_x + cH + dWR$$

Where Pop is county population in 2000,  $Y_x$  is 1990 county exogenous income, H is timber harvest per square mile in the county in 1988, the most recent peak year of harvest, and WR is the square miles of wild and roadless areas within a 50 mile radius of the county centroid.

We also estimate this equation in change format:

$$(6) \Delta \text{Pop} = a' + b' \Delta Y_x + c' \Delta H + d' \text{WR}$$

In the change model, the changes are those over the 1990-2000 period. The equations contain two amenities. The intensity of timber harvest (H) is used to represent the disamenities associated with the negative environmental impacts associated with commercial timber harvest. The positive economic impacts associated with timber harvest are picked up in the exogenous earnings variable, which includes earnings in forest products. The other amenity is the density of wild and roadless lands in the county (WR). Since this did not change significantly over this period, the level of this amenity was used as a structural variable affecting population change.

Table 1 reports the estimates of Equations (5) and (6). Exogenous income is measured by three variables, labor earnings in land-based industries, non-employment income, and retail trade center activity. Amenities are measured by the intensity of timber harvest and the density of wild and roadless lands. We expect the exogenous income variables to have positive signs, the intensity of timber harvest to have a negative sign, and the density of wildlands to have a positive sign.

In the estimate of Equation (5) in which the level of 2000 population is regressed on the 1990 levels of the independent variables, all of the independent variables are significant and have the expected signs: higher densities of protected areas, lower timber harvest intensities, and larger levels of the different types of exogenous income all support higher population levels. Section 1a reports these results. Section 8 of this paper interprets the estimated coefficients.

Table 1: Population Regression Results							
1a.	Size of Population on Exogenous Income and Amenities (N = 56)						
	Economic Base	Non-Empl Income	Retail Trade Loc. Coef.	Harvest Intensity	50 mile Wild and Roadless	Adj. R <sup>2</sup>	F-Stat
	0.29 *** (12.2)	30343 * (1.6)	12,825 ** (2.16)	-120,589 * (1.40)	3.19 *** (2.51)	0.89	94
1b.	Change in Population on Change in Exogenous Income and Amenities (N= 56)						
	Change in Economic Base	Change in Non-Empl Income	Change in Retail Trade Loc. Coef.	Change in Harvest Intensity	50 mile Wild and Roadless	Adj. R <sup>2</sup>	F-Stat
	0.141 *** (3.91)	8,674 (0.74)	1,647 (0.76)	-144,303 ** (-1.99)	1.30 *** (2.59)	0.42	8.9

t statistic in parentheses; single tail significance test.

\* significant at 10% level; \*\* significant at the 5% level; \*\*\* significant at the 1% level.

When the equation is estimated in change format all of the coefficients again have the expected signs, but the coefficients on non-employment income and retail trade center activity are not significant. See Section 1b in the table above.

### 7. Property Tax Base, Timber Harvest, and Protected Landscapes

Because state forests are partially to be managed in support of public schools, not harvesting timber and, instead, protecting the natural qualities of state forestland can be portrayed as undermining public school finance.

If, however, protecting natural forest characteristics stimulates local economic development because the protected natural amenities attract people and economic activity, the tax base upon which school funding primarily relies may expand, providing support for schools and other public services.

The analysis above can be carried out not in terms of population but in terms of the residential and commercial tax base. In doing so, the implicit assumption being made is that the residential and commercial tax base is determined by the size of the local population. With that assumption, a reduced form equation relating the local residential and commercial tax base to the same variables as were in the population equation can be estimated.

The change in the taxable value of residential and commercial property between 1990 and 2000 was used to represent the change in tax base associated with population. The Montana Department of Revenue provides this data in its biennial reports.

When the 2000 commercial and residential taxable values are regressed on 1990 values of the independent variables, only the coefficients on earnings in land based economic activities and the density of wildlands are significant. Both have the expected signs. The coefficient on harvest density, while having the expected negative sign, is not significant. See Table 2.

When the equation is estimated in change format, the change in land-based earnings, the change in harvest intensity, and the density of wildlands are significant with the expected signs. The non-employment income and retail trade center variables were not significant. See section 2b in the table below. Note that the change in basic industry earnings and change in harvest intensity are only barely significant at the 10 percent level.

Table 2: Residential and Commercial Taxable Value Regression Results							
2a.	Size of Res. & Comm. Taxable Value on Exogenous Income and Amenities (N = 56)						
	Economic Base	Non-Emp Income	Retail Trade Loc. Coef.	Harvest Intensity	50 mile Wild and Roadless	Adj. R <sup>2</sup>	F-Stat
	300 *** (8.8)	-11,646,547 (-0.39)	11,356,409 (1.23)	-71,797,603 (-0.56)	5,930 *** (3.19)	0.83	55
2b.	Change in Residential & Commercial Tax Value on Change in Exogenous Income and Amenities (N= 56)						
	Change in Economic Base	Change in Non-Emp Income	Change in Retail Trade Loc. Coef.	Change in Harvest Intensity	50 mile Wild and Roadless	Adj. R <sup>2</sup>	F-Stat
	82 * (1.35)	-6,439,040 (-0.33)	1,977,860 (0.54)	-203,452,866 * (-1.66)	3,492 *** (4.13)	0.40	8

t-statistic in parentheses; single tail significance test.

\* significant at 10% level; \*\* significant at the 5% level; \*\*\*significant at the 1% level.

## 8. Interpreting the Empirical Results: The Impact of Changes in Timber Harvest on Local Economic Vitality and Tax Base

We interpret the estimated coefficients by considering the implied impact on the local economy of a 10 million board feet (mmbf) expansion in timber harvest. The average harvest level across Montana counties with a significant timber harvest was 31 mmbf in 1998. A 10 mmbf increase, then, would represent a 32 percent increase in harvest. This may seem to be an unreasonably large increment, but average harvest declined between 1988 and 1998 by an average of 14 mmbf across all of these counties. In addition, about three-quarters of the Montana timber harvest is concentrated in six counties that in 1998 had an average harvest of about 120 mmbf. The 10 mmbf increment represents only an 8 percent increase in harvest in those counties and is small compared to the 66 mmbf decline in average harvest between 1988 and 1998.

Within our model the impact of increased harvest is conveyed in three ways. First the expanded timber harvest increases earnings in the exogenous economic base that supports a larger population and tax base. Second, the higher intensity of logging has a disamenity affect that makes the area less attractive due to the direct degradation of the environment associated with the harvest. Finally, to the extent that the expanded logging requires accessing current un-roaded, un-logged areas, the logging reduces the local inventory of “backcountry wildlands” partially eliminating an amenity and also reducing the attractiveness of the area.

### A. Impact on Population

#### *i. The Impact of Increased Basic Earnings*

Increased timber harvest leads to increased earnings in the road building and harvest process as well as in the local processing of that wood fiber. In the context of the economic base model, those earnings then circulate through the local economy putting people to work and generating earnings through backward and forward linkages with the rest of the local economy. Those higher earnings support a larger population. It is important to note that this higher level of harvest cannot be a one-time occurrence if it is to have this impact on population; it has to be a higher level of harvest that is sustained over a lengthy period of time before one can expect population to adjust in this way.

The relationship between earnings in forest products and timber harvest in Montana is unclear. A simple regression of real forest products earnings on timber harvest for the 1969-2000 period is barely significant at the 10 percent level. The adjusted  $R^2$  is only 0.06. The coefficient on timber harvest indicates that a 10 mmbf change in harvest would result in only about \$10,000 in additional earnings. In general, real earnings in forest products have changed very little with changes in timber harvest. For instance, dramatic expansions and then contractions in timber harvest between 1984 and 1994 had almost no impact on real forest products earnings.

The relationship between the level of timber harvest and the level of forest products industry employment in Montana is also complex. Increased utilization of harvested wood fiber during the 1970s as a pulp mill expanded and particle and fiber board mills were constructed led the average employment per mmbf harvested to rise 44 percent, from 9 to 13 jobs per mmbf of harvest. During the 1980s, however, increased mechanization of both harvest and forest products manufacturing reduced labor intensity dramatically. Employment per mmbf harvested fell back to 9 by 1987. High raw material prices, environmental constraints, and the shift to more value-added manufacturing (e.g. log homes) led labor intensity to rise again during the 1990s, reaching as high as 14 by the end of the decade.

As a result of these complex adjustments within the forest products industry, employment did not track harvest very closely. When harvest expanded by a third between 1984 and 1987, employment actually declined slightly. As harvest declined by almost 50 percent between 1987 and 2000, employment declined by only 8 percent.

A simple regression of forest products employment on timber harvest between 1969 and 2000 or between 1983 and 2000 indicates a relatively low marginal impact of changes in harvest on employment: about 2.5 jobs per mmbf change in timber harvest. A core employment level of about 9,000 workers, about 80 percent of the total, appears to be unaffected by the level of timber harvest, both as timber harvest rose to record levels and as it fell to record lows.

This data indicates that as harvest levels actually changed, the impacts on forest products earnings and employment were quite low. In our calculations below, we will rely on the data on how forest products employment in Montana actually adjusted to changes in timber harvest. This leads to a larger impact than the *earnings* relationship would suggest.

A 10 mmbf increase in harvest is associated with 25 additional jobs in forest products. The average annual forest products industry pay per job in the 1990-2000 period (expressed in year 2000 dollars) was about \$34,600. These figures imply that a 10 mmbf change in harvest would lead to an additional \$865,000 in exogenous earnings. The population increase associated with such a long-term increase in timber harvest would be about 250 or 122 depending on whether the equation is estimated in terms of the levels of the variables or the changes in the variables. See Table 3.

### *ii. The Disamenity Impact of Higher Harvest Intensity*

Higher levels of harvest lead to a higher intensity of harvest per square mile of county area. The intensity of timber harvest is taken as a measure of the environmental disturbance associated with timber harvest: water quality and fisheries deterioration, loss of wildlife habitat, degraded scenic beauty, reduced recreation value, etc. The estimates confirm that this is a disamenity, reducing population. The *intensity* of harvest will depend on the size of the county. The average county size for those Montana counties that had significant timber harvests was 2,700 square miles. For these illustrative calculations we used 3,000 square miles to represent the size of the county. The estimated coefficients on timber harvest intensity indicate that a 10 mmbf increase in harvest would result in a population decrease of about 400 to 480 depending on which form of the equation is estimated.

### *iii. The Impact on Population of Reduced Wild-Roadless Amenities*

The focus of the conflict over timber harvest has been on proposals to enter areas where timber harvest has not previously taken place, especially areas to which timber road networks have not yet been extended. Since the density of wild and roadless areas in a county was used as a measure of the amenities provided by “wildlands” and “natural forests,” timber development of such areas reduces that amenity and, through that, has an additional negative impact.

Measuring this disamenity effect requires that we know the acreage associated with a 10 mmbf harvest. Forest inventory data for Montana indicates that timber yields on harvested lands average about six thousand board feet per acre or 166.67 acres per mmbf harvested. Ten million board feet would require 1,667 acres or 2.60 square miles each year. Our estimated coefficients indicate that each year the additional 10 mmbf is harvested, population would decline by 3 to 8. Over a 25-year period of such sustained harvest, the population reduction would be about 85 to 207; over a ten-year period it would be between 35 and 85. See Table 3.

The coefficient on the density of wildlands can also be interpreted to indicate what additional population has been supported by the amenity effect of the environmental services provided by those protected landscapes. The average area of protected landscapes within the fifty-mile circle in the timber producing counties in Montana was about 1,800 square miles. Our estimated coefficient indicates that this average density of protected landscapes would be associated with an additional 2,300 to 5,700 people in such a county.

### *iv. The Total Impact on Population*

When these three different effects of a 10 mmbf increase in timber harvest in a county are combined, the impact on population ranges from a 235 to a 444 person loss depending on the time period used. Table 3 below summarizes these offsetting effects.

Model	Wood Product Earnings	Harvest Density	Development of Wld & Roadless Lands			Total Impact	
			1 year	10 years	25 years	10 years	25 years
Population or Exogenous Income	250	-402	-8.3	-8.3	-207	-235	-359
Change in Pop on Change in Exog Income	122	-481	-3.4	-3.4	-85	-39.3	-44.4

The average population in Montana's timber harvest counties was about 23,000 in 2000. A change of 200 to 400 people represents a relative small change in population, about 1 to 2 percent.

### B. Impact on Residential and Commercial Tax Base

The interpretation of the coefficients on the residential and commercial tax base regressions parallel that provided above for the population equation. In general, the increased timber harvest leads to higher residential and commercial taxable values due to the expansion in the local economic base. This is offset by declines in that tax base due to the disamenity effects associated with the higher timber harvest. The net effect is a \$110,000 to \$924,000 decline in taxable values depending on the time period used. See Table 4.

Model	Wood Product Earnings	Harvest Density	Development of Wld & Roadless Lands			Total Impact	
			1 year	10 years	25 years	10 years	25 years
Population or Exogenous Income	\$270,000	NS	-\$15,400	-\$154,000	-\$380,000	\$116,000	-\$110,000
Change in Pop on Change in Exog Income	\$71,000	-\$768,000	-\$9,079	-\$91,000	-\$227,000	-\$788,000	-\$924,000

NS = coefficient not statistically significant

The average commercial and residential taxable value in Montana's timber harvest counties was about \$25 million in 2000. A \$900,000 change in taxable value would be a relatively small change, about 3 percent.

Of course, knowing that the tax base has changed does not tell us whether the demand for service changed in a way that had a positive or negative impact on local fiscal balance. Regression analysis shows that the *per capita* residential and commercial tax base was higher in faster growing counties and that as population grows the *per capita* tax base grows too. Whether growth imposes disproportionate service costs that offset these increases in the tax base is beyond the scope of this paper.

### 9. Limitations of the Econometric Results

These results are somewhat sensitive to model specification and the interpretation of the coefficients of the model. Specifying a model in which *changes* in population depend on changes in the independent variables leads to smaller positive impacts of harvest than if the *level* of population is related to earlier period values of the independent variables. In addition, if the average relationships between timber harvests and forest products earnings and employment are used instead of the marginal relationships, the positive impacts of additional timber harvests are higher still. The combination of these two changes in modeling and interpretation would reverse the sign on our results. It would

still remain the case, however, that there is a significant offsetting relationship between the positive impact of additional timber harvest and the negative impact of the damage done to natural area values when it comes to local economic vitality and that the net effect of expanded timber harvest on local population and tax base would be quite small.

In our econometric analysis the state of Montana was treated as a single economic region. Montana, however, like most geographically large states, is actually quite diverse. One of the more dramatic differences is that between the Great Plains portion of eastern Montana and the Rocky Mountain western portion. These two areas have quite different economies and have been on quite different economic trajectories for many decades. Since timber harvest and protected landscapes tend to be concentrated in the western portion of the state, the analysis we have carried out may be assigning to protected wildlands and timber harvest results that are actually tied to other differences between these two regions of the state.

We conducted the analysis for the state as a whole despite this concern because it is possible that eastern Montana has shown much less economic vitality because it lacks the natural amenities found in the western part of the state. Testing to see whether the presence or absence of protected natural areas has an impact on local economic vitality in both parts of the state appears to be a reasonable thing to do. In addition, introducing variables to represent the unique features of eastern or western Montana is likely to lead to collinearity problems.

We explored the sensitivity of our results to this problem in two ways. First, we carried out the regression using only those counties with significant timber harvests. Those counties were exclusively in western and southwestern Montana. The number of observations was reduced from 56 to 27. This smaller sample produced results quite similar to the larger sample for the estimation in change format. The impact of land-based economic activities was somewhat reduced and the impact of wildlands increased. The similarity in results is not surprising given that in the change format, values of variables that were the same at the beginning and the end of the period would not have impacted the estimation. When the equations were estimated using the level of the dependent and independent variables, the intensity of timber harvest ceased to be significant with the smaller sample.

We also explored adding a dummy variable to represent the Great Plains counties but using all 56 counties. Again the estimates in change format were quite similar to those in the regression that did not include the regional dummy. The coefficients on the land-based economic activity, timber harvest intensity, and wildlands were somewhat smaller. The dummy variable was not significant. The estimates using the level of the variables, however, did produce one significant difference: The wildlands variable ceased to be significant while the Great Plains dummy variable was significant. Given the high correlation between these two variables, it is difficult to know how to interpret and what weight to give to this result.

## 10. A Critique of an Earlier Empirical Analysis of the Impact of Timber Harvest and Protected Landscapes on Local Economic Vitality in Montana

The Forestry Division of the Montana Department of Natural Resources and Conservation asked forest economist David Jackson to explore the impact of timber harvest and forest preservation on local economic vitality (Jackson 2003).

Jackson's approach involved regressing the change in county population on the change in the non-farm labor force, the intensity of timber harvest, and the presence or absence of federal classified wilderness in the county. He also included an estimate of commercial capital stock and the relative importance of retail trade in the county. He found that the presence of wilderness did not have a statistically significant impact on local economic vitality but that the intensity of timber harvest had a positive impact on population growth. That is, landscape preservation did not have a measurable amenity effect, but timber harvest did; but timber harvest was an amenity, not a disamenity.

This result may have been tied to several problems with Jackson's statistical analysis.

Jackson used a "yes/no" wilderness variable to represent the impact of the presence of protected landscapes. The extent of protected landscapes within a county was not measured, nor was the potential presence of protected landscapes just across county lines considered. In addition, only federally classified wilderness was considered: National Parks, National Monuments, and classified roadless areas, all of which represent forest lands protected from timber harvests, were ignored. A better measure of the extent to which lands have been protected from timber harvest would be the density of lands public lands that have not been open to timber harvest within commuting distance of a community. That is the variable we have used.

In addition, the wilderness "yes/no" variable was strongly correlated with the intensity of timber harvest (0.51). This is not surprising since counties with extensive forests are likely to have high levels of both timber harvest and protected wildlands. That correlation means that the impact of each variable on population can get inappropriately spread over the other variable. The use of our variable that measured the percentage of the county land base that was wildlands reduced this correlation with the intensity of timber harvest dramatically. The coefficient of determination declines from 0.26 to 0.032 (alternatively, the correlation coefficient declines from 0.51 to 0.18).

Jackson only studied counties that had significant commercial timber harvest. Other counties were ignored even if they had significant protected landscapes. This selective sample of Montana counties may well have biased the estimates. In addition it increased the likelihood that the separate roles of timber harvest and protected landscapes could not be distinguished.

Jackson included changes in the size of the workforce as an independent variable, but changes in the size of the workforce is clearly not independent of changes in population.

This is a basic econometric error. Jackson's equation cannot be presented as a reduced form equation. He has ignored the simultaneity between population and workforce.

The relationship developed and estimated in this paper avoids all of these problems and, therefore, is likely to present a more accurate depiction of the relationship between the intensity of harvest, protected landscapes, and local economic vitality.

Jackson also claims to estimate the impact of timber harvest intensity and landscape protection on the tax base. He concludes that higher levels of timber harvest boost residential property values. His analysis sought to link residential property values per household to changes in population. He used his results on how timber harvest intensity and landscape protection influence population change to link residential property values to those timber harvest variables.

All of the problems with the link between that change in population and timber harvest discussed above are carried forward into his residential property value analysis. For that reason those results cannot be relied on either.

Jackson's results on the relationship between population growth and home values are parallel to those reported above. He finds that faster growing communities tend to have higher home values. The analysis above found that faster growing communities have high per capita residential and commercial tax bases.

## 11. Conclusions

Previous analysts have found evidence that natural landscapes can have a significant impact on local economic vitality. Those natural landscapes serve as amenities attracting new residents and the economic activity associated with them. The absence of such attractive natural amenities has also been cited as a serious developmental problem on the Great Plains.

Natural landscapes can also be the source of commercially valuable products that may be extractable only by doing some significant damage to the natural values of the land base. In such a setting, one would expect there to be tradeoffs between two different approaches to enhancing local economic vitality: preserving the natural amenities and extracting the natural resources.

We have analyzed that tradeoff in the context of timber harvest in Montana where additional timber harvest, while generating jobs and earnings, often does significant damage to water quality, fisheries, scenic beauty, wildlife habitat, roadless area values, and recreation opportunities. Our analysis suggests that the population and tax base losses associated with the disamenity effects of expanded timber harvest may outweigh the positive impacts associated with an expanded economic base. The result of increased timber harvest may be a small net loss of residents and the tax base associated with them.

These results are tied to an analysis of one state using a relatively small number of observations. That small number of observation limited the number of variables that could be used to specify the model. In the future we plan to explore this issue on a much wider geographic scope, covering all of the counties in the Mountain West states. This larger data base will allow us to include many more variables to represent amenities, disamenities, cost factors, and local structural differences.

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<sup>1</sup> There is some controversy over what a “natural” forest is and what it is not. For millennia human activities have modified the forests of North America. It is also possible that there are negative characteristics associated with “wildlands.” These issues are not discussed in this paper.

<sup>2</sup> The compact with the United States when Montana was granted admission to the Union as a state contained this language. That compact was appended to the original 1889 state constitution and the 1972 Montana Constitution incorporated that compact by reference in Article 1.

<sup>3</sup> The definition of the economic problem that is analyzed here and a good deal of the approach that is taken has been dictated by the desire to respond to a study the Montana Division of Forestry commissioned that concluded that timber harvest not only supported local economic activity directly through employment and earnings, but that timber harvest was also an attractive amenity that drew people to counties where it was taking place. That study is discussed in Section 10 of this paper.

<sup>4</sup> Montana borders on Canada, but the protected acreage on the Canadian side of the border was not included in this measure. Because of the size of the Montana counties, only a small part of the 50 mile radius circle on the centroid of the northern tier counties spilled over into Canada. However, there are some protected areas immediately adjacent to the Canadian border north of four of Montana’s 56 counties (Valley, Phillips, Glacier, and Flathead). Flathead, Valley, and Phillips counties are large enough that almost no Canadian land lay within the 50 mile circle. For Glacier County, some of the Canadian Waterton National Park lies within the 50 mile circle. Our implicit assumption is that the border effectively eliminates ready access to those Canadian lands.

<sup>5</sup> The “wilderness” and roadless acreage were developed by Paul Lorah. A discussion of that data base and its use can be found in Lorah and Southwick, 2001, and Lorah 2000.

<sup>6</sup> Because of the nature of public school funding in Montana, the state school trust accounts are not an independent incremental source of school funding. Those revenues go into the general fund out of which schools and most other state programs are funded. In that sense, school funding is not significantly affected by the flow of funds into the school trust accounts.

<sup>7</sup> The coefficient on mmbf harvest for the 1983-2000 period was 2.4 workers, with a t-statistic of 5.6 and an adjusted R-square of 0.64. The constant represented 8,992 workers.

<sup>8</sup> Bureau of Economic Analysis, U.S. Department of Commerce, Regional Economic Information System CD-ROM, RCN-0295. Lumber and Wood Products earnings were deflated using the CPI and divided by lumber and wood products employment to obtain real pay per job for each county.

<sup>9</sup> Conner, 1993, Tables 11, 12, and 22.

<sup>10</sup> Both relationships are statistically significant.