Technical Memorandum 2.3

Net Economic Impacts of Irrigation in Montana

Revised August 2008

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In Technical Memorandum 2.1 we presented an analytical framework for describing the economic importance of irrigation and irrigated agriculture in Montana. A central concept of the framework is that water has economic importance when it, plus the ecosystem of which it is a part, provide goods and services for human use and enjoyment. Some water-related goods and services have a positive value and increase the economic well-being of Montanans, as when the irrigation services of water used by farmers increase the value of their crops. Others have a negative value and reduce economic well-being, as when flooding damages infrastructure and disrupts economic activities. Another central concept is that Montanans typically derive many goods and services from a given body of water and, hence, there often is competition for water resources. In a competitive situation, using water to irrigate crops generates economic benefits for the irrigators, but spillover effects, or externalities for others. When irrigation diminishes the supply of water-related goods and services for others, the externality is negative; when it increase the supply, the externality is positive.

Montana's water-related goods and services have economic importance not just for their *economic value,* however, but also for their *economic impacts*, i.e., their ability to generate jobs and income. Economic values and impacts are not the same thing. Something with a high value may generate few jobs and little income, and vice versa. In general, water-related goods and services generate jobs and income when people spend money on them, and the expenditures course through the commercial sectors of the economy. They also can sometimes have an impact on jobs and income by influencing household-location decisions that, in turn, influence business investment decisions. Others have high environmental values, which can have an indirect, often powerful, impact on jobs and income by stimulating voluntary or regulatory changes in behavior.

In this Technical Memorandum we focus on describing the net economic impacts of water used for irrigation.

I. CONCEPTUAL ISSUES

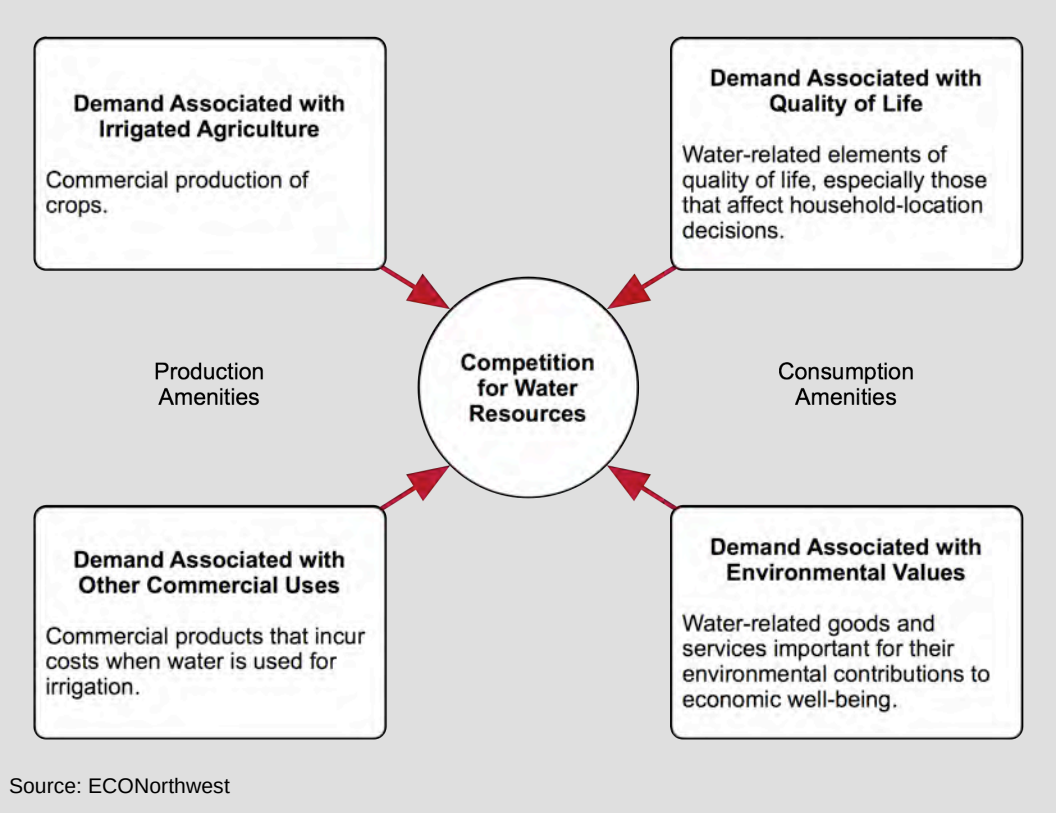
Our approach applies the central concepts of the analytical framework in Technical Memorandum 2.1. We recognize that water affects jobs and incomes only as it provides humans with goods and services. Using water to irrigate crops stimulates an increase in jobs and income associated with irrigation infrastructure and the operations of irrigated farms, but has spillover impacts on the jobs and income associated with irrigation's effects on other goods and services. Some of the spillover impacts increase jobs and income, others decrease them. The net impact may be positive or negative. To understand the net impact of an increase or decrease in irrigation, one also must account for the economy's inherent adaptability, which tends to accent the positive impacts and attenuate the negative ones.

A. Competing Demands

To organize our examination of different ways in which the state's different water-related goods and services impact jobs and income, we use the framework of competing demands illustrated in Figure 1. It illustrates four major types of competing demands for the state's water resources. In the upper left is the demand from irrigators. The lower left represents other commercial activities that incur costs when water is used for irrigation. These costs might materialize, for example, when water is withdrawn from a stream to irrigate one set of fields depleting supplies that otherwise would be available to support a recreational boating enterprise or to irrigate fields downstream.

On the left side of Figure 1, water-related goods and services are economically important because they are inputs in the production of other things—crops, hydroelectricity, etc.—that consumers want to have. On the right side, the connection to consumers is more direct. Here, consumers consider Montana's water resources economically important for how they directly contribute to their well-being. In economic parlance, these are known as consumption amenities.[1] There are two types of demand for water-related consumption amenities: one directly affects residential location decisions; the other does not.

Figure 1. Competing Demands for Montana's Water Resources



Source: ECONorthwest

[1] For the remainder of the memorandum we follow common practice and use "amenities" to refer to consumption amenities.

Consumption Amenities and Residential Location. Some water-related goods and services, such as recreational opportunities and scenic vistas, contribute directly to the well-being of people who have access to them. Their contribution to consumers' well-being makes them economically important in their own right, but they have additional economic importance when they also influence the location decisions of households and firms. We show the demands for consumption amenities that influence location decisions in the upper right portion of Figure 1.

Economists' explanation of why some consumption amenities can influence location revolves around the concept of *consumer's surplus*. Whenever a consumer derives a benefit (increase in well-being) from a good or service that exceeds the cost he or she pays to obtain it, the net benefit represents an increase in well-being. This increment is called consumer's surplus.

In general, the nearer people live to amenities, the lower their cost of using them. Thus, consumers can increase their consumer's surplus, and, hence, their economic well-being, by living in a place that offers recreational opportunities, pleasant scenery, wildlife viewing, and other amenities they consider important. This consumer's surplus is, in effect, a *second paycheck* a resident receives from living in a place where she has easy access to these amenities, so that her total welfare is the sum of the second paycheck plus the purchasing power of her money income (her first paycheck). The size of the second paycheck, in effect, measures the quality of life residents enjoy by living in a given place. To measure the full impacts of irrigation, one must account not just for those that materialize through its contributions to the first paycheck (the left side of Figure 1) but also those that materialize through its contributions to the second paycheck.

Quality-of-life values can be powerful. Many Montanans say the primary reason they live here is to enjoy the quality of life, especially the state's natural-resource amenities.[2] Some of them undoubtedly could enjoy higher earnings living elsewhere, but choose not to do so because their total welfare (the sum of the first and second paychecks) is higher here. Such choices are not unusual: research at the national level has found that differences in amenities (of all types, not just those related to natural resources) account for about half the interstate differences in job growth.[3] All else equal, if the state's water-related consumption amenities improve, some people already here will tend to stay and additional people will tend to move in. Degradation of the amenities will have the reverse impacts.

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[2] PPL Montana. 2006. *A Quality-of-Life Study for Montana: Results of a Survey of Montana Residents.* Retrieved May 27, 2008, from http://www.pplmontana.com/NR/rdonlyres/C5A88D64-6404-4DD4-BD7B-06A6B6A27342/0/QualityOfLifeSurveyReport_032806.pdf

[3] Partridge, M. and D. Rickman. 2003. "The Waxing and Waning of Regional Economies: The Chicken-Egg Question of Jobs Versus People." *Journal of Urban Economics* 53: 76-97.

Environmental Values. The lower right portion of Figure 1 represents demands associated with economic values that do not necessarily entail a conscious, explicit use of water-related goods and services. We call these environmental values. There are two general categories: nonuse values and values of goods and services that generally go unrecognized.

Nonuse values arise whenever people place a value on maintaining some aspect of the environment, even though they do not use it and have no intention to do so. Research has documented nonuse values for maintaining the existence of species threatened with extinction, for example, and for special natural areas, such as national parks. They also can materialize when people want to maintain a particular cultural or ecological characteristic of a resource, as when people want to maintain the existence of landscapes associated with traditional ranching or native wilderness, for enjoyment by future generations.

Environmental values also can be important when a water-related ecosystem provides valuable services that people generally consume without being aware of them. Some of these are part of the so-called web of life: operating at local, regional, and global scales, they help sustain life. Others have a more direct link to the well-being of Montanans. On its own, for example, the muck found in a wetland may have no commercial value nor contribute in any visible way to the quality of life of nearby residents. Nonetheless, to the extent that it helps support life of all types in the ecosystem, then it also helps support the lives of people living here and contributes to their well-being. Even though those living nearby might not consciously consider the benefits of these services on a day-to-day basis, they probably would do so if they had a better understanding of them or if the services were to become threatened or noticeably diminished.[4] Many people today, for example, consciously consider the economic values associated with the services produced by the global climate, in ways that were unknown, even to scientists, just a few years ago. Some scientists and economists believe many more services have great economic value although this value and, hence, the demands for the services lie dormant.[5]

People do not ordinarily link their behavior to the value they place on protecting an endangered species, a ranching landscape, or the muck of a wetland. Sometimes they do, however. Acting through political processes, people sometimes implement regulations to restrict activities potentially harmful to the continued existence of some species and landscapes, for example. Or, they may voluntarily alter their behavior, as when a rancher refuses to sell land to a

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[4] Researchers have found that environmental values typically increase as people learn more about the environment, the services it provides, and environmental degradation. *See,* for example, Blomquist, G.C. and J.C. Whitehead. 1998. "Resource Quality Information and Validity of Willingness to Pay in Contingent Valuation." *Resource and Energy Economics*, 20: 179-196.

[5] *See*, for example, Daily, G.C. 1997. *Nature's Services: Societal Dependence on Natural Ecosystem*. Washington, D.C.: Island Press.

developer, preferring instead to keep the land as ranchland for future generations. Both of these actions can influence jobs and income.

We describe the competing demands for a reason: to drive home the message that there are multiple pathways via which Montana's water resources generate jobs and incomes and competition among them means that, as water resources generate jobs and income along one pathway, jobs and income that otherwise would materialize along another are forgone. In the language we used in Technical Memorandum 2.2, the jobs and incomes resulting from irrigation can be offset by negative externalities on jobs and incomes elsewhere in the economy. We emphasize, as we did in Technical Memorandum 2.2, that irrigation also can generate positive externalities. These are sometimes known as irrigation's complementary impacts on jobs and income.

B. The Economy's Dynamic Adaptability

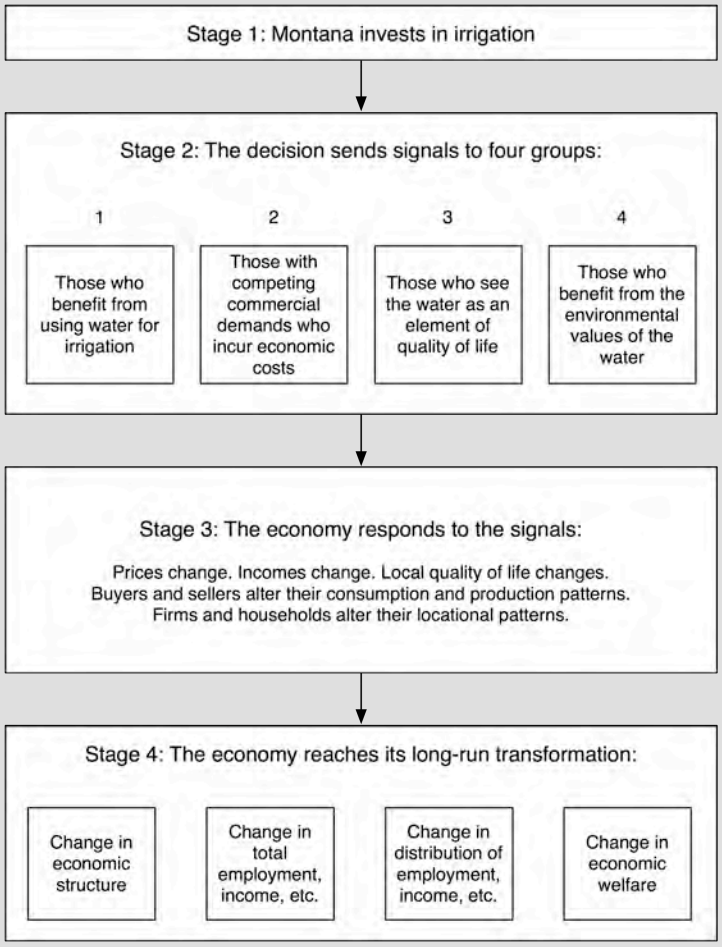
Changes in irrigation can effect strong responses in Montana's local, and statewide economies, in both the short and the long run. These response can materialize, more or less symmetrically, with increases or decreases in irrigation. These response will occur in four general stages, shown in Figure 2, where, for convenience, we focus on increase in irrigation resulting from an investment. The stages of the economy's response will be similar whether the investment aims to prevent dilapidation of an existing irrigation system or to create new irrigation capacity.

In Stage 1, a decision to invest in irrigation is made and, in Stage 2, this action sends economic signals to the local and statewide economies (and also the larger regional, and national economies), indicating a change in the economic role of water resources. The signals have four major destinations, which correspond to the four competing demands for water represented in Figure 1. Although Figure 2 shows Stages 1 and 2 occurring as a single, abrupt event, they generally transpire over a longer period.

Stages 3 and 4 illustrate the dynamic character of the economy's response to the decision to invest in irrigation. In Stage 3, the economy responds to the economic signals and specifically to anticipated or actual changes in prices, income, or both triggered by the investment decision. For example, if the investment results in increased production of an irrigated crop, such as potatoes, it might cause the crop's price to fall, lowering the income of potato growers elsewhere. If it results in increased demand for farm machinery, and increased supply of boating opportunities on a reservoir, but diminished opportunities for river kayaking, the workers, businesses, and governmental entities would adjust accordingly. Farm-machinery and motor-boat businesses might expand, a business selling kayaks might close. Some households that place a premium on reservoir boating might relocate to the area, while some that want to live near kayaking opportunities may relocate elsewhere.

In Stage 4, prices and incomes reach their new levels, and the economy exhibits the long-run effects of the adoption of the irrigation-investment decision. (The long-run adjustment may entail feedback loops, through which changes in prices and incomes may influence future decisions affecting water management, irrigated agriculture, and other segments of the economy.) Alterations in the structure of the economy will occur locally and statewide. The precise path through Stages 3 and 4 will depend, not just on the characteristics of the decision itself, but also on the multiple economic forces and trends that are continuously altering and shaping the economy. Most markets, including those for property and labor, should adjust quickly, and they may even adjust in anticipation of the decision. The adjustment may take longer if national markets are depressed, however. A national recession may make it more difficult for workers who lose their jobs because of the investment to find replacement jobs; deflationary conditions in housing markets, such as the current collapse of the housing bubble, may make it more difficult for households to sell their current homes and purchase new ones.

Figure 2. The General Process by Which Investment in Irrigation Leads to Changes in the Economy



Source: ECONorthwest

C. The Economic Base Model of Economic Impacts: an Approach That Doesn't Work

Measuring the impacts of a change in irrigation, in the context of a dynamic economy, is difficult. Consequently, many analytical tools for assessing economic impacts make powerful, simplifying assumptions. This is especially true of the economic-base model. Because it is so frequently applied, and yields results so misleading, we single it out.

An economic-base model divides the state's economy into two sectors: the export sector, which produces goods and services sold to buyers elsewhere, and the "local" sector, which sells its products inside the state. Proponents of the economic-base model conclude that, because the export sector brings in money that is spent on local goods, it is the "economic base" that "supports" the local sector. With such models, the fate of the state's economy is in the hands of outsiders: the welfare of Montanans can improve only if outsiders buy more of the state's exports. Montana's agricultural industry typically exports its products to other regions or countries and, hence, proponents of the economic-base approach conclude that this industry plays a "basic" role in sustaining the state and its communities. Operationally, the model often includes a snapshot of the economy, in the form of an input-output matrix, showing the pattern of transactions among different sectors of the economy at a given point in time.[6] The matrix is used to trace how an increase or decrease in irrigation would ripple through the economy if the pattern of these transactions remained unchanged.

These core characteristics of economic-base models are its fundamental weaknesses. According to the model, agriculture is one of the state's major, basic industries and expansion or contraction would necessarily lead to proportionate expansion or contraction in the state's other industries. Instead, as we show below, the state's overall levels of jobs and income in Montana have grown over the years as jobs and income in the agricultural industry have, if not fallen, then not kept pace. This reversal of the model's prediction arises from three major factors. One, the economic-base model does not recognize the potential for local entrepreneurs and firms to develop new business activities that would generate growth. Instead, it sees growth occurring only from outside sources. Thus, the economic-base model is unable to foresee the emergence of the state's high-technology industry, which industry representatives estimate now employs more than 10,000 workers—more than 3 percent of statewide employment—with an annual payroll of $429 million.[7]

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[6] The input-output matrices often are derived from IMPLAN data sets compiled by Minnesota IMPLAN Working Group, Inc. (http://www.implan.com/).

[7] AeA (formerly the American Electronics Association). 2007. "About the AeA Washington Council." Retrieved February 28, 2008, from http://www.aeanet.org/AeACouncils/WA_AboutUs.asp

Two, it focuses on industries, and, hence, the model cannot see non-industrial, mechanisms of economic growth. In particular, it does not recognize the potential for Montana's natural-resource amenities to generate growth by attracting households and investment. Some evidence indicates this source of growth is as important as growth that originates with industrial investments, and it will become more important in the foreseeable future.[8]

Three, the model does not account for competition. The model predicts that an expansion of irrigation would increase jobs but it does not anticipate that, under full-employment conditions, if the expansion in irrigation did not occur, the workers would be working elsewhere. The new jobs can be filled only if existing jobs become vacant, and the net impact on jobs would certainly be smaller than the number of new jobs, and perhaps near zero.

In sum, a change in irrigation would have both positive and negative impacts on jobs and income. Estimates of the impacts derived from an economic-base model necessarily are fundamentally flawed and biased: they overestimate the positive impacts of an expansion in irrigation and underestimate the negative impacts. Conversely, they overestimate the negative impacts and underestimate the positive impacts of a contraction in irrigation. Because of these flaws, we do not report the findings of past studies that have employed the economic-base model

II. Irrigation-Related Jobs and Income: Past and Present

In this section we first give an overview of irrigated agriculture in Montana and how it has evolved. We then the summarize available information regarding irrigation-related jobs and income.

A. Irrigated Agriculture in Montana

Irrigation is, without a doubt, the most dominant commercial use of the state's water resources. The U.S. Geological Survey reports that, in 2000, Montana's irrigators withdrew over 11 million acre-feet of water, which represents about 96 percent of all surface and ground water withdrawn for any purpose.[9] Figure 3 shows that irrigation is used primarily to produce hay and pasture, but also barley, wheat, sugar beets, corn, potatoes, and other crops. Although some hay, pasture, barley, and wheat is irrigated, considerable production comes from non-irrigated lands. The percents shown in Figure 3 are rough approximations, derived from a survey of farmers and ranchers that asked respondents to

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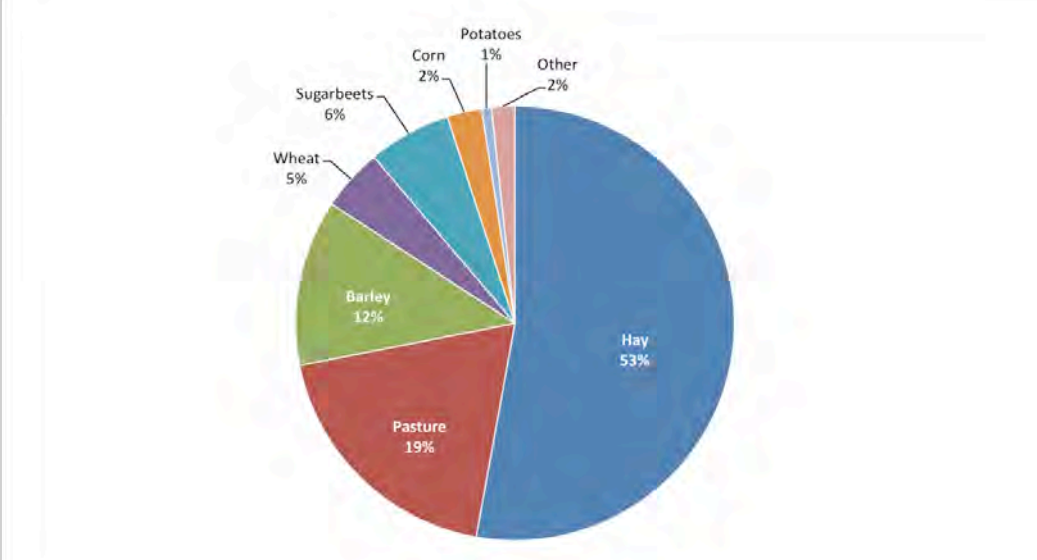
[8] Partridge, M. and D. Rickman. 2003. *See* footnote 3.

[9] Cannon, M.R. and D.R. Johnson. 2004. *Estimated Water Use in Montana 2000.* U.S. Department of the Interior, U.S. Geological Survey, and the Montana Department of Natural Resources and Conservation. Scientific Investigations Report No. 2004-5223. Retrieved February 7, 2008, from http://pubs.usgs.gov/sir/2004/5223/pdf/sir2004_5223.pdf

Figure 3. Percent of Irrigation Water Applied by Crop[a] in Montana, 2003



Source: ECONorthwest, with data from U.S. Department of Agriculture, National Agricultural Statistics Service. 2004. *Farm and Ranch Irrigation Survey (2003)*. Volume 3, Special Studies, Part 1. 2002 Census of Agriculture. Report No. AC-02-SS-1. November.

[a] Hay includes alfalfa and other hay varieties; Corn includes seed and silage varieties; Other includes soybeans, dry edible beans, other grains, vegetables, orchards, and other crops.

estimate the quantity of water they applied in 2003. The survey results indicate that 72 percent of all irrigation water in Montana is applied to irrigate hay and pastureland. Only about 18 percent of all harvested cropland in the state is irrigated.[10]

Two sets of data report the number of irrigated acres in Montana over time. The U.S. Geological Survey (USGS) publishes data on water use, including an inventory of irrigated acres, for each state every five years. Data from the these reports show that, overall irrigated acreage fell about 14 percent between 1960 and 2000, with a steep decline occurring during the 1980s.[11] Another source of data on irrigated acres in Montana comes from the Census of Agriculture. These data show that irrigated acres remained largely constant over roughly the same period, between 1959 and 2002. Figure 4 shows the long-term trend in irrigated acres in Montana since 1960, as reported by both the USGS and the Census of Agriculture. Differences between the two data sources likely differ due to the methodology each uses to determine the number of irrigated acres: the Census of Agriculture relies on farm operator survey responses, statistically adjusted to

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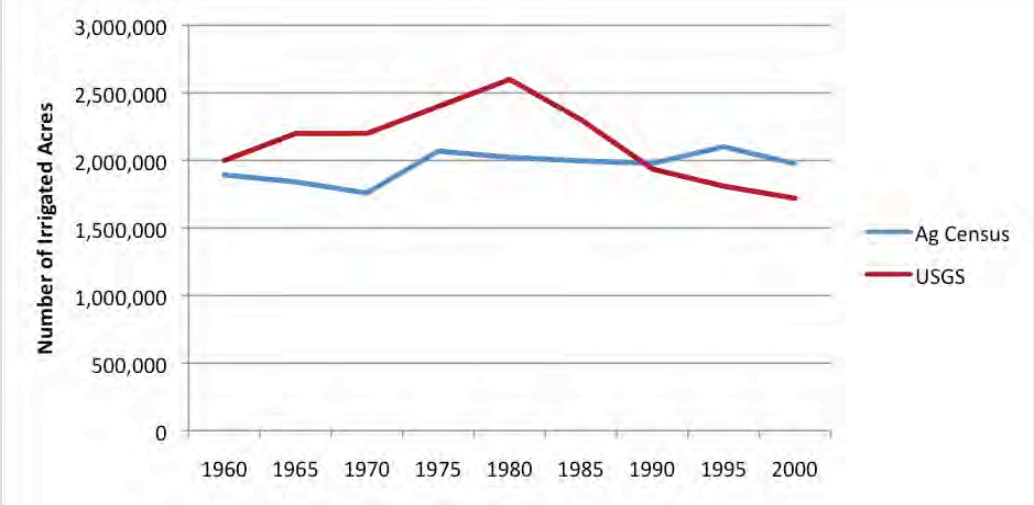
[10] U.S. Department of Agriculture, National Agricultural Statistics Service. 2004. *2002 Census of Agriculture: Montana, State and County Data.* Vol. 1, Geographic Area Series Part 26. AC-02-A-26. Table 23. June.

[11] United States Geological Survey. 1961-2004. *Estimated Use of Water in the United States* [Reports for 1960 to 2000]. Retrieved May 27, 2008, from http://water.usgs.gov/watuse/50years.html

Figure 4. Irrigated Acres in Montana from 1960 to 2002



Source: ECONorthwest, with data from the U.S. Department of Agriculture, National Agricultural Statistics Service. 2004. *2002 Census of Agriculture: Montana, State and County Data.* Vol. 1, Geographic Area Series Part 26. AC-02-A-26. Table 1. June; U.S. Department of Commerce, Census Bureau. *U.S. Census of Agriculture* [for years 1958 and 1964]; and United States Geological Survey. 1961-2004. *Estimated Use of Water in the United States* [Reports for 1960 to 2000]. Retrieved May 27, 2008, from http://water.usgs.gov /watuse/50years.html

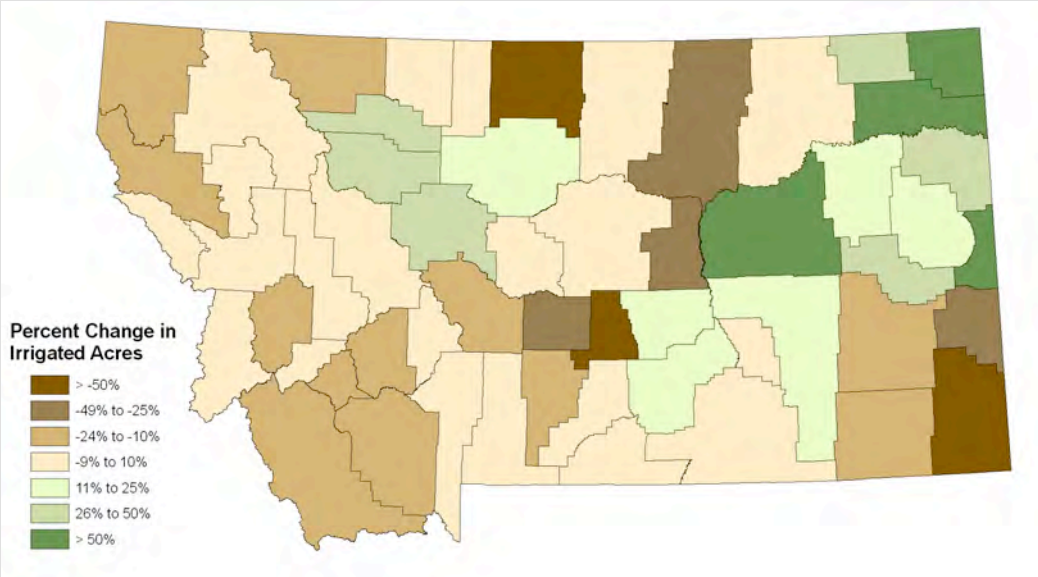
account for nonresponse and other errors; the USGS derives its estimates from data provided by state and federal crop reporting programs and water right records. USGS scientists familiar with the water use data reported for Montana suggest that the data from recent USGS reports probably underestimate the irrigated acreage, because irrigated pasture is not included in the total acreage and data from older USGS reports probably overestimate the irrigated acreage, because acres were derived from water right records, and not ground-truthed for accuracy.[12] Correcting for these under- and over-estimates over time would likely align the USGS data more closely with the Census of Agriculture data. The USGS is considered by many to be the authoritative voice regarding water use data. In this case, though, the report of a large decline in acreage since the 1980s is not consistent with its own irrigation water use data, which indicate withdrawals for irrigation decreased by only 4 percent between 1985 and 2000.[13]

[12] Personal communication with Fred Bailey, United States Geological Survey, Montana Water Science Center. May 29, 2008.

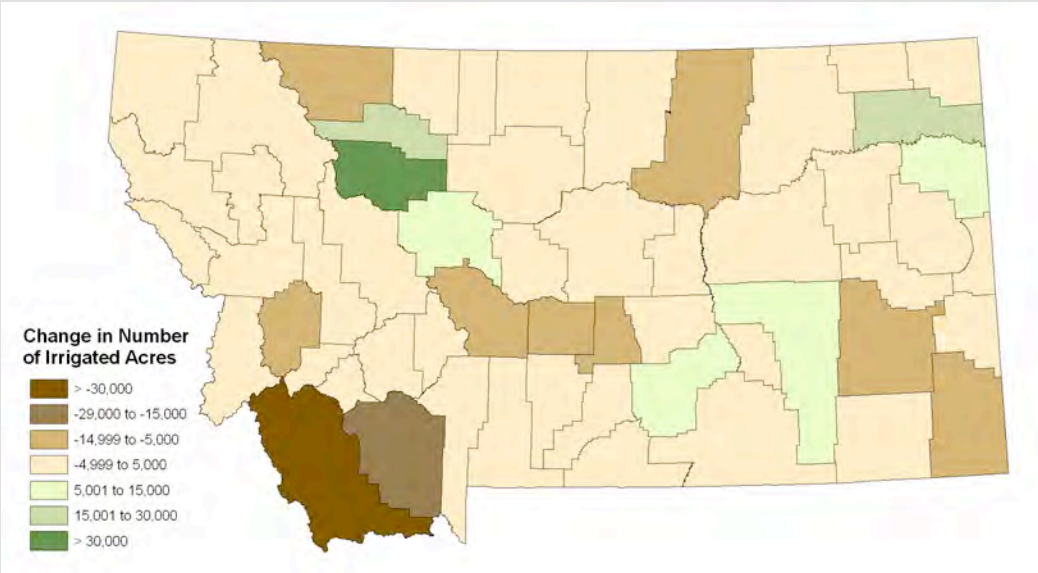
[13] United States Geological Survey. 1961-2004. *See* footnote 11.

Figure 5 shows the percent change and change in number of irrigated acres by county between 1987 and 2002, using data from the Census of Agriculture. For most counties (those in light beige on the maps in Figure 5), the overall change in irrigated acres is not great. Counties with more substantial declines are concentrated in the southwestern and southeastern regions of the state, and it is likely that drought has contributed to these losses. The loss of irrigated acres in

Figure 5. Change in Percent and Number of Irrigated Acres by County, 1987 to 2002



Source: ECONorthwest, with data from U.S. Department of Agriculture, National Agriculture Statistics Service. 1992-2002. *Census of Agriculture*.



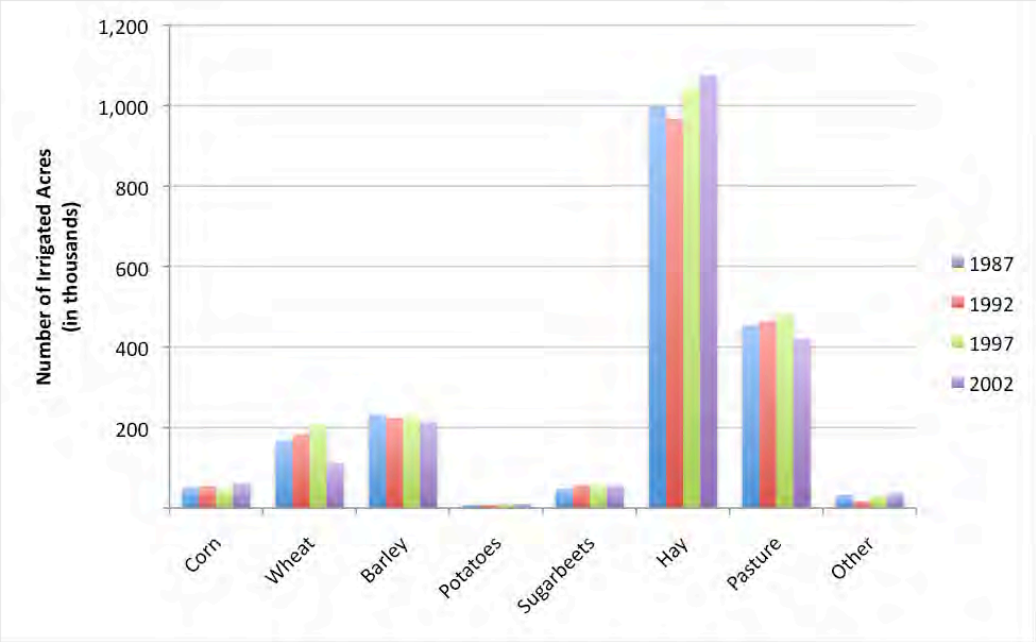
Source: ECONorthwest, with data from U.S. Department of Agriculture, National Agriculture Statistics Service. 1992-2002. *Census of Agriculture*.

counties throughout the western region of Montana is likely also due to the transition from agricultural to recreation-based economies that these counties have experienced in recent years (for more discussion of these trends, see the Bitterroot Case Study in *Technical Memorandum 2.5 – Case Studies*). Irrigated acres in some counties, particularly in the central and northeastern regions of the state have increased. The increases in counties where the lower Missouri and lower Yellowstone Rivers flow, including Richland, Roosevelt, Rosebud, Prairie, and Wibaux counties is potentially related to the state's water reservations for irrigated agriculture in these rivers (for more discussion of these trends, see the Lower Yellowstone and Lower Missouri River Case Study in *Technical Memorandum 2.5 – Case Studies*). The increase in Teton, Cascade, and Pondera counties, in the central part of the state, is likely driven by several well-run irrigation systems, operated by irrigation districts and companies, which have been able to increase efficiencies and bring more acres under irrigation (for more discussion of these trends, see the Greenfields Irrigation District Case Study in *Technical Memorandum 2.5 – Case Studies)*.

Figure 6 shows data from the Census of Agriculture on irrigated acreage, by crop from 1987 to 2002. The acreage remained fairly constant for corn, potatoes, and sugar beets, but declined for barley and rose then fell for wheat and pasture. Irrigated acreage of hay fell, but then increased in recent years. More broadly, these data show that there haven't been any major increases or decreases in any type of irrigated crop over the last two decades.

Table 1 shows the cash receipts farmers received from selling different crops in 2006. Wheat was by far the largest revenue generator, but the majority of the

Figure 6. Irrigated Acres, by Crop, 1987 to 2002



Source: ECONorthwest, with data from the U.S. Department of Agriculture, Census of Agriculture for years 1987 to 2002.

Table 1. Cash Receipts from Marketing, by Commodity, 2006

Commodity	Receipts (thousand dollars)
Wheat	$688,415
Barley	$96,561
Sugar beets	$51,778
Hay	$93,642
Potatoes, fall	$28,880
Oil crops	$9,977
Oats	$2,037
Dry beans	$5,846
Corn	$5,198
Cherries, sweet	$1,071
All other crops	$86,572
Total Crops	$1,069,977

Source: ECONorthwest, with data from USDA, National Agricultural Statistics Service, Montana Office. "Cash Receipts from Marketing by Commodities." *2007 Annual Statistical Bulletin.* Retrieved February 28, 2008, from http://www.nass.usda.gov/Statistics_by_State/Montana/Publications/Annual_Statistical _Bulletin/economic.pdf.

state's wheat crop is not irrigated. Sugar beets and potatoes, which require intensive irrigation, generated revenues of $52 million and $29 million, respectively. Corn, another intensively irrigated crop generated $5 million. Sales of livestock and related products, to which irrigated alfalfa, hay, and pasture serve as an important input, generated revenues of $1.3 billion in 2006.

Irrigated lands typically produce crops with higher value than non-irrigated lands: on average, the market value of crops produced on irrigated lands is 64 to 80 percent higher per acre than those produced on dryland.[14] The higher revenues can arise because irrigation increases the yield of a crop: the average yield of alfalfa hay on irrigated land is 3.2 tons per acre, but only 0.9 tons per acre on dry land.[15] Irrigation also may enable a farmer to grow a higher-value crop that cannot be grown on dry land.

[14] U.S. Department of Agriculture, National Agricultural Statistics Service. 2004. *2002 Census of Agriculture: Montana, State and County Data.* Vol. 1, Geographic Area Series Part 26. AC-02-A-26. Table 11. June.

[15] U.S. Department of Agriculture, National Agricultural Statistics Service. 2004. *See* footnote 14. At Table 33.

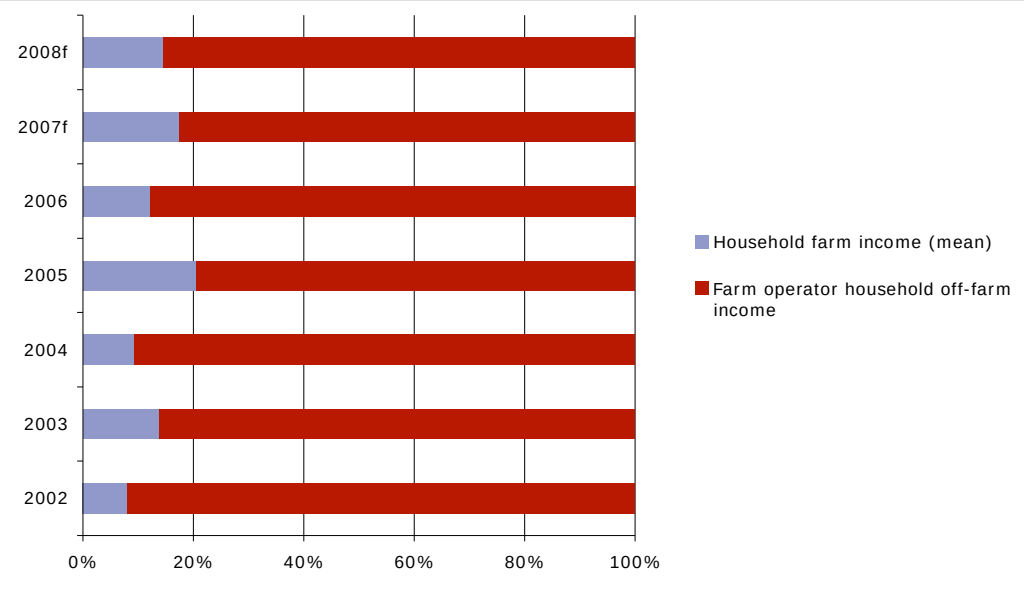
B. Agricultural Jobs and Income

We have found no information that systematically and comprehensively describes the jobs and income associated with irrigated agriculture, separate from those associated with dryland agriculture. As a result, we report data on the current level and recent trends in jobs and income in the farm sector as a whole and in related sectors.

Montana's agricultural industry employed 31,535 people (both full-time and part-time) in 2005. Farm owners and employees earned almost $464 million that year, equal to about 20 percent of the state's total receipts from agricultural sales. For most farmers and ranchers, however, income derived from farm operations is a small proportion of total income. Figure 7 shows that, for the Mountain Region, which includes Montana, farm income was only 20 percent of total income for farm households in 2005.

Figure 8 illustrates how average farm income (the operator's gross earnings from farm operations, before taxes and expenses) varies across the state's counties. In 2002, ten counties—Beaverhead, Glacier, Liberty, Hill, Choteau, Broadwater, Meagher, Wheatland, Musselshell, and Treasure—saw average farm incomes greater than $15,000 per farm. Average farm income was less than $5,000 in seven counties—Lake, Silver Bow, Carbon, Sheridan, Richland, Wibaux, and Fallon. Farm incomes have risen since 2002.

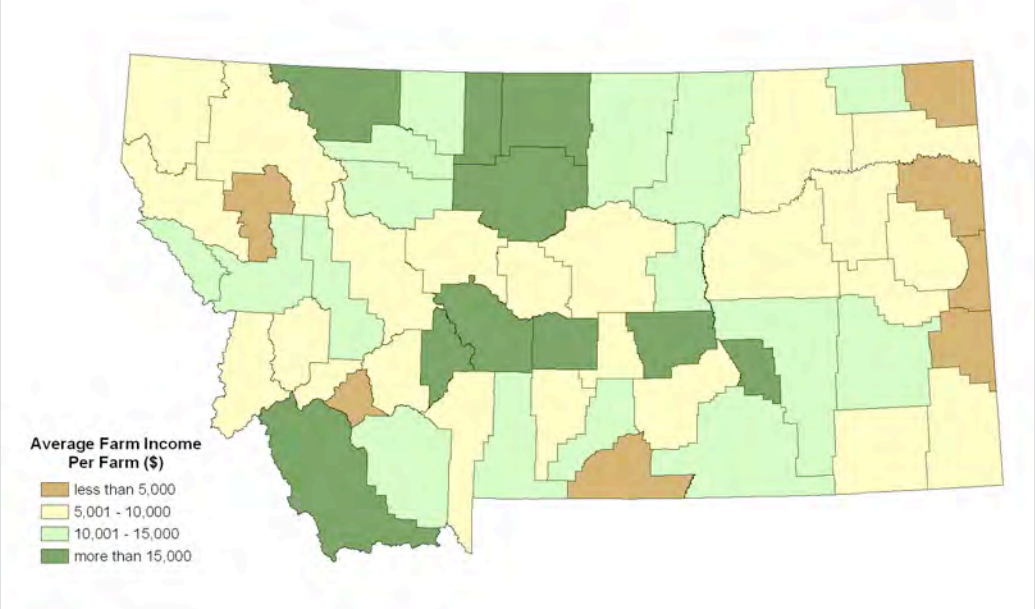
Figure 7 . Farm Income (from Farm Operations) as a Percentage of Total Income of Farm Households, Mountain Region, 2002 to 2008



Source: ECONorthwest, with data from the U.S. Department of Agriculture, Economic Research Service. 2008. *Farm Household Economics and Well-Being: Income Forecast and Income in Perspective.* Retrieved on February 27, 2008, from http://www.ers.usda.gov/Briefing/WellBeing/farmhouseincome.htm

Note: Data for 2007 and 2008 are forecasts.

Figure 8. Average Farm Income per Farm, by County, 2002



Source: ECONorthwest, with data from the U.S. Department of Agriculture, National Agricultural Statistics Service. 2004. *2002 Census of Agriculture: Montana, State and County Data.* Vol. 1, Geographic Area Series Part 26. AC-02-A-26. Chapter 2, Table 6.

Changes in farm employment and income show mixed patterns and trends over the past several decades. Figure 9 shows, for example, that most counties lost farm jobs and farm income between 1970 and 2000.[16] Changes in farm employment seem to mirror more general trends in population across the state: the population in western Montana grew rapidly between 1970 and 2000, and employment, including farm employment grew with it, although at a slower rate; the population in many counties in eastern Montana declined during the same period, leading to overall declines in employment, including farm employment. Figure 10 shows more recent patterns and trends, from 2001 to 2005, in farm employment and farm income.[17] Changes in farm employment were slight, but most counties lost some jobs. Seventeen counties experienced a reduction in farm income.[18]

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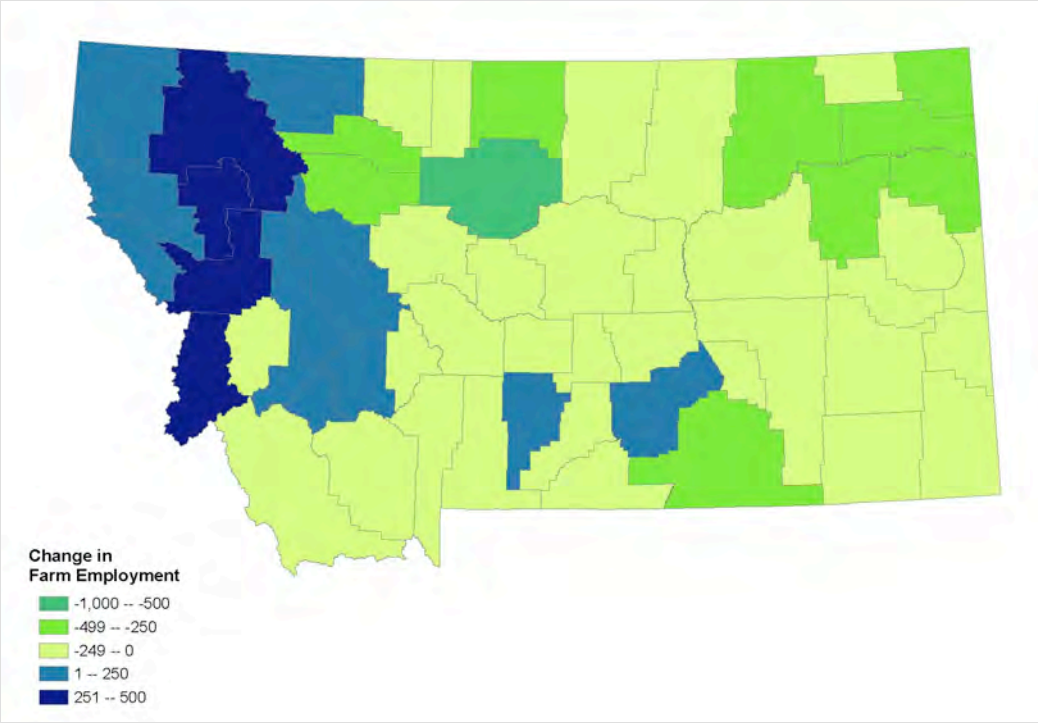
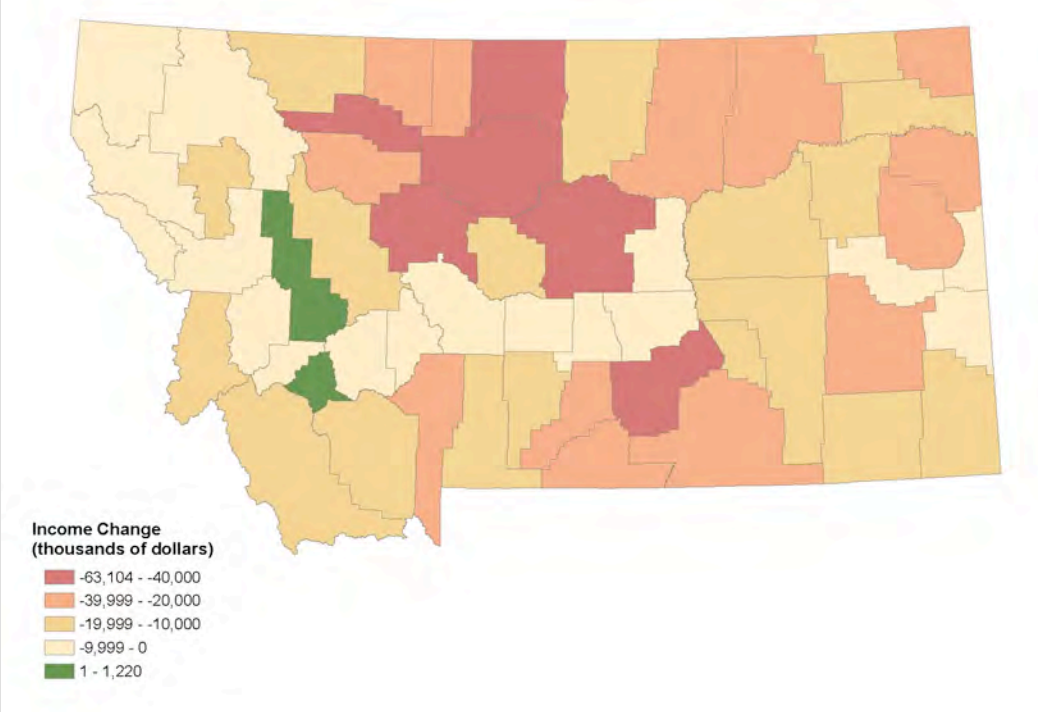
[16] A 2001 change in the categorization of employment and income, by industry makes it difficult, if not impossible, to compare data before with data after that year.

[17] Farm employment means the number of workers engaged in the direct production of agricultural commodities, either livestock or crops, whether as a sole proprietor, partner, or hired laborer. Farm income is comprised of the net income of sole proprietors and the wages, salaries, pay-in-kind, and other labor income of hired farm laborers. Farm income specifically excludes the income of non-family farm corporations.

[18] We performed the comparison of income earned in 1970, 200, 2001, and 2005 in terms of real dollars (2007 $).

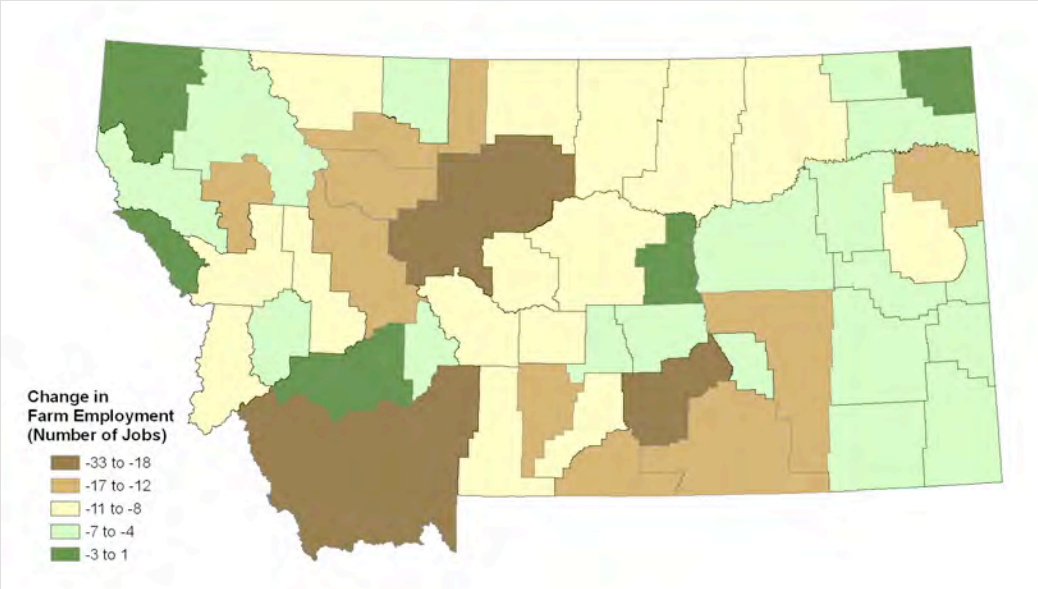
Figure 9. Change in Farm Employment and Income, by County, 1970 to 2000

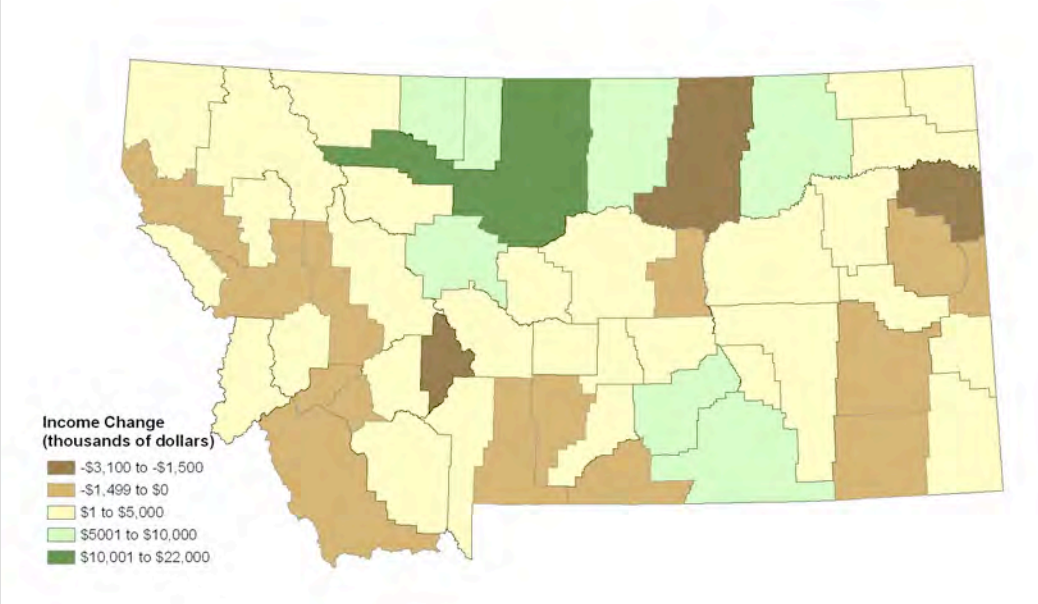




Source: ECONorthwest, with data from U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System. 2007. *Total Employment by Industry*. Tables CA 25 and CA25 (N). Retrieved February 6, 2008, from http://www.bea.gov/regional/reis; and U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System. 2007. *Farm Income and Expenses*. Table CA45. Retrieved February 6, 2008, from http://www.bea.gov/regional/reis.

Figure 10. Changes in Farm Employment and Income, by County, 2001 to 2005



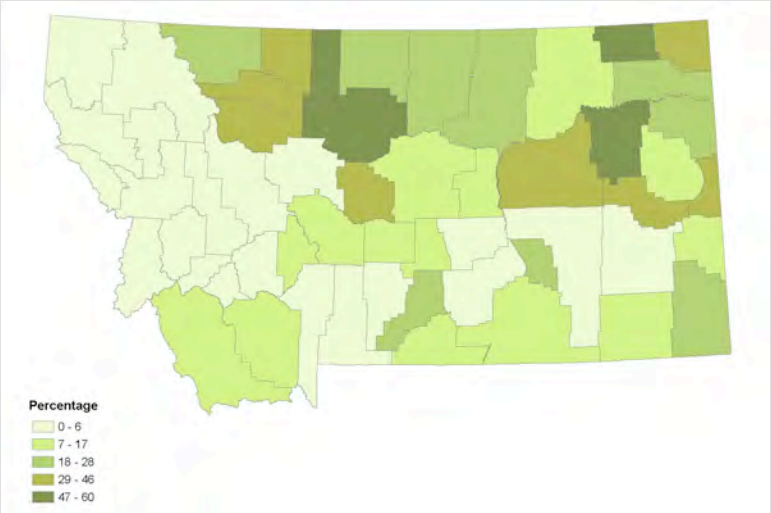


Source: ECONorthwest, with data from U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System. 2007. *Total Employment by Industry*. Tables CA 25 and CA25 (N). Retrieved February 6, 2008, from http://www.bea.gov/regional/reis; and U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System. 2007. *Farm Income and Expenses*. Table CA45. Retrieved February 6, 2008, from http://www.bea.gov/regional/reis.

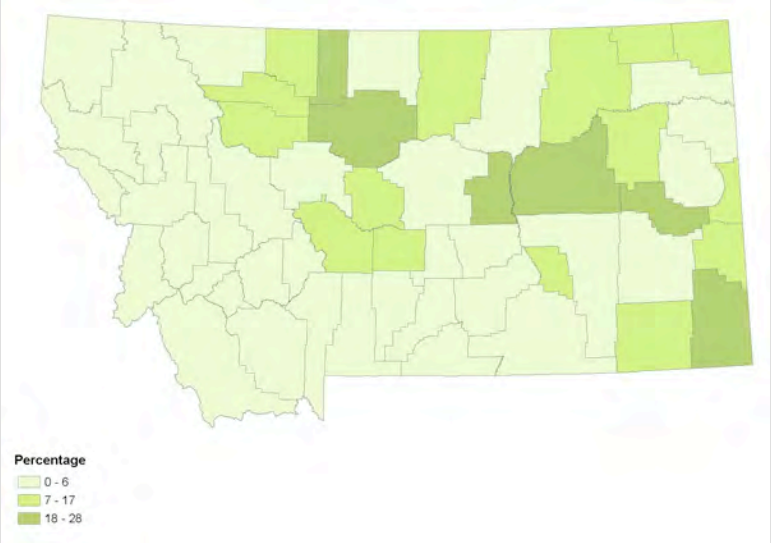
Figure 11 illustrates the contribution farm income makes to total personal income in counties across the state. In 1975, farm income was 29 percent or more in Teton, Pondera, Judith Basin, Garfield, Prairie, Wibaux, and Sheridan counties, and 47 percent or more in Liberty, Choteau, McCone, and Daniels counties. In 2005, farm income was less than 29 percent in all counties. It was 6 percent or less in most counties—all of the western counties and most of the southern counties, except those in the southeast. Farm income as a percent of total income was most stable in the southeastern corner of the state.

Figure 11. Farm Income as a Share of Total Personal Income in Montana, by County, 1975 and 2005

1975

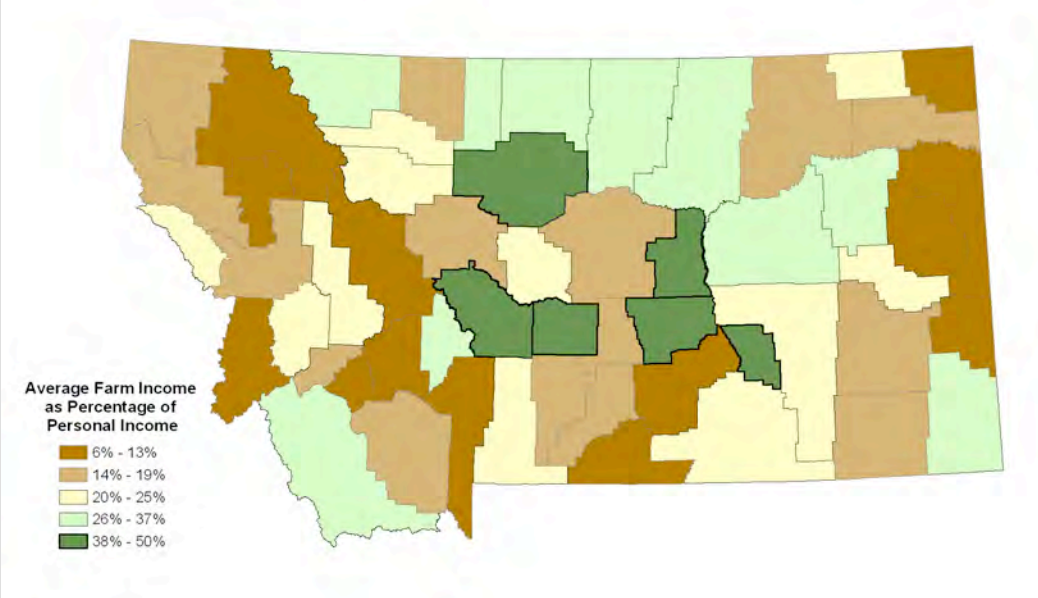


2005



Source: Bureau of Economic Analysis. 2007. *Local Area Personal Income.* Table CA04 Personal Income and Employment Summary. Retrieved February 27, 2008, from http://www.bea.gov/regional/reis/

Figure 12. Average Farm Income as a Percent of Personal Income per Household by County, in 2002



Source: ECONorthwest, with data from 2002 Ag Census; personal income is for 2002, from BEA Table CA05N. Personal income by major source and earnings by NAICS industry; number of housing units for 2002, from the Census, http://www.census.gov/popest/housing/tables/HU-EST2006-04-30.xls; number of households and household units for 2000, from the Census, http://www.census.gov/acs/www/Products/Profiles/Chg/2002/0002/Tabular/040/04000US301.htm

Figure 12 compares average farm income to personal income per household in 2002. In every county, farm income represents less than 50 percent of personal income per household, and in most counties, it represents less than 25 percent.

Data on the average farm income masks considerable variation in income among farms. In 2002, for example, the Census of Agriculture found the average farm income in Montana was $12,569. Slightly less than half the farms had negative farm income that year, though, losing $20,991 on average. Slightly more than half had positive net farm income, averaging $44,967 per farm. These data provide important insights. Not all farms are profitable all the time. Some are not profitable most of the time. The data also suggest using caution when evaluating the potential impacts of a specific, proposed investment in irrigation. One would be wise not to assume that statewide averages will apply to the irrigators that would benefit from the investment. With considerable research, it may be possible to learn that, more likely than not, they would outperform or underperform, relative to the average.

Table 2 provides another portrait of the value of Montana's agricultural production. The top portion shows that farm operations produced crops and livestock for sale as well as some other goods and services, such as food and housing by farm families. In 2006, the total value of the state's farm production was $2.79 billion. The middle portion of Table 2, labeled "Purchased Inputs" shows that the value of these inputs was $1.64 billion. Some of these inputs came

Table 2. USDA's Estimate of Value Added to the U.S. Economy by Montana's Agricultural Sector

ITEM	2002	2003	2004	2005	2006
	Million Dollars				
Value of crop production	761.2	879.3	1,032.7	1,082.7	924.7
Food grains	421.4	433.9	585.6	620.1	688.4
Feed grains	200.1	190.1	186.0	222.5	197.4
Oil crops	9.7	10.8	12.7	12.3	10.0
Fruits	4.8	4.0	5.3	4.9	1.7
Vegetables	36.7	40.0	53.8	63.8	68.6
All other crops	93.2	118.9	98.0	102.1	103.9
Home consumption	3.0	2.5	2.0	1.9	1.5
Value of inventory adjustment 1/	(7.7)	79.1	89.4	55.1	(146.7)
Value of livestock production	961.2	1,067.1	1,232.5	1,341.4	1,285.5
Meat animals	914.3	1,010.4	1,166.4	1,166.0	1,175.7
Dairy products	41.2	42.2	53.7	56.3	45.6
Poultry and eggs	4.8	6.6	6.6	4.1	4.8
Miscellaneous livestock	41.0	49.6	51.7	52.3	53.1
Home consumption	3.3	4.0	4.7	5.5	6.5
Value of inventory adjustment 1/	(43.3)	(45.7)	(50.6)	57.2	(0.2)
Revenues from services and forestry	437.1	424.2	395.0	562.9	581.8
Machine hire and custom work	41.8	40.6	18.6	56.9	43.4
Forest products sold	3.0	3.0	3.0	3.0	3.0
Other farm income	195.9	180.2	125.5	143.1	149.9
Gross imputed rental value of farm dwellings	196.5	200.4	247.9	359.9	385.5
Value of agricultural sector production 2/	2,159.5	2,370.6	2,660.3	2,987.0	2,792.1
(LESS) Purchased inputs	1,294.4	1,323.2	1,235.6	1,422.4	1,642.2
Farm origin	330.2	297.2	244.4	281.6	368.0
Feed purchased	163.8	155.9	114.4	116.5	130.3
Livestock & poultry purchased	106.3	83.2	78.1	98.2	159.5
Seed purchased	60.2	58.1	51.9	66.9	78.3
Manufactured inputs	375.5	360.6	386.6	467.0	500.4
Fertilizers & lime	121.8	104.4	111.6	143.2	154.0
Pesticides	92.7	88.2	92.9	99.2	105.5
Petroleum fuel & oils	118.9	127.6	147.9	183.5	201.4
Electricity	42.2	40.3	34.2	41.1	39.4
Other purchased inputs	588.6	665.4	604.5	673.8	773.8
Repairs & maintenance of capital items	192.9	179.2	186.9	197.3	232.3
Machine hire and custom work	42.0	52.1	45.3	33.6	46.4
Marketing, storage, and transportation expenses	57.3	69.8	62.7	90.6	107.9
Contract labor	15.3	13.3	20.4	18.4	21.1
Miscellaneous expenses	281.1	351.0	289.2	333.9	366.1
(PLUS) Net government transaction	122.5	226.7	148.9	221.0	84.8
+ Direct government payments	262.0	355.8	282.5	381.8	275.3
- Motor vehicle registration and licensing fees	11.4	12.2	12.1	12.3	10.5
- Property taxes	128.0	117.0	121.5	148.5	180.0
Gross value added	987.7	1,274.0	1,573.6	1,785.6	1,234.6
(LESS) Capital consumption	332.0	339.3	366.8	409.4	440.8
Net value added 2/	655.7	934.6	1,206.9	1,376.2	793.9
(LESS) Payments to stakeholders	460.0	453.9	492.1	558.0	537.0
Employee compensation (total hired labor)	153.4	136.2	152.7	178.6	189.8
Net rent received by non-operator landlords	119.9	147.6	170.1	188.1	130.1
Real estate and non-real estate Interest	186.7	170.2	169.3	191.2	217.2
Net farm Income 2/	195.7	480.7	714.8	818.2	256.8

1/ A positive value of inventory change represents current-year production not sold by December 31. A negative value is an offset to production from prior years included in current-year sales.

2/ Value of agricultural sector production is the gross value of the commodities and services produced within a year. Net value-added is the sector's contribution to the National economy and is the sum of the income from production earned by all factors-of-production, regardless of ownership. Net farm income is the farm operator's share of income from the sector's production activities. The concept presented is consistent with that employed by the Organization for Economic Cooperation and Development.

SOURCE: Economic Indicators of the Farm Sector, State Income and Balance Sheet Statistics, UDSA—ERS

Source: USDA, National Agricultural Statistics Service, Montana Office. *2007 Annual Statistical Bulletin.* Retrieved February 28, 2008, from http://www.nass.usda.gov/ Statistics_by_State/Montana/Publications/ Annual_Statistical _Bulletin/economic.pdf

from within Montana, some came from other states. The bottom portion of the table, labeled "Capital Consumption" and "Payments to Stakeholders" shows that, after accounting for the consumptions of farm capital, payments to labor, and adjustments for rent and other real estate concerns, the net value of the state's farm production, also known as net farm income, was almost $257 million.

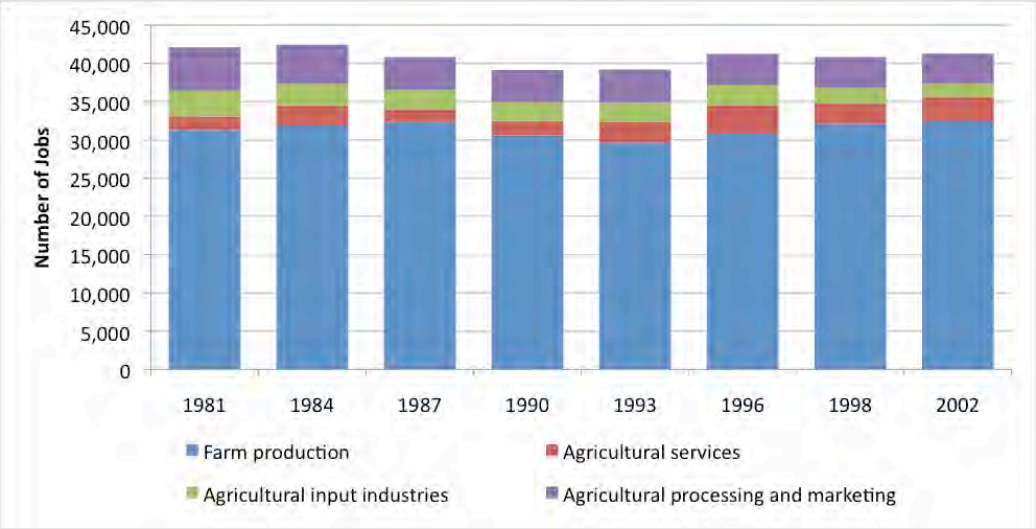
C. Jobs and Income in Related Sectors

As farm operations purchase inputs they generate jobs for the providers of those inputs. Figure 13 illustrates the magnitude of these jobs, in Montana, relative to on-farm jobs. Jobs in input industries fall into two categories: agricultural services and agricultural input industries. The former includes services from legal and financial advisors, farm-maintenance and repair providers, and similar vendors. The latter includes purchases, such as seed and farm equipment.

Figure 13 also includes jobs in Montana in industries that directly process and market agricultural products. The data show that, in general, on-farm jobs account for about 80 percent of the total, the two input categories, combined, for about 10 percent, and the processing/marketing industries for about 10 percent. During the period shown, on-farm jobs and jobs in agricultural services have grown relative to the others: farm production grew by almost 4 percent and agricultural services increased by over 44 percent. Jobs in processing and marketing have declined by 44 percent and 94 percent, respectively. In 2004, less than 10 percent of Montana exports were in a processed or value-added form.[19]

Some past studies of farm-related jobs have a broader perspective. They reasoned that the expenditures of the input industries would create additional jobs, as would the expenditures of farm families, farm workers, and the

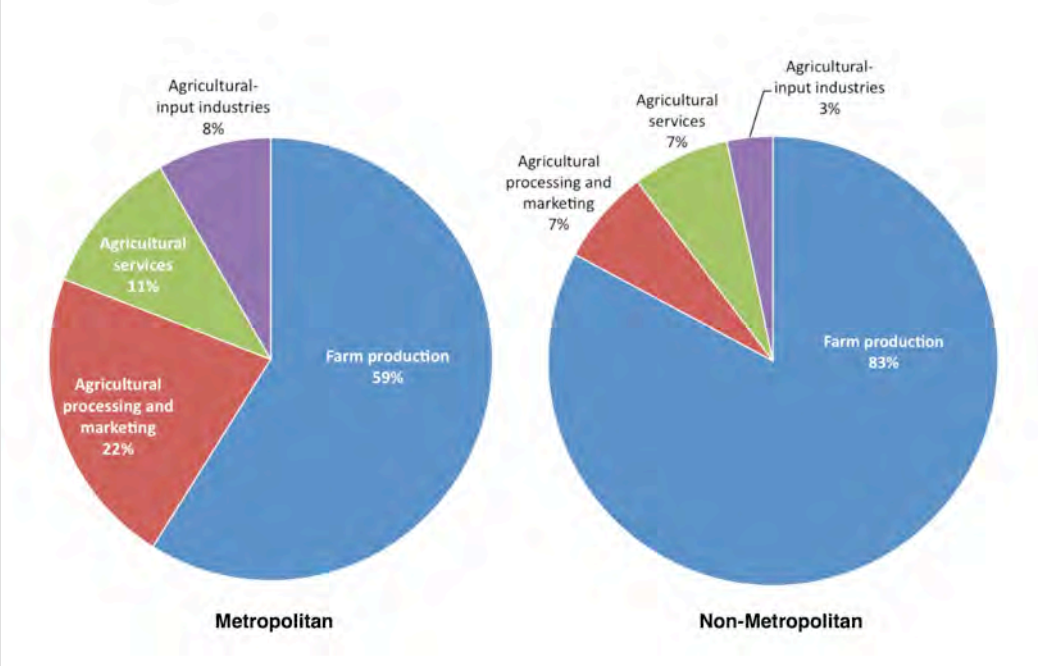
Figure 13. Farm and Farm-Related Employment in Montana, 1981 to 2002



Source: ECONorthwest, with data from USDA, Economic Research Service. 2005. *Farm and Farm Related Employment.* Retrieved February 27, 2008, from http://www.ers.usda.gov/Data/FarmandRelatedEmployment/ViewData.asp?GeoAreaPick=STAMT_Montana

[19] Kiwi TB Inc. 2006. "Chapter 4: Montana's Agricultural and Food Industry." In *Unlocking the Food Buying Potential of Montana's Public Institutions: Towards a Montana-Based Food Economy.* The National Center for Appropriate Technology—Grow Montana. July. Retrieved February 29, 2008, from http://www.growmontana.ncat.org/unlocking.php

Figure 14. Metropolitan versus Non-Metropolitan Farm Employment and Farm-Related Employment, 2002



Source: ECONorthwest, with data from USDA, Economic Research Service. 2005. *Farm and Farm Related Employment.* Retrieved February 27, 2008, from http://www.ers.usda.gov/Data/FarmandRelatedEmployment/ViewData.asp?GeoAreaPick=STAMT_Montana

employees of the input industries. The firms and workers benefiting from these expenditures would, in turn spend their income, creating even more jobs, and the process would continue until eventually it would peter out. The tool for tracing the these so-called ripple effects on jobs (and income) is known as an input-output matrix. It also calculate the multiplier, i.e., the ratio of the total number of jobs linked directly or indirectly to farm operations to the number of on-farm jobs. A wide body of research conducted across the U.S. indicates that multipliers usually are about two. This indicates that, for every on-farm job, the ripple effects generate additional employment in the state equivalent to roughly one more job. Multipliers applicable to substate regions, counties, or communities, are smaller.

Figure 14 shows the distribution of farm jobs and farm-related jobs between the state's three metropolitan areas—Billings, Great Falls, and Missoula—and the remainder of the state. Overall, the non-metropolitan areas have the bulk of the on-farm and farm-related jobs. The metropolitan areas, however, have a greater concentration of farm-related jobs.

III. External Impacts on Jobs and Income

In this section we discuss the potential impacts on jobs and income that arise from irrigation's externalities affecting commercial interests (other than those related to agriculture), quality of life, and environmental values. These impacts

generally are easier to understand in concept than to quantify. Hence, we offer the following discussion anticipating that it will help Montanans, not by providing precise measurements of external impacts, but by enhancing their understanding of the multiple interactions between agriculture, especially irrigated agriculture, and some major forces at play in the overall economy.

A. External Impacts on Commercial Sectors

Irrigation can have positive or negative impacts on jobs and income through the externalities it creates for commercial interests other than those related to agriculture. We provide background information regarding those that might materialize through subsidies to irrigated agriculture; supplying water for municipal, domestic, and industrial water users; and the recreation industry.

1. Subsidies

Montana specializes in the production of a few commodities and has experienced little diversification in the past few decades.[20] The three leading crops—hay, wheat and barley—can be grown without irrigation. Both technological advancements and federal farm policy, however, have allowed the state's farmers to branch out recently and grow crops new to the region. Researchers developed a new type of corn that can grow in an environment with a shorter growing season, for example, while past farm bills have provided incentives for farmers to grow sugar beets.[21] Both corn and sugar beets require extensive irrigation, placing additional demands on Montana's water resources.

Countering these trends toward diversification and expansion of irrigated agriculture are some other powerful factors, most notably the conversion of agricultural land to nonagricultural uses, increases in the costs of fuel and other inputs, and the deterioration of irrigation infrastructure. In concept, the adoption of more efficient irrigation technology might enable ranchers and farmers to produce the same amount of forage and crops on the smaller areas that remain in production as development occurs and costs increase, but doing so probably would lower jobs and income even further. The irrigation technology most widely employed in the state has changed little for decades. Landowners divert water from a stream into a canal, then open gates on the canal so water floods over the land. This flood-irrigation technology persists because landowners incur lower costs with it than they would with alternatives, such as computerized sprinklers. All else equal, any transition to alternative technology probably would impose higher costs on irrigators. Absent subsidies to cover these additional costs, some landowners would see less incentive to resist offers to take land out of agricultural production and sell it for residential development. Such

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[20] Smith, V.H. No date. *The Changing Role of Agriculture in Montana's Economy: 1965-2005.* Montana Department of Fish, Wildlife, and Parks. Retrieved February 8, 2008 from http://fwp.mt.gov/content/getItem.aspx?id=30180

[21] Smith, V.H. No date. *See* footnote 20.

sales would eliminate even more irrigation-related jobs and income. Alternative irrigation technologies offer no guarantee for sustaining jobs and income, however, as they tend to substitute capital for labor.

In sum, strong economic pressures are pushing down irrigation-related jobs and income. These pressures might be offset if agriculture prices were to jump to high levels and remain there. Over the last year, farmers have received record prices for some crops, such as wheat, corn, and soybeans. The U.S. Department of Agriculture (USDA) identifies a handful of different factors, some long-term and some short-term, that are contributing to the current high prices. Among the long-term trends are a decline in the rate of growth in production and a more rapid growth in demand, particularly from developing countries. Short-term factors include adverse weather conditions in 2006 and 2007, and the recent rapid rise in oil prices, increasing the costs of production and transportation of commodities.[22] Changes in one or several of these trends could relieve some of the pressure currently on commodity markets, causing prices to moderate. This rise represents the latest upward trend in food commodity prices. Such rises in price have historically returned to previous price levels within a few years, and the same will probably hold true this time as the markets adapt to new conditions and global competition in the agricultural sector continues to increase. Even trends associated with crops that can be used to produce biofuels and that have contributed to tremendous increases in their prices may come to an end, considering the results of new studies showing that biofuels, especially those made from corn, may not decrease the greenhouse gases by as much as previously thought, and may even increase them.[23] Should such studies deter further expansion of the biofuel industry, the demand for and prices of corn and other crops likely will decrease before too long.

Thus, it appears that future declines in irrigation-related jobs and incomes will be avoided only if irrigators receive sufficient financial assistance—subsidies—to sustain, or even expand production. Subsidies can occur through federal programs that support the earnings of farmers and ranchers; and state programs that underwrite the costs of reservoirs and other facilities. Subsidies may be motivated by a desire to accomplish several objectives, including these: to sustain farm jobs, incomes, and communities; to maintain landscapes associated with traditional ranching; to increase the supply of complementary goods and services, such as return flows from flooded fields that recharge shallow aquifers; and to guard against possible encroachment by other states on Montana's water. These benefits, though, would come at a cost, not just of the subsidies themselves, but also of any adverse effect on competing demands for water resources. In the past, many of the costs associated with subsidies came from the

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[22] U.S. Department of Agriculture, Economic Research Service. 2008. *Global Agricultural Supply and Demand: Factors Contributing to the Recent Increase in Food Commodity Prices.* Report No. WRS-0801. May Retrieved May 2, 2008, from http://www.ers.usda.gov/publications/wrs0801/

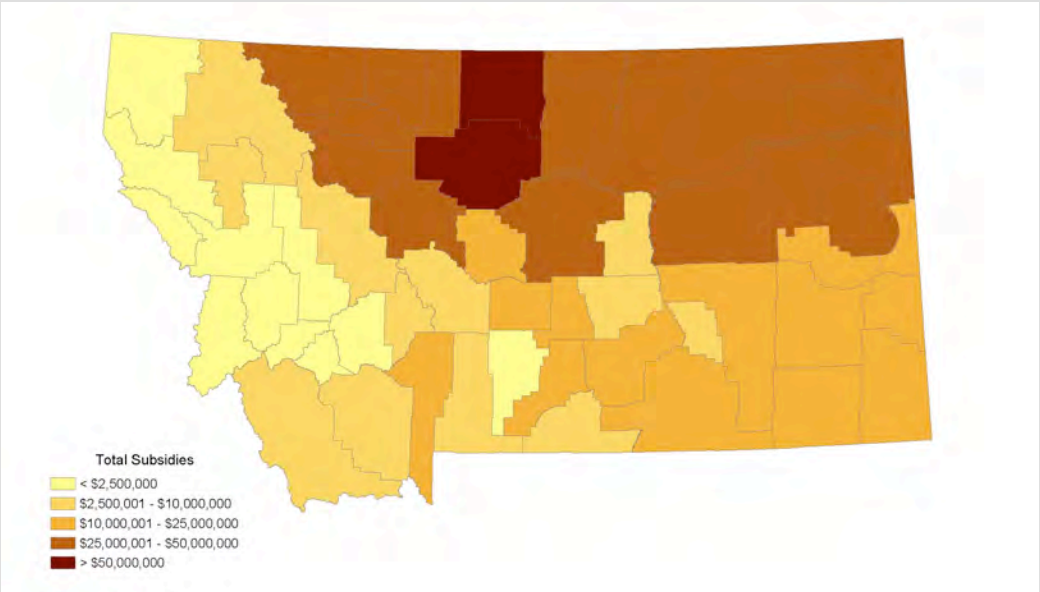
[23] United Nations-Energy. 2007. *Sustainable Bioenergy: A Framework for Decision Makers.* Retrieved February 26, 2008, from http://esa.un.org/un-energy/pdf/susdev.Biofuels.FAO.pdf

federal government and were borne by taxpayers, businesses, and households in other states. To the extent that future subsidies are provided by the state, then so too will the negative impacts on jobs and income that accompany transfers of money from taxpayers, businesses, and households to irrigators.

Figure 15 shows the extent to which farmers and ranchers in the state received cash from federal farm-subsidy programs between 2003 and 2005. Some subsidies are for conservation activities, such as protecting riparian (streamside) areas. Others sustain commercial operations by offsetting losses from drought, storms, and other disasters, and supporting production of farm commodities. Additionally, Montana's ranchers currently receive federal subsidies in the form of reduced costs for grazing permits. Recent data indicate livestock producers pay about $14 per AUM less for grazing on federal lands than they would if federal agencies charged grazing fees the same as those the State of Montana charged for grazing on state-owned lands.[24]

The overall impact from subsidies on jobs and income could be positive or negative. Considerable evidence suggests that, more likely than not, the overall impact would be negative. This is especially the case with subsidies provided by the state. In general, providing a subsidy to irrigated agriculture would entail

Figure 15. Payments from Federal Farm-Subsidy Programs by County, 2003 to 2005[a]



Source: ECONorthwest, with data from the Environmental Working Group. 2006. "Farm Subsidy Database." Retrieved February 29, 2008, from http://www.ewg.org/farm/

[a] All values adjusted to 2007 dollars.

[24] U.S. General Accountability Office. 2005. *Livestock Grazing: Federal Expenditures and Receipts Vary, Depending on the Agency and the Purpose of the Fee Charged*. September.

transferring funds to irrigated agriculture, which exhibits a low ability to generate higher levels of jobs and income, from other sectors that exhibit a higher ability to do so. Thus, the overall impact is likely to be a net loss of jobs and income for the state as a whole. This general conclusion might not apply to a specific proposal to subsidize irrigated agriculture, or there may be other important reasons for subsidizing a specific irrigation system. Economists who reviewed a proposal to rehabilitate the St. Mary Diversion Project, for example, concluded that the project would not only extend the supply of water for local farmers but also ensure water supplies for municipal and domestic users and create job opportunities in a part of the state where few opportunities exist.[25]

Whatever the overall impact of future subsidies, they will stimulate jobs and incomes in areas and businesses linked to the recipients. It is impossible to predict what the future pattern will be. To the extent that they sustain community institutions, the subsidies may have the ancillary benefit of sustaining relationships that enable the community's residents to accomplish commercial and other tasks more efficiently, increasing the likelihood that jobs and income will remain in the community.

2. Municipal, Domestic, and Industrial Water Users

Some of the state's irrigation systems provide water for municipal, domestic, and industrial users. As a consequence, these users enjoy access to water supplies at a cost lower than they would otherwise experience. In concept, the cost savings leave the beneficiaries with more disposable income to spend on other things and, when they do so, they generate jobs and income locally and statewide.

Municipal and Domestic Water Users. According to the U.S. Geological Survey, about 1.5 percent of all water withdrawn and about 3.1 percent of all water consumed, or 178,000 acre-feet per year and 82,000 acre-feet per year, respectively, goes to public and domestic users.[26] We expect that these amounts will increase over time. In the next decade, Montana's population is estimated to exceed 1 million people, reaching 1,083,050 by 2020.[27] Assuming that the levels for public withdrawals per capita and percent of population benefiting from public supplies seen in 2000 remain constant in the future, we estimate that, by 2020, public consumption of water will increase by about 32 percent.[28] Such a

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[25] Bioeconomics. 2006. *St. Mary Diversion & Milk River Project: Preliminary Economic Analysis; Impacts and Benefit-Cost Analysis. Final Report.* August 30. Retrieved December 26, 2007, from http://dnrc.mt.gov/st_mary/reports/tdhpartII/EconReport.pdf.

[26] Cannon, M.R. and D.R. Johnson. 2004. *See* footnote 8.

[27] NPA Data Services Inc. 2006. *Montana Population Projections: Total Population*. November. Retrieved February 7, 2008, from http://ceic.mt.gov/Demog/project/NPAallcounties_1106_web.pdf

[28] Cannon, M.R. and D.R. Johnson. 2004. *See* footnote 8. The authors calculate a per capita rate of water withdrawals of 223 gallons per day for public supplies. Hutson et al. 2004 (Hutson, S.S., N.L. Barber, J.F. Kenny, K.S. Linsey, D.S. Lumia, and M.A. Maupin. 2004. *Estimated Use of Water in the United States in 2000.* U.S. Geological Survey. Retrieved February 7, 2008, from

figure is probably an underestimate since trends have shown that, as people switch from self-supplied sources of water to public sources, they consume more. Currently, about a quarter of Montana's population relies on self-supplied sources but their water withdrawals represent only a tenth of the withdrawal levels for publicly supplied water.[29]

A 1997 study by Forest Service economists estimated the extent of the potential conversion of agricultural land to urban uses between 1990 and 2040. It found that the expected conversion would reduce the water available for irrigation by 94.77 million gallons per day and irrigated acreage by 25,070 acres in the region that includes Lincoln, Flathead, Sanders, Lake, Mineral, Missoula, and Ravalli Counties. They also found it would reduce the water available for irrigation by 18.05 million gallons per day and irrigated acreage by 4,620 acres in the region that includes Powell, Lewis and Clark, Granite, Deer Lodge, and Silver Bow Counties.[30]

Industrial Water Users. The major industrial demands for water come from the production of electricity, pulp and paper, and petroleum and sugar processing.[31] Relative to the amount of water used for irrigation, industrial use is small: only 1.6 percent of water consumed in Montana for all purposes. These industries require some water to operate, but the availability of additional water is unlikely to be the critical determinant of industrial expansion. Instead, operations will depend on other factors, such as global and national market conditions, and the strategies of individual companies. If these industries should expand, their demand for water probably would not expand one-for-one. Instead, production managers would look for ways to conserve water if the costs of securing adequate supplies become too great.

The overall job outlook in these industries is difficult to predict. An analysis published by the Federal Reserve Bank of Kansas City indicates that most of these water-consuming industries are poor sources of future employment growth.[32] Jobs directly related to agriculture are particularly sensitive to changes

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http://pubs.usgs.gov/circ/2004/circ1268) estimate that 74 percent of Montana's population consumes water from public sources.

[29] Cannon, M.R. and D.R. Johnson. 2004. *See* footnote 8.

[30] Haynes, R.W. and A.L. Horne. 1997. "Economic Assessment of the Basin." In T.M. Quigley and S.J. Arbelbide, eds., *An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins, Volume IV*. Vol. General Technical Report PNW-GTR-405. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. June. 1801-02.

[31] Cannon, M.R. and D.R. Johnson. 2004. *Estimated Water Use in Montana in 2000*. U.S. Department of the Interior, U.S. Geological Survey, and Montana Department of Natural Resources and Conservation. Scientific Investigations Report 2004-5223. Retrieved February 6, 2008, from http://pubs.usgs.gov/sir/2004/ 5223/pdf/sir2004_5223.pdf

[32] Wilkerson, C. 2005. "What Do Expected Changes in U.S. Job Structure Mean for States and Workers in the Tenth District?" *Economic Review: Federal Reserve Bank of Kansas City*: 59-93.

in crop outputs and prices, as well as trade agreements that influence their levels. For instance, economists in Minnesota estimated in 2005 that if the Congress had ratified the proposed Central American Free Trade Agreement, the drop in the price of sugar that would follow would have "devastating effects on the U.S. sugar industry," in general, and on the sugarbeet producers and processors of Montana, Minnesota, and North Dakota, in particular.[33] In the end, the trade agreement singed into law in 2005 protected the U.S. sugar industry from its demise but the incident shows that Montanans cannot rely on some agricultural industries to substantially contribute to job creation.

Future events may prove these analyses incorrect, but, for now, the weight of the evidence indicates these industries are unlikely to generate much increase in jobs and incomes.

The only water-consuming industry in the state generating significant numbers of new jobs and additional income is the oil-and-gas industry. Many expect the current boom will last a decade or more, though others voice skepticism, given the industry's boom-bust nature. Some evidence indicates that areas with large numbers of oil-and-gas jobs experience slow growth in overall employment.[34] The industry's expansion plans seem closely linked to Montana's water resources and thus to the state's agriculture segment that depends on irrigation. Montana and its neighboring states, like Wyoming and Colorado, have experienced a dramatic increase in the number of wells drilled for the extraction of coalbed methane, or natural gas. The thousands of gallons of groundwater extracted during the process and then released directly into rivers has damaged the water quality of some streams in Montana and adversely impacted irrigated crops due to their elevated salt content. The change in the quality of the water used for irrigation in some parts of Montana has imposed costs on ranchers by changing ecosystem conditions that promote the expansion of invasive nonpalatable grass species, such as cattails, to the detriment of alfalfa crops.[35]

3. Recreation

Recreationists' expenditures on recreational activities associated with natural-resource amenities generate jobs and income. Some of these effects occur near their homes—as recreationists purchase equipment, for example, some occur while recreationists are enroute from their homes to the recreational site, and some occur at the site. Table 3 shows these expenditures total more than $900 million per year. The proportion of these expenditures that occurred in the state

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[33] Mahon, J. 2005. "The Beet Generation: The Upper Midwest Is the Nation's Biggest Sugar-Producing Region, but Farmers Are Worried Trade Impacts Could Dissolve it All." Federal Reserve Bank of Minneapolis. Retrieved February 7, 2008, from http://minneapolisfed.org/pubs/fedgaz/05-05/beet.cfm

[34] Templet, P.H. 1995. "Equity and Sustainability: An Empirical Analysis." *Society and Natural Resources* 8: 509-523.

[35] McGuire, K. 2007. "'No One Is Neutral' in Water Fight." *The Denver Post.* August 12.

Table 3. Expenditures on Goods and Services Related to Fishing, Watching Wildlife, and Hunting in Montana, 2006

Activity	Activity Level	Total Expenditures
Fishing (angler days)	2,998,000	$229.6 million
Wildlife-Watching (participants)	899,000	$365.1 million
Hunting (participants)	195,000	$315.3 million
Total	- -	$910.0 million

Source: U.S. Fish and Wildlife Service. 2007. *2006 National Survey of Fishing, Hunting, Wildlife-Associated Recreation: State Overview. Preliminary Findings.* July. Retrieved February 7, 2008, from http://library.fws.gov/nat_survey2006_state.pdf

is unknown—some involved purchases and travel outside the state—but those that occurred Montana, generated jobs here.

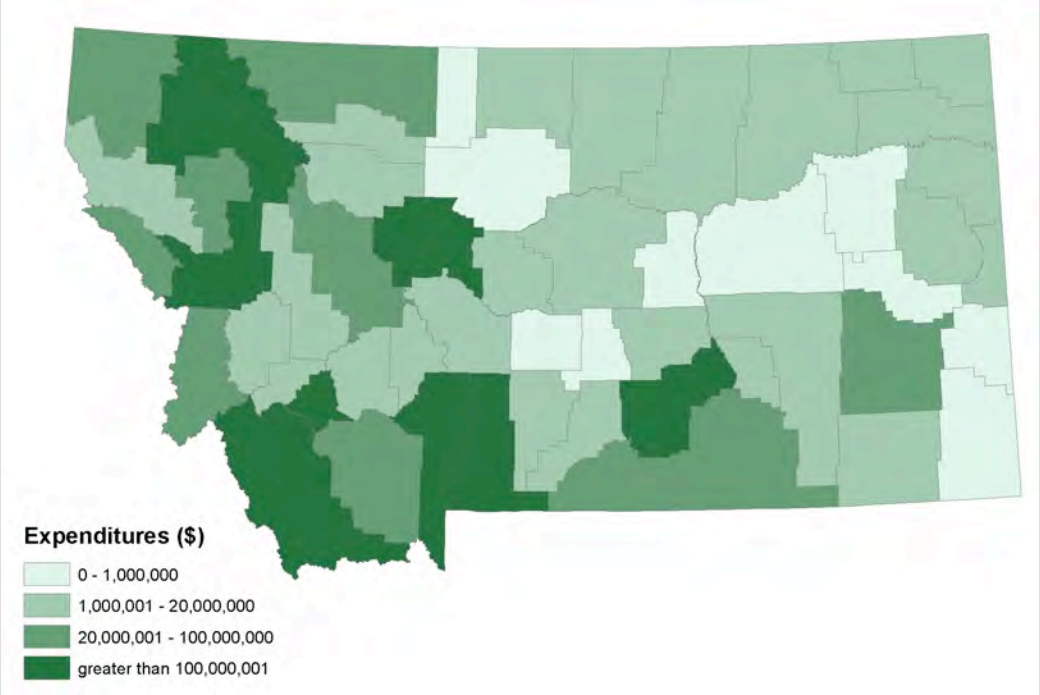
In the last decade the industry of travel and tourism in Montana has steadily captured a bigger portion of the state's economy. The University of Montana's Institute for Tourism and Recreation Research has found that travel expenditures in Montana have increased by a billion dollars, from $1.76 billion in 1997 to $2.77 billion in 2005, accounting for about 9.2 percent of the state's Gross Domestic Product in 2005. These expenditures create jobs and in 2005 employment related to travel spending was estimated to be around 45,900 and accounted for 7.9 of Montana's total non-farm employment.[36] Figure 16 shows the distribution of travel expenditures by nonresidents in Montana.

Not all of these travel expenditures were for recreation-related travel, and data are not available for recreation-related expenditures alone. However, the data suggest that recreation-related travel probably accounted for a large portion of the total travel-related expenditures in Montana. Outdoor recreation accounted for 25 percent of day trips and 29 percent of overnight trips for residents of Montana and 24 percent of the non-residents who visited Montana described the purpose of their trip as vacation (versus business, shopping, visiting friends or relatives, or passing through). Nonresidents almost $119 million on outfitter and guide services in 2005, $45 million on campgrounds and RV parks, and probably contributed a considerable percent of the total $2.67 billion spent in 2005. All but two of Montana's top 10 attractions and seven of the top 10 activities for nonresidents were related to outdoor recreation.

It is more difficult to account for how much of the travel-related expenditures were related to water-based recreation. Again, however, evidence suggests that visitors traveling in Montana are spending money on water-related activities. Of

[36] Grau, K., M. Bruns-Dubois, and N.P. Nickerson. 2006. *The Economic Review of the Travel Industry in Montana.* 2006 Biennial Edition. The Institute for Tourism and Recreation Research, University of Montana – Missoula. December. Retrieved February 8, 2008, from http://www.itrr.umt.edu/ecorev/Economic review2006.pdf

Figure 16. Nonresident Travel-Related Expenditures in Montana, 2005



Source: ECONorthwest, with data from Institute for Tourism and Recreation research, University of Montana. *Nonresident Travel Survey: Expenditures Report*. Retrieved February 20, 2008, from http://www.itrr.umt.edu/NonResident2005/ITRRSearch.aspx

the top-ten tourist destinations between 2002 and 2005, water is a central theme in three of the top four (Glacier National Park, Yellowstone National Park, and Fort Peck Lake), and of Montana's top 10 attractions for nonresidents in 2005, "wildlife and fish" ranked sixth and "rivers" ranked eighth.

Several studies provide additional insight. An analysis of recreationists' expenditures associated with visits to the wildlife refuges in the region that includes Montana, Colorado, Nebraska, Utah, Wyoming, South and North Dakotas, found that, on average, every 1,000 visits resulted in sales of $37,300, 0.63 jobs, and $12,000 in worker's earnings.[37] These numbers include the so-called multiplier effect within the national economy. It arises when recreationists' expenditures trigger additional expenditures so that the overall impact on the economy is larger than the initial, direct impact. The spatial distribution of the jobs and incomes, and the income per job will vary, depending on the type of location of the expenditure. As opposed to other areas in the country that have lost manufacturing companies, Montana is well positioned to benefit financially from expenditures on recreational activities since it is home to a few

[37] Carver, E. and J. Caudill. 2007. *Banking on Nature 2006: The Economic Benefits to Local Communities of National Wildlife Refuge Visitation.* Division of Economics, U.S. Fish and Wildlife Service. September. Retrieved February 7, 2008, from http://www.fws.gov/Refuges/pdfs/BankingonNature2006_1123.pdf.

manufacturers of specialized equipment for recreationists, both local and out of state, generating jobs and incomes with their investments.

Another study offers a different perspective of recreation's importance to the state's economy. The authors compiled data for the rural counties in the U.S. and developed an index of recreational activity that reflects several factors: employment and income earned in recreation-related sectors of the economy; percentage of housing units intended for seasonal or occasional use; and sales by motels and hotels. They found that high-recreation counties, as a whole, grew about 2.5 times faster than the overall average for nonmetropolitan counties, with most of this growth stemming from rapid, net in-migration.[38] The index reveals that twelve of Montana's nonmetropolitan counties have a high concentration of recreation-related economic activity.[39] These counties also have irrigated agriculture, raising the possibility that some of the recreational attractions involve irrigation-related reservoirs, hunting, fishing, and wildlife-watching. It is highly unlikely that none of the other nonmetropolitan counties in Montana is unable to generate amenity-driven growth. A more plausible explanation is that these counties possess valuable recreational potential, but this potential has not yet translated into local expenditures, jobs, and income. To the extent this latter explanation is correct, the absence of recreational activity today means there are opportunities for future efforts to fill in the gap.

In the short run, efforts to capitalize further on the state's water-related recreational opportunities probably would generate jobs and incomes just in the recreation sector of the economy. In the long run, though, such efforts may have an even larger effect, by altering the character of the local economy. This possibility arises because different recreation activities tend to attract enthusiasts with different age, income, and educational characteristics. A 1994-1995 national study, describing the characteristics of participants in 62 different outdoor recreational activities, found, for example, that more than 60 percent of kayaking enthusiasts nationwide had completed college, the highest percentage among the 62 different activities.[40] College graduates also constituted more than half of the enthusiasts participating in sailboarding, sailing, and cross-country skiing. In contrast, big-game hunting had the lowest percentage of college graduates, 17 percent. Other activities for which less than 20 percent of the enthusiasts had college graduates were warm-water fishing, and snowmobiling.

These numbers indicate that, if residents of Montana manage its natural resources to increase the supply of some recreational opportunities rather than

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[38] Beale, C.L. and K.M. Johnson. 2002. "Nonmetro Recreation Counties: Their Identification and Rapid Growth." *Rural America* 17 (4).

[39] The twelve counties are: Carbon, Deer Lodge, Flathead, Gallatin, Garfield, Glacier, Granite, Madison, Meagher, Mineral, Park, and Sweet Grass.

[40] Cordell, H.K., B.L. McDonald, J.A. Briggs, R.J. Teasley, R. Biesterfeldt, J. Bergstrom, and S.H. Mou. 1997. *Emerging Markets for Outdoor Recreation in the United States*. Sporting Goods Manufacturers Association and the Outdoor Products Council. April.

others, they might influence the future composition of the state's workforce, households, and industrial mix. All else equal, an economic-development strategy that aims to attract more college-educated workers, retirees, and investors may be more successful if it were to emphasize the availability of the recreational activities that this group tends to find most attractive.

Some raise questions about the ability of the recreation industry to generate economic growth in areas that are most remote from population centers.[41] There is no easy answer. Montana, however, already attracts large numbers of recreationists from other states: in 2006, 42 percent of the anglers who fished were from out of state and nonresidents accounted for close to 48 percent of the days spent watching wildlife.[42] These figures indicate that many of the participants in these activities value them highly enough to incur significant travel costs. Similar percentages and values probably apply to other resource-related recreational activities. At least in concept, these high numbers represent opportunities for Montanans to find ways to direct visitors to all areas of the state.

Particular concern arises about the likelihood that tourism-related businesses generate low-wage jobs. The probability that such an outcome would materialize remains ambiguous, however. One study in this region, for example, found the long-term residents of rural counties with high concentrations of natural-resource amenities and/or high concentrations of recreational businesses had higher incomes than counterparts in counties lacking these attributes, but the higher incomes were offset, more or less, by higher costs of living.[43] Several, more extensive analyses that looked across the national landscape, however, have found that indicators of socioeconomic well-being generally are higher in rural areas where resource-related recreational activities have emerged than in areas where they have not. These statements, from an overview of the relationship between resource-related recreation and the well-being of rural areas, ratify this conclusion:

> Rural tourism and recreational development leads to higher employment growth rates and a higher percentage of working-age residents who are employed. Earnings and income levels are also positively affected. Although the cost of living is increased by higher housing costs, the increase offsets only part of the income advantage.

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[41] *See*, for example, Dissart, J.-C. and D.W. Marcouiller. 2004. *Impact of Outdoor Recreation Facilities on Rural Economic Growth*. Conference on Natural Amenities and Rural Development, June 18-19, University of Wisconsin-Madison. May 14. Retrieved February 7, 2008, from http://www.wisc.edu/urpl/otherlinks/ARD_CONF/Papers/DissartMarcouiller.pdf

[42] U.S. Fish and Wildlife Service. 2007. *2006 National Survey of Fishing, Hunting, Wildlife-Associated Recreation: State Overview. Preliminary Findings*. July. Retrieved February 7, 2008, from http://library.fws.gov/nat_survey2006_state.pdf.

[43] Hunter, L.M, J.D. Boardman, and J.S. Onge. 2004. *The Association between Natural Amenities, Rural Population Growth, and Long-Term Residents' Economic Well-Being*. Research Program and Environment and Behavior, University of Colorado. Working paper. EB2004-0005. September. Retrieved February 7, 2008, from http://www.colorado.edu/ ibs/pubs/eb/eb2004-0005.pdf

Rural tourism and recreational development results in lower local poverty rates and improvements in other social conditions, such as local educational attainment and health (measured by mortality rates). Although rates of serious crimes are elevated with this kind of development, this may be misleading because tourists and seasonal residents, while included as victims in the crime statistics, are not included in the base number of residents. Rapid growth brings its own challenges, particularly pressures on infrastructure. The one growth-strain measure examined in the study, commuting time to work, revealed little evidence of traffic congestion in rural recreation areas.

Rural recreation counties have not benefited equally. Rural counties with ski resorts were among the wealthiest, healthiest, and best educated places in the study, while those with reservoir lakes or those located in the southern Appalachian mountains were among the poorest and least educated.[44]

B. Quality of Life

Whenever the state's recreational opportunities, scenic vistas, and other resource-related amenities induce households to locate in the state to enjoy its quality of life, they stimulate growth in jobs and income. The growth in jobs and income occurs through a process of economic growth known as *people-first-jobs-follow*. It materializes when workers and their families opt to locate in a community even though they have no immediate job prospects, instead basing their location decisions largely on the quality of life the community offers. Businesses, often in service and retail industries, recognize the growing pool of workers and consumers and make investments that create jobs.

This process of economic growth is markedly different from one that predominated in the past, when economies grew largely by a process in which business investment, often in a resource-extraction or manufacturing industry, created job opportunities that attracted workers and their families. Economists call this growth process *jobs-first-people-follow*. In it, the availability of jobs is the primary determinant of a household's decision about where to locate, and resources generate jobs by facilitating the production of agricultural, mining, and other products.

Growing evidence indicates that the *people-first* process is becoming more important. One analysis found that such a process now accounts for about half of the differences in job growth among the 50 states.[45] This finding indicates, at a minimum, that amenities and their influence on household-location decisions may be a major determinant of economic growth, and perhaps the primary determinant in some parts of the country.

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[44] Reeder, R.J. and D.M. Brown. 2005. *Recreation, Tourism, and Rural Well-Being*. U.S. Department of Agriculture, Economic Research Service. Economic Research Report Number 7. August. Retrieved February 7, 2008, from http://www.ers.usda.gov/publications/err7/err7.pdf

[45] Partridge, M. and D. Rickman. 2003. "The Waxing and Waning of Regional Economies: The Chicken-Egg Question of Jobs Versus People." *Journal of Urban Economics* 53: 76-97.

Many different types of amenities contribute to an area's quality of life and influence households location decisions. Some of those related to water resources—the presence of clean streams and lakes, the existence of fishing and boating opportunities—have the greatest impacts.[46] More robust growth in jobs and income generally occurs in areas having resource-related amenities, such as outdoor recreational opportunities and high environmental quality, whereas areas with higher emissions of hazardous materials experience slower growth.[47]

Existing studies typically do not attempt to measure the influence specific natural-resource amenities exert on employment and household location. Instead, researchers have verified generally that such amenities do have some impacts on these variables, and provided some insight into how these impacts materialize. One study, for example, examined population patterns in the nonmetropolitan areas of western states between 1970 and 1997 and concluded that households increasingly are locating away from urban centers, in areas rich with amenities, especially those that have not already experienced sufficient in-migration to drive up housing prices.[48] Montana appears to fall within this category, especially in the western and central regions, where amenities are attracting in-migration. The authors predict growth in amenity-rich, nonmetropolitan areas of the West will continue, as both young people and retirees seek them out.

Other studies have reached similar conclusions. Researchers with the U.S. Department of Agriculture, for example, identified nonmetropolitan counties throughout the country in which recreation exerts a strong economic influence, and all of these counties, with exception of those associated with casinos, have a high concentration of natural resource amenities.[49] A related analysis examined the influence on migration of five natural resource amenities: winter and summer temperatures, days of sunshine, summer humidity, area of waterbodies, and extent of hills and mountains.[50] Figure 17 shows the correlation between a county-level amenity index representing these variables and growth in population between 1970 and 1996. Population grew only 1 percent in counties

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[46] For a more thorough discussion of relevant research, *see,* for example, McGranahan, D.A. 1999. *Natural Amenities Drive Rural Population Change*. AER-781. U.S. Department of Agriculture, Economic Research Service.

[47] Templet, P.H. 1993. "The Emissions-to-Jobs Ratio." *Environmental Science & Technology* 27: 810-812.

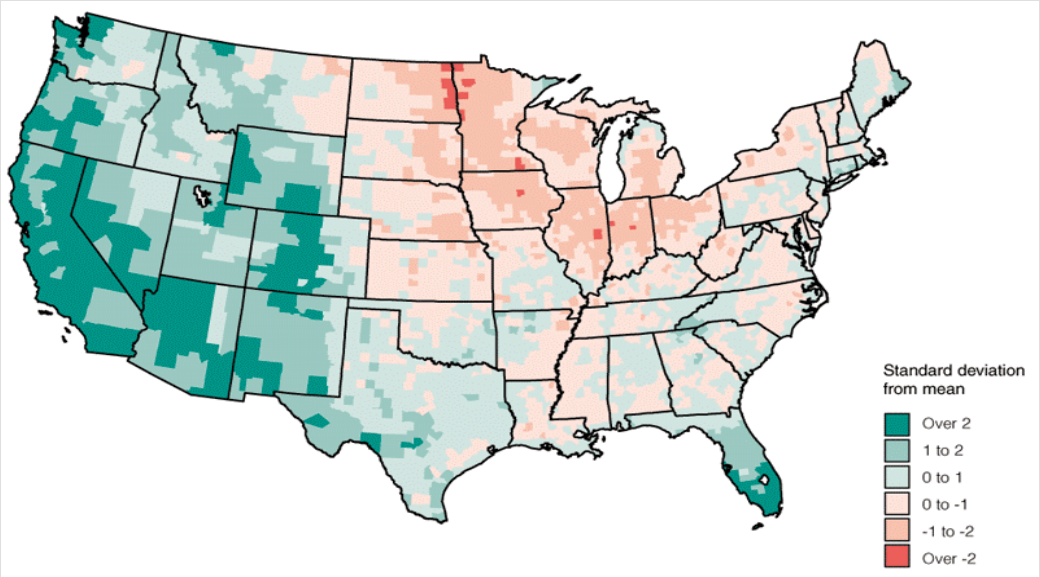
[48] Cromartie, J. and J. Wardwell. 1999. "Migrants Settling Far and Wide in the Rural West." *Rural Development Perspectives* 14 (2): 2-8. Retrieved February 9, 2008, from http://www.ers.usda.gov/epubs/pdf/rdp/rdpsept99/rdpsept99a.pdf

[49] Johnson, K.M. and C.L. Beale. 2002. "Nonmetro Recreation Counties: Their Identification and Rapid Growth." *Rural America* 17 (4): 12-19. Retrieved February 8, 2008, from http://www.luc.edu/depts/sociology/johnson/ra174b.pdf

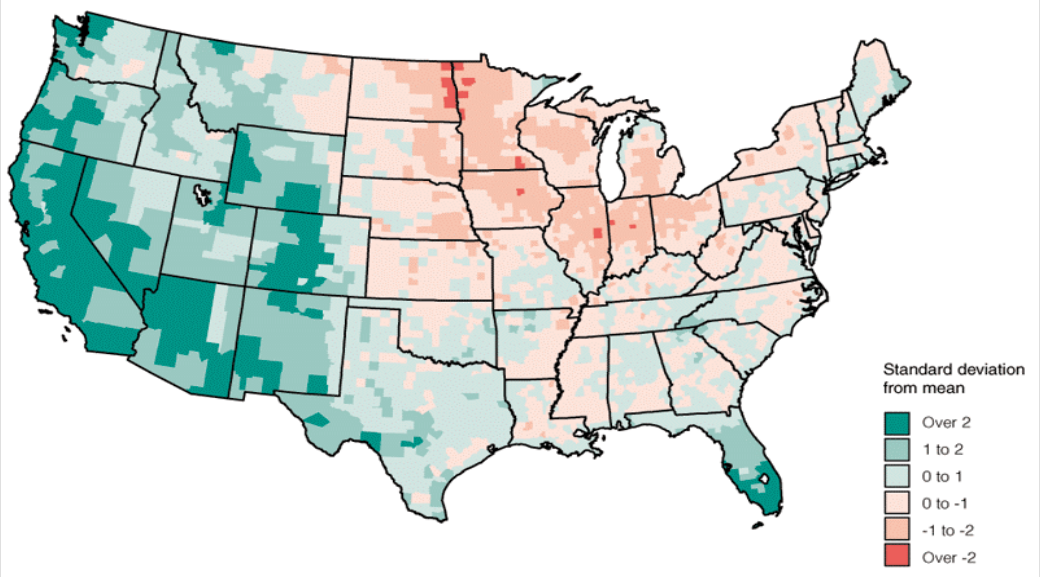
[50] McGranahan, D. 1999. *Natural Amenities Drive Rural Population Change*. Food and Rural Economics Division, Economic Research Service, U.S. Department of Agriculture. September. Retrieved February 8, 2008, from http://www.ers.usda.gov/ publications/aer781/aer781.pdf

Figure 17. Natural-Resource Amenities and Population Growth

Amenity scale by county, 1970-96



Population Change by County, 1970-96



Source: McGranahan, D.A. 1999. *Natural Amenities Drive Rural Population Change.* U.S. Department of Agriculture, Economic Research Service, Food and Rural Economics Division. Agricultural Economic Report No. 781. September.

with the lowest amenity index, but 120 percent for those with the highest. The correlation is strongest for counties associated with high levels of retirees.

Figure 17 shows that these national tendencies generally materialized in the state. The top map in Figure 17 shows that the amenity index for counties in the state, especially those in the central and western parts, exceeds the national average. The bottom map shows that population in Montana grew faster than the

national average for several nonmetropolitan counties. Amenities are not the only influence on economic growth, of course: much of the growth in the state stems from industries, such as oil-and-gas development, instead of from amenities. Nonetheless, for the nation as a whole, there seems to be a strong correlation between amenities and growth.[51]

Insights into this correlation come from studies of the influence natural-resource amenities exert on business location decisions. One study focused on the Rocky Mountain states and concluded that, as amenities attract people to these states, businesses follow.[52] Another surveyed firms in three nonmetropolitan counties in Montana and found businesses tended to place greater importance on natural resource amenities—including recreational opportunities, proximity to public lands, scenic beauty, and quality-of-life reputation—than on factors, such as taxes, that conventionally are touted as influencing business decisions.[53]

A related, later study sought to determine which factors caused the economies of some counties in western states to grow faster than others.[54] To measure economic strength, the authors looked at changes in personal income between 1970 and 2000. They found that two factors have been especially important: proximity to public lands managed for the protection of their amenities rather than for the production of commodities; and proximity to an airport. The authors also found that counties with the fastest growth in incomes tended to have a greater concentration of employment in the producer-services industry, a population with higher levels of education, a ski area, a concentration on employment in arts-related sectors, and mountains. In contrast, the counties with the slowest growth in personal incomes tended to lie farther from a major city, and have employment concentrated in a few industries and especially in resource-extractive industries, such as logging, mining, and oil-and-gas development.

Another illustrative study examined rates of growth in jobs and incomes in the early 1990s in three sets of counties: (1) extensively scenic counties along the Rocky Mountain front range and in the Midwest; (2) moderately scenic counties; and (3) other rural counties.[55] The study found the average annual growth in jobs

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[51] Not all studies support this conclusion. *See*, for example, Kim, K-K., D.W. Marcouiller, and Deller S.C. 2005. "Natural Amenities and Rural Development: Understanding Spatial and Distributional Attributes." *Growth and Change* 36 (2): 273-297, which concludes that natural-resource amenities do not explain variation in economic-growth variables for Minnesota, Wisconsin, and Michigan.

[52] Vias, A. 1999. "Jobs Follow People in the Rural Rocky Mountain West." *Rural Development Perspectives* 14 (2): 14-23.

[53] Johnson, J.D. and R. Rasker. 1995. "The Role of Economic and Quality of Life Values in Rural Business Location." *Journal of Rural Studies* 11 (4): 405-146.

[54] Rasker, R., B. Alexander, J. van den Noort, and R. Carter. 2004. *Prosperity in the 21st Century West: The Role of Protected Public Lands*. Sonoran Institute. July.

[55] Henderson, J. and K. McDaniel. 1998. "Do Scenic Amenities Foster Economic Growth in Rural Areas?" *Regional Economic Digest, Federal Reserve Bank of Kansas City* (First Quarter): 11-16.

was 3 percent, 1.7 percent, and 1.4 percent, respectively. The corresponding rates for growth in per capita incomes were 1.2 percent, 0.4 percent, and 0.1 percent. The authors concluded these differences arose largely because more scenic counties attracted more retired persons and experienced faster growth in the tourism industry.

The demand for high-quality, resource-related amenities generally increases with income. This relationship is illustrated by a recent analysis of groups who moved into (in-migrants), moved out of (out-migrants), or stayed in (nonmigrants) rural counties of the Mountain West states during the between 1994 and 1997.[56] The researchers compared the average incomes of these three groups in counties with the highest concentration of recreational and scenic amenities against their counterparts in four other categories of counties, whose economies are characterized by concentrations of government, mining and manufacturing, farming, or sectoral diversification. The amenity-rich counties had the highest rate of net immigration. Moreover, the average per capita income of in-migrants to these counties was at least 39 percent higher than the average income of in-migrants to the other categories of counties. It was 60 percent higher than the average income of in-migrants to counties with the highest concentration of farming activity. Overall, immigration to the amenity-rich counties increased total incomes in these counties 11 to 23 times the immigration-related increases in incomes in the other types of counties.

The linkage between natural-resource amenities and the location decisions of persons with higher incomes suggests there also is a linkage with higher education. Persons with a bachelor's degree, for example, earn 75 percent more than persons with only a high school diploma, and persons with a professional degree earn almost four times more.[57] Attracting persons with high education levels can have far-reaching impacts on economic growth. A study of rural counties in southern states, for example, found that, in counties where the proportion of adults attending college in 1980 was 5 percentage points higher, per capita incomes grew 2.5 percent faster per year over the next two decades, and jobs grew 5.5 percent faster.[58]

The linkage to education and incomes is reinforced by studies that have found natural-resource amenities influence the location decisions of people with strong entrepreneurial capabilities. All else equal, the greater a community's population

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[56] Shumway, J.M. and S.M. Otterson. 2001. "Spatial Patterns of Migration and Income Change in the Mountain West: The Dominance of Service-Based, Amenity-Rich Counties." *Professional Geographer* 53 (4): 492-502.

[57] Estimates are for earnings of workers 25 to 64 years old and the period, 1997-99. Day, J.C. and E.C. Newburger. 2002. *The Big Payoff: Educational Attainment and Synthetic Estimates of Work-Life Earnings.* U.S. Department of Commerce, Economics and Statistics Administration, U.S. Census Bureau. July.

[58] Reported in Gibbs, R. 2005. "Education as a Rural Development Strategy." *Amber Waves* 3(5): 20-25.

of entrepreneurs, the greater the likelihood it will experience the development of new businesses, jobs, and incomes. Two studies, published by the Federal Reserve Bank of Kansas City, described the relationship in these terms:

> The self-employed are especially free to locate where they please due to the small scale of their firms. Many will locate in areas with attractive topography, abundant water area, and comfortable weather. In the 1990s, the growth of entrepreneurs was stronger in rural areas that enjoyed high levels of natural amenities [and] there appears to be a strong relationship between rugged landscapes, scenic beauty, and [entrepreneurial performance].[59]

> Given the industry mix of entrepreneurs, it is not surprising to find stronger entrepreneur growth in rural communities with service-based economies and natural amenity areas that attract vacationers and retirees. … The most scenic rural areas, which often serve as recreation and retirement destinations, enjoyed growth [in rural nonfarm self-employment] of almost 4 percent, while the least scenic rural counties grew barely half that.[60]

Figure 18 shows that today Montana follows two different patterns of demographic growth during the 1990s: the western and central regions of Montana have experienced tremendous population increases, with some counties exceeding 25 percent growth, i.e. Ravalli (44%), Gallatin (34%), Broadwater (32%), Jefferson (27%), and Lake (26%); in the meantime, the eastern region of the state has lagged behind and underwent high rates of outmigration, with counties, such as Garfield, McCone, Prairie, and Sheridan, losing between 12 and 20 percent of their population. It is no surprise that the counties that experienced the greatest population growth are located nearby national forest lands and score high on the amenity scale.[61] These counties owe their economic growth, in part, to being able to capitalize on their resource-related amenities to generate jobs and income.

This does not mean that amenities do not or can not play a role in building the economy of eastern Montana. In fact, research focused on states in the Midwest, with landscapes and economies similar to those of eastern Montana reinforces the conclusion that amenities can play an important economic role in this region.[62] It examined economic growth between 1990 and 2001 in the 734 counties of Illinois, Iowa, Kansas, Minnesota, Missouri, Nebraska, South Dakota, and Wisconsin. Its purpose was to determine the extent to which differences in a large set of economic characteristics correlate with differences in the growth in

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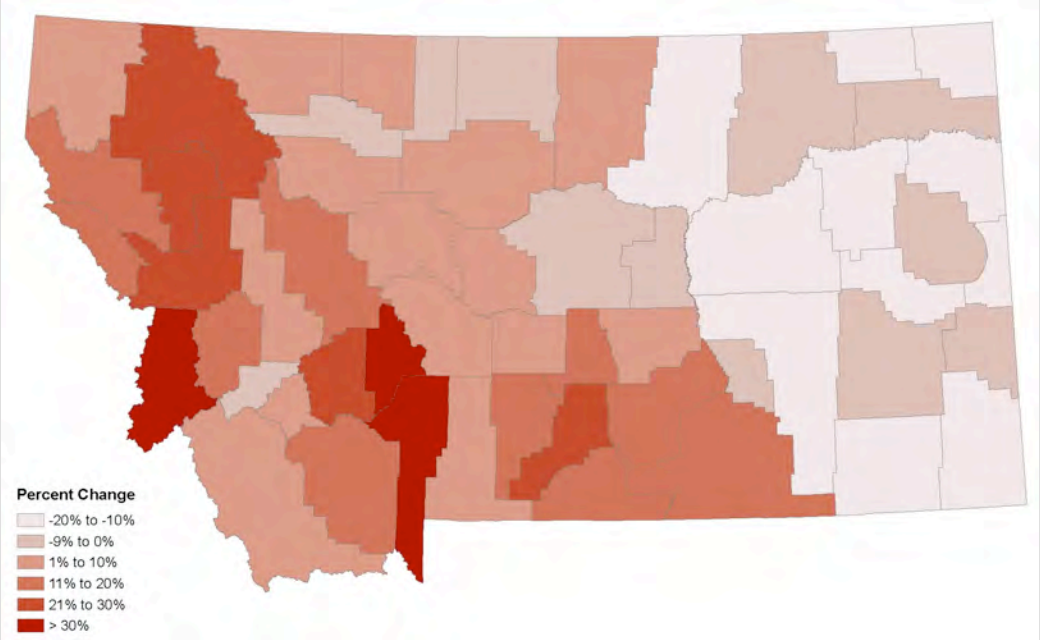
[59] Low, S., J. Henderson, and S. Weiler. 2005. "Gauging a Region's Entrepreneurial Potential." *Economic Review* 90 (3): 61-89.

[60] Henderson, J. 2002. "Building the Rural Economy with High Growth Entrepreneurs"." *Economic Review* 87 (3): 45-70.

[61] Beale, C.L. and K.M. Johnson. 2002. *See* footnote 38.

[62] Monchuk, D.C., J.A. Miranowski, D.J. Hayes, and B.A. Babcock. 2005. *An Analysis of Regional Economic Growth in the U.S. Midwest.* Working Paper 05-WP-392. Center for Agricultural and Rural Development, Iowa State University. April. http://www.econ.iastate.edu/research/webpapers/paper_12294.pdf (accessed April 26, 2006).

Figure 18. Population Change in Montana, 1990-2000



Source: ECONorthwest, with data from U.S. Census Bureau. 2007. *Montana QuickLinks: Estimates for Montana Counties.* Retrieved January 15, 2008, from http://www.census.gov/popest/counties/tables/CO-EST2005-01-30.xls [for 2000 and 2005 data]; and U.S. Census Bureau. 2007. *Montana QuickLinks: Historic Population Counts.* Retrieved January 15, 2008, from http://www.census.gov/population/cencounts/mt190090.txt [for 1960-1990 data].

total county income, population, and per capita income. The authors included two indicators of natural-resource amenities: swimming areas at facilities operated by the U.S. Army Corps of Engineers; and an index of outdoor recreation amenities that includes rails-to-trails miles, acres of recreational land in the National Resources Inventory, acres of recreational water in the National Resources Inventory, and comparable data on the amenities of state parks. The authors found that, for a representative county, increasing the value of the amenity index by one standard deviation (a standardized measure) would increase per capita income by $270. Increasing the number of swimming areas by a comparable amount would increase per capita income by $187. By comparison, a comparable increase in the share of total county income from farming would decrease per capita county income by $1,410, and a comparable increase in the growth in livestock receipts would increase per capita income by $47. Based on these and related findings, the authors concluded that, for this region:

> Recreational amenities, both those created locally and those provided by the federal government, have a positive and statistically significant impact on county economic growth. We hypothesize that this occurs because local recreational amenities provide incentives to employers to site plants and businesses near such amenities to attract employees and their families who make residence location decisions based in part on proximity to these amenities. Further, we anticipate that recreational amenities will play an even more important role in the future as demand for outdoor recreation grows with growing incomes, leisure time, and population.

This evidence highlights the potential for natural-resource amenities, especially those in public ownership, to contribute to the economies of this region. The studies strongly suggest that enhancing the amenities available to the public on publicly owned lands in eastern Montana would stimulate amenity-driven growth in the state. In conclusion, if the counties in the state's eastern region are to experience growth from sources other than agriculture, they likely will have to come from taking advantage from the ability of their amenities to attract households and investment. Conversely, actions that constrict the supply of amenities, including water-related amenities, may weaken growth in sectors unrelated to the industries that rely on natural-resource consumption.

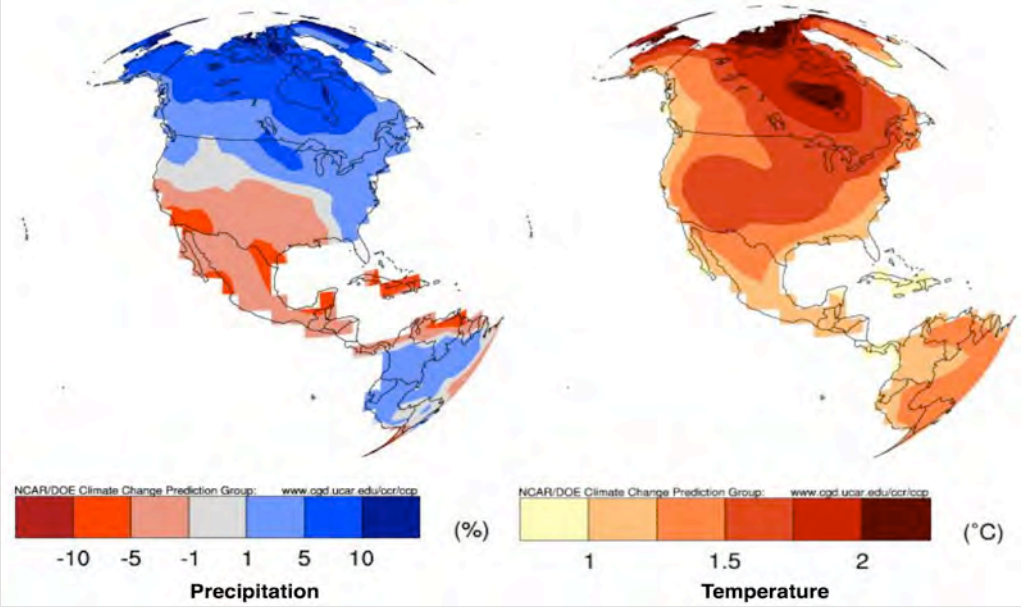
C. Environmental Values

We explain, in our discussion of Figure 1, above that some of the competition for the state's water resources comes about because these resources provide goods and services that that can have considerable value, even though people may not be aware of them and/or they do not involve direct use of the resources. These demands are more abstract and harder to quantify than the other types of demand. But the difficulties in measuring them does not mean they are not important. Growing evidence indicates that, in some circumstances, they can have powerful economic impacts. To illustrate this observation, we consider the evolving understanding of and responses to climate change, and then look at the economic impacts of actions, such as protecting threatened and endangered species and natural landscapes.

Climate Change. Extensive research indicates that climate change is driven by increasing emissions of greenhouse gases, including carbon dioxide (CO_2) and methane (CH_4). Scientists now predict that climate change will increase average temperatures and decrease annual precipitation throughout much of the western United States, but not in Montana. Figure 19, for example, shows some recent, integrated results from three of the leading climate models regarding expected changes in annual precipitation and the number of days with extreme temperatures. The maps suggest that the first-order effects of expected changes in the climate on Montana's agricultural sector might increase both the sector's output and the demand for its products. The increase in output might arise as the state's farmers see more annual precipitation, warmer temperatures and a longer growing season. At the same time, the demand for agricultural products from Montana might rise as farmers to the south see less annual precipitation and increases in temperature sufficient, perhaps, to suppress crop growth.

There remains considerable uncertainty about how changes in climate will affect agriculture. Some of it arises from our lack of knowledge about how temperature and precipitation will change, and how these changes will interact with agricultural practices and markets. More arises from our lack of knowledge about other potential effects of climate change: on the incidence and severity of drought, the incidence and severity of storms, the frequency and intensity of wildfire, changes in vegetation composition, the spread of invasive species, and rates of erosion. All of these effects could have significant impacts on farming

Figure 19. Expected Changes in Annual Precipitation, Temperature, …



Source: Tebaldi et al. 2006. "Going to the extremes; An intercomparison of model-simulated historical and future changes in extreme events." *Climatic Change* 79(3-4): 185-211.

operations in Montana (and elsewhere). We discuss these possibilities more in Technical memorandum 2.2.

Potential second-order impacts of climate change are likely to materialize as society implements, or not, several proposed steps for mitigating climate change. Many states have surged ahead of the federal government in their efforts to control greenhouse-gas emissions and establish carbon markets, and the western states are leading the way. In February, 2007, the governors of Arizona, California, New Mexico, Oregon, and Washington announced the Western Climate Initiative (WCI), a collaborative effort to reduce greenhouse gas emissions. The state of Utah and the Canadian Provinces of British Columbia, Manitoba, Ontario, Quebec, and Newfoundland have since joined the WCI, or announced their intention to collaborate with it. Several other western states, including Colorado, Nevada, and Wyoming are participating in the effort as observers. In August, 2007, the WCI announced a regional goal to reduce greenhouse gases to 15 percent below 2005 levels by 2020, and efforts are underway to design a market-based mechanism, due to be released by August, 2008, to help achieve this goal.[63]

These efforts may create opportunities for farmers and ranchers to earn revenues through the emerging, market-like mechanisms to control greenhouse-gas emissions. For example, they may be able to sell carbon-offset credits for

[63] Western Climate Initiative. 2007. *Western Climate Initiative (WCI)*. Retrieved September 18, 2007, from http://www.westernclimateinitiative.org/

commitments to manage their lands in a manner that would sequester carbon in soils, vegetation, or both.

Some scientists and policy makers are looking to terrestrial carbon sequestration—in soils, forests, rangelands, and croplands—as a primary strategy in reducing atmospheric levels of CO_2.[64] Soils represent the third largest carbon reserve on earth, after oceanic and geologic reserves. Many of these soils, in Montana and elsewhere, are affected by grazing. The soils that support grazing in the U.S. cover approximately 30 percent of the nation.[65] Globally, grazing lands contain 10 to 30 percent of the world's soil organic carbon, although due to poor management and grazing over the last century, much of this has been lost. For these reasons, researchers have focused considerable attention on enhancing the ability of rangeland and pasture to sequester carbon and mitigate climate change. According to Follett, Kimble, and Lal,[66] who dedicate an entire book to this topic, "because many grazing land soils are degraded, still poorly managed, or not managed at all, and also receive low levels of inputs, they have a high potential to sequester C if we apply best management practices (BMPs) and increase inputs to them."[67]

Such a system involving tradable carbon credits for rangeland carbon sequestration has already been launched on the voluntary Chicago Carbon Exchange (CCX). Since May of 2007, ranchers have been able to generate carbon credits to sell on the CCX by implementing certain land management practices on their rangeland that have been shown to increase the rate at which carbon is sequestered in the soil.[68] On August 13, 2007, the CCX markets closed at $3.60 per ton of CO_2. This price is well below what will be required to curtail emission of greenhouse gases: prices closer to $100 per ton of CO_2.[69] However, the CCX

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[64] J. Lewandrowski et al. 2004. *Economics of Sequestering Carbon in the U.S. Agricultural Sector.* United States Department of Agriculture. Technical Bulletin No. TB1909. March 31. Retrieved September 12, 2007, from http://www.ers.usda.gov/Publications/TB1909/, P.J. Unkefer et al. 2001. "Native Plants for Optimizing Carbon Sequestration in Reclaimed Lands." Presented at the First National Conference on Carbon Sequestration. May 14-17. Retrieved September 18, 2007, from http://www.netl.doe.gov/publications/proceedings/01/carbon_seq/p51.pdf

[65] T.M. Sobecki,, D.L. Moffitt, J. Stone, C.D. Franks, and A.G. Mendenhall. 2000. "A Broad-Scale Perspective on the Extent, Distribution, and Characteristics of U.S. Grazing Lands." in R.F. Follett, J.M. Kimble, and R. Lal (eds). *The Potential of U.S. Grazing Lands to Sequester Carbon and Mitigate the Greenhouse Effect.* Boca Raton: Lewis Publishers. 21-64.

[66] R.F. Follett, J.M. Kimble, and R. Lal, eds. 2001. *The Potential of U.S. Grazing Lands to Sequester Carbon and Mitigate the Greenhouse Effect.* Boca Raton, FL: Lewis Publishers.

[67] J.M. Kimble, R.F. Follett, and R. Lal. 2001. "Introduction: The Characteristics and Extent of U.S. Grazing Lands." in R.F. Follett, J.M. Kimble, and R. Lal, eds. *The Potential of U.S. Grazing Lands to Sequester Carbon and Mitigate the Greenhouse Effect.* Boca Raton, FL: Lewis Publishers, p. 7.

[68] National Carbon Offset Coalition. No date. "CCX Rangeland Soil Carbon Management Offsets." Retrieved October 16, 2007, from http://www.ncoc.us/downloads/CCXRangelandProtocol.doc.

[69] Stern, N. 2006. *The Economics of Climate Change: The Stern Review*. Cambridge, United Kingdom: Cambridge University Press. Retrieved October 30, 2006, from http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm.

carbon price is also low compared to carbon prices on markets that operate where mandatory carbon limits are already in place. For instance, on the same day, August 13, 2007, a ton of CO_2 traded for around $20 on the European market.

The CCX carbon price also is low compared to the range of estimates provided by analysts of what the price of carbon could reach under a mandatory cap-and-trade system in the United States. Once mechanisms are in place to control greenhouse gases, researchers have estimated that the price of a ton of CO_2 likely would equal or exceed $40 in the next few years.[70] This means that some farmers and ranchers in Montana may have considerable opportunity to earn income by managing their lands with a primary focus on sequestering carbon rather than on growing crops and livestock.

Selling carbon credits may generate income, but it will not come without a cost. Experts predict that the management changes required to generate carbon credits on rangelands will cost between $7 and $17, and until the market prices for carbon credits meet or exceed these costs, the incentives to make such changes are weak. The electric utilities of the western states recently concluded, however, that the emissions limits adopted by California indicate that the price of carbon dioxide in this region is likely to reach $40 per metric ton in the foreseeable future.[71] The prospect of prices anywhere near this level should dramatically alter the decisions of land owners.

Protecting Species and Landscapes. For the most part, nonuse values have little, if any, direct impact on behavior and, hence, on jobs and income. They can, however, trigger significant changes in economic behavior when the risks to species and landscapes become so extreme that people take voluntary or regulatory action to prevent the risks from growing.

One significant study of the impacts of voluntary actions to protect the environment examined the effects of the Conservation Reserve Program (CRP), which pays farmers to retire environmentally sensitive cropland and pasture from production.[72] The authors initiated the study in response to fears that taking land out of agricultural production would have devastating effects on local economies. They found, however, no statistically significant evidence supporting these fears. Specifically, they found no evidence indicating that the CRP has had

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[70] Western Regional Transmission Expansion Partnership Economic Analysis Subcommittee. 2007. *Benefit-Cost Analysis of Frontier Line Possibilities: Final Report.* April 27. Retrieved June 21, 2007, from http://www.ftloutreach.com/images/FTL_Econ_Analysis_Final_Report_4-27-07.doc.

[71] Western Regional Transmission Expansion Partnership Economic Analysis Subcommittee. 2007. *See* footnote 27.

[72] Sullivan, P., D. Hellerstein, L. Hansen, R. Johansson, S. Koenig, R.N. Lubowski, W. McBride, D.A. McGranahan, M.J. Roberts, S.J. Vogel, and S. Bucholtz. 2002. *The Conservation Reserve Program: The Implications for Rural America*. U.S. Department of Agriculture, Economic Research Service. Agricultural Economic Report 834. September, pp. iv, 23-25, 32.

a negative effect on the population of rural areas throughout the U.S. Moreover, they found the negative effects, if any, on rural employment were short lived, whereas, in the long run, protection and restoration of habitat under the CRP seems to correlate with positive employment growth.

Several studies have attempted to quantify the impacts of regulatory actions, particularly those taken under the federal Endangered Species Act. Using changes in employment and other indicators of economic activity, they have concluded that, benefits of regulations that protect the environment usually offset their costs. One study representative of this literature looked at the net impacts of regulations associated with the federal Endangered Species Act on employment in 333 non-metropolitan counties in eleven western states, and found "the hypothesis that endangered species listing has had a negative effect on the non-metropolitan county economies of the U.S. West is not supported by the data."[73] Another study found that "[s]tates with better environmental conditions had significantly higher income growth rates [and] stricter environmental policies did not significantly depress income growth." [74]A third study looked at the impacts of state environmental regulations and found that "interstate differences in environmental regulations do not systematically affect the location of most manufacturing plants."[75]

These findings are not surprising. When environmental resources have been degraded to the point where they jeopardize significant environmental values held by large numbers of people, actions against further degradation and/or incremental restoration to correct past degradation often will yield economic benefits greater than the costs. Many studies have documented this conclusion;[76] we discuss these studies in more detail in Technical Memorandum 2.2.

IV. Looking to the Future

Irrigation's impacts on jobs and income will change in the future. Changes will arise from three main sources: (1) changes in the supply of water available for irrigation alters the amount and location of irrigated agriculture; (2) Changes in irrigated agricultural practices and related activities; and (3) changes in irrigation's externalities.

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[73] Duffy-Deno, K.T. 1997. "Economic Effect of Endangered Species Preservation in the Non-Metropolitan West." *Growth and Change* 28 (Summer): 263-388.

[74] Goetz, S.J., R.C. Ready, and B. Stone. 1996. "U.S. Economic Growth vs. Environmental Conditions." *Growth and Change* 27 (Winter): 97-110.

[75] Levinson, A. 1996. "Environmental Regulations and Manufacturers' Location Choices: Evidence from the Census of Manufactures." *Journal of Public Economics* 62: 5-29.

[76] For an overview, *see* Loomis, J.B. and D.S. White. 1996. "Economic Benefits of Rare and Endangered Species: Summary and Meta-Analysis." *Ecological Economics* 18: 197-206

A. Potential Changes in the Supply of Water

The supply of water available for irrigation may change in response to changes in climate and the outcome of current and potential disputes of the allocation of water.

Climate Change. Potential changes in climate likely will have both positive and negative impacts on the supply of water available for irrigation. Surface water supplies depend heavily on winter snowpack: historically, it has accounted for about 75 percent of Montana's annual water supply. Over the past 50 years, however, typical snowpack has declined 15 to 30 percent and further increases in winter temperatures are expected to cause further reductions.[77]

Water Disputes. Several on-going and pending disputes over the allocation and use of water might alter the total supply of water available for irrigation in the state and/or the supply available to individual groups of irrigators. One major dispute involves Montana's suit claiming that Wyoming has violated the 57-year old Yellowstone River Compact by withholding water from the Tongue and Powder Rivers to the detriment of irrigators and other water users in Montana.[78] A decision favoring Montana could increase the supply of water available for irrigation in Montana, increasing irrigation-related jobs and incomes.

Another dispute involves four oil and gas companies, which sued the State of Montana, claiming its water-quality standards regarding salinity levels, are excessively restrictive and harm business.[79] Whatever the outcome of this suit, the underlying issues likely will affect future supplies of high-quality available for irrigation in areas of the state producing fossil fuels.

A third dispute concerns proposals to mine for coal and coal-bed methane in the Flathead River Basin, north of Glacier National Park, on Canadian territory. Montana claims that the mine production would negatively affect the quality of water in the basin. Some potential impacts might have repercussions for the supply of high quality water for irrigation.[80]

Irrigation Infrastructure. One factor that prompted the present study is concern that the state's irrigation infrastructure, much of which is several decades old and deteriorated, will become dilapidated. In some cases there are fears that the

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[77] Saunders, S. and M. Maxwell. 2005. *Less Snow, Less Water: Climate Disruption in the West.* The Rocky Mountain Climate Organization. September.

[78] "State of Montana v. State of Wyoming and State of North Dakota." U.S. Supreme Court No. 137.

[79] Brown, M. 2007. "Settlement Would Protect Tongue, Exclude Other Waterways." *The Missoulan.* November 5. Retrieved February 12, 2008, from http://www.missoulian.com/articles/2007/11/05/bnews/ br87.txt

[80] "Baucus Wants Investigation into Canada Mine Plan: Senator Asks Secretary of State Rice to Convene International Panel." 2007. March 13. Retrieved February 12, 2008, from http://baucus.senate.gov/ newsroom/details.cfm?id=270551

infrastructure might become inoperable, reducing or eliminating the supply of water for farms that are currently irrigated. Another underlying concern comes from the belief that, with appropriate investment in new infrastructure, additional dry lands could be irrigated in the future.

B. Potential Changes in Irrigated Agriculture

Jobs and income related to irrigation in Montana are likely to change in response to many factors, including the impacts of climate change on farming operations, the evolution of markets for farm products, rising irrigation costs, and technological advances.

Climate Change. Climate change may affect farmers' costs, operations, and crop yields in several ways. Extreme storms and droughts may directly stress plants and reduce crop yields. Intense storms could damage irrigation infrastructure and farmers' fields and crops. Intense drought could have similar impacts, by reducing water supplies.

Changes in precipitation and temperature may alter the suitability of irrigated lands in Montana for growing different crops. Corresponding changes elsewhere may alter the ability to grow some crops elsewhere and, hence, change the demand for crops grown in Montana. These and similar changes could have positive impacts on farm-related jobs and income in Montana, negative change, or both.

Implementation of policies to mitigate climate change could significantly alter the operations of Montana's irrigators. According to the *Montana Climate Change Action Plan*, agriculture in Montana contributed about 9.5 million metric tons of carbon dioxide equivalent in 2000, accounting for a quarter of the total greenhouse-gas emissions. Enteric fermentation, manure management, agricultural soils, and residue burning were responsible for the most emissions in the agricultural sector. The Governor's Action Plan identified several opportunities to decrease the greenhouse gases: production of renewable fuels, protection of agricultural land from conversion to developed use, and promotion of no-till techniques to increase soil carbon content.[81]

Markets. The demand for Montana's agricultural output will continue to evolve, not just in response to climate change but also as global and national demand for farm and ranch products grows and shifts. China, for example, represents both a source of growing demand for some food and fiber products and a source of competing supplies.

Irrigation Costs. Irrigators are likely to see rising costs from several directions. Those who pump water, for example, are likely to see increases in the costs of

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[81] Montana Climate Change Advisory Committee. 2007. *Montana Climate Change Action Plan*. November. Retrieved February 12, 2008, from http://www.mtclimatechange.us/ewebeditpro/items/O127F14041.pdf

energy to power the pumps. All are likely to continue experiencing rising prices for the metals, cement, and other materials needed to construct irrigation infrastructure and equipment. The list of other costs likely to rise is long.

Future subsidies might offset the rise in costs. Many believe that agricultural subsidies will never end; others suggest that subsidies must end soon as the U.S. wrestles with budgetary and international pressure to eliminate them

Technological Advances. It is likely that technological progress—affecting new seeds, irrigation equipment, farm-management practices, and marketing opportunities—will increase the number of opportunities for Montanan irrigators to grow even more crops. Some technologies might increase farm-related jobs and income; others might decrease them.

C. Potential Changes in Irrigation's Externalities

Irrigation's external impacts on jobs and income likely will change in response to two major factors: economic trends, and changes in the scarcity of the goods and services affected by the externalities of irrigated agriculture.

Economic Trends. Montana's recent past offers insights about what to expect of the future. Population growth is likely to continue, and many new residents will want to locate on lands currently used to produce irrigated crops. The state's future residents are likely to have higher levels of income and wealth, characteristics that, in the past, have been associated with greater demand for many goods and services affected by irrigation's externalities. These include greater demand for outdoor recreation, especially water-related recreation, improved levels of air and water quality, lower levels of pollution, open space, pastoral landscapes, scenic vistas, and other natural-resource amenities. Irrigation is likely to increase the supply of some of these goods and services, and to decrease the supply of others. Insofar as the past is prologue to the future, we anticipate that the value of the amenities negatively affected will outpace those that will be positively affected. Hence, there will be increasing economic pressure to curtail the practices of irrigated agriculture that diminish these and other amenities.

Scarcity. Irrigated agriculture will be adversely affected insofar as it diminishes the supply of scarce goods and services and/or as other factors diminish their supply. Especially important will be the impacts of irrigation on threatened or endangered species. Unless attitudes change markedly, the American public is not likely to tolerate irrigation practices that put added pressure on species facing significant risk of extinction. Some scientists predict the cumulative effects of past and future activities—related to agriculture, mining, urban development, logging, etc.—will continue to push some species, such as bull trout, toward extinction. Others predict that climate change will accelerate and broaden the process, so that threats to species already at significant risk of extinction will worsen and more species will face significant risk.

V. DISTRIBUTION OF NET IMPACTS

A description of the net economic benefits and impacts of an investment in irrigation is not complete unless it addresses the distribution of effects among different groups. Any investment will produce winners and losers. Whether one is a winner or a loser will, of course, affect one's assessment of the immediate economic importance of a given investment. Sometimes, though, the distribution has broader consequences. Investments that impose costs on an already disadvantaged group, for example, might be widely seen in a negative light not just by those in that group but by others as well. Past experience indicates that these concerns may be important:

- The gross and net benefits and impacts accruing to tribal members.
- Offsetting consequences among different groups of farmers, with an investment in irrigation benefiting one group at the expense of another.
- Benefits accruing primarily to households with high levels of wealth and income, and costs accruing to households with low levels of wealth and income.
- Differential consequences for rural and urban residents, with one group incurring costs to subsidize the other.
- Benefits accruing primarily to non-Montanans, such as corporate stockholders, and costs accruing to Montanans.