A Research Paper by

HEADWATERS ECONOMICS

The Effects of Climate Change on the Downhill Skiing and Recreational Fishing Economy in the Crown of the Continent

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ABOUT HEADWATERS ECONOMICS

Headwaters Economics is an independent, nonprofit research group whose mission is to improve community development and land management decisions in the West.

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TABLE OF CONTENTS

I. EXECUTIVE SUMMARY

The people living and working in the Crown of the Continent are linked inextricably to the landscape around them. Their jobs and their quality of life come in large part from nearby public lands and privately owned open spaces. Climate change already is affecting the Crown and will continue to do so. The economic consequences of these changes will largely be determined by the ability of land managers, businesses, and residents to maintain the unique experiences and resources of the Crown.

From a land management perspective, the Crown's diverse habitats, vast expanses of public lands, and connections to other wild lands make the region more likely to respond successfully to the changing climate. The ecological advantages are leveraged by human advantages too. The region's extensive public lands also offer a chance for scientists, land-managers, and resource users to coordinate adaptation and mitigation efforts at the landscape-level, the best scale for addressing the broad impacts of climate change. And collaborative efforts like the Blackfoot Challenge offer models for how to coordinate planning efforts among diverse groups of people and across large, privately-owned landscapes.

This report analyzes the region's economy by reviewing published literature, compiling demographic and economic data, and presenting the results of a series of interviews with business owners, land managers, scientists, and advocates in the region. We found that the Crown region is closely tied to both the amenity qualities and productive values of its wild lands and working landscapes. The majority of all new jobs in the region since 1970, for example, are related directly or indirectly to the landscape and the amenities it provides. This close economic link makes the region's jobs and income vulnerable to the potential impacts of climate change.

The Crown's economy has grown and diversified in recent decades, with the majority of jobs and income related to service industries, and to retirement and investment income; but the opportunities associated with these jobs and this income varies geographically within the region. The majority of economic activity is centered in Flathead, Missoula, and Lewis and Clark counties—all of which have small cities with access to larger metropolitan areas. In counties where access to larger job markets is difficult, natural resource sectors—including agriculture and forestry—still play a large role.

This study then examines more specifically the role of downhill skiing and recreational fishing in the Crown's economy. These two sectors play key roles in the tourism industry. While only a small portion of the overall economy, skiing and fishing contribute to the "quality of life" that has attracted families and businesses to the region, contributing significantly to population and job growth.

The impact of climate change on the downhill skiing and recreational fishing industries will be mostly associated with warmer temperatures, reduced snowpack, and the timing of precipitation. Changes in the number and intensity of disturbance events like rain on snow events and floods also will impact skiing and fishing, as well as other economic sectors in the region, such as irrigated agriculture and forestry.

The report concludes by offering recommendations for climate change mitigation and adaptation activities for the downhill skiing and recreational fishing industries as well as for the region as a whole.

For the ski industry, adapting to changing opportunities to provide quality visitor experiences throughout the year is especially important. The industry initially has responded to climate change by looking to increase energy and snowmaking efficiency in order to increase reliable snow coverage, minimize their carbon footprint, and reduce operations costs. Some ski areas are considering—and others have already pursued—more diverse activities that are less subject to variations in snow conditions. These include

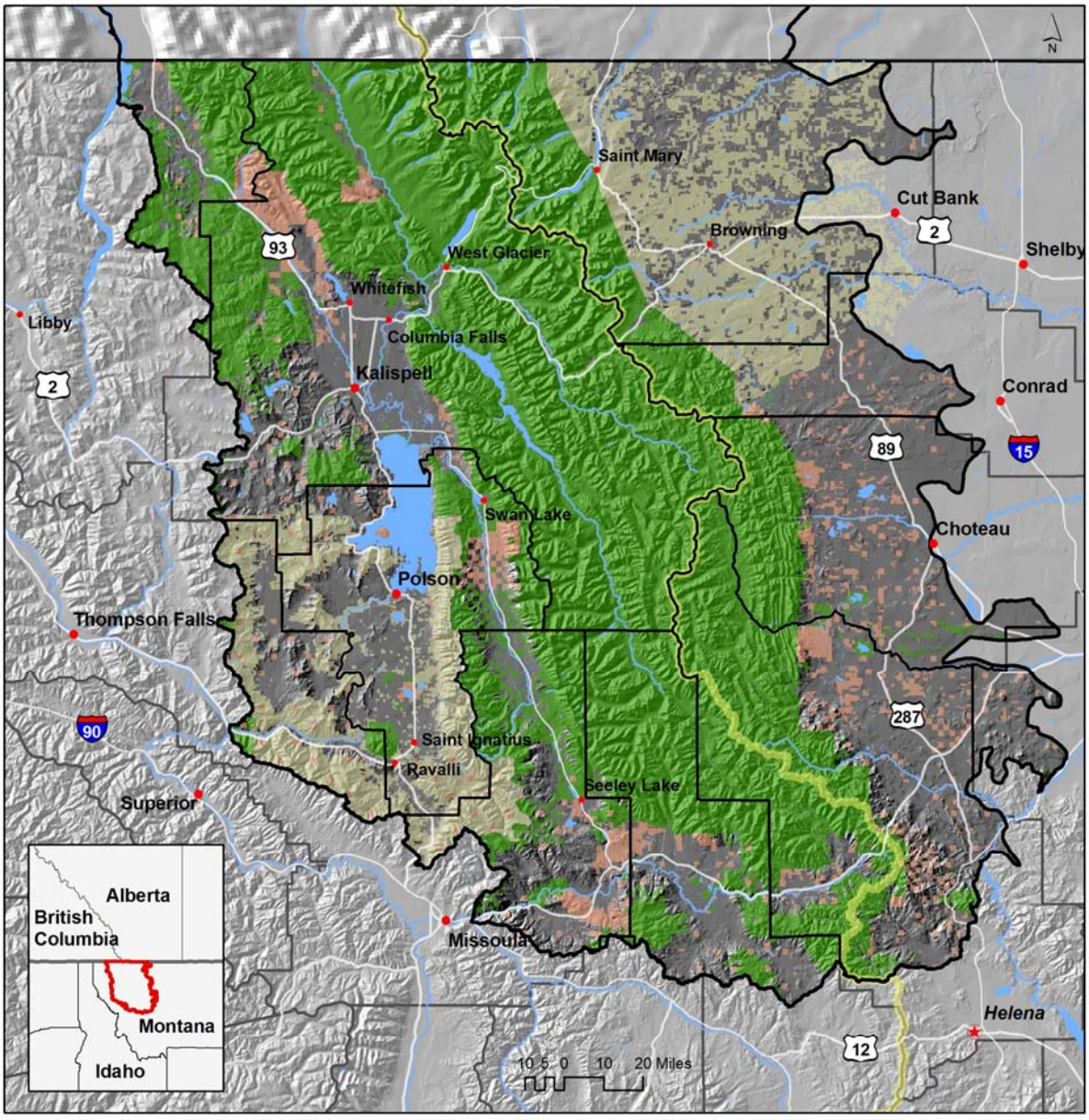
snowshoeing, tubing runs, and terrain parks in winter; and mountain biking, zip lines, festivals, and other events in summer.

For the Crown's recreational fishing industry, offering unique chances to catch trout, and particularly native trout, is of primary importance. Restoring bull and cutthroat trout in the Flathead drainage and the upper Blackfoot, for example, will lead to significant economic opportunities.

The majority of jobs in the region and nearly all the population and income growth over the past 30 years are closely linked to the natural amenities and the natural resources of the Crown. Future activities such as restoration—including removing diversions on rivers, restoring forest health, controlling noxious weeds, and limiting non-native fish—will help mitigate the impacts of climate change while improving the opportunity for the region's economy to adapt and thrive.

Map 1

The Montana Portion of the Crown of the Continent



Federal Public Lands
State Lands
Tribal Lands
Private Lands
Rivers
Lakes
Counties
Limited Access Highway
Principal Highway
State Capital
Population > 10,000
Population < 10,000
Continental Divide

Data Sources: Roundtable on the Crown of the Continent, http://www.crownroundtable.org; US Census; US Geological Survey

World Mercator Projection

Map Date: 1/10/2011

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II. INTRODUCTION

By now it is well known that the centerpiece of the Crown of the Continent, Glacier National Park, is losing its famous glaciers due to increasing temperatures, decreased snowpack, and an earlier onset of spring.[1] In the last century, three-quarters of Glacier National Park's glaciers have melted.[2]

The Crown of the Continent region includes portions of Montana, Alberta, and British Columbia. In this report we focus only on the Montana portion of the region (referred to herein as simply the Crown, or Crown region). We do this for a practical reason: the published data needed to describe economic sectors, such as the downhill skiing and recreational fishing industries and their role in the larger economy, are more readily available in the U.S. portion of the region. Given the similarities in ecological and economic conditions across the border, we believe the findings of this report are also applicable to the Canadian portion of the Crown of the Continent.

Scientists predict that the Crown region's climate will continue to warm and that the way it receives moisture will change significantly. These changes will have a number of broad effects on ecological communities, species, and ecosystem processes at multiple scales. Climate change will also affect the region's residents, their quality of life, and the economy. The Crown of the Continent's public lands provide large blocks of contiguous habitats that have the potential to help facilitate the many dynamic migrations and redistributions that are expected to accompany climate change.[3] Given the broad impacts of climate change, management planning to adapt to such impacts must be coordinated at the landscape-level.

After a brief overview of the land, people, and economy of the Crown region, this report proceeds to a more in-depth review of the role of downhill skiing and recreational fishing in the region. These industries directly depend on snowpack and related run off, so climate change is likely to impact them significantly. While only a small portion of the overall economy, skiing and fishing are harbingers of potential impacts on other sectors—such as irrigated agriculture and forestry—that are vulnerable to changes in snowpack, river flows, and temperature. They also are also important amenities that bring new people and businesses to the region, contributing significantly to population and job growth.

This report is not, in the strict economic sense, an impact analysis of the effects of climate change on downhill skiing and recreational fishing. Rather, this study shows the possible ways that climate change may affect these two important components of the region's economy, and discusses strategies that may be employed in order to adapt to anticipated future conditions.

Climate change presents a significant challenge. We believe this report will help decision makers and residents plan for the future while maintaining the resources integral to the region's economic resiliency.

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[1] Pederson, G. T., Gray, S. T., Ault, T., Marsh, W., Fagre, D. B., Bunn, A., Woodhouse, C. A. and Graumlich, L. J. 2010. Climatic Controls on the Snowmelt Hydrology of the Northern Rocky Mountains, USA. In review. *Journal of Climate*; Stewart, I. T., Cayan, D. R. and Dettinger, M. D. 2005. Changes Toward Earlier Streamflow Timing Across Western North America. *Journal of Climate* 18, 1136-1155; . Barnett, T. P., Pierce, D. W., Hidalgo, H. G., Bonfils, C., Santer, B. D., Das, T., Bala, G., Wood, A. W., Nozawa, T., Mirin, A. A., Cayan, D. R. and Dettinger, M. D. 2008. Human-Induced Changes in the Hydrology of the Western United States. *Science* 319, 1080-1083.

[2] See CNN World, Montana's Melting Glaciers: The Poster Child for Climate Change. October 6, 2010. http://www.cnn.com/2010/WORLD/americas/10/06/montana.glaciers.climate/index.html (last accessed 10/28/10.

[3] A number of groups actively are researching the impacts of climate change to the Crown region, including a number of U.S. Geological Service (USGS) research scientists; the Climate Change in Mountain Ecosystems (CCME) group conducts research in Glacier and the surrounding mountains. See: http://www.nrmsc.usgs.gov/research/global.htm (last accessed 10/28/10). Among the other groups, see the Crown Managers Partnership (CMP), which represents one collaborative effort, http://www.crownmanagers.org/steer.php (last accessed 10/28/10).

III. THE CROWN OF THE CONTINENT

Public lands define the Crown of the Continent, which encompasses more than 10 million acres of healthy, intact wildlands straddling 250 miles of the Continental Divide most of the region is protected as national parks and wilderness areas.

The Crown region is also ecologically and culturally diverse. About 340,000 people live in just the Montana portion of the Crown, which includes the cities of Missoula, Helena, and Kalispell, numerous small towns, extensive privately owned timber and agricultural lands, and the Blackfoot and Flathead Reservations.

The economy has grown and changed significantly during the last 30 years, from one mainly dependent on commodity production to one that now also includes an "amenity" economy, meaning that people are attracted to live in the region in large part because of the quality of life in the small cities and towns and the access to the outdoors. Future economic well being therefore will be closely associated with maintaining the Crown's unique natural values.

This section describes the natural and political geography, demographics, and economy of the Crown. We profile only the Montana portion of the Crown, and most of the data is available at the county scale.

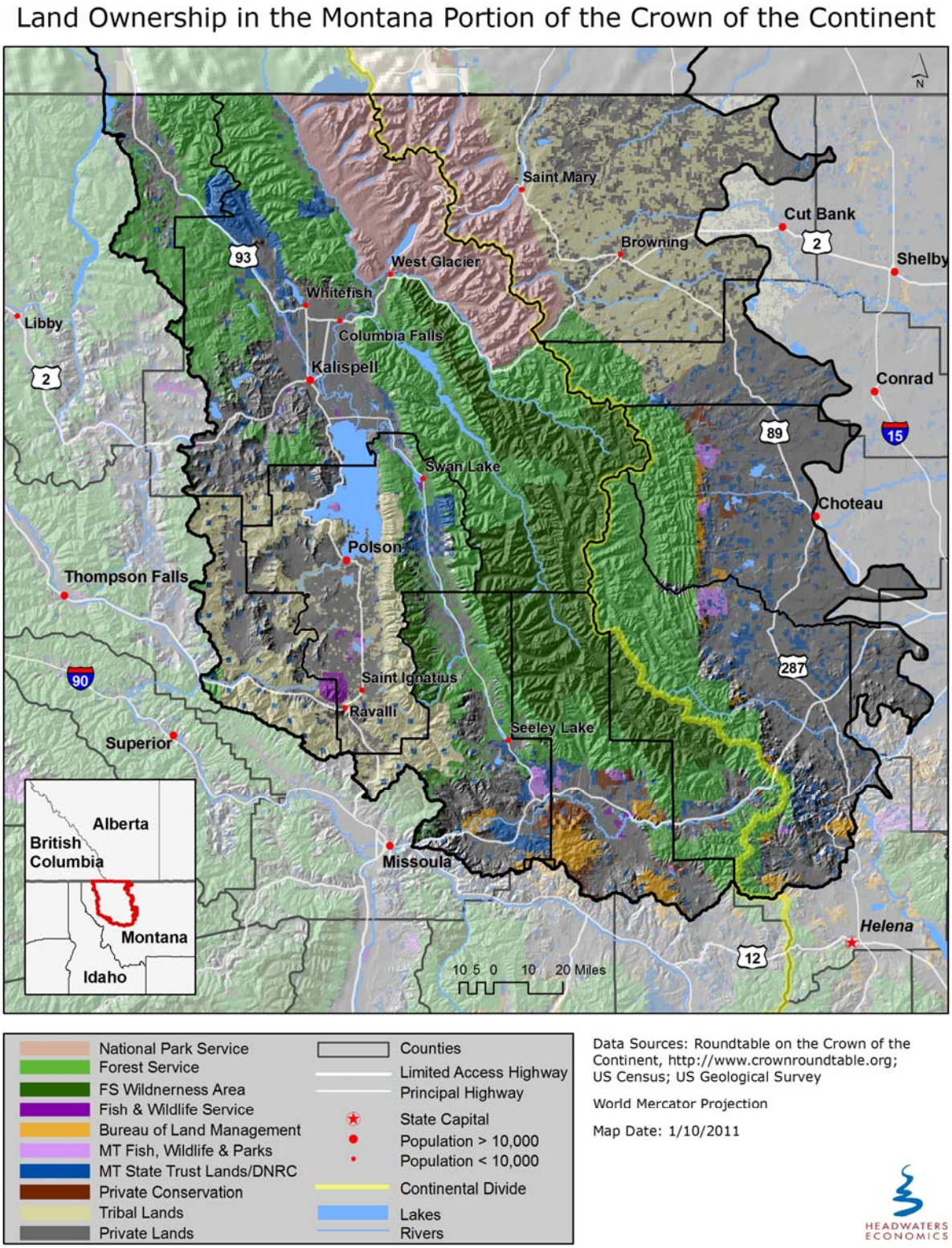
The Land

The Crown of the Continent (Map 2, next page) is a large, relatively intact ecosystem, consisting of 44,000 square kilometers, or 16,000 square miles. The Crown is characterized by the convergence of four climatic zones and a wide elevation gradient, which together create diverse habitats and landscapes, including irrigated farms, rangeland, grassland prairie, cedar rainforests, boreal forests, and alpine tundra. The Crown is the headwaters to the Columbia, Missouri, and Saskatchewan river systems and is known for clean water and healthy aquatic ecosystems that support native trout species along with vast stretches of backcountry that harbor grizzly bears, wolverines, and wolves. [4]

The Crown also serves as part of a larger system of connected wildlands that link wildlife from Yellowstone National Park in Wyoming northward along the spine of the Rockies, through the wild country of Montana, Alberta, British Columbia, and the Yukon. The Crown's connection to other wildland ecosystems, like terrestrial islands running along the Rockies, provides a greater range to animals whose natural movements are altered by climate change.

[4] For a detailed description of the values of the Crown of the Continent and threats to the region see: Clark, M. et. al, 2008. Conservation of the Crown of the Continent Ecosystem. National Parks Conservation Association. Washington, D.C. Crown of the Continent Geotourism Council: http://www.crownofthecontinent.net/ (last accessed 10/28/10). and The Crown of the Continent Ecosystem Education Consortium: http://www.crownofthecontinent.org/coceec.htm (last accessed 6/10/10). Another useful site is the Roundtable on the Crown of the Continent, in particular the list of different initiatives in and around the region: http://www.crownroundtable.org/ (last accessed 6/28/10).

Map 2


Land Ownership in the Montana Portion of the Crown of the Continent
Saint Mary
Cut Bank
Browning
Shelby
West Glacier
Whitefish
Libby
Columbia Falls
Kalispell
Conrad
Swan Lake
Choteau
Polson
Thompson Falls
Saint Ignatius
Ravalli
Seeley Lake
Superior
Missoula
Helena
Alberta
British Columbia
Montana
Idaho
10 5 0 10 20 Miles
National Park Service
Forest Service
FS Wildnerness Area
Fish & Wildlife Service
Bureau of Land Management
MT Fish, Wildlife & Parks
MT State Trust Lands/DNRC
Private Conservation
Tribal Lands
Private Lands
Counties
Limited Access Highway
Principal Highway
State Capital
Population > 10,000
Population < 10,000
Continental Divide
Lakes
Rivers
Data Sources: Roundtable on the Crown of the Continent, http://www.crownroundtable.org; US Census; US Geological Survey
World Mercator Projection
Map Date: 1/10/2011
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In response to changing climatic conditions, many communities and species are expected to shift in latitude and elevation. This dynamic migration means that animals and plants will have to move across large landscapes, so management planning to adapt to such changes must be coordinated at the landscape-level. Scientists expect that the Crown, because of the relatively intact condition of its ecosystems, along with its diverse climactic zones and habitats, may be able to adapt more successfully to climate change impacts than other regions.[5] The large blocks of public lands within the Crown of the Continent provide contiguous habitats that have the potential to help facilitate the many dynamic migrations and redistributions that are expected to accompany climate change.

Consequently, the Crown region—in contrast to more highly fragmented and developed landscapes, where dense human settlement and more discontinuous habitats are likely to inhibit plant and wildlife movement—has great potential for illustrating how species might adapt to climate change by successfully relocating to suitable habitats within a contiguous landscape that spans a wide gradient of environmental and climatic conditions.

Understanding how climate change is likely to impact amenity industries like skiing and fishing are likely to be impacted by climate change is especially important in the Crown Region, because both people and wildlife have the potential to adapt to climate change and prosper in the region.

The federal government manages more than half of the land base in the Crown region (as defined by the nine counties depicted in Map 2), through various agencies, including (see Appendix A for details and data sources):

- National Park Service: 5.3 percent of the region's land base; 15 percent in Flathead County, 18.7 percent in Glacier County;
- Forest Service: 44.1 percent of the region's land base; more than half of the land base in Flathead, Lewis and Clark, Lincoln, and Powell counties; 47.4 percent in Missoula County);
- Bureau of Land Management: 1.3 percent of the region's land base.

One-third of the federal lands (more than 2.8 million acres) can be classified as "highly protected," with permanent land designations in the form of national park, wilderness, and other federal designations that prioritize conservation and strongly limit commercial resource extraction (see Appendix A for county-by-county details, definitions, and data sources).

Thirty-five percent of the land is privately owned; State Trust lands constitute another 4.5 percent; and municipal lands, waterbodies, and tribal lands make up the remainder. Although tribal lands are only 7.5 percent of the region's land base, they are a significant portion of the land in Glacier County (42.5%) and Lake County (29.5%).

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[5] The following reference the important role of public lands in climate change adaptation: CCSP (Climate Change Science Program). 2008. Preliminary Review of Adaptation Options for Climate□Sensitive Ecosystems and Resources (SAP 4.4). Washington, DC: U.S. Environmental Protection Agency. Easterling, W. E. I., B.H. Hurd, and J.B. Smith. 2004: Coping with Climate Change: The Role of Adaptation in the United States. In Change, P. C. editor, Arlington, VA, 40. Kareiva, P., C. Enquist, A. Johnson, S.H. Julius, J. Lawler, B. Petersen, L. Pitelka, R. Shaw, and J.M. West. 2008. Synthesis and Conclusions. In Preliminary Review of Adaptation Options for Climate□Sensitive Ecosystems and Resources (SAP 4.4), edited by CCSP. Washington, DC: U.S. Environmental Protection Agency. U.S. DOI. 2009. Addressing the Impacts of Climate Change on America's Water, Land and Other Natural and Cultural Resources. Order No. 3289. Washington, DC: U.S. Department of the Interior, Secretary of the Interior. September 14. http://www.blm.gov/pgdata/etc/medialib/blm/wy/programs/science.Par.90488.File.dat/SO_3289.pdf (last accessed 10/25/10).

The People

The Crown region is home to 337,357 people, most of who (three-quarters of the population) live in Flathead County (Kalispell), Missoula County (Missoula) and Lewis and Clark County (Helena). More than 80 percent of economic activity, measured in terms of the proportion of jobs and personal income, are in these three counties.[6] The counties included in the demographic and economic profile include (population in parenthesis): Flathead (89,104 people), Glacier (13,361), Lake (28,373), Lewis and Clark (61,156), Lincoln (18,751), Missoula (107,552), Pondera (5,852), Powell (7,036), and Teton (6,171).[7]

The region is relatively urbanized despite the rural appearance of the landscape. Kalispell and Helena are both defined by the U.S. Census Bureau as micropolitan areas (defined as having one urban cluster of at least 10,000 but less than 50,000 people) and Missoula is defined as metropolitan (defined as having at least one urbanized area of 50,000 or more inhabitants). Phrased another way, despite the many small towns scattered throughout the region, three-quarters of the residents do not live in a rural area.[8]

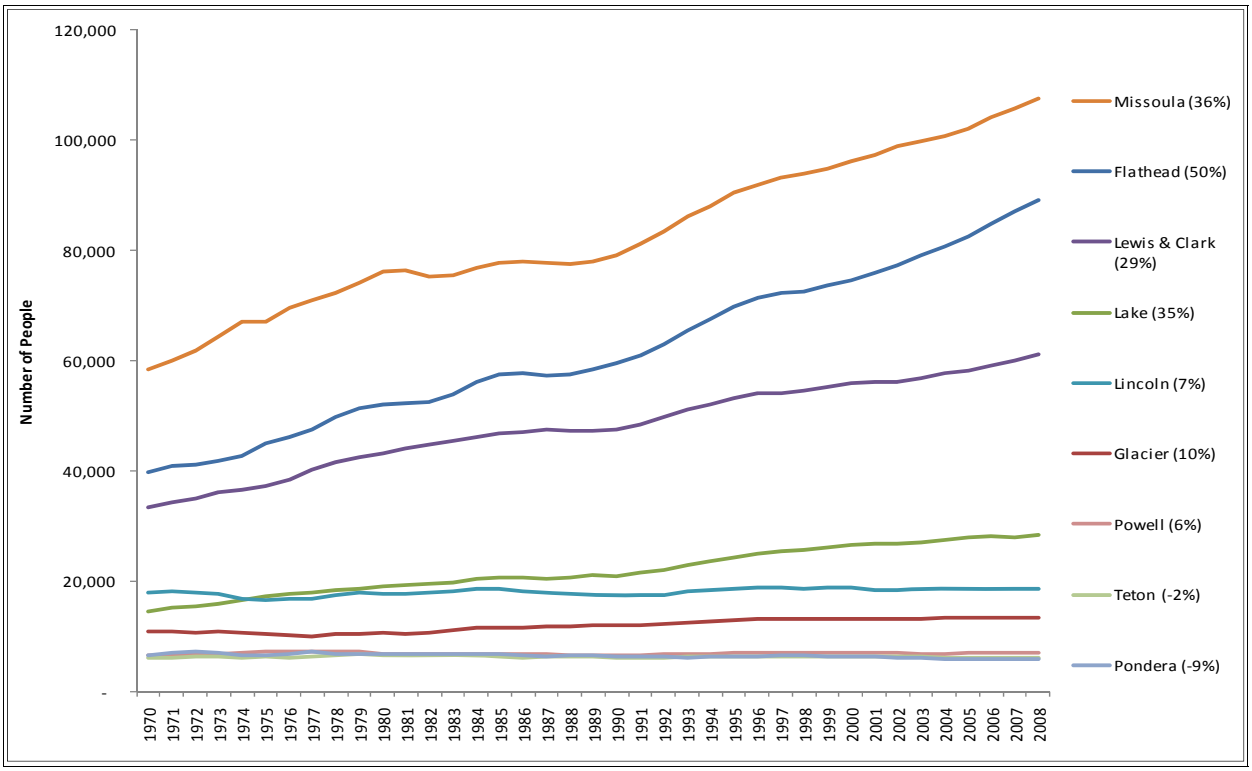
A number of Native American tribes live in the Crown region, including the Kootenai, Blackfeet, Flathead, Pend d'Oreille and Salish. There are two large reservations in the Montana portion of the region: the 7,800-square-kilometer (3,000-square-mile) Blackfoot Indian Reservation, primarily in Glacier County, and the almost 5,300-square-kilometer (2,030-square-mile) Flathead Indian Reservation.[9]

Overall the Crown has been a fast-growing region, though the growth rate in some counties has been slower than the region as a whole.[10] From 1970 to 2008, the population of the Crown grew by 73 percent, compared to 49 percent for the nation; total jobs grew by 180 percent (99% for the nation), and real personal income grew by 198 percent (164% for the nation).[11]

Figure 1 shows population change in the Crown. Since 1990, the population has grown by an additional 81,000 people, with 90 percent of the growth in three counties: Flathead, Lewis and Clark, and Missoula. Two counties, Pondera and Teton, lost population since 1990 (these also have the highest proportion of employment in agriculture: 154% and 19.7%, respectively).

[6] County jurisdictions do not follow watershed or ecological boundaries, and therefore the nine-county region as defined here is somewhat larger than the boundaries of the Crown of the Continent. Population figures are from U.S. Department of Commerce. 2010. Bureau of Economic Analysis, Regional Economic Information System, Washington, D.C. (BEA/REIS 2010).
[7] BEA/REIS 2010.
[8] In this paper "rural" is defined as neither micropolitan nor metropolitan. For official definitions, see U.S. Census Bureau: http://www.census.gov/population/www/metroareas/aboutmetro.html (last accessed 6/10/10).
[9] See Appendix C for data sources.
[10] During the same period of time the population of Pondera County declined by 12.7 %. The slowest-growing county was Teton County, where the population grew by only 0.7% from 1970 to 2008.
[11] BEA/REIS 2010.

Figure 1: Population in counties of the Crown Region, 1970 to 2008
(% change 1990 to 2008 in parenthesis)



Source: BEA/REIS 2010.

The Economy

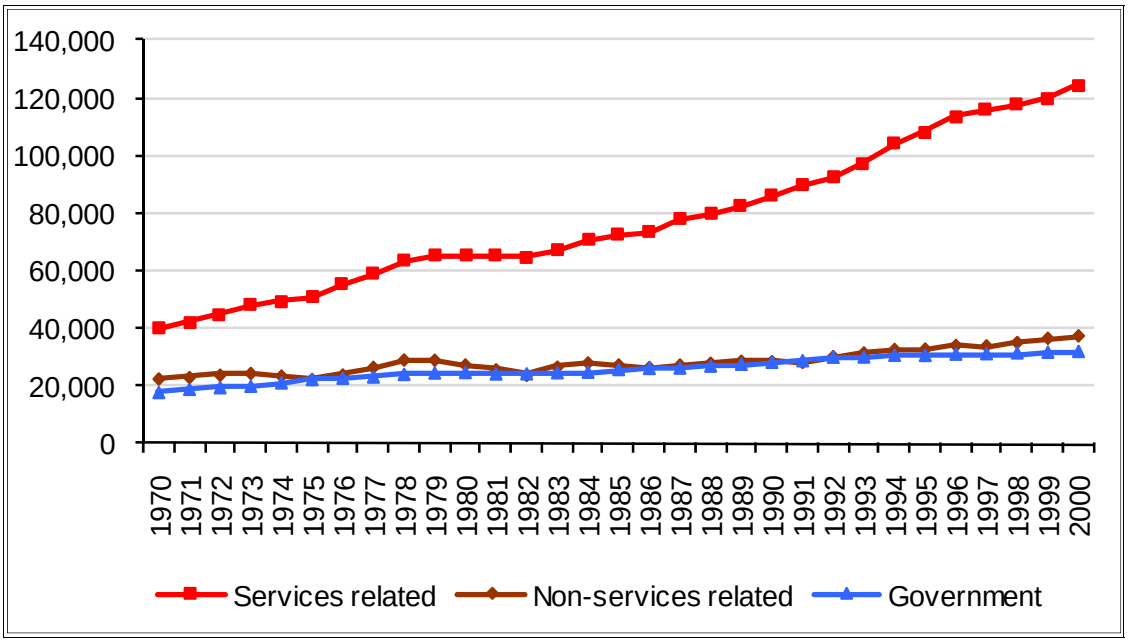
The Crown's economy hinges on both the amenity qualities and productive values of the region's wildlands and working landscapes. Economic opportunities for residents vary, depending largely on access to markets and level of education.

Throughout the Crown region, the economy has moved beyond its historical dependence on farming, ranching, mining, and the wood products industry. In 2008, 4 percent of total direct jobs in the region were in timber and mining, including oil and gas. In a few counties, this percentage was higher: the proportion employed in the timber sector was 20 percent in Powell County, followed by 8 percent in Lincoln County. The most mining-dependent county, with 7 percent of total employment in oil and gas production, was Glacier County.[12] Agriculture, which includes farming and ranching, constitutes 2.7 percent of all jobs in the region, with significant variability from county to county. The highest proportion of agricultural jobs is in Teton County (20%), followed by Pondera County (15%) and Powell County (9.3%).[13]

Figures 2 and 3 show that the bulk of new jobs in the Crown have been in service-related occupations.[14]

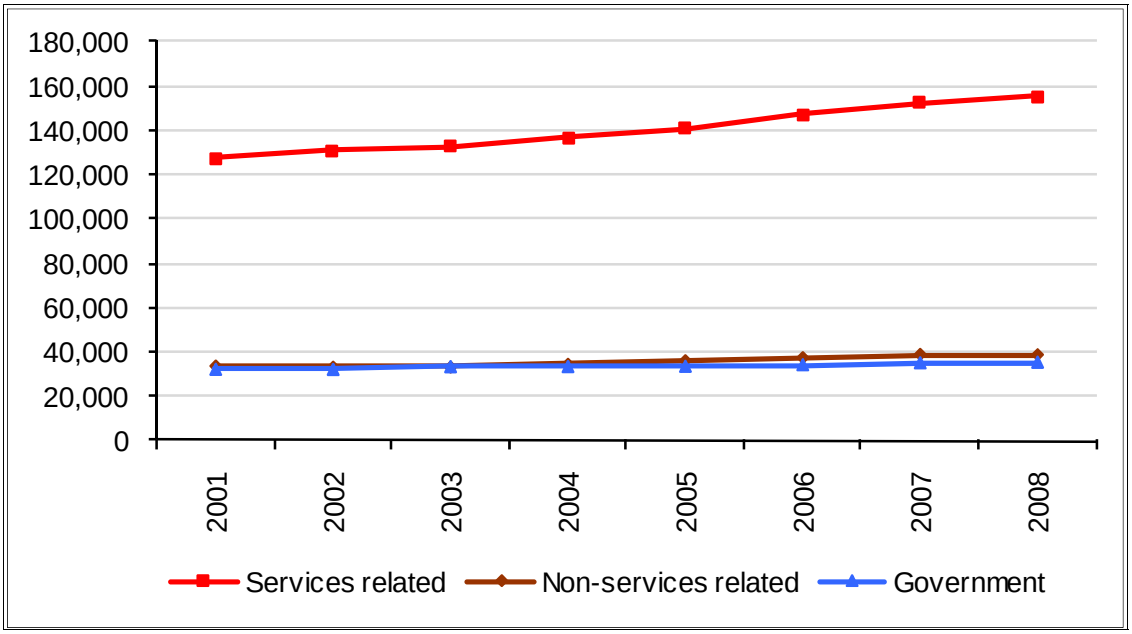
[12] U.S. Department of Commerce. 2010. Census Bureau, County Business Patterns, Washington, D.C. (CBP).
[13] BEA/REIS 2010.
[14] Long-term trends have to be shown in separate figures because beginning in 2001 the U.S. Department of Commerce switched to a different method of organizing data, which is not completely backward compatible with historical data.

Figure 2: Employment by Major Category in the Montana Portion of the Crown of the Continent, 1970 to 2000.



Source: BEA/REIS 2010.

Figure 3: Employment by Major Category in the Montana Portion of the Crown of the Continent, 2001 to 2008.



Source: BEA/REIS 2010.

From 1970 to 2000, jobs in services-related industries grew from 40,185 to 124,316, a 209 percent increase, while jobs in non-services-related industries grew from 22,763 to 37,054, a 63 percent increase.

During the same time, government jobs grew from 17,889 to 31,628, a 77 percent increase.
From 2001 to 2008, jobs in services-related industries grew from 127,533 to 155,336, a 22 percent increase, while those from non-services-related industries grew from 33,650 to 38,721, a 15 percent increase. During the same time, government jobs grew from 32,225 to 35,281, a 9 percent increase.

Service Industries

Region-wide, service-related industries accounted for 67 percent of all jobs in 2008. There is significant variability in service-related jobs, which include high-wage (e.g., engineers, architects) and low-wage occupations (e.g., leisure and hospitality workers). In Missoula County, for example, the average service-related job pays more than $30,000 per year and some of the highest paying jobs in the county are service-related (for example, information and financial services pay over $40,000 per year and professional and business services pay $38,500 annually). In contrast, average service-related sectors in Glacier County pay $24,700 per year, compared to more than $48,000 in mining in that county ("mining" in Glacier County is primarily related to oil and gas).[15]

Role of Government Jobs

Government jobs represented 15 percent of total jobs in the region in 2008. In some communities, government employment is a significant component of the economy; in Glacier County 37 percent of jobs are in government, followed by 30 percent in Powell. In Lewis and Clark County, which contains Helena, the capital of Montana, 24 percent of jobs are in government. In some places, federal jobs, including those related to public lands, are the highest paying in the county. In Glacier County, for example, federal jobs pay, on average, $54,850 per year (compared to an average for all occupations of $27,263, and higher than mining jobs; federal jobs in the county are also twice as numerous as oil and gas jobs).[16]

Non-Labor Income

Another important element in the economy is the growing presence of non-labor income, which consists of dividends, interest and rent (earnings from investments), and government transfer payments (primarily related to aging, such as federal retirement payments). In the Crown region, non-labor income represented 39.5 percent of all personal income in 2008. From 1970 to 2008, non-labor income contributed 46 percent of all net new dollars in the region. In other words, close to half of the growth in the economy can be explained by retirement and investment income.[17]

In summary, direct jobs in the region in 2008 were distributed as follows: agriculture (2.7%); resource extraction (mining, oil, gas, forestry; 4%); service (67%) and government (15%). The remaining 11 percent consists of non-forestry related manufacturing and construction. In terms of personal income, 39.5 percent of all personal income in 2008 was from non-labor sources.

[15] U.S. Department of Labor. 2010. Bureau of Labor Statistics, Quarterly Census of Employment and Wages, Washington, D.C. (BLS)
[16] *Ibid.*
[17] BEA/REIS 2010. Non-labor income, as counted by BEA/REIS, is an underestimate of the contribution of retirement income because it does not include private pensions and savings, such as 401ks.

The Economic Role of Amenities

A large body of literature shows a strong link between economic growth and the presence of protected lands and the environmental and recreational amenities they provide.[18] People have discovered that communities adjacent to national parks, wilderness areas, and free-flowing rivers are desirable places to live. The transformation from extraction economies to attraction economies [in the West?] began in the late 1980s and accelerated the following two decades, transforming many formerly rural, resource depended economies into more diverse service-based economies.

The diversification of the economy and the growth of service-related occupations and non-labor income are the result of a number of factors, including:

- The ability of some professionals, such software developers, financial consultants, engineers, architects and other so-called "knowledge-based" occupations to "de-couple" from the city and the factory floor, thereby becoming "footloose," able to live (almost) anywhere;

- The advancement of telecommunications technology, efficient delivery services (e.g., FedEx, UPS), and the growth of regional transportation networks (especially airports), which make it possible for people to live in more remote, "rural" locations than they could 10 or 20 years ago;

- The scattering of the global assembly line, where the factory can be at one end of the world, and the entrepreneurs, managers, marketers, designers, and other "footloose" occupations can reside in Missoula, Kalispell, Helena, or even in smaller places like Polson or Chouteau;

- The rising affluence of the baby boom generation;[19]

- An aging population, both the World War II generation and especially the retiring baby boomers, who, with their savings, investments, and business connections, relocate to places with a high quality of life to either retire, semi-retire, or open a business;[20]

- The increased demand for outdoor recreation;

- The relative scarcity of, and rising demand for, places with a high quality of life that includes vast wide-open spaces and pristine environment.

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[18] See, for example: Cromartie, J.B. and J.M. Wardwell. 1999. Migrants Settling Far and Wide in the Rural West. *Rural Development Perspectives.* Vol. 14(2), 2-8; Beyers, W.B., D.P. Lindahl, and E. Hamill. 1995. Lone Eagles and Other High Fliers in the Rural Producer Services. Paper presented at the Pacific Northwest Regional Economic Conference, May 1995, Missoula, Montana; Fuguitt, G.V. and C.L. Beale. 1996. Recent Trends in Nonmetropolitan Migration: toward a New Turnaround? *Growth and Change.* Vol. 27, 156-174; McGranahan, D.A. 1999. Natural Amenities Drive Population Change. Food and Rural Economics Division, Economic Research Service, U.S. Department of Agriculture. Report 781, 1-24;; Hansen, A.J, R. Rasker, B,. Maxwell, J.L. Rotella, J.D. Johnson, A. Wright Parmenter, U. Langer, W. B. Cohen, R. L. Lawrence, and M. P.V. Kraska. 2002. Ecological Causes and Consequences of Demographic Change in the New West. *BioScience.* Vol. 52(2), 151-162. For a list of studies on the economic role of protected public lands, see: http://www.headwaterseconomics.org/protectedlands.php (last accessed 11/10/10).

[19] The 1990s created $33 trillion in new income – an unprecedented amount in US history. By 2052 there will be a wealth transfer of $40.6 trillion from baby boomers and their parents to the younger generation. This in turn will stimulate other sectors of the economy, like construction, recreation and tourism, retail trade, and medical services. See: *Baby Boomer Wealth Transfer*, Insurance Journal. February 23, 2004. http://www.insurancejournal.com/magazines/west/2004/02/23/features/37126.htm?print=1 (last accessed 7/7/10).

[20] The Economic Research Service of the U.S. Department of Agriculture found that from 1990 to 2000, the net migration of baby boomers was the highest in places that had the highest natural amenity score. See: Cromartie, J. and P. Nelson. 2009. Baby Boom Migration and Its Impact on Rural America. Economic Research Service, Report Number 29. Washington, D.C.

Many Crown residents consider skiing and fishing—the two economic sectors this report focuses on—both central to their quality of life and to their decision to live in the region. The economic impact of these sectors thus extends beyond direct expenditures on items such as ski lift tickets and fishing gear to include their value as recreational and environmental amenities, and their ability to attract people and businesses to the Crown.

However, economic success requires more than just environmental amenities. Recent studies have shown that it is easier to capitalize on environmental amenities if the local economy also has access to larger markets, especially via air travel.[21] For many communities the combination of amenities and access to markets is a combination that leads to very rapid economic growth. This is a large part of the reason why Flathead, Lewis and Clark, and Missoula counties, with their large commercial airports, are responsible for most of the growth, and contain three-quarters of the population, jobs and personal income in the region.

A good example of the combination of environmental and recreation amenities and a large commercial airport is Flathead County, where 42.8 percent of the land base is in federal protected status, in the form of wilderness and national park. In the last few decades, tourists, footloose businesses and other entrepreneurs, and retirees "discovered" the county, resulting in explosive growth. From 1970 to 2008, the county's population more than doubled (124% increase), while employment and real personal income more than quadrupled (300% increase).[22] Similar patterns of growth occurred in Lake, Lewis and Clark, and Missoula counties. (See Appendix B.)

[21] For a discussion of the role of amenities in business location, including the limitations of this theory of economic development, as well as the importance of air travel, see: Rasker, R., P.H. Gude, J.A. Gude, J. van den Noort. 2009. The Economic Importance of Air Travel in High-Amenity Rural Areas. *Journal of Rural Studies*. 25(2009), 343-353.
[22] BEA/REIS 2010.

The Economic Contributions of Travel and Tourism

Outdoor recreation is a large and fast-growing part of the U.S. economy. According to a report produced by Southwick Associates for the Outdoor Industry Foundation, outdoor recreation in 2006 contributed $730 billion to the national economy. Across the country, expenditures by recreationists created nearly 6.5 million jobs and generated $88 billion in state and local taxes.[23]

Travel- and tourism-related activity is also an important component of the Crown region's economy; these activities depend heavily on a high-quality natural environment. Outdoor recreation is an integral part of the local culture and for many a principle reason for living in the region. It is also a big draw for visitors who participate in a wide variety of activities, including fishing and skiing, whose economic impact is substantial. According to the University of Montana's Institute for Tourism and Recreation Research (ITRR), in 2008 non-resident travelers to Montana spent $2.7 billion, resulting in 31,000 tourism-related jobs and $181 million in state and local taxes.[24]

In 2008, the counties of the Crown region received more than $805 million in spending from non-resident visitors, resulting 8,983 tourism-related jobs and $452.1 million in state and local taxes. Close to one-third (28%) of all non-residents' expenditures in Montana are made in the nine-county Crown region. More than 90 percent of these expenditures were in four counties: Flathead, Lewis and Clark, and Glacier. Two counties—Flathead and Missoula—receive 75 percent of all expenditures.[25] Figure 4 shows the 2005 average group expenditures by nonresident travelers, by county.

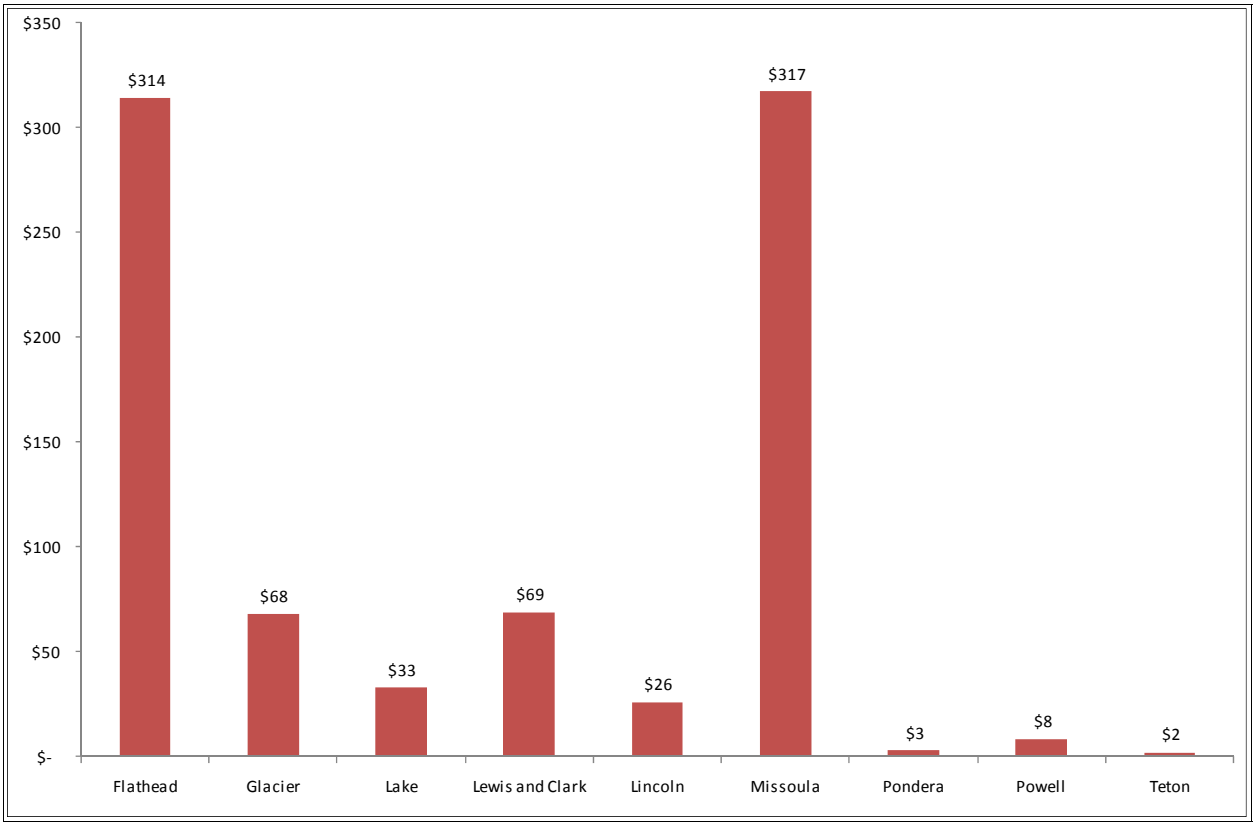
As it has most sectors of Montana's economy, the recession has also affected tourism. Figure 5 shows the long-term trends in expenditures by nonresident travelers to the state, and to the nine-county Crown region. From 2004 to 2007, before the recession, expenditures grew, in real terms, by 44 percent. From 2007 to 2009, they declined by a third.[26]

Downhill skiing and recreational fishing—the principle topics of this report—are an important part of tourism in Montana. According to one estimate, recreational fishing alone created 4,556 jobs and $23.6 million in state and local taxes in Montana in 2006.[27] A recent study showed that downhill skiing in the 2009–2010 winter season contributed $83 million to Montana's economy. Expenditures by nonresident travelers contributed to more than 1,000 jobs and $43 million in employee, property, and other property income.[28]

[23] Outdoor Industry Foundation. 2006. The Active Outdoor Recreation Economy. http://www.outdoorindustry.org/research.php?action=detail&research_id=26 (last accessed 7/7/10).
[24] Institute for Tourism and Recreation Research. 2010. 2008 Montana Nonresident Traveler Economic Impacts and Expenditures. (ITRR 2010). http://www.itrr.umt.edu/index.html (last accessed 6/15/10).
[25] Institute for Tourism and Recreation Research. 2005 Nonresident Visitor Data Set. http://www.itrr.umt.edu/reportBuilder.htm (last accessed 6/15/10).
[26] *Ibid.* http://www.itrr.umt.edu/nonres/09NonresExpendTrends.pdf (last accessed 10/15/10).
[27] Allen, T. and R. Southwick.2008. Sportfishing in America. Southwick Associates and the American Sportfishing Association. Alexandria, Virginia. http://www.asafishing.org/images/statistics/resources/Sportfishing%20in%20America%20Rev.%207%2008.pdf (last accessed 7/7/10).
[28] Nickerson, N. and K. Grau. 2010. 2009-10 Ski Season: Economic Impact and Skier Characteristics: Montana. Institute for Tourism and Recreation Studies. Research Report 2010-3. University of Montana. http://www.itrr.umt.edu/research10/MTAlpineSkiReport0910RR2010_3.pdf (last accessed 7/9/10).

Outdoor recreation is also important to Montana residents. In 2005, Montanans took 10.5 million pleasure trips (up from 9.2 million trips in 1997).[29] When surveyed about the purpose of their trip, 19 percent did so for outdoor recreation; 17 percent participated in fishing, and 6 percent in downhill skiing.[30]

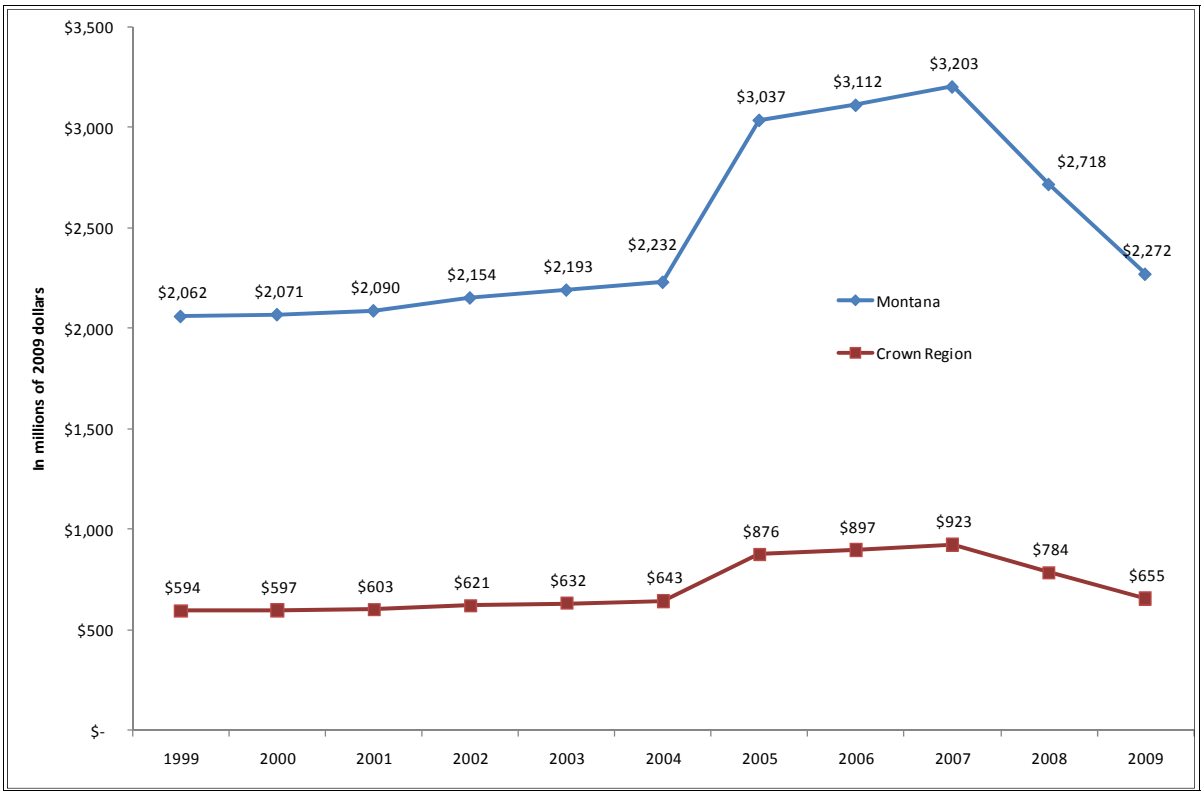
Figure 4: Nonresident Traveler Expenditures (Average Daily Group) by County in the Montana Portion of the Crown of the Continent, 2005.



Source: ITRR 2010. County estimates derived from on-line "report builder" tool: http://www.itrr.umt.edu/reportBuilder.htm (last accessed 10/15/10).

[29] Niche News: MT Resident Pleasure Travel Trip Volume – 2005. ITRR. http://www.itrr.umt.edu/NicheNews06/ResPleasureTripVol.pdf (last accessed 8/9/10).
[30] Niche News: 2005 Montana Resident Recreation. ITRR. http://www.itrr.umt.edu/NicheNews06/ResRec.pdf and Niche News: 2005 Montana Resident Travel. ITRR. http://www.itrr.umt.edu/NicheNews06/ResTravelfullyear.pdf (last accessed 8/9/10).

Figure 5: Total Expenditures by Nonresident Travelers in Montana and the Montana Portion of the Crown of the Continent, 1990 to 2009.



Source: ITRR 2010: http://www.itrr.umt.edu/nonres/09NonresExpendTrends.pdf (last accessed 10/15/10). The proportion of expenditures in the Crown region was assumed to remain the same as in 2005 estimates from ITRR. 2009 statewide expenditure figures are estimates by ITRR.

IV. THE POSSIBLE CONSEQUENCES OF CLIMATE CHANGE

Across the Crown region, average temperatures over the past century have warmed two to three times faster than global increases. The ecological impacts are already evident.[31] Warming has resulted in reduced snowpack, more precipitation falling as rain instead of snow, earlier onset of peak spring runoff, increased frequency of winter and spring flood events, and increased occurrence of summer droughts and low summer flows in rivers and streams. These trends are expected to continue into the future.[32]

Because of these changes, drought has been a growing concern in Montana, and a common question among Montanans at the end of the winter is: What is our snowpack?[33] If not 100 percent of normal, it causes concerns about drought, less water in the streams for fish, lower water flows for irrigation, and the seemingly inevitable and increasing conflicts over water demands. In recent years, for example, because of drought and competing demand for water among farmers and ranchers, recreational anglers, and fishing guides, the Montana Department of Fish, Wildlife and Parks (FWP) has had to impose seasonal closures on a number of rivers, including several population blue ribbon trout fisheries.

Montana's Department of Environmental Quality has phrased the concerns as follows:

> In Montana, the availability of adequate late-summer instream flows is an important consideration to the health and viability of certain fish species. Over the past two decades, Department of Fish, Wildlife & Parks managers and fisheries biologists have called for an alarming number of mid- and late-summer fishing closures on certain streams to protect the resources. Drought conditions in recent seasons have led to diminished access to other forms of water recreation as well, such as boating and rafting. Drought conditions also affect agricultural production. The allocation of water becomes more contentious as the resource becomes scarce. Drought conditions put government and tribal holders of instream rights at odds with historic consumptive uses for agricultural purposes. Low stream flows and warmer temperatures also may allow invasive species to advance while forcing native species to retreat to higher elevation waters.[34]

For most of the year, Montana is relatively dry, and seasonal snow accumulation at upper elevations and water from melting snowpack sustain both terrestrial and aquatic environments. Because mountain snowpack acts as a reservoir of water for spring and summer flows, decreased winter and spring snowpack results in less water availability in the summer for aquifer recharge and for inputs to rivers and streams. These changes will likely have significant impacts on people who use water and stream resources, including ranchers, farmers, boaters, fishermen, and outfitters, and the many businesses that rely on snow and water resources.

[31] Peterson et al. 2010.
[32] Peterson et al., 2010; Ibid, Barnett et al., 2008; Selkowitz, D. J., Fagre, D. B. and Reardon, B. A. 2002. Interannual Variations in Snowpack in the Crown of the Continent Ecosystem. *Hydrological Processes* 16, 3651-3665; Stewart, I. T., Cayan, D. R. and Dettinger, M. D. 2005. Changes Toward Earlier Streamflow Timing Across Western North America. *Journal of Climate* 18, 1136-1155. Knowles, N., M. D. Dettinger, and D. R. Cayan. 2006. Trends in Snowfall Versus Rainfall in the Western United States. *Journal of Climate* 18:4545–4559.
[33] According to Montana's Department of Environmental Quality, Montana experienced extended drought conditions for the seven-year period from 1999 to 2006, and we may yet remain in a drought cycle perhaps one linked to global warming. http://deq.mt.gov/ClimateChange/NaturalResources/Water/Drought.mcpx (last accessed 7/9/10).
[34] *Ibid.*

According to one estimate, up to 75 percent of stream water in the West originates in snowpack. A decreased snowpack could affect the wood products industry, agriculture, and municipal water supplies.[35] It also could affect the two industries that are the focus of this report: skiing and recreational fishing. For those who enjoy skiing and who depend on the industry for a living, a healthy snowpack is an indication of another good ski season. For anglers, fishing guides, and anyone who sells goods and services to them, a normal, predictable snowpack means water in the streams and healthy fish populations.

Warming temperatures during the past century have already influenced a number of environmental conditions that have profound implications for Montana's water resources. Increased temperatures, especially spring and summer temperatures, have decreased the winter snowpack and caused earlier spring snowmelt and lower summer flows.[36] Average temperatures in Montana from 2003 to 2007 were 2.1°F higher than the average temperature during the twentieth century. One of the consequences is a shift in the timing of precipitation.[37] According to one estimate, a 2 to 3.4°F increase in temperature from 1950 to 2009 reduced snowpack throughout the West, and shifted snowmelt one to three weeks earlier in the year.[38]

These changes are occurring at rates two-to-three times the global average and are expected to result in decreased groundwater recharge and reduced inputs to rivers and streams, further contributing to low late-summer flows.[39] Year-to-year variability in streamflows is increasing. Extreme precipitation events such as winter floods have also increased in the Crown region, even as persistent drought conditions are occurring more frequently.[40]

In the future, the climate of the Crown will be warmer and possibly wetter during winter months, but with a higher proportion of the moisture arriving in the form of rain rather than snow and an increased frequency of summer drought conditions.[41] Model projections for the Crown region suggest that annual temperatures will increase by 4°F.[42] A key finding from model projections is that even modest temperature increases will have dramatic impacts on water availability for much of the Crown region: an annual average increase of only 2 to 3°F will result in increased rates of evapotranspiration that are not expected to be offset by precipitation (even where precipitation is projected to increase), which will cause

[35] Running, S. 2010. Impacts of Climate Change on Forest of the Northern Rocky Mountains. Bipartisan Policy Center. University of Montana, Missoula, Montana. http://www.bipartisanpolicy.org/library/research/impacts-climate-change-forests-northern-rocky-mountains (last accessed 6/15/10).
[36] Stewart et al., 2005; Barnett et al., 2008.
[37] Saunders, S., C. Montgomery, T. Easley, and T. Spencer. 2008. Hotter and Drier: the West's Changed Climate. The Rocky Mountain Climate Organization and Natural Resource Defense Council. http://www.nrdc.org/globalWarming/west/fwest.pdf (last accessed 6/15/10).
[38] University of Washington, Climate Impacts Group: http://www.ipcc-wg1.unibe.ch/ (last accessed 6/15/10).
[39] Pederson et al., 2010; Haak et al., 2010; Stewart et al., 2005; Rood, S. B., Pan, J., Gill, K.M., Franks, C.G., Samuelson, G.M., and Shepherd, A. 2008. Declining Summer Flows of Rocky Mountain Rivers-Changing Seasonal Hydrology and Probable Impacts on Floodplain Forests. *Journal of Hydrology* 349, 397-410; Luce, C. H. and Holden, Z. A. 2009. Declining Annual Streamflow Distributions in the Pacific Northwest United States, 1948-2006. *Geophys. Res. Lett.* 36.
[40] McCabe, G. J., Palecki, M. A. and Betancourt, J. L. 2004. Pacific and Atlantic Ocean influences on Multidecadal Drought Frequency in the United States. *Proceedings of the National Academy of Sciences of the United States of America* 101, 4136-4141; Pagano, T., and Garen, D. 2005. A Recent Increase in Western U.S. Streamflow Variability and Persistence. *Journal of Hydrometeorology* 6, 173-179; Hamlet, A. F., and Lettenmaier, D.P. 2005. Production of temporally consistent gridded precipitation and temperature fields for the continental United States. *Journal of Hydrometeorology* 6, 330-336.
[41] According to the Intergovernmental Panel on Climate Change (IPCC) there is a greater than 95% chance that human activities, such as greenhouse gas emissions, aerosols, and land surface changes, have exerted a substantial net warming influence on climate since 1750: http://www.ipcc-wg1.unibe.ch/ (last accessed 6/15/10). For a summary of IPCC findings, see the University of Washington's Climate Impacts Group: http://www.ipcc-wg1.unibe.ch/ (last accessed 6/15/10).
[42] Ray, A. J., J.J. Barsugli, K.B Averyt, K.Wolter, M. Hoerling. 2008. Colorado Climate Change: A Synthesis To Support Water Resource Management and Adaptation. Boulder, Colorado: A report for the Colorado Water Conservation Board by the NOAA-CU Western Water Assessment, 52.

increased drought severity, duration, and frequency.[43] Thus, it seems likely that decreased water availability, linked to declines in snowpack and increased drought conditions, will have important impacts on a number of industries that rely on snow and water resources.

While temperatures are predicted to generally increase across the landscape in the coming decades, potential changes in precipitation for the Crown region are less well understood, but seem likely to lead to conditions similar to those predicted by a temperature increase. Models generally predict increased winter precipitation for parts of the Northern Rocky Mountains.[44] The Intergovernmental Panel on Climate Change (IPCC) predicts that Montana will experience a 10 percent increase in precipitation during the winter months and a 10 to 15 percent decrease in precipitation during the summer, but the uncertainty associated with these predictions is high.[45] Changes in precipitation patterns are predicted to include a greater proportion of winter precipitation falling as rain than snow,[46] decreased snow season length at most elevations, decreased spring snowpack, earlier snowmelt runoff and peak streamflows,[47] increased frequency of droughts and low summer flows,[48] and amplified dry conditions due to increased evapotranspiration, even in places where precipitation increases, as mentioned above.[49] These changes have important implications. Historically, moisture delivered through snowmelt provided inputs to aquifers, rivers, and streams gradually throughout the summer.

In contrast, rain—especially if it falls on top of snow in the winter and in large amounts in the spring and summer—is not stored in high elevations the way snow is, and therefore flows off the land more rapidly. As a consequence, rather than high elevation snowpack (including glaciers) replenishing the soil and keeping it moist throughout the summer, climate scientists predict that land in the Crown will be saturated early in the year and then dry up much sooner than in the past.

Changes That Have Already Occurred

Research by leading climate scientists shows that the following changes already are occurring:

- Rising temperatures (2 to 3°F since 1900);
- Less snow, more rain;
- Less water stored in snowpack;
- Early spring snowmelt and peak runoff;
- Lower stream flows in summer.

[43] McWethy, D. B., Gray, S. T., Higuera, P. E., Littell, J. S., Pederson, G. T., Ray, A. J., Whitlock, C. 2010. Climate and terrestrial ecosystem change in the U.S. Rocky Mountains and Upper Columbia Basin: Historical and future perspectives for natural resource management, *National Park Service, Natural Resource Report NPS/XXXX/NRR*-20XX/XXX., Fort Collins, Colorado; Hoerling, M. P. and Eischeid, J. K. 2007. Past Peak Water in the Southwest. *Southwest Hydrology* 6, January/February.

[44] McWethy et al., 2010; Littell, J. S., M. M. Elsner, G. Mauger, E. Lutz, A. F. Hamlet, and E. Salathé. Regional Climate and Hydrologic Change in the Northern U.S. Rockies and Pacific Northwest: Internally Consistent Projections of Future Climate for Resource Management . University of Washington Climate Impacts Group, Seattle, Washington, USA. *In press.*

[45] Intergovernmental Panel on Climate Change. 2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Cambridge University Press, Cambridge, United Kingdom and New York, New York: http://www.ipcc.ch/publications_and_data/publications_and_data_reports.htm#1 (last accessed 6/17/10).

[46] Knowles et al., 2006; Selkowitz et al., 2002.

[47] Pederson et al., 2010.

[48] Barnett et al., 2008; McCabe et al., 2004; Stewart, I. T., Cayan, D. R. and Dettinger, M. D. 2005. Changes Toward Earlier Streamflow Timing Across Western North America. *Journal of Climate* 18, 1136-1155

[49] Hoerling and Eischeid, 2007.

Expected Future Changes

Models project that in the future, the Crown region will experience:

- Longer and more persistent summer droughts;
- Increased water stress;
- Increased frequency of extreme weather events (e.g., winter floods, droughts);
- More insect infestations;
- Larger wildfires that impact more extensive areas of the West and the Crown region;
- Large economic impacts.

Climate change will affect many sectors of the Crown's economy. The skiing and fishing industries do not represent the bulk of the economy, but because they rely heavily on snowpack, this report focuses on them as a starting point for understanding the complex ways in which climate change will affect the region.

Possible Impacts on Downhill Skiing

As a result of climate change, the ski industry may face a number of issues that include:

- Less snow[50]
- More unpredictable and unreliable snow patterns[51]
- Wetter, denser snow and more rain-on-snow events
- Changing avalanche conditions[52]
- More extreme events like landslides resulting from melting of permafrost and changing vegetation[53]
- Increased use of water to make artificial snow[54]
- Increased need to create water transportation and storage facilities
- Ski seasons that start later and are shorter[55]
- Closure of low elevation ski terrain

Rising temperatures and changing climate conditions will likely force ski areas in the Crown to adapt their businesses. Some ski areas may be forced to "climb up the mountain," pushing into higher alpine environments in search of consistently suitable snow conditions. For some this may require building new ski lifts, extending existing lifts into higher elevations, and developing downloading capacity.

[50] Ibid, Running 2010.
[51] In Europe, for example, a 2^0 C increase is predicted to bring the predictability of snowfall from 85% to 63%: Koenig, U. and B. Abegg. 1997. "Impacts of Climate Change on Winter Tourism in the Swiss Alps." *Journal of Sustainable Tourism* 5: 46-57.
[52] One possible consequences is an earlier incidence of wet avalanches: Lazar, B. and M. Williams. 2008. "Climate Change in Western Ski Areas: Potential Changes in the Timing of Wet Avalanches and Snow Quality for the Aspen Ski Area in the Years 2030 and 2100." *Cold Regions Science and Technology* 51(2-3):219-228.
[53] UNEP News Service. Many Ski Resorts Heading Downhill as a Result of Global Warming. http://www.grida.no/news/press/1616.aspx Accessed 6/23/10.
[54] Burki, R., H. Elsasser, and B. Abegg. 2003. "Climate Change and Winter Sports: Environmental and Economic Threats." 5th World Conference on Sport and Environment. IOC/UNEP. December 2-3, 2003. Turin, Italy.
[55] A study on the possible impacts of climate change to the ski industry in Aspen, Colorado revealed that, depending on future CO_2 emissions and attendant climate change, by 2030 the ski season may be delayed or shortened, with losses to the region's economy ranging from $16 to $56 million: Aspen Global Change Institute and others. 2006. Climate Change and Aspen: An Assessment of Impacts and Potential Responses. http://www.agci.org/library/publications/about/publication_details.php?recordID=16844 Accessed 6/23/10.

Most ski areas will have to expand artificial snow making to supplement natural falling snow.[56] This may require purchasing additional water rights, drilling new wells, augmenting water transportation infrastructure, and developing new water storage facilities. It may also require a significant investment in newer snow making technologies and almost certainly new operations costs.[57]

Because of climate change, some ski areas may close—either because they cannot make artificial snow or afford the costs of artificially sustaining snowpack.[58] To avoid this outcome, resorts are already looking at ways to diversify their recreational offerings. Many resorts now offer mountain biking, mountaineering, hiking, and events in the summer, and activities requiring less snow such as snowshoeing, cross country skiing, and terrain parks in the winter.

Climate change may also bring secondary effects to communities adjacent to ski areas, above and beyond the impacts on tourism. One of those secondary effects may be a slowing down, or reversal, of amenity migration—the movement of people into areas for quality of life reasons.

If winter recreation is an important draw for people who choose to live and work in mountain communities, at least in part because of the skiing opportunities, then there could be a ripple effect through other sectors of the economy. The most obvious concern is that poorer ski conditions will negatively affect the real estate market. But the economic linkages could be more complex. Fewer migrants, retirees, and second homebuyers also will affect the finance, construction, retail, utility, transportation, and health care sectors.

Possible Impacts on Recreational Fishing

The fishing industry can also expect a wide variety of impacts due to climate change. A recent report by the Pew Center on Global Climate Change stated:

> Projected increases in mean temperature in the United States are expected to greatly disrupt present patterns of plant and animal distributions in freshwater ecosystems and coastal wetlands. For example, cold-water fish like trout and salmon are projected to disappear from large portions of their current geographic range in the continental United States, when warming causes water temperature to exceed their thermal tolerance limits. Species that are isolated in habitats near thermal tolerance limits (like fish in Great Plains streams) or that occupy rare and vulnerable habitats (like alpine wetlands) may become extinct in the United States. In contrast, many fish species that prefer warmer water, such as largemouth bass and carp, will potentially expand their ranges in the United States and Canada as surface waters warm.[59]

[56] Machine-made snow is only possible under certain climatic conditions, and is inversely proportional to temperature: Irland, L.C., D. Adams, R.A. Alig, C.J. Betz, C. Chen, M. Hutchins, B.A. McCarl, K. Skog, and B.L. Sohingen. 2001. "Assessing Socioeconomic Impacts of Climate Change on US Forests, Wood-Products Markets, and Forest Recreation." *BioScience*. 51(9): 753-764.

[57] For example, the Sunday River resort in Maine uses approximately 26 million kilowatt-hours per year, most of it used for snow-making, at an annual cost of $2 million. Large resorts can be expected to spend more than $100,000 per night making snow; see Irland et. al 2001.

[58] U.N. News Service. 2003. Global Warming Threatens Many Low-Level Ski Resorts with Ruin – UN Study. http://www.un.org/apps/news/story.asp?NewsID=9035&Cr=climate&Cr1=change Accessed 6/23/10.

[59] Poff, L. N., M.M. Brinson, and J.W. Day. 2002. Potential Impacts on Inland Freshwater and Coastal Wetland Ecosystems in the United States. Pew Center on Global Climate Change, Washington, D.C. http://www.pewclimate.org/docUploads/aquatic.pdf (last accessed 6/17/10).

The report also indicated that in the Rocky Mountain region, "an increase in air temperature of only 1°C is predicted to reduce suitable stream habitat for trout by 7 to 16 percent, and a 3°C increase would reduce habitat by 42 to 54 percent."[60]
Climate change in the Crown in the Continent will bring changes in snowpack, runoff, and stream flows. The water resources of the Crown region are already heavily used; municipal, tribal, recreational (e.g., fishing and boating), and agricultural users all compete for water. The Montana Fish, Wildlife and Parks, for example, already has had to impose seasonal closure on a number of rivers due to drought in the last decade.

The Crown's diversity and connectivity may provide opportunities for selected species of plants, animals and fish to move to more suitable habitats as climate conditions change. For example, as lower elevation rivers and streams warm, some species, such as trout, may shift to stream and river reaches at higher elevations.[61] Warming temperatures at high elevations, however, will pose significant problems for species dependent on these environments.[62] As conditions warm in alpine environments, the extent of suitable habitat for alpine species will shrink and habitat patches will likely become more isolated. In some cases, species associated with alpine environments may not be able to move to suitable habitats at higher elevations or higher latitudes quickly enough to keep pace with warming, making them more vulnerable to local or regional extirpation.[63] More heat-tolerant invasive species will likely establish themselves in mountain environments as alpine habitats shrink and become increasingly isolated.[64]

Of particular importance for the Crown is the disproportionate effect that changes in the timing of runoff and flood events may have on native fish. For example, bull trout spawn in the winter when increased flood flows can scour redds. One study suggests that a combination of warming water, and changing seasonality and timing of streamflows may reduce bull trout populations by 90 percent.[65]

Climate change will also impact native cutthroat trout spawning in the late spring, not due to floods, but rather to drought. As river flows drop earlier, redds dug in the spring may end up high and dry before eggs hatch. If they do hatch successfully, warmer water typically leads to smaller than average fry exposed to a greater risk of predation.

Warming temperatures will also affect fisheries as a result of an increase in the extent and size of wildfires.[66] Loss of canopy vegetation following fires often increases stream temperatures; while these

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[60] *Ibid*, page 9. References cited in Pew report: Keleher, C.J., and F.J. Rahel. 1996. Thermal Limits to Salmonid Distributions in the Rocky Mountain Region and Potential Habitat Loss Due to Global Warming: A Geographic Information System (GIS) Approach. *Transactions of the American Fisheries Society* 125,1-13; Rahel, F.J., C.J. Keleher, and J.L. Anderson. 1996. Habitat Loss and Population Fragmentation for Coldwater Fishes in the Rocky Mountain Region in Response to Climate Warming. *Limnology & Oceanography* 41, 1116-1123.
[61] Haak, A. L., Williams, J.E., Isaak, D., Todd, A., Muhlfeld, C., Kershner, J.L., Gresswell, R., Hostetler, S., Neville, H.M. 2010. The Potential Influence of Changing Climate on the Persistence of Salmonids of the Inland West. *U.S. Geological Survey Open-File Report* 74.
[62] Ray, A. J., J.J. Barsugli, Jr., K.E. Wolter, J.K. Eischeid. 2010. Rapid-Response Climate Assessment to Support the FWS Status Review of the American Pika. NOAA report for the U.S. Fish and Wildlife Service, 47.
[63] Ray et al. 2010.
[64] For a review of the possible ecological changes to mountain environments, see: Beniston, M. 2003. Climatic Change in Mountain Environments: A Review of Possible Impacts. *Climatic Change* 59, 5-31.
[65] Jager, H.I., H.E. Cardwell, M.J. Sale, M.S. Bevelhimer, C.C. Coutant, and W.Van Winkle. 1997. Modeling the linkages between flow management and salmon recruitment in streams. *Ecological Modeling* 103, 171-191. Wildlife Management Institute (ed) with cooperation from Ducks Unlimited, Trout Unlimited, BASS/ESPN, Izaak Walton League of America, Association of Fish and Wildlife Agencies, Coastal Conservation Association, American Sportfishing Association, and Pheasants Forever. 2002. *Seasons' End: Global Warming's Threat to Hunting and Fishing.*
[66] Westerling, A. L., Hidalgo, H. G., Cayan, D. R. and Swetnam, T. W. 2006. Warming and Earlier Spring Increase Western US Forest Wildfire Activity. *Science* 313, 940-943; Ibid, Hoerling and Eischeid, 2007.

impacts are typically short-lived, more frequent fires may alter vegetation structure in ways that reduce shading, further increasing water temperatures.[67]
Importantly, more frequent wildfires can remove the vegetation that stabilizes steep slopes, resulting in increased frequency and magnitude of landslides and debris flows, which can fill streams with sediment slurries and scour channels, degrading fish habitat, and in some cases causing extirpation of local fish populations.[68]

As a result of climate change, the fishing industry may face a number of challenges that include:

- Restricted fishing seasons and seasonal closures;[69]
- More conflicts among irrigators, anglers, fishing guides, and municipalities for a increasingly scarce water;
- Degradation and loss of habitat due to warming water temperatures, post-fire sediment and debris flows, and increased frequency of extreme events such as floods and late summer drought;
- Smaller fish stocks and smaller fish;
- Increased disease;
- Displacement and cross-breeding of native trout with non-native species;
- Negative economic impacts on fishing guides, stores, restaurants, hotels, and other businesses that sell goods and services to anglers.

The native fish species in the Crown region have adapted over millions of years to specific conditions, which climate change could altered. For example, there is some evidence that with earlier stream flows, insects that fish feed on will emerge earlier and will be smaller, and therefore less nutritional.[70] Similarly, changes in water quantity could alter the timing of breeding. Faster flow in rivers early in the season may affect the survival rate young fish, and low flows later in the season may impact the fish's ability to move to cooler, higher elevations.[71] Changing water conditions may lead to increases in certain types of disease. They also may enhance the survival of non-native species, thereby increasing competition with native species for an already reduced food supply and habitat.[72]

[67] Gresswell, R. E. 1999. Fire and aquatic ecosystems in forested biomes of North America. *Transactions of the American Fisheries Society* 128, 193-221; Dunham, J. B., Rosenberger, A.E., Luce, C.H., and Rieman, B.E. 2007. Influences of wildfire and channel reorganization on spatial and temporal variation in stream temperature and the distribution of fish and amphibians. *Ecosystems* 10, 335-346; McKenzie, D., Z. Gedalof, D.L. Peterson, and P. Mote. 2004. Climatic Change, Wildfire, and Conservation. *Conservation Biology* 18, 890-902; van Mantgem, P. J. and N.L. Stephenson. 2007. Apparent Climatically Induced Increase of Tree Mortality Rates in a Temperate Forest. *Ecology Letters* 10, 909-916.
[68], Gresswell, 1999; Dunham et al., 2007; May, C. L., and R.E. Gresswell. 2003. Processes and rates of sediment and wood accumulation in headwater streams of the central Oregon Coast Range. *Earth Surface Processes and Landforms* 28, 409-424;
[69] Montana's Department of Environmental Quality: http://deq.mt.gov/ClimateChange/NaturalResources/Water/Drought.mcpx (last accessed 7/9/10).
[70] Harper, M.P. and B.L. Peckarsky. 2006. Emergence Cues of a Mayfly in a High Altitude Stream Ecosystem: Potential Response to Climate Change. *Ecological Applications.* 16(2):612-621.
[71] For a recent study that includes a comprehensive review of the literature on the possible effects of climate change on trout, see Effects of Global Warming on Trout and Salmon in U.S. Streams. 2002. Defenders of Wildlife and Natural Resources Defense Council: http://www.defenders.org/resources/publications/programs_and_policy/science_and_economics/global_warming/effects_of_global_warming_on_trout_and_salmon.pdf (last accessed 6/15/10).
[72] For example, rainbow and brown trout could displace brook trout as streams temperatures increase. See: Meisner, J.D. 1990. Effect of Climatic warming on the Southern Margins of the Native Range of Brook Trout, *Salvelinusfontinalis*. *Can. J. Fish. Aquat. Sci.* 47: 1065-1070.

V. DOWNHILL SKIING

In this section we describe the skiing industry in the region, it's economic impacts – in terms of expenditures and role in providing quality of life for local residents – and summarize the results of interviews with leaders in this industry, who were asked about the impacts of climate change on their businesses.

Geographic Overview

Downhill skiing is a popular activity in the Crown of the Continent. There are 74 commercial ski areas in the four states and two provinces surrounding the Crown (see Appendix C). In Montana, 14 ski areas currently operate. Until recently, there were four ski areas in the Montana portion of the Crown. Two small ski hills, Teton Pass and Marshall Mountain, have recently closed. Teton Pass closed after the 2008-09 season and Marshall Mountain closed after the 2002-03 season, although Teton Pass re-opened in early 2011. The remaining ski areas are Whitefish Mountain Resort near Whitefish and Montana Snowbowl near Missoula. (See Map 3.)[73]

Whitefish Mountain Resort has been open for 63 years. The ski area is privately owned and is located eight miles north of Whitefish. Whitefish Mountain leases 2,500 acres from the U.S. Forest Service. The resort ranges in elevation from 4,464 feet at the base to 6,817 feet at the summit. Snowbowl Resort is located 12 miles north of Missoula. Snowbowl has 950 acres of ski-able trails and leases 1,138 acres from the Forest Service. The elevation of the resort is 5,000 feet at the base and 7,600 feet at the summit. Whitefish Mountain and Snowbowl each receive about 300 inches of snow annually. Both resorts operate on public lands under Forest Service special use permits and must report annual skier days to the agency as a condition of the permits.

The number of ski visits (or "skier days") in the Montana portion of the Crown, while erratic from year to year, has been stable in the long term, averaging 338,492 skier days per season (Table 1 and Figure 6). The highest numbers of skier days were in the 1990–2000 ski season (382,390 skier days) and the lowest were in the 2004–2005 season (253,655 skier days). The 2009–2010 season recorded 333,919 skier days. More than 80 percent of ski visits are to Whitefish Mountain, with the remainder in the Snowbowl ski area (when Teton Pass and Marshall Mountain were open they together represented, on average, 7% of total skier days).[74]

A recent study of the 2009–2010 winter ski season showed that nonresident visitors to the Whitefish Mountain resort spent, on average, $1,267 per group per trip. This resulted in a direct contribution of $15.4 million dollars to the economy. Residents spent considerably less. The average resident spent $188 during their ski trips and collectively spent $7.7 million during the season.[75]

[73] Montana Ski Area Trends 1990-2010. The Institute for Tourism and Recreation Research, The University of Montana, Missoula. Sources: USDA Forest Service, Big Sky Resort, Moonlight Basin, Great Divide Ski Area.
[74] *Ibid.*
[75] Nickerson, N. and K. Grau. 2010. 2009-'10 Ski Season: Economic Impact and Skier Characteristics: Montana. Institute for Tourism and Recreation Studies. Research Report 2010-3. University of Montana: http://www.itrr.umt.edu/research10/MTAlpineSkiReport0910RR2010_3.pdf (last accessed 7/9/10).

Map 3

Ski Resorts and the Montana Portion of the Crown of the Continent

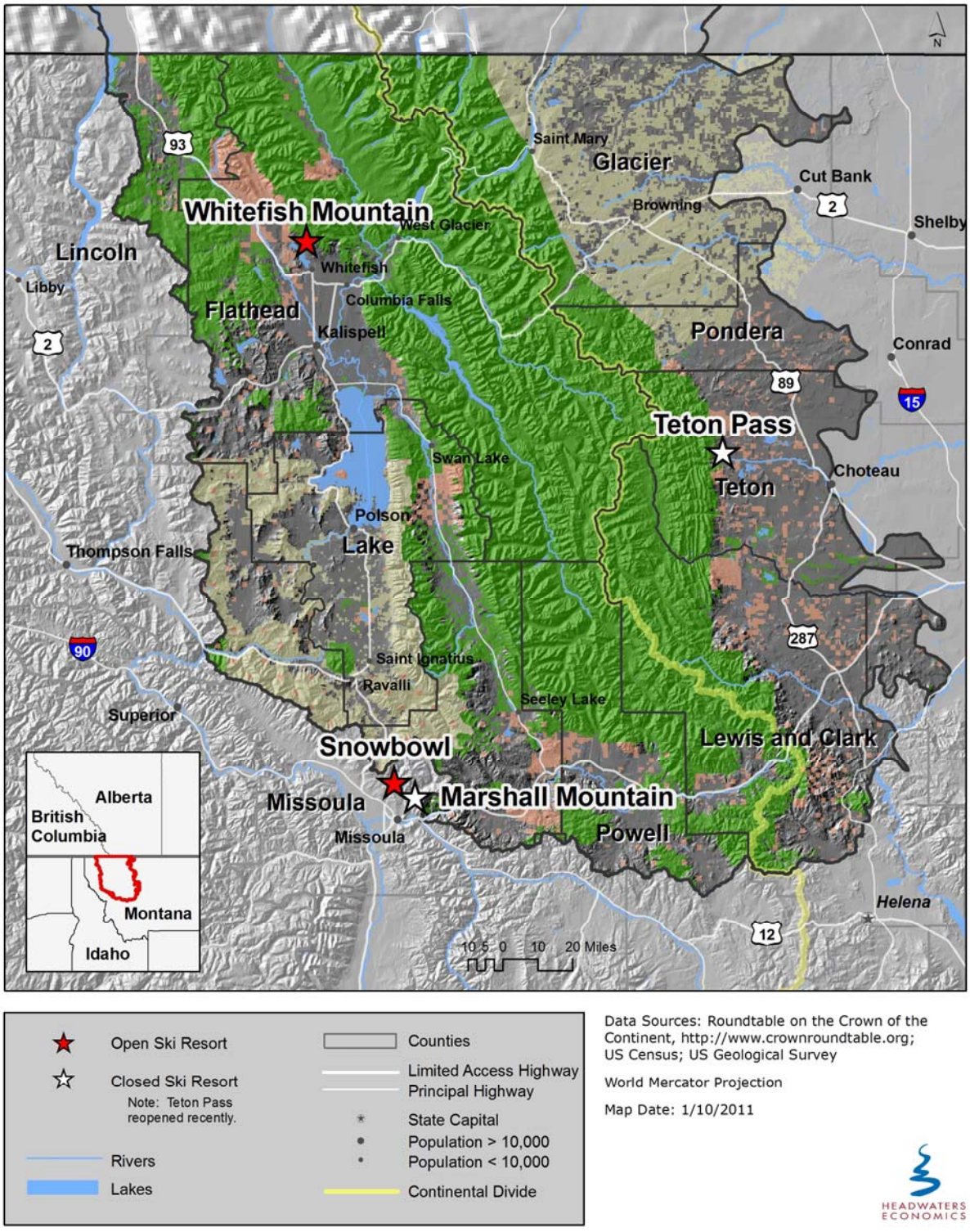
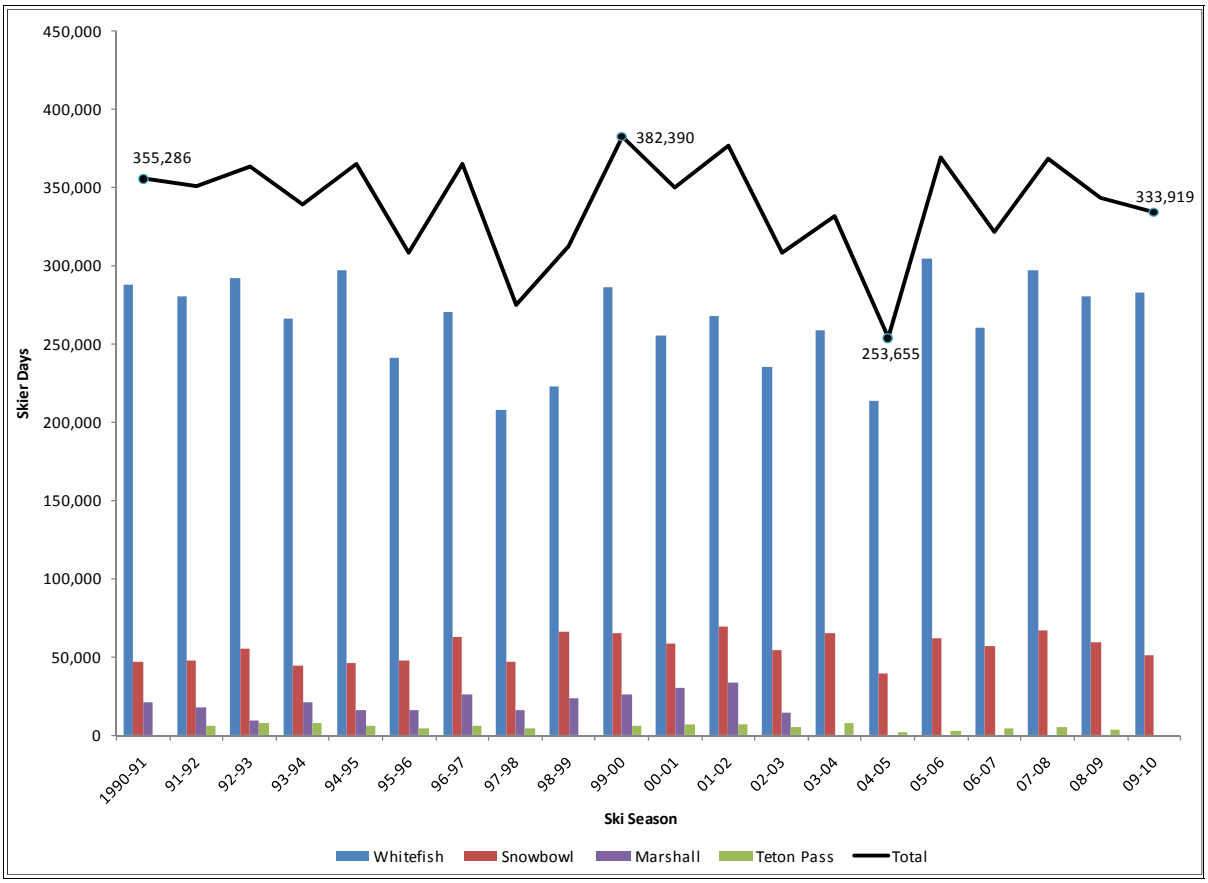


Figure 6: Skier Days by Ski Area in the Montana Portion of the Crown of the Continent, 1990 to 2010.



Source: ITRR 2010.

There is a close relationship between snow conditions and skier days. The 2004-2005 winter was the worst snow year in the Crown region in recent years and it corresponds to the lowest number of skier days in the last decade. This close relationship between snow conditions and skier days is why ski resorts are keenly interested in how climate change will affect the timing, amount, and durability of snow on mountains in the Crown region.

The Economic Impact of Spending by Skiers

We used the software IMPLAN to develop estimates of the economic impact of the skiing industry in the Crown of the Continent region for the following Montana counties: Flathead, Glacier, Lake, Lewis and Clark, Lincoln, Missoula, Pondera, Powell and Teton.

IMPLAN is an input/output model that is based on the theory that when new money enters an economy, some of it is re-spent one or more times in the local economy, thereby creating a multiplier effect. For example, a nonresident skier will spend money at a restaurant. The restaurant, in turn, will hire workers, order supplies from wholesalers, and so forth. Also, the employees of the restaurant will spend at least a portion of their earnings in the local economy. All of these expenditures constitute part of the multiplier effect. The results of the IMPLAN model are shown in terms of jobs created as a result of expenditures by skiers, the value of the goods and services produced, and the state and local taxes generated. (See Appendix E for the results of the IMPLAN modelling).

Resident and non-resident skiers (and snowboarders) stimulate the economy by spending more than $25 million in a variety of establishments in the Crown region (in restaurants, gas stations, grocery stores, and ski shops, etc.). Through the miltuplier effect, these expenditures result in jobs, economic output, and taxes. In the 2009-2010 ski season, expenditures by non-residents resulted in an estimated 288 jobs, $24.6 million in economic output, and $1.9 million in state and local taxes. When the expenditures of resident and non-resident skiers were combined, they resulted in an estimated 457 jobs, $39.8 million in ecoomic output, and $3.1 million in state and local taxes (see Table 1).

An important aspect of the ski industry's impact on the regional economy is the contribution of non-residents: the majority of the value of economic output (62%) is derived from expenditures made by non-residents. In other words, while skiing is important to residents and part of the reason they live where they do, much of the profit for the ski industry depends on visitors. This is particularly true of WhiteFish Mountain which is the only destination ski resort in the Crown and, after Big Sky, brings more non-resident skiers to Montana than any other ski area in the state.

Table 1: Economic Impacts of Resident and Nonresident Skiing/Snowboarding in the Montana Portion of the Crown of the Continent, 2009/2010 Season ($2010)

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	329	$7,225,782	$13,123,776	$25,004,765
Indirect Effect	70	$2,571,301	$4,481,479	$8,508,233
Induced Effect	59	$1,914,957	$3,638,003	$6,283,231
Total Effect	457	$11,712,040	$21,243,258	$39,796,230

Source: Institute for Tourism and Recreation Research, The University of Montana ITRR 2010 and IMPLAN Analysis (see Appendix E for details). Also used: national downhill expenditures on national forests: http://www.fs.fed.us/recreation/programs/nvum/spending_profiles_2006.pdf (last accessed 8/15/10).

The diversification of the region's economy, especially the growth of service-related occupations and non-labor income, are largely the result of the ability and willingness of people to decide to live and do business based on environmental and recreational amenities.

Thus, while the multiplier effect resulting from visitor expenditures is important, the economic impact of the ski industry is more significant than this measure indicates. Access to good downhill skiing is one of

the numerous factors that make up the high quality of life in the Crown region, and it is an important reason why some residents and businesses decide to move to the region and to settle there.

Climate Change Impact and Adaptation in the Ski Industry

We interviewed ski resort owners, snow operations staff, and snow sport activity directors to find out their current thinking on the impacts of climate change to the ski industry in the Crown and their ideas on how the industry is adapting now or might adapt in the future to changing climate conditions.

Climate change is very much on the radar of the ski industry. There is widespread concern that warmer temperatures and precipitation changes that could dramatically affect the industry. While some of the focus nationally has been on reducing the industries carbon footprint and improving sustainability practices, there are also a range of more localized decisions and efforts focused on mitigating the negative impacts of climate change.[76]

Because the current effects of climate change on snow conditions are difficult to determine, snow conditions change so much year-to-year for other reasons (e.g., la Nina versus el Niño years), and the future impact of climate change on snow conditions in the Crown is not yet manifest, significant measures to adapt to an environment dramatically affected by climate change has not yet taken place.

As climate change impacts in the Crown become more evident, the industry will be paying close attention and will adapt within their constraints and abilities as businesses. Below are some of the major considerations and operating concerns we heard in our interviews. We focus on Whitefish Mountain and Snowbowl Montana, each of which have a different perspective based on their market, location, terrain, and elevation.

The timing of when snow comes in the fall is extremely important. This is especially true for Whitefish Mountain, which relies heavily of non-resident skiers and advance bookings. Early season snow creates a "buzz" about a good winter season in the making and helps ensure high levels of advance reservations. Currently, Whitefish Mountain books the holidays at 100 percent and this is crucial to their overall revenue for the entire year. If climate change results in significantly delayed snow deposition, making it difficult to operate during the holidays, it would be a substantial setback to the ski industry's peak period and business viability. A delayed season start would have less of an impact on Snowbowl but would reduce peak ticket sales from residents. If a delayed opening day also coincided with an earlier closure because of inadequate snowpack, it would hurt both businesses.

After timing, the amount of snowfall and the ability to retain that snowfall are important to a successful ski season. As mentioned earlier, there is a direct correlation between snowfall and skier days. Less snowfall translates into fewer skier days and more snowfall into more skier days. The way advance-bookings work has changed in recent years. More skiers now are waiting until the last minute to book ski trips. They are evaluating options with access to rich snow condition information available online and making reservations only one to two weeks before a trip. Resorts with bad snow years pay a price as never before, and this effect can linger as people often remember a poor skiing experience.
The challenge at Whitefish Mountain is to increase bookings in off-peak weeks (outside Christmas to New Years and President's Day week). Good coverage and big storms boost bookings. Similarly, at

[76] In 2000 many ski areas adopted an Environmental Charter that "identifies climate change as a potential threat to the environment and our business. Although we are not a major source of greenhouse gas (GHG) emissions, many resorts across the country already are taking steps to reduce their own, limited GHG emissions." See: http://www.nsaa.org/nsaa/environment/climate_change/(last accessed 8/15/10)

Snowbowl a combination of good coverage and large "dumps" bring skiers out. Staff at both resorts noted that Montana skiers are finicky about ski conditions and love big powder days—that these larger dumps are what stimulates non-season pass holders to purchase tickets. So, while base coverage is important, large dumps matter too. Although climate change will likely make consistent coverage a growing challenge, it could help with larger and less predictable snowfall.

Snow coverage is especially important to Snowbowl because the resort can struggle to maintain coverage on the lower part of the mountain. The layout of the resort, with most green and blue runs at the top and more black diamond runs on lower slopes, means that it can be difficult to provide a way for beginner and intermediate skiers to get down to the base area. At Whitefish Mountain base coverage during the normal operating season is rarely a problem. More snowfall and regularly cloudy conditions help preserve snow depth and quality, even in warmer temperatures.

Both resorts employ snowmaking equipment on their lower mountain runs. Neither area has invested in state-of-the-art snowmaking technology, which is more efficient but is also more costly. One perennial challenge with making artificial snow is that it requires cold temperatures. As a result making snow is a better solution when it is cold and there is little snow than when it is warm and snow is melting off. Temperature volatility is also a challenge for the application of artificial snow. Each resort has a budget for making artificial snow. If they use these allocated funds to establish early snow or redress melting snow and then a subsequent thaw erases this base they will not have resources to make additional snow. Climate volatility increases risks for resorts and places a premium on understanding weather patterns.

Snowbowl has water rights and could expand these to increase snowmaking. The cost of new snow making technology, piping, and impoundments may be difficult to afford at this smaller area which has more modest skier traffic, lower ticket prices, and targets local skiers. Whitefish Mountain does not have extensive water rights and may find it difficult to expand these. It could more easily afford newer snow making technologies, though this would require significant new investment.

Neither ski area has terrain that would allow them easily to move their base areas up the mountain if they could not sustain lower elevation snowpack. Whitefish Mountain could possibly expand into new terrain, for example, utilizing higher elevation and north-facing slopes in what is out of bounds now in the area known as "the canyon." This would require Forest Service approval and be subject to public review. Snowbowl could look at providing upper-mountain only skiing with downloading of skiers from upper lifts to the base lodge. This would require a different lift configuration or possibly a new tram dedicated to this purpose.

Avalanches could become more of a ski safely management challenge with climate change. This would not likely affect Snowbowl which does not have high avalanche prone terrain. It would, however, affect Whitefish Mountain, which actively manages avalanche conditions now.

Both ski areas have thought about diversifying their recreational activities. This has happened more in the summer months to date. Events like weddings are important to Snowbowl. They generate off-season revenue and allow the resort to keep a core staff employed, which eases the fall hiring crunch. At Whitefish Mountain, zip line, mountain biking, and hiking activities have similar benefits. This past July and August were the first non-winter months that Whitefish Mountain was cash flow positive during the off-season. This revenue means the resort enters the ski season with that much less to pay off before they turn profitable in winter. Activity volumes are small today but could grow. Despite this promise, no one we talked to thought summer activities could offset losses in winter revenue that is the profit center for ski resorts. (For destination resorts, real estate sales also have been a crucial part of the business model, but with the most recent recession this revenue source dried up and it is difficult to predict the future of resort real estate markets.)

Diversifying winter offerings is another promising adaptation strategy. Any popular winter activity that complements downhill skiing and requires less snow or can be managed over a smaller area could be beneficial. Terrain parks, which are popular with snowboarders and a younger demographic sought out by ski areas, can be created with less snow and are more easily sustained with artificial snow making. Nordic skiing also requires less snow coverage. Sledding and tubing runs can be popular. Skating rinks, which are artificially refrigerated, are another option. Together, these activities create a buffer against poor snow conditions and their effect on skier bookings.

Currently, the sentiment at ski areas can best be described as concerned. But since the more dramatic effects of climate change have yet to be felt or are not well enough understood it is difficult to plan effectively for them. In addition, ski areas are vulnerable to other, in some cases, more immediate challenges to their industry such a national recessions, changing demographics, and shifting travel and recreation preferences.

And yet the industry attitude we encountered was grounded in a love of skiing and a sense that planning and new technologies would be crucial to the ability of the skiing industry to thrive in a warmer climate with very different precipitation patterns. The example of east coast ski areas which have been dealing with much more volatile ski conditions shows the industry can adapt it's offering, employ sophisticated snow making and conserving technologies, and generate off-season revenue.

Montana's Crown of Continent region has some of the best skiing in the world. Resident skiers enjoy incredible terrain and great powder, and out-of-state skiers come for the same experience. Adapting to more contingent and perhaps less favorable conditions will test area resorts and their ability to appeal to skier expectations, manage costs, and stay competitive in the winter recreation market.

VI. RECREATIONAL FISHING

In this section we describe the recreational fishing opportunities in the Crown and present findings on the estimated economic impacts of expenditures by resident and nonresident anglers, including direct jobs and spending contributions. We then go on to discuss the broader role of fishing in terms of quality of life and discuss how climate change might affect the fishing industry.

Geographic Overview

Fishing in the Crown of the Continent is remarkable for the quality and diversity of fishing opportunities. The Flathead River system is one of the last best strongholds of native fish in the Interior West, offering spectacular fishing for native cutthroat trout and large migratory bull trout. The legendary Blackfoot River, flowing mostly across private land, allows anglers to emulate the Reverend Maclean and fly-cast for feisty rainbows and browns.

For the purpose of assessing the potential economic impact of climate change on fishing in the crown, we identify three distinct fishing regions, each unique in fishing character, economic opportunities, and resource challenges.[77]

The Flathead Drainage

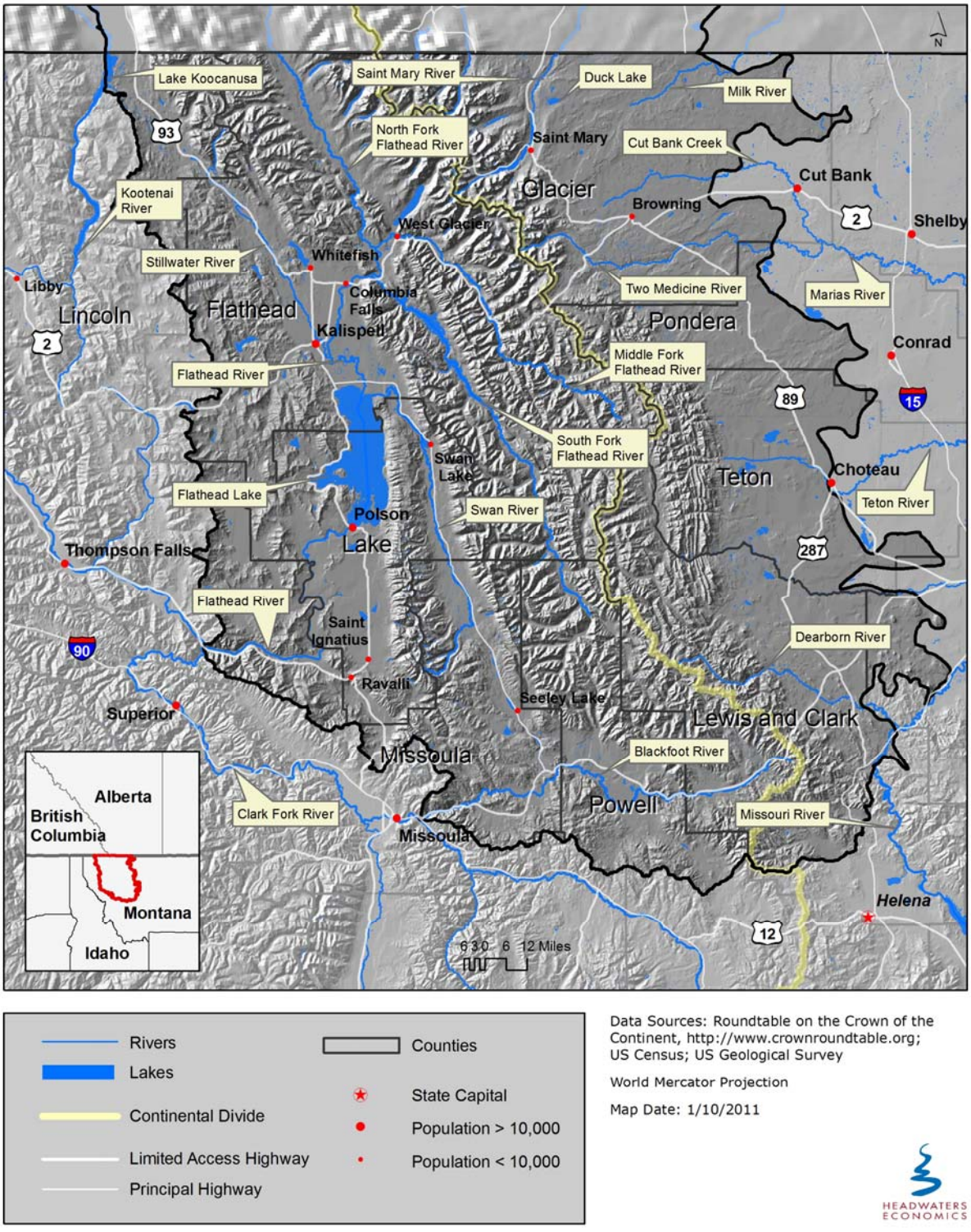
Most of the recreational fishing in the Crown takes place on the west side of the Continental Divide (more than 80% of angler days in 2007). (An "angler day" is one angler fishing one body of water for any length of time in a given day). (See Appendix D for details.) Flathead Lake and the Flathead River and its tributaries are the most popular fisheries on the west side, accounting for 41 percent of total angler days in the Crown. (See Map 4, for a depiction of major rivers and lakes and Map 5 for a depiction of fishing pressure by hydrological unit.)

Flathead Lake is the trifecta “engine” of the Flathead River fishery. Bull trout in particular grow large in the lake and enter the rivers each year to spawn. The cutthroat fishery is also bolstered by recruitment from the lake. Finally, Flathead Lake is also perhaps the premier lake trout fishery in the state.

[77] The sport fisheries in the Montana portion of the Crown of the Continent are described using information from Montana Department of Fish, Wildlife and Parks (MT FWP), who maintain the Montana Fisheries Information System (MFISH), a relational database of the state's hydrologic features and their corresponding fish and angling characteristics.

Map 4

Rivers and Lakes of the Montana Portion of the Crown of the Continent



Data Sources: Roundtable on the Crown of the Continent, http://www.crownroundtable.org; US Census; US Geological Survey

World Mercator Projection

Map Date: 1/10/2011

HEADWATERS ECONOMICS

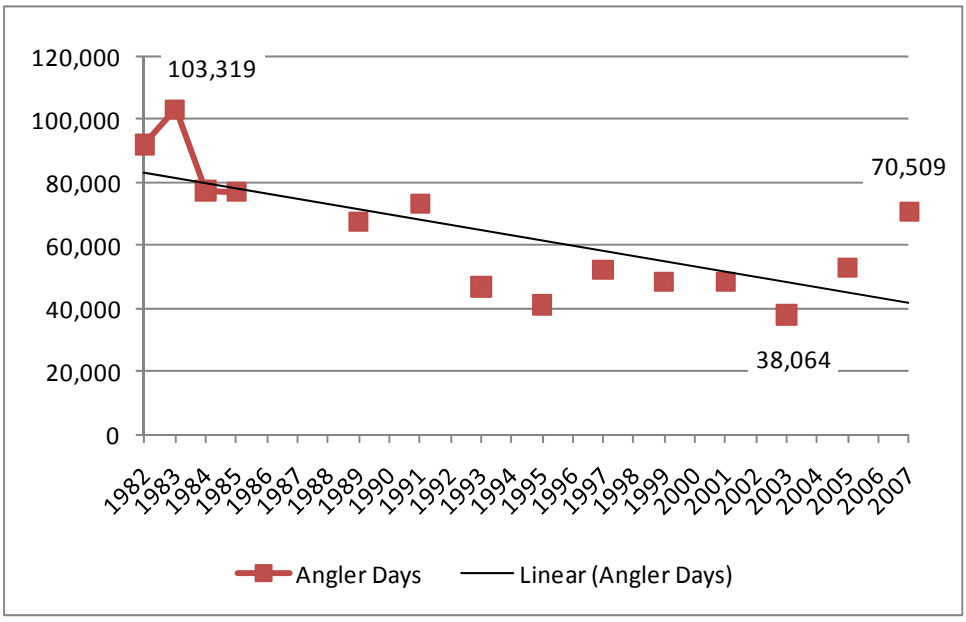
The headwaters of the rivers that feed the lake lie mostly in protected public lands and provide some of the best cold-water fisheries habitat in the country. High alpine streams and lakes in Glacier National Park and surrounding wilderness areas draw adventurous anglers seeking solitude and pristine landscapes.

Predation by lake trout and competition with mysis shrimp in Flathead Lake have significantly depleted stocks of bull trout and kokanee salmon in Flathead Lake and the Flathead River. (see sidebar next page). As a result, fishing in the region has declined precipitously over the last 25 years, from a high of over 100,000 angler days in 1983 to a low of only 38,000 in 2005. However, in 2007, angler numbers on Flathead Lake rebounded to more than 70,000 angling days (Figure 7). Fishing on the North Fork of the Flathead River has similarly declined and rebounded in recent years.

These are promising trends, but cannot counter the negative impact of mysis shrimp and lake trout. For example, on the South Fork, isolated from Flathead Lake by Hungry Horse Dam, the native fish are protected from the lake trout and mysis shrimp. Bull trout and cutthroat trout are still prolific, and fishing has more than doubled over the same time (from an average of 4,500 angler days annually in the 1980s to an average of 11,000 angler days per year in the 2000s). In fact, the South Fork Flathead is the only place in the state where anglers can legally target bull trout.

The increase in fishing on the South Fork is consistent with the economic growth of the region, particularly in Flathead County, and with the increasing interest in trout fishing throughout the 1990s and 2000s. It is likely that Flathead Lake, the North Fork and Middle Fork Flathead would also have experienced the same increase in fishing pressure if not for the significant decline in fishing opportunities.

Figure 7: Angler Days on Flathead Lake, Montana, 1982 to 2006.



Source: Montana Department of Fish, Wildlife and Parks (MT FWP), Montana Fisheries Information System (MFISH) database 2010.

A small charter boat industry has sprung up on Flathead Lake to target the lake trout population; lake trout live in deep water and are not often available to anglers without access to a boat and specialized fishing tackle. However, for many, lake fishing does not have the allure of floating down a blue ribbon

trout stream, fishing for native trout with a dry fly. The charter boat industry, thus, does not support nearly the same size industry as we would expect from restored native fish populations or kokanee salmon.

Lake trout and mysis shrimp will continue to be the dominant factors affecting the recreational fishing industry in the Flathead fishery, unless lake trout populations can be controlled in order to restore native fish. Restoring the native fish presents a tremendous economic opportunity for the Crown; if successful, the region will offer a unique fishing opportunity that will draw anglers in greater numbers than the existing lake trout fishery. If angling trends on the Middle Fork Flathead indicate the popularity of catching native fish, angler numbers could reach more than double what they are today. Maintaining the habitat quality in the Flathead River and its tributaries, and maintaining connectivity so that fish can access spawning areas will be important to the success of any attempts to limit lake trout numbers in Flathead Lake.

Lake Trout in Flathead Lake

Lake trout are steadily eating their way through the largest freshwater lake in the Inland West, Flathead Lake. Introduced about 100 years ago, "lakers" existed as part of a diverse fishery that included native bull and cutthroat trout, as well as introduced kokanee salmon. But the balance was upset when Montana Fish, Wildlife and Parks introduced mysis shrimp into the lake.

The shrimp were intended to be a food source for the popular kokanee salmon (also an introduced species), but ended up competing for their phytoplankton food source. Kokanee populations declined while lake trout benefited from the mysis food source. With more lake trout and fewer kokanee, the lake trout took a huge toll on bull trout in particular. The population of bull trout dropped from about 13,000 in 1982 to 3,000 in 2007 as a result, while the estimated population of lake trout is 400,000 "catchable" fish in the lake.

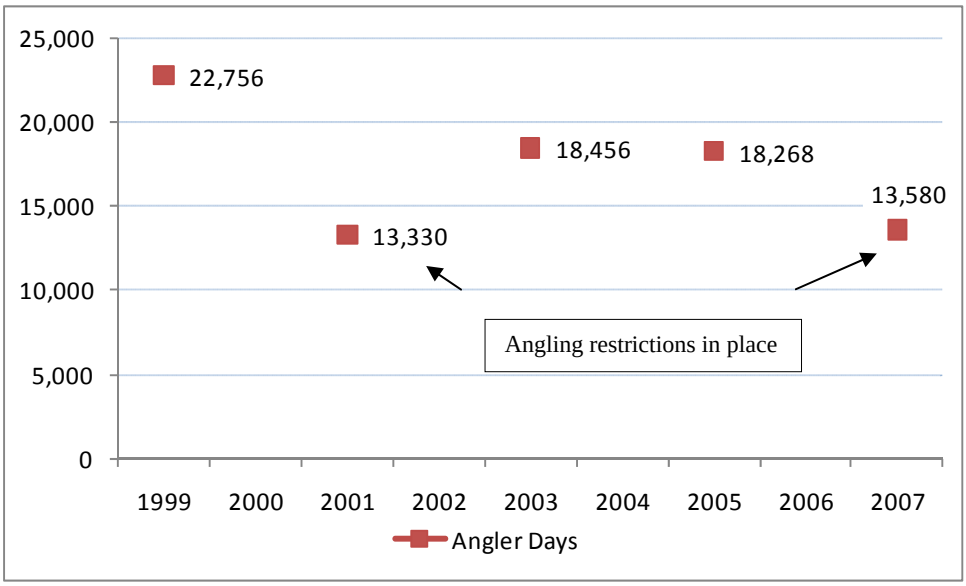
The Salish Kootenay Tribe hosts the annual Mac Days (Mackinaw trout is another name for lake trout), a 33-day fishing derby with thousands of dollars in prizes, as an attempt to control the lake trout population. Despite good catches, lake trout numbers continue to increase. Today, the tribes are leading studies aimed at estimating the ecological and economic impact of a netting operation to control lake trout. Charter captains who make a living from lake trout are opposed to reducing the population, but the opportunity cost of losing bull trout and cutthroat trout may far outweigh the economic benefits of lake trout in Flathead Lake.

The Blackfoot

Further south on the west slope of the Continental Divide, the Blackfoot River draws the most angler-days from non-resident anglers of any river in the Crown region. Fishing for rainbow and brown trout on the Blackfoot River is excellent, and the fishery supports significant guiding and lodging opportunities for Southwest Montana that leverage other opportunities on the Clark's Fork, Bitterroot, Rock Creek, and other rivers and streams in the Missoula area. The Blackfoot accounts for the majority of commercial recreational fishing opportunities in and around the Crown.

Fishing for bull trout on the Blackfoot is restricted because of their "threatened" status under the Endangered Species Act. Even so, anglers who target trout often catch these fish, which can grow to 20 pounds. Just knowing that these native fish are in the river draws anglers to the upper Blackfoot River. Closures on the Blackfoot River in recent years due to drought and warm water have decreased the river's popularity. Montana Fish, Wildlife and Parks called for voluntary and mandatory fishing restrictions in 2000, 2001 and 2007 due to high water temperatures (warmer water carries less oxygen, limiting the ability of fish to recover from the stress of being caught). In 1999, there were more than 22,000 angler days on the Blackfoot. Angler visits dropped to 13,000 angler days in 2001, and again in 2007, when with fishing restrictions were in place (Figure 8). In the intervening years, angler numbers had recovered to around 18,000 angler days annually. Drought and fishing closures are certainly a contributing factor for the low angler visits in 2001 and 2007.

Figure 8: Angling Days on the Blackfoot River, Montana, 1999 to 2007.



Source: Montana Department of Fish, Wildlife and Parks (MT FWP), Montana Fisheries Information System (MFISH) database 2010.

The effects of mining, logging and grazing also stress the health of the river, and unplanned residential development continues to threaten it. Because many of these threats occur on private land, they are potentially more difficult to manage. The Blackfoot Challenge—a collaborative effort by landowners, agencies, fisherman, and others to restore and preserve the river and the lands surrounding it—offers a model collaborative approach to managing a resource that crosses private and public lands. Climate change places additional stress on the river, and increases the importance of these and other collaborative efforts across the Crown.

The Rocky Mountain Front

Rivers draining Glacier National Park and the Rocky Mountain Front on the east side of the Continental Divide have a different character from those on the west. The Sun, Cut Bank, Teton, Dearborn, and Two Medicine rivers that flow to the Missouri have their headwaters on high-elevation public land, but become warmer and are diverted for agriculture as they flow east across the high plains to the Missouri River. The upper reaches offer good fishing for native cutthroat and non-native rainbow, brown, and brook trout. The

lower sections have seasonal migrations of rainbow and brown trout up from the Missouri, but are relatively poor trout streams. The most frequently fished river on the east side of the Continental Divide is the Dearborn River (in the Upper Missouri River-Dearborn hydrological unit), accounting for less than 1 percent of total angling days in 2007. The headwaters of the Belly and Saint Mary rivers in Montana flow northeast from Glacier National Park to Hudson Bay. Upper and Lower St Mary Lake also offer fishing for lake trout, and bull trout live in the St Mary River.

Fishing in the alpine streams and lakes of Glacier National Park is popular mainly among tourists who combine fishing with a visit to the park, and who generally do not hire a guide. Generally only locals and fisherman looking for solitude have the commitment required to fish the upper reaches of the main rivers.

Anglers can also lake fish for trophy rainbow trout on Blackfeet Reservation in the Crown. The lakes are mainly spring-fed and do not support wild populations, but are continually stocked by the Blackfoot Nation Fish and Wildlife Department.[78] They offer fantastic still-water fishing that is largely under-appreciated, although Duck Lake is well known among local and regional anglers. These lakes are sensitive to drought and may be particularly affected by climate change.

The Rocky Mountain Front offers fewer direct economic opportunities than the west side because of relatively poor fishing compared to the fisheries in Southwest Montana and Alberta, which are in close proximity. The region's remoteness also limits both the recreational fishing and economic opportunities associated with public lands and outdoor amenities. For example, residents or tourists who include fishing with their visit to Glacier National Park account for many of the angler days. These resident and tourist-anglers are unlikely to hire a guide and there are few fishing-specific lodges in the region, resulting in fewer economic returns.

The most popular river on the Rocky Mountain Front is the Dearborn River, a major spawning tributary of the Missouri River, and most of the fishing is associated with fish migrating up from the Missouri in spring and fall to spawn. The Missouri is one of the nation's premier trout streams.

Fishing Trends in the Region

Table 2 and Figure 9 show the total number of angling days in the Montana portion of the Crown, from 1995 to 2007. Residents in the Crown region account for a higher proportion of fishing days than non-residents. Fishing in the Crown has increased slightly from 13 percent of all fishing in the state in 1995 to 15 percent in 2007. Fifteen percent, however, is relatively low, given the size of the region and the number of rivers and lakes it contains. As discussed above, a number of challenges, such as the introduction of non-native lake trout, have limited the region's full potential as a destination fishery.

The various waterbodies (hydrological units, as classified by Montana Fish, Wildlife and Parks) of the area shown in Table 3. The fishing pressure by hydrological unit is shown in Map 5.

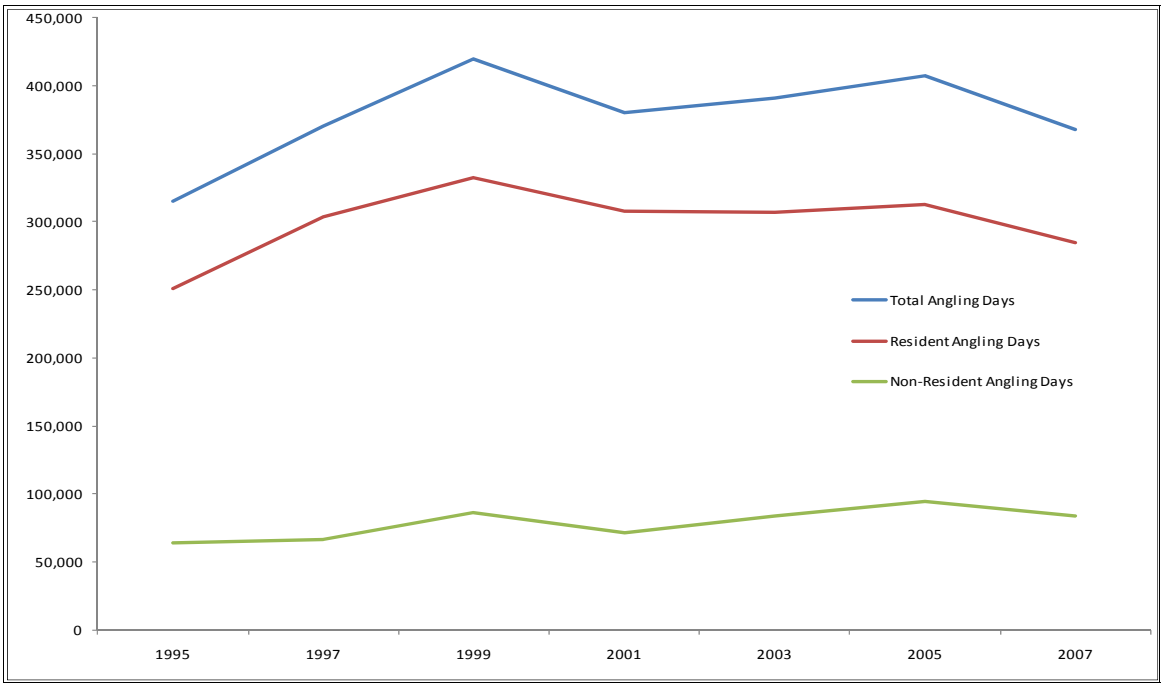
[78] See http://blackfeetfishandwildlife.com/ (last accessed 1/10/11).

Table 2: Angling Days in the Montana Portion of the Crown of the Continent and Statewide, 1995 to 2007.

	Yearly Totals:	1995	1997	1999	2001	2003	2005	2007
Montana Portion of Crown Ecosystem	Total Angling Days	314,854	370,470	419,413	379,967	390,919	407,843	368,330
	Resident Angling Days	251,006	304,064	332,782	308,226	307,269	313,058	284,559
	Non-Resident Angling Days	63,848	66,406	86,631	71,741	83,650	94,785	83,771
Statewide (MT)	Total Angling Days	2,491,687	2,814,617	3,139,886	2,771,800	2,795,422	2,834,015	2,419,873
	Resident Angling Days	1,863,761	2,118,504	2,380,628	2,076,827	1,974,229	2,019,564	1,696,650
	Non-Resident Angling Days	627,926	696,113	759,258	694,973	821,193	814,451	723,223
Crown as Percent of Statewide	Total Angling Days	13%	13%	13%	14%	14%	14%	15%
	Resident Angling Days	13%	14%	14%	15%	16%	16%	17%
	Non-Res Angling Days	10%	10%	11%	10%	10%	12%	12%

Source: MT FWP, MFISH database 2010.

Figure 9: Angling Days in the Montana Portion of the Crown of the Continent, Residents and Non- Residents, 1995 to 2007.



Source: MT FWP, MFISH database 2010.

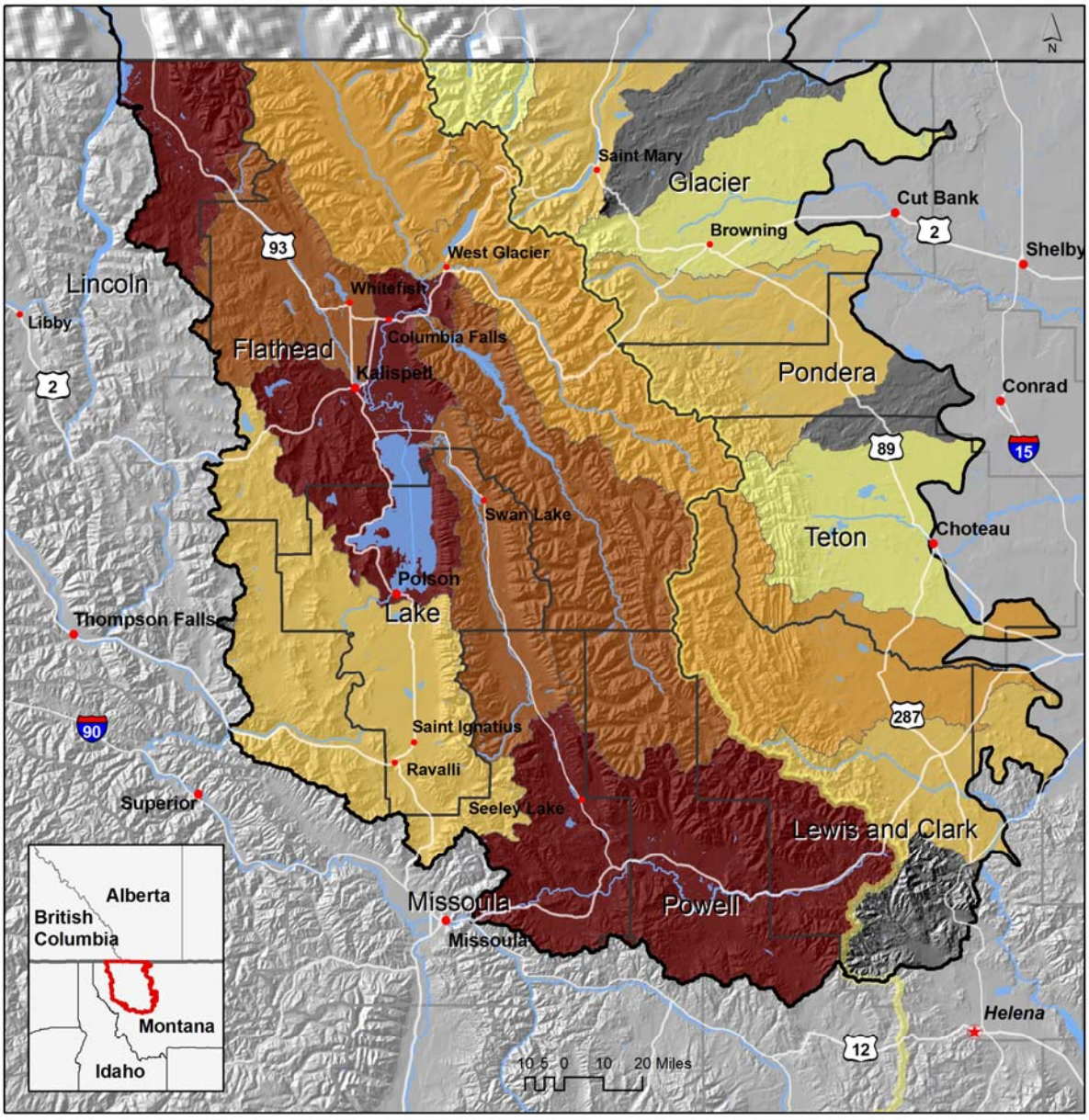
Table 3: Angling Use by Waterbody and Hydrological Unit Representing the Top 80 Percent of Angling Days in the Montana Portion of the Crown of the Continent, 2007.

Crown Waterbody	Total Angling Days	Resident Angling Days	Non-Resident Angling Days	Hydrologic Unit (MT FWP)	Percent of 2007 Total Angling Days
Flathead Lake	70,509	60,618	9,891	Flathead Lake	19%
Lake Koocanusa	38,082	24,947	13,135	Upper Kootenai	10%
Flathead River	37,684	29,519	8,165	Flathead Lake	10%
Blackfoot River	33,733	20,618	13,115	Blackfoot	9%
Kootenai River	25,274	16,227	9,047	Upper Kootenai	7%
North Fork Flathead River	10,173	6,835	3,338	North Fork Flathead	3%
Swan River	9,837	5,822	4,015	Swan	3%
South Fork Flathead River	9,805	7,212	2,593	South Fork Flathead	3%
Browns Lake	7,856	7,234	622	Blackfoot	2%
Hungry Horse Reservoir	7,401	6,911	490	South Fork Flathead	2%
Swan Lake	7,018	5,544	1,474	Swan	2%
Middle Fork Flathead River	7,014	4,754	2,260	Flathead	2%
Seeley Lake	4,386	3,382	1,004	Blackfoot	1%
Whitefish Lake	4,148	3,525	623	Stillwater	1%
Nilan Reservoir	3,970	3,519	451	Sun	1%
Echo Lake	3,549	3,490	59	Flathead Lake	1%
Salmon Lake	3,172	3,134	38	Blackfoot	1%
Beaver Lake	3,037	2,834	203	Stillwater	1%
Placid Lake	2,505	1,235	1,270	Blackfoot	1%
Church Slough	2,341	2,341	0	Flathead Lake	1%
Tetrault Lake	2,187	1,837	350	Upper Kootenai	1%
Lower Stillwater Lake	2,159	1,703	456	Stillwater	1%
Whitefish River	2,159	2,097	62	Stillwater	1%
Foy Lake	2,005	1,573	432	Flathead Lake	1%

Source: MT FWP, MFISH database 2010.

Map 5

Fishing Pressure in the Montana Portion of the Crown of the Continent



2007 Angling Days by Hydrological Unit

- 1 - 1,000
- 1,001 - 5,000
- 5,001 - 20,000
- 20,001 - 50,000
- 50,001 - 125,858
- No Data
- Continental Divide

- Counties
- Limited Access Hwy
- Principal Highway
- State Capital
- Population > 10,000
- Population < 10,000
- Rivers
- Lakes

Data Sources: MT Fish, Wildlife and Parks; Roundtable on the Crown of the Continent, http://www.crownroundtable.org; US Census; US Geological Survey

World Mercator Projection

Map Date: 1/10/2011

HEADWATERS ECONOMICS

The Economic Impacts of Spending by Anglers

As with the skiing industry, we use IMPLAN to estimate the current contributions of resident and non-resident anglers in the Crown of the Continent (see Appendix E for full methods and results from the IMPLAN analysis).

In 2007 expenditures by non-residents resulted in an estimated 166 jobs, $14.5 million in economic output (Table 21), and $1.2 million in state and local taxes (Table 22). When the expenditures of residents and non-resident anglers were combined, they resulted in an estimated 457 jobs, $38.2 million in ecoomic output (Table 23), and $3.4 million in state and local taxes (Table 24).

An important point about the economic impacts of fishing is that residents of the Crown stimulate the majority (62%) of the economic output.

When the direct and indirect impact of residents and non-resident anglers are combined, they resulted in an estimated 457 jobs (coincidentally, the same estimate as with downhill skiing). Total impact of direct and indirect spending is estimated to be $38.2 million in economic output and $3.4 million in state and local taxes.

Table 4: Employment and Spending Contributions of Resident and Nonresident Anglers in the Montana Portion of the Crown of the Continent, 2007 (2010 Dollars)

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	336	$8,119,191	$13,985,736	$24,220,690
Indirect Effect	59	$2,167,371	$4,070,214	$7,386,818
Induced Effect	62	$2,013,345	$3,825,150	$6,606,497
Total Effect	457	$12,299,907	$21,881,100	$38,214,005

Source: Adapted from Southwick Associates. Sportfishing in America: An Economic Engine and Conservation Powerhouse. Produced for the American Sportfishing Association with funding from the Multistate Conservation Grant Program, 2007. Expenditure and participation data obtained from the U.S. Fish and Wildlife Service's 2006 National Survey of Fishing, Hunting and Wildlife-Associated Recreation; and IMPLAN Analysis (see Appendix E for details).

The fishing industry as a whole is a relatively small portion of the overall economy of the Crown region, contributing only two jobs in a thousand (total employment in the region is 255,000).

Fishing in the Crown of the Continent is closely linked to fishing on the Missouri River in Southwest Montana and in British Columbia and Alberta (e.g., the Elk River). People coming to the region to fish will often make a loop, for example flying into Bozeman and fishing the Yellowstone or Madison rivers, then up to the Missouri or Blackfoot rivers, the Flathead River, and then into Canada to fish the Elk River in Alberta. Whether or not an angler follows this particular route, the point is that the Crown benefits from being part of a wider fishing region that offers diverse fishing opportunities.

These linkages also mean that this analysis does not account for some of the region's business activity, or even for some of the guides working in the Crown. For example, Missoula area guides (based outside the hydrological unit analysis area) routinely take clients to the upper Blackfoot River, or even to the

Flathead River, and guide shops located on the Missouri River offer trips into the Rocky Mountain Front and on the Dearborn River.

Being a part of a wider fishing region also means that the impact of climate change on nearby fisheries will affect businesses in the Crown. Declines in these other fisheries may benefit the Crown (because the Crown fisheries may be more resilient to climate change); however, climate change could offset these benefits if it weakens the region's attraction and fewer anglers visit Montana in general.

Several of the fishing guides we interviewed seem to think that declines in other fisheries are benefiting the Crown. Purchases of fishing licenses in other western states and nation-wide are flat or declining. In Montana, however, fishing license sales are up, particularly among non-residents. This could be an indication that more people are choosing to visit Montana because the rivers and streams are in relatively better shape.

For the traveling angler who has the world to choose from, the opposite may be happening. Bookings through international travel companies are down for Montana as anglers are traveling to new, more exotic, and perhaps more consistent fisheries around the globe. This market segment is lucrative but small compared to the resident and domestic angling market.

Although the direct number of jobs associated with fishing in the Crown is relatively small, there are economic benefits that are tied to the "amenity economy." For example, one study found rapid growth in Flathead County was "directly tied to Glacier Park and the region's natural environment and small-town character."[79] The amenities most often listed as attractions for people and businesses to the Crown include Glacier National Park and other public lands, small towns and rural atmosphere, and outdoor recreation, including fishing. The fishing industry in the Crown benefits from and contributes to these other amenities. As one business owner we interviewed put it, "this isn't old guys sitting around the lodge smoking cigars and drinking scotch. [These visitors] bring their families here (to the Crown)."

Another indicator of fishing's contributions to the wider economy is that local residents generate the majority (62%) of the economic output related to fishing. In other words, people living in and moving to the Crown are anglers. Many of the business owners we talked to point to influence of fishing on the real estate market—for example, riverfront properties with access to good fishing sell for a premium. This also reinforces the finding that many of these anglers' neighbors and business peers live and work in the region because of the access to the outdoors.
In addition to the recreation opportunities they provide, public lands and outdoor recreation in the Crown also have a stabilizing effect on employment; the Park Service and Forest Service offer stable and high-paying jobs in the region, particularly important during the recent recession.

The future economic contributions of fishing will be closely related to the uniqueness of the fishing opportunities and the quality of the public land and community amenities. Several indicators point to bull trout as one of the most important fish in the region in terms of attracting anglers to the region, particularly to the Flathead drainage. The integrity of the bull trout habitat and the access to protected public lands is a large part of the attraction for anglers.

Any efforts to improve fisheries and their habitat in order to maximize their economic contributions to the region must also recognize the key role played by the small towns and cities, airports, and an educated workforce. The greatest economic success lies at the intersection of unique individual experiences, vast public land amenities, and quality education, and transportation infrastructure.

[79] Swanson, L.D., N. Nickerson, and J.Lathrop. 2003. Gateway to Glacier: The Emerging Economy of Flathead County. National Parks and Conservation Association. Washington, D.C.

Climate Change Impact and Adaptation

Warming Water and Drought

A recent study published in the journal of the American Meteorological Society on the declining mountain snowpack in the West began with the following statement:

> Mountain snowpack in western North America is a key component of the hydrological cycle, storing water from the winter (when most precipitation falls) and releasing it in the spring and early summer, when economic, environmental, and recreational demands for water throughout the West are frequently greatest.[80]

The authors found that: "It is becoming ever clearer that [the] projected declines in [snow water equivalent], which is already well underway, will have profound consequences for water use in a region already contending with the clash between rising demands and increasing allocations of water for endangered fish and wildlife."

In interviews, climate scientists, fisheries biologists, and business owners in the Crown all point to warmer water, and less of it in late summer, as most significant effect of climate change on fisheries and the fishing industry. For example, the floating season on the Middle Fork of the Flathead River ends typically after July 1st as the water drops after runoff. If the water drops earlier, or if warm water temperatures lead to mandatory or voluntary closures on the Flathead or other rivers, fishing opportunities in the region will decline, and the industry will feel the affect.

The Blackfoot River experienced voluntary and mandatory fishing restrictions in 2000, 2001, and 2007 due to high water temperatures and it appears these restrictions are directly linked to fewer angler days in these years.

Lakes on the Blackfoot Reservation are particularly sensitive to drought. The Blackfoot Nation Fish and Wildlife Department reports that it has stopped stocking at least five of its lakes because low water has resulted in winter fish kills. In recent years, Duck Lake has not produced the numbers of trophy fish it is famous for; lower water levels—due to a combination of drought and the proliferating wells that supply the shoreline vacation homes—are at least one contributing factor.

To adapt to drought and warm waters, guides and shop owners are recommending that their clients visit earlier in the summer or in the fall, to avoid potentially slow fishing or closed rivers through August. When waters do warm, guides are moving to rivers with the coolest water. This includes tailwaters like the Kootenay and Missouri rivers just outside the Crown that benefit from the cold water released from reservoirs through the summer. If rivers in the Crown are not fishable in the summer, anglers will shift their attention out of the region. Some anglers will turn their attention to smaller streams at higher elevations or to high-mountain lakes, but fewer people are able to hike or pack into these areas, and the economy linked to wilderness fishing is smaller.

Ensuring that rivers and streams have clean and cold water in the face of climate change requires two mitigations: maintaining intact habitat and riparian vegetation and ensuring sufficient instream-flows. On public lands in the region, the habitat is largely intact. For example, the Flathead River and most rivers on the Rocky Mountain Front have the headwaters in protected public lands (wilderness and national park).

[80] Mote, P. W., A. F. Hamlet, M. P. Clark, and D.P. Lettenmaier. 2005 Declining Mountain Snowpack in Western North America. *American Metrological Society*. January, 39-49.

On private lands, improving irrigation systems, increasing instream-flows, restoring riparian vegetation, and limiting development in floodplains will all contribute to healthier and more resilient watersheds.

Efforts like the Blackfoot Challenge should serve as a model for how to work across boundaries in order to mitigate against climate change.[81] On the Blackfoot, efforts at habitat restoration, for example, have signficantly benefited the river. Like many pressing problems in the region, the ability to mitigate against climate change will depend on relationships with neighbors and communities.

The Impact of Invasive Species

Another important impact climate change will have on recreational fishing relates to aquatic habitat and the spread of invasive species. Climate change is generally expected to increase the spread of invasive species through direct effects on habitat suitability and indirect effects on nutrient availability and disturbance regimes.[82]

Invasive species are expected to better adapt to climate change than native species because they possess broad climatic tolerances and robust dispersal mechanisms. One study identified five consequences climate change will have for invasion dynamics: altered invasion pathways, changes in environmental constraints, altered distribution of existing invasive species, altered impacts of invasive species, and a change in management effectiveness.[83] An "altered invasion pathway," for example, could be increased recreational boat traffic which could increase the spread of nuisance species.

Ways in which climate change is expected to influence invasive species distribution and presence across landscapes include:

- Plant and animal species, both native and invasive, will generally migrate upslope and northward;
- Changes in precipitation will likely drive the expansion of invasive plants;
- Warmer stream temperatures and a reduction in ice cover will facilitate the spread of aquatic invasives and may increase their impacts;
- Changes in the timing of snowmelt and a subsequent increase in disturbance caused by spring floods may increase the risk of aquatic and riparian invasions;

[81] Blackfoot Challenge website can be found at http://blackfootchallenge.org/Articles/ (last accessed 1/10/11)
[82] Ashton, I. W. 2010: Observed and projected ecological response to climate change in the Rocky Mountains and Upper Columbia Basin: A synthesis of current scientific literature. In NPS/ROMN/NRR-2010/220, N. R. R., editor, Fort Collins, Colorado: National Park Service; Dukes, J. S., and H. A. Mooney. 1999. Does global change increase the success of biological invaders? *Trends in Ecology & Evolution* 14, 135-139; Fausch, K. D., Y. Taniguchi, S. Nakano, G. D. Grossman, and C. R. Townsend. 2001. Flood disturbance regimes influence rainbow trout invasion success among five holartic regions. *Ecological Applications* 11, 1438-1455; Hellmann, J. J., J. E. Byers, B. G. Bierwagen, and J. S. Dukes. 2008. Five potential consequences of climate change for invasive species. *Conservation Biology* 22, 534-543; Mohseni, O., H. G. Stefan, and J. G. Eaton. 2003. Global warming and potential changes in fish habitat in US Streams. *Climatic Change* 59, 389-409; Petersen, J. H., and J. F. Kitchell. 2001. Climate regimes and water temperature changes in the Columbia River: Bioenergetic implications for predators of juvenile salmon. *Canadian Journal of Fisheries and Aquatic Sciences* 58, 1831-1841; Rahel, F. J., and J. D. Olden. 2008. Assessing the effects of climate change on aquatic invasive species. *Conservation Biology* 22, 521-533; Scott, M. L., J. M. Friedman, and G. T. Auble. 1996. Fluvial process and the establishment of bottomland trees. *Geomorphology* 14, 327-339.
[83] Hellman et al 2008.

- Warmer temperatures may change human visitation patterns to natural areas and increase the pathways for the spread of many invasives.

The following are four examples of how invasives may alter ecosystem dynamics in the Crown Region:

1. It is suspected that climate is a major driver of the spread of invasive warm-water fishes.[84] Stream temperatures are expected to warm with warmer air temperatures and lower flows, increasing the amount of suitable habitat for warm-water fishes by an estimated 31 percent nationwide.[85]

2. Warmer temperatures may increase the impact of invasive species. In the Columbia River, for example, increasing temperatures have caused smallmouth bass (*Micropterus dolomieu)* to consume more native salmon,[86] and whirling disease is more virulent in warmer streams.[87]

3. Earlier melting of snowpack will alter streamflows, may increase disturbance and flood events, and favor invasive species. It is predicted that such changing conditions may increase rainbow trout (*Oncorhynchus mykiss*) invasions in Colorado. However, native species such as cottonwoods could benefit from larger spring flood events that facilitate establishment and recolonization.[88]

4. Whirling disease will also be a problem. The prevalence of the parasite (*Myxobolus cerebralis)* causing whirling disease is strongly tied to habitat suitability for the worm *Tubifex tubifex*, which acts as a host during the life cycle of the parasite and is required for the parasite to complete its life cycle. Degraded, lower elevation rivers and streams found in agricultural landscapes provide optimal habitat for *Tubifex* worms and play an important role in the prevalence and spread of whirling disease. Streambeds are typically dominated by sediments rather than by cobble—and stream reaches are most commonly highly impacted by sediment deposition related to ranching and other agricultural activities in the surrounding landscape. Additionally, it has been demonstrated that whirling disease is more virulent in warmer streams.[89]

While the presence of lake trout in Flathead Lake currently is not associated with climate change, it serves as an important reminder of the potential impact that non-native species can have. There is growing concern about the impact of existing and potentially new exotic and nuisance species in the region. Non-native trout thrive in rivers affected by drought or compromised by habitat loss. Rainbow, brown and brook trout are encroaching on native fish in mainstem rivers and headwaters regions where warming water and other threats are affecting natives. Because of the attraction native fish hold in some of the main fisheries (for example, bull trout in the Flathead and Blackfoot rivers), encroachment by non-natives could become an economic issue.

People we interviewed also expressed concerns about invasive species and noxious weeds and aquatic organisms that may thrive in warmer waters. The single-celled organism *Didymo* is making advances into Montana's rivers and the establishment of other nuisance species will be more likely in the future as a direct result of climate change.

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[84] Rahel, F. J., and J. D. Olden. 2008. Assessing the effects of climate change on aquatic invasive species. *Conservation Biology* 22, 521-533; Schisler, G. L., E. P. Bergersen, and P. G. Walker. 2000. Effects of multiple stressors on morbidity and mortality of fingerling rainbow trout infected with Myxobolus cerebralis. *Transactions of the American Fisheries Society* 129, 859-865., Rahel and Olden 2008.
[85] Mohseni et al. 2003.
[86] Petersen and Kitchell 2001.
[87] Rahel and Olden 2008.
[88] Scott et al. 1996
[89] Rahel and Olden 2008.

Due to increasing threats from nuisance species, Idaho now requires boat inspections and permits for visiting anglers. Other states have banned felt-soled waders. Simms—a Montana fishing-products company—no longer manufactures felt-soled wading boots because wet-felt is an ideal environment for transporting unwanted organisms from waterbody to waterbody. New Zealand has banned felt-soled wading boots nation-wide to limit the spread of *Didymo,* most likely brought from North America via wet fishing gear.

Dams and Diversions

Another threat to fishing in the region will come from downstream demand for water and power. One river advocate described the Crown of the Continent as "the last great un-appropriated fountainhead in the West." Increasing demand to deliver water to endangered salmon and steelhead downstream, to provide power to California's renewable energy market, or to meet increased agricultural and municipal consumption within and outside the region will result in calls for new dams and diversions on the Crown's rivers and streams.

However, dams and diversions can have significant consequences on aquatic habitat by lowering streamflows and aggravating the affect of drought and "thermal pollution" (or high water temperatures). Dams also block migration routes important to native bull trout, in particular. Fragmentation of river habitat is one of the issues that led to the listing of bull trout as a threatened species under the U.S. Endangered Species Act.

Several organizations are pursuing new Wild and Scenic River designations that would limit the potential of new dams and other instream structures. These designations, in addition to protecting the rivers, also draw attention to their pristine nature, thus increasing the profile of the region as a fishing destination.

Disturbance Events (Fire, Flood, Landslides)

Current climate change models predict that catastrophic events will increasingly impact fisheries in the Crown. For example, large wildfires will be more likely, which will cause increased erosion and silt in streams, harming trout eggs and insect life. Large flood events, including early rain on snow events, can damage resources in the short term (floods and fires tend to benefit rivers over time, but significant events can damage fisheries in the short term).

Managing for large disturbance events is not always possible, but a few strategies can help to mitigate the impact when they occur. Forest restoration including vegetation treatments, re-vegetation, and controlling noxious weeds can reduce the likeliness and severity of fires. Even with such measures, however, wildfires will occur. Removing and restoring failing forest roads, improving stream crossings, and other watershed restoration efforts can limit the potential for large sediment events following wildfires and can reduce overall sediment transport into rivers and streams during floods.

Additional Stresses on Rivers and Streams

Thinking about the effects of climate change as one addition to the many existing stresses on rivers and streams can help in developing effective responses. Planning for the stresses associated with climate change is critical, but so is understanding and limiting the other stresses on watersheds and fisheries when possible. For example, the agreement between Montana and British Columbia to ban mining and oil and gas development in the British Columbia Flathead and the Montana North Fork Flathead River Basin is

an important step in the right direction.[90] The decision will protect the North Fork Flathead River from potential impacts due to mineral extraction activities and the associated roads and infrastructure.

The threats posed by these activities are still ripe in other areas of the Crown, however. For example, drilling for oil and natural gas on the Rocky Mountain Front could place additional stresses on the rivers and streams there.[91]

The fisheries in the Crown face multiple threats. Climate change will increase the stress on the rivers and lakes of the region, increasing the need to work collaboratively to address existing and potential threats from land use changes and competition for water. Climate change also introduces new threats, including changes in the timing and amount of water and the potential for large-scale disturbance events. Businesses, biologists, landowners, and activists in the region are already working together to understand and solve these issues. The benefits will be measured in healthy watersheds, robust native fish populations, and as jobs and dollars flowing to the region based, at least in part, on these unique amenities.

[90] Schweitzer, B.C. chief ink Flathead mining ban. Rob Chaney. The Helena Independent Record, February 19, 2010. http://helenair.com/news/local/state-and-regional/article_b84c1728-1d27-11df-8ff4-001cc4c002e0.html (last accessed 6/10/10)
[91] For example, see the Coalition to Protect the Rocky Mountain Front. http://www.savethefront.org/ (last accessed 1/15/11).

VII. CONCLUSIONS AND RECOMMENDATIONS

The climate in the Crown of the Continent is changing in a number of ways, including reduced snowpack, precipitation coming later in the fall and winter, more precipitation falling as rain instead of snow, earlier onset of peak spring runoff, increased frequency of winter and spring flood events, increased occurrence of summer droughts, and lower summer flows in rivers and streams. These trends are expected to become more significant in the future.

Climate change will directly impact the region's economy. The majority of jobs in the region, and nearly all the population and income growth over the past 30 years, are closely linked to the natural amenities and the natural resources of the Crown.

In this report, we looked at how climate change may affect two sectors of the Crown's economy—downhill skiing and recreational fishing. While these two industries are a small component of the overall regional economy, we selected them because they are "snowpack dependent" and because of their larger role as part of the quality of life of the region that attracts families and businesses to the Crown. We used quantitative techniques to document the geographic distribution and economic impacts of these sectors, and supplemented these with interviews with people closely involved in the skiing and fishing industries.

The Land

Because of the Crown's relatively unfragmented landscapes, diverse climactic zones, variety of habitats, and linkages to other wild land areas, many scientists consider it a region that could adapt more successfully than others to the impacts of climate change. The Crown is therefore a natural laboratory for studying the effects of climate change.

From a scientific and management perspective, larger landscapes provide better possibilities for protection and restoration than smaller areas when the threats are as diverse and widespread as those predicted from climate change. The extensive public lands in the Crown provide large blocks of contiguous habitats that will facilitate the kinds of conservation and restoration activities that may be necessary to maintain these habitats in the face of climate change. In more highly fragmented and developed landscapes, where plant and wildlife movements are likely to be inhibited by dense human settlement and more discontinuous habitats, the Crown provides models of successful collaborations—such as the Blackfoot Challenge—among groups of people with a diverse set of perspectives and skills, who are tackling resource issues that cross ownership boundaries.

The Economy

The overall economic context of the Crown is important background to this study because the region has undergone significant changes. The economy of the Montana portion of the Crown can be characterized as fast growing (although there are significant differences between counties), with the bulk of the jobs and income in three counties: Flathead, Missoula, and Lewis and Clark. Despite its rural feel, only a quarter of the population resides in a rural area.

In 2008, direct jobs in the region were distributed as follows: agriculture (2.7%); resource extraction (mining, oil, gas, forestry; 4%); services (67%), and government (15%). The remaining 11 percent consisted of non-forestry-related manufacturing and construction. In terms of personal income, 39.5 percent of all personal income in 2008 was from non-labor sources, including retirement and investment income. In addition, it is estimated that about one-third of all spending by tourists visiting Montana occurs in the Crown region.

As is the case in many areas in the West with vast expanses of open space and recreation opportunities (and with connections to the outside world via highways and regional airports), the makeup of the Crown's economy and much of the region's growth can be can be attributed to the in-migration of people—and their businesses—for quality of life reasons. This in-migration has contributed to the fact that in terms of population, job, and personal income growth, the region has outpaced the rest of the county, and it helps explain the relative prominence of service-based industries and non-labor sources of income.

Many Crown residents consider skiing and fishing—the two economic sectors this report focuses on—both central to their quality of life and to their decision to live in the region. The economic impact of these sectors thus extends beyond direct expenditures on items such as ski lift tickets and fishing gear to include their value as recreational and environmental amenities, and their ability to attract people and businesses to the Crown.

The Ski Industry and Climate Change

Until recently, four ski areas operated in the Montana portion of the Crown of the Continent; today only two major ski areas remain in operation, though one small one has reopened after closing in 2009. In the 2009-2010 season, expenditures by non-residents resulted in an estimated 288 jobs, $24.6 million in economic output, and $1.9 million in state and local taxes. When the expenditures of resident and non-resident skiers were combined, they resulted in an estimated 457 jobs, $39.8 million in economic output, and $3.1 million in state and local taxes.

Ski resorts in the Crown that attempt to adapt to rising temperatures and changing climate conditions will likely face higher operating. Some ski areas may be forced to "climb up the mountain," pushing into higher alpine environments in search of consistently suitable snow conditions. Because of the close relationship between snow conditions and skier days, most ski areas will have to expand artificial snow making, which may require purchasing new snow making technology and adding water infrastructure and storage facilities.

Resorts already are looking at ways to diversify their recreational offerings. Many resorts now offer mountain biking, mountaineering, hiking, and events in the summer, and activities requiring less snow—such as snowshoeing, cross country skiing, and terrain parks—in the winter.

Another important economic contribution of downhill skiing, which is difficult to quantify but widely supported by published literature, is that is it part of the overall "quality of life" package that attracts and retains people (and their businesses) to the Crown region.

If winter recreation is an important draw for people who choose to live and work in mountain communities, at least in part because of the skiing opportunities, then there could be a ripple effect through other sectors of the economy. The most obvious concern is that poorer ski conditions will negatively affect the real estate market. But the complex economic linkages that this report reveals mean that fewer migrants, retirees, and second homebuyers—that is, less amenity migration—also will affect the finance, construction, retail, utility, transportation, and health care sectors.

The Fishing Industry and Climate Change

From an economic perspective, the most valuable aspect of the fisheries in the Crown is the unique opportunity they offer, better than any others in the state, to catch native bull trout and cutthroat trout in

pristine rivers and streams. These scenic and remote rivers draw anglers to the Crown and contribute to the wild character of the region that attracts and retains residents and businesses.

Expenditures by non-resident and resident anglers in the Crown region generated 457 jobs, $38.2 million in economic output, and $3.4 million in state and local taxes. Resident-spending on recreation, however, stimulates the majority (62%) of the economic output in the region, reinforcing an important point this report makes: recreation is a key reason why people live in the Crown region.

Restoring and maintaining the Crown's unique fish and pristine fishing experiences will be central to the future contributions of the fishing industry. The decline of bull and cutthroat trout in the Flathead drainage contributed to a significant decrease in fishing, and the emergent lake trout fishery on Flathead Lake did not make up for the lost angler days. The possibility of encountering a large bull trout remains a large part of the popularity of fishing on the Upper Blackfoot.

Climate change will lead to conditions that will affect the fishing industry, including: warmer water and increased drought; loss of habitat; displacement of native fish with non-native species; increased disease, and invasive and nuisance species; and more frequent disturbance events, including floods and wildfires. Restricted fishing seasons and seasonal closures; increased conflicts over water resources and new calls for dams and diversions; and extra costs associated with managing invasive species will likely result from changing climate conditions. All of these consequences may have negative effects on fishing guides, sporting goods stores, and other businesses catering to anglers.

Guides and shop owners are already adapting to some of these changes, recommending to their clients that they visit earlier in the year or in the fall to avoid low, warm waters during the summer. Some anglers are heading to smaller streams at higher elevations, or are fishing the larger tailwater rivers, like the Missouri and Kootenay that have consistently cooler waters through the summer months. Maintaining the integrity of headwaters habitat, riparian areas, and limiting diversions are critical to keeping cold water flowing for fish.

Land use change, dams and diversions, and mining activities already stress the health of rivers in the Crown. Climate change will place additional strain on rivers, making it all the more important to reduce impacts from commercial activities. Since protecting rivers from these activities has been more feasible for those that originate on public lands, like wilderness and national parks, the importance of these protected areas to increasing the chances of successful adaptation to climate change is clear. Collaborative efforts like the Blackfoot Challenge offer models for creating relationships and partnerships that can address landscape-scale impacts across large areas with multiple land-owners.

The introduction of the mysis shrimp and lake trout, both non-native, have significantly and negatively affected native fish populations (bull trout and cutthroat trout, as well as kokanee, another non-native that declined precipitously) and the quality of the fishery. While these species were introduced on purpose, they illustrate what is expected to occur more frequently with changing climatic conditions—a higher incidence of non-native species that will likely arrive uninvited and unannounced.

Recommendations

A number of activities can increase the chances of adapting successfully to climate change:

Downhill Skiing:

- Pursue energy efficiency and snowmaking capabilities that reduce longer-term operating costs and increase reliable snow coverage;
- Seek to increase advance bookings for non-peak weeks during the winter season, trading on unpredictable storms and shorter booking windows;
- Explore expanding into higher elevation terrain and slopes with a northern aspect that are better able to support snow coverage;
- Diversify winter recreation activities (e.g., sledding, skating, terrain parks) that are more concentrated and can be more easily sustained when snowpack is poor;
- Grow summer recreation (e.g., mountain biking) and events (e.g., weddings) to boost off-season revenue.

Fishing:

- Restore unique native bull trout and cutthroat trout fisheries by controlling lake trout in Flathead Lake and other non-native species throughout the Crown;
- Protect and restore the headwaters of the Crown's rivers and streams to maintain water quantity and temperature;
- Remove and prevent new dams and diversions to maintain migration routes for native fish (Wild and Scenic River designations can eliminate these threats on public lands);
- Reduce the impact of land use change on watersheds (residential development, oil and gas development, logging, and mining).
- Increase collaborative efforts, such as the Blackfoot Challenge, to establish working relationships among diverse groups of people to improve river health.

Climate change already is affecting the Crown of the Continent and will have a larger impact in the future. Looking ahead, the economic well being of the Crown will be determined in large part by the ability of land managers, businesses, and residents to maintain or improve the unique experiences and resources of the Crown.

Fortunately, the Crown's size and the diversity of its public lands make the region more likely to mitigate and adapt to the effects of a changing climate. The challenge now is for scientists, land-managers, resource-users, and others to coordinate at the landscape-level to address the broad impacts of climate change.

APPENDIX A: CROWN OF THE CONTINENT LAND OWNERSHIP AND FEDERAL LANDS AND THEIR MANAGEMENT PRIORITY

Tables 5 and 6.

Land Ownership (Acres)

	Flathead	Glacier	Lake	Lewis and Clark	Lincoln	Missoula	Pondera	Powell	Teton	Crown Region
Total Area	4,049,138	1,942,994	1,084,303	2,712,424	2,439,085	1,847,559	1,054,968	1,796,372	1,589,577	18,516,421
Private Lands	713,133	696,601	403,630	964,180	512,646	734,292	762,904	641,617	1,057,881	6,486,884
Federal Lands	3,079,215	393,410	197,060	1,557,090	1,817,509	896,522	115,050	1,042,635	399,865	9,498,356
Forest Service	2,447,836	28,766	170,007	1,451,363	1,815,719	875,612	112,878	924,857	347,924	8,174,961
BLM	0	971	0	84,365	15	20,881	1,403	109,876	18,265	235,775
National Park Service	619,616	363,579	0	0	0	0	0	1,594	0	984,788
Military	34	0	0	3,227	12	29	105	0	0	3,407
Other Federal	11,729	94	27,053	18,136	1,764	0	664	6,309	33,676	99,425
State Lands	133,062	8,130	62,575	169,558	71,481	111,052	56,847	109,733	119,459	841,896
State Trust Lands*	130,136	8,130	55,069	134,569	66,042	69,673	56,847	61,238	103,350	685,054
Other State	2,925	0	7,507	34,989	5,439	41,378	0	48,495	16,109	156,843
Tribal Lands	28,637	826,492	320,267	0	0	93,886	113,250	0	0	1,382,532
Water	94,937	18,362	100,771	20,825	37,449	9,356	6,917	2,387	12,372	303,376
City, County, Other	154	0	0	772	0	2,452	0	0	0	3,377
Percent of Total										
Private Lands	17.6%	35.9%	37.2%	35.5%	21.0%	39.7%	72.3%	35.7%	66.6%	35.0%
Federal Lands	76.0%	20.2%	18.2%	57.4%	74.5%	48.5%	10.9%	58.0%	25.2%	51.3%
Forest Service	60.5%	1.5%	15.7%	53.5%	74.4%	47.4%	10.7%	51.5%	21.9%	44.1%
BLM	0.0%	0.0%	0.0%	3.1%	0.0%	1.1%	0.1%	6.1%	1.1%	1.3%
National Park Service	15.3%	18.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	5.3%
Military	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Other Federal	0.3%	0.0%	2.5%	0.7%	0.1%	0.0%	0.1%	0.4%	2.1%	0.5%
State Lands	3.3%	0.4%	5.8%	6.3%	2.9%	6.0%	5.4%	6.1%	7.5%	4.5%
State Trust Lands*	3.2%	0.4%	5.1%	5.0%	2.7%	3.8%	5.4%	3.4%	6.5%	3.7%
Other State	0.1%	0.0%	0.7%	1.3%	0.2%	2.2%	0.0%	2.7%	1.0%	0.8%
Tribal Lands	0.7%	42.5%	29.5%	0.0%	0.0%	5.1%	10.7%	0.0%	0.0%	7.5%
Water	2.3%	0.9%	9.3%	0.8%	1.5%	0.5%	0.7%	0.1%	0.8%	1.6%
City, County, Other	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%

Relative Management Designations of Federal Lands (Acres)*

	Flathead	Glacier	Lake	Lewis and Clark	Lincoln	Missoula	Pondera	Powell	Teton	Crown Region
Total Federal Land Area	3,079,215	393,410	197,060	1,557,090	1,817,509	896,522	115,050	1,042,635	399,865	9,498,356
Highly Protected	1,318,262	363,639	27,005	466,993	53,377	171,043	6,729	283,576	119,198	2,809,821
Less Protected	2,509	0	224	32,631	204,774	41,192	53,561	55,970	43,865	434,726
Unprotected	1,758,153	29,771	169,832	1,040,584	1,557,582	684,258	54,636	703,089	204,935	6,202,840
Percent of Total										
Highly Protected	42.8%	92.4%	13.7%	30.0%	2.9%	19.1%	5.8%	27.2%	29.8%	29.6%
Less Protected	0.1%	0.0%	0.1%	2.1%	11.3%	4.6%	46.6%	5.4%	11.0%	4.6%
Unprotected	57.1%	7.6%	86.2%	66.8%	85.7%	76.3%	47.5%	67.4%	51.3%	65.3%

** Federal public lands that are managed primarily for natural, cultural, and recreational features. These lands include national parks and preserves (NPS), wilderness (NPS, FWS, FS, BLM), national conservation areas (BLM), national monuments (NPS, FS, BLM), national recreation areas (NPS, FS, BLM), national wild and scenic rivers (NPS), waterfowl production areas (FWS), wildlife management areas (FWS), research natural areas (FS, BLM), areas of critical environmental concern (BLM), and national wildlife refuges (FWS).

Highly Protected: national parks and preserves (NPS), wilderness (NPS, FWS, FS, BLM), national conservation areas (BLM), national monuments (NPS, FS, BLM), national recreation areas (NPS, FS, BLM), national wild and scenic rivers (NPS), waterfowl production areas (FWS), wildlife management areas (FWS), research natural areas (FS, BLM), areas of critical environmental concern (BLM), and national wildlife refuges (FWS).

Less Protected: wilderness study areas (NPS, FWS, FS, BLM), inventoried roadless areas (FS).

Unprotected: public domain lands (BLM), O&C Lands (BLM), national forests and grasslands (FS).

NPS = National Park Service; FS = Forest Service; BLM = Bureau of Land Management; FWS = Fish and Wildlife

Data Sources: Rasker, R. 2006. An Exploration Into the Economic Impact of Industrial Development Versus Conservation on Western Public Lands. *Society and Natural Resources*. 19(3): 191-20; MT Natural Heritage Program, 2008; Conservation Biology Institute, 2006.

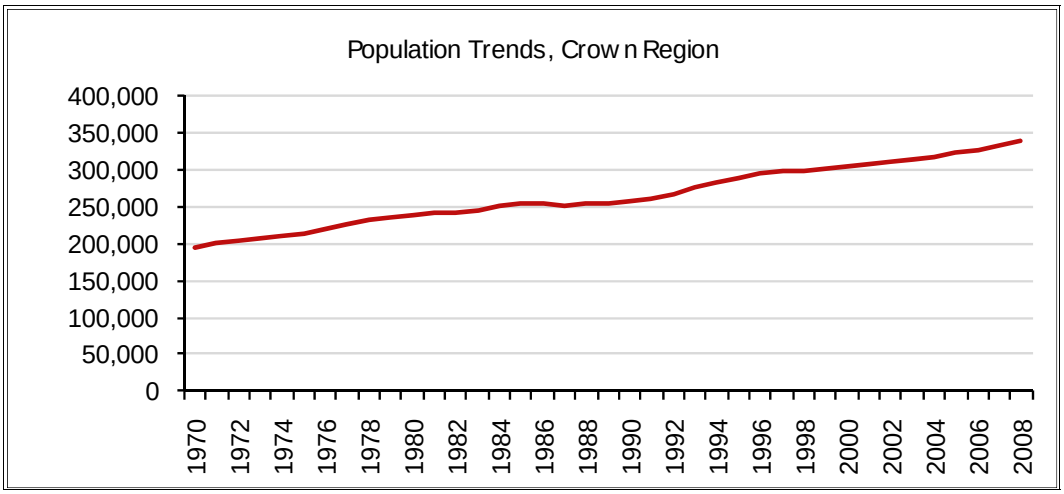
APPENDIX B: SUMMARY OF SOCIOECONOMIC STATISTICS FOR COUNTIES IN THE MONTANA PORTION OF THE CROWN OF THE

	Flathead, MT	Glacier, MT	Lake, MT	Lewis and Clark, MT	Lincoln, MT	Missoula, MT	Pondera, MT	Powell, MT	Teton, MT	Crown Region	U.S.
Trends											
Population % change, 1970-2008	124.4%	23.5%	94.4%	82.8%	3.8%	83.9%	-12.7%	5.6%	0.7%	73.3%	49.4%
Employment % change, 1970-2008	307.7%	53.6%	211.2%	169.1%	37.9%	213.1%	6.9%	46.7%	41.2%	180.5%	99.1%
Personal income % change, 1970-2008	306.6%	87.3%	265.7%	195.8%	51.2%	236.4%	16.8%	54.2%	58.7%	198.3%	164.7%
Prosperity											
Unemployment rate, 2009	10.7%	8.7%	8.4%	4.5%	13.5%	5.7%	5.7%	8.3%	4.4%	7.4%	9.3%
Average earnings per job, 2008 (2009 $s)	$33,486	$38,067	$27,028	$40,748	$28,617	$37,744	$33,983	$30,956	$32,143	$35,864	$50,080
Per capita income, 2008 (2009 $s)	$34,858	$27,305	$27,059	$38,107	$27,094	$34,983	$33,439	$24,075	$37,049	$33,891	$40,023
Economy											
Non-Labor % of total personal income, 2008	40.9%	45.2%	50.9%	35.3%	51.0%	35.4%	49.9%	42.7%	46.8%	39.5%	33.4%
Services % of total employment, 2007	*77.4%*	*87.6%*	*81.7%*	*90.7%*	*72.8%*	87.8%	*80.3%*	*70.8%*	*93.0%*	*84.4%*	82.2%
Government % of total employment, 2008	8.1%	37.3%	19.2%	23.9%	13.7%	13.2%	12.9%	29.8%	14.4%	15.3%	13.5%
Use Sectors^											
Timber % of total employment, 2007	*4.5%*	*0.1%*	*4.9%*	*0.2%*	*8.2%*	*3.6%*	*0.1%*	*19.6%*	*0.3%*	*3.4%*	0.9%
Mining % of total employment, 2007	*0.1%*	7.0%	*0.0%*	*0.2%*	*4.3%*	*0.1%*	*0.2%*	*0.2%*	0.0%	*0.4%*	0.6%
Fossil fuels (oil, gas, & coal), 2007	*0.0%*	*7.1%*	0.0%	*0.0%*	0.0%	*0.1%*	*0.3%*	0.0%	0.0%	*0.2%*	0.4%
Other mining, 2007	*0.1%*	*-0.1%*	*0.0%*	*0.2%*	*4.3%*	*0.0%*	*-0.1%*	*0.2%*	0.0%	*0.2%*	0.1%
Agriculture % total employment, 2008	1.7%	9.8%	8.9%	1.5%	3.5%	0.9%	15.4%	9.3%	19.7%	2.7%	1.5%
Travel & Tourism-related % total empl., 2007	*18.8%*	*21.5%*	*16.4%*	*16.5%*	*18.6%*	*19.9%*	*17.8%*	*22.8%*	*12.3%*	*18.6%*	14.5%
	5%	7%	5%	0%	12%	4%	0%	20%	0%	4%	
Federal Land*											
Federal Land % total land ownership	76.0%	20.2%	18.2%	57.4%	74.5%	48.5%	10.9%	58.0%	25.2%	51.3%	20.8%
Forest Service %	60.5%	1.5%	15.7%	53.5%	74.4%	47.4%	10.7%	51.5%	21.9%	44.1%	8.9%
BLM %	0.0%	0.0%	0.0%	3.1%	0.0%	1.1%	0.1%	6.1%	1.1%	1.3%	8.5%
Park Service %	15.3%	18.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	5.3%	1.3%
Military %	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%
Other %	0.3%	0.0%	2.5%	0.7%	0.1%	0.0%	0.1%	0.4%	2.1%	0.5%	1.1%
Federal land % protected*	42.8%	92.4%	13.7%	30.0%	2.9%	19.1%	5.8%	27.2%	29.8%	29.6%	21.4%
Federal payments % of county revenue, FY07	na	na	na	na	na	na	na	na	na	na	na
Development											
Residential land area % change, 1980-2000	137.8%	49.1%	101.1%	22.0%	35.1%	10.1%	12.0%	20.4%	5.2%	57.8%	32.1%
Wildland-Urban Interface % developed, 2000	21.4%	0.9%	14.0%	7.2%	13.3%	8.9%	0.0%	0.9%	0.0%	11.8%	13.9%

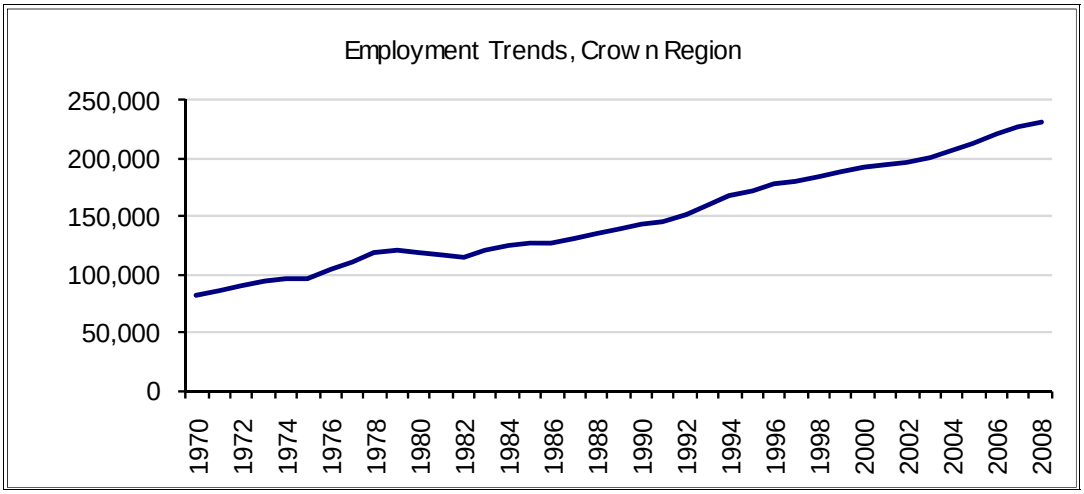
CONTINENT

Table 7 and Figures 10, 11, 12: Population, Employment and Real Personal Income in the Montana Portion of the Crown of the Continent, 1970 to 2008.

Source: U.S. Department of Commerce. 2010. Bureau of Economic Analysis, Regional Economic Information System (BEA/REIS), Washington, D.C. Table CA30.



From 1970 to 2008, population grew from 194,627 to 337,356 people, a 73% increase.



From 1970 to 2008, employment grew from 82,149 to 230,397 jobs, a 180% increase.

From 1970 to 2008, personal income grew from $3,832.4 million to $11,433.2 million, in real terms, a 198% increase.

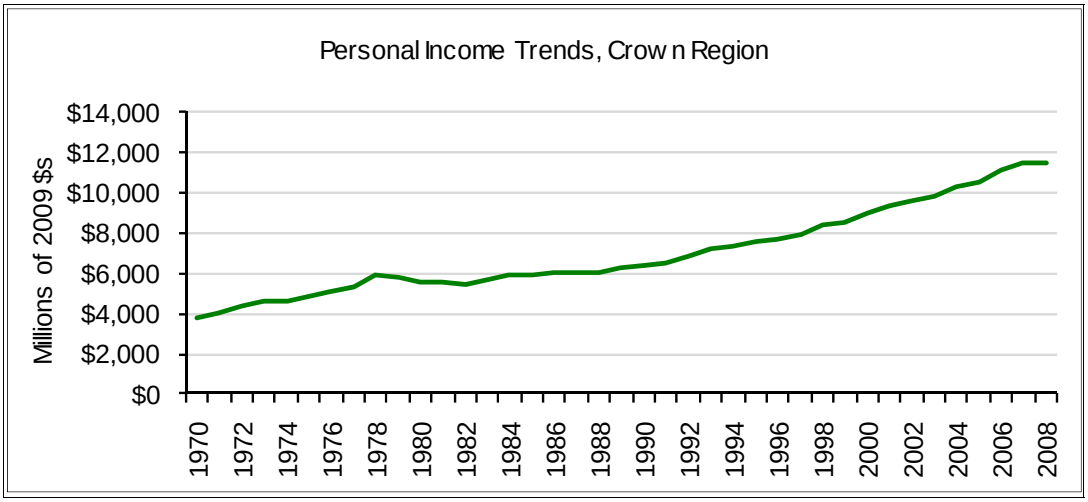


Table 8: Employment by Industry in the Montana Portion of the Crown of the Continent, 1970 to 2000.[92]

[92] Some of the data are withheld by the federal government to avoid disclosure of potentially confidential estimation. Headwaters Economics employs a number of techniques to estimate these "disclosure restrictions." For a copy of the methods used, see: www.headwaterseconomics.org/eps-hdt (last accessed 1/26/11).

Employment by Industry, 1970-2000

	1970	1980	1990	2000	Change 1990-2000
Total Employment (number of jobs)	82,149	118,911	142,349	192,802	50,453
Non-services related	*22,763*	*27,400*	*28,504*	*37,054*	8,550
Farm	5,572	5,787	5,990	6,526	536
Agricultural services, forestry, fishing & other	629	1,134	1,843	*3,542*	1,699
Mining (including fossil fuels)	*465*	*1,125*	*1,287*	*964*	-323
Construction	5,585	6,832	6,532	*12,548*	6,016
Manufacturing (including forest products)	10,512	12,522	12,852	13,474	622
Services related	*40,185*	*65,290*	*85,815*	*124,316*	38,500
Transportation & public utilities	*5,164*	*8,073*	*7,153*	9,555	2,402
Wholesale trade	*2,338*	4,234	4,272	*5,602*	1,330
Retail trade	13,500	19,986	25,691	36,046	10,355
Finance, insurance & real estate	5,116	8,013	9,254	13,615	4,361
Services	*14,067*	*24,984*	39,445	59,498	20,053
Government	17,889	24,596	28,008	31,628	3,620

Percent of Total

					% Change 1990-2000
Total Employment					35.4%
Non-services related	*27.7%*	*23.0%*	*20.0%*	*19.2%*	30.0%
Farm	6.8%	4.9%	4.2%	3.4%	8.9%
Agricultural services, forestry, fishing & other	0.8%	1.0%	1.3%	*1.8%*	92.2%
Mining (including fossil fuels)	*0.6%*	*0.9%*	*0.9%*	*0.5%*	-25.1%
Construction	6.8%	5.7%	4.6%	*6.5%*	92.1%
Manufacturing (including forest products)	12.8%	10.5%	9.0%	7.0%	4.8%
Services related	*48.9%*	*54.9%*	*60.3%*	*64.5%*	44.9%
Transportation & public utilities	*6.3%*	*6.8%*	*5.0%*	5.0%	33.6%
Wholesale trade	*2.8%*	3.6%	3.0%	*2.9%*	31.1%
Retail trade	16.4%	16.8%	18.0%	18.7%	40.3%
Finance, insurance & real estate	6.2%	6.7%	6.5%	7.1%	47.1%
Services	*17.1%*	*21.0%*	27.7%	30.9%	50.8%
Government	21.8%	20.7%	19.7%	16.4%	12.9%

All employment data are reported by *place of work*; estimates for data that were not disclosed are shown in *italics* in the table above.

Source: BEA/REIS 2010.

The above employment data are organized according to the Standard Industrial Classification (SIC) system. The data end in 2000 because in 2001 the Bureau of Economic Analysis switched to organizing industry-level data using a new system, called the North American Industrial Classification System (NAICS). Because NAICS and SIC use different methods, they are not backward compatible and must be displayed in two separate tables.

Table 9: Employment by Industry in the Montana Portion of the Crown of the Continent, 2001 And 2008.

Employment by Industry, 2001-2008

	2001	2008	Change 2001-2008
Total Employment (number of jobs)	194,785	230,397	35,612
Non-services related	*33,650*	*38,721*	5,071
Farm	6,484	6,255	-229
Forestry, fishing, & related activities	*2,393*	*2,550*	157
Mining (including fossil fuels)	*722*	*1,680*	958
Construction	*13,743*	*18,568*	4,825
Manufacturing	*10,308*	9,668	-640
Services related	*127,533*	*155,336*	27,802
Utilities	*580*	*655*	75
Wholesale trade	*4,649*	*5,215*	566
Retail trade	24,006	27,933	3,927
Transportation and w arehousing	*5,637*	*5,617*	-20
Information	4,030	*3,752*	-278
Finance and insurance	*7,264*	8,774	1,510
Real estate and rental and leasing	*6,830*	*12,206*	5,376
Professional and technical services	*10,975*	*13,099*	2,124
Management of companies and enterprises	*658*	*648*	-11
Administrative and w aste services	*7,973*	*11,143*	3,169
Educational services	*2,009*	*3,080*	1,071
Health care and social assistance	*19,722*	*23,853*	4,131
Arts, entertainment, and recreation	*5,186*	7,242	2,056
Accommodation and food services	*15,726*	18,251	2,525
Other services, except public administration	12,288	*13,869*	1,581
Government	32,225	35,281	3,056
Percent of Total			% Change 2001-2008
Total Employment			18.3%
Non-services related	*17.3%*	*16.8%*	15.1%
Farm	3.3%	2.7%	-3.5%
Forestry, fishing, & related activities	*1.2%*	*1.1%*	6.6%
Mining (including fossil fuels)	*0.4%*	*0.7%*	132.7%
Construction	*7.1%*	*8.1%*	35.1%
Manufacturing	*5.3%*	4.2%	-6.2%
Services related	*65.5%*	*67.4%*	21.8%
Utilities	*0.3%*	*0.3%*	13.0%
Wholesale trade	*2.4%*	*2.3%*	12.2%
Retail trade	12.3%	12.1%	16.4%
Transportation and w arehousing	*2.9%*	*2.4%*	-0.4%
Information	2.1%	*1.6%*	-6.9%
Finance and insurance	*3.7%*	3.8%	20.8%
Real estate and rental and leasing	*3.5%*	*5.3%*	78.7%
Professional and technical services	*5.6%*	*5.7%*	19.4%
Management of companies and enterprises	*0.3%*	*0.3%*	-1.6%
Administrative and w aste services	*4.1%*	*4.8%*	39.8%
Educational services	*1.0%*	*1.3%*	53.3%
Health care and social assistance	*10.1%*	*10.4%*	20.9%
Arts, entertainment, and recreation	*2.7%*	3.1%	39.6%
Accommodation and food services	*8.1%*	7.9%	16.1%
Other services, except public administration	6.3%	*6.0%*	12.9%
Government	16.5%	15.3%	9.5%

All employment data are reported by *place of work* ; estimates for data that w ere not disclosed are show n in *italics* .

Source: BEA/REIS 2010.

APPENDIX C: THE GEOGRAPHIC EXTENT OF DOWNHILL SKIING IN THE MONTANA PORTION OF THE CROWN OF THE CONTINENT

To determine skier trends we first discovered which ski areas were within the boundaries of the Montana portion of the Crown of the Continent. Table 10 shows the four ski areas and the long-term skiing trends. Table 11 shows all of the ski areas in the states and provinces that include or surround the Crown region. Table 12 shows the specifics characteristics of the ski areas in the Montana portion of the Crown.

Table 10: Trends in Skier Visits in the Ski Areas of the Montana Portion of the Crown of the Continent.

Ski Season	Whitefish	Snowbowl	Teton Pass	Marshall	Total	Whitefish as % of Total	Snowbowl as % of Total
1990-91	288,056	46,672	0	20,558	355,286	81%	13%
91-92	279,808	47,121	6,153	17,115	350,197	80%	13%
92-93	291,554	55,106	7,630	9,124	363,414	80%	15%
93-94	265,798	44,608	7,861	20,866	339,133	78%	13%
94-95	296,909	45,900	6,066	15,640	364,515	81%	13%
95-96	241,179	47,421	4,024	15,770	308,394	78%	15%
96-97	270,527	62,347	6,001	25,769	364,644	74%	17%
97-98	207,592	47,059	4,093	16,143	274,887	76%	17%
98-99	223,013	66,060	0	23,051	312,124	71%	21%
99-00	285,681	64,768	5,931	26,010	382,390	75%	17%
00-01	254,922	58,050	6,394	30,153	349,519	73%	17%
01-02	267,731	68,832	6,643	33,526	376,732	71%	18%
02-03	235,018	54,027	4,692	14,207	307,944	76%	18%
03-04	258,738	65,065	7,712	0	331,515	78%	20%
04-05	213,409	38,950	1,296	0	253,655	84%	15%
05-06	304,366	61,933	2,716	0	369,015	82%	17%
06-07	260,278	56,600	4,536	0	321,414	81%	18%
07-08	296,708	66,548	4,855	0	368,111	81%	18%
08-09	280,484	59,608	2,931	0	343,023	82%	17%
09-10	282,933	50,986	0	0	333,919	85%	15%

Sources: Montana Ski Areas & Resorts: http://www.montanaskiareas.com/ (last accessed 8/31/10).

Table 11: Downhill Ski Areas of the State and Provinces of Crown of the Continent, 2010.

Note: Marshall Mountain Closed in 2003 and Teton Pass in 2009. Teton Pass recently re-opened, in 2011.

Ski Area Name	Location
MONTANA	
Whitefish Mountain Resort	Whitefish - 4 miles northwest of Whitefish on Big Mountain Road.
Snowbowl	Missoula - 12 miles northwest of Missoula on Snow Bowl Road.
Bear Paw Ski Bowl	Havre - 22 miles south of Havre on Hwy 234.
Big Sky Ski Resort	Big Sky - 5 miles southwest of Big Sky on Lone Mountain Trail.
Blacktail Mountain Ski Area	Lakeside - 14 miles west of Lakeside off Hwy 93 S on Blacktail Road.
Bridger Bowl	Bozeman - 16 miles north of Bozeman off Hwy 86 on Bridger Canyon Road.
Discovery Ski Area	Anaconda - 14 miles northwest of Anaconda off Highway 1 on Discovery Basin Road.
Great Divide	Marysville -1 mile west of Marysville on Belmont Drive.
Lost Trail Powder Mountain	Sula - 12 miles south of Sula on US Hwy 93.
Maverick Mountain Ski Area	Polaris - 8 miles north of Polaris on Maverick Mountain Road.
Moonlight Basin	Big Sky - 3 miles northwest of Big Sky on Highway 64.
Red Lodge Mountain Resort	Red Lodge - 5 miles west of Red Lodge on West Fork Rd/Ski Run Road
Showdown Montana Ski Area	Neihart - 10 miles southwest of Neihart on US Hwy 89.
Turner Mountain	Libby - 11 miles north of Libby on Montana 567 (Pipe Creek Road).
IDAHO	
Bald Mountain Ski Area	Pierce - 10 miles northwest of Pierce off Highway 11 on Bald Mountain Road.
Bogus Basin Ski Resort	Boise - 3 miles northeast of Boise on Bogus Basin Road.
Brundage Mountain	McCall - 8 miles southwest of McCall off ID-55 N. on Goose Lake Road.
Cottonwood Butte	Cottonwood - 5 miles northwest of Cottonwood off US 95 Business on Cotton Butte Road.
Kelly Canyon	Ririe - 9 miles northeast of Ririe off Highway 26 on Kelly Canyon Road.
Lookout Pass Ski Area	Wallace - 9 miles west of Wallace off Interstate 90 on the Idaho/Montana border.
Pebble Creek Ski Area	Inkom - 4 miles southeast of Inkom off Interstate highway 15 on East Green Canyon Road.
Pomerelle Mountain Resort	Albion - 13 miles southeast of Albion off Idaho 77 on Howell Canyon Road.
Schwitzer Mountain Resort	Sandpoint - 3 miles northwest of Sandpoint off US 2 E/US 95 N on Schweitzer Mountain Road.
Silver Mountain	Kellogg - 3 miles southwest of Kellogg off I 90 on Sierra Nevada.
Snowhaven	Grangeville - 4 miles southeast of Grangeville off Fish Creek Rd/Natl Forest Develop Road 221.
Soldier Mountain	Fairfield - 4 miles northeast of Fairfield off Highway 20 on Soldier Mountain Lane.
Sun Valley	Sun Valley - 1 mile southwest of downtown Sun Valley on Sun Valley Road.
BRITISH COLUMBIA	
Apex Mountain Resort	Penticton, South Okanagen
Big White Ski Resort	Kelowna, Okanagan Valley
Crystal Mountain	West Bank, Okanagan Valley
Cypress Mountain	West Vancouver, Greater Vancouver
Fernie Alpine Resort	Fernie, BC Rockies
Grouse Mountain-The Peak of Vancouver	North Vancouver, Greater Vancouver
Harper Mountain	Kamloops, Thompson Okanagan
Hemlock Resort	Agassiz, Hemlock Valley
Hudson Bay Mountain Resort	Smithers, North West BC
Kicking Horse Resort	Golden, BC Rockies
Kimberley Alpine Resort	Kimberley, BC Rockies
Manning Part Resort	Manning Provincial Park, Southwest BC
Mount Seymour	North Vancouver, Greater Vancouver
Mount Washington Alpine Resort	Courtenay, Central Vancouver Island
Mt. Baldy Family Ski Area	Oliver, Similkameen, South Okanagan
Mt. Cain Resort	Woss, North Vancouver Island
Murray Ridge Ski Area	Fort St. James, North West BC
Panorama Mountain Village	Panorama, Invermere, BC Rockies
Phoenix Mountain	Grand Forks, Boundary Country
Powder King Mountain Resort	Mackenzie, North East BC
Purden Ski Village	Prince George, North East BC
Red Mountain Resort	Rossland, BC Kootenays
Revelstoke Mountain Resort	Revelstoke, BC Kootenays
Salmo Ski Area	Salmo, BC Kootenays
Shames Mountain	Terrace, North West BC
Silver Star Mountain Resort	Vernon, North Okanagan Valley
Summit Lake Ski Area	Nakusp, BC Kootenays
Sun Peaks Resort	Kamloops, Thompson Okanagan
Whistler Blackcomb Mountains	Whistler, North of Vancouver BC
Whitewater Ski Resort	Nelson, BC Kootenays
ALBERTA	
Canada Olympic Park	Calgary
Canyon Ski Area	Red Deer
Castle Mountain Resort	Pincher Creek
Edmonton Ski Club	Edmonton
Hidden Valley Resort	Elkwater
Kinosoo Ridge Snow Resort	Cold Lake
Lake Louise Mountain Resort	Banff
Marmot Basin	Jasper
Mt. Norquay	Banff
Nakiska Ski Area	Canmore
Nitehawk Ski Hill	Grand Prairie
Pass Powderkeg	Blairmore
Rabbit Hill Snow Resort	Edmonton
Silver Summit Ski Area	Edson
Snow Valley	Edmonton
Sunridge Ski Area	Edmonton
Sunshine Village	Banff

Sources:
Montana Ski Areas & Resorts: http://www.montanaskiareas.com/ (last accessed 8/31/10);
Idaho Skiing and Snowboarding in Idaho | Alpine at http://www.visitidaho.org/winter/downhillski/ (last accessed 8/31/10);
Alberta Tourism, Parks and Recreation - Home Page on http://tpr.alberta.ca/ (last accessed 8/31/10);
Tourism British Columbia | Official Travel Website of BC Canada at http://www.hellobc.com/ (last accessed 8/31/10)

Table 12: Details of the Downhill Ski Areas of the Montana Portion of Crown of the Continent, 2010.

Montana Crown Ecosystem Ski Areas	Whitefish Mountain Resort	Montana Snowbowl
Street	3840 Big Mountain Road	1700 Snowbowl Road
City	Whitefish	Missoula
State	Montana	Montana
Zip	59937	59807
Owner	Winter Sports, Inc.	MSB, Inc.
Nearest Town	Whitefish	Missoula
Directions	8 miles north of downtown Whitefish off National Forest Development Rd 316 on 9790.	20 miles north of downtown Missoula off Grant Creek Road on Snowbowl Road.
Skier Days (2009 - 2010):		
Season Dates	December 5th - April 4th	Ending April 4th
Days of Operation	7 days / week	Thursday - Sunday
Elevation Top:	6,817 feet	7,600 feet
Elevation Bottom:	4,464 feet	5,000 feet
Terrain:	3000 acres, 94 trails	950 acres, 39 trails
Terrain Difficulty:		
Beginner	15%	20%
Intermediate	35%	40%
Advanced and Expert	50%	40%
Mountain Stats:		
Base Elevation	4464 Ft.	5000 Ft.
Summit Elevation	6817 Ft.	7600 Ft.
Vertical Drop	2353 Ft.	2600 Ft.
Longest Run	3.3 miles	1.2 miles
Projected Days Open	121	N/A
Days Open Last Year	143	N/A
Years Open	63	49
Average Snow Fall	300 in.	300 in.
2009-2010 Rates - Adult 1 day	$61	$39
Lifts:	13 total, 3 high-speed	2 doubles, 2 surface
High-speed quads	3	
Quad chairlifts	2	
Triple chairs	5	
Magic Carpet conveyor	1	
T-bars	2	

Sources: "Whitefish Mountain Resort Downhill Ski Area." Winter Montana - Official State Travel and Information Site. Montana Office of Tourism http://wintermt.com/categories/MoreInfo_Ski.asp?SiteID=1&IDRRecordID=17857 (last accessed 8/28/10); "Montana Snowbowl." Winter Montana - Official State Travel and Information Site. Montana Office of Tourism. http://wintermt.com/categories/MoreInfo_Ski.asp?SiteID=1&IDRRecordID=353 (last accessed 8/28/10).

APPENDIX D: THE GEOGRAPHIC EXTENT OF RECREATIONAL FISHING IN THE MONTANA PORTION OF THE CROWN OF THE CONTINENT

To determine the size and distribution of the sport fishing industry in the Montana portion of the Crown of the Continent, it was first necessary to identify the geography, which is defined in terms of waterbodies and hydrological units. The next step was to identify patterns of use, by geography and over time, expressed in terms of angler days.

Crown Waterbodies

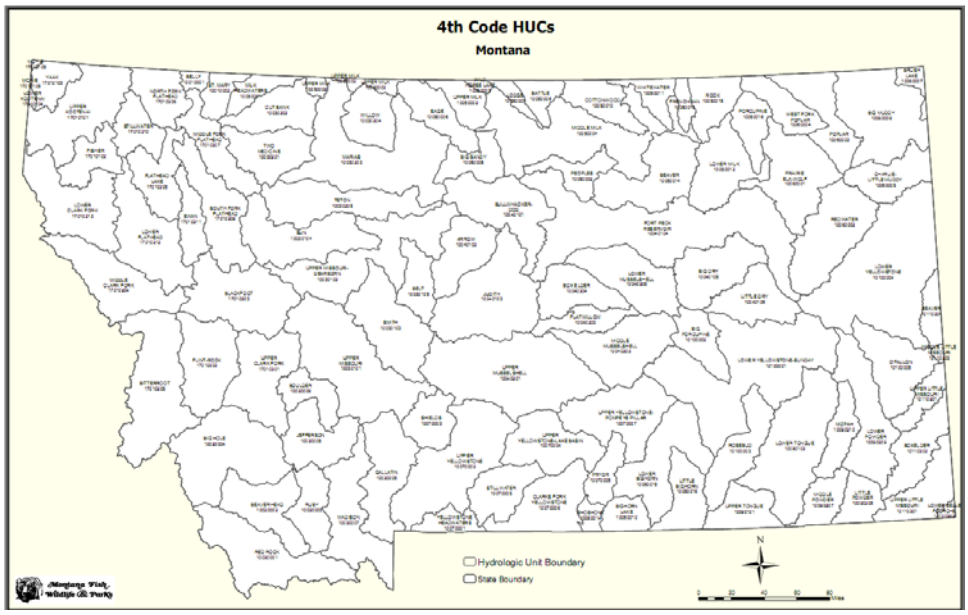
The Montana Department of Fish Wildlife and Parks (MT FWP) maintains the Montana Fisheries Information System (MFISH) relational database of the state's hydrologic features and their corresponding fish and angling characteristics.[93] The MFISH system divides the state into polygons based on major river drainages that are referred to as hydrologic units. The database maintains records on all lakes and streams based on their location within these hydrologic units.

An inventory of waterbodies within the study area was developed using a combination of methods, including queries from the MFISH database and individual identification of features on detailed topographic and hydrologic unit maps. Waterbodies in the Crown ecosystem were identified by first comparing the detailed MFISH hydrologic unit polygon maps to topographic maps to determine the Crown ecosystem boundary intersections. The comparison revealed five MFISH hydrologic unit polygons contained completely within the Crown ecosystem and 11 more with overlapping boundaries. Overall, 1,612 streams and 728 lakes were identified within the Montana portion of the Crown ecosystem. The hydrological units for the state of Montana are shown in Map 6. The hydrological units that are fully included in the region, or partially included, are shown in Table 13 and Map 5.

Three major drainages were identified for the Montana portion of the Crown ecosystem. The northern divide forms with the headwaters of the Belly and Saint Mary Rivers flowing northeast from Glacier National Park to Hudson Bay. The Flathead, Kootenai, and Blackfoot rivers flow west from the Crown to the Columbia River, while the headwaters of the Sun, Cut Bank, Teton, Dearborn, and Two Medicine Rivers form on the east side of the Continental Divide and feed the Missouri River.

[93] MFISH is available on the MT FWP website: http://fwp.mt.gov/fishing/mFish/ (last accessed 6/8/10).

Map 6: Montana Department of Fish, Wildlife and Parks Hydrological Units



Source: MT FWP http://fwpiis.mt.gov/content/getItem.aspx?id=37414 (last accessed 6/8/10)

Table 13: Hydrological Units Included in the Montana Portion of the Crown of the Continent

Hydrologic Units Fully Included in the Crown Ecosystem:	Hydrologic Units Partially Included in the Crown Ecosystem:
Belly	Blackfoot
Middle Fork Flathead	Cut Bank
North Fork Flathead	Flathead Lake
South Fork Flathead	Lower Flathead
Swan	St. Mary
	Stillwater
	Sun
	Teton
	Two Medicine
	Upper Kootenai
	Upper Missouri - Dearborn

Source: Hydrological units from MT FWP http://fwpiis.mt.gov/content/getItem.aspx?id=37414 (last accessed 6/8/10); Crown boundaries as defined in Map 1.

Table 14: Angling Use by Waterbody and Hydrological Unit in the Montana Portion of the Crown of the Continent, 2007.

Crown Waterbody	Total Angling Days	Hydrologic Unit (MT FWP)	Crown Waterbody	Total Angling Days	Hydrologic Unit (MT FWP)	Crown Waterbody	Total Angling Days	Hydrologic Unit (MT FWP)
Flathead Lake	70,509	Flathead Lake	Two Medicine River	545	Swan	Cooney Creek	114	Two Medicine
Lake Koocanusa	38,082	Upper Kootenai	Upper Two Medicine Lake	514	North Fork Flathead	Trail Creek	114	Blackfoot
Flathead River	37,684	Flathead Lake	Gibson Reservoir	508	Lower Flathead	Chimney Creek	114	Flathead Lake
Blackfoot River	33,733	Blackfoot	Mccaffery Lake	501	Blackfoot	Lost Lake	114	Middle Fork
Kootenai River	25,274	Upper Kootenai	Loon Lake	467	Blackfoot	Cyclone Creek	114	Swan
North Fork Flathead	10,173	North Fork Flathead	Bear Lake	467	Stillwater	Avalanche Lake	114	Swan
Swan River	9,837	Swan	Plummer Lake	451	Sun	Canyon Creek	114	Swan
South Fork Flathead	9,805	South Fork Flathead	Holland Lake	432	South Fork Flathead	South Fork Elk	113	Sun
Browns Lake	7,856	Blackfoot	Link Lake	411	Upper Kootenai	Gray Wolf Lake	113	Blackfoot
Hungry Horse	7,401	South Fork Flathead	Gold Creek	408	U. Missouri-Dearborn	Nevada Creek	113	Blackfoot
Swan Lake	7,018	Swan	Elk Creek	399	Lower Flathead	Shay Lake	113	Lower Flathead
Middle Fork Flathead	7,014	Middle Fork Flathead	Upsata Lake	395	Sun	Gold Creek Lake	113	South Fork
Seeley Lake	4,386	Blackfoot	Beaver Lake	391	Blackfoot	Bowl Creek	113	South Fork
Whitefish Lake	4,148	Stillwater	Jim Creek	383	Upper Kootenai	George Lake	113	Swan
Nilan Reservoir	3,970	Sun	Kintla Lake	348	Flathead Lake	Olor Lakes	106	Middle Fork
Echo Lake	3,549	Flathead Lake	Spook Lake	343	South Fork Flathead	Biglow Creek	106	North Fork
Salmon Lake	3,172	Blackfoot	Upper Whitefish Lake	324	South Fork Flathead	Clack Creek	99	Blackfoot
Beaver Lake	3,037	Stillwater	Metcalf Lake	320	Flathead Lake	Silver King Lake	95	U. Missouri-
Placid Lake	2,505	Blackfoot	North Fork Sun River	305	Swan	Little Therriault	95	Stillwater
Church Slough	2,341	Flathead Lake	Giefer Lake	289	Blackfoot	Dog Lake	88	Flathead Lake
Tetrault Lake	2,187	Upper Kootenai	Peterson Lake	287	Upper Kootenai	Heart Lake	88	Middle Fork
Lower Stillwater Lake	2,159	Stillwater	Graves Creek	283	South Fork Flathead	Sullivan Creek	85	Flathead Lake
Whitefish River	2,159	Stillwater	Pike Lake	278	Blackfoot	Swimming Lake	85	South Fork
Foy Lake	2,005	Flathead Lake	Crescent Lake	259	Blackfoot	Clayton Creek	85	Swan
Dearborn River	2,002	U. Missouri-Dearborn	Swisher Lake	256	Blackfoot	Green Gulch	85	Upper Kootenai
Nevada Reservoir	1,998	Blackfoot	South Fork Dearborn	254	Swan	Elizabeth Lake	62	Lower Flathead
Tobacco River	1,921	Upper Kootenai	Quartz Lake	233	North Fork Flathead	Hellroaring Creek	57	Sun
Willow Creek Reservoir	1,912	Sun	North Crow Creek	231	Middle Fork Flathead	Crystal Lake	57	Blackfoot
Stillwater River	1,859	Stillwater	Frenchy Creek	228	Swan	Cottonwood Creek	57	Blackfoot
Lake Inez	1,740	Blackfoot	South Fork Sun River	227	Blackfoot	Skyland Creek	57	Blackfoot
Dollar Lake	1,574	Stillwater	Landers Fork	227	Swan	Benedict Creek	57	Blackfoot
Blanchard Lake	1,570	Stillwater	Smith Creek	226	Middle Fork Flathead	Beaver Lake	57	North Fork
Lake Alva	1,526	Blackfoot	Dickey Lake	226	South Fork Flathead	Fatty Lake	57	North Fork
Clearwater River	1,478	Blackfoot	Middle Fork Creek	226	South Fork Flathead	Clear Creek	57	South Fork
Glen Lake	1,460	Upper Kootenai	Egan Slough	211	Stillwater	Johnson Lake	57	South Fork
Harpers Lake	1,334	Blackfoot	Trout Lake	210	Blackfoot	Lower Necklace	57	Stillwater
Rattlesnake Creek	1,305	Middle Clark Fork	Spring Creek	203	Swan	Russ Lake	57	Stillwater
Wood Lake	1,266	Sun	McWhorters Pond	186	South Fork Flathead	Condon Creek	57	Swan
Lake Blaine	1,257	Flathead Lake	Woodward Lake	177	Blackfoot	South Fork Cold	57	Swan
Diversion Lake	1,240	Sun	Pass Creek	171	Stillwater	White River	57	Swan
Youngs Creek	1,183	Sun	Estes Lake	171	Upper Kootenai	Owl Creek	56	Sun
Pishkun Reservoir	1,143	Upper Kootenai	South Jewel Lake	170	Swan	Rainbow Lake	56	Blackfoot
Murphy Lake	1,128	Upper Kootenai	Brenneman Slough	169	Teton	Goss Creek	56	Blackfoot
Sophie Lake	1,099	Middle Fork Flathead	Mud Creek	169	Blackfoot	Mcdonald Lake	56	Flathead Lake
Mcdonald Lake	1,046	Sun	Badger Creek	169	Flathead Lake	Doris Creek	56	Middle Fork
Little Salmon Creek	953	Blackfoot	Mule Creek	164	North Fork Flathead	Lake Dinah	56	North Fork
Nyack Creek	947	Blackfoot	Bond Lake	163	Teton	Lake Marshall	56	North Fork
Split Rock Lake	937	Swan	Hidden Lake	162	North Fork Flathead	Jim Lake 8	56	South Fork
North Fork Blackfoot	884	South Fork Flathead	Emery Creek	162	South Fork Flathead	Spring Creek	56	Stillwater
Rainy Lake	880	St Mary	Green Creek	157	St Mary	Grave Creek	56	Swan
Glacier Creek	877	Swan	Boyle Lake	149	Middle Clark Fork	Depuy Creek	56	Swan
Gold Creek	862	South Fork Flathead	Clearwater Lake	145	North Fork Flathead	Lower Cold Lake	56	Swan
Spotted Bear River	857	Flathead Lake	Skylark Lake	142	Middle Fork Flathead	North Fork Lost	56	Swan
Duck Lake	797	Lower Flathead	Peterson Creek	141	North Fork Flathead	West Fork North	56	Swan
Lindbergh Lake	782	Stillwater	Moran Lake	141	South Fork Flathead	Morrell Lake	50	St Mary
Abbot Lake	757	South Fork Flathead	Gorge Creek	136	Blackfoot	Half Moon Slough	50	Blackfoot
Lion Lake	756	Flathead Lake	Fish Creek	134	Two Medicine	Red Meadow Lake	50	Middle Fork
Halfmoon Lake	747	Lower Flathead	Spoon Lake	117	Blackfoot	Teton River	50	Swan
Bootjack Lake	743	Blackfoot	Twin Lakes	117	Swan	Upper	47	Flathead Lake
Crow Creek	740	Swan	Yakinikak Creek	115	Blackfoot	Dunham Creek	47	Stillwater
Fish Lake	694	Two Medicine	Turtle Lake	115	Blackfoot	Hungry Horse	39	St Mary
Handkerchief Lake	587	Sun	Bighorn Lake	115	Flathead Lake	Straight Creek	39	Swan
Lake Five	584	Flathead Lake	West Tranquil Basin Lake	115	South Fork Flathead	Rinker Creek	38	Sun
Jocko River	562	Swan	Lower Saint Mary Lake	115	Stillwater	Schafer Creek	38	Blackfoot
Monture Creek	560	Sun	Beaver Creek	115	Swan	Chain Lake 1	38	Swan
Van Lake	560	Flathead Lake	Big Creek	115	Swan	TOTAL	368,330	

Source: MT FWP, MFISH database 2010.

Fishing: Use and Trends

The MFISH database includes estimates of angling use by Montana residents and nonresidents along with the hydrology and fish species information described above. Estimates of angling days by waterbody are developed biannually from a systematic survey of anglers conducted by MT FWP. The estimation system defines an angler day as one angler fishing one body of water for any length of time in a given day.

Because of the sampling nature of the survey, use estimates are not developed for every waterbody during each biannual study year. However, virtually all high-use waterbodies are sampled and estimates are made during every biannual survey. Therefore, estimates of statewide use, and for use of the Crown and its popular waterbodies, will be fairly accurate across individual sample years. Estimates for lesser-used individual waterbodies, however, would be most accurate if averaged over a number of biannual sample periods. Some lightly used waterbodies with viable sport fish populations may not appear in this use estimation process, but this should not contribute significantly to underestimation of use at the Crown and statewide aggregate levels.

Analysis of the MFISH database identified 649 of the 2,340 waterbodies within the Crown that had measurable angling pressure on at least one of the biannual angling surveys between 1989 and 2007.

APPENDIX E: ECONOMIC IMPACT ESTIMATES OF FISHING AND SKIING IN THE CROWN OF THE CONTINENT REGION USING THE IMPLAN MODEL.

The software IMPLAN was used to develop estimates of the economic impact of the skiing and fishing industries in the Crown of the Continent region for the following Montana counties: Flathead, Glacier, Lake, Lewis and Clark, Lincoln, Missoula, Pondera, Powell and Teton. IMPLAN is an input/output model that is based on the theory that when new money enters an economy, some of it is re-spent one or more times in the local economy, thereby creating a multiplier effect. For example, a nonresident skier will spend money at a restaurant. The restaurant, in turn, will hire workers, order supplies from wholesalers, and so form. Also, the employees of the restaurant will spend at least a portion of their earnings in the local economy. All of these expenditures constitute part of the multiplier effect.

The IMPLAN model requires several data inputs, consiting of the number of visitors (i.e., skier vistis and anlger days), whether they are residents or non-residents, and their expenditures in various sectors of the economy (for example, in restaurants, hotels, at ski areas, tackle shops, and sporting goods stores). The number of skier vists in the Crown region were obtained from sources described in Appendix C. The number of angler days in the Crown region were obtained as described in Appendix D.

The expenditures of resident and non-resident skiers in the Crown region were obtained from the results of a recent survey conducted by the University of Montana's Insitute for Tourism and Recreation Research.[94] Expenditures of fishing were adapated from a nation-wide angler survey conducted by Southwick Associates and the U.S. Fish and Wildlife Service's national survey of fishing, hunting, and wildlife-associated recreation.[95]

The output of the IMPLAN model yields information on the direct, indirect, and induced jobs associated with each sector, the total economic value of the activities in the region's economy, and the amount of state and local taxes generated. Results are reported in the following pages in terms of the impact of nonresident and nonresident plus resident expenditures for the skiing and fishing industries in the nine-county Crown region.

[94] Montana Ski Area Trends 1990-2010. The Institute for Tourism and Recreation Research, The University of Montana, Missoula.

[95] Southwick Associates. Sportfishing in America: An Economic Engine and Conservation Powerhouse. Produced for the American Sportfishing Association with funding from the Multistate Conservation Grant Program, 2007; Methodology: Expenditure and participation data obtained from the U.S. Fish and Wildlife Service's 2006 National Survey of Fishing, Hunting and Wildlife-Associated Recreation.

Definitions:

Direct effect: the changes in economic activity during the first round of spending for businesses that sell directly to skiers and anglers, e.g., skiers buying ski lift tickets, anglers buying fishing gear.

Indirect effect: the changes in economic activity in those sectors that supply goods and services to skiing and fishing businesses, e.g., wholesalers supplying food to restaurants.

Induced effect: the changes in economic activity resulting from spending income earned in skiing and fishing businesses, e.g. a lift ticket operator buying food at a local grocery store.

Value added: the sum of the total income and indirect business taxes; this measure avoids double counting of intermediate sales by capturing only the "value added" by the region to final products.

Output: the total value of sales of goods and services to skiers and anglers.

Results: Downhill Skiing

Resident and non-resident skiers (and snowboarders) stimulated the economy by spending more than $25 million in a variety of establishments in the Crown region in 2009 (Table 15). These expenditures in turn created a miltuplier effect in the economy, resulting in jobs, economic output, and taxes.

Expenditures by non-residents generated an estimated 288 jobs, $24.6 million in economic output (Table 16), and $1.9 million in state and local taxes (Table 17). When the expenditures of resident and non-resident skiers were combined, they resulted in an estimated 457 jobs, $39.8 million in ecoomic output (Table 18), and $3.1 million in state and local taxes (Table 19).

An important aspect of the ski industry's impact in the Crown region is the contribution of non-residents: the majority of the value of economic output (62%) is derived from non-resident expenditures.

Table 15: Expenditures by Resident and Non-Resident Downhill Skiers in the Crown of the Continent Region, 2009.

Retail and Service Visitor Survey Expenditure Category(ies)	IMPLAN Industry - Activity	Annual MT Resident consumer expenditures in the Crown	Annual Nonresident consumer expenditures in the Crown	Total annual consumer expenditures in the Crown
Retail	Retail - Electronics and appliances	$70,953	$219,253	$290,205
Groceries	Retail - Food and beverage	$934,236	$1,588,585	$2,522,821
Retail	Retail - Health and personal care	$70,953	$219,253	$290,205
Gas	Retail - Gasoline stations	$1,926,640	$738,823	$2,665,463
Retail	Retail - Clothing and clothing accessories	$70,953	$219,253	$290,205
Retail	Retail - Sporting goods, hobby, book and m	$70,953	$219,253	$290,205
Retail	Retail - General merchandise	$70,953	$219,253	$290,205
Retail	Retail - Miscellaneous	$70,953	$219,253	$290,205
Transport fares	Air transportation	$0	$10,568	$10,568
Transport fares	Rail transportation	$0	$4,529	$4,529
Auto/RV rental	Automotive equipment rental and leasing	$0	$550,960	$550,960
Equipment rental; Snowmobile/Snowcoach	General and consumer goods rental except v	$242,854	$335,377	$578,232
Permits, entrance fees	Travel arrangement and reservation services	$7,039	$26,932	$33,971
Lessons	Other educational services	$233,487	$358,585	$592,072
Lift tickets	Amusement parks, arcades, and gambling in	$2,923,373	$3,406,825	$6,330,199
Guided trip	Other amusement and recreation industrie	$0	$69,470	$69,470
Accommodations	Hotels and motels, including casino hotels	$627,386	$3,575,929	$4,203,315
Accommodations	Other accommodations	$69,710	$397,325	$467,035
Restaurant, bar	Food services and drinking places	$2,065,950	$2,952,331	$5,018,281
Other services	Other personal services	$130,348	$86,270	$216,618
	TOTAL	$9,586,740	$15,418,025	$25,004,765

Table 16: Crown Economic Impacts, Montana Non-resident Skiing/Snowboarding, 2009/2010 Season ($2010)

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	208	$4,554,855	$8,094,291	$15,418,025
Indirect Effect	43	$1,583,934	$2,753,422	$5,246,149
Induced Effect	37	$1,197,567	$2,274,920	$3,929,001
Total Effect	288	$7,336,356	$13,122,633	$24,593,175

Table 17: Crown State and Local Taxes, Montana Non-resident Skiing/Snowboarding, 2009-2010 Season ($2010)

Description	Employee Compensation	Proprietor Income	Indirect Business Tax	Households	Corporations	Total
Dividends					$64,334	
Social Ins Tax- Employee Contribution	$5,322	$0				
Social Ins Tax- Employer Contribution	$22,899					
Indirect Bus Tax: Sales Tax			$326,294			
Indirect Bus Tax: Property Tax			$727,865			
Indirect Bus Tax: Motor Vehicle Lic			$33,422			
Indirect Bus Tax: Severance Tax			$288,724			
Indirect Bus Tax: Other Taxes			$51,782			
Indirect Bus Tax: S/L NonTaxes			$149,716			
Corporate Profits Tax					$45,783	
Personal Tax: Income Tax				$107,623		
Personal Tax: NonTaxes (Fines- Fees				$25,254		
Personal Tax: Motor Vehicle License				$13,787		
Personal Tax: Property Taxes				$3,493		
Personal Tax: Other Tax (Fish/Hunt)				$21,687		
Total State and Local Tax	$28,221	$0	$1,577,803	$171,844	$110,118	$1,887,986

Table 18: Crown Economic Impacts, Montana Resident and Non-resident Skiing/Snowboarding, 2009-2010 Season ($2010)

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	329	$7,225,782	$13,123,776	$25,004,765
Indirect Effect	70	$2,571,301	$4,481,479	$8,508,233
Induced Effect	59	$1,914,957	$3,638,003	$6,283,231
Total Effect	457	$11,712,040	$21,243,258	$39,796,230

Table 19: Crown State and Local Taxes, Montana Resident and Non-resident Skiing, 2009-2010 Season ($2010)

Description	Employee Compensation	Proprietor Income	Indirect Business Tax	Households	Corporations	Total
Dividends					$105,882	
Social Ins Tax- Emplc	$8,389	$0				
Social Ins Tax- Emplc	$36,092					
Indirect Bus Tax: Sales Tax			$538,482			
Indirect Bus Tax: Property Tax			$1,201,196			
Indirect Bus Tax: Motor Vehicle Lic			$55,157			
Indirect Bus Tax: Severance Tax			$476,481			
Indirect Bus Tax: Other Taxes			$85,455			
Indirect Bus Tax: S/L NonTaxes			$247,076			
Corporate Profits Tax					$75,350	
Personal Tax: Income Tax				$172,306		
Personal Tax: NonTaxes (Fines- Fees				$40,432		
Personal Tax: Motor Vehicle License				$22,074		
Personal Tax: Property Taxes				$5,592		
Personal Tax: Other Tax (Fish/Hunt)				$34,721		
Total State and Loca	$44,481	$0	$2,603,848	$275,125	$181,232	$3,104,686

Source: Montana Ski Area Trends 1990-2010. ITRR 2010.

Results: Recreational Fishing

In 2007, resident and non-resident anglers spent more than $22 million in the economy of the Crown region (Table 20).

Expenditures by non-residents resulted in an estimated 166 jobs, $14.5 million in economic output (Table 21), and $1.2 million in state and local taxes (Table 22). When the expenditures of residents and non-resident anglers were combined, they resulted in an estimated 457 jobs, $38.2 million in ecoomic output (Table 23), and $3.4 million in state and local taxes (Table 24).

An important point about the economic impacts of fishing is that residents of the Crown region stimulate the majority (62%) of the economic output.

Table 20: Estimates of Expenditures by Resident and Non-Resident Anglers in the Crown of the Continent Region, 2006.

Retail and Service Visitor Survey Expenditure Category(ies)	IMPLAN Industry - Activity	Annual MT Resident consumer expenditures in the Crown	Annual Nonresident consumer expenditures in the Crown	Total annual consumer expenditures in the Crown
Food; Ice; Heating & cooking fuel	Retail - Food and beverage	$1,394,964	$968,327	$2,363,291
Boat fuel; Private transportation	Retail - Gasoline stations	$3,413,971	$1,980,298	$5,394,269
Bait (live, cut, prepared); Rods, reels & components; other equipment	Retail - Sporting goods, hobby, book and music	$4,669,781	$1,140,649	$5,810,430
Other misc. fishing expenditures	Retail - Miscellaneous	$64,361	$10,064	$74,425
Airfare	Air transportation	$152,236	$292,921	$445,157
Cabins; Land purchased for fishing; Land leased	Real estate	$187,141	$21,034	$208,174
Equipment rental	General and consumer goods rental	$179,733	$181,012	$360,745
Private land use fees	Travel arrangement and reservation services	$79,081	$43,690	$122,771
Boat launching, mooring, etc.	Other amusement and recreation industries	$975,056	$739,476	$1,714,532
Lodging	Hotels and motels, including casino hotels	$527,663	$1,287,184	$1,814,847
Lodging	Other accommodations	$131,916	$321,796	$453,712
Food	Food services and drinking places	$1,117,179	$834,248	$1,951,428
Boat launching; Boat mooring; Public land use fees	Other Federal Gov. Enterprises	$331,177	$92,340	$423,517
Public transportation	State and local government passenger transit	$19,906	$140,263	$160,169
Boat launching; Boat mooring; Licenses and fees; Public land use fees	Other state and local government enterprises	$550,749	$269,764	$820,512
	TOTAL	$13,794,914	$8,323,068	$22,117,982

Table 21: Crown Economic Impacts, Montana Non-resident Sport Fishing, 2007 Season ($2010).

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	120	$2,982,725	$5,088,435	$9,171,735
Indirect Effect	23	$840,058	$1,547,922	$2,841,300
Induced Effect	23	$748,317	$1,421,735	$2,455,510
Total Effect	166	$4,571,101	$8,058,092	$14,468,545

Source: Adapted from Southwick Associates. Sportfishing in America: An Economic Engine and Conservation Powerhouse. Produced for the American Sportfishing Association with funding from the Multistate Conservation Grant Program, 2007. Expenditure and participation data obtained from the U.S. Fish and Wildlife Service's 2006 National Survey of Fishing, Hunting and Wildlife-Associated Recreation.

Table 22: Crown State and Local Taxes, Montana Non-resident Sport Fishing, 2007 Season ($2010)

Description	Employee Compensation	Proprietor Income	Indirect Business Tax	Households	Corporations	Total
Dividends					$37,496	
Social Ins Tax- Employee Contribution	$3,242	$0				
Social Ins Tax- Employer Contribution	$13,948					
Indirect Bus Tax: Sales Tax			$210,829			
Indirect Bus Tax: Property Tax			$470,297			
Indirect Bus Tax: Motor Vehicle Lic			$21,595			
Indirect Bus Tax: Severance Tax			$186,554			
Indirect Bus Tax: Other Taxes			$33,458			
Indirect Bus Tax: S/L NonTaxes			$96,736			
Corporate Profits Tax					$26,683	
Personal Tax: Income Tax				$67,396		
Personal Tax: NonTaxes (Fines- Fees				$15,815		
Personal Tax: Motor Vehicle License				$8,634		
Personal Tax: Property Taxes				$2,187		
Personal Tax: Other Tax (Fish/Hunt)				$13,581		
Total State and Local Tax	$17,190	$0	$1,019,469	$107,613	$64,179	$1,208,451

Table 23: Crown Economic Impacts, Montana Resident and Non-resident Sport Fishing, 2007 Season ($2010)

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	336	$8,119,191	$13,985,736	$24,220,690
Indirect Effect	59	$2,167,371	$4,070,214	$7,386,818
Induced Effect	62	$2,013,345	$3,825,150	$6,606,497
Total Effect	457	$12,299,907	$21,881,100	$38,214,005

Table 24: Crown State and Local Taxes, Montana Resident and Non-resident Sport Fishing, 2007 Season ($2010)

Description	Employee Compensation	Proprietor Income	Indirect Business Tax	Households	Corporations	Total
Dividends					$101,170	
Social Ins Tax- Employee Contribution	$8,731	$0				
Social Ins Tax- Employer Contribution	$37,565					
Indirect Bus Tax: Sales Tax			$599,982			
Indirect Bus Tax: Property Tax			$1,338,384			
Indirect Bus Tax: Motor Vehicle Lic			$61,456			
Indirect Bus Tax: Severance Tax			$530,900			
Indirect Bus Tax: Other Taxes			$95,215			
Indirect Bus Tax: S/L NonTaxes			$275,295			
Corporate Profits Tax					$71,996	
Personal Tax: Income Tax				$181,314		
Personal Tax: NonTaxes (Fines- Fees				$42,546		
Personal Tax: Motor Vehicle License				$23,228		
Personal Tax: Property Taxes				$5,885		
Personal Tax: Other Tax (Fish/Hunt)				$36,536		
Total State and Local Tax	$46,296	$0	$2,901,232	$289,509	$173,166	$3,410,203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