SOCIOECONOMIC REPORT

Analysis of Ecosystem Services in the Yellowstone River Corridor and Economic Impacts of Tourism and Yellowtail Dam

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Part 1

Ecosystems are integrated natural communities stemming from the interactions among and between humans, animals, and the physical environment. The natural functions maintained by a healthy ecosystem provide ecological goods and services which preserve the natural capital required to maintain biodiversity and provide for the social, cultural, and economic needs of humans. The beneficial outcomes of these ecological processes provide "provisioning services" such as food, water and timber; "regulating services" such as flood and disease regulation; "cultural services" including recreational and spiritual services; and "supporting services" such as soil formation and nutrient cycling (Millennium Ecosystem Service Assessment, 2005).

The worth of natural ecosystems stem from their explicit market values (when applicable) and their implicit non-market values, which are often overlooked in private decision making processes. Since the economic value of ecosystem services is equal to the total social benefits they provide, it is important to account for both the market and non-market values of these resources (Freeman, 1993). Undervaluation of ecosystem resources is known to cause an inadequate provision of natural capital; thus, conservation and restoration efforts usually stem from the coordination of government agencies and public trusts. Conservation easements and fee-title acquisitions can protect non-market values associated with biodiversity and wildlife abundance, maintain aesthetic beauty, and protect social and culturally significant features of landscapes and livelihoods (Ehrlich and Ehrlich, 1992; Daily, 1997; Millennium Ecosystem Service Assessment, 2005). Ecosystem services, such as flood mitigation, water purification, oxygen production, pollination, and waste breakdown, are also maintained and/or enhanced through land preservation (Millennium Ecosystem Service Assessment, 2005). These services can have significant impacts on the welfare of those living in the area and beyond.

Land use decisions within the Yellowstone River Corridor, both on private and public lands, impact the quality of ecosystem services which in turn have economic implications throughout the corridor. In the following sections, the economic impacts associated with changes in relevant ecosystem services caused by development along the Yellowstone River Corridor will be discussed in detail. The nature of this report is qualitative, not quantitative. That is to say, no analytical modelling was done to estimate economic impacts within the corridor. Rather, economic impacts discussed in the following sections draw upon economic theory and as well as empirical evidence from peer-reviewed quantitative studies and other working documents.

A term used by economists – and frequently mentioned in this analysis – that portrays the economic value of something is willingness to pay. Someone's willingness to pay for a good is the maximum amount that individual is willing to sacrifice to procure said good (Loomis et al., 2000). Although some ecosystem services are traded on the open market, namely raw materials, many ecosystem services are not. Thus, those services that are not traded on the open market do not have prices explicitly associated with them. However, prices are helpful with decision-making processes because they translate the values of different goods into one commensurate unit. Therefore, economists estimate individuals' willingness to pay for different ecosystem services to better understand how to manage ecosystem services in order to optimize social welfare. There are many methods used to estimate willingness to pay for ecosystem services, some of which are mentioned throughout this analysis in regard to referencing outside studies. The reader should note that regardless of the type of method used by a referenced study, the concept of "willingness to pay" remains unchanged. As an example of estimating individuals' willingness to pay for ecosystem services that are not traded on an open market, see Loomis et al. (2000), where it is estimated that households in a given area were willing to pay an average of $21 per month to have five ecosystem services restored along a 45-mile stretch of river.

The ecosystem services provided by the Yellowstone River Corridor are classified by three distinct categories: Provisioning Services, Regulating Services, and Cultural Services. Provisioning services describe the products obtained from ecosystems. Regulating Services describe the benefits obtained from an ecosystem when components of the natural environment help to control other naturally occurring components or byproducts of the ecosystem. Cultural Services describe the benefits people acquire through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences (Millennium Ecosystem Service Assessment, 2005).

Provisioning Services

Provisioning services describe the products obtained from the ecosystem. For example, the Yellowstone River Corridor provides fresh water to users throughout the region. Those users include native and nonnative animal species and habitats, as well as humans in the agricultural, municipal, and industrial sectors. Furthermore, the corridor provides other raw materials to the region, such as timber.

Fresh Water

Fresh Water provides vast benefits to human well-being and is becoming increasingly scarce as demand for it grows. The Yellowstone River Corridor – which provides fresh water to many uses/users – is no exception. Beyond providing fresh water to the natural environment, the corridor also supplies fresh water to agricultural, municipal, recreational, and industrial users. Thus, it is important to understand the caveats of estimating the value of fresh water in order to best understand the importance of fresh water within the Yellowstone River Corridor.

The value of water varies across industry (i.e., use), space, and time (Gibbons, 1986). Consider a farmer using fresh water for irrigation and a household using fresh water for indoor use. The residential user pays a higher per unit price than does the farmer, and the farmer is using considerably more water. Furthermore, the farmer has little to no need for water in the winter and fall months, and therefore values water even less during the winter; compared to a residential user whose demand for indoor water changes very little from month to month, maintaining a relatively constant value of water year-round. To portray how the value of water varies across space, consider how a farmer in water-scarce Colorado will value water compared to a farmer in Ohio, where it is common practice to install drainage tile to drain excess rain water from fields.

Fresh Water having economic value is not just an abstract idea – values of water can and have been estimated according to what individuals/entities are willing to pay for water. For example, the value of water in agriculture in the Missouri River region was estimated to be $138 per acre-foot (in 2015 dollars; Frederick, et. al. 1996). However, the average price of municipally-supplied water in the U.S. is $2 per 1,000 gallons (U.S. Environmental Protection Agency, 2009). Using like units, the average willingness to pay for water for agricultural use in the Missouri River Basin was $138 per acre-foot, while the nation's average cost for municipally-supplied water was $709 per acre-foot. Of course, the previous statement is only a rough approximation of a comparison. For example, the price of municipal water incorporates an implicit cost for water treatment that the agricultural measure does not. Also, the price of municipal water only represents a lower-bound of willingness to pay – it is assumed that residential users would be willing to pay relatively higher prices for water (Dalhuisen, et. al., 2003). Therefore, it should be noted that even though the value of fresh water varies across industry, space, and time, comparing values originating from different estimation techniques can be difficult and/or problematic (see Young and Loomis, 2014, for a more in-depth discussion).

As is the case with most ecosystem services, the consumption decisions made by one individual will affect other's consumption decisions. That is to say, suppose there is an industrial user upstream that diverts a given quantity of instream flows, and whose consumption patterns are the same from day to day. If river flow levels were relatively unchanged over the long-run, then downstream users would presumably adjust to the constant level of flows experienced at their place on the river. Now, suppose stream flows were drastically reduced by a drought and the industrial user did not change the quantity of fresh water they used. If the industrial user consumes the same quantity it consumes during non-drought periods, then everyone downstream would have proportionately less water. However, each user would have the same proportion of water if the industrial user consumed the same percentage of in-stream flows as they had before, during non-drought periods. This action would have very adverse consequences for downstream users. Although legislation is in place to prevent occurrences as drastic as this illustration, the aggregation of individual decisions across the river corridor can have adverse effects on downstream users.

The doctrine of prior appropriations determines water rights within the region, meaning that whichever user was the first to put the water to beneficial use maintains the right to use that water. Upstream users cannot deny downstream water rights holders from their legal share. In this regard, downstream non-consumptive uses can prohibit upstream consumptive uses, but upstream non-consumptive uses do not affect downstream uses for either consumptive or non-consumptive uses.

Most of the water in the region is already appropriated, and many uses are tied to junior water rights. Junior water rights can only be exercised during high-flow years, thereby being unreliable from year to year. Any new uses of water require either a transfer of water rights, increases in water supply through reservoir storage, or mining of ground water.

When considering the allocation of fresh water within the Yellowstone River Corridor, it is essential to take into account all the different users of fresh water within the region, and the ways in which space and time impact their value of fresh water, as well as how one user's consumption habits affect other users within the region. Each type of user has different preferences and needs regarding fresh water consumption. Thus, it is important to know how much fresh water a type of user demands in order to allocate fresh water efficiently throughout the river corridor. For anthropocentric uses, allocation can be determined by the amount a typical user is willing to pay and the number of users within a certain area. For example, a town of 500 people will demand a different amount of water than a town of 5,000 people. For fisheries and wildlife uses, however, the amount of fresh water required is typically based on a biological threshold. Thus, it is important to know how different users' dependency on water and demand for water vary in order to understand the value of the ecosystem service.

Raw Materials

Ecosystems generate benefits through providing raw materials for food, manufacturing, construction and fuels. Specific examples would be timber stands which can be used for building materials and manufacturing, as well as biofuels. Economically, a capital stock could be considered the market value of a stand of timber at a given time. But the ecosystem provides further services that generate economic benefits: a suitable environment for such materials to grow. A steady flow of economic benefits from raw materials is possible through sustainable extraction and management practices. For example, clear-cutting an acre of timber and developing that acre for residential use will result in a one-time payoff of that timber, and benefits from only the residential use thereafter. However, implementing a harvest rotation and leaving that acre in its otherwise natural state will allow multiple market-value payoffs from the timber. Additionally, a properly implemented timber harvest rotation allows for some forest habitat to remain in existence, and for forest regeneration. This is typically not the case where that area of timber is clear-cut in order to be developed.

Cottonwood forests regenerate on the Yellowstone through a complex and lengthy process of forest senescence, channel erosion of forests, recruitment of new seedlings and growth cycles covering a century or more (Report: Riparian Systems). Although no data are readily available, it is thought that a significant portion of the cottonwood forest along the riparian corridor was removed for fuel and to develop agriculture prior to 1950. Presently, changes in historic flows caused by regulating dam releases are impairing natural recruitment of seedlings and growth of new forests due to reduced moisture reaching the riparian areas (Reports: Hydrology; Riparian Systems). Thus, the economic value of raw materials has been negatively impacted by development and flow regulation within the corridor.

Regulating Services

Regulating Services describe the benefits obtained from the ways in which an ecosystem helps to regulate environmental events. That is, it is the benefits generated by the ways an ecosystem helps control things like water flow, flooding, erosion, etc. The Yellowstone River Corridor provides services that regulate water flows, soil erosion, and water quality. Beneficiaries from these services include human users and animal and plant species.

Water Regulation

The ecosystem service Water Regulation is the ways in which "land cover, including, in particular, alterations that change the water storage potential of the system, such as the conversion of wetlands or the replacement of forests with croplands or croplands with urban areas [impacts] the timing and magnitude of runoff, flooding, and aquifer recharge" (Millennium Ecosystem Assessment, 2003). Development in the Yellowstone River Corridor has created barriers within the corridor, resulting in isolated floodplain area – some portion of the floodplain that is no longer accessible to flood waters – along the river. Thus, the economic benefits provided by the floodplain is, to a degree, lost when some type of development/land use causes floodplain isolation. Along the YRC the largest cause of 100-year floodplain isolation is agriculture (9,090 acres of 100-year floodplain isolated), with railroads (active and abandoned, 3,526 acres and 2,303 acres, respectively), hydrologic alteration (3,234 acres), transportation (2,054 acres), and general urban development (1,230 acres) also causing floodplain isolation (Report: Hydraulic Assessment). Collectively, 12.4% of the 100-year floodplain has been isolated (21,437 acres out of 172,419). Generally, approximately 5-20% of the 100-year floodplain has been isolated in any given reach of the river; and approximately 20-50% of the 5-year floodplain has been isolated in any given reach. The dominant water use in the basin is irrigation for agriculture.

A specific type of landscape – wetlands – play a particularly significant role in water regulation. Wetlands hold and slowly release flood water and snow melt. A single acre of wetlands can store somewhere between 1 and 1.5 million gallons of floodwater (3 to 4.5 acre-feet). There are approximately 7,750 acres of wetlands habitat in the Yellowstone River Corridor; nearly 2,500 acres fall within the 100-year floodplain, of which around 500 have been isolated (Report: Hydraulic Assessment).

Although the land uses contributing to floodplain isolation create benefits to society, there is an economic cost associated with the forgone benefits of the isolated floodplains. That is, a certain degree of flood control and mitigation has been traded off for the benefits generated by the above land uses. One way to conceptualize the opportunity cost of the forgone benefits of flood prevention (as a result of floodplain isolation) is to consider the cost of some alternative methods of controlling floods: although not entirely accurate, the costs of flood insurance and flood cleanup offer some insight into the forgone benefits of floodplains after they have become isolated. For example, the average flood insurance policy in Montana in 2011 was $572, annually (Montana Commissioner of Securities and Insurance, 2014). This figure, while not providing a direct estimation of a per unit value of the ecosystem service water regulation, does clearly indicate a willingness to pay for services that reduce the risk of experiencing damages from a flood. Thus, it can be inferred that development resulting in a reduction in water regulating services would cause an increase in the average flood insurance premium observed within the corridor, since the severity of damage caused by a flood would increase in probability.

Erosion Control

An ecosystem provides Erosion Control when vegetative cover helps to retain soil and prevent erosion and maintain or improve soil fertility. Soil provides a physical support system for plants and retains and delivers nutrients to them. Soil fertility is essential for plant growth and agriculture, and well-functioning ecosystems supply the soil with nutrients required to support plant growth. Furthermore, soil can hold and release water flexibly, providing flood control and water purification benefits (U.S. Environmental Protection Agency, 2001). Thus, removal of vegetation from an ecosystem generally has a negative impact on soil retention and fertility. From 1950 to 2001 there was an estimated 1 percent decrease in riparian cover across the entire Yellowstone River Corridor, going from 22% to 21% (Report: Riparian Systems). Even though the removal of riparian vegetation might result in the generation of benefits because of development, it comes at a cost: the depletion of erosion-prevention services and soil fertility. For example, consider a plot of land that was covered in cottonwood in its natural state. Soil erosion on that plot would be moderated by the cottonwood stand. Suppose that the plot of land is cleared and put into irrigated agriculture. The erosion control services once provided by the ecosystem would no longer exist, and the plot of land would experience higher levels of erosion thereafter.

The previous example illustrates the economic tradeoffs of development and erosion control. A plot of land could generate new sources of revenue for the land owner by developing it, but it might come at a cost which is borne by downstream users or society, in general. In the above example, agricultural land likely sees higher financial returns than does a stand of Cottonwoods, but erosion control becomes a forgone benefit once the development takes place. In a scenario like that, the land owner is not the only individual bearing the cost of soil erosion: downstream users would also bear the economic cost as they would be subjected to higher levels of sediment.

A study conducted from 2002 to 2005 of homes near lakes in Prescott, Arizona shows that individuals are willing to pay for erosion control (Yoo, et. al., 2014). More specifically, households were willing to pay between $145 and $334 per ton of decreased sedimentation load into neighboring lake(s). Although these values are likely not representative of the Yellowstone River Corridor, they illustrate how individuals are willing to pay for the ecosystem service erosion control.

Water Purification

An ecosystem provides Water Purification by processing and/or filtering out pollutants such as metals, viruses, oils, excess nutrients, and sediment as water moves through wetland areas, forests, and riparian zones (Daily, 1997). This purification process provides water suitable for industrial uses, recreation, and wildlife habitat, as well as decreasing treatment costs to public utilities. Thus, any development along the river corridor would likely have a negative impact on water purification. Although changes in riparian extent across individual reaches were different (i.e., some reaches saw little to no change in riparian vegetation, while others experienced relatively high degrees of change), Regions A and C saw net losses from 1950 to 2001 (Report: Riparian Systems). It should be noted, however, that large-scale conversions of riparian areas are assumed to have taken place prior to the 1950 study time (i.e., the early 1800's) by way of early agricultural development and timber harvesting for fuel and construction. Wetlands – another natural landscape that helps to purify water – are very dynamic, thereby created and removed by high flow events. The Yellowtail Dam has decreased the river's high flow events, causing less dramatic peaks in the spring and summer. The reduction in channel-forming flows will negatively affect the long-term viability of the riparian and wetland communities (Report: Wetland Systems), and therefore decrease water purification potential. There are no precise measurements of temporal change in wetlands in the corridor, but estimates of losses ranging from 25-33% of the historic extent due to development (Report: Wetland Systems).

Although the land uses negatively impacting water purification create benefits to society, there is an economic cost associated with the forgone benefits of water purification. Consider an acre of riparian vegetation cleared for urban uses: that acre would generate benefits to society by way of said urban development, but then would result in less purified water downstream. For example, developing a natural area into a residential area would not only provide additional space to live, but also generate property taxes. However, once that area had been developed for residential use it would no longer offer the same degree of water purification services – a cost that would be borne by users downstream, such as fish species or another municipality subject to more pollutants. One way to conceptualize the opportunity cost of the forgone benefits of water purification as a result of land use changes is to consider the cost of some alternative methods: although not entirely accurate, the costs of municipal water treatment and removal of pollutants from surface water offer some insight into the forgone benefits of water purification. For example, a study done in Louisiana showed that wastewater treatment by way of natural wetland was 6 times more cost-effective than the conventional sand-treatment method (Jae-Young, et. al., 2004). That is, from a benefit-cost perspective, the wetlands method was 6 times more efficient than the conventional method. Of course, such a metric admittedly disregards other benefits generated by wetlands, like recreation, habitat support, water regulation, etc. Therefore, the depletion of water purification ecosystem services as a result of development generates a loss of economic benefits to the region.

Cultural Service

Cultural Services describe the benefits people acquire through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences. The Yellowstone River Corridor provides individuals with the opportunity to experience unique things and the opportunity to conduct research on and within a unique natural environment.

Opportunity to Experience

Ecosystems provide enjoyment and happiness to people in two distinct ways. The first type of enjoyment/happiness occurs when an individual interacts with the ecosystem. This includes enjoyment experienced from some type of recreation, like fishing, rafting, or bird watching and also includes residents who experience enjoyment from living within the ecosystem region or nearby some specific feature of the ecosystem. Economists commonly refer to this first type of enjoyment as use value. The second type of enjoyment/happiness that ecosystems provide occur when an individual finds contentment in just knowing that the ecosystem exists and/or finds contentment in knowing that future generations will have the opportunity to enjoy that ecosystem. Economists refer to the latter types of values as existence and bequest values, respectively; but generally those types of values are known as nonuse values.

Use values are measured by someone's willingness to pay for an environmental good on/in which to recreate or enjoy firsthand. Numerous studies have been conducted to estimate how much an individual values a single day of hiking, fishing, and so on. For example, a study done in Montana, Colorado, and Wyoming found that backpackers were willing to pay $63 (in 2015 dollars) for each day of backpacking (Bhat, et. al., 1998). A U.S. Fish and Wildlife Service study estimated that users were willing to pay $23 for each day of wildlife viewing in Montana (Aiken and la Rouche, 2003).

Nonuse values are measured by an individual's willingness to pay for an environmental good even if they do not intend on using it. The Yellowstone River Corridor provides nonuse values to individuals, within the region. For example, the Crow Nation states they have existence and bequest values for the Yellowstone River Corridor ecosystem (Gilbertz et. al., 2006). Furthermore, nonuse values can – and oftentimes do – exist outside the region, as well. As an illustration, consider an individual living in the Midwest who is willing to pay to protect a fish species in the Yellowstone River, even if they never intend on visiting the region. An often-cited example is the Exxon Valdez Oil Spill that occurred in Alaska in 1989, where a nation-wide study found an aggregate loss of nonuse value to be $4.8 billion (Carson et. al., 2003).

The idea of nonuse values has been a part of the environmental economics field for decades (Krutilla, 1967) and has become extremely prevalent in the literature and federal agency economic analysis procedures (U.S. Environmental Protection Agency, 2000). It is essential to consider how individuals' opportunities to experience are affected by land use decisions and development along the Yellowstone River Corridor in order to best understand the economic impacts of development.

Opportunity to do Research

Another ecosystem service provided by the region is the Opportunity to do Research. This service provides scientists the opportunity to conduct research on species, biological processes, geological processes, etc. Given the fact that some species and biological/geological processes can be region-specific, the opportunity to do research in that particular region is essential to understanding said species traits/characteristics and biological/geological processes. In most instances, the findings from research done in one region can be generalized to other regions across the globe. For example, a land-grant university would perform hydrologic studies on a river within its state and share the findings via professional papers and meetings or extension in other parts of the state, other parts of the country, or other parts of the world, particularly in developing countries. As a general rule, being able to conduct research will result in improved management decisions and increased flows of benefits to society from an ecosystem.

The quality of research opportunities provided by an ecosystem are determined by the end goal. That is, if the research question is 'what are soil-erosion rates given moderated peak flows caused by a dam in a river basin where 20-40% of the 5-year floodplain has been isolated due to development?', then it would be essential to perform the research in a river basin which had experienced comparable anthropogenic impacts. However, if the research question is 'what are the natural mating habits of a native fish species?', then the ecosystem service would be depleted and less rich had the ecosystem experienced anthropogenic impacts. That said, the opportunity to do research provided by an ecosystem is generally regarded as being more valuable the less developed it is. The reason is because natural or undeveloped areas are becoming increasingly scarce. In this way the Yellowstone River is very unique, as it is the longest undammed river in the contiguous United States.

To illustrate the point that undeveloped areas are rare and provide valuable opportunities to study ecosystems: there are very few fresh water ecosystems on earth, relative to saltwater ecosystems. Since fresh water ecosystems attract human settlement and development, particularly irrigated agriculture, virtually all of them have experienced some degree of anthropocentric development. Thus, fresh water ecosystems that are relatively undeveloped are rare, and the opportunity to conduct research in such ecosystems are scarce.

The Yellowstone River Corridor provides many opportunities to do hydrogeological research (e.g. hydrology, geomorphology, hydraulics, etc.). However, the corridor also provides unique opportunities to do biological research on many types of fish and avian species. Although every native species in an ecosystem plays a role in that ecosystem, the value of a given species generally comes from recreation, the opportunity to experience and the opportunity to do research.

The ecosystem service opportunity to do research has economic value. Numerous grants are handed out every year for the sole purpose of conducting research so that the findings might contribute to the overall wellbeing of the general public. Consider the National Science Foundation, who financially backs roughly 24% of all federally-funded research (National Science Foundation, 2015). The National Science Foundation (NSF) is an independent federal agency created by Congress in 1950 "to promote the progress of science; to advance the national health, prosperity, and welfare." The agency states, "no single factor is more important to the intellectual and economic progress of society, and to the enhanced well-being of its citizens, than the continuous acquisition of new knowledge." A study done in 1998 estimated that North Carolina households were willing to pay between $251 and $698 million annually for water quality research and extension programs (Whitehead, et. al., 2001). Although these figures cannot be directly applied to the Yellowstone River Corridor, they do indicate that there is economic value for the opportunity to do research.

Part 2

The following analysis is a departure from ecosystem services and the explicit and implicit values associated with ecosystem services provided within the corridor. Rather, this section analyzes and discusses the economic impacts of tourism and recreation within the Yellowstone river corridor, as well as the economic impacts of the Yellowtail Dam.

Economic Impact of Nonresident Tourism and Recreation in Yellowstone River Corridor Counties

Along the Yellowstone River, Montana's landscape encompasses wide open vistas, mountains and valleys, unique Rimrock landscape and badlands. A number of natural sites include Gallatin National Forest, Makoshika State Park, Pompey's Pillar National Historic Landmark, entrance points to Yellowstone National Park in Gardiner and Cooke City, Absoroka and Beartooth mountain ranges as well as the Paradise Valley outside of Livingston. These sites of natural, cultural and historic significance draw visitors outside of the state for tourism and recreation each year. According to the Statewide Comprehensive Outdoor Recreation Plan of 2014, visitors to Montana counties along the Yellowstone River enjoy scenic driving, photography, wildlife watching, visiting historical sites and day hiking. During the stay, visitors spend money on gasoline and diesel, retail purchases—particularly those associated with fishing, restaurants and bars and hotels and motels, groceries and snacks and other services like fishing or river guides. These nonresident expenditures generate economic activity in the local economy which can be estimated.

The economic impact result from the visitor spending, shown in Table 1 have been estimated by the Institute for Tourism and Recreation at the University of Montana for years 2012-2013 by using IMPLAN, an economic input-output model. (Grau, K., 2014) (Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government). Economic input-output models capture the complex interactions of consumers and producers of goods and services in local economies. The estimates include direct, secondary and combined impacts in industry output and employment.

Employment represents the number of jobs generated in the region from a sector in the economy. Estimates for employment include *full time, part time, and temporary jobs.* Economic impact of industry output refers to the value of goods and service produced by an industry which nonresidents purchase. Economies are complex webs of interacting consumers and producers in which goods produced by one sector of an economy become inputs to another, and the goods produced by that sector can become inputs to yet other sectors. Thus, the final demand for a good or service can generate a ripple effect throughout an economy. The direct effect of a purchase of a good or service can cause local businesses to purchase labor and supplies to meet the demand for services. The income and employment resulting from these purchases from local businesses represent the direct effects of demand within the economy. Direct effects measure the net amount of spending that stays in the local economy after the first round of spending; the amount that doesn't stay in the local economy is termed a leakage (Carver and Caudill, 2013). In order to meet demand from local businesses, input suppliers must also purchase inputs from other industries. The income and employment resulting from these secondary purchases by input suppliers are the indirect effects within the economy. Employees of the directly affected businesses and input suppliers use their incomes to purchase goods and services. The resulting increased economic activity from employee income is the induced effect. The indirect and induced effects are known as the secondary effects. “Multipliers” (or “response coefficients”) capture the size of the secondary effects, usually as a ratio of total effects to direct effects (Stynes, 1998). The sums of the direct and secondary effects describe the total economic contribution of a sector in a local economy.

Rosebud, Prairie, Treasure and Sweet Grass counties were omitted from the analysis and the report due to particularly low visitor spending estimates in those counties.

Table 1 shows the economic impacts for nonresident travel between years 2012 and 2013. Yellowstone County sees the largest number of direct impacts on industry output and employment at $288,550,000 and 3,400 respectively. Park County is the second with direct impacts of $142,360,000 in industry outputs and 2,060 in employment.

Table 1: Economic Impact of Nonresident Travel 2012-2013

	Industry Output ($)			**Employment (# of jobs)**		
	Direct	Secondary	Combined	Direct	Secondary	Combined
Richland	$31,990,000	$9,100,000	$41,090,000	390	90	480
Dawson	$26,410,000	$9,140,000	$35,550,000	310	90	400
Custer	$61,230,000	$25,790,000	$87,020,000	800	260	1,060
Yellowstone	$288,550,000	$158,280,000	$446,820,000	3,400	1,450	4,850
Carbon	$49,190,000	$18,380,000	$67,570,000	740	180	920
Stillwater	$29,850,000	$6,570,000	$36,420,000	370	70	440
Park	$142,360,000	$52,950,000	$195,320,000	2,060	580	2,640

Source: Grau, K., 2014, Institute for Tourism and Recreation Research, University of Montana

Yellowtail Dam

Yellowtail Dam is located in Southcentral Montana. It was built between 1963 and 1966 as a part of the Pick-Sloan Missouri Basin Program. The dam serves multiple purposes; providing irrigation water, flood control, recreation and power generation. (Bureau of Reclamation, 2015) As a result of the Dam, it has been estimated that flood damage was reduced by $113 million between the years of 1965 and 2007. (National Park Service, 2015) The power produced by the Yellowtail Power plant supplies electrical energy to the surrounding area. The electricity produced is owned and managed by the Western Area Power Administration (WAPA). The irrigation water supplied by the dam travels northeast along the Yellowstone River, helping provide water to over one hundred thousand acres of agricultural land. Canyon views, boating, hiking, camping and fishing recreational opportunities attract local and non-local users to experience the Bighorn Canyon National Recreation Area which resulted from construction of the Yellowtail Dam.

Power Generation

Yellowtail Power plant has an installed capacity of 250,000 kilowatts. The production of power at the dam supplies electricity for residential and commercial use in the surrounding area. (Bureau of Reclamation)

Table 2 displays the average generation of power at the Yellowtail dam as a percentage of the average total generation for Pick-Sloan over a five year period. The average generation is equivalent to marketed energy for Pick-Sloan power. (Gierard, J. and Radecki, M., written commun.) Figure 1 shows the geographic area of Pick-Sloan as a whole, the Eastern Division, the Western Division, and the Missouri River Basin watershed. While Yellowtail dam produces 21.2% of total load in the Western division, it only produces 4.3% of the total load in the Eastern Division. This averages to 7.1% of total load generation for Pick-Sloan from the Yellowtail dam. The percentage of population served by the Western Division, where the Yellowtail Dam power generation is at 21.2%, varies by state and is highest in rural South Dakota and lowest in urban Colorado.

Table 2: Average Generation of power at Yellowtail Dam, Courtesy of WAPA

	Yellowtail Generation (GWh)	Total Generation (GWh)	% of Yellowtail Dam Generation/Load
Western Division plus Mt. Elbert Plant	401	1,888	21.2%
Eastern Division	401	9,382	4.3%
Total Pick-Sloan	802	11,270	7.1%

Source: Western Area Power Administration

Figure 1: Pick-Sloan Service Area. Courtesy of Western Area Power Administration

Bighorn Canyon National Recreation Area

The construction of the Yellowtail Dam increased recreational opportunities for local and non-local residents. The cold water flows into the Bighorn River from the dam created a world class trout fishery which has become the most fished stream in the state of Montana. Yellowtail Dam also led to the designation of Bighorn Canyon National Recreation Area in 1968. (National Park Service) Each year Bighorn Canyon National Recreation Area welcomes over 200,000 visitors who are seeking fishing, wild life viewing, hiking, bird watching, boating and camping. These visitors contribute to the economic activity of the region through their spending. Local and non-local visitor spending is captured by National Park Service through surveys. This information is then used in an input-output model to estimate the economic impact and economic contribution of non-local and local visitors to the recreation area.

Economic input-output models are commonly used to determine the contribution of specific economic sectors to a local or regional economy. The results presented here are published in the 2013 National Park Service Visitor Spending Effects report and are estimated using IMPLAN (Impact Analysis for Planning), a widely used input-output software and data system. The IMPLAN platform was developed by the U.S. Forest Service and is now privately maintained and updated by the IMPLAN Group, LLC. The

IMPLAN model draws upon data collected from multiple federal and state sources including the Bureau of Economic Analysis, Bureau of Labor Statistics, and the U.S. Census Bureau (Olson and Lindall, 1999).

Economic input-output models capture the complex interactions of consumers and producers of goods and services in local economies. Economies are complex webs of interacting consumers and producers in which goods produced by one sector of an economy become inputs to another, and the goods produced by that sector can become inputs to yet other sectors. Thus, the final demand for a good or service can generate a ripple effect throughout an economy. The direct effect of a purchase of a good or service can cause local businesses to purchase labor and supplies to meet the demand for services. The income and employment resulting from these purchases from local businesses represent the direct effects of demand within the economy. Direct effects measure the net amount of spending that stays in the local economy after the first round of spending; the amount that doesn't stay in the local economy is termed a leakage (Carver and Caudill, 2013). In order to meet demand from local businesses, input suppliers must also purchase inputs from other industries. The income and employment resulting from these secondary purchases by input suppliers are the indirect effects within the economy. Employees of the directly affected businesses and input suppliers use their incomes to purchase goods and services. The resulting increased economic activity from employee income is the induced effect. The indirect and induced effects are known as the secondary effects. "Multipliers" (or "response coefficients") capture the size of the secondary effects, usually as a ratio of total effects to direct effects (Stynes, 1998). The sums of the direct and secondary effects describe the total economic contribution of a sector in a local economy.

For the purposes of an economic impact and contribution analysis, a region (and its economy) is typically well-defined. Only spending that takes place within this regional area is included as contributing to economic activity. The size of the region influences both the amount of spending captured and the multiplier effects. For this analysis, Stillwater, Big Horn, Carbon, Yellowstone, Musselshell, Rosebud, and Treasure Counties of Montana as well as Sheridan, Big Horn, Hot Springs, Johnson, Park and Washakie Counties of Wyoming were included as the region. Regional economic contributions from the IMPLAN model are reported for the following categories:

- Employment represents the number of jobs generated in the region from a sector in the economy. IMPLAN estimates for employment include *full time, part time, and temporary jobs.*
- Labor Income includes employee wages and salaries, including income of sole proprietors and payroll benefits.
- Value Added measures contribution to Gross Domestic Product. Value added is equal to the difference between the amount an industry sells a product for and the production cost of the product, and is thus net of intermediate sales.

Tables 3 and 4 show Non-local recreation visits and associated economic impacts as well as total recreation visits and associated economic contribution from visitor spending. Total recreation visit for 2013 to the Bighorn Canyon National Recreation Area was slightly over 241 thousand people. These visitors contributed close to $11 million dollars in total output from which almost $10 million dollars was generated from non-local visitor spending. A total of 140 jobs were created through recreation visits and visitor spending, while 126 of those jobs were created due to non-local visitor spending.

Table 3: Impacts of Non-local Visitor Spending, 2013

Park Unit	Non-Local Recreation Visits	Non-Local Visitor Spending ($ Thousands)	Impact of Non-Local Visitor Spending			
			Jobs	Labor Income ($ Thousands)	Value Added ($ Thousands)	Output ($ Thousands)
Bighorn Canyon National Recreation Area	166,325	$8,756.2	126	$3,298.5	$5,479.2	$9,926.8

Source: Cullinane Thomas, C., 2013 National Parks Visitor Spending Effects

Table 4: Contribution of all Visitor Spending, 2013

Park Unit	Total Recreation Visits	Total Visitor Spending ($ Thousands)	Contribution of all Visitor Spending			
			Jobs	Labor Income ($ Thousands)	Value Added ($ Thousands)	Output ($ Thousands)
Bighorn Canyon National Recreation Area	241,528	$9,893.5	140	$3,646.6	$6,026.7	$10,850.1

Source: Cullinane Thomas, C., 2013 National Parks Visitor Spending Effects

Conclusion

The Yellowstone River Corridor's natural environment provides benefits to human users and animal and plant species through ecosystem services. The ecosystem services provided by the river corridor can be classified as Provisioning, Regulating, or Cultural Services. These ecosystem services are typically valued using non-market valuation techniques, since they do not have market prices explicitly associated with them.

The Yellowstone River Cumulative Effects Analysis was generated by a need to know the status of the river's water flows and floods (hydrology and hydraulics) and their relationship with the geomorphology of the river channel and environment. It further looked at the long term effects on the biology of the river corridor to determine if there were cumulative impacts to the biology from social and economic efforts to control river flooding, bank erosion, and other changes to the river channel.

It is essential to account for the ecosystem services provided by the Yellowstone River Corridor during land use decision-making processes to place in context ecology, land use decisions, and economic interactions. Furthermore, it is necessary to understand how different types of development impact the corridor's ecosystem services, and in turn, how different types of development impact human users, wildlife species, and plant species within the region and outside of the region. In better understanding these interactions, decision-makers can be better informed with designing and implementing best management practices.

This evaluation has offered a qualitative analysis on the impacts of development on ecosystem services within the Yellowstone River Corridor. Thus, the analysis was grounded in theory and drew upon outside research and empirical evidence, offering examples from the Yellowstone River where appropriate. In order to more accurately estimate the impacts of development on ecosystem services within the river corridor as well as understand the benefits and costs of land use changes, a quantitative analysis on the Yellowstone River Corridor should be conducted in order to help form best management practices. More specifically, data on individuals' willingness to pay to maintain current levels of ecosystem services or reestablish natural levels of ecosystem services could be used to estimate the value of those ecosystem services. In turn, those values could be compared to market values typically earned as a result of development. Such data are typically collected through a survey and the estimation process referred to by economists as contingent valuation. Another estimation technique, referred to as the hedonic property method, uses property and home sales data to estimate the value of ecosystem services. Regardless of the method, a quantitative analysis on the Yellowstone River Corridor and its ecosystem services would allow land owners, utilities directors, and industrial managers to more accurately understand the impacts of their decisions. Furthermore, a quantitative analysis would provide pertinent information with which policy-makers might use to form policy.

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