Regional Economic Values of the Bear River

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EXECUTIVE SUMMARY

The Bear River is an important component of life in the Bear River Watershed; the River provides water for agriculture, municipal and industrial uses, hydropower, recreation opportunities, and valuable ecosystem services. The Bear River is hydrologically connected to Bear Lake and the Great Salt Lake and is thus tied to the health and function of these two critically important water bodies. Understanding how the Bear River contributes to the regional economy can aid the development of policies that ensure a sustainable economic future for Bear River communities. Conservation Economics and ECONorthwest were commissioned to conduct a full economic valuation of the Bear River system detailing current economic conditions and illustrating potential effects resulting from future climatic and land use scenarios.

To assess the total economic values of the Bear River, we conducted market and non-market valuations of six primary categories of economic value dependent on Bear River water: agriculture (crops and livestock), municipal water use, hydropower, recreation, heritage, and environmental services. For market values, we use IMPLAN economic modeling software to estimate regional economic impacts and contributions from sales of goods and services that would likely not exist in the region without the Bear River. In addition to regional market values, we estimate the non-market values associated with environmental services and outdoor recreation. The regional economic zone for the Bear River Basin is inclusive of 10 counties in the states of Utah, Idaho, and Wyoming that contain the Bear River and its primary tributaries. The majority of the goods and services derived from Bear River water are exported out of this 10-county regional economic zone to surrounding metro areas (e.g., Salt Lake City and Pocatello), throughout the Pacific Northwest, and even internationally. All dollar amounts in the summary and throughout the report are presented in 2022 dollars, using the Consumer Price Index to account for inflation when necessary. All calculated values are annual values.

Much of the Bear River Basin (850,000 acres) is used for agriculture (both livestock and crop production) with 75% of these lands being irrigated. Thus, the majority of withdrawals from the Bear River system are for agricultural purposes. For Bear River agriculture we found that:

- Bear River agriculture accounts for approximately 1.3 to 2.6 million acre-feet of diverted water annually. A significant portion of irrigation water (estimated at up to 38%) stays within the Bear River Basin via groundwater and surface recharge and irrigation return flows, especially in areas where surface or flood irrigation is used.
- Bear River irrigation is the impetus for almost all sales of crops and livestock in the region. Bear River Basin crops generate $510 million in annual revenues. Bear River Basin livestock and livestock product sales generate approximately $350 million in annual revenues.
- Approximately 70% of all crop and livestock annual revenue come from products exported outside of the 10-county Bear River regional economic zone. The majority of exports go to neighboring counties and Intermountain West states.

With the Bear River contributing approximately 39% of water entering the Great Salt Lake (Utah Division of Water Resources), we assume 39% of the estimated Great Salt Lake economic values are attributable to the Bear River. This attribution is done to recognize that when Bear River water quality and levels fall below specific thresholds, Great Salt Lake economic values also are diminished.

Based on prior research investigating the economic value of the Great Salt Lake, we show that:

- Bear River water accounts for approximately $372 million (39%) of annual Great Salt Lake industrial mineral revenues (e.g., magnesium, titanium, salt, potash).
- Bear River water supports $18.5 million (39%) of annual revenues associated with Great Salt Lake aquaculture industries (e.g., brine shrimp).

The use of Bear River water for municipal and other industrial activities (aside from agriculture) was examined. For municipal and industrial water use, we found that:

- There is very little non-agricultural industrial use of Bear River water. For municipal water use, most Bear River Basin municipalities rely primarily on groundwater sources, suggesting little of municipal and industrial water is withdrawn directly from the Bear River.
- Bear River Basin municipalities and industries use roughly 50,000 to 132,000 acre-feet of water each year (average of 91,000 ac-ft/year) mostly from groundwater and surface springs – equal to 4% to 5% of Bear River water diverted for agriculture. The relationship between groundwater sources and Bear River surface water is not well documented (e.g., the use of deep groundwater sources may contribute to Bear River flows while other groundwater uses may diminish Bear River flows).
- Average annual sales of municipal water in the Bear River Basin, primarily from groundwater and surface springs, are estimated at $63.6 million (91,000 ac-ft/year at $700/ac-ft).

The generation of hydroelectric power is a historical use of the Bear River and provides substantial renewable energy to Bear River communities. PacifiCorp owns and operates five hydropower facilities on the Bear River: Soda, Grace, Oneida, Cutler, and Last Chance. Regarding Bear River hydroelectric plants, we found that:

- Total annual net generation from the facilities averages more than 200 thousand megawatt hours.
- Annual sales of Bear River hydroelectricity are approximately $18.2 million.
- Approximately 90% of Bear River hydropower is used within the region, while the remaining 10% is exported outside the region.

The Bear River also affords a multitude of recreation opportunities. Each year, an estimated two million visits are made to primary Bear River recreation sites. When non-locals visit the area to recreate and engage in nature tourism, the money they spend on gear, lodging, restaurants, etc. impacts the region's economy in a similar manner as the export of agricultural products. An examination of Bear River related outdoor recreation reveals:

- Primary recreational activities of the Bear River system include boating, hiking, beach-lounging (Bear Lake), wildlife viewing (especially birding), fishing, waterfowl hunting, and camping.
- Non-locals visiting for the primary purpose of outdoor recreation spend nearly $74 million annually in communities near the Bear River.
- The Bear River portion of Great Salt Lake annual recreation expenditures is estimated at $41 million.
- Bear Lake is a significant vacation destination for visitors from Salt Lake City, Pocatello, and other Western cities. Recreation and visitation to Bear Lake represents approximately half of all Bear River-related visits and annual expenditures.
- Recreationists who participate in waterfowl hunting, fishing, boating, and birding along the Bear River derive $16.6 million in annual non-market benefits.

The history and settlement of the Bear River Basin has resulted in significant cultural and heritage values. These values are primarily non-market and qualitative in nature, though we do document market values previously estimated related to Bear River heritage tourism.

- Remembrance of the Bear River Massacre in 1863 and pre-settlement culture has immeasurable value to the Shoshone and other Native American Tribes.
- Historical homesteading, farming, and ranching in the Bear River Basin has tremendous heritage values, particularly for ancestors of Mormon settlers.
- The Bear River Heritage Area draws visitors interested in exploring the Basin's rich culture, heritage, and history. An estimated 326,250 visits are made to Bear River Heritage Area sites each year (excluding Bear Lake), resulting in $27 million in annual regional visitor expenditures.

The Bear River provides myriad environmental services, such as fish and wildlife habitat, ecological functions, scenic attributes, and spiritual inspiration. Primary environmental services of the Bear River, like the provision of clean and consistent water, are key ingredients for the production of marketed goods, but also spur numerous non-market values – values stemming from goods and services for which there is no market. In the environmental services section, we examined non-market values of the Bear River and found:

- As demonstrated by numerous non-market economic valuations of other rivers, wetlands, and lakes in the American West, regional households are likely willing to pay to restore and protect the Bear River, typically for passive use values related to existence, option, and bequest values.
- For the restoration and protection of two degraded and important sections of the Bear River, we estimate an annual willingness to pay of $28.6 million.
- We estimate an annual willingness to pay for Bear River wetlands protection of $3.7 million.
- Attributing 39% of the Great Salt Lake's value to the Bear River yields an estimated annual willingness to pay of $52.6 million to protect the Bear River's portion of the Great Salt Lake.
- Conservation easements are being enacted to protect Bear River environmental services, with more than 11,000 acres in the Bear River Basin protected under easements over the last four years, generating $2.76 million annually (these are included in our market analysis).
- The Bear River Basin conservation easements also are estimated to provide $51.6 million of regional annual ecosystem service benefits, or additional non-market values at the current pace of easement purchases.

Aggregating each Bear River value category reveals almost $1.5 billion in total annual market revenues and $153 million in annual non-market values (see Table ES1).

Table ES1: Annual Market Revenue and Non-Market Values by Bear River Value Category

Bear River Value Category	Market Revenue	Non-Market Value
Crops	$510,005,000	
Livestock	$351,070,000	
Great Salt Lake Minerals	$372,000,000	
Great Salt Lake Aquaculture	$18,500,000	
Municipal and Industrial	$63,570,000	
Hydropower	$18,240,000	
Recreation	$115,000,000	$16,650,000
Cultural/ Heritage Tourism	$27,210,000	
River Restoration/ Protection		$28,610,000
Wetlands		$3,710,000
Great Salt Lake Protection		$52,650,000
Conservation Easements	$2,760,000	$51,600,000
Total	**$1,471,145,000**	**$153,220,000**

Additional regional market impacts are spurred by exported goods and services when this new wealth requires supporting services (known as indirect effects) and induces new household spending (induced effects). When adding indirect and induced effects from exported goods to our direct effects from exported and non-exported goods, we get total annual regional economic impacts and contributions of the Bear River (e.g., $1.80 billion in total output). Finally, we add our annual non-market values (approximately $153 million) to the total output to illustrate market and non-market values of the Bear River. **A conservative estimate for the total annual value afforded by the Bear River is $1.95 billion.**

Table ES2: Total Annual Regional Economic Values of the Bear River

Annual Values	Total Employment	Total Labor Income	Total Output/Value
Market Impacts and Contributions	11,428	$403,270,000	$1,795,890,000
Non-Market Values	--	--	$153,220,000
Totals	**11,428**	**$403,270,000**	**$1,949,110,000**

The numerous benefits and values afforded by the Bear River are dependent upon sufficient streamflow and sufficient water quality, both of which are currently at risk due to increased demands on water supplies, numerous and widespread water quality impacts, and recent drought conditions in the Intermountain West. We found that:

- Bear River streamflow has decreased considerably over the last 50 years; at the Corrine gage streamflow has declined more than 40% from 1971 to 2021.
- Much of the Bear River is impaired (303(d)-listed), with nearly all samples taken at Corrine showing pollutant levels that exceed phosphorus water quality indicators leaving most of the Bear River unable to meet its aquatic life designated uses. Water quality concerns are amplified by decreases in streamflow.
- Climate change is expected to decrease the region's available water supply and increase temperatures, thereby exacerbating trade-offs between water users and associated economic activities.

Population growth, development, and climate change pose significant threats to the Bear River, Bear Lake, the Great Salt Lake, and the human communities and natural ecosystems that rely on them. Trade-offs between water users have implications for economic values associated with the Bear River. If additional water is allocated to support population growth and residential development, less water will be available for other uses such as agriculture, hydropower, and recreation. Water supply constraints in the Bear River Basin are already creating upward pressure on the value of water; water rights values in the region have risen sharply during recent years and are currently estimated to be between $150 and $2,000 per acre-foot annually. Rising water rights values are increasing interest in water conservation methods and water development projects.

In summary, the Bear River has many beneficiaries, ranging from business owners and the people that are employed due to the presence of the Bear River, to the local communities that receive secondary water and low-cost renewable hydropower, to the consumers of Bear River goods and services far and wide, to the people that recreate in the Bear River watershed, and to the public that appreciate the Bear River and would like to bequeath a healthy Bear River to future generations. However, the sustainability of the Bear River, and its associated economic values, are at risk of being diminished if Bear River flows are reduced and if Bear River water becomes too degraded.

CONTENTS

1. INTRODUCTION

The Bear River travels hundreds of miles across the Rocky Mountains, from source waters on the north slope of Utah's Uinta Mountains all the way to the Great Salt Lake. On its winding journey that begins and ends in Utah, the Bear River flows around the Wasatch Range with the River traversing southwestern Wyoming and southeastern Idaho in its upper and middle sections. The Bear River system includes majestic Bear Lake, half in Idaho and half in Utah, and the Great Salt Lake at the Bear River's terminus. The Bear River is estimated to account for 39% of total inflows to the Great Salt Lake.[1]

Water is scarce in the arid and rural sagebrush steppe that surrounds much of the Bear River. This water scarcity makes the Bear River system an incredibly valuable natural resource and essential for settlement and rural economic development in the region. Indeed, the Bear River has been a "working" river for well over a century, affording extensive irrigation for agriculture and providing for municipal and industrial water use and hydropower. More recently, the Bear River system has supported outdoor recreation, including boating, camping, fishing, hiking, and hunting activities, that generate regional economic impacts from out-of-region visitors and has influenced some people to permanently or seasonally relocate to the region. The Bear River is also incredibly valuable as bird, fish, and wildlife habitat and supports numerous biophysical processes that are essential for humans and biodiversity alike. Culturally, the Bear River has tremendous heritage and historical importance for modern settlers and for Native American tribes, particularly the Shoshone people.

Collectively, the Bear River system has immense economic value as a natural resource. However, this immense value is threatened by overuse, pollution, and drought conditions. The myriad uses of Bear River water are dependent on consistent and ample water quantity and clean water quality. Recent drought conditions have been prevalent throughout the system. Relic, but still existing, water diversion plans from prior state legislation during wetter periods (e.g., the Bear River Development Act)[2] are ever-looming. Rapidly increasing residential growth in adjacent regions and industrial development are stressing the Bear River system. Increasing water demands and decreasing flows necessitate updated planning efforts for allocating an already scarce and diminishing resource. The economic baseline, or the total economic value afforded by the Bear River system, is critical information for informing new policies and proposals that may affect the Bear River.

In this report we present the results of a full economic valuation of the Bear River system, inclusive of Bear Lake and the Great Salt Lake, that can serve as a scientifically-derived economic baseline for current conditions and be used to illustrate value trade-offs resulting from future climatic and land use scenarios. Our guiding economic valuation question was, "what values are at risk of being lost or diminished if the Bear River and its tributaries, as we know it, were not available." Thus, we analyzed all market and non-market economic activities that were deemed dependent on the Bear River.

We conducted a regional economic impact analysis of marketed commodities and services supported by Bear River water and exported from the region that highlights the industrial output and employment (direct effects), inter-industry backward linkages (indirect effects), and employee spending and recirculation of wages (induced effects) associated with the Bear River system. The regional economic impact analysis component traces the ripple effects (multiplier effects) of economic activity that come from exported products (*which produce regional economic impacts)* associated with the Bear River throughout the regional economy

1 Utah Division of Water Resources. 2023. The estimated total inflow of 39% is the 20-year average from 2001-2020 compiled from USGS stream gages for the Bear River, the Weber River, and the Jordan River, along with groundwater input from Waddell and Fields 1977 and precipitation from DAYMET.

2 https://le.utah.gov/xcode/Title73/Chapter26/C73-26_1800010118000101.pdf.

using the input-output model IMPLAN.[3] For Bear River-supported commodities and services sold within the region and not exported (*non-exports produce regional economic contributions*), such as local hydropower and municipal water use, we tabulated only the direct market effects. Exports have added regional economic importance, as compared to the locally sold goods and services, because exports bring "new" wealth into the region. For this reason, we estimate the indirect and induced effects of exports but not for non-exports. The associated economic contributions of non-exports, such as the number of jobs, output, and income are also presented, but only as direct effects, and added to the export impacts. Additionally, we investigated the non-market values associated with the Bear River and illustrate how economic values may be affected under a range of future Bear River water flows and development scenarios.

The primary categories of economic value stemming from the Bear River system are:

- Agriculture, including ranching and crop production;
- Municipal and industrial water use;
- Hydropower production;
- Outdoor recreation, including water sports, wildlife/bird viewing, fishing, and hunting;
- Cultural values, including aesthetics, historical importance, and heritage values;
- Environmental services, including biodiversity protection, biophysical processes (supporting and regulating ecosystem services), air quality, and water quality.

Before the economic valuation categories are presented, we provide a brief description of the Bear River Basin's economy. After the economic values are examined and totaled, we provide important background on the water quantity and water quality of the Bear River and how both affect and are affected by the economic uses of the Bear River. We end with a discussion of tradeoffs and water prices in the region.

2. REGIONAL ECONOMIC CONTEXT OF THE BEAR RIVER (STUDY AREA)

The Bear River Basin is situated at the intersection of Northeastern Utah, Southeastern Idaho, and Southwestern Wyoming. Spanning an area of approximately 7,500 square miles, the Bear River and its primary tributaries traverse a circuitous route across three states and ten counties in Utah, Wyoming, and Idaho (see Figure 1).[4] The ten counties – Bear Lake, Caribou, Franklin, and Oneida, ID; Summit, Rich, Cache, and Box Elder, UT; and Uinta and Lincoln, WY – are the basis of the study area used for our economic valuations. Although the Bear River doesn't flow through Oneida County, Idaho, the County is included in our study area due to the presence of Bear River tributaries and the use of Bear River water for irrigation purposes within the County. The 2021 total population for all ten counties is 305,108.[5] The five most populous cities in the Basin are Logan, Brigham City, Smithfield, Evanston, and North Logan (all located in Utah, save for Evanston, Wyoming). In general, the Bear River region is a rural and agricultural-dependent region, especially in Idaho, but is within relatively close proximity to more populated areas such as the Wasatch Front and Salt Lake City to the South and Pocatello to the North.

3 IMPLAN is an input-output (I-O) model that allows users to determine the indirect and induced effects of changes in regional final demand. IMPLAN shows impacts in various economic categories such as output, income, employment, and value added. For more information see: https://implan.com/cloud/.

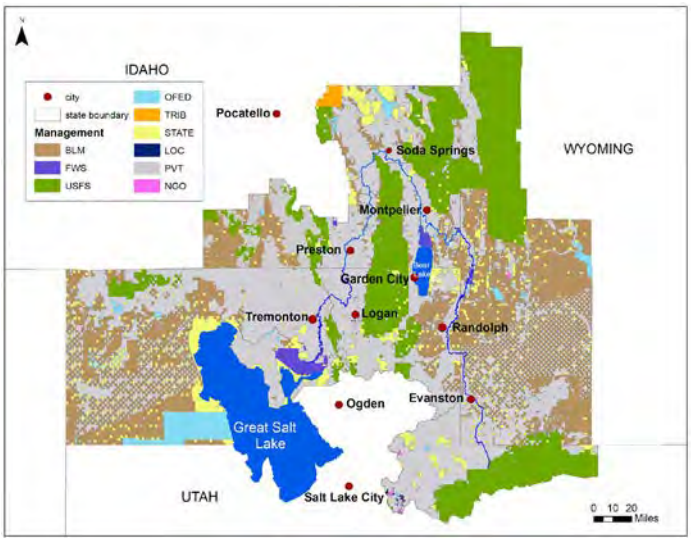
4 An eleventh county, Bannock County, Idaho, receives a very small portion of Bear River basin irrigation but has no census-designated places within the Basin. Given the miniscule effects of the Bear River on Bannock County, we do not include Bannock County in our regional economic zone.

5 US Department of Commerce. 2022. Census Bureau, American Community Service Office, Washington D.C.

Figure 1. Regional economic study area of the Bear River

Cache County, Utah is the area's most populated county and home to more than 40% of the Bear River regional population. Cache County is home to Cache Valley, including the city of Logan, and is known for producing dairy products, hay, and alfalfa. At the other extreme is Summit County, Utah, which contains the headwaters of the Bear River and has a much different economy than most other Bear River counties, as it is home to destination ski resorts (e.g., Park City), has experienced rapid amenity migration and amenity-based development,[6] is one of the wealthiest counties in the nation, and accounts for 35% of total personal income for the Bear River region.[7] Furthermore, in Summit County much of the Bear River is located on public (federal) lands, primarily U.S. Forest Service lands, whereas the rest of the Bear River is located on mostly private lands (see Figure 2).

Figure 2. Ownership and Management Patterns of the Bear River Basin



Aside from agricultural production, other primary economic activities include oil and gas production and refinement in the Wyoming sections, phosphate mining around Soda Springs and the northern arc of the Bear River in Idaho, and university and research extension work in the Cache Valley of Utah. The leading industrial sectors by output value in the Bear River regional economy are real estate ($2.3 billion in output in 2022), cheese manufacturing ($2.1 billion in output in 2022), and motor vehicle parts manufacturing ($1.1 billion in output in 2022), while leading industrial sectors by employment are local and state government/education, limited-service restaurants, and farming.[8]

2.1. THE BEAR RIVER'S JOURNEY

The question of how to divide the Bear River's limited water supply amongst users in Idaho, Utah, and Wyoming has been a source of contention since the 1800s and ultimately led to the 1958 Bear River Compact. The Compact divided the Bear River into its Upper, Central, and Lower Divisions, apportioned flows of the River and its tributaries between the three states, defined each state's storage rights in reservoirs upriver from Bear Lake, and established an "irrigation reserve" level for Bear Lake below which water could not be released

6 Hjerpe, E., Armatas, C. A., & Haefele, M. (2022). Amenity-based development and protected areas in the American West. *Land Use Policy*, *116*, 106064.

7 IMPLAN County Data, 2022. For example, average per capita income for all other counties except Summit County is $27,640, while per capita income for Summit County is $60,760.

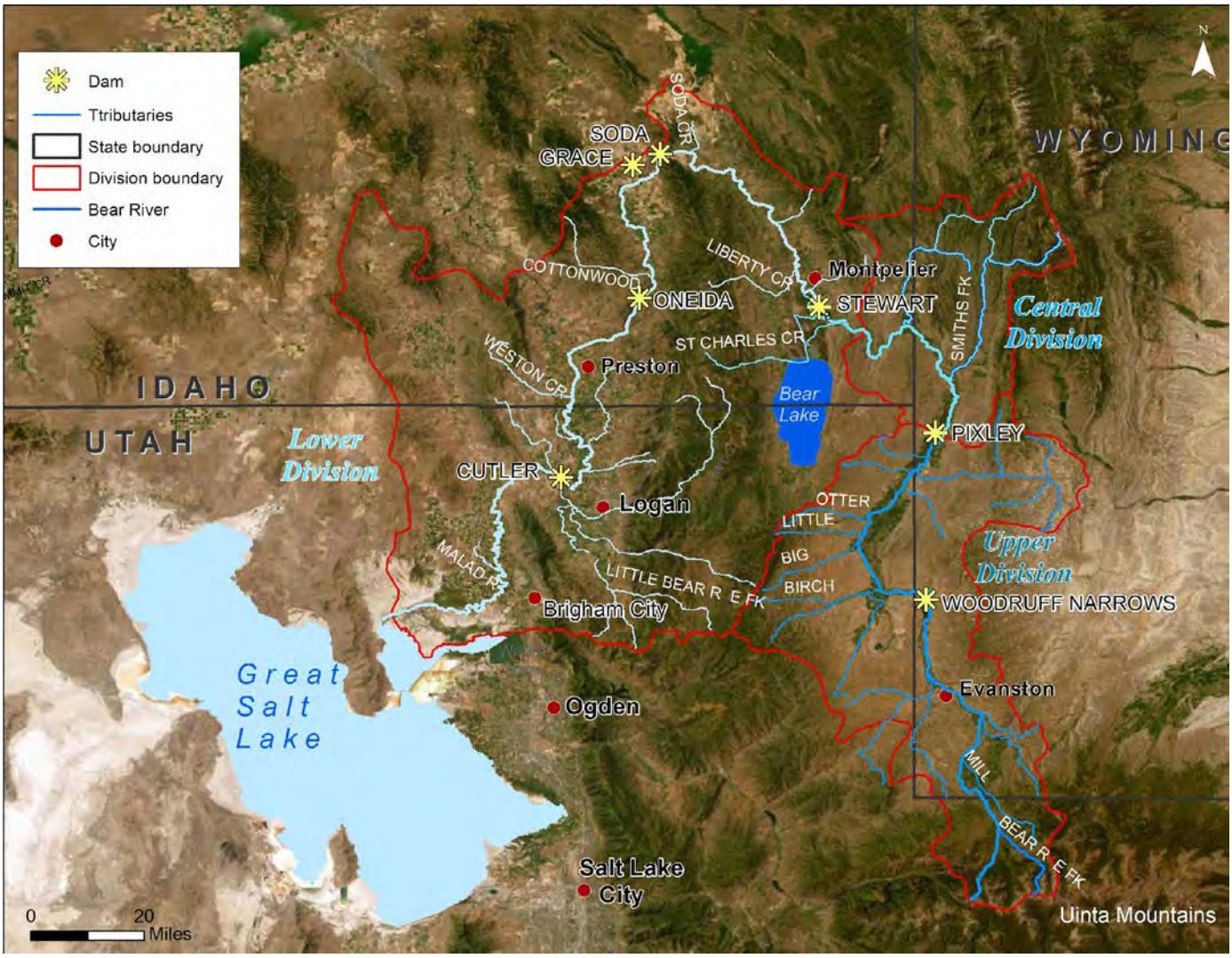
8 IMPLAN County Data, 2022.

solely for power production purposes. The Bear River Compact is periodically reviewed (reviews are conducted at least every 20 years) and necessary revisions made.

The Bear River's headwaters are located high in the Uinta Mountains of Utah. From its headwaters the River flows north into Wyoming where it is first impounded just east of the Utah-Wyoming border at Woodruff Dam where water is stored for irrigation and recreation purposes. (Figure 3 provides a map of the Bear River Basin, including the Bear River, its tributaries, dams, and the locations of major cities.) Further downriver in Wyoming is Pixley Dam – a structure that diverts irrigation water into two canals and which also serves as the dividing point between the River's Upper and Central Divisions. The Bear River continues to meander north and flows through the Cokeville Meadows National Wildlife Refuge before flowing into Idaho. Soon after entering Idaho, the Bear River reaches Stewart Dam – the dividing point between the Central and Lower Divisions of Bear River and the first of five dams owned and operated by PacifiCorp. At Stewart Dam the River's flow is diverted via canal to Bear Lake,[9] where the Compact allows PacifiCorp to store water to be released for irrigation and production of hydroelectric power. Stored Bear Lake water returns via the Outlet Canal to the Bear River approximately seven miles downstream from Stewart Dam. This 7-mile stretch of the Bear River is thus essentially dewatered.

9 Bear River and Bear Lake have been connected since the construction of Stewart Dam and the associated canal system in the 1900s. Prior to construction of the canal system the River and Lake had on occasion been hydrologically connected during especially wet periods, though this had not occurred for 11,000 years.

Figure 3. Bear River, Tributaries, and Dams



After roughly 100 river miles the Bear River encounters PacifiCorp's Soda Dam near Soda Springs, Idaho, where its waters are once again stored for irrigation purposes, with hydroelectric power produced when waters are released through the Dam. Last Chance Canal (located several miles downstream of Soda Dam) is one of the largest diversions of the Bear River; Last Chance Canal diverts 60,000 acre-feet of water (approximately 1/10th of the River's annual flow at that location) for irrigation purposes. A second dewatering of the Bear River occurs downstream from Last Chance Canal at Grace Dam, where nearly all Bear River water is diverted to Grace Power Plant and subsequently returned to the River's original channel a few miles downstream.

The Bear River is again impounded for irrigation and power production purposes at Oneida Dam near Preston, Idaho and finally at Cutler Dam near Logan, Utah. At Cutler Reservoir, three large tributaries – Logan River, Blacksmith Fork, and Little Bear River – nearly double the Bear River's flow. Approximately 45 miles downriver from Cutler Dam the Malad River (which drains the northwestern part of the Bear River Basin) converges with the Bear River. Twenty miles later the Bear River reaches its terminus at the Bear River Migratory Bird Refuge and Willard Bay of the Great Salt Lake.

3. AGRICULTURE

The Bear River Basin encompasses more than 850,000 acres of farmland and is notable for the cultivation of major crops, such as alfalfa hay, winter wheat, barley, and pasture. Half the Basin's croplands are located in Idaho, followed by 42% in Utah and 8% in Wyoming. The Basin boasts a rich agricultural and ranching heritage and an agro-tourism industry that provides opportunities to visit working historic family homesteads and showcases the region's production of apple cider, ice cream, artisan cheeses, and similar products.[10] Without the Bear River, agricultural production would largely not exist in most locations in the Basin. Thus, we begin the agriculture assessment with a focus on Bear River irrigation and build out our agricultural production and economic values from there.

3.1. IRRIGATION FOR AGRICULTURAL USES

Approximately 75% of the Basin's 850,000 acres of farmland are irrigated. Table 1 presents the Basin's irrigated acreage by state and irrigation type. The most prevalent form of irrigation is flood irrigation, which comprises 327,350 acres (52%) of total irrigated acres within the Basin. The second most common form of irrigation is sprinkler irrigation (223,600 acres), followed by sub-irrigated (78,580 acres).

10 Bear River Heritage Area: Explore the Bear River Basin. bearriverheritage.com/explore-the-bear-river-basin/

Table 1: Average Bear River Basin Irrigated Agricultural Land by Irrigation Method, 2018-2022

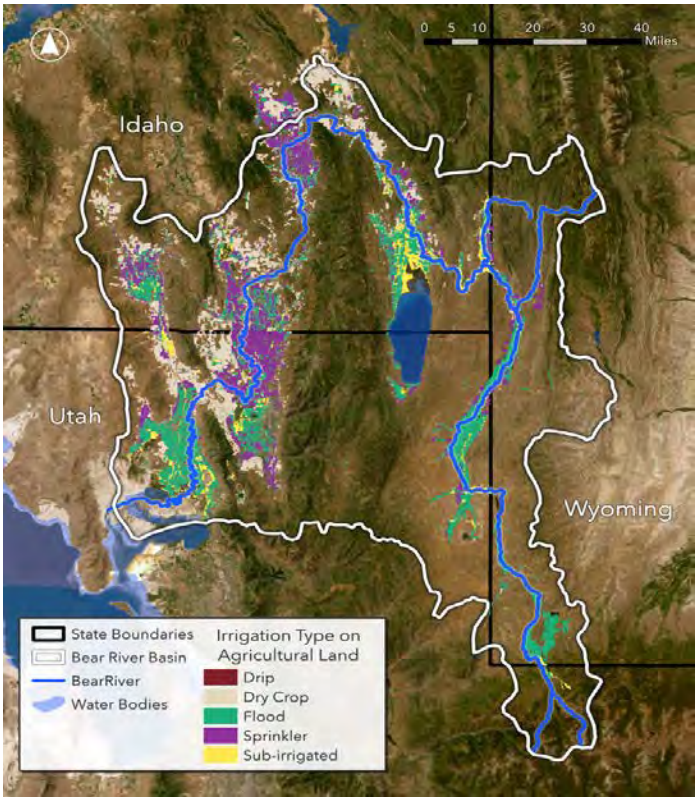
Irrigation Type	Idaho		Utah		Wyoming		
	Acres	Percent	Acres	Percent	Acres	Percent	Total
Flood	119,641	43%	153,039	54%	54,671	79%	327,350
Sprinkler	116,728	42%	94,806	34%	12,067	17%	223,600
Sub-irrigated	41,285	15%	34,739	12%	2,556	4%	78,580
Drip	4	0%	198	0%	-	0%	202
Total	**277,657**	**100%**	**282,782**	**100%**	**69,293**	**100%**	**629,732**

Source: Utah Division of Water Resources. (Retrieved 2023, October 3). ***Water Related Land Use****. gis.utah.gov/data/planning/water-related-land/*

Note: The discrepancy between irrigated acres and identified cropland acres is due to fallowed and non-irrigated cropland.

Most irrigated acres within the Basin are found in Utah and Idaho; Wyoming accounts for only 70,000 acres (11%) of the Basin's irrigated acreage. Wyoming disproportionately relies on flood irrigation; 79% of Wyoming's irrigated acres use flood irrigation, whereas 43% and 54% of Idaho and Utah's irrigated acres use flood irrigation. Figure 4 illustrates the geographic extent of irrigated agricultural land within the Basin by irrigation method.

Figure 4. Irrigation of Agricultural Lands within the Bear River Basin by Irrigation Method



Source: Utah Geospatial Resource Center, Google (2023)

Estimating water usage for agricultural production is challenging due to the variety of crops cultivated and the diverse irrigation techniques employed in the area. The use of flood irrigation typically results in higher water application rates than other types of irrigation.[11] Reliance on relatively less efficient flood irrigation can result in significant amounts of excess applied water on agricultural lands, which is prone to runoff and can lead to subsurface infiltration and replenishment of the region's groundwater and surface water system. Thus, excess water applied in flood irrigation can stay within the local hydrologic system. Additionally, conveyance losses of surface water via infiltration can be substantial. On average the consumptive use of irrigation water (i.e. the portion of withdrawn irrigation water that is removed from availability through evaporation, transpiration, and incorporation into crops) is estimated at 62%, suggesting a significant portion of irrigation water, particularly flood irrigation, stays in the Bear River Basin hydrologic system through recharge of groundwater.[12]

The 'applied water' figures used in our analysis are calculated as a function of county level surface water irrigation withdrawals and irrigated acres. The assumed amount of applied water (or water withdrawals) used to calculate total agricultural water use in the Bear River Basin relies on published estimates from the USGS. The level of applied water varies by irrigation type, but due to data constraints, the estimated applied water values for the Bear River Basin are regional averages. The 'low applied water' scenario assumes an agricultural application rate of 2.07 based on the average applied surface water use for agriculture in Box Elder, Cache, Rich, and Summit Counties, Utah between 2005 and 2015.[13] The 'high applied water' scenario assumes an application rate of 3.68, which corresponds to the average applied surface water use for agriculture in Bear Lake, Caribou, Franklin, and Oneida Counties, Idaho between 2005 and 2015[14]. Similar data were not available for relevant Wyoming counties. The range in potential applied agricultural surface water estimates reflects variations in regional precipitation, weather patterns, and prevailing irrigation methods. We use the range of application rates to estimate that agricul-

11 Dieter, C., Maupin, M. A., Caldwell, R. R., Harris, M. A., Ivahnenko, T. I., Lovelace, J. K., . . . Linsey, K. S. (2018). *Estimated Use of Water in the United States in 2015* (No. 1441). US Geological Survey.

12 *Ibid.*

13 USGS. (Retrieved 2023, December 10). USGS Water Use Data for Utah. https://waterdata.usgs.gov/ut/nwis/wu

14 USGS. (Retrieved 2023, December 10). USGS Water Use Data for Idaho. https://waterdata.usgs.gov/id/nwis/wu

ture water uses between 1.3 and 2.6 million acre-feet of Bear River water annually.[15]

Table 2. Agricultural Water Use in the Bear River Basin by Water Scenario, Acre-Feet per Year (AFY)

		Estimated Agricultural Water Use	
	Basin Acres	Low (2.07 AFY)	High (3.68)
Flood	327,350	677,400	1,204,300
Sprinkler	223,600	467,300	1,012,900
Sub-Irrigated	78,580	164,200	356,000
Drip	200	400	900
Total	**629,730**	**1,309,300**	**2,574,100**

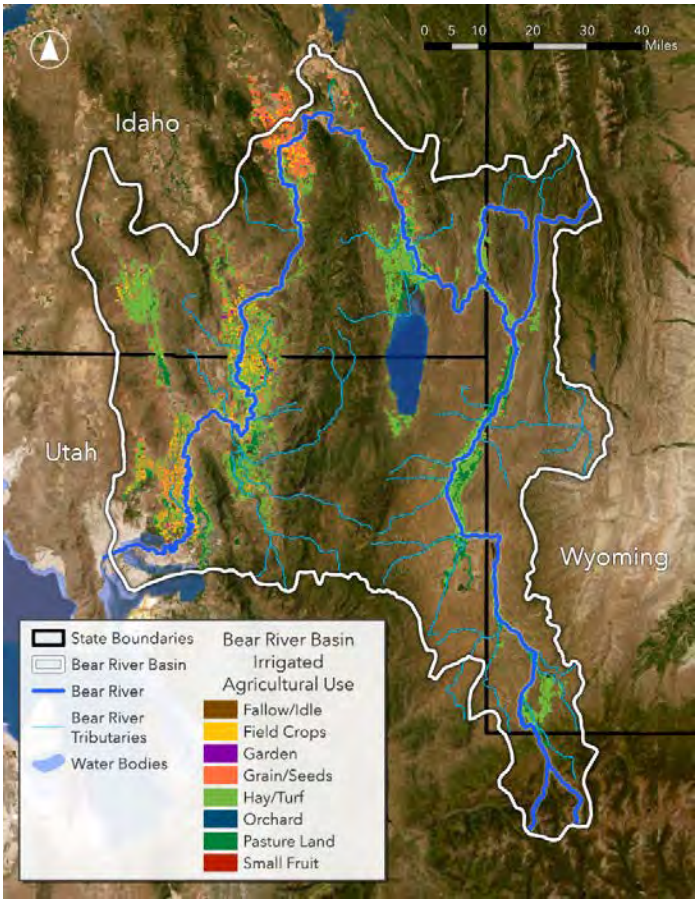
Source: USGS. (Retrieved 2023, December 10). USGS Water Use Data for Utah. https://waterdata.usgs.gov/ut/nwis/wu; USGS. (Retrieved 2023, December 10). USGS Water Use Data for Idaho. https://waterdata.usgs.gov/id/nwis/wu.

3.2. IRRIGATED FARMLAND IN THE BEAR RIVER BASIN

Utah has the most irrigated farmland in the Basin (45% of total Basin irrigated farmland), although Idaho has nearly as many irrigated acres with 44% of the total Basin irrigated farmland acres. Figure 5 illustrates the geographic extent of irrigated acreage in the Bear River Basin.

Credit: Dirk Baker

Figure 5. Irrigated Agricultural Production in the Bear River Basin (2022)



Source: (Utah Division of Water Resources, Retrieved 2023)

As depicted in Figure 5, irrigated agricultural production in the Bear River Basin is primarily focused on feed and grain crops. The five-year average geographic distribution of cropland is presented in Table 3 by crop type and state. Between 2018 and 2022 nearly 95% of Basin irrigated agricultural land was planted in either hay/alfalfa (61%), grain (18%), or pasture (16%). Acreage values for specific crop types are presented in Table **3**. More land is used to grow alfalfa hay than any other crop; alfalfa hay is grown on 35% of the Basin's agricultural land, while grass hay (the second most common crop) is grown on 26% of the Basin's irrigated agricultural land.

15 The low estimated agricultural water use value (presented in Table 2 and calculated using USGS data) is similar to the Bear River Basin agricultural surface water diversions detailed by Utah's Division of Water Resources water budget data available online at https://dwre-utahdnr.opendata.arcgis.com/pages/water-budget-data.

Table 3. Irrigated Agricultural Acreage by Crop Type in the Bear River Basin, 2018-2022 Average

Crop Type	Idaho	Utah	Wyoming	Total	Percent of Total
Alfalfa	114,161	96,854	9,101	220,116	35%
Grass Hay	63,799	64,422	34,428	162,649	26%
Pasture	24,166	51,073	22,734	97,973	16%
Winter Wheat	12,557	25,346	-	37,903	6%
Corn	7,652	24,785	-	32,437	5%
Barley	21,897	5,472	637	28,006	4%
Fallow/Idle	7,967	5,755	1,546	15,268	2%
Spring Wheat	11,407	782	22	12,211	2%
Potato	7,915	342	-	8,257	1%
Oats	2,033	931	826	3,790	1%
All Other Crops	4,103	7,021	-	11,124	2%
Total	**277,657**	**282,783**	**69,294**	**629,734**	**100%**

Source: Utah Division of Water Resources. (Retrieved 2023, October 3). ***Water Related Land Use****.* gis.utah.gov/data/planning/water-related-land/

3.3. IRRIGATED CROPLAND ESTIMATED REVENUES

Crop revenues are a function of irrigated crop yield (crop production per acre, e.g. tons/ac, lbs/ac, etc.) and price per unit of crop production. Together these factors can be used to estimate the per-acre revenue for each major crop grown in the Basin. It is important to note that for pastureland, lease rates are used to estimate per-acre revenues. Revenues per acre and Basin crop acreage are used to estimate the total value of agricultural production in the Basin.

3.3.1. Irrigated Crop Yields

Irrigated crop yield for each major crop type in the Basin is presented in Table 4**.** Published crop yields are available from National Agricultural Statistics Service and Utah State University. Due to data availability, yield figures are derived from the sources deemed to be relevant based on crop type, irrigation, and geography. Yield figures are presented at the State level and estimated; the specific sources used to estimate each crop yield are referenced in Table 4. For pasture (including rangeland), yields are presented in Animal Unit Months (AUMs), the amount of forage a 1,000-pound cow and her unweaned calf will consume over the course of a month. An acre of pasture forage production is expected to yield between 2 and 6 tons annually, supporting between 3 and 10 AUMs depending on pasture productivity.[16] We impose the conservative assumption that Bear River Basin pasture has a carrying capacity of 3 AUMs/acre.

Table 4. Irrigated Crop Yields by Major Crop Type for the Bear River Basin

Crop Type (unit)	Idaho	Utah	Wyoming	Source
Alfalfa Hay (tons/acre)	6.00	6.00	6.00	Box Elder, Utah
Grass Hay (tons/acre)	2.90	2.70	2.80	Idaho and Utah
Pasture (AUM/acre)	3.00	3.00	3.00	Utah

16 Utah State University. (Accessed 2023). *How Much Feed and Forage You Need for Livestock.* extension.usu.edu/smallfarms/research/forage-needs

Crop Type (unit)	Idaho	Utah	Wyoming	Source
Winter Wheat (BU/acre)	120.00	120.00	120.00	Idaho
Corn (BU/acre)	218.00	213.00	179.00	Idaho, Utah, Wyoming
Barley (BU/acre)	87.00	87.00	87.00	Utah
Fallow/Idle				
Spring Wheat (BU/acre)	120.80	120.80	120.80	Idaho
Potato (CWT/acre)	451.00	200.00	325.50	Idaho and Utah
Oats (BU/acre)	76.80	85.50	105.70	Idaho, Utah, Wyoming

Source: Alfalfa information: Utah State University (2006). Costs and Returns per acre from Growing Alfalfa Hay, Box Elder County. https://extension.usu.edu/apec/files/uploads/Agribusiness-and-Food/Budgets/Crops/Box-Elder/Alfalfa2006.pdf.

Barley Information: Utah State University. (2006). Crop Profile for Barley in Utah. https://ipmdata.ipmcenters.org/documents/cropprofiles/UTbarley.pdf .

*Pasture information: Utah State University. (Accessed 2023). **How Much Feed and Forage You Need for Livestock**. https://extension.usu.edu/smallfarms/research/forage-needs*

*Other crop information: National Agricultural Statistics Service. (Accessed 2023). **Quick Stats**. quickstats.nass.usda.gov/.*

Note: AUM = Animal Unit Month. BU = bushels. CWT = hundredweight = 100 pounds.

3.3.2. Crop Prices

We use data published by the NASS and Bureau of Land Management (BLM) to estimate state-level crop and pasture prices received by farmers for each major crop grown in the Bear River Basin (Table 5). Crop prices are estimated as a weighted average by crop acreage in each of the three states over a ten-year period.[17] Pasture prices are estimated using state-specific private rangeland grazing rates published annually by the BLM.[18]

Table 5. Per-Unit Price ($2022) for Major Bear River Basin Crops

Crop Type	Idaho	Utah	Wyoming	Source
Alfalfa Hay ($/ton)	$205.69	$214.81	$194.55	Idaho, Utah, Wyoming
Grass Hay ($/ton)	$204.93	$213.27	$190.46	Idaho, Utah, Wyoming
Pastureland ($/AUM)	$19.00	$18.50	$24.50	Idaho, Utah, Wyoming
Winter Wheat ($/BU)	$6.51	$7.01	$6.15	Idaho, Utah, Wyoming
Corn ($/BU)	$4.94	$4.94	$4.20	Idaho, Utah, Wyoming
Barley ($/BU)	$6.42	$4.46	$6.14	Idaho, Utah, Wyoming
Fallow/Idle	$0.00	$0.00	$0.00	
Spring Wheat ($/BU)	$6.83	$8.83	$7.03	Idaho and Utah
Potatoes ($/CWT)	$9.19	$9.19	$9.19	Idaho
Oats ($/BU)	$3.85	$4.88	$3.92	Idaho, Utah, Wyoming

*Source: Crop information: National Agricultural Statistics Service. (Accessed 2023). **Quick Stats**. quickstats.nass.usda.gov/. Pasture information: Bureau of Land Management. (2022, March 17). **2022 Grazing Fee, Surcharge Rates, and Penalty for Unauthorized Grazing Use Rates**. www.blm.gov/policy/im-2022-02.*

Note: AUM = Animal Unit Month. BU = bushels. CWT = hundredweight = 100 pounds.

3.3.3. Crop Revenues in the Bear River Basin

The price received for each crop (as presented in Table 5) and the irrigated crop yield (as presented in Table 4) are utilized to estimate per-acre annual revenues for each major Bear River Basin crop (Table **6**).

17 Throughout this report the CPI is used to inflate all dollar amounts to 2022 dollars.

18 Bureau of Land Management. (2022, March 17). *2022 Grazing Fee, Surcharge Rates, and Penalty for Unauthorized Grazing Use Rates*. www.blm.gov/policy/im-2022-02.

Table 6. Per-Acre Average Annual Revenue ($2022) for Major Irrigated Bear River Basin Crops

Crop Type	Idaho	Utah	Wyoming
Alfalfa Hay	$1,234	$1,289	$1,167
Grass Hay	$594	$576	$533
Pasture	$57	$56	$74
Winter Wheat	$782	$842	$738
Corn	$1,076	$1,053	$751
Barley	$559	$388	$534
Fallow/Idle	$0	$0	$0
Spring Wheat	$825	$1,067	$850
Potatoes	$4,145	$1,838	$2,991
Oats	$296	$417	$414

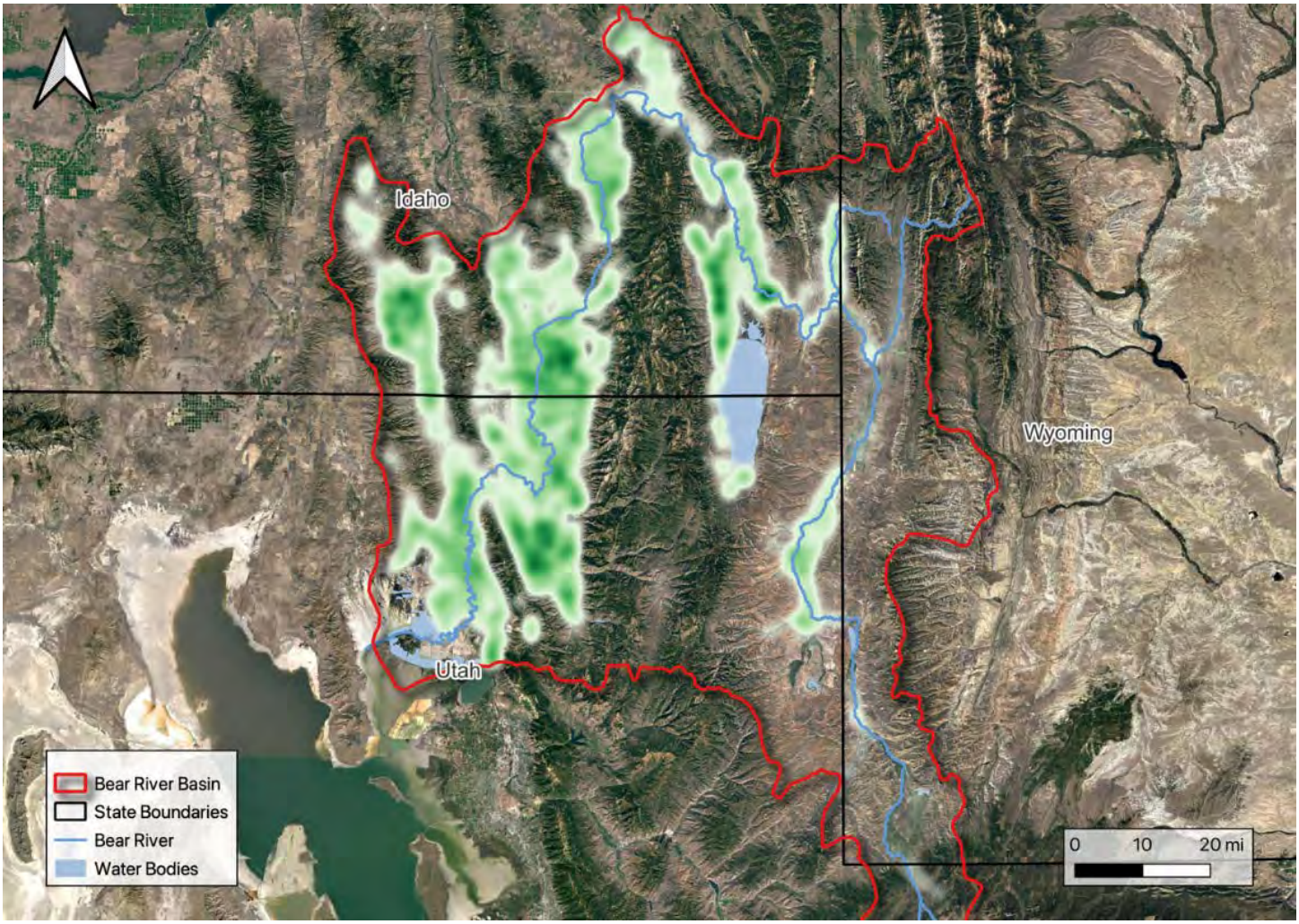
The per-acre average annual revenues in Table **6** are multiplied by average annual crop acreage (Table **3**) to estimate total annual revenues obtained from farming in the Bear River Basin (Table 7). Together Idaho and Utah account for 95% of the Basin's total irrigated cropland production value.

Table 7. Average Total Annual Irrigated Crop Revenues (in thousands of $2022) in the Bear River Basin

Crop Type	Idaho	Utah	Wyoming	Basin Total
Alfalfa Hay	$140,889	$124,829	$10,623	$276,341
Grass Hay	$37,915	$37,096	$18,360	$93,372
Pasture	$1,377	$2,835	$1,671	$5,883
Winter Wheat	$9,815	$21,331	$0	$31,146
Barley	$12,232	$2,123	$340	$14,695
Fallow/Idle	$0	$0	$0	$0
Spring Wheat	$9,413	$834	$19	$10,266
Corn	$8,236	$26,090	$0	$34,325
Potatoes	$32,806	$629	$0	$33,435
Oats	$602	$389	$342	$1,333
All Other Crops	$3,926	$5,283	$0	$9,209
Total Annual Value	**$257,211**	**$221,439**	**$31,356**	**$510,005**

Figure 6. Heatmap of Agricultural Land per-Acre Values in the Bear River Basin

Source: Utah Department of Natural Resources (2023); National Agricultural Statistics Service. (2017). ***2017 Census of Agriculture, County Profile****. www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles; USDA NASS (2023)*



3.4. LIVESTOCK

Credit: Matt Coombs

The Bear River Basin has a large livestock industry. In 2017 the counties that compose the Bear River Basin had over 387,000 head of cattle and calves that generated $243 million in cattle/calf sales and $157 million in milk sales.[19] Utah's Box Elder and Cache Counties contained one-third of the cattle and calves (136,309 head) and accounted for roughly one-third of the cattle/calf revenues ($78 million) and two-thirds of the milk revenues ($111 million). The ten counties that compose the Bear River Basin are also major producers of sheep and lambs; in 2017 the counties had 131,241 sheep and lambs that yielded $24 million in revenues. These and other county-level livestock figures are presented in Table 8.

19 The 2017 Census of Agriculture provides the most up-to-date figures of livestock within the region. National Agricultural Statistics Service. (2017). *2017 Census of Agriculture, County Profile*. www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles

Table 8. County Level Livestock Count and Revenues (thousands of $2022)

	Cattle and Calves			Sheep and Lambs	
	Livestock Count	Animal Revenue	Milk Revenue	Livestock Count	Revenue
Utah					
Box Elder	78,614	$44,573	$36,395	46,914	$7,931
Cache	57,695	$33,837	$74,817	2,685	$548
Rich	39,726	$21,290	$0	7,501	$0
Summit	18,707	$13,613	$0	12,603	$3,026
Idaho					
Bear Lake	28,175	$17,146	$4,571	6,175	$216
Caribou	25,146	$32,080	$4,602	2,186	$313
Franklin	33,532	$11,372	$35,114	664	$138
Oneida	23,388	$14,670	$0	305	$73
Wyoming					
Lincoln	43,358	$33,111	$1,996	20,090	$6,334
Unita	38,737	$21,188	$0	32,118	$5,506
Total	**387,078**	**$242,880**	**$157,495**	**131,241**	**$24,085**

Source: National Agricultural Statistics Service. (2017). 2017 Census of Agriculture, County Profile. www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles

The Basin contains a substantial portion of the total county-wide livestock populations detailed in Table 8, though precise livestock figures are not available for the Basin's geographical area. To estimate the livestock population within the Basin and the corresponding annual revenues from animal and milk sales, we assume a uniform distribution of livestock across the region's agricultural lands. On average it is assumed the Basin encompasses approximately 80% of the livestock within the 10-county region. Cattle and calf sales in the Basin generate an estimated $197 million each year, milk sales generate an additional $137 million, and sales of sheep and lambs generate another $18 million (details are provided in Table 9).

Table 9. Bear River Basin Livestock Count and Revenues (thousands of $2022)

	Cattle and Calves			Sheep and Lambs	
	Livestock Count	Animal Revenue	Milk Revenue	Livestock Count	Revenue
Utah					
Box Elder	58,725	$33,296	$27,187	35,045	$5,925
Cache	49,098	$28,795	$63,669	2,285	$466
Rich	35,356	$18,948	$0	6,676	$0
Summit	5,201	$3,784	$0	3,504	$841
Idaho					
Bear Lake	24,850	$15,123	$4,032	5,446	$191
Caribou	23,134	$29,513	$4,234	2,011	$288
Franklin	28,737	$11,632	$35,918	569	$119

	Cattle and Calves			Sheep and Lambs	
	Livestock Count	Animal Revenue	Milk Revenue	Livestock Count	Revenue
Oneida	19,318	$12,118	$0	252	$60
Wyoming					
Lincoln	33,646	$25,694	$1,549	15,590	$4,915
Unita	33,043	$18,074	$0	27,397	$4,697
Total	**311,108**	**$196,977**	**$136,589**	**98,775**	**$17,502**

3.5. AGRICULTURE EXPORTS

The regional economic impact analysis requires information regarding the value of crops and livestock exported out of the region. Due to the rural nature of the region and relatively small population base, we assume the majority of crops and livestock products are exported out of the immediate region. Table 10 summarizes assumptions made regarding the percent of each crop type and livestock product exported outside the region and the associated revenues. Agricultural products exported from the Bear River Basin generate more than $595 million in revenues annually. The non-exported, or locally sold, agricultural products generated an additional $266 million in annual revenues. **Appendix A** illustrates our assumptions and estimates for export markets supported by Bear River irrigation.

Table 10: Revenues from Bear River Basin Agricultural Exports (thousands of $2022)

Crop Type	Revenues from Goods Sold Outside of the Ten-County Region
Alfalfa & Other Hay	$184,857
Corn	$27,460
All Other Crops	$100,084
Livestock	$214,479
Milk	$68,295
Total	**$595,175**

The Bear River Basin agricultural sector is a sizeable water user; between 1.3 and 2.6 million acre-feet of Bear River water are annually diverted for agriculture.

Sales of agricultural products generate over $860 million in annual revenues. Much of the agricultural production is exported outside the counties containing the Bear River.

4. MUNICIPAL AND INDUSTRIAL WATER

4.1. MUNICIPAL WATER SOURCES AND USES

For each Bear River Basin incorporated community with a population greater than 1,000 people, Table 11 lists the community's municipal water source. While larger municipalities typically have water plans that detail their water sources and uses, smaller municipalities generally do not maintain such documentation. The absence of a water plan presents a challenge in determining whether a particular municipality relies on groundwater or surface water.

The municipal water supply for Basin communities includes a combination of groundwater and surface water sources. Springs provide water at the

surface but are technically considered groundwater sources because they intersect with groundwater at or below the local water table.[20] The intersection of surface water and groundwater hydrology, especially where it relates to springs, makes it difficult to completely separate the two sources to estimate the municipal water use of the Bear River. We assume springs are groundwater sources with no connection to surface waters unless a municipal water plan explicitly establishes a direct connection between the spring and a surface water source. This assumption helps streamline the categorization of water sources and uses. As depicted in Table 11, the majority of communities in the Basin rely on groundwater sources.

Table 11. Bear River Basin Communities, Population and Municipal Water Source

Community	Population	Municipal Water Source	Water Plan Source
Logan, UT	52,420	Wells, Springs	Logan City, 2020
Brigham City, UT	19,373	Wells, Springs, Surface	Brigham City Corporation, 2019, Utah Department of Natural Resources, 2020
Smithfield, UT	13,263	Wells, Springs	Smithfield City, 2013
Evanston, WY	11,802	Surface Water	The State of Wyoming Water Development Office, 2012
North Logan, UT	10,705	Wells, Springs, Surface	Cache-Landmark Engineering, 2019
Tremonton, UT	9,727	Wells, Springs	Hansen, Allen, & Luce, 2017
Hyrum, UT	9,330	Wells, Springs	Hyrum City, 2022
Providence, UT	8,199	Wells, Springs	Providence, 2022
Nibley, UT	7,160	Wells	Jones and DeMille Engineering, 2019
Preston, ID	5,545		NA
Perry, UT	5,444	Wells, Springs	Bear River Water Conservancy District, 2017
Hyde Park, UT	5,116	Wells, Springs	Sunrise Engineering, Inc., 2023
Wellsville, UT	4,036		NA
Soda Springs, ID	3,084	Wells, Springs	City of Soda Springs, 2020
Richmond, UT	2,881	Wells, Springs	Richmond City, 2020
Montpelier, ID	2,610	Wells	Montpelier Planning and Zoning Commission, 2002
Garland, UT	2,559	Springs	Bear River Water Conservancy District, 2017
River Heights, UT	2,156	Wells	River Heights City, 20203
Malad City, ID	2,112	Wells, Springs, Surface*	Utah Dept. of Natural Resources, 2020.
Lewiston, UT	2,043	Wells, Springs (Surface)	JUB Engineers, 2021
Millville, UT	1,844	Wells, Springs	Millville City, 2016
Willard, UT	1,813	Wells, Springs	Bear River Water Conservancy District, 2017
Honeyville, UT	1,665	Wells, Springs	Bear River Water Conservancy District, 2017
Elwood, UT	1,496	Wells, Springs, Surface	Elwood Town, 2022, Utah Department of Natural Resources, 2020
Grace, ID	1,356	NA	
Mendon, UT	1,317	Wells, Springs, Surface	Utah Department of Natural Resources, 2020
Mantua, UT	1,075	Wells, Springs	Bear River Water Conservancy District, 2017

20 USGS. (2019, June 8). *Springs and the Water Cycle*. www.usgs.gov/special-topics/water-science-school/science/springs-and-water-cycle

Community	Population	Municipal Water Source	Water Plan Source
Other Incorporated	14,279		
Unincorporated	6,194		
Total	**210,604**		

Source: US Census Bureau. (2021). ACS 5-year Estimates: S0101. For Community Water Plan Sources see **Appendix B**.

NA indicates the lack of a water plan or the absence of relevant water source information within an existing water plan.

**Surface water is not withdrawn from the Bear River*

The American Geosciences Institute suggests that most homes and businesses in rural or remote areas procure water from groundwater sources, as opposed to larger urban or suburban areas that typically pipe in their water from a central water supply like a river, natural lake, or reservoir.[21] For the purposes of this analysis, we assume municipalities without water plans—most of which have populations below 1,000—rely on groundwater. Of the municipalities that do maintain water plans, the majority rely on wells and springs (i.e., groundwater) for their water supply.

We have identified three municipalities that specify surface water withdrawal in their water management plans: North Logan, Utah; Lewiston, Utah; and Evanston, Wyoming. We have also included available data for the municipalities of Brigham City, Elwood, and Mendon as per the Utah Municipal and Industrial Use Data report. Although surface water listings do not guarantee a direct connection to the Bear River, we assume one exists based on the location of the municipalities within the Basin and the absence of other water bodies in the area. A more detailed discussion of these communities' water use is located in **Appendix B.**

4.2. INDUSTRIAL WATER SOURCES AND USES

The most recent update to the Bear River Basin Water Plan suggests there were only two self-supplied industrial users in 2001 – Chevron and BP Amoco. (All other industrial water users within the Basin obtain their water from municipalities.) Chevron's Whitney Canyon/Carter Creek plant utilizes surface water from Woodruff Narrows Reservoir, while BP Amoco relied on groundwater from bedrock aquifer wells. The 2001 Plan reported annual water usage of 310 acre-feet of surface water and 90 acre-feet of groundwater. However, with changing production and processing methods, water consumption decreased. Chevron greatly improved water efficiency in 2002, reducing water usage to between 22 and 37 acre-feet per year (a reduction of 88 to 93%). BP Amoco closed their Whitney Canyon/Carter Creek facility in 2007, further reducing water use. BP Amoco now uses approximately 2.6 acre-feet of groundwater annually, and Chevron processes both their gas production and the BP Amoco production. **Presently, the Basin's industrial production consumes about 22 to 37 acre-feet of surface water and about 5 acre-feet of groundwater annually**.[22]

4.3. SUMMARY OF MUNICIPAL AND INDUSTRIAL WATER USE

We use existing literature on water consumption patterns in the previously identified municipalities to extrapolate municipal water use to both a conservative (low) and nonconservative (high) estimate of total water usage, encompassing both residential and non-residential (industrial, commercial, and institutional) municipal consumption (Table 12). Residential water use is presented in the North Logan water plan as 150 Gallons per Capita per Day (GPCD) and in the Lewiston water plan as 216 GPCD.[23] These

21 American Geosciences Institute. (2023). *How is Water Distributed?* www.americangeosciences.org/education/k5geosource/content/water/how-is-water-distributed

22 *Ibid.*

23 Cache-Landmark Engineering. (2019). Conserve Water Utah. conservewater.utah.gov/wp-content/uploads/SubmittedWaterPlans/North-Logan-City-2018.pdf; JUB Engineers. (2021). Conserve Water Utah. conservewater.utah.gov/wp-content/uploads/SubmittedWaterPlans/Lewiston-City-2021.pdf

estimates are consistent with state-wide estimates of residential water use in Wyoming (156 GPCD), Utah (169 GPCD), and Idaho (184 GPCD).[24] Utilizing the ratio of residential to non-residential municipal water consumption available in the North Logan and Lewiston Water Plans, the total municipal water consumption is extrapolated across the Bear River Basin (see Table 12). The figures presented in Table 12 represent total consumption and are not disaggregated based on water source.

The majority of municipal water use in the Basin relies on groundwater sources, and municipal surface water use in the region is expected to be minor. To date, groundwater availability has been reliable, but the impact of reduced snowpack due to changing climate is unknown. The connectivity between groundwater and the Bear River is an important factor in area water management, but is not fully understood. If there is substantial groundwater recharge by Bear River flows and supplemental use of groundwater in times of low Bear River flows, conjunctive (connected) management is important to consider when discussing water use in the Basin. This is likely an important area for future research at the Basin scale.

24 Dieter, C., Maupin, M. A., Caldwell, R. R., Harris, M. A., Ivahnenko, T. I., Lovelace, J. K., . . . Linsey, K. S. (2018). Estimated Use of Water in the United States in 2015 (No. 1441). US Geological Survey.

Table 12: Estimated Municipal and Industrial Water use in the Bear River Basin

	Gallons per Capita per Day (GPCD)	
	Low	High
Basin Population	210,604	210,604
Residential Water Use (GPCD)	150	220
Total Estimated Residential Water Use (Gallons per Day)	31,590,600	46,332,880
Non-Residential Water Use (GPCD)	60	340
Total Estimated Non-Residential Water Use (Gallons per Day)	12,636,240	71,605,360
Total Estimated Municipal Water Use (Gallons per Day)	**44,227,000**	**117,938,000**
Total Estimated Annual Water Use (Acre-Feet per Year)	**49,534**	**132,091**

The estimated municipal water use figures for the Bear River Basin presented in Table 12 are only 4 to 5% of the Basin's estimated agricultural water use of 1.3 – 2.6 million acre-feet per year. Therefore, conservation of municipal water use will have little effect on the overall use of Bear River water. Notably, while municipal water consumption predominantly relies on groundwater sources, agricultural water usage is considerably more dependent on surface water withdrawals from the Bear River.

To determine the market value of municipal and industrial water use in the region, we take the average of annual water use for the Low and High estimates (90,800 acre-feet per year) and apply a market price of $700 per acre foot.[25] Thus, we estimate total sales of $63.6 million for municipal water throughout the Basin, inclusive of ground and surface water in the Basin. Total sales were then entered in IMPLAN to determine economic contributions of associated regional employment and output, similar to other non-export goods and services.

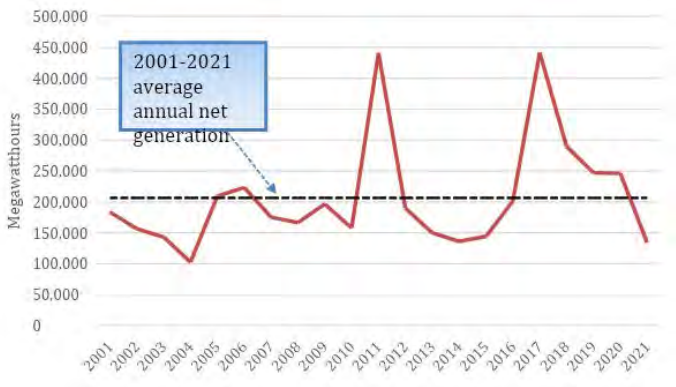
25 Municipal water prices in the Bear River Basin have a wide range of prices and fluctuations. We incorporate the average of $500-$900/acre-foot for the Cache Valley. Personal communication with Nathan Daugs, Cache Irrigation District.

Estimated total annual municipal and industrial water consumption is 50 to 132 thousand acre-feet per year, depending upon water conservation practices, generating approximately $63.6 million in annual revenue.

5. HYDROPOWER

As the number of settlers in the area increased during the late 1800s and early 1900s, so did demands on the Bear River and its tributaries. In addition to using water for irrigation purposes, settlers also used water as a source of hydropower – first through the construction of gristmills and later through the construction of hydropower plants.[26] Ownership of Bear River hydroelectric property and accompanying water rights has changed hands numerous times in the ensuing decades. Since 1987, PacifiCorp has controlled and managed the Bear River's flow in the Bear River's Lower Division between Stewart Dam and the Great Salt Lake. Hydroelectric power is produced when the Bear River's natural flow and waters held in Bear Lake pass through five hydroelectric plants – Soda, Grace, Oneida, Cutler, and Last Chance Dams – all constructed in the early 1900s and located downstream from Bear Lake.[27] The five plants have a combined generating capacity of 108.7 megawatts and account for 94% of all hydropower production within the Bear River Basin.[28] Between 2001 and 2021 the Bear River facilities' total average annual net generation was 206,447 megawatt hours, though variation in annual precipitation causes notable variation in the facilities' annual net generation (Figure 7).[29]

Figure 7. Annual Bear River Hydropower Net Generation, 2001-2020



Source: U.S. Energy Information Administration Electricity Data Browser.

PacifiCorp is a full-service provider (meaning PacifiCorp generates, transmits, and delivers electricity to its customers) comprised of two business units – Rocky Mountain Power (which services customers in UT, WY, and ID) and Pacific Power (which services customers in OR, CA, and WA). PacifiCorp generates electricity at assorted hydroelectric, natural gas, coal, solar, wind, and geothermal facilities located in eight states. The electricity generated at these facilities is used to meet the demands of PacifiCorp customers, and when necessary, electricity is purchased and sold on wholesale markets to balance net generation with demand.

Credit: Evan Hjerpe

Our IMPLAN model requires input pertaining to how much of the energy produced on the Bear River is consumed within our study area and how much is exported outside the study area. Using information contained in the 2022 Form 10-K filed by Berkshire Hathaway Energy Company[30] we es-

26 Palacios, P., Luecke, C., & Robinson, J. (2007). Bear Lake basin: history, geology, biology, people. *Natural Resources and Environmental Issues*, *14*(1), 1.

27 Jibson, Wallace N. (1991). *History of the Bear River Compact*. Bear River Commission.

28 Although other companies own and operate numerous additional small hydroelectric facilities within the Bear River Basin (including hydroelectric developments on the Malad River, Logan River, Blacksmith Fork, Mink Creek, and others), our research is focused on hydropower produced on the mainstem of the Bear River.

29 Net power generation is total power generated by a power plant less the amount of power required to operate the plant.

30 PacifiCorp is a subsidiary of Berkshire Hathaway Energy Company. The 2022 10-K form for Berkshire Hathaway Energy Company is available here: www.sec.gov/Archives/edgar/data/75594/000108131623000005/bhe-20221231.htm.

timate that 90% of PacifiCorp's net energy generation is sold to PacifiCorp customers, while the remaining 10% of net generation is exported. The information used in deriving these estimates is available only for PacifiCorp as a whole and is not available on a smaller geographic scale. We therefore impose the assumption that these values apply to the hydroelectric power produced by the Bear River hydroelectric facilities. For the Bear River system this translates to an assumption that 90% of the Bear River system's annual net generation (185,820 MWhs) is sold to Rocky Mountain Power customers in Idaho, Utah, and Wyoming, and the remaining 10% (20,645 MWhs) is exported out of the region.

To assess the value of the Bear River system's net generation used by Rocky Mountain Power customers we use the 2022 weighted average electricity price (for all sectors) for Idaho, Utah, and Wyoming, or 8.69 cents per kilowatt hour. To assess the value of the Bear River system's net generation exported out of the study area, we use data from four western electricity hubs to calculate the hubs' 2022 average electricity price: 10.16 cents per kilowatt hour.[31] Based on local and exported prices, we estimate that Bear River hydropower generates a total of $18.2 million in annual revenues, with $16.1 million of these revenues coming from locally sold hydropower. Additional details regarding prices and volumes used in our analysis and how they were calculated can be found in **Appendix D**.

Bear River hydropower generates an estimated $18.2 million in annual revenues.

6. RECREATION

While much of the Bear River is prioritized for agriculture and ranching, there are a number of outdoor recreation opportunities and activities in and around the River, including boating, fishing, hunting, hiking, birding, biking, soaking, and camping. Figure 8 shows the locations of major recreation areas along the Bear River. These same major recreation areas are listed in **Table 13**, along with annual visitation estimates and the primary recreation activities at each site.

31 Average annual electricity retail prices were obtained from the US Energy Information Administration: www.eia.gov/electricity/data/browser/. Wholesale electricity prices were also obtained from the US Energy Information Administration: www.eia.gov/electricity/wholesale/#history.

Credit: The Preston Citizen

Figure 8. Major Bear River Recreation Sites

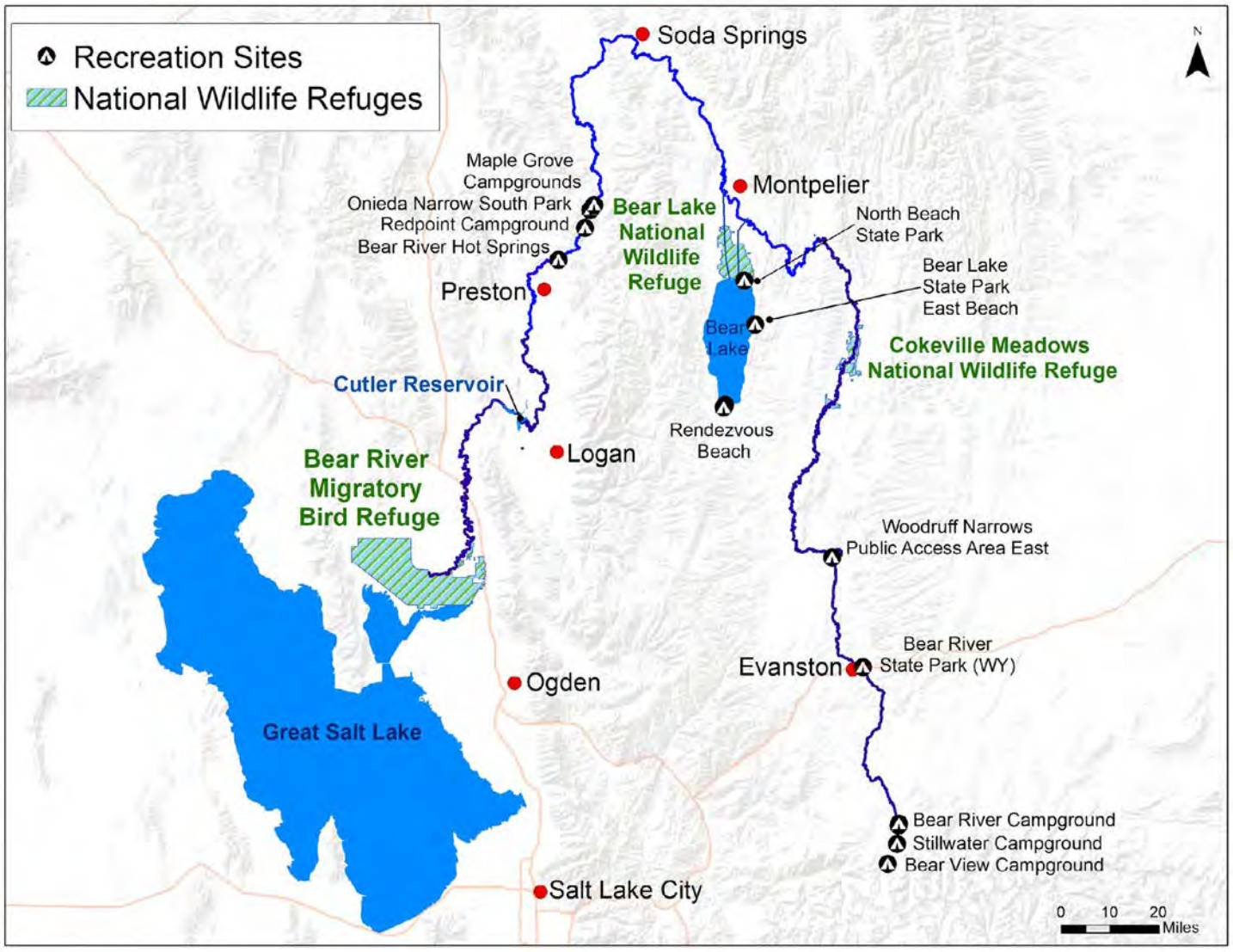


Table 13. Primary Bear River Recreation Sites

Site	State	Estimated Annual Visits	Primary Activities	Estimated Annual Regional Expenditures ($2022)
Bear River Headwaters (Uinta-Cache-Wasatch NF)	Utah	230,000	hiking, camping, fishing, snowmobiling	$7,181,071
Bear River State Park	Wyoming	130,590	biking, hiking, picnicking	Non-primary, local use
Woodruff Narrows Reservoir	Wyoming	5,640	fishing, boating, hunting	Local use
Cokeville Meadows National Wildlife Refuge (USFWS)	Wyoming	3,170	birding, fishing, hunting	$81,610
Bear Lake National Wildlife Refuge (USFWS)	Idaho	12,000	birding, auto touring	$308,934
Bear Lake	Idaho	1,115,000	beach lounging, boating, jet skiing	$54,521,654

Site	State	Estimated Annual Visits	Primary Activities	Estimated Annual Regional Expenditures ($2022)
Soda Dam/Alexander Reservoir (PacifiCorp)	Idaho	48,790*	boating, fishing, picnicking	Local use
Grace Dam/Black Canyon Gorge (PacifiCorp)	Idaho	21,495*	fishing, kayaking, picnicking	Local use
Oneida Narrows Reservoir and Canyon (PacifiCorp/BLM)	Idaho	79,130*	tubing, camping, fishing	$2,037,173
Cutler Reservoir (PacifiCorp)	Utah	255,345*	bird hunting, boating, fishing	$6,573,683
Bear River Migratory Bird Refuge (USFWS)	Utah	120,000	birding, photography, hunting, fishing	$3,089,340
Total		**2,021,160**		**$73,793,465**

*Notes: Visitation estimates come from the most recent year available, generally 2020--2022. *PacifiCorp visitation estimates are from 2014 and have had a 20% increase applied to account for general increase in outdoor recreation visitation as found in Aldrich and Hjerpe 2022[32] for similar years nationally.*

32 Aldrich, G and E, Hjerpe. 2022. The Conservation Funding Crisis. Conservation Economics Institute. 27p. https://www.conservationecon.org/_files/ugd/5fc209_964863909ec745818cdb5a8643623366.pdf.

Outdoor recreation and nature tourism activities lead to economic impacts in the communities next to the Bear River when visitors (and local recreation participants) spend money on gear, lodging, restaurants, fuel, and groceries. When out-of-town visitors engage in outdoor recreation and nature tourism along the Bear River this is considered an export industry (similar to exported agriculture products); "new" outside money is brought into the region and expended on the consumption of a natural service produced in-region (Bear River recreation), thereby generating income and employment in the tourism sector. The remainder of this section focuses on quantifying the expenditures made by recreationists and nature tourists in the Bear River Basin.[33]

Using multiple sources and methodologies, we estimate annual visitation and visitor expenditures for each major recreation area.[34] Estimated visitor expenditures were then entered into IMPLAN impact analysis software to illustrate economic impacts and total contributions. When measuring the regional economic impact of outdoor recreationists and nature tourists, a number of "attribution" issues must be considered, such as accounting for locals versus non-locals and whether or not the visit to the site was the primary purpose of the trip or incidental to another site.[35] For example, non-locals spend more money at the recreational site as they have more lodging, fuel, and grocery needs than locals. Non-locals also can have trip expenditures made prior to the trip, but these out-of-region expenditures have little economic impact near the recreation site. Most impact analyses of recreation consider visitor spending within 50 miles of the recreation site to affect the local economy.[36] Expenditures from 'out-of-region' visitors, or new monetary stimulus coming from outside areas only, that were not incidental to the trip, generate regional economic *impacts*---when including spending from locals and from non-primary trips,

33 Outdoor recreation also provides non-market values above and beyond recreationists' expenditures. These non-market values are discussed in the Environmental Services section.

34 Visitation estimates were collected from site managers. When on-site visitation estimates were not available, we used Placer.ai cell phone-based visitation estimates. Placer.ai is an artificial intelligence platform that uses observed mobile location data to estimate foot-traffic and visitor behavior to various points of interest (e.g., a business establishment, a campground, or any geofenced area you specify). Their visit estimates are extrapolated, using a proprietary algorithm, from a panel dataset of over 25 million U.S.-based cellular devices.

35 For a comprehensive discussion on "attribution" issues and outdoor recreation visitor expenditures, see White, E. M. (2017). *Spending patterns of outdoor recreation visitors to national forests*. PNW-GTR-961. United States Department of Agriculture, Forest Service, Pacific Northwest Research Station.

36 White, E. M. (2017). *Spending patterns of outdoor recreation visitors to national forests*. PNW-GTR-961. United States Department of Agriculture, Forest Service, Pacific Northwest Research Station.

regional economic *contributions* are generated.[37]

In addition to visitation estimates, **Table 13** also includes for each major recreation area an estimate of recreation expenditures to be used in deriving regional economic impacts. The process for each site starts with estimating overall visits in a per-person per-day format. Then, the portion of local versus non-local visits is determined using survey data or determining distance driven to account for in-county residents and out-of-region residents, or local and non-local visitors. Next, attribution of visitor expenditures is considered based on assumptions regarding whether visits to the recreation site are considered the primary destination or incidental visitation as part of another destination site not related to the Bear River.

When total primary and non-local visits are identified, the next step is to apply appropriate expenditure profiles to these site visits. We have identified a mix of expenditure profiles most relevant to Bear River visitation, including the US Department of Interior National Wildlife Refuge expenditure profiles,[38] US Forest Service's National Visitor and Use Monitoring expenditure profiles,[39] and Bear Lake expenditure profiles from recent research.[40] Methods and details for all individual Bear River recreation sites are presented in **Appendix E**.

Total annual recreation visitor expenditures of $73.8 million (Table 13) were considered as Bear River recreation-related exports and were included in our IMPLAN impact analysis. These out-of-region visitors were estimated to account for 80% of the total visits to Bear River recreation sites. The remaining 404,200 visits made by local residents (and some incidental visitors) represent the non-export recreation sector of the Bear River regional economy, which we were unable to properly estimate. While local recreationists have some expenditures attributable to the Bear River recreation site being visited, their expenditures are dramatically less than out-of-region visitors as they typically will have minimal purchases for a local visit.

Each year over 2 million visits are made to established recreation sites along the Bear River.

Expenditures on food, lodging, gear, etc. by non-local recreationists total an estimated $73.8 million a year.

7. CULTURAL AND HERITAGE VALUES

The Bear River Watershed has a rich history that shapes how it is used and enjoyed today by both residents and visitors. The Watershed was historically used by the Shoshone, Ute, Sioux, and Blackfoot Indian tribes, but in the 1820s Euro-American fur trappers and traders began exploring the area. The 1840s brought government-sponsored expeditions intent on identifying emigration routes and corridors for a railroad to connect eastern states with California. When the Oregon and Mormon Trails brought thousands of settlers to the area, relations between the settlers and the tribes were at first friendly, but harsh winters and scarce food resulted in rising tensions. The Native American way of life was threatened by the influx of settlers, the establishment of settlements, and the clearing of land for agriculture. Settlers and Native tribes were both intent on protecting their way of life, leading to frequent raids and attacks.

In 1863, the U.S. Army was sent to aid the settlers and attacked the Shoshone winter encampment near present-day Preston, Idaho. Hundreds of Shoshone were killed in what is now known as the Bear River Massacre – one of the deadliest Indian defeats in history and a turning point in the region's histo-

37 Caudill, J., & Carver, E. (2019). *Banking on nature 2017: The economic contributions of national wildlife refuge recreational visitation to local communities*. US Fish and Wildlife Service, Falls Church, Virginia; White, E. M. (2017). *Spending patterns of outdoor recreation visitors to national forests*. PNW-GTR-961. United States Department of Agriculture, Forest Service, Pacific Northwest Research Station.

38 *Ibid*.

39 For more information see: www.fs.usda.gov/about-agency/nvum.

40 Conservation Economics Institute (CEI), 2022. Regional economic contributions of Bear Lake. https://www.conservationecon.org/_files/ugd/5fc209_bb7487a9203d4c12bebaf-ca89d95b0cd.pdf.

ry. Ultimately the Shoshone lost their native lands, but in 2018 the Shoshone purchased the sacred land where the Massacre occurred. The Tribe is rehabilitating the land through the removal of invasive Russian Olive trees (which use up to 75 gallons of water per day, with implications for Bear River streamflow and temperature) and the planting of native species. The Tribe hopes to restore Bonneville Cutthroat trout to this stretch of the Bear River and plans to build an interpretive center to honor their relatives killed in the Massacre.

The first transcontinental railroad (completed in 1869) provided access to markets for agricultural products grown in the region, thus fueling the continued growth and development of agriculture as a core component of the region's economy and culture. Despite challenges brought by two World Wars, the Great Depression, and sustained drought, the agricultural sector has endured in the Bear River Basin and continues to be an important component not only of the region's economy but also of the Mormon settlement culture that pervades the region as evidenced by the multitude of agricultural attractions detailed on the Bear River Heritage Area website.[41] In 2000 the Bear River Heritage Area (BRHA) was formed to support and protect the region's heritage and foster economic development through heritage tourism. Many heritage sites, attractions, and businesses with historic ties to the area have been endorsed by the BRHA. Examples include the Bear River Massacre Site, Oneida Pioneer Museum, Holmgren Historical Farm, Niter Ice Cave, Riverside Trail, and the Welsh Heritage Festival. These and other cultural sites and events attract tourists to the area and have a significant impact on the region's economy.

To gain understanding of visitor demographics, characteristics, expenditures, and the economic impact of heritage tourism on the local economy, during the summer and fall of 2012 researchers from Utah State University conducted surveys of BRHA visitors.[42] Though many of the surveyed visitors were from either Utah or Idaho, nearly three-quarters were from outside the seven-county BRHA area and many were from other states or abroad. Burr and Jakus (2014) estimate the BRHA attracted more than 1.1 million visitors to the region in 2012, and that visitors' expenditures supported between 500 and 900 part- and full-time jobs and generated $39-$72 million in economic output, $11.5-$21 million in labor income, and $22.8-$41.6 million in value added.[43] Regional economic impacts stemming from cultural and heritage tourism are clearly significant, and the study's findings suggest opportunities exist to increase visitation and thereby economic impacts.

For our overall regional economic impact analysis, we include heritage-based tourism economic impacts that are not already captured in our recreation economic impacts. The BRHA visitor expenditures are for visitation to numerous BRHA sites, one of which we have already included in the previous recreation section—Bear Lake. Thus, the economic impacts modeled by Burr and Jakus (2014)[44] for the BRHA, minus the Bear Lake visitor expenditures, can be updated and transferred. Subtracting the 375,000 visits to Bear Lake in 2012[45] from the 1.1 million BRHA visitors in 2012 results in 725,000 visits. Updating visits to 2022 (see recreation section for PacifiCorp visitation estimates) would conservatively add 20% for a total of 870,000 annual visits to BRHA sites.

Results from the survey showed that about 75% of BRHA visitors were from outside the 7-county study region used by Jakus (2014) and that approximately 50% of visitors indicated the survey intercept BHRA site was their primary destination.[46]

41 Agriculture in the Bear River Heritage Area available at: https://bearriverheritage.com/.

42 Baird, Tyler A. and Burr, Steven W. 2013. Bear River Heritage Area visitor survey – General results. Utah State University Cooperative Extension. No. IORT/032.

43 Burr, Steven W. and Jakus, Paul M. 2014. The economic impact of Bear River Heritage Area tourism. Utah State University Cooperative Extension. No. IORT/035.

44 *Ibid.*

45 See Figure 2 in Conservation Economics Institute (CEI), 2022. Regional economic contributions of Bear Lake. Available at: https://www.conservationecon.org/_files/ugd/5fc209_bb7487a9203d4c12bebafca89d95b0cd.pdf.

46 Baird, Tyler A. and Burr, Steven W. 2013. Bear River Heritage Area visitor survey – General results. Utah State University Cooperative Extension. No. IORT/032.

Applying these percentages to the 870,000 annual BRHA visits yields 326,250 annual out-of-region and primary destination visits for all BRHA sites excluding Bear Lake. Burr and Jakus (2014)[47] found mean per-person BHRA visitor expenditures of $68.30 ($2013) spread out across accommodations (21%), gasoline/convenience stores (37%), restaurants (18%), groceries (11%), and souvenirs/miscellaneous (13%). Our updated BHRA visitor expenditures are presented in Table 14.

Table 14: Annual Regional Bear River Heritage Area (BRHA) Visitor Expenditures ($2022)

Spending Category	Percent Allocation	Visitor Expenditures
Lodging	21%	$5,713,943
Gas/oil	37%	$10,067,423
Restaurants	18%	$4,897,665
Groceries	11%	$2,993,018
Souvenirs/ miscellaneous	13%	$3,537,203
Totals	**100%**	**$27,209,250**

Note: Does not include Bear Lake visitor expenditures.

Heritage tourism in the Bear River region generates approximately $27 million of annual visitor expenditures.

Credit: Matt Coombs

47 Burr, Steven W. and Jakus, Paul M. 2014. The economic impact of Bear River Heritage Area tourism. Utah State University Cooperative Extension. No. IORT/035.

8. ENVIRONMENTAL SERVICES AND NON-MARKET VALUES

The Bear River provides numerous environmental, or ecosystem, services to residents, visitors, and the public in the form of fish and wildlife habitat, scenic values, and spiritual inspiration. Although most of these ecosystem services are not traded in markets, in contrast to the agriculture commodities discussed above, they hold immense personal value and produce what are known as non-market values (values associated with goods and services for which there are no markets and thus no price data). In this section we provide an overview of Bear River non-market values, assess the economic value of a subset of Bear River non-market values, and provide a look at one set of market values (conservation easements) that reflect some of the ecosystem services highly valued by the public.

8.1. NON-MARKET VALUES

As discussed in previous sections, the Bear River provides numerous recreation activities and plays a critical role in the region's agricultural sector, assorted industries, and hydropower production. The Bear River also affords various non-market values, including the value derived from ecosystem services (such as carbon sequestration, wildlife habitat, or water purification) and recreation consumer surplus (the difference between the maximum amount a consumer will pay for a recreation experience and the actual amount they pay for the recreation experience). Economists have developed various methods for estimating the values of such goods and services in the absence of market data.[48]

The Bear River supports a complex and important ecosystem within the River itself and within the broader Basin. The River is home to twelve native fish species, including Bonneville cutthroat trout (Utah's state fish), northern leatherside chub, and bluehead sucker, all of which are listed as Species of Greatest Conservation Need (SGCN). The health of

48 Champ, P.A., Boyle, K.J. and Brown, T.C. (2003). A primer on nonmarket valuation. Dordrecht: Kluwer Academic Publishers.

the River is intricately linked to the health and well-being of species throughout the Basin, including the golden eagle, sage grouse, pika, and pilose crayfish - all considered SGCN in Utah, Idaho, and/or Wyoming. Furthermore, the River's headwaters are located in a vital part of the Rocky Mountain Wildlife Corridor – a wildlife migration route that extends from Colorado to Montana and is the only major link for wildlife migration between the northern and southern Rocky Mountain ecosystems.

Wetland areas along the River's edge and within numerous wildlife refuges provide habitat and resting areas for innumerable waterfowl and bird species, including the white-faced ibis, cinnamon teal, red-headed duck, and great egret, many of which also breed and nest in these areas. The importance of the Basin's wetland areas is amplified because the region is part of the Pacific Flyway[49] and because wetlands compose only 1% of Utah, Idaho, and the Intermountain West as a whole, and most (85%) of Utah's wetlands are found at the Great Salt Lake.[50] Furthermore, wetlands provide crucial habitat to more than 75% of the region's wildlife during some phase of their life cycle.[51]

Impacts of the Bear River and the health of the River extend to Bear Lake. The Bear River contributes approximately 30% of total inflows to Bear Lake and is thus intricately linked with the health of the Lake and integral to the preservation of four fish species endemic to Bear Lake – Bonneville Cisco, Bonneville Whitefish, Bear Lake Whitefish, and Bear Lake Sculpin – all of which are listed as SGCNs. The Bear River is similarly linked to the health of the Great Salt Lake, contributing approximately 39% of the freshwater flows to the Lake. The Bear River thus plays a crucial role in maintaining the Great Salt Lake's temperature, salinity, water level, and migratory bird habitat.

Given the absence of Bear River specific studies, we employ the benefit transfer method from the existing non-market valuation literature to estimate Bear River ecosystem non-market values. Benefit transfer entails transferring benefit estimates from previous studies conducted in other locations to the Bear River. In our estimates below we use two different forms of benefit transfer – unit value transfer (the transfer of the value from a single source study) and measure of central tendency value transfer (the transfer of the average or other measure of central tendency from several studies).[52] Benefit transfer provides an approximation of the value of these environmental services. An important priority for improving the accuracy of the value of these environmental services is to undertake Bear River specific valuation studies.

8.1.1. River Restoration and Protection

As discussed above, the Bear River is water-quality impaired and in need of restoration. A review of the economics literature yielded numerous river restoration studies from which we selected the most relevant and appropriate for benefit transfer to the Bear River (summarized in Table 15). The elements of river restoration measured and valued in these studies include fish and wildlife habitat, vegetation type and density, and water quality. We use the river restoration estimates provided by these studies as proxies for the value of overall river protection - the value the public places on a healthy and well-functioning river ecosystem. For each primary study listed in Table 15 we calculated the household (HH) willingness to pay (WTP) for a mile of river restoration by dividing total household WTP by the number of restored river miles. The median of the resulting WTP/HH/mile values listed in Table 15 indicates the average household is willing to pay $5.86 per mile of river restoration to ensure a healthy and well-functioning river.

49 The Pacific Flyway is one of four flyways in North America (the other three are the Atlantic, Mississippi, and Central Flyways). Migratory birds use these four routes when they migrate in the spring and fall, as these routes offer efficient paths with places to stop and rest. The Pacific Flyway extends from the Pacific Ocean to the Rocky Mountains, and from South America to Alaska.

50 US Fish & Wildlife Service. (2013). *Bear Lake National Wildlife Refuge and Oxford Slough Waterfowl Production Area Comprehensive Conservation Plan*.; Frank et al. (2016). *Water rights for wetlands in the Bear River Delta. Utah State University*.

51 Fretwell, J. D., Williams, J. S., & Redman, P. J. (Eds.). (1996). *National water summary on wetland resources* (Vol. 2425). US Government Printing Office.

52 Rosenberger, RS and Loomis, JB. 2003. Benefit transfer. In 'A primer on nonmarket valuation.' (Eds PA Champ, KJ Boyle, TC Brown) pp. 445-482 (Dordrecht: Kluwer Academic Publishers).

Table 15. Non-Market Economic Values of River Restoration and Protection

Primary Study (Publication Year)	River, State	Annual WTP $/HH/mile (2022 $)
Broadbent et al. (2015)	Upper San Pedro, Arizona	1.64
Broadbent et al. (2015)	Middle Rio Grande, New Mexico	1.11
Holmes et al. (2004)	Little Tennessee River, NC	7.72
Loomis et al. (2000)	South Platte River, Colorado	10.45
Weber and Stewart (2009)	Middle Rio Grande, New Mexico	13.37
Weber and Stewart (2009)	Middle Rio Grande, New Mexico	4.00

Note: Citation information for these four studies is provided in footnote below.[53]

To demonstrate how WTP for river restoration might translate to the Bear River we estimate total WTP for the restoration of the two stretches of the Bear River discussed in the water quality section above – the section between the WY/ID border and Dingle Marsh (water quality in this section is degraded and impacts Bonneville Cutthroat trout as well as Bear Lake water quality) and the section between Benson, UT and Cutler Dam (a section with one of the largest jumps in the portion of samples that exceed total phosphorus criteria). We assess the WTP for restoration of these two stretches rather than the entire river in part because river restoration is likely to be undertaken in a piecemeal fashion that places priority on the most polluted sections of the river and in part to provide a conservative estimate of the value of Bear River restoration. For each stretch of River, we extrapolate the median annual household WTP to households within the study area's ten counties.

Between the WY/ID border and Dingle Marsh the Bear River is approximately 35 miles in length. With a median annual WTP of $5.86/HH/mile, households within the ten-county area would be willing to pay $23.8 million to restore this stretch of River. The section between Benson, UT and Cutler Dam is notably shorter – approximately 7 miles in length. Extrapolating the WTP estimate of $5.86/mile to households within the ten-county study area generates an annual WTP of $4.8M.[54] Because the Bear River plays a critical role in the health of the Great Salt Lake and thus in the health of the Pacific Flyway, households outside the ten-county area (and in fact across the US) will be willing to pay to restore and protect the Bear River, although the WTP amount will be lower than for households within the ten counties.[55] Accounting only for the WTP of households within the ten-county area further increases the conservative nature of our Bear River restoration and protection value estimates.

Households within the ten-county area have an annual WTP of $28.6 million to restore and protect these two stretches of the Bear River.

8.1.2. Wetlands

To estimate the economic value of the study area's wetlands we focus on protection values for one photogenic waterfowl species of the Bear River, the Northern Pintail. While there are economic valuations of wetlands available in the literature that can be used

53 Broadbent, C. D., Brookshire, D. S., Goodrich, D., Dixon, M. D., Brand, L. A., Thacher, J., & Stewart, S. (2015). Valuing preservation and restoration alternatives for ecosystem services in the southwestern USA. Ecohydrology, 8(5), 851-862.
Holmes, T. P., Bergstrom, J. C., Huszar, E., Kask, S. B., & Orr III, F. (2004). Contingent valuation, net marginal benefits, and the scale of riparian ecosystem restoration. Ecological Economics, 49(1), 19-30.
Loomis, J., Kent, P., Strange, L., Fausch, K., & Covich, A. (2018). Measuring the total economic value of restoring ecosystem services in an impaired river basin: results from a contingent valuation survey. In Economics of water resources (pp. 77-91). Routledge.
Weber, M. A., & Stewart, S. (2009). Public values for river restoration options on the Middle Rio Grande. *Restoration Ecology*, *17*(6), 762-771.

54 County household numbers are obtained from IMPLAN.

55 The decrease in value with an increase in distance has been demonstrated in prior studies. See Loomis, JB. 2001. BLM Upper Snake River Contingent Valuation Methodology Study Report, prepared for BLM, Wyoming State Office. See also Loomis, J.B., 2000. Vertically summing public good demand curves: an empirical comparison of economic versus political jurisdictions. Land Economics, pp.312-321.

for benefits transfer,[56] most include multiple value streams that we have included separately (e.g., recreation consumer surplus, water purification for culinary and secondary use, protection of Bear River biodiversity). We use estimates derived by Haefele et al. (2018) in their assessment of WTP to protect wetland habitat for Northern Pintails, one of the many waterfowl species supported in critical ways by the Bear River and its associated lakes, wetlands, and wildlife refuges.[57] For US households, Haefele et al. estimate a mean annual WTP of $34.71 to help stabilize the Northern Pintail population through the protection of their US wetland habitat.[58] This WTP reflects the amount survey respondents were willing to pay to protect pintail habitat throughout the US, and in that regard may overestimate the value of the Bear River and its associated wetlands. On the other hand, the value estimated by Haefele et al. captures the mean WTP only for Northern Pintail wetlands habitat and does not account for the multitude of other waterfowl and shorebirds that also depend on this habitat. In this way the WTP derived by Haefele et al. likely underestimates the value of the Bear River and its associated wetlands.

Bearing these considerations in mind, we extrapolate the mean annual household WTP of $34.71 to households in the ten-county area, resulting in an annual willingness to pay of $3.7 million.

Households within the ten-county study area have an estimated annual WTP of $3.7 million to protect wetland areas along the Bear River.

8.1.3. Recreation

In this section, we provide the results of estimating recreational consumer surplus[59] – the non-market values above and beyond recreationists' expenditures – for four activities: waterfowl hunting, bird viewing, fishing, and boating.

Waterfowl Hunting

The Bear River is integral to the region's waterfowl populations and thus the provision of waterfowl hunting opportunities. An economic analysis of proposed federal migratory bird hunting regulations is published each year by the US Fish & Wildlife Service (USFWS). As part of their analysis the USFWS summarizes the economics literature pertaining to waterfowl hunting consumer surplus (CS). In their assessment of the 2023-2024 regulations[60] the USFWS makes use of flyway-specific consumer surplus estimates derived by Hay (1988).[61] For the Pacific Flyway Hay estimated a mean waterfowl hunting consumer surplus of $68.01/day, comprising $46.24/day in the northern states (including Idaho) and $84.33/day in the southern states (including Utah). For comparative purposes the USFWS calculated the mean of CS estimates from 20 state- or region-level studies, yielding a mean consumer surplus of $66.96/day.[62] We include in our analysis a subset of the 20 studies referred to by the USFWS; the Recreation Use Values Database lists eight waterfowl hunting studies conducted in the Mountain and Pacific states that yield an average waterfowl hunting CS estimate of $85.28/day.

A 2015 study of waterfowl hunting in North and South Dakota provides more recent and notably higher estimates of waterfowl hunting consumer

56 E.g., Costanza, R., d'Arge, R., De Groot, R., Farber, S., Grasso, M., Hannon, B., ... & Van Den Belt, M. (1997). The value of the world's ecosystem services and natural capital. Nature, 387(6630), 253-260.

57 Haefele et al. 2018. Multi-country willingness to pay for transborder migratory species conservation: A case study of Northern Pintails. *Ecological Economics* 157: 321-331.

58 Respondents were willing to pay additional amounts for preservation of Northern Pintail wetland habitat in Mexico and Canada.

59 Consumer surplus is the difference between willingness to pay and the price actually paid.

60 US Fish & Wildlife Service. 2023. Economic Analysis. Final Rulemaking for Migratory Bird Hunting for the 2023-2024 Season.

61 Hay, Michael J. 1988. Analysis of the 1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Net Economic Recreation Values for Deer, Elk and Waterfowl Hunting, and Bass Fishing. Report 85-1.

62 Data was obtained from two databases that contain data from valuation studies conducted between 1958 and 2015 – the Recreation Use Values Database (2016) and the USGS Benefit Toolkit (2016).

surplus.[63] The average consumer surplus for North Dakota waterfowl hunting trips was estimated to be $196.62/day, while the CS estimated for South Dakota waterfowl hunting is $153.34/day. The USFWS notes that these high CS values may be due to high quality hunting available in the study area. These values are summarized in Table 16.

Table 16. Waterfowl Hunting Consumer Surplus ($2022)

Information Source	Region	Consumer Surplus ($/day)
Hay (1988)	Pacific Flyway	68.01
Hay (1988)	Pacific Flyway - northern states	46.24
Hay (1988)	Pacific Flyway - southern states	84.33
Loomis et al. (2015)	North Dakota	196.62
Loomis et al. (2015)	South Dakota	153.34
Recreation Use Values Database	all Mountain & Pacific state studies	85.28

Although the higher CS estimates in Loomis et al. (2015) may be applicable to the Bear River and its associated lakes and wetlands, to provide a conservative estimate of the consumer surplus associated with waterfowl hunting along the Bear River we use the average Pacific Flyway CS of $68.01 in a unit value benefit transfer.

Credit: Brett Prettyman

63 Loomis et al. 2015. Economic contributions, impacts, and economic benefits of deer, waterfowl, and upland game bird hunting in North and South Dakota: Relationship to CRP lands.

The US Fish and Wildlife Service estimates 5% of all wildlife refuge visits are for hunting purposes and that waterfowl hunting composes 39% of all hunting visits.[64] We apply these percentages to total estimated annual visits for the subset of Bear River recreation sites that allow waterfowl hunting,[65] and thereby estimate approximately 15,100 annual waterfowl hunting visits. The unit benefit transfer method therefore results in an estimated annual waterfowl hunting consumer surplus values of approximately $1.0 million.

Waterfowl hunting along the Bear River generates an estimated consumer surplus of $1.0 million annually.

Birding

To assess consumer surplus derived by the multitude of people who engage in bird watching activities along the Bear River and its associated lakes and wetlands, we draw on estimates provided in Eubanks et al. (2004).[66] Eubanks et al. merge data from four studies they conducted in Nebraska, New Jersey, California, and Texas. Using the combined data, they calculate a mean birding CS of $80.85/day.

Although birding is not one of the non-consumptive recreation activities specifically delineated in their report, the USFWS[67] estimates that 80% of all wildlife refuge visits are for non-consumptive recreation purposes, such as photogra-

64 Caudill, J., & Carver, E. (2019). Banking on nature 2017: The economic contributions of national wildlife refuge recreational visitation to local communities. US Fish and Wildlife Service, Falls Church, Virginia.

65 Sites that allow waterfowl hunting are Bear River headwaters, Woodruff Narrows, Cokeville Meadows National Wildlife Refuge (NWR), Bear Lake NWR, Soda Dam/Alexander Reservoir, Grace Dam/Black Canyon Gorge, Oneida Narrows Canyon, Cutler Reservoir, and Bear River Migratory Bird Refuge. Although waterfowl hunting is permitted at Bear Lake, we assume hunters will preferentially go to the Bear Lake NWR and thus assume no waterfowl hunting occurs at Bear Lake.

66 Eubanks et al. 2004. Understanding the diversity of eight birder subpopulations: Sociodemographic characteristics, motivations, expenditures, and net benefits. *Journal of Ecotourism* 3(3): 151-172.

67 Caudill, J., & Carver, E. (2019). Banking on nature 2017: The economic contributions of national wildlife refuge recreational visitation to local communities. US Fish and Wildlife Service, Falls Church, Virginia.

phy, boating, auto tour, etc.[68] It is likely that many of the people participating in auto tour, pedestrian, boating, and photography activities are also engaging in birding activities. We therefore impose the conservative assumption that bird watching activities occur at the three wildlife refuges and are fully captured by photography visits, which the USFWS estimates compose 23% of non-consumptive recreation visits. Taking 80% of total annual visits to the three Bear River wildlife refuges (approximately 135,000 annual visits) results in total non-consumptive annual visits to refuges of 108,000. Portioning 23% of these non-consumptive visits represented by photography results in (almost 25,000 visits each year). Applying the 25,000 visits to the average CS value of $80.85/day derived by Eubanks et al. yields an estimated $2.0 million in birding CS.

Bird watching activities along the Bear River yield an estimated $2.0 million in consumer surplus each year.

Fishing

Every five years the USFWS conducts the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Data from each survey is used to produce a variety of publications, though both the survey questions and the analyses conducted with the data vary. The 2006 survey asked respondents questions regarding actual trip expenses as well as the level of expenditures that would have caused the respondent to cancel their fishing trip. The resulting data were used to calculate mean and median resident and non-resident consumer surplus values for each state (values for Idaho, Utah, and Wyoming are provided in Table 17).[69]

68 The non-consumptive recreation activities demarcated in the report are photography, pedestrian, auto tour, visitor center, boating, interpretive, bicycling, and other.

69 Harris. 2010. Trout fishing in 2006: A demographic description and economic analysis: Addendum to the 2006 National Survey of Hunting, Fishing, and Wildlife-Associated Recreation. US Fish & Wildlife Service Report 2006-6.

Table 17. Fishing Consumer Surplus ($2022)

		Resident CS $/day		Non-Resident CS $/day	
Reference	State	Mean	Median	Mean	Median
Harris (2010)	Idaho	69.69	31.94	87.11	72.59
Harris (2010)	Utah	88.56	37.75	161.16	84.21
Harris (2010)	Wyoming	72.59	36.30	110.34	87.11

The USFWS estimates that 15% of all visits to national wildlife refuges are made for fishing purposes. Because all Bear River recreation sites permit fishing activities, we therefore assume 15% of all visits made to each of the Bear River sites are for fishing purposes. These assumptions result in more than 300,000 fishing visits to the Bear River each year.

Credit: Chris Hunt

Although both resident and non-resident anglers visit the Bear River, because the River is neither one of the West's iconic rivers nor one of the West's premier fishing rivers, we impose the assumption that for each recreation site along the Bear River, 90% of anglers are residents of the relevant state (UT, ID, WY). Furthermore, because mean values can be skewed by outliers we instead use median values to estimate consumer surplus associated with fishing on the Bear River. Imposing these assumptions results in an estimated consumer surplus for Bear River fishing of approximately $11.6 million.

We estimate fishing CS as follows:

$$\sum_{i=1}^{3}\sum_{j} SiteVisits_{i,j}\left(0.9 * ResMedCS_{i} + 0.1 * NonResMedCS_{i}\right)$$

where i denotes the i^{th} state, j denotes the j^{th} recreation site, SiteVisits denotes the number of fishing trips, *ResMedCS* denotes the median CS derived by a resident angler, and *NonResMedCS* denotes the median CS derived by a non-resident angler. Imposing these assumptions results in an estimated consumer surplus for Bear River fishing of approximately $11.6 million.

Fishing activities at sites along the Bear River yield an estimated $11.6 million in consumer surplus each year.

Boating

To assess the value of boating activities on the Bear River we use values derived by Loomis and Bair (2023) in their recent review of existing studies regarding the economic value of boating.[70] For the Intermountain region they find an average CS value of $42.97/day for motorized boating and $39.58/day for non-motorized boating.

To determine the number of boating trips made to the Bear River each year we again use information provided in the 2019 USFWS report, which estimates that 3% of all non-consumptive recreation trips are for boating purposes. Applying this to estimated annual visits for the various Bear River recreation sites yields a total of roughly 48,500 boating trips. Because both motorized and non-motorized boating occur on the Bear River, we use the average of the two CS values derived by Loomis and Baird ($41.28) to calculate total consumer surplus.

Bear River boating activities yield an estimated $2.0 million in consumer surplus each year.

In total the Bear River provides at least $48 million in estimated annual non-market benefits. Table 18 summarizes the non-market value estimates.

Table 18. Bear River Annual Non-Market Values (Millions of $2022)

Non-market Value	Conservative
Recreation Consumer Surplus	
Waterfowl Hunting	1.0
Birding	2.0
Fishing	11.6
Boating	2.0
River Restoration	
WY/ID border to Dingle Marsh	23.8
Benson, UT to Cutler Dam	4.8
Wetlands	3.7
Total	**48.9**

Each year the Bear River provides $48.9 million in non-market benefits.

70 Loomis, J., & Bair, L. (2023). Recreation Use Values for Water-Based Recreation. In Oxford Research Encyclopedia of Environmental Science.

8.2. CONSERVATION EASEMENT VALUES

Conservation easements are voluntary agreements between a landowner and a land trust (or agency) that restrict future development and protect agriculture opportunities, other resource values, and ecosystem services.[71] Landowners receive payments in exchange for foregoing non-agricultural uses so that water quantity and quality, wetlands, habitat and ecosystem services, and farming and ranching opportunities can be protected as best as possible for future generations.

Bear River regional land trusts work with the USDA Natural Resources Conservation Service (NRCS– which administers the Agriculture Conservation Easement Program)[72] to leverage federal easement funds from state, local, and private funds including for example, PacifiCorp. Likewise, the US Fish and Wildlife Service (USFWS) administers wetland easements in areas where farming and waterfowl habitat can be best sustained simultaneously. Conservation easement sales can therefore represent a source of "new" money coming into the region, provide an economic stimulus in rural areas, and are critically important to affected landowners. More than 11,000 acres in the Bear River Basin have been conserved with conservation easements during the last four years, primarily with funding from the NRCS and the USFWS. Purchase prices for the 11,150 acres totaled almost $11 million across 12 easements, with an annual average of $2.76 million in conservation easement sales in the region and almost 2,800 acres of easements for the last four years.[73]

Seidl et al. (2018)[74] conducted research on how Colorado farmers and ranchers spent conservation easements funds, finding that about half of easement funding (52%) is typically re-invested into land payments and debt, while another large portion (17%) goes towards savings. The rest of conservation easement funds are generally spent on reinvestments for agricultural production (16%), including the purchase of farming inputs (e.g., livestock) and farming equipment, and for additional land purchases for agriculture expansion (13%). Some easement funds are used to promote non-agricultural enterprises, such as hunting and outdoor recreation, additional land purchases, charitable giving, and education of a family member. We assume all funding for easements comes from outside of the region, and thereby treat conservation easements as an export service. We use the Seidl et al. (2018) findings to apply Bear River conservation easement payments to our regional economic impact analysis (see Table 19). The annual averages represent the last four years of easement purchases, so if the rate of purchases into the future slows, the annual values will decrease accordingly.

Table 19: Annual Regional Bear River Conservation Easement Expenditures

Spending Categories	Percentage Allocation	Annual Expenditures
Debt repayment	52%	$1,435,157
Savings	17%	$469,186
Farm equipment/ inputs	16%	$441,587
Land purchases	13%	$358,789
Outdoor recreation	1%	$27,599
Charitable giving	1%	$27,599
Totals	**100%**	**$2,759,918**

Notes: The Savings spending category is excluded for the regional economic impact analysis as it likely does not spur a stimulus in the region.

Beyond the regional economic impacts, conservation easements also generate public ecosystem service benefits (non-market values) by maintaining open space, water quantities, and water quality. Research from Colorado shows that conservation easements generate public ecosystem service benefits of approximately $18,500 for each acre con-

71 Seidl, A. (2020). Economic impact of future federal conservation easement investments on (rural) Colorado communities (Policy Brief, Colorado State University. Libraries).

72 For more information see: https://www.nrcs.usda.gov/programs-initiatives/acep-agricultural-conservation-easement-program.

73 Personal communication with Matt Coombs, Bear River Watershed Conservation Coordinator for the Sagebrush Steppe Land Trust and the Bear River Land Conservancy on 10/18/23 and Carli Bergey, Realty Specialist US Fish and Wildlife Service on 12/22/23..

74 Andrew Seidl, Ryan Swartzentruber, and Rebecca Hill. (2018). Estimated Economic Impact of Federal Agricultural Conservation Easement Programs (ACEP) on Colorado, 2009-2017. July 2018. Colorado State University. 32 pp.

served, or a return on investment of $13-$21 for every dollar invested into conservation easements.[75] Based on the current annual average of 2,790 acres conserved in the Bear River Watershed, we expect correlating annual public ecosystem service benefits of $51.6 million.

Over 11,000 acres have been conserved in the Bear River Watershed over the last four years. Total annual regional expenditures for conservation easements are estimated at $2.76 million.

We expect correlating annual public ecosystem service benefits of $51.6 million.

9. TOTAL REGIONAL ECONOMIC VALUES OF THE BEAR RIVER

In this section we aggregate the economic values of the Bear River. We start by presenting the regional market economic impacts and contributions of the Bear River Watershed, then illustrate the additional market values associated with the Bear River's input to the Great Salt Lake, and end with a discussion of all market and non-market values of the Bear River.

75 Andrew Seidl, Ryan Swartzentruber, and Rebecca Hill. 2018. Public benefits of private lands conservation: Summary of alternative compensation estimates. College of Agricultural Sciences, Colorado State University. 25 pp.

9.1. REGIONAL ECONOMIC IMPACTS AND CONTRIBUTIONS OF THE BEAR RIVER

For the regional economic impact analysis (EIA), the marketed goods and services presented in the previous sections that are primarily attributable to Bear River water were aggregated and entered into IMPLAN economic modeling software. IMPLAN is used to estimate economic impacts by illustrating direct, indirect, and induced effects typically for "new" wealth coming into the region for exported commodities and services.[76] Combining the out-of-region sales for farming, ranching, recreation, heritage tourism, hydropower, and conservation easements that are all dependent on the Bear River results in a regional change in final demand of over $700 million spread across 30 primary industrial sectors (see Table 20).

76 Part of the reason regional EIA is focused on exported goods and services is to reduce double counting that would occur if all final sales from both exported and locally sold goods were entered as final demand to determine direct and indirect effects. For example, consider regional livestock production and winter feed. The locally produced hay for winter feed represents an indirect effect, or a backward linkage needed to supply the final exported beef cattle. If the locally sold hay is treated as original final demand, along with regionally exported beef cattle, some double counting would occur as much of the locally sold hay will already be represented in the indirect effects for exported beef cattle.

Table 20: Bear River-Dependent Change in Final Demand and Affected Industries

IMPLAN Sector Description	Final Demand
Beef cattle ranching and farming, including feedlots... (11)	$197,087,397
All other crop farming (10)	$194,065,500
Grain farming (2)	$85,010,397
Dairy cattle and milk production (12)	$68,294,500
Vegetable and melon farming (3)	$33,435,000
Retail - Gasoline stores (408)	$22,110,013
Animal production, except cattle and poultry and eggs (14)	$17,502,000
Other real estate (447)	$14,032,408
Retail - Food and beverage stores (406)	$13,498,614
Hotels and motels, including casino hotels (507)	$12,583,610
Limited-service restaurants (510)	$10,534,097

IMPLAN Sector Description	Final Demand
Retail - Miscellaneous store retailers (412)	$6,271,513
Employment and payroll of state govt, other services (541)	$4,219,204
Tenant-occupied housing (448)	$4,102,086
Retail - Sporting goods, hobby, musical instrument and book stores (410)	$3,139,698
Other accommodations (508)	$2,734,724
Full-service restaurants (509)	$2,472,253
Electric power transmission and distribution (47)	$2,097,502
Retail - Motor vehicles and parts dealers (402)	$2,085,890
Other amusement and recreation industries (504)	$1,533,019
Automotive repair and maintenance, except car washes (512)	$717,579
Employment and payroll of federal govt, non-military (546)	$717,579
Performing arts companies (496)	$678,572
Amusement parks and arcades (502)	$509,453
Non-depository credit (439)	$415,457
Monetary authorities and depository credit intermediation (441)	$415,457
Travel arrangement and reservation services	$110,397
Support activities for forestry and agriculture (19)	$110,397
Farm machinery and equipment manufacturing (260)	$53,035
Religious organizations (521)	$27,599
Totals	**$700,564,948**

The $700 million in final demand was entered into IMPLAN's impact analysis program for the 10-county Bear River regional economic zone across the listed industrial sectors. After margining retail commodities, such as gasoline purchases, to account for product transportation costs and markups going from producer to purchaser prices (i.e., wholesale to retail), the direct output was approximately $669 million. This indicates that $31 million, or about four percent, of overall revenue initially leaked out of the region due to the supply of commodities that were not produced in the Bear River regional economy.

Exported commodities and services dependent on Bear River water were responsible for over 6,500 direct full and part-time jobs in the region. Table 21 shows the total effects. When including indirect and induced effects, approximately 8,144 jobs and over $928 million in regional output were sustained by the Bear River. Our IMPLAN model yields multiplier effects (the ratio of total effects to direct effects) of a magnitude expected for rural areas; multipliers range from 1.25 for employment to 1.52 for labor income. The output multiplier of 1.39 illustrates that for every dollar of Bear River associated regional output, another 39 cents is generated by indirect and induced output.

Table 21: Regional Economic Impacts of Bear River Exports ($2022)

Impact	Employment	Labor Income (Millions)	Value Added* (Millions)	Output (Millions)
Direct Effect	6,518	$118.10	$353.64	$669.27
Indirect Effect	1,200	$44.18	$83.22	$189.71
Induced Effect	426	$17.60	$39.47	$69.91
Total Effect	**8,144**	**$179.87**	**$476.34**	**$928.89**
Multiplier Effect	**1.25**	**1.52**	**1.35**	**1.39**

Source: IMPLAN, Bear River 10-County Region, 2022, Type SAM Multipliers

**Value added is the difference between an industry's total output and its intermediate inputs. It includes employee compensation, taxes, and surplus.*

To calculate total Bear River economic impacts and contributions, we add direct effects from locally distributed (non-export) surface and groundwater used by municipalities and industries, locally distributed (non-export) hydropower electricity, and locally produced and distributed (non-export) milk to the effects generated by exported goods and services (shown in previous Table 22).[77] Non-export recreation, or expenditures of local recreationists, is not included here due to minimal local expenditures and to a lack of spending pattern data. Entering the previously estimated annual municipal and industrial water sales of $63.6 million, local hydropower sales of $16.1 million, and local milk sales of $68.3 million into IMPLAN shows that these non-exports are responsible for an additional 279 direct full and part-time jobs, $19.4 million in direct labor income, and $148 million in direct regional output (see Table 22).

Table 22: Regional Economic Impacts and Contributions of the Bear River (Without Great Salt Lake Portion) ($2022)

Impact/Contribution	Employment	Labor Income (Millions)	Output (Millions)
Total Impact of Exports	8,144	$179.87	$928.89
Direct Effect for Non-Exports	279	$19.4	$148.0
Total Impacts and Contributions	**8,423**	**$199.27**	**$1,076.89**

77 Note that non-exported goods produced using Bear River water that are, in turn, inputs to the production of exported goods using Bear River water (e.g., alfalfa/hay sold locally as winter feed for exported livestock) are represented in the indirect effects calculated for export products. To avoid double counting we do not separately include revenues from non-exported goods that are inputs to Bear River exported goods. Additional details are provided in **Appendix A**.

The Bear River (without the GSL portion) supports the provision of commodities and services that yield regional economic contributions of 8,423 jobs, $199 million in labor income, and $1.1 billion in output.

9.1.1. Including Great Salt Lake Market Values Attributable to the Bear River

In addition to the economic impacts and contributions discussed above that stem from the use of Bear River water, the full economic value of the Bear River must also account for the industries and people that rely on the Great Salt Lake, to which the Bear River contributes 39% of inflows.[78]

The annual value of the Great Salt Lake to the regional economy has been estimated at $1.84 bil-

78 Utah Division of Water Resources. 2023.

lion.[79] In addition, the Great Salt Lake contributes roughly 7,700 jobs and $523 million in labor income. Assuming a linear relationship between economic activity and water supply, the Bear River accounts for approximately 39% of total Great Salt Lake output ($719 million annually), $204 million in annual labor income, and roughly 3,000 jobs in the region. Table 23 presents the annual value of export products from the Great Salt Lake to the regional economy as well as the portion of the annual value related to water from the Bear River.[80]

Table 23: Total and Bear River Portion of Annual Great Salt Lake Economic Effects (Millions of $2022)

	GSL Total Economic Effect	Bear River Economic Effect
Total Economic Output		
Recreation Sector	$189	$74
Industrial Sector (Mineral)	$1,576	$615
Aquaculture (brine shrimp eggs)	$79	$31
Total	**$1,844**	**$719**
Total Labor Income		
Recreation Sector	$64	$25
Industrial Sector (Mineral)	$431	$168
Aquaculture (brine shrimp eggs)	$28	$11
Total	**$523**	**$204**
Total Employment		
Recreation Sector	1,764	688
Industrial Sector (Mineral)	5,368	2,094
Aquaculture (brine shrimp eggs)	574	224
Total	**7,706**	**3,005**

Source: (Bioeconomics, 2012) and ECONorthwest Analysis. Total effects include direct, indirect, and induced effects.

Total regional economic impacts and contributions of the Bear River can be determined by summing the Bear River-specific impacts and contributions and the proportioned economic impacts stemming from the Bear River's input to the Great Salt Lake (Table 24).

Table 24: Total Annual Regional Economic Impacts and Contributions of the Bear River ($2022)

Impact/Contribution	Employment	Labor Income (Millions)	Output (Millions)
Total Impact of Exports	8,144	$179.87	$928.89
Direct Effect for Non-Exports	279	$19.4	$148.0
Total Impact of GSL-Portioned Exports	3,005	$204	$719
Total	**11,428**	**$403.27**	**$1,795.89**

79 Bioeconomics. (2012). *Bioeconomics.* Retrieved from Great Salt Lake Council: https://documents.deq.utah.gov/water-quality/standards-technical-services/great-salt-lake-advisory-council/Activities/DWQ-2012-006863.pdf

80 Note that the Great Salt Lake economic effects, and the portion attributable to the Bear River, are for export products and are presented as total effects inclusive of indirect and induced effects. The Bear River portions of Great Salt Lake total output stem from initial annual revenues of $372 million for minerals, $18.5 million for aquaculture, and $41 million for recreation, or 39% of all Great Salt Lake annual export revenue.

When the Bear River's portion of the Great Salt Lake's economic activity is included, the total annual regional impacts and contributions of the Bear River are approximately 11,428 full and part-time jobs, $403 million of labor income, and $1.80 billion of regional output.

9.2. TOTAL NON-MARKET VALUES OF THE BEAR RIVER

The Bear River spurs numerous non-market values related to the enjoyment of recreating in and around the River, the societal desire to protect and restore the River, and the value society places on wetlands habitat. The non-market values presented in the Environmental Services section results in approximately $100 million of annual non-market values.

Additionally, the Great Salt Lake spurs numerous annual non-market values, though we are not aware of any peer-reviewed primary studies valuing the Lake's non-market values.[81] Previous efforts[82] at estimating Great Salt Lake non-market values used benefits transfer methods to incorporate passive use values from willingness to pay estimates for the protection of a similar saline lake in the American West, Mono Lake.[83] Bioeconomics (2012)[84] found approximately $135 million (in $2022) in annual passive use value for the Great Salt Lake. We attribute 39% of this amount to the Bear River, resulting in $52.65 million of annual non-market value. Given that the passive use values exclude consumer surplus of Great Salt Lake recreationists, we presume that our estimates of Great Salt Lake non-market values are vastly understated.

In total, we estimate approximately $153 million of annual non-market values associated with the Bear River. There is a great need for primary non-market valuations to be conducted, using choice experiments or contingent valuation, on the Bear River and the Great Salt Lake. Relying on existing river and lake non-market valuations, as we have done in this report, to extrapolate non-market values provides a starting point for actual non-market values. Future research can greatly improve the precision of these non-market values and thus, the comprehensive economic accounting of the Bear River.

Total annual non-market values for the Bear River are conservatively estimated at $153 million.

9.3. TOTAL REGIONAL ECONOMIC VALUES OF THE BEAR RIVER

Finally, we show the total market and non-market values of the Bear River. The Bear River has many beneficiaries, ranging from business owners and the people that are employed due to the presence of the Bear River, to the local communities the receive drinking water and low-cost renewable hydropower, to the consumers of Bear River goods and services far and wide, to the people that recreate in the Bear River watershed, and to the public that appreciate the Bear River and would like to bequeath a healthy Bear River to future generations.

In total, the Bear River is responsible for over 11,400 regional jobs, $403 million in regional labor income, $1.8 billion in regional output, and

81 In 2021, a group of undergraduate students at the University of Utah conducted a contingent valuation of protecting the Great Salt Lake. While the resulting report was a quality first step in our understanding of non-market values of the Great Salt Lake, the study lacked the economic methodological rigor typically found in peer-reviewed economic valuations; the study exhibited limited sample size, mixed survey populations, and limited statistical interpretation. Despite the study limitations, the results showed strong convergence with previous benefits transfer from the Mono Lake study (from Bioeconomics 2012) that we have used in this report. The student report can be found here: https://www.hinckley.utah.edu/wp-content/uploads/sites/84/2022/07/Hinckley-Journal-2021_d.pdf#page=23.

82 E.g., Bioeconomics. (2012). Economic Significance of the Great Salt Lake to the State of Utah. Prepared for Great Salt Lake Advisory Council.

83 Loomis, J. B. (1987). Balancing public trust resources of Mono Lake and Los Angeles' water right: An economic approach. *Water Resources Research*, *23*(8), 1449-1456.

84 Bioeconomics. (2012). Economic Significance of the Great Salt Lake to the State of Utah. Prepared for Great Salt Lake Advisory Council.

$153 million of non-market value every year (see Table 25). Combining annual market output with annual non-market value shows a total Bear River economic value of $1.95 billion annually.[85]

Table 25: Total Annual Regional Economic Values of the Bear River

Regional Values	Total Employment	Total Labor Income	Total Output/Value
Market Impacts and Contributions	11,428	$403,270,000	$1,795,900,000
Non-Market Values	--	--	$153,220,000
Totals	**11,428**	**$403,270,000**	**$1,949,110,000**

85 We consider our total estimates to be conservative. Multiple valuation categories were not included due to a lack of secondary data and modeling complexity, including market values of local recreationists and additional non-market value categories that are applicable to Bear River recreationists like consumer surplus for hiking. For the valuation categories included, we typically chose conservative modeling assumptions when possible (e.g., using lower bound estimates for non-market values; not separately modeling indirect effects of winter feed for regional livestock).

A conservative estimate for the total annual value afforded by the Bear River (annual regional output plus annual regional non-market values) is $1.95 billion.

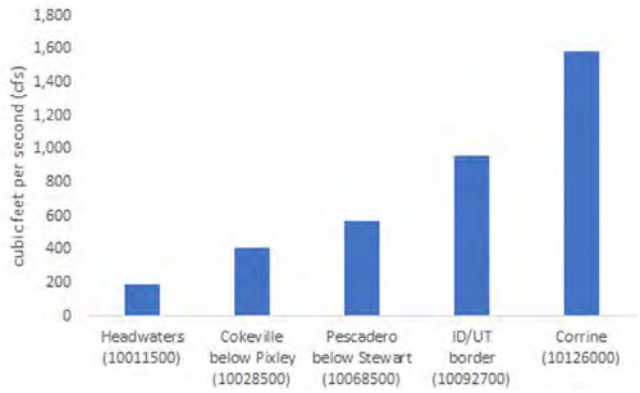
10. BEAR RIVER WATER QUANTITY AND QUALITY

All economic values supported by the Bear River are dependent on sufficient water quantity and quality. In this section we investigate trends in water supply and availability and then turn to assessing trends in water quality.

10.1. BEAR RIVER WATER QUANTITY

The hydrology of the Bear River continually changes and is heavily impacted by diversions for irrigation,[86] municipal or industrial/commercial use, and reservoirs constructed for hydroelectric power and/or to store water for agricultural uses. Temperature and precipitation also impact the River's hydrology, which therefore changes both spatially (as the River runs from its headwaters through the Bear River Watershed to the Great Salt Lake) and temporally (due to annual and seasonal changes in temperature, precipitation, and water use). Figure 9 depicts the fifty-year average annual discharge (measured in cubic feet per second (cfs)) from a subset of the streamgages used to monitor Bear River flows.[87] As the Bear River journeys from its headwaters in the Uinta Mountains to the Great Salt Lake it is joined by various tributaries, resulting in an increase in flows.

Figure 9. Bear River Fifty-Year Average Annual Flow at Select Streamgages



Source: USGS National Water Information System

Figure 10 depicts this increase as well, but also illustrates how flows vary from year to year. Variations in flow are so large that during especially dry years the flow at Corrine (the gage located 8

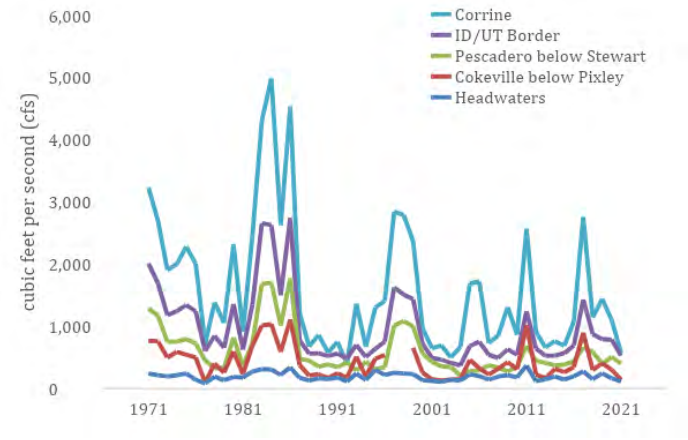
86 Within the Bear River Basin there are over 450 irrigation companies that divert water from the Bear River.

87 The dates for which streamflow (discharge) data are available are different for each streamgage. We assess discharge data for 1971 to present because this is the time period for which data is consistently available for the gages of interest.

miles upstream from the Great Salt Lake) has been nearly equivalent to the headwaters flow during especially wet years. An analysis of streamflow at select streamgages indicates that while flow at the Bear River's headwaters has declined minimally in the last five decades, flows at the Corrine gage have declined substantially. Specifically, we compared average streamflow for the 10-year period between 1971 and 1980 with that between 2012 and 2021. The 2012-2021 10-year average was 4.5% lower than the 1971-1980 average at the headwaters gage. By the time the Bear River reaches the gage at Cokeville, the 2012-2021 average flow is 33.1% lower than the 1971-1980 average flow. The decline in streamflow becomes steadily more and more pronounced at downstream gages. By the time the Bear River reaches the Corrine gage the 2012-2021 average flow is 43.3% lower than the 1971-1980 average flow.

Decreasing water supply is clearly of concern for the Bear River, and there are at least three factors likely contributing to the decline – increased surface water withdrawals, increased groundwater withdrawals, decreased precipitation, and a warming climate and associated increased evapotranspiration. However, our study does not include an assessment of the factors contributing to declining Bear River streamflows; the causes of streamflow declines and the relative importance of the different causes are areas of needed future research. (Additional details regarding trends in streamflow are provided in **Appendix C**.)

Figure 10. Bear River Average Annual Flow, 1971-2021



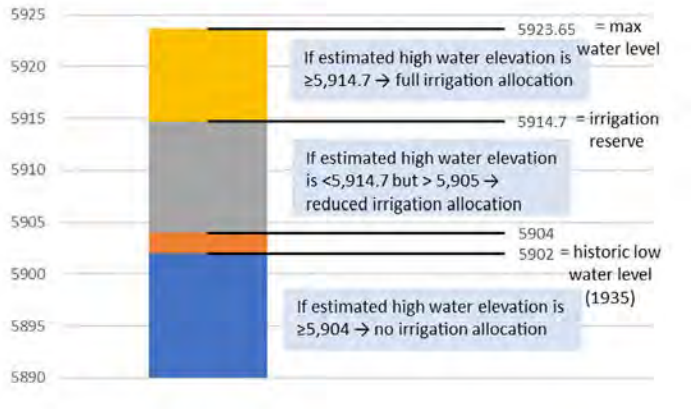
Source: USGS National Water Information System

Irrigation is the primary use of water within the Bear River Watershed,[88] and the various impoundments along the River's course allow water to be stored for summer irrigation. Bear Lake is the most significant of the Basin's impoundments and composes more than 90% of the Watershed's storage capacity. PacifiCorp owns and operates the structures that control the flow of water in and out of Bear Lake (Stewart Dam, Rainbow Canal, Lifton Pump Station, and the Outlet Canal), as well as five hydropower facilities located downriver from Bear Lake. PacifiCorp is able to control the level of Bear Lake between its historic low water level of 5,902 feet and its maximum allowed height of 5,923.65 feet – a range of 21.65 feet, which equates to 1,452,000 acre-feet of storage.[89] Per the Bear River Compact, when the elevation of the Lake falls below the irrigation reserve level of 5914.7 feet PacifiCorp may only release water for irrigation purposes; below 5914.7 feet water releases may not be made solely for the purpose of hydropower production. Figure 11 depicts the relationship between Bear Lake water levels and irrigation allocation options.

88 Journey through the Bear River Watershed. extension.usu.edu/waterquality/files-ou/Lesson-Plans/journey_through_the_bear_river_watershed.pdf.

89 Bear River Commission. 1997. Findings Concerning the Need for Compact Revision. waterrights.utah.gov/techinfo/bearrivc/bear20.html.

Figure 11. Bear Lake Water Levels and Irrigation Management



Less than half the Bear River's flow is allocated and controlled by the Bear River Compact.[90] The 1980 amendment of the Bear River Compact took the Bear River's unallocated waters and divided them between Utah, Idaho, and Wyoming.[91] In an arid region with a growing population (for example, Utah's population is expected to increase from 3.3 million in 2020 to 5.5 million in 2060) there is undoubtedly rising demand for additional sources of water and power. The Bear River Development Act, passed into law in 1991, authorizes the use of 220,000 acre-feet of Utah's 275,000 acre-feet of unused Bear River water. In 2006 the Utah Governor signed into law a bill authorizing pre-construction work. Although the Bear River Development Act would help meet projected future increased water demands, it raises a multitude of concerns, including how the Bear River can sustain current uses and values and how the project will impact the already-shrinking Great Salt Lake.[92] To meet future increased power needs PacifiCorp has proposed building a pumped storage dam in the Bear River's Oneida Narrows.

Over the past 5 decades Bear River streamflow has decreased minimally in the headwaters but more notably farther downstream. At the Corrine gage flows have declined more than 40% since the early 1970s.

10.2. BEAR RIVER WATER QUALITY

All market and non-market uses of the Bear River rely on both an adequate water supply and sufficient water quality; declines in either water supply or water quality can have deleterious effects on associated economic uses and values. Having shown decreasing trends in Bear River streamflow, we now examine trends in water quality. Water quality standards are set by individual states and comprise three elements – designated beneficial uses, numeric pollutant criteria (set by states to ensure water quality supports streams' beneficial uses), and antidegradation. The beneficial uses designated for the Bear River by Wyoming, Idaho, and Utah are listed in Table 26.

90 Journey through the Bear River Watershed. extension.usu.edu/waterquality/files-ou/Lesson-Plans/journey_through_the_bear_river_watershed.pdf.

91 *Ibid.*

92 It is estimated that prior to settlement and the development of irrigation structures and diversions, the Bear River annually delivered an average of nearly 1.8 million acre-feet to the Great Salt Lake. With settlement, irrigation, and other uses of the Bear River, the annual delivery of water to the Great Salt Lake has been reduced by nearly half to approximately 1 million acre-feet.

Table 26. Bear River Designated Beneficial Uses

Wyoming	Idaho	Utah
drinking water	cold water aquatic life	infrequent primary contact recreation
game fish	salmonid spawning	agricultural water supply
non-game fish	primary contact recreation	
fish consumption	agricultural water supply	*portion in Rich & Summit Counties:*
other aquatic life	industrial water supply	cold water aquatic life

Wyoming	Idaho	Utah
recreation	wildlife habitat	*portion in Box Elder & Cache Counties:*
wildlife	aesthetics	warm water aquatic life
agriculture		waterfowl, shore birds, & other water-oriented wildlife
industry		
scenic value		

Sources: Wyoming: Wyoming Surface Water Classification List. (nrc.gov). Idaho: IDAPA 58 - Department of Environmental Quality.book (idaho.gov). Utah: DWQ-2021-017555.pdf (utah.gov).

At its origin in the Uinta Mountains the Bear River is pristine, but as it travels through its basin it picks up sediments, nutrients, and other pollutants from both point and nonpoint pollution sources. Bear River point source pollution primarily stems from municipal water treatment discharges, though other point sources, such as confined animal feeding operations (CAFOs) and industrial sources (e.g. fish hatcheries), also impact the River. Nonpoint pollution of the Bear River results from ranching, farming, mining, logging, oil and gas exploration, roads, and urban land use. Water quality concerns also stem from reservoirs and other alterations to the River's flow.[93] Primary Bear River water quality concerns include high levels of sediment, nutrients (particularly phosphorus), and temperature. Because some nutrients adsorb to sediment, nutrient levels can be higher when sediment levels are high. Excess sediment can clog the gills of fish and reduce their uptake of oxygen, impair fish spawning, and decrease the light available for aquatic vegetation. Excess nutrients can lead to algal blooms, oxygen depletion, and possible toxins, ultimately killing aquatic life and possibly making humans ill. Because warm water holds less dissolved oxygen than cold water, increased temperature can also harm aquatic life.

Every two years states must submit to the EPA findings regarding the status of assessed waters, a 303(d) list of impaired waters and the causes of impairment, and the status of actions being taken to alleviate impairments. Near its headwaters the Bear River is supporting its designated beneficial uses, but the reach of the Bear River between the confluence with Sulphur Creek and Woodruff Narrows Reservoir is 303(d) listed due to excess sedimentation.[94] As of submission of Wyoming's 2022 Integrated Report, the Wyoming portion of the Bear River downstream from Woodruff Narrows Reservoir was not yet assessed. Per Idaho's 2022 Integrated Report, most of Idaho's Bear River reaches are on the 303(d) list due to excess levels of total phosphorus (TP) and total suspended solids (TSS). In Utah all portions of the Bear River are on the 303(d) list, generally due to excess temperature, dissolved oxygen, TP, and/or sediment.[95] The Bear River's most commonly impacted beneficial uses are cold water aquatic life, salmonid spawning, primary contact recreation, warm water aquatic life, and aquatic wildlife (waterfowl, shorebirds, etc.).

Water quality is clearly a concern for most of the Bear River. Although just a partial picture of the Bear River's health, we assess TP levels (a water quality concern throughout much of the River) as one measure of water quality and river health. Although water quality monitoring has since shifted to Bear Lake, between 2006 and 2015 the three state's DEQ departments collaborated to collect water quality data at 21 monitoring locations along the length of the Bear River four times annually.[96] We

93 Journey through the Bear River Watershed. extension.usu.edu/waterquality/files-ou/Lesson-Plans/journey_through_the_bear_river_watershed.pdf.

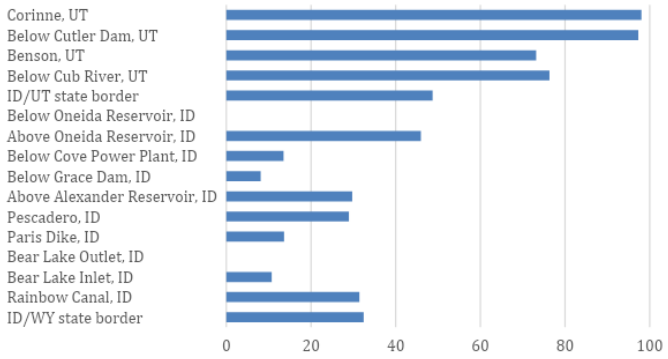
94 Water quality information for the Wyoming reaches of the Bear River was retrieved from Wyoming's Department of Environmental Quality website and interactive map: deq.wyoming.gov/water-quality/watershed-protection/surface-water-monitoring/.

95 Harris, H. (2017). *Bear River Basin TMDL Five-Year Review*. State of Idaho Department of Environmental Quality. www2.deq.idaho.gov/admin/LEIA/api/document/download/11669; State of Idaho Department of Environmental Quality. (2022). *Idaho's 2022 Integrated Report*. storymaps.arcgis.com/stories/67e18aab48ea4377a8004cdb5f19a66c

96 Data collected during this effort was uploaded to the EPA's Water Quality Portal where it is available for retrieval by the public. The Idaho DEQ collected data during lower basin runoff (March and April), upper basin runoff (May and June), summer base flow (July – September), and winter base flow (October – February).

use the water quality data collected through this Idaho DEQ effort to compare measured TP levels with numeric criteria or targets and calculate for each monitoring location the percent of samples that exceeded the relevant TP criteria or target.[97]

Figure 12. Percent of Samples Exceeding State Phosphorus Standard or Target (2006-2015)



Source: Idaho Department of Environmental Quality data obtained from EPA Water Quality Portal (Water Quality Data Home).

Phosphorus-containing particles tend to settle out of water in reservoirs and lakes and be covered by sediment. As a result, total phosphorus levels may be lower downstream of reservoirs and lakes, as is depicted in Figure 12 at the Bear Lake Outlet and below Oneida Reservoir. In general, a greater portion of samples exceed criteria at downstream monitoring locations, in part due to Utah's TP water quality indicator being more restrictive than Idaho's target, but also due to the additive effect of phosphorus flowing into the Bear River, both directly and from its tributaries. In addition to spatial fluctuations, phosphorus levels also fluctuate temporally. Because phosphorus attaches to sediment, TP levels tend to be elevated when TSS levels are high, which is particularly common during spring runoff.

When the Bear River enters Idaho, its waters are already significantly impaired, with more than 30% of samples taken at the Idaho/Wyoming border exceeding the Idaho TP target. The health of the Bear River between the ID/WY border and Dingle Swamp has implications not only for the River itself but for the health of Bear Lake as well. Restoration efforts within this stretch of River are thus of particular interest as they would benefit both Bear River and Bear Lake. By the time the River reaches the UT/ID border it is sufficiently impaired that nearly half of samples taken at the border exceed the Utah TP water quality indicator. By the time the Bear River has flowed through Cutler Dam nearly all samples exceed water quality standards.[98] Because much of the jump in the portion of samples exceeding standards occurs between Benson, UT and Cutler Dam, this is another stretch of River of particular interest for restoration efforts.

Addressing water quality concerns is a complex matter with many spatial, temporal, political, and economic intricacies. CAFOs, agriculture, and wastewater treatment plants are notable sources of phosphorus in the Bear River. Addressing phosphorous and other pollutants will require widespread changes to land management practices, channel and bank modifications, and wastewater technologies. The sheer size of the Bear River Basin makes it difficult to attain water quality improvements, as modifications and improvements in one area of the Basin can be easily swamped by continued poor practices elsewhere.[99] Improvements in Bear River water quality will thus require significant investments of time, commitment, collaboration and coordination across the three states, and monitoring of greatest threats.

97 Wyoming does not have a numeric criteria or target for TP. Utah has set a numeric TP criteria for streams and rivers of 0.05 mg/L, while Idaho has a target level of 0.075 mg/L.

98 Analysis of samples collected between 1990 and 2000 show similar exceedance frequencies at all six sampling stations in the Lower Bear River (between Cutler Dam and the Great Salt Lake). At all six sampling locations the average annual TP was at least 0.14 mg/L, thus far exceeding the 0.05 mg/L water quality indicator. Additional information may be found in: Utah DEQ Division of Water Quality. 2002. Lower Bear River Watershed Restoration Action Strategy: A Sub-basin Assessment for the Lower Bear River and Tributaries from the Great Salt Lake to Cutler Reservoir in Box Elder County, Utah. F:\Administrative\TMDL's\Final TMDLs\Lower Bear TMDL final.PDF (utah.gov)

99 In contrast, it is possible for water quality concerns in small tributaries to be readily addressed by a single landowner's efficacious efforts and changes to land management practices.

Commonly occurring Bear River water quality concerns include sediment, nutrients, and temperature. Samples taken between 2006 and 2015 found that water quality is nearly pristine at the headwaters but deteriorates downstream.

At Corinne nearly 100% of samples exceeded phosphorous water quality standards.

11. TRADE-OFFS AND DISCUSSION

The Bear River faces increasing pressure on its water supply due to rapid population growth and nearby development, along with increasing pollutants in the River. Compounding this challenge is the looming threat of climate change, which is anticipated to impact the quality, quantity, and reliability of Bear River water, posing a significant threat to the well-being of the human communities and natural ecosystems that rely on it.

11.1. CLIMATE CHANGE AND THE BEAR RIVER

The degree to which climate change will impact the Bear River Basin is contingent, in part, on the future management of the River. The most prominent and controversial future management prospect is the Bear River Development Project. Authorized by the Bear River Development Act of 1991, this project features 13 potential reservoir combinations and pipeline alignments. Its primary objective is to deliver 220,000 acre-feet of water annually to counties on the Wasatch Front, facilitated by four water districts. The 2019 Bear River Development Report includes climate change datasets that have been developed to estimate potential impacts of climate change on water supply and the associated implications for the project.[100]

Nine climate scenarios developed by Wood and Bardsley (2015)[101] were integrated into the Bear River Development Project's BearSim model in an effort to predict potential future River flows. The simulation of storage characteristics for each of the 13 reservoir combination scenarios resulted in more than 100 sets of outcomes. The inclusion of these simulated climate change scenarios generally reduced the required storage capacity to meet the 10% supply shortage reliability goal. Assuming a storage capacity of 400,000 acre-feet and using data from the 50th percentile, most of the scenarios were found to deliver an average annual volume of between 202,000 and 206,000 acre-feet, with a maximum annual supply shortage of 22,000 acre-feet.[102]

According to the Utah Rivers Council, the Bear River Development Project is expected to divert up to 20% of the water that would naturally reach the Great Salt Lake which could result in an 8.5- to 14-inch reduction in the Lake's water levels and expose an additional 30-45 square miles of lakebed.[103] Numerous references indicate that Great Salt Lake levels have dropped substantially over the last century. The decrease in water levels has intensified since 2020, with an average deficit of 1.2 million acre-feet per year. Although climate change is not the primary factor contributing to Great Salt Lake water loss, evaporation resulting from climate change accounts for an estimated 8-11% of the Lake's decline.[104] Further loss of lake water may result in the degredation of Great Salt Lake habitat, exposure of toxic dust, and increased

100 Utah Division of Water Resources (2019, October). Volume I of III: Bear River Development Report. Utah Division of Water Resources. Accessed online at https://water.utah.gov/wp-content/uploads/2019/11/Bear-River-Development-Report-Volume-I-Report-Final.pdf.

101 Wood, A. and T. Bardsley. (2015). Vic Model Calibration and Future Hydroclimate Analysis in Selected Utah Watersheds: Report to the Utah Division of Water Resources. Accessed online at: https://wwa.colorado.edu/sites/default/files/2021-08/Weber_River_Basin_Climate_Vulnerability_Assessment.pdf.

102 Utah Division of Water Resources (2019, October). Volume I of III: Bear River Development Report. Utah Division of Water Resources. Accessed online at https://water.utah.gov/wp-content/uploads/2019/11/Bear-River-Development-Report-Volume-I-Report-Final.pdf.

103 Utah Rivers Council. (no date). Bear River Development. Accessed online at: https://utahrivers.org/bear-river-development.

104 Anderegg et al. (2023). Great Salt Lake Policy Assessment: A Synthesized Resource Document for the 2023 General Legislative Session. Accessed online at: https://gardner.utah.edu/wp-content/uploads/GSL-Assessment-Feb2023.pdf?x71849

salinity levels that are incompatible with the Lake's food webs.[105]

In May of 2010, scientists and managers representing 20 public agencies convened to consolidate information on the known and projected impacts of climate change in the Bear River Basin. Workshop participants reviewed two likely climate change scenarios developed by scientists at the National Center for Atmospheric Research and the University of Colorado's Western Water Assessment. Taken together, the two scenarios predict that by 2040-2060, there will be a 4.9-6.3°F warming of the climate, a 5-18% reduction in annual runoff, a later accumulation of fall snowpack with a 10-15% reduction in peak accumulation, an earlier spring melt (by two to four weeks), earlier runoff timing (by one to three weeks), a 10-15% reduction in low summer flows, a 25-50% reduction in high summer flows, and a 30-50% increase in interflows due to more rain events. (Similar predictions are detailed in the Great Salt Lake Strike Team report; by 2050 a high greenhouse gas emission scenario is projected to increase temperatures by 5°F and increase GSL evaporation by 8%.) Pursuant to these scenarios, participants involved in the workshop identified a series of potential impacts on the Bear River Basin, focusing primarily on wetlands and the Bonneville Cutthroat Trout. Findings included warming water temperatures, diminished water quality, reduced stream connectivity, diminished aquatic habitat, and reduced habitat complexity.[106]

The pressures facing water supply and water quality in the Bear River Basin and the Great Salt Lake impact water use and associated economic activity. Trade-offs between water use by users, including residential development, agricultural, environmental, and industrial uses, will impact the economic values associated with the Bear River. For example, if additional water is allocated to residential development, less water will be available for other uses, including agriculture and recreational use in the Great Salt Lake. Such trade-offs will impact who benefits from Bear River water as well as the magnitude of the benefits. Climate change and its expected potential reduction on water quantity in the region will exacerbate water use trade-offs, especially in years of drought. While estimating the economic impacts of water use trade-offs is beyond the scope of this report, the values are expected to be significant.

11.2. THE VALUE OF BEAR RIVER WATER RIGHTS AND CONSERVATION

Water supply pressures in the Bear River and the Great Salt Lake affect the value of water in the region. When the demand for water considerably outpaces a constrained supply, as in the Bear River Basin, there is significant upward pressure on the value of water. In such instances, water conservation often becomes a more cost-effective alternative than purchasing water rights.

Unlike land, water is not owned, but a water right entitles the owner of the right to use a specific allocation of water, subject to availability. Water rights are generally not traded in a traditional market setting (such as the real estate market for property sales), but water rights can still be bought and sold subject to regulatory and legal constraints. When looked at together, water right sales in a region can be used to understand the market for water rights including the potential price of a water right.

Water markets are highly location and use specific. Water right sales data are often limited or nonexistent since transactions are generally not publicly disclosed. Despite the lack of water right price data, there are at least two methods for estimating the value of water rights. The 'comparable sales' approach uses available water right sales data to estimate the value of similar or comparable water rights. Alternatively, the cost of water conservation and other alternative measures developed to reduce water demand or increase water supply can provide a measure of a city's willingness to pay

105 Abbott et al. (2023). Emergency measures needed to rescue Great Salt Lake from ongoing collapse. Accessed online at: https://pws.byu.edu/GSL%20report%202023.

106 Degiorgio, Joan; McCarthy, Patrick; Cross, Molly; Garfin, Gregg; Gori, Dave; Tuhy, Joel. (2010). Bear River Climate Change Adaptation Workshop Summary. Southwest Climate Change Initiative. https://www.cakex.org/sites/default/files/documents/SWCCI-BearRiver-Climate-Adaptation-Wkshp-FINAL-Report-Nov-2010.pdf.

for additional water supplies. While not an actual water right value, these willingness-to-pay values can be utilized to estimate the value of water in a region.

Traditionally, the comparable sales approach values a specific water right based on comparable water rights sales with similar characteristics. Since our goal is to assess the value of water rights in the Bear River Basin, water right transactions (or quoted prices) in the Basin are deemed relevant for the entire basin. Although water right sales data are not publicly available for the Bear River Basin, one-year lease prices for agricultural water (leased for environmental instream flow) are estimated at between $150 and $2,000 per acre-foot annually according to Jared Manning, Deputy State Engineer with the Utah Division of Water Rights.[107]

11.2.1. Conservation and Reuse

Municipalities can rely on water conservation to avoid or reduce the need for additional water supplies. The cost of water conservation indicates a city's willingness to pay for additional water supplies. However, because water conservation not only reduces the need for acquiring a water right, but also for treatment and conveyance, the cost of conservation can be considered a lower bound of a city's willingness to pay to acquire an additional water right.

Residential and agricultural conservation measures have been shown to provide significant reductions in water use. Table 27 provides a list of such conservation measures, including the cost of technology per acre-foot of water saved and the total potential water savings in Utah. The list is not intended to provide a complete overview of water conservation technology; the list is provided to illustrate the potential cost of water conservation.

Table 27. Conservation Measures Relevant to the Bear River Basin ($2022)

Technology	Cost ($/AF)	Water Savings (AFY)
Residential Watering at Night	$0	1,266
Commercial Watering at Night	$0	525
Institutional Watering at Night	$0	844
Residential Irrigation Scheduling	$132	90,335
Commercial Irrigation Scheduling	$134	5,112
Institutional Irrigation Scheduling	$134	8,211
Agriculture Irrigation Scheduling	$185	349,351
Ag Conversion to Sprinkler Irrigation	$202	247,213
Low Flow Showers	$291	5,693
Rainwater Harvesting, Rain Barrels	$582	11,886
Secondary Wastewater Reuse	$686	69,173
Low Flow Toilets	$813	41,667
Turf Conversion	$4,236	104,708
High Efficiency Clothes Washers	$7,421	4,804
Weighted Average	**$741**	

Source: (Edwards & Null, 2019)[108]

Note: Although assessed by Edwards & Null, we have excluded agriculture canal piping from this list because research is inconclusive on the effectiveness of canal piping as a water conservation technology.[109]

11.2.2. Water Development Projects

Due to limited water supplies in the Region, water development projects have been evaluated in the area.[110]

107 Larsen, Leia (2023, March 14). Farmers are skeptical about participating in water leasing to save the Great Salt Lake. Here's why. The Salt Lake Tribune. Accessed online at https://www.sltrib.com/news/environment/2023/03/14/farmers-are-skeptical-about/.

108 Edwards, E. C., & Null, S. E. (2019). The cost of addressing saline lake level decline and the potential for water conservation markets. *Science of the Total Environment*, 435-442.

109 https://extension.usu.edu/irrigation/research/understanding-irrigation-water-optimization Pérez-Blanco, C. D., Hrast-Essenfelder, A., & Perry, C. (2020). Irrigation technology and water conservation: A review of the theory and evidence. Review of Environmental Economics and Policy. Morrisett, C. N., Van Kirk, R. W., Bernier, L. O., Holt, A. L., Perel, C. B., & Null, S. E. (2023). The irrigation efficiency trap: rational farm-scale decisions can lead to poor hydrologic outcomes at the basin scale. Frontiers in Environmental Science, 11, 1.

110 Alternative measures developed to increase water supply are presented here to highlight willingness to pay for additional supplies, regardless of the political nature of the projects.

Though development projects do not directly represent the market value of water rights in the region, they are highlighted here to illustrate regional users' high willingness to pay for additional water.

The Utah Division of Water Resources presented aquifer storage and recovery (ASR) as a method to store surface water for future municipal and industrial use.[111] ASR can be used to store treated surface water during periods of low water demand for later use during periods of peak water demand. ASR has been shown to enhance the reliability of existing water supplies and allow for increased instream flows to support aquatic species and habitat during low-flow periods. The cost of ASR development presented by the Utah Division of Water Resources is $553 per acre-foot. Costs per acre-foot are derived for the Bear River Development Project, a water development project in the Bear River region - by dividing the total project cost by the project's potential water delivery. Resulting values range from $780 to $970 per acre-foot for the Bear River Development Project.[112]

The range in potential water values is likely an indicator of the general shortage of available marketable water rights in the region. Though not a perfect substitute for the market value of water rights, the value of conservation water and water development projects can provide context for the value of water in the region. With the potential trade-offs facing regional water users and the exacerbating effects of climate change on water supply, the value of water in the region will continue to increase and water conservation across all water user groups may allow for the continued economic benefits of water use in the Bear River Basin.

11.3. CONCLUSION

The Bear River is essential for rural communities located along its path. The vast market and non-market values that have been detailed in this report are all dependent upon the Bear River maintaining sufficient and consistent water quantities that are not impaired by pollutants. As water quantity and quality decrease in the Bear River, all the documented economic values are at risk of being lost, or severely diminished. Adversely affected economic values are unlikely to decrease at a linear rate with decreasing water quantity and quality. As documented along the Bear River, in the Great Salt Lake, and in Bear Lake, water levels have critical thresholds where even a small decrease in water levels can cause much larger damage to the corresponding economic values (as a relative percentage). This likely also holds true for water impairment of the Bear River.

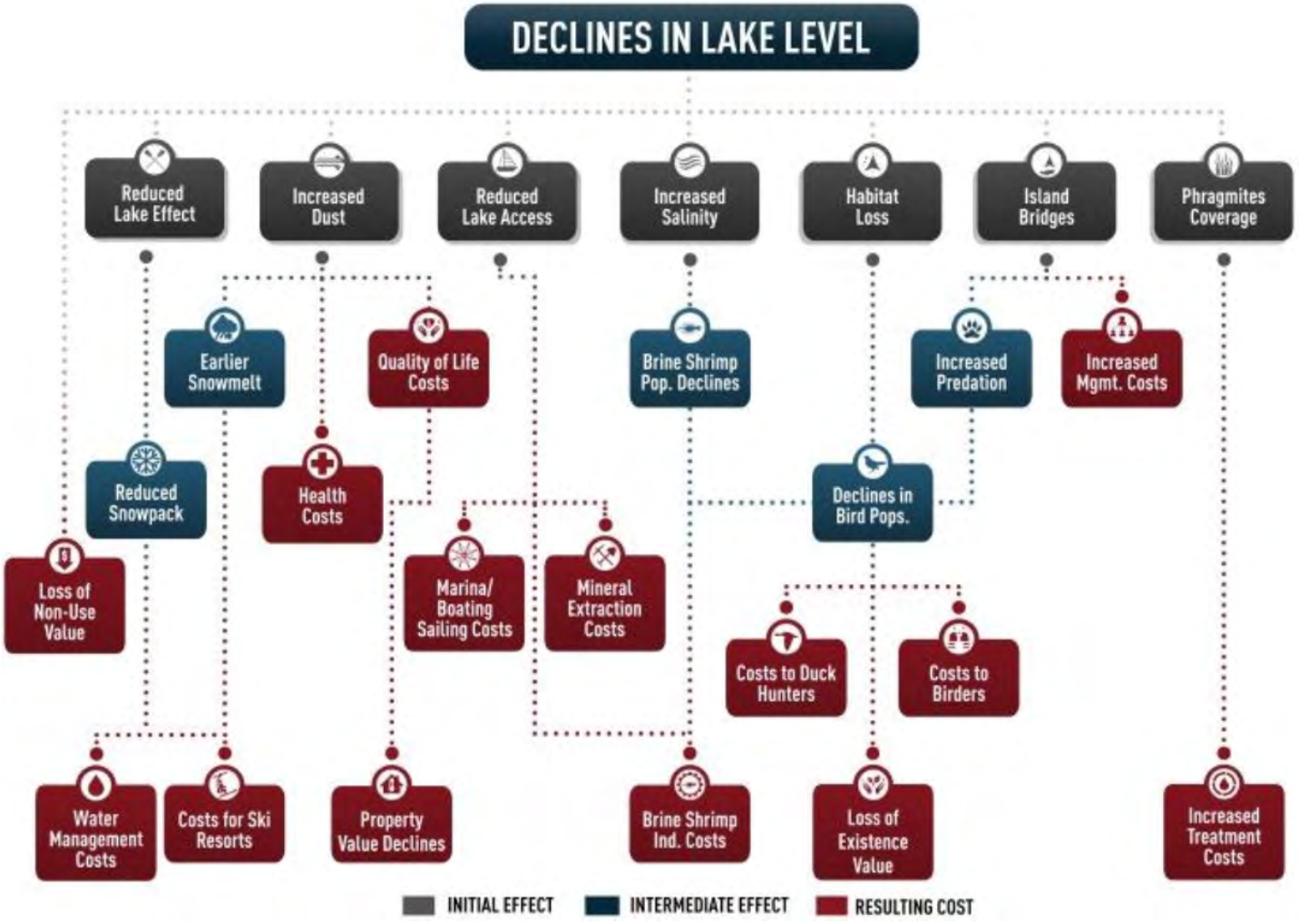
With the Bear River accounting for 39% of all inflows to the Great Salt Lake, decreases in Bear River water can spur decreases in Great Salt Lake economic values. A decrease in Great Salt Lake water levels would adversely affect the Great Salt Lake values that we have included in our Bear River values, but would lead to additional costs to the local economy that are not quantified here, including health costs and mitigation/maintenance costs due to habitat loss, invasive species, and increased dust.[113] Figure 13 illustrates the potential effects and costs associated with a decline in water levels at the Great Salt Lake.

111 Utah Division of Water Resources (2004). Bear River Basin Planning for the Future. Accessed online at https://water.utah.gov/wp-content/uploads/2020/06/Bear-River-2004.pdf.

112 Edwards, Eric C., Bosworth, R. C., Adams, P., Baji V., Burrows, A., Gerdes C., and Jones, M. (2017). Economic Insight from Utah's Water Efficiency Supply Curve. *Water*, 214.

113 ECONorthwest. (2019). *Assessment of Potential Costs of Declining Water Levels in Great Salt Lake.* Retrieved from Prepared for the Great Salt Lake Advisory Council.

Figure 13: Costs associated with a Decrease in Water Levels at Great Salt Lake



Source: (ECONnorthwest, 2019)

Thus, the importance of a healthy and full Bear River is not only relevant to the communities and people that live in the Bear River Basin and those who rely on Bear River goods and services but is also important to all the people that depend on the Great Salt Lake. This report has detailed the numerous market and non-market economic values of the Bear River and has illustrated the connectivity of the Bear River to the greater region. As regional water policy continues to evolve, the values presented in this report can be used as a monitoring baseline and as a starting point for understanding how Bear River economic values may be affected by new policies.

Numerous data limitations were encountered in the process of conducting this research that, if addressed, would improve the ability to glean insights from this analysis. For example, a lack of primary non-market valuations for the Bear River, Bear Lake, and Great Salt Lake necessitated the use of benefit transfer methods. Similarly, transfer methods were required for some of our recreation expenditure profiles, as the only primary economic study of recreation activities in the area is that conducted by CEI at Bear Lake in 2022. Future research incorporating advanced hydro-economic models would better help elucidate water use trade-offs, connections and interplay between groundwater and the Bear River, and critical water quantity and water quality thresholds in the Bear River, Bear Lake, and Great Salt Lake.

APPENDIX A: METHODS FOR ESTIMATING REGIONAL ECONOMIC IMPACTS AND CONTRIBUTIONS FOR THE BEAR RIVER

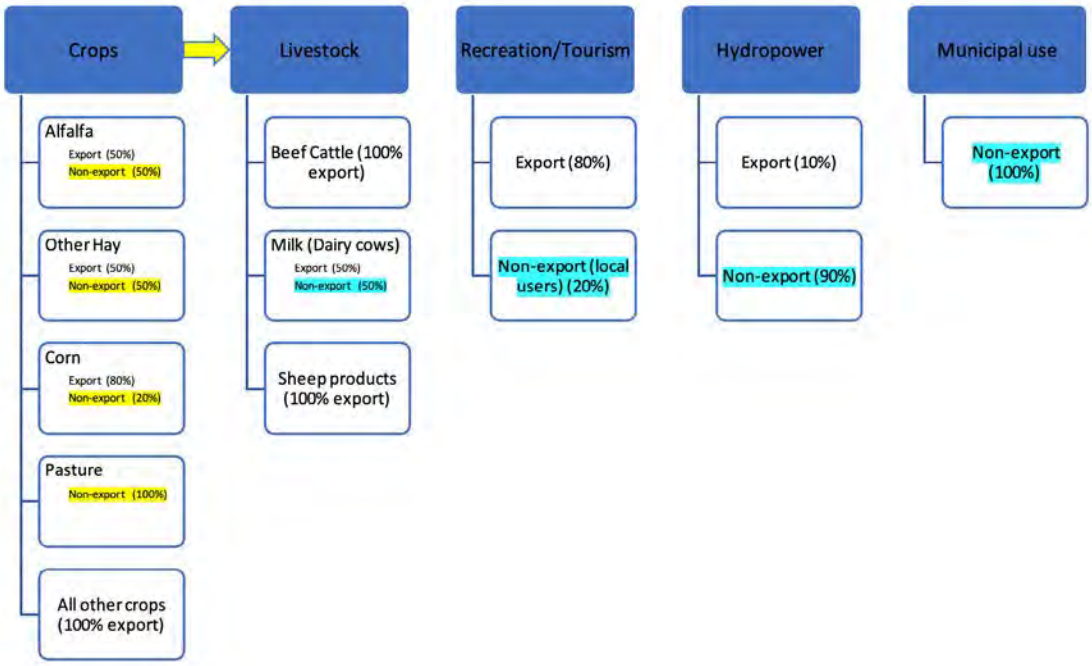
Regional economic impact analysis is predicated on economic base theory that emphasizes the importance of exported goods that bring revenue in from outside of the area.[114] This injection of out-of-region money is brought into communities and is then recirculated in the regional economy for local goods and services that support the export industry (indirect effects) and that support the employees and households of the export industry with infilling services (induced effects). Exports can be especially important in rural areas with limited economic opportunities, such as the Bear River region.

Some of the largest exports from the Bear River regional economic zone are beef cattle, alfalfa, milk, and outdoor recreation, all of which are dependent on Bear River water and could be lost if Bear River water quantity and quality were critically reduced. Some locally grown hay and corn is sold in-region to support livestock and some is exported out of the region. Crops sold for export represent new wealth, while locally sold crops are critically important to export production (e.g. hay in the production of cattle) and represent a recirculation of regional wealth. Exported goods generate regional economic "impacts" that can be attributed with generating new rounds of direct, indirect, and induced effects, while non-exported goods and services generate regional economic "contributions" that have indirect and induced effects that represent recirculated local wealth.

Due to the complexity of estimating regional economic impacts attributable to a river spanning multiple counties and states and the complexity of determining the exact sales location and flows of marketed goods and services, a simplified economic model must be constructed based on generalized export percentages. To construct our export assumptions, we combine the use of relevant literature, hypothesized models, and feedback from local stakeholders. Figure A1 shows the primary goods and services attributable to Bear River water and illustrates the assumed export and non-export percentages for each category.

114 Watson, P., Wilson, J., Thilmany, D., & Winter, S. (2007). Determining Economic Contributions and Impacts: What is the difference and why do we care?. *Journal of Regional Analysis & Policy*, *37*(2), 140-146.

Figure A1. Model for Marketed Export and Non-Export Products Attributable to Bear River Water



Notes: There are two primary types of non-exports, or products sold locally. Non-exports highlighted in yellow are inputs used in the production of Bear River Basin goods that are exported (specifically, in the production of Bear River Basin livestock, most of which are exported). Non-exports highlighted in light blue are consumed locally and are not inputs for Bear River exported products.

In this report we estimate the export percentage for all crops and livestock, outdoor recreation, and hydropower in order to conduct regional economic impact analysis for the exported goods, (for which direct, indirect, and induced effects are tabulated in IMPLAN). For the non-exported goods and services highlighted in light blue in Figure A1, we only estimate direct effects,[115] or direct contributions associated with employment, labor income, and regional output because non-exported goods do not spur "new" indirect and induced effects regionally. However, the non-exported goods utilized by Bear River exported goods (e.g., alfalfa/hay sold locally as winter feed for exported livestock) and highlighted in yellow in Figure X will be represented in the indirect effects (backward linkages) calculated for export products and are not separately aggregated to avoid double counting.

Detailed methods for estimating the amount of Bear River crops exported and sold locally are presented below. Methods for estimating export percentages for recreation, tourism, and hydropower are included in those individual sections.

ESTIMATING THE EXPORT MARKET FOR BEAR RIVER BASIN AGRICULTURE AND LIVESTOCK

Many of the crops and livestock produced in the Bear River Basin are exported out of the region to customers in other parts of Idaho and Utah, throughout the U.S., and abroad. Extensive international markets are available for agricultural products coming from the three Bear River states, as shown in Table A1.[116] It is important to note these figures exclusively represent international exports and do not account for domestic trade.[117] The significant value of exported agricultural production from Idaho, Utah, and Wyoming indicates an established export market out of the immediate region.

115 The one exception is for non-exported recreation and tourism, for which we do not estimate a marketed economic value. While local recreationists have some expenditures attributable to the Bear River recreation site being visited, their expenditures are dramatically less than out-of-region visitors as they typically will not need to purchase lodging and will have much lower expenditures for fuel, food, gear, and entertainment. Additionally, expenditure profiles for local users are not as prevalent as those for out-of-region visitors and are limited in their applicability to Bear River recreation sites.

116 The agricultural products presented encompass only those with significant production within the Basin. These figures are based on five-year averages.

117 ERS. (2022, December 8). U.S. Agricultural Exports, State Detail by Commodity: Calendar Years 2000-2021. www.ers.usda.gov/data-products/state-agricultural-trade-data/

Table A1. Average 2000-2021 International Exports of Agricultural Products by State (millions of $2022)

Crop Type	Idaho	Utah	Wyoming	Basin Total
Beef	$236.90	$67.80	$131.40	$436.10
Dairy Products	$494.30	$71.10	$5.30	$570.70
Vegetables, fresh	$182.10	$0.00	$2.70	$184.80
Wheat	$381.70	$23.30	$11.90	$416.90
Corn	$27.00	$4.20	$4.20	$35.40
Grain	$77.30	$17.20	$18.00	$112.50
Feed	$138.30	$44.80	$49.70	$232.80
Other Plant Products	$586.20	$159.00	$59.60	$745.20
Total	**$2,123.80**	**$387.40**	**$223.20**	**$2,734.40**

Source: (ERS, 2022)

Due to the rural nature of the region and relatively small population base, the majority of crops are assumed to be exported outside of the immediate region, apart from a small agro-tourism industry primarily catering to fruit and vegetable sales along Highway 89. Due to the large livestock industry in the region, feed exports and pasture requirements for local livestock are estimated separately.

HAY, ALFALFA, AND OTHER

The Bear River Basin produces a significant amount of animal feed, much more than is necessary to support the local livestock and dairy industry. Livestock in the region are usually grazed May through October and fed hay overwinter from November through April. Overwinter feeding requirements are on average 0.4 tons per month for cattle and 0.1 tons per month for sheep. For the six months of winter this equates to a total of 2.4 tons for cattle and 0.6 tons for sheep.[118] County-level livestock and feed requirements are presented in Table A2. In total, the overwinter feed requirements necessary to support the cattle and sheep livestock in the ten counties is estimated at roughly 1 million tons.

On average nearly 1.8 million tons of irrigated alfalfa and other grass hay are grown in the Bear River Basin each year, suggesting a surplus of almost 800,000 tons (45% of total irrigated Basin hay production) available for export. This figure represents a lower bound of hay exports due to the potential for alternative feed sources, including late season grazing on alfalfa fields and substitution of grain/corn and other feed for hay/alfalfa. If corn and other feed supplant just 5% of alfalfa/hay needed for winter livestock feed, we assume 50% of all alfalfa and other hay is exported from the Bear River Basin.

Table A2. Livestock Feed Requirements in the Region

	Livestock Counts (by County)		Feed Requirements (in tons)		
	Cattle & Calves	Sheep & Lamb	Cattle & Calves	Sheep & Lamb	Total
Utah					
Box Elder	78,614	46,914	188,674	28,148	216,822
Cache	57,695	2,685	138,468	1,611	140,079
Rich	39,726	7,501	95,342	4,501	99,843

118 USU. (Accessed 2023). *How Much Feed and Forage You Need for Livestock.* extension.usu.edu/smallfarms/research/forage-needs

Summit	18,707	12,603	44,897	7,562	52,459
Idaho					
Bear Lake	28,175	6,175	67,620	3,705	71,325
Caribou	25,146	2,186	60,350	1,312	61,662
Franklin	33,532	664	80,477	398	80,875
Oneida	23,388	305	56,131	183	56,314
Wyoming					
Lincoln	43,358	20,090	104,059	12,054	116,113
Unita	38,737	32,118	92,969	19,271	112,240
Total	**387,078**	**131,241**	**928,987**	**78,745**	**1,007,732**

Source: National Agricultural Statistics Service. (2017). ***2017 Census of Agriculture, County Profile****. www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles; USU. (Accessed 2023).* ***How Much Feed and Forage You Need for Livestock****. https://extension.usu.edu/smallfarms/research/forage-needs*

Based on our modeling, we assume 50% of alfalfa and other hay production is exported from the region and 50% is sold locally. For corn production, we assume 80% is exported and 20% is sold locally.

PASTURE: GRAZING

Grazing is measured in animal unit months (AUMs). To estimate forage requirements we assume 1.2 AUM per month for cattle (or 7.2 AUM over the six-month grazing season) and 0.2 AUM per month for sheep (or 1.2 AUM over the grazing season).[119]

Utah's irrigated pastures yield roughly 3 to 6 AUMs per acre annually on low productivity pasture and 6 to 10 AUM per acre annually on highly productive pasture. For the 97,973 acres of pasture in the Bear River Basin, estimated yield ranges from approximately 290,000 AUMs to 980,000 AUMS.

The forage requirements and pasture yields described above can be used to estimate the carrying capacity (or maximum stocking rate) of Basin pasture. This approach indicates Basin pasture can support between 40,822 and 136,074 cattle, between 244,933 and 816,442 sheep, or some mix of both annually (see Table A3).

Table A3. Pasture Grazing Carrying Capacity (Supply) in the Bear River Basin

	Yield (AUMs/ Acre)	Basin Total AUMs	Carrying Capacity - Cattle	Carrying Capacity - Sheep
Max	10.0	979,730	136,074	816,442
Min	3.0	293,919	40,822	244,933
Average	6.5	**636,825**	**88,448**	**530,687**

Source: USU. (Accessed 2023). ***How Much Feed and Forage You Need for Livestock****. https://extension.usu.edu/smallfarms/research/forage-needs; (Utah Division of Water Resources, Retrieved 2023)*

119 *Ibid.*

Based on these figures, the 387,078 cattle and 131,241 sheep residing in the 10-county region would require between 294,445 and 981,484 acres of pasture for their summertime forage. We therefore conclude the Basin's 97,973 acres of pasture are insufficient to provide adequate forage for the entire Basin's livestock. **Basin pasture is thus likely grazed exclusively by animals residing in the 10-county region.**

Table A4. Pasture Grazing Demand in the Bear River Basin

	Cattle	Sheep	Total
Animal Count	387,078	131,241	518,319
AUM Requirements	2,786,962	157,489	2,944,451
Grazing Requirements in Acres			
High productivity Pasture	278,696	15,749	294,445
Low productivity pasture	928,987	52,496	981,484
Average productivity pasture	428,763	24,229	452,992

Source: USU. (Accessed 2023). How Much Feed and Forage You Need for Livestock. https://extension.usu.edu/smallfarms/research/forage-needs

The difference between local supply and demand of pasture can be explained by looking at alternative feed (including hay and grain) and supplemental grazing supply. Public grazing leases can supplement summertime private pasture grazing. The Bureau of Land Management permits livestock grazing for domestic animals on 11.5 million acres of public rangeland in Idaho,[120] 22 million acres in Utah,[121] and 17.4 million acres in Wyoming.[122]

Livestock and Milk Exports

While a miniscule amount of sheep products and beef are likely sold for local consumption within the 10-county Bear River regional economic zone, we assume all beef and sheep products are exported out of the region. Milk from dairy cows, on the other hand, is sold both inside and outside the region. For example, cheese manufacturing in Cache County, Utah generates over $2 billion a year (IMPLAN, Cache County data 2022), and while the required milk is not exclusively sourced from dairy cows in the Bear River Basin, a substantial amount of the milk likely comes from the Basin's cows. For our regional economic model, we assume 50% of Bear River Basin milk production is sold within the 10-county regional economic zone and 50% is exported out of the region.

All beef cattle and sheep are assumed to be exported (100%), while 50% of milk production is assumed to be exported.

APPENDIX B: BEAR RIVER MUNICIPAL WATER USE

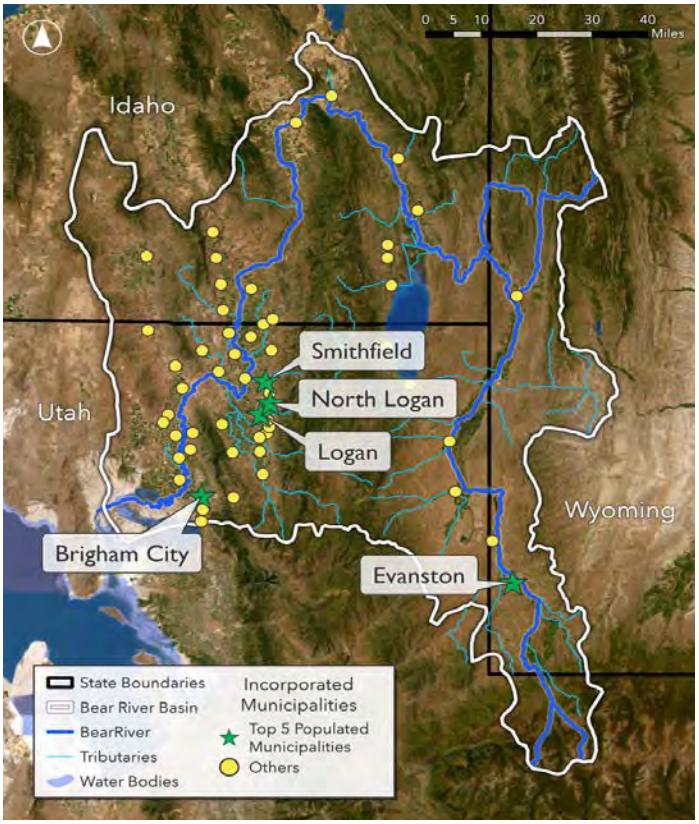
Most municipalities within the Bear River Basin depend upon groundwater; we identified only six municipalities that depend upon surface water. Although reliance on surface water does not guarantee a direct connection to the Bear River, we assume one exists based on the location of the municipalities within the Basin and the absence of other water bodies in the area. This appendix provides additional details regarding municipal water use for the six communities identified as reliant on surface water - Evanston, WY and the Utah municipalities of North Logan, Lewiston, Brigham City, Elwood, and Mendon.

120 Bureau of Land Management. (2016). *Idaho Rangeland Management and Grazing*. www.blm.gov/programs/natural-resources/rangeland-and-grazing/rangeland-health/idaho.

121 BLM. (Accessed 2023). *Utah Rangeland Management and Grazing*. Retrieved from Bureau of Land Management: https://www.blm.gov/programs/natural-resources/rangeland-and-grazing/rangeland-health/utah.

122 BLM. (Accessed 2023). *Wyoming Rangeland Management and Grazing*. Retrieved from Bureau of Land Management: https://www.blm.gov/programs/natural-resources/rangeland-and-grazing/rangeland-health/wyoming.

Figure B1. Municipalities in the Bear River Basin



Source: US Census Bureau. (2021). ACS 5-year Estimates: S0101.

CACHE COUNTY, UTAH

The towns of North Logan and Lewiston are located in Cache County. Cache County observes an annual groundwater recharge of approximately 200,000 acre-feet and consumptive use of approximately 30,000 acre-feet annually.[123] Although groundwater volume tends to be relatively stable, there is little information regarding the interactions between groundwater and Bear River surface water or how they influence one another. Much of the groundwater originates from springs and sources close to the surface, making it somewhat difficult to distinguish between groundwater and surface water. For instance, the City of Logan utilizes various springs via artesian wells - wells that tap into confined aquifers, relying on natural underground pressure to bring water to the surface without the need for mechanical pumping. Cache County municipalities use roughly 10,000 acre-feet of groundwater from these springs annually. Major consumers include the Utah State University campus, golf courses, and cemeteries.

Moreover, about one-third of the secondary water systems provided to residents in Cache County come from canal companies. This water is likely surface water sourced from Bear River tributaries. Additionally, the small town of Hyrum, UT, relies entirely on Bear River tributary surface water for its community secondary water system.

NORTH LOGAN, UTAH

North Logan relies on six wells and several springs in Green Canyon for its culinary water supply. Approximately 50% of residents access secondary water from canal companies, primarily through pressurized pipes. In 2017, the city provided 1,783 acre-feet of culinary water to 2,518 connections, averaging 150 gallons per capita per day (GPCD). Projected 2050 demand for North Logan stands at 3,114 acre-feet per year (AFY), well within the city's rights. However, as of 2019 the city was struggling with unaccounted systems losses: North Logan typically supplies about 17% more water than its customers consume. The unaccounted losses are suspected to result from various factors, including overflows, fire hydrant use, meter errors, and system leaks. To promote conservation, the city aims to save 15% of culinary water by 2050.[124]

123 Personal communication with Nathan Daugs, Cache Water District Manager on 10/03/23.

124 Cache-Landmark Engineering. (2019). *Conserve Water Utah*. conservewater.utah.gov/wp-content/uploads/SubmittedWaterPlans/North-Logan-City-2018.pdf

Table B1. North Logan, UT Water Sources and Capacity

Source	Volume (gpm)	Total (gpm)	AFY
Wells		5,265	8,493
Green Canyon Well 1	580		
Green Canyon Well 2	420		
*Green Canyon Well 3	175		
Green Canyon Well 4	2,250		
Beef Hollow Well	40		
1st West Well (Jacks Well)	1,800		
Spring/Surface		936-1,040	1,510-1,678
Springs from Water Canyon**	936-1,040		

Source: Cache-Landmark Engineering. (2019). ***Conserve Water Utah****. conservewater.utah.gov/wp-content/uploads/SubmittedWaterPlans/North-Logan-City-2018.pdf*

**Well under influence of surface water*

***Includes four springs and surface water from runoff*

LEWISTON, UTAH

Lewiston, Utah municipal water sources include both wells and springs, with springs explicitly indicated as a surface water source. Specific sources in the Lewiston water system include Griffin Well, Hy Bair Spring, and Clear Creek Spring (see Table B2). Note that the water right is not necessarily the actual amount used each year, but a maximum potential that can be limited by availability.

Table B2. Lewiston, UT Existing Water Sources

Source	Source Type	Current Beneficial Use	Minimum Reliable Flow (gpm)	Volume of Water Right (Acre-Feet)
Griffin Well (WS004)	Well	Municipal	897	364
Hy Bair Spring (WS002)	Spring (Surface)	Municipal	360	1,518
Clear Creek Spring	Spring (Surface)	Municipal	500	1,173
Total			**1,257**	**1,882**

Source: (JUB Engineers, 2021). Note: Clear Creek Spring is currently offline due to overflow air gap concerns.

In 2020, the city reported a residential consumption rate of 216 GPCD and an overall system consumption rate of 479 GPCD. Like North Logan, Lewiston is also monitoring system leaks with the goal of preventing water loss. Over the past five years, the city has successfully reduced total system losses from approximately 10.5% to 6.7%.[125]

EVANSTON, WYOMING

Although the city of Evanston once relied on groundwater to meet municipal demand, it now relies almost exclusively on surface water from the Bear River and Sulphur Creek. Evanston supports approximately 4,200 municipal connections. In 2009, the city's estimated surface water withdrawal was 4,088 AFY and their consumptive use was approximately 2,408 AFY (Table B3).

125 JUB Engineers. (2021). *Conserve Water Utah.* Retrieved from Lewiston, Utah 2021 Water Conservation Plan: https://conservewater.utah.gov/wp-content/uploads/SubmittedWaterPlans/Lewiston-City-2021.pdf.

Table B3. Evanston, WY Consumptive Water Use

Year	Municipal Population	Avg. Day (GCPD)	Avg. Day (MGD)	Surface Water Withdrawal	Avg. Annual Wastewater Discharge (AFY)	Surface Water Consumed
2001	12,200	316	3.86	4,300	1,547	1,000
2009	11,773	310	3.65	4,088	1,680	2,408

Source: The State of Wyoming Water Development Office. (2012). ***Wyoming State Water Plan****.* waterplan.state.wy.us/plan/bear/2011/finalrept/finalplan.pdf

Unused water is typically either reintroduced into the Bear River as lawn irrigation return flows or discharged from the wastewater treatment plant into the Yellow Creek Tributary. The 2011 update to Wyoming's Bear River Basin Water Plan indicates that Evanston's municipal water system also supplies water to an 18-hole golf course.[126] Given the decline in population between 2001 and 2009, the doubling of surface water consumption during that time frame is likely attributable to the establishment of the golf course.

BRIGHAM CITY, ELWOOD TOWN, MENDON CITY

In the most recent update of their Municipal and Industrial Use Report, the Utah Division of Water Resources attributes 30,408.7 acre-feet worth of reliable surface water supply to the Brigham City Water System, 474.5 acre-feet to the Elwood town system, and 724.5 acre-fee to the Mendon city system.[127] Table B4 shows water supply by source type for each supplier. Notably, there is no explicit mention of surface water withdrawals in the individual water plans for these municipalities. In light of this discrepancy, we have consolidated the aforementioned data into a single table rather than devoting a section to each municipality.

Table B4. Reliable Potable Sources for Community Water Systems, Select Communities

Water Supplier	Reliable Wells (ac-ft)	Reliable Springs (ac-ft)	Reliable Surface (ac-ft)	Total (ac-ft)
Brigham City Water System	6,872.1	10,976.0	30,408.7	48,256.8
Elwood Town	560.9	22.0	474.5	1,057.4
Mendon City	309.1	161.4	724.5	1,195.0

126 The State of Wyoming Water Development Office. (2012). *Wyoming State Water Plan*. waterplan.state.wy.us/plan/bear/2011/finalrept/finalplan.pdf.

127 Utah Department of Natural Resources. (2020). *Utah Department of Natural Resources.* Retrieved from 2015 Municipal and Industrial Water Use Data (2020 Update): https://water.utah.gov/wp-content/uploads/2020/07/2015WaterDataV3.pdf.

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APPENDIX C: BEAR RIVER STREAMFLOW AND PRECIPITATION TRENDS

We use trendlines to assess how Bear River flows have changed over time. Figure C1 contains a separate chart depicting the flow, trendline, and trendline equation for each of several select streamgage stations. Of particular interest is the slope of the trendline for each streamgage station. Comparing the trendline slopes illustrates that while streamflow at the Bear River's headwaters has declined minimally in the last five decades, flow reductions have been steadily more pronounced at gages located farther downstream (see Table C1). The more pronounced declines in streamflow that occur at downstream gages are the cumulative result of increases in withdrawals and slight decreases in precipitation.

Table C1. Bear River Streamflow trendline slopes (1971-2021)

Gage	Streamflow trendline slope
Headwaters	-0.493
Cokeville	-5.5778
Pescadero	-10.823
Idaho/Utah border	-16.993
Corrine	-27.701

Figure C1. Average Annual Discharge (1971-2021) for Select Bear River Streamgages

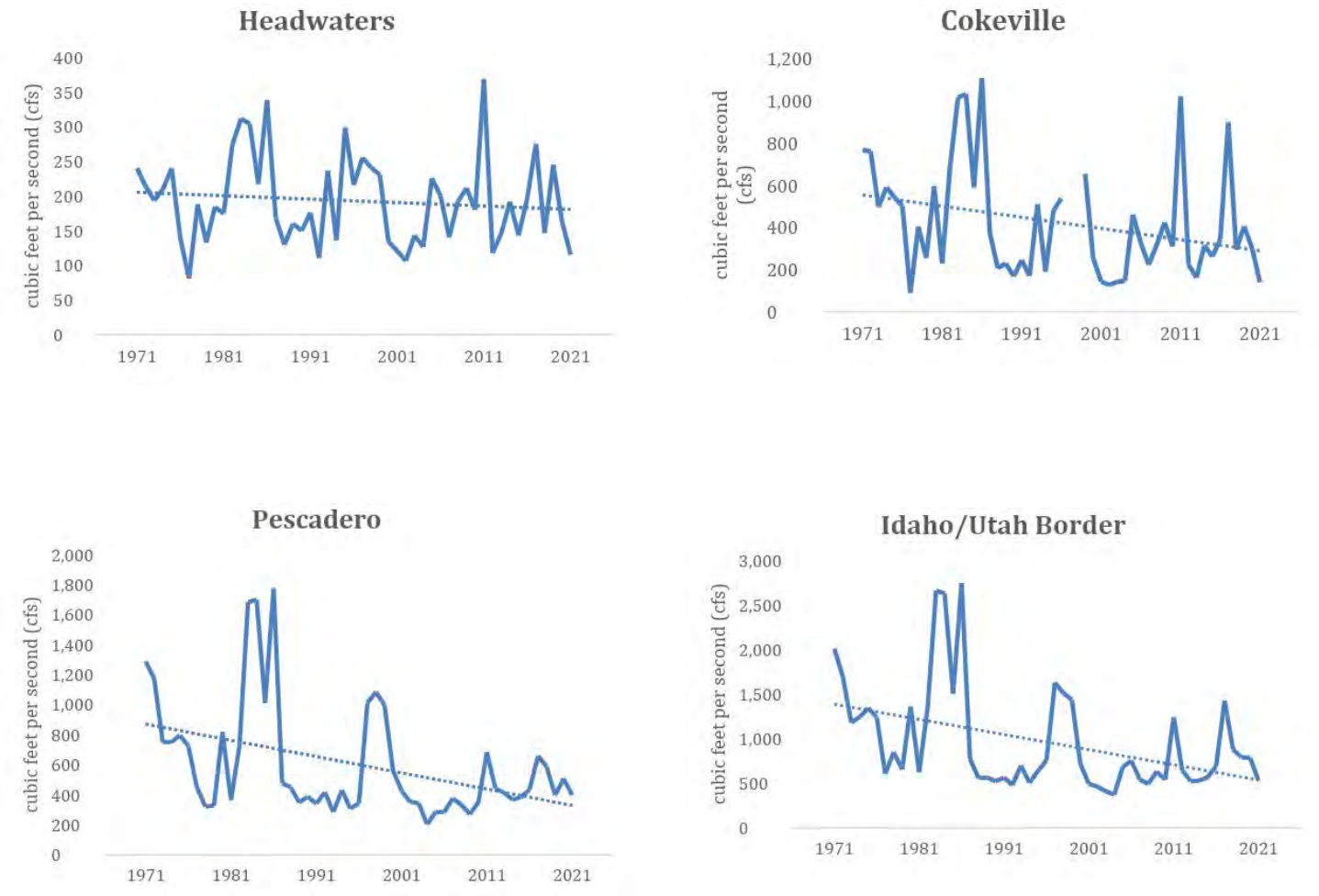
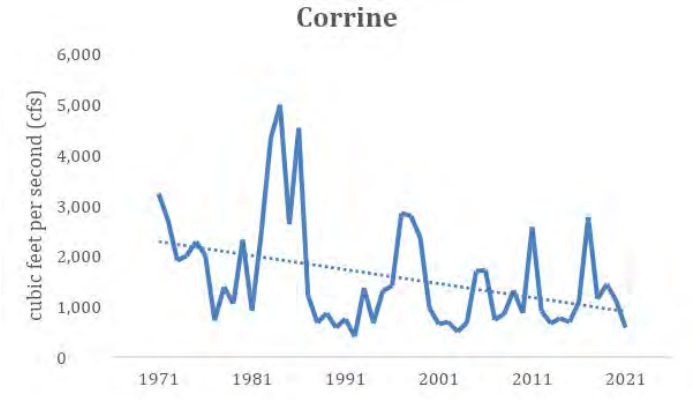
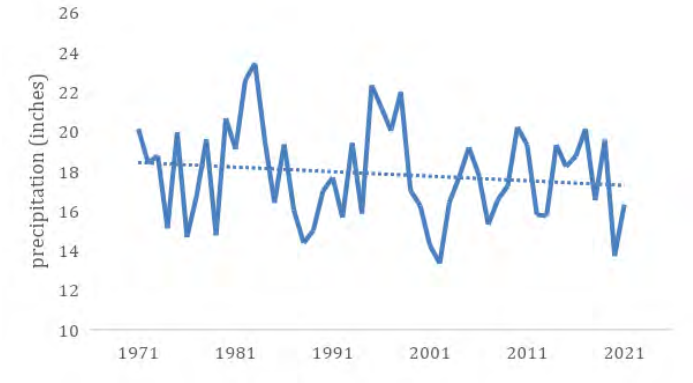


Figure C1. Average Annual Discharge (1971-2021) for Select Bear River Streamgages (Continued)



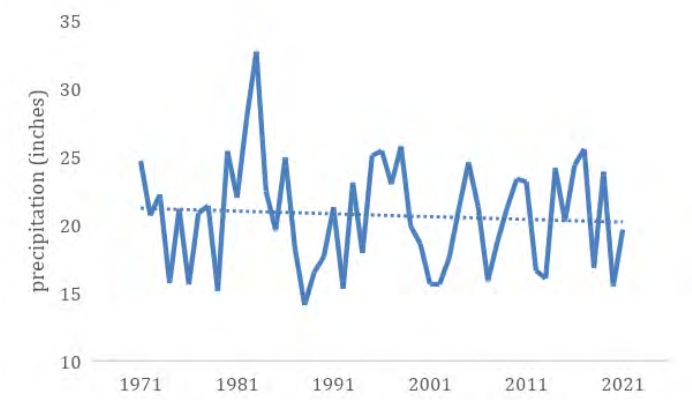
From NOAA's National Centers for Environmental Information, we downloaded county-level data (for 1971-2021, the same period used in the streamflow charts) for the 10 mainstem counties in our study area as well as state-level data for ID, UT, and WY. Total annual average precipitation data for the 10 counties and three states were charted and a trendline included for each (see Figure C2 and Figure C3). Although the precipitation trendlines have negative slopes, the precipitation trendlines are less steep than the Bear River discharge trendlines; the decline in streamflow has been more pronounced than the decline in precipitation.

Figure C2. ID, UT, and WY Average Annual Precipitation (inches)



Source: https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/statewide/time-series

Figure C3. Mainstem Counties' Average Annual Precipitation (inches)



Source: https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/county/time-series

APPENDIX D: HYDROPOWER VALUATION METHODS

This appendix provides details regarding the data, assumptions, and calculations used to derive the values pertinent to our analysis of Bear River hydropower. Energy production and price data was obtained from the 2022 Form 10-K filed by PacifiCorp's parent company, Berkshire Hathaway Energy Company. Table D1 details the amount of electricity (gigawatt hours) sold in 2022 by PacifiCorp to their customers (in Utah, Wyoming, Idaho, Oregon, Washington, and California) and on the wholesale market. Table D2 lists the percent of PacifiCorp's 2022 GWh sales generated and purchased by PacifiCorp.

Table D1. GWhs sold by PacifiCorp on the Retail and Wholesale markets (2022)

Customer Class	GWhs	%
Total Retail	**57,164**	**92%**
Residential	18,425	30%
Commercial	19,570	32%
Industrial	17,622	28%
Other	1,547	2%
Wholesale	**4,836**	**8%**
Total GWhs sold	**62,000**	**100%**

Source: Berkshire Hathaway Energy Company's 2022 Form 10-K

Table D2. PacifiCorp GWh sales by energy source (2022)

Energy Source	% of total
Generated	**80%**
Coal	43%
Natural gas	21%
Wind	11%
Hydroelectric and other	5%
Purchased - long-term contracts (renewable)	**15%**
Purchased - short-term contracts & other	**5%**

Source: Berkshire Hathaway Energy Company's 2022 Form 10-K

In our calculations we assume power sold by PacifiCorp to their customers is a mix of electricity produced by PacifiCorp and electricity purchased by PacifiCorp on the wholesale market. In contrast we assume power sold by PacifiCorp on the wholesale market is entirely produced by PacifiCorp. Imposing these assumptions and using data in Table D1 and Table D2, we estimate that in 2022 PacifiCorp provided to its customers with 11,433 GWhs purchased by PacifiCorp on the wholesale market:

*portion of energy purchased by PacifiCorp on wholesale market*GWhs sold to PacifiCorp customers=0.2*57,164=11,433.*

The remainder of power provided to PacifiCorp's customers – an estimated 45,731 GWhs (57,164 – 11,433 = 45,731) – was generated by PacifiCorp.

PacifiCorp produced an estimated 50,567 GWhs during 2022:

=GWhs generated by PacifiCorp and sold to PacifiCorp customers+GWhs generated by PacifiCorp and sold on the wholesale market=45,731+4,836=50,567.

The majority (90%) of the power produced by PacifiCorp is provided to its customers:

$$= \frac{GWhs\ generated\ by\ PacifiCorp\ and\ sold\ to\ customers}{total\ estimated\ generation} = \frac{45{,}731}{50{,}567} = 0.90$$

The remaining 10% of PacifiCorp's production is sold on the wholesale market. Although these calculations are based on data pertaining to PacifiCorp as a whole, we assume analogous estimates apply to power produced at Bear River hydroelectric facilities. Thus, we assume 90% of the average annual net power generated at Bear River hydroelectric facilities is provided to customers in Idaho, Utah, and Wyoming (Rocky Mountain Power customers), while the remaining 10% is exported outside the region.

For the portion of power produced on the Bear River and provided to Rocky Mountain Power (RMP) customers we use the information in Table D3 to estimate a weighted-average price of 8.69 cents per kilowatt hour:

$$P_{RMP} = \sum_{i=1}^{3} \left(\frac{GWh_i}{\sum_{i=1}^{3} GWh_i} * P_i \right)$$

where *GWhi* denotes the number of GWhs sold by PacifiCorp to Rocky Mountain Power customers located in state *i*, *Pi* denotes the average price of electricity for state *i*, and *i* denotes either Idaho, Utah, or Wyoming.[128]

128 Idaho, Utah, and Wyoming have some of the lowest retail prices in the country.

Table D3. State-Level Retail Electricity Sales and Prices (2022)

	Electricity sold to RMP customers		Average price of electricity (cents/kwh) (all sectors)
	GWhs	% of total	
Utah	26,100	68%	8.86
Wyoming	8,666	23%	8.24
Idaho	3,707	10%	8.53
Weighted average			**8.69**

Source: GWh data was obtained from Berkshire Hathaway Energy Company's 2022 Form 10-K.

Price data was obtained from US Energy Information Administration: https://www.eia.gov/electricity/data/browser/.

For the portion of power produced on the Bear River and exported outside the region we calculate an average price using 2022 volume (MWhs) and daily weighted average price ($/MWh) data from the four western electricity hubs for which the US Energy Information Administration (EIA) has data – the Northwest (Mid-Columbia), Northern California (CAISO), Southwest (Palo Verde), and Southern California (CAISO) price hubs. Using data from these four hubs reflects the fact that there are few limits on where excess electricity can flow, yet there are disconnects between the Western, Eastern, and Texas Interconnections – the three Interconnections operate relatively independently, with little power flowing between them.[129] The western region's total revenue and volume (Table D4) are used to calculate an average price of 10.16 cents per kilowatt hour.[130]

Table D4. Price hub annual revenue and volume (2022)

Price Hub	Revenue (2022 $)	Volume (MWhs)
Northwest (Mid-Columbia)	518,831,320	5,242,400
Northern California (CAISO - NP15)	17,596,460	155,600
Southwest (Palo Verde)	149,727,032	1,312,400
Southern California (CAISO - SP15)	277,126,176	2,767,200
Total	**963,280,988**	**9,477,600**

Source: US EIA https://www.eia.gov/electricity/wholesale/

APPENDIX E: METHODS FOR ESTIMATING VISITOR EXPENDITURES FOR BEAR RIVER PRIMARY RECREATION SITES

In this section, we provide information for seven categories of Bear River recreation sites and provide visitation and methodological assumptions used in our analysis. Bear River recreation sites were grouped into the following categories: National Forest headwaters, Bear Lake, US Fish and Wildlife Service National Wildlife Refuges (Cokeville Meadows, Bear Lake, and Bear River Migratory Bird), PacifiCorp recreation areas (Soda, Grace, Oneida Narrows, and Cutler), Bear River State Park, and Woodruff Narrows. The recreation sites are presented below in downstream order.

1. Bear River Headwaters --Uinta-Wasatch-Cache National Forest day-use and camping areas along the Bear River and East Fork Bear River.

The headwaters of Bear River originate on the north slope of the Uinta mountains in Utah and comprises Hayden Fork, Stillwater Fork, and East Fork Bear River. Along these tributaries and the upper main stem of Bear River are numerous campgrounds and day-use sites managed by the Evanston/Mountain View Ranger District of the Uinta-Wasatch-Cache National Forest. Highway 150, including much of the Mirror

129 U.S. Energy Markets 101: How Electricity Markets Work (leveltenenergy.com).

130 Wholesale prices differ from retail prices for numerous reasons, including the fact that wholesale prices change throughout the day, whereas retail prices are set infrequently (PacifiCorp prices are set once or twice annually); transmission costs; demand; weather; and transmission constraints.

Lake Scenic Byway, affords easy access to the Bear River headwaters for hiking and boating. In the winter, the Bear River headwaters are a snowmobile and skiing destination.

Bear River Headwaters annual visitation was estimated using Placer.ai cell phone-based visitation estimates. From 2020-2022 the annual average number of visits (one person for one day) is approximately 230,000 with 80% of visits occurring in the summer months. Unlike many parts of the Uinta-Wasatch-Cache National Forest, the Bear River Headwaters are generally farther away (> 50 miles) from the closest major population centers in the Wasatch Front. Placer.ai cell-phone visitation estimates revealed that 88% of Bear River Headwaters visits were from greater than 50 miles away.

We use National Visitor Use and Monitoring (NVUM) national averages for forest visitor expenditures, with specific details from the Uinta-Wasatch-Cache NF (such as reports for average party size to convert to visits)[131] to estimate annual change in recreation demand for the Bear River Headwaters. Based on visitation and drive distance, we apply expenditures only to non-local visits (88% of all visits) that are also primary purpose visits (89%), resulting in approximately 180,000 annual visits. NVUM expenditure profiles are provided by trip types, including day-use/overnight and local/non-local, where overnight non-locals have the greatest expenditures. To be conservative, we apply estimated expenditure averages for non-local day users and add lodging expenditures at the rate of overnight occurrence (estimated at 14% of all primary visits). About half of overnight visitors camp within the National Forest and about half get lodging accommodations adjacent to the National Forest.

In total, we estimate that the 180,000 annual non-local, primary purpose visits to Bear River headwaters in the Uinta-Wasatch-Cache National Forest result in $7,181,071 of annual visitor expenditures in the region. This "new" wealth coming into the region generates important local employment and income across 10 primary industrial sectors. Annual expenditures by industry sector are illustrated in Table E1 and are included in our overall economic impact analysis.

Table E1: Bear River Headwaters Annual Visitor Expenditures in Region ($2022)

Spending Categories	Per visit expenditures	Annual Expenditures
Motel	$4.42	$795,683
Camping	$0.74	$132,721
Restaurant	$7.50	$1,350,569
Groceries	$5.42	$975,665
Gas and oil	$15.34	$2,761,488
Other transportation	$0.29	$53,035
Entry fees	$2.09	$376,733
Recreation and entertainment	$1.50	$270,662
Sporting Goods	$1.60	$288,036
Souvenirs and miscellaneous	$0.98	$176,479
Totals	**$39.89**	**$7,181,071**

Sources: Placer.ai and NVUM national visitor spending profiles. Note: Annual expenditures are for 180,000 annual visits from non-locals with primary purpose.

2. Bear River State Park, Evanston, Wyoming and Woodruff Narrows Reservoir, Wyoming

Bear River State Park is a 324-acre day-use area in Evanston, Wyoming offering a number of activities and amenities associated with biking, hiking, fishing, and picnicking. The Park's proximity to Interstate 80 affords easy access to summer tourists traveling through southwestern Wyoming. We use Placer.ai cellphone-based visitation estimates for Bear River State Park, finding 130,590 annual visits, of which approximately 56% were from out-of-region visitors (or > 50 miles drive distance). While Bear River State Park and its trails are well used by locals and by visitors taking a break from Interstate 80, it is not a destination park for out-of-region tourists. Thus, most expenditures related to Bear River State Park visitation are incidental (e.g., souvenirs at the visitor's center) to

131 White, E. M. (2017). *Spending patterns of outdoor recreation visitors to national forests.* PNW-GTR-961. United States Department of Agriculture, Forest Service, Pacific Northwest Research Station.

other destinations and we do not include visitor expenditures for Bear River State Park.

Woodruff Narrows Reservoir is a small reservoir north of Evanston, Wyoming off Highway 89. The reservoir is popular for fishing and boating. Placer.ai estimates approximately 5,640 annual visits, with only 13% of visits coming from out-of-region visitors. With such high local use of Woodruff Narrows Reservoir, we do not include visitor expenditures.

3. Cokeville Meadows National Wildlife Refuge, Wyoming

Cokeville Meadows National Wildlife Refuge (NWR) is located in eastern Wyoming south of the town of Cokeville. Cokeville Meadows NWR encompasses approximately 20 miles of Bear River valley at the end of the Wyoming portion of the Bear River and supports one of the highest densities of nesting waterfowl in Wyoming.[132] Visitors come to Cokeville Meadows NWR to view birds and other wetlands species, as well as to fish and hunt.

Visitation was estimated for annual Cokeville Meadows NWR using Placer.ai cell phone-based visitation estimates using the average of the last three complete years (2020-2022).[133] Overall annual visitation is estimated at 3,170 visits, with 65% being from outside the region. Estimated visitor expenditures come from Caudill and Carver (2019)[134] and are combined with the two other refuges (Bear Lake NWR and Bear River Migratory Bird Refuge). See details under the Bear River Migratory Bird Refuge section below.

4. Bear Lake National Wildlife Refuge, Idaho

Bear Lake National Wildlife Refuge is located south of Montpelier, Idaho and encompasses Mud Lake and Dingle Swamp. Bear Lake NWR is just north of Bear Lake along the canals that divert Bear River water in and out of Bear Lake and is home to numerous waterfowl and other migratory birds. Primary activities in Bear Lake NWR include boating, hiking, driving tours, fishing, and hunting.

Visitation is estimated at 12,000 annual visits, with many visitors incorporating a visit to the Refuge as part of their Bear Lake vacation.[135] Estimated visitor expenditures come from Caudill and Carver (2019)[136] and are combined with the two other refuges (Bear Lake NWR and Bear River Migratory Bird Refuge). See details under the Bear River Migratory Bird Refuge section below.

5. Bear Lake, Idaho and Utah

In terms of outdoor recreation and nature tourism, Bear Lake is the crown jewel of the Bear River system. Bear Lake is a 109 square mile freshwater lake that straddles southeastern Idaho and northeastern Utah, and for over 100 years has served as a storage reservoir for Bear River water. The turquoise-colored waters of Bear Lake have earned it the nickname of the "Caribbean of the Rockies," and numerous visitors from Salt Lake City and the Wasatch Front recreate on Bear Lake in the summers.

In 2022, an in-depth regional economic contribution analysis of Bear Lake visitor expenditures was conducted by the Conservation Economics Institute, showing that there were approximately 1,115,000 visits to Bear Lake in 2021 that resulted in over $54 million of in-region visitor expenditures.[137] Full methodological details are contained in the CEI report.

132 Cokeville Meadows National Wildlife Refuge at: https://www.fws.gov/refuge/cokeville-meadows.

133 Visitation estimates obtained via Placer.ai included data for multiple years. To represent the most recent conditions, we took the average visitation from the last three years.

134 Caudill, J., & Carver, E. (2019). *Banking on nature 2017: The economic contributions of national wildlife refuge recreational visitation to local communities*. US Fish and Wildlife Service, Falls Church, Virginia.

135 Personal communication with Refuge manager Jeremy Jirak.

136 Caudill, J., & Carver, E. (2019). Banking on nature 2017: The economic contributions of national wildlife refuge recreational visitation to local communities. US Fish and Wildlife Service, Falls Church, Virginia.

137 Conservation Economics Institute (CEI), 2022. Regional economic contributions of Bear Lake. Available at: https://www.conservationecon.org/_files/ugd/5fc209_bb7487a9203d4c12bebafca89d95b0cd.pdf.

Table E2: Bear Lake Annual Visitor Expenditures in Region ($2022)

Expenditure Type (IMPLAN Sector #)	Total Expenditures
Other real estate (447)	$13,673,618.58
Retail - Food and beverage stores (406)	$7,111,784.05
Hotels and motels, including casino hotels (507)	$5,469,447.43
Retail - Gasoline stores (408)	$4,444,806.57
Tenant-occupied housing (448)	$4,102,085.57
Employment and payroll of state govt, other services (541)	$3,614,667.32
Other accommodations (508)	$2,734,723.72
Full-service restaurants (509)	$2,472,252.51
Limited-service restaurants (510)	$2,472,252.51
Retail - Motor vehicles and parts dealers (402)	$2,085,890.31
Retail - Sporting goods, hobby, musical instrument and book stores (410)	$1,944,856.15
Retail - Miscellaneous store retailers (412)	$1,651,025.51
Other amusement and recreation industries (504)	$1,234,757.84
Automotive repair and maintenance, except car washes (512)	$678,572.16
Performing arts companies (496)	$415,456.73
Amusement parks and arcades (502)	$415,456.73
Total	**$54,521,653.68**

Source: CEI 2022. Note: Spending is only within Bear Lake County, Idaho and Rich County, Utah. All out-of-region expenditures for Bear Lake visits are excluded. Resident, off-season, and non-primary visits are also excluded, resulting in expenditures for 880,000 visits.

6. PacifiCorp Facilities (Idaho and Utah)--Soda Dam/Alexander Reservoir, Grace Dam (and Black Canyon Gorge), Oneida Dam/Oneida Narrows Reservoir, and Cutler Dam and Reservoir

As the Bear River flows out of Bear Lake, it flows north and around the north end of the Wasatch Mountain Range and begins its journey south through Idaho into Utah. Throughout these River sections, there are four hydropower facilities and associated reservoirs that provide many recreational opportunities focused on boating, fishing, hunting, hiking, wildlife viewing, and picnicking. Most of the PacifiCorp-managed facilities are day-use only, with a couple of campgrounds managed by the BLM in the Oneida Narrows region. The three Idaho hydroelectric projects (Soda, Grace, and Oneida) are all part of what is collectively known as the Bear River Project.

The Soda Hydroelectric Power Development project, near the town of Soda Springs, was initially completed in 1923 and created the Alexander Reservoir which is popular, primarily among local residents, for boating and fishing (including ice fishing).[138] At Grace Power Plant, located outside of the town of Grace, most of the Bear River is diverted into flowlines to the Grace powerhouse. Recreational opportunities include river fishing and day-use areas. However, a few times a year water is allowed to flow through the Black Canyon, spurring world-class kayaking opportunities. When this occurs, destination kayakers come from far places to boat class IV and V rapids in Black Canyon, spending money in the local area on lodging, food, and trip necessities. Because the kayaking opportunities only occur a couple times per year, we do not specifically include these additional recreation expenditures.

The Oneida Development and Oneida Narrows Reservoir, located near Preston, is a scenic area open for boating and fishing. The canyon below the Reservoir is a very popular destination among both locals and out-of-region visitors for tubing and rafting, and a campground is available for overnight use. The last major hydroelectric development on the Bear River is the Cutler Project and Cutler Reservoir located in Box Elder County, Utah, not far from the city of Logan. Cutler Reservoir is a sprawling, often marshy, lake that has many recreational facilities and boat launches around its perimeter. Waterfowl hunting is a popular activity there, with many duck hunters coming from outside of the region.[139]

Visitor estimates for the four PacifiCorp recreation sites were obtained from Federal Energy

138 Personal communication with Mark Stenberg, PacifiCorp Senior Project Manager, on 09/27/23.

139 Personal communication with Eve Davies, PacifiCorp Principal Scientist, on 08/19/23.

Regulatory Commission (FERC) documentation associated with Licensed Hydropower Development Recreation Reports and Final License Applications (FLA) for the hydropower facilities. The most recent visitation estimates are for 2014. However, because general outdoor recreation trends have been increasing steadily we updated the 2014 visitation estimates by applying a 20% increase as found in Aldrich and Hjerpe (2022)[140] for similar years for general outdoor recreation nationally. The 20% increase is likely an underestimate given recent COVID-19 pandemic booms in outdoor recreation and known increases in Bear Lake visitation over the same timeframe (a tripling of visits). Table E3 shows expected expenditures and associated spending categories.

Total annual visits across the four PacifiCorp facilities are estimated at 404,760. For attribution purposes and based on communication with PacifiCorp managers, we assume most of the Soda and Grace visitors reside in the local area and about half of Oneida Narrows and Cutler visitors are out-of-region visitors. Additionally, we assume the majority (90%) of visits are primary purpose visits. These assumptions yield an estimated 150,510 non-local visitors making primary purpose trips.

Because the majority of recreation visits to PacifiCorp reservoirs are for birding, fishing, and waterfowl hunting, we presume visitors to PacifiCorp reservoirs and facilities are similar to USFWS national wildlife refuge visitors. We use allocation estimates from Caudill and Carver (2019)[141] who estimate a national average of $57.21 of expenditures per visit to USFWS national wildlife refuges for lodging, groceries, restaurants, transportation, and equipment. Given the focus on wildlife-related visitor activities, we use spending category proportions used in White (2017).[142]

Table E3: Estimated Annual Regional Recreational Expenditures ($2022) for Bear River PacifiCorp Hydropower Development Projects

Spending Categories	Portion of Visitor Expenditures	Total Expenditures
Hotels	5%	$430,543
Camping	5%	$430,543
Groceries	20%	$1,722,171
Restaurants	15%	$1,291,628
Oil and gas	40%	$3,444,342
Equipment/ miscellaneous	15%	$1,291,628
Totals	**100%**	**$8,610,856**

Notes: Expenditures are based on 150,510 primary non-local visitors spending an average of $57.21 per visit.

7. Bear River Migratory Bird Refuge, Utah

The Bear River Migratory Bird Refuge (BRMBR) encompasses 80,000 acres at the terminus of the Bear River where it enters Willard Bay of the Great Salt Lake. The marshes of BRMBR are the largest freshwater component of the Great Salt Lake ecosystem and are thus critical habitat for waterbirds and wildlife.[143] Visitors can experience the BRMBR via an auto-tour, walking trails, and the visitor center. Fishing and waterfowl hunting are popular activities at BRMBR as well.

Based on communication with Refuge staff, 2022 visitation was approximately 120,000. Approximately half of 2022 visitors were from outside the region and most visits were primary-purpose visits.[144] All wildlife Refuges are day use only, so overnight lodging is lower than recreation sites with campgrounds and is relegated to nearby hotels and off-site camping.

Combining annual visits for all three Refuges results in 135,000 total annual visits. For attribution purposes and based on communication with Refuge managers, we assume approximately half of all visits are from locals within the county, half are from out-of-region visitors, and 90% of visits are primary purpose visits, resulting in 60,825

140 Aldrich, G and E, Hjerpe. 2022. The Conservation Funding Crisis. Conservation Economics Institute. 27p. Available at: https://www.conservationecon.org/_files/ugd/5fc209_964863909ec745818cdb5a8643623366.pdf.

141 Caudill, J., & Carver, E. (2019). Banking on nature 2017: The economic contributions of national wildlife refuge recreational visitation to local communities. US Fish and Wildlife Service, Falls Church, Virginia.

142 White, E. M. (2017). *Spending patterns of outdoor recreation visitors to national forests*. PNW-GTR-961. United States Department of Agriculture, Forest Service, Pacific Northwest Research Station.

143 Bear River Migratory Bird Refuge, available at: https://www.fws.gov/refuge/bear-river-migratory-bird.

144 Personal communication with Karleen Vollherbst, Bear River Migratory Bird Refuge Visitor Services Manager, on 10/27/23.

non-local primary visits. We use allocation estimates from Caudill and Carver (2019)[145] showing a national average of $57.21 of expenditures per visit to USFWS national wildlife refuges for lodging, groceries, restaurants, transportation, and equipment. Given the focus on wildlife-related visitor activities, we use spending category proportions used in White (2017).[146]

Table E4: Estimated Annual Regional Expenditures ($2022) for Bear River-Associated USFWS Refuges (Includes Cokeville Meadows, Bear Lake, and Bear River Migratory Bird NWRs)

Spending Categories	Portion of Visitor Expenditures	Annual Expenditures
Motel	5%	$173,994
Camping	5%	$173,994
Restaurant	15%	$695,977
Groceries	20%	$521,983
Gas and oil	40%	$1,391,954
Equipment/ miscellaneous	15%	$521,983
Totals	**100%**	**$3,479,884**

Notes: Expenditures are based on 60,825 primary non-local visitors spending an average of $57.21 per visit.

145 Caudill, J., & Carver, E. (2019). Banking on nature 2017: The economic contributions of national wildlife refuge recreational visitation to local communities. US Fish and Wildlife Service, Falls Church, Virginia.

146 White, E. M. (2017). *Spending patterns of outdoor recreation visitors to national forests*. PNW-GTR-961. United States Department of Agriculture, Forest Service, Pacific Northwest Research Station.