

Bristol Bay Wild Salmon Ecosystem Economics

2008 Update

July 2009

This document provides updated estimates of the economic values associated with sustainable use of wild salmon ecosystem resources, primarily fisheries and wildlife, of the major watersheds of the Bristol Bay, Alaska region. The original study (Duffield et al. 2007) provided estimates based on 2005 data. This update provides estimated for the most recent available data year, 2008. Both regional economic significance and social benefit-cost accounting frameworks are utilized. This study reviews and summarizes existing economic research on the key sectors in this area and reports findings based on original survey data on expenditures, net benefits, attitudes, and motivations of the angler population.

The major components of the total value of the Bristol Bay area watersheds include subsistence use, commercial fishing, sportfishing and other recreation, and the preservation values (or indirect values) held by users and the U.S. resident population. The overall objectives of this study is to estimate the share of the total regional economy (expenditures, income and jobs) that is dependent on these essentially pristine wild salmon ecosystems, and to provide a preliminary but relatively comprehensive estimate of the total economic value (from a benefit-cost perspective) that could be at risk from extractive resource development in the region.

The rivers that flow into the Bristol Bay comprise some of the last great wild salmon ecosystems in North America (Figure 1). The Kvichak River system supports the world's largest run of sockeye salmon. While these are primarily sockeye systems, all five species of Pacific salmon are abundant, and the rich salmon-based ecology also supports many other species, including Alaska brown bears and healthy populations of rainbow trout. The Naknek, Nushagak, Kvichak, Igushik, Egegik, Ugashik, and Togiak watersheds are all relatively pristine with very few roads or extractive resource development. Additionally, these watersheds include several very large and pristine lakes, including Lake Iliamna and Lake Becherof. Lake Iliamna is one of only two lakes in the world that supports a resident population of freshwater seals (the other is Lake Baikal in Russia). The existing mainstays of the economy in this region are all wilderness-compatible and sustainable in the long run: subsistence use, commercial fishing, and wilderness sportfishing. The commercial fishing is largely in the salt water outside of the rivers themselves and is closely managed for sustainability. The subsistence, sportfish and other recreation sectors are relatively low impact (primarily personal use and catch and release fishing, respectively). Additionally, there are nationally-important public lands in the headwaters, including Lake Clark National Park and Preserve, Katmai National Park and Preserve, Togiak National Wildlife Refuge, and Wood-Tikchick State Park (the largest state park in the U.S.).

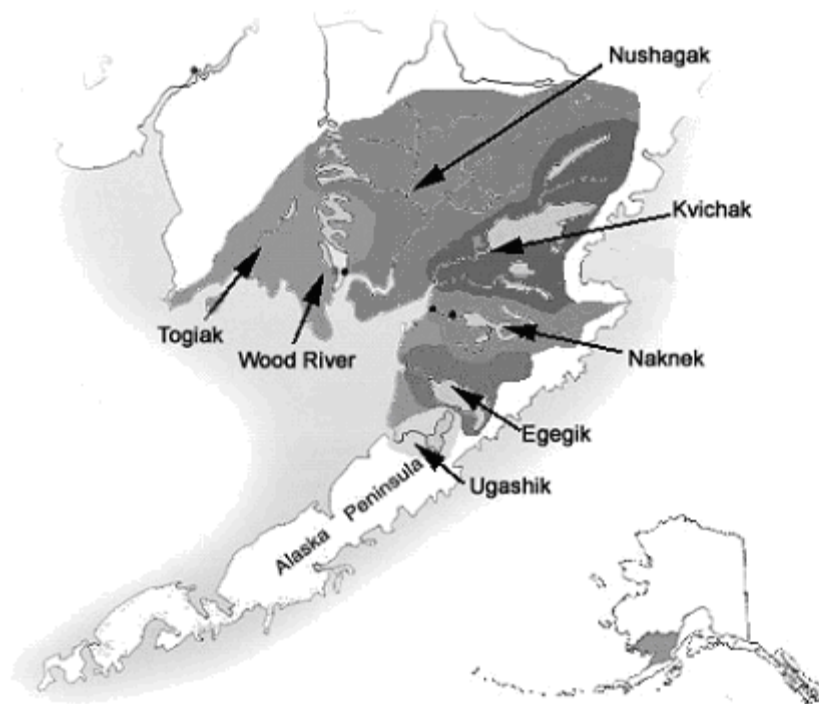


Figure 1. Map of Bristol Bay Study Area

A complete economic analysis would be conducted in several phases. The current study focuses on: 1) an overview of values based on existing data and previous studies, 2) original data collection focused on the sportfish sector, including angler surveys, and 3) estimation of both the regional economic significance (focusing on jobs and income) of these ecosystems using an existing regional economic model, as well as total value in a social benefit-cost framework. The objective is to provide a preliminary but relatively comprehensive estimate of the range of fishery-related values in this region (Figure 1).

This summary provides a brief characterization of each of the major sectors, followed by the primary economic findings.

The Bristol Bay economy is a mixed cash-subsistence economy. The primary features of these socio-economic systems include use of a relatively large number of wild resources (on the order of 70 to 80 specific resources in this area), a community-wide seasonal round of activities based on the availability of wild resources, a domestic mode of production (households and close kin), frequent and large scale noncommercial distribution and exchange of wild resources, traditional systems of land use and occupancy based on customary use by kin groups and communities, and a mixed economy relying on cash and subsistence activities (Wolfe and Ellanna, 1983; Wolfe et al. 1984). The heart of this cash-subsistence economy is the resident population of 7,611 individuals (in the year 2000) located in 25 communities (Table 1) spread across this primarily un-roaded area (Figure 2). Archeological evidence indicates that Bristol Bay has been continuously inhabited by humans at least since the end of the last major glacial period about 10,000 years ago. Three primary indigenous cultures are represented here: Aleuts, Yupik

Eskimos, and the Dena'ina Athapaskan Indians. The share of the population that is Alaska Native is relatively high at 70 percent, compared to Alaska as a whole, with 16 percent.

Table 1. Bristol Bay Area Communities, Populations, and Subsistence Harvest

| Bristol Bay Area Community /year of harvest data | Population (2000 census) | Per Capita Harvest | Total Annual Harvest | % Native Population |
|---|-------------------------------------|-------------------------------|---------------------------------|--------------------------------|
| Aleknagik 1989 | 221 | 379 | 54,079 | 81.9% |
| Clark's Point 1989 | 75 | 363 | 20,325 | 90.7% |
| Dillingham 1984 | 2,466 | 242 | 494,486 | 52.6% |
| Egegik 1984 | 116 | 384 | 37,450 | 57.8% |
| Ekwok 1987 | 130 | 797 | 85,260 | 91.5% |
| Igiugig 2005 | 53 | 542 | 22,310 | 71.7% |
| Iliamna 2004 | 102 | 508 | 51,816 | 50.0% |
| King Salmon 1983 | 442 | 220 | 81,261 | 29.0% |
| Kokhanok 2005 | 174 | 680 | 107,644 | 86.8% |
| Koliganek 2005 | 182 | 899 | 134,779 | 87.4% |
| Levelock 2005 | 122 | 527 | 17,871 | 89.3% |
| Manokotak 2000 | 399 | 384 | 118,337 | 94.7% |
| Naknek 1983 | 678 | 188 | 72,110 | 45.3% |
| New Stuyahok 2005 | 471 | 389 | 163,927 | 92.8% |
| Newhalen 2004 | 160 | 692 | 110,720 | 85.0% |
| Nondalton 2004 | 221 | 358 | 79,118 | 89.1% |
| Pedro Bay 2004 | 50 | 306 | 15,300 | 40.0% |
| Pilot Point 1987 | 100 | 384 | 24,783 | 86.0% |
| Port Alsworth 2004 | 104 | 133 | 13,832 | 4.8% |
| Port Heiden 1987 | 119 | 408 | 41,985 | 65.6% |
| South Naknek 1992 | 137 | 297 | 39,893 | 83.9% |
| Ugashik 1987 | 11 | 814 | 8,144 | 72.7% |
| Togiak City 2000 | 809 | 246 | 179,005 | 86.3% |
| Portage Creek | 36 | -- | -- | 86.1% |
| Twin Hills 2000 | 69 | 499 | 34,398 | 84.1% |
| Total communities | 7,447 | -- | -- | -- |
| Unincorporated areas | 164 | -- | -- | -- |
| Total (interpolated to include unincorporated areas) | 7,611 | 274 | 2,085,933 | 69.6% |

Sources: US Census Bureau (2000 census statistics), and ADF&G Division of Subsistence Community Profile Data Base. & Fall et al. 2006.
Note: % native indicates those who classify themselves as Native only.

Wild renewable resources are important to the people of this region and many residents rely on wild fish, game and plants for food and other products for subsistence use. Total harvest for these 25 communities is on the order of 2.1 million pounds based largely on surveys undertaken in the late 1980's and early 1990's, as summarized in the Alaska Division of Subsistence community profile data base. A new round of surveys is now underway to update this data. Estimates for the 2004-2008 study years (Fall et al. 2006; 2008) are included in the data presented in Table 1. Per capita harvests averaged about 274 pounds. Primary resources used include salmon, other freshwater fish, caribou, and moose. Subsistence use continues to be very important for communities of this region, based on these recent surveys, and participation in subsistence activity, including harvesting, processing, giving and receiving is quite high. Compared to other regions of Alaska, the Bristol Bay area has some characteristic features, including the great time

depth of its cultural traditions, its high reliance on fish and game, the domination of the region's market economy by the commercial salmon fishery, and the extensive land areas used by the region's population for fishing, hunting, trapping and gathering. (Wright, Morris, and Schroeder, 1985).

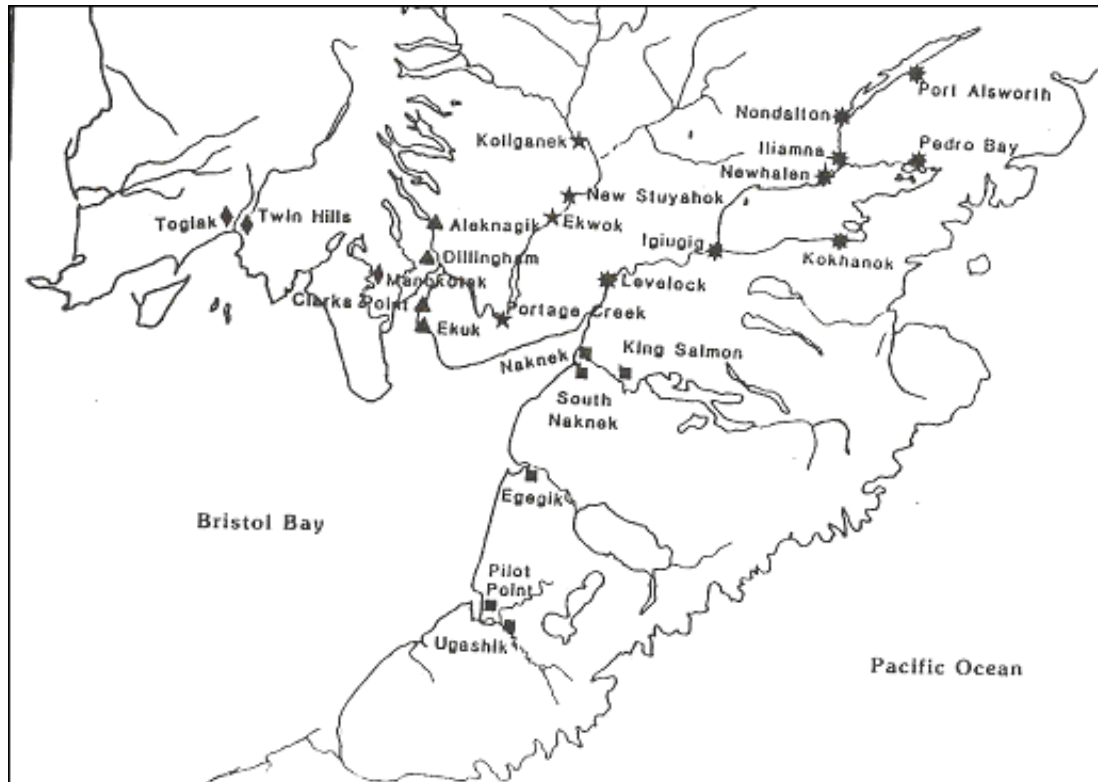


Figure 2. Bristol Bay Area Location and Major Communities

The primary private source of cash employment for participants in Bristol Bay's mixed cash-subsistence economy is the commercial salmon fishery. The compressed timing of this fishery's harvesting activity makes it a good fit with subsistence in the overall Bristol Bay cash-subsistence economy. Many commercial fishing permit holders and crew members, as well as some employees in the processing sector, are residents of Bristol Bay's dominantly-native Alaskan villages. In 2008, there were 993 resident commercial fishing permit holders in the Bristol Bay study area, as well as 981 crew members. This is a significant share of the area's total adult population. An ADF&G summary of subsistence activity in Bristol Bay (Wright, Morris, and Schroeder 1985) noted that as of the mid-1980's traditional patterns of hunting, fishing, and gathering activities had for the most part been retained, along with accommodations to participate in the commercial fishery and other cash-generating activities. In the abstract to this 1985 paper, the authors characterize the commercial salmon fishery as "a preferred source of cash income because of its many similarities to traditional hunting and fishing, and because it is a short, intense venture that causes little disruption in the traditional round of seasonal activities while offering the potential for earning sufficient income for an entire year." Commercial fishing

is a form of self employment requiring many of the same skills, and allowing nearly the same freedom of choice as traditional subsistence hunting and fishing. (Wright, Morris, Schroeder 1985; p. 89).



Figure 3. Bristol Bay Area Commercial Salmon Fishery Management Districts

The Bristol Bay commercial fisheries management area encompasses all coastal and inland waters east of a line from Cape Menshikof to Cape Newenham (Figure 3). This area includes eight major river systems: Naknek, Kvichak, Egegik, Ugashik, Wood, Nushagak, Igushik and Togiak. Collectively these rivers support the largest commercial sockeye salmon fishery in the world (ADF&G, 2005). This is an interesting and unique fishery, both because of its scale and significance to the local economy, but also because it is one of the very few major commercial fisheries in the world that has been managed on a sustainable basis.

The five species of pacific salmon found in Bristol Bay are the focus of the major commercial fisheries. Sockeye salmon is the primary species harvested both in terms of pounds of fish and value. Annual commercial catches between 1988 and 2007 averaged nearly 25 million sockeye salmon, 66,000 chinook, 957,000 chum, 97,000 coho, and 231,000 (even year only) pink salmon (ADF&G, 2009). Prices for sockeye salmon are typically higher than for other salmon species, making the Bristol Bay fishery the most valuable of Alaska's salmon fisheries (CFEC, 2004). Nearly one-third of all earnings from Alaska salmon fishing come from the Bristol Bay fishery (Table 2). This is also the largest Alaska fishery in terms of the number of permit holders. In 2008, there were 1,863 potentially active entry permits in the drift gillnet fishery and 981 in the set gillnet fishery (CFEC, 2010).

Table 2. Bristol Bay and Alaska Commercial Fishery Permits, Harvest, and Gross Earnings, 2008

| Sector | # permit holders | # permits | Pounds | Gross earnings |
|---------------------------|------------------|-----------|-------------|----------------|
| Bristol Bay Salmon | 2,843 | 2,319 | 169,243,554 | \$ 121,095,394 |
| Drift gillnet | 1,863 | 1,469 | 139,115,944 | \$ 100,139,700 |
| Set gillnet | 980 | 850 | 30,127,610 | \$ 20,955,694 |
| All Alaska Salmon | 11,138 | 7,474 | 635,076,014 | \$ 412,154,633 |

Source: Derived from ADFG (2009)

The fishery is organized into five major districts (Figure 3) including Togiak, Nushagak, Naknek-Kvichak, Egegik, and Ugashik. Management is focused on discrete stocks with harvests directed at terminal areas at the mouths of the major river systems (ADF&G, 2005). The stocks are managed to achieve an escapement goal based on maximum sustained yield. The returning salmon are closely monitored and counted and the openings are adjusted on a daily basis to achieve desired escapement. Having the fisheries near the mouths of the rivers controls the harvest on each stock, which is a good strategy for protection of the discrete stocks and their genetic resources. The trade-off is that the fishery is more congested and less orderly, and the harvest is necessarily more of a short pulse fishery, with most activity in June and early July. This has implications for the economic value of the fish harvest, both through effects on the timing of supply, but also on the quality of the fish. Most fish are canned or frozen, rather than sold fresh. The fishery is quite cyclical in terms of run size and potential harvest. For example, harvests were as low as only several million fish in the early 1970's, but exceeded 45 million fish in the early 1990's. Prices have also varied quite dramatically historically. In real terms (constant 2005 dollars) prices peaked at \$3.15 per pound in 1989 and reached a recent historical low of about \$0.40 a pound in 2002. Prices are currently low because of competition with farmed salmon and other factors. For the period 1985 to 2005, total production value for processors averaged about \$288 million, with a low of \$95 million in 2002. Total production value in 2005 was \$225 million. According to the Commercial Fish Entry Commission (2004) the total salmon return to Bristol Bay is strongly influenced by sockeye returns to the Kvichak River, which is historically the largest salmon resource in the region, and perhaps the largest in the world. The sockeye return to the Kvichak is highly variable, and exhibits a pattern of oscillating cycles. In recent years the Kvichak sockeye return has been weaker, and the river has been classified as a "stock of management concern" by the Alaska Department of Fish and Game and the Alaska Board of Fisheries.

Next to commercial fishing and processing, recreational angling is the most important private economic sector in the Bristol Bay region. The 2005 Bristol Bay Angler Survey, which was undertaken for purposes of this report, confirmed that the fresh water rivers, streams, and lakes of the region are a recreational resource equal or superior in quality to other world renowned fisheries.

In their survey responses Bristol Bay anglers consistently emphasized the importance of Bristol Bay's un-crowded, remote, wild setting in their decisions to fish the area. Additionally, a significant proportion of respondents to the survey specifically traveled to the region to fish the world-class rainbow fisheries. These findings indicate that Bristol Bay sport fishing is a

relatively unique market segment, paralleling the findings of Romberg (1999) that angler motivation and characteristics vary significantly across Alaska sport fisheries.

Recreational fishing use of the Bristol Bay region is roughly divided between 65% trips to the area by Alaska residents and 35% trips by nonresidents. These nonresidents (approximately 16,500 trips in 2008 (personal communication, ADF&G, 2010)) account for the large majority of total recreational fishing spending in the region. It is estimated that in 2008 approximately \$66 million was spent in Alaska by nonresidents specifically for the purpose of fishing in the Bristol Bay region. In total, it is estimated that \$75 million was spent in Alaska in 2008 on Bristol Bay fishing trips.

While sport fishing within the Bristol Bay region comprises the largest share of recreational use and associated visitor expenditures, several thousand trips to the region each year are also made for the primary purpose of sport hunting and wildlife viewing.

Table 3 through 8 detail the summary results of the analysis of economic values. Table 3 shows estimated direct expenditures in Alaska related to harvest or use of Bristol Bay area renewable resources. Total estimated direct expenditures (that drive the basic sector of the economy) were estimated to be \$392 million in 2008. The largest component is commercial fishing harvesting and processing. These estimates were obtained from the Alaska Department of Revenue and the Commercial Fishing Entry Commission. The range shown of low and high estimates reflects the cyclical nature of this sector, and is based on a 95 percent confidence interval for total earnings in this sector between 1985 and 2008. The next most significant component is sportfishing at \$75 million in 2008. This estimate is derived from original survey data as described below, and a 95 percent confidence interval for this 2005 estimate is relatively imprecisely estimated at zero to \$166.2 (this broad range reflects the statistical uncertainty within a number of estimated parameters used to estimate spending, including average spending per angler and average number of trips per year per angler). Sport hunting and wildlife viewing / tourism are less important economically. The wildlife viewing and tourism estimates are approximate, and reflect a small share of the visitation at Katmai National Park. Most of the visitation at Katmai is expected to be picked up in the sportfishing use estimates and is excluded here to avoid double-counting.

Table 3. Summary of Regional Economic Expenditures Based on Wild Salmon Ecosystem Services (Million 2008 \$)

| Ecosystem Service | Estimated direct expenditures / sales per year | Low estimate | High estimate |
|--|---|---------------------|----------------------|
| Commercial fish wholesale value | 280.0 | 280.0 | 368.5 |
| Sport fisheries | 74.6 | 0 | 166.1 |
| Sport hunting | 11.1 | 11.1 | 11.1 |
| Wildlife viewing / tourism | 18.9 | 18.9 | 18.9 |
| Subsistence harvest expenditures | 7.9 | 7.9 | 7.9 |
| Total direct annual economic impact | 392.4 | 317.9 | 572.5 |

Table 4 provides additional detail on recreation expenditures, including number of trips and spending by residence of the participants. A large share of sportfish expenditures, and hence of total recreation expenditures, is by nonresident anglers (\$66.4 of \$74.7 million). This reflects the high quality of this fishery, in that it is able to attract participants from a considerable distance in the lower 48 states as well as foreign countries.

Table 4. Total Estimated Recreational Direct Spending in Alaska Attributable to Bristol Bay Wild Salmon Ecosystems, 2008

| Sector | Alaska Residents | | Nonresidents | Total | |
|----------------------------|------------------|---------------------|---------------|---------------|----------------|
| | Local residents | Non-local residents | Total Alaska | | |
| (A) TRIPS | | | | | |
| Sport fishing | 8,748 | 3,153 | 11,901 | 16,561 | 28,462 |
| Sport hunting | - | 1,538 | 1,538 | 2,310 | 3,848 |
| Wildlife viewing / tourism | - | 1,000 | 1,000 | 9,000 | 10,000 |
| Total | 8,748 | 5,691 | 14,439 | 27,871 | 42,310 |
| (B) SPENDING | | | | | |
| Sport fishing | \$ 3,273,000 | \$ 5,005,000 | \$ 8,278,000 | \$ 66,400,000 | \$ 74,678,000 |
| Sport hunting | \$ - | \$ 1,282,000 | \$ 1,282,000 | \$ 9,815,691 | \$ 11,097,691 |
| Wildlife viewing / tourism | \$ - | \$ 1,069,360 | \$ 1,069,360 | \$ 17,824,266 | \$ 18,893,626 |
| Total | \$ 3,273,000 | \$ 7,356,360 | \$ 10,629,360 | \$ 94,039,957 | \$ 104,669,317 |

Table 5a summarizes the full time equivalent employment (annual average) associated with the sectors of the Bristol Bay economy dependent on wild salmon ecosystems—recreation, commercial fishing, and subsistence. The total of 4,837 includes both the direct employment effect as well as the indirect effects throughout the economy of the state. Commercial fishing, including both harvesting and processing, accounts for the largest share of the total-3,567 jobs. Recreation, including fishing, hunting, and non consumptive visits to the region generates 1,225 jobs. Expenditures associated with subsistence activities account for 45 jobs. (We also estimate a level of effort in subsistence by residents of the region which amounts to the equivalent of an additional 843 full time equivalent non-market jobs.)

Table 5a. Total Full Time Equivalent (FTE) Employment in Alaska Dependent on Bristol Bay Wild Salmon Ecosystems, 2008

| | ANNUAL AVERAGE JOBS IN ALASKA TAKEN BY | | | | |
|------------------------|--|--------------------|-----------------------|------------|-------|
| | Local Resident | Non-Local Resident | Total Alaska Resident | Non Alaska | TOTAL |
| GRAND TOTAL | 1,337 | 1,873 | 3,210 | 1,627 | 4,837 |
| TOTAL RECREATION | 375 | 687 | 1,062 | 163 | 1,225 |
| sport fishing | 258 | 483 | 741 | 146 | 887 |
| sport hunting | 40 | 76 | 116 | 2 | 118 |
| sport viewing | 77 | 128 | 205 | 15 | 220 |
| TOTAL COMMERCIAL | 949 | 1,154 | 2,103 | 1,464 | 3,567 |
| commercial harvest | 597 | 780 | 1,377 | 562 | 1,939 |
| commercial processing | 352 | 374 | 726 | 902 | 1,628 |
| TOTAL SUBSISTENCE | 13 | 32 | 45 | - | 45 |
| subsistence market | 13 | 32 | 45 | - | 45 |
| subsistence non market | 843 | | | | |

(A related perspective is that angler effort in the sport fishery is on the order of 100,000 angler days (107,000 in 2008), mostly during the summer. From a theoretical economic “household production” perspective of anglers utilizing capital and labor resources to produce a good outdoor experience for themselves, this is the equivalent of about 400 full time equivalent jobs. An interesting feature of the sportfish sector, and one that limits its economic impact relative to the commercial fishery, is that there is essentially no commercial processing sector in this predominantly catch and release fishery.)

Local residents of the Bristol Bay region account for 1,337 of the jobs, again measured on a full time equivalent basis, while residents of other regions within the state account for 1,873 jobs. Non Alaska residents account for the remaining 1,627 jobs.

Table 5b shows that most of the jobs are located in the Bristol Bay region, but that the rest of Alaska also accounts for about one fourth of the total. This is because much of the indirect employment is generated in Southcentral Alaska and also because a large share of the seasonal workers live in Southcentral Alaska.

Table 5b. Total Full-Time Equivalent (FTE) Employment Dependent on Bristol Bay Wild Salmon Ecosystems, by Location of Job. 2008

| Sector | ANNUAL AVERAGE JOBS BY LOCATION OF JOB | | |
|------------------------|--|--------------|-------|
| | Bristol Bay | Other Alaska | TOTAL |
| GRAND TOTAL | 3,533 | 1,304 | 4,837 |
| TOTAL RECREATION | 638 | 588 | 1,226 |
| sport fishing | 493 | 394 | 887 |
| sport hunting | 43 | 75 | 118 |
| sport viewing | 102 | 119 | 221 |
| TOTAL COMMERCIAL | 2,882 | 684 | 3,566 |
| commercial harvest | 1,522 | 417 | 1,939 |
| commercial processing | 1,360 | 267 | 1,627 |
| TOTAL SUBSISTENCE | 13 | 32 | 45 |
| subsistence market | 13 | 32 | 45 |
| subsistence non market | 843 | | |

The overall structure of the Bristol Bay economy is shown in Table 6. This estimate was derived starting with the official employment data reported by the Alaska Department of Labor (wage and salary employment) and the US Department of Commerce (self employed proprietors). The wage and salary total was augmented by an estimate of wage and salary jobs located within the region but reported elsewhere (Anchorage) in the mining sector. The self employment data was augmented by estimates of non local resident employment in fish harvesting (data from the Alaska Department of Labor) and of non local resident employment in the recreation sector not included in the self employment data for the region.

Table 6. Structure of the Bristol Bay Economy, 2008

| SECTOR | ANNUAL AVERAGE | JULY | JAN | SEASONAL SWING |
|--------------------------|----------------|--------|-------|----------------|
| TOTAL | 6,556 | 16,386 | 3,792 | 12,594 |
| BASIC | 5,149 | 14,877 | 2,430 | 12,447 |
| Harvesting | 1,113 | 6,909 | - | 6,909 |
| Processing | 1,385 | 4,480 | 354 | 4,126 |
| Recreation | 432 | 1,297 | - | 1,297 |
| Govt+Health | 2,039 | 1,712 | 2,056 | (344) |
| Mining | 180 | 479 | 20 | 459 |
| NON BASIC | 1,406 | 1,509 | 1,362 | 147 |
| Construction | 61 | 92 | 55 | 37 |
| Trade/Transport/Leisure | 634 | 717 | 593 | 124 |
| Finance | 155 | 142 | 162 | (20) |
| Other WS | 239 | 241 | 235 | 6 |
| Proprietors | 317 | 317 | 317 | (0) |
| TOTAL / BASIC | 1.27 | 1.10 | 1.56 | 1.01 |
| SUBSISTENCE (NON MARKET) | 843 | | | |

The resulting employment total for the peak summer season (July) of 16,386 was allocated into 5 activities considered “Basic” as well as a number of support activities. In addition the annual average employment of 6,566 for the region was calculated based upon assumptions about the seasonal pattern of each type of job. (For example the average fish harvesting job lasts 2 months, so 6 such jobs is equivalent to 1 annual full time equivalent job).

Of the Basic activities, commercial fishing (harvesting and processing) directly accounts for the largest number of jobs, both during the peak of the summer and on an annual average basis. However government employment (here including both hospitals and other non profit enterprises which are publicly funded) , supported by revenues generated outside the region, is nearly as large. Recreation is next in importance with mining contributing the smallest share of direct jobs among the Basic activities.

The support sector, composed of businesses that provide services to households and to other businesses, is not well developed in the region. There is only one support job for every 4 Basic activity jobs on an annual average basis, and only one support job for every 10 Basic activity jobs in the summer season.

This demonstrates that the private economy is almost totally dependent on Bristol Bay’s wild salmon ecosystem (the direct commercial fishing and recreation employment as well as a large share of the support sector employment). However much of the government sector employment can also be attributed to the wild salmon ecosystem since it is serving the needs of the local population that resides in the region because of the presence of the wild salmon. Were the salmon to disappear, the population would fall and the government activity would decline. Table 6 also underscores the extreme seasonal nature of the economy. From a winter low of 3,792 jobs, employment climbs by 12,594 to a peak of 16,386 in the summer. Since the resident population is only about 7,400, a large share of the seasonal increase must be filled by non local residents either from elsewhere in Alaska or outside the state.

The most seasonally stable component of the economy is government, which declines slightly in the summer due to the seasonal closure of the schools. The winter employment pattern reveals the bare bones of the local cash economy, absent almost all of the cash employment jobs associated with fishing and recreation.

Subsistence users are not the only hunter-gatherers in this economy. Essentially the entire private economy is “following the game” (or in this case fish), with many commercial fishermen, processors, sport anglers, sport hunters, and wildlife viewers coming from elsewhere in Alaska or outside the state to be part of this unique economy at the time that fish and game are available. The estimated earnings associated with the salmon ecosystem dependent jobs is shown in Table 7. The total of \$196 million was divided among \$48 million for residents of the Bristol Bay region, \$67 million to residents of the rest of Alaska, and \$80 million to residents of other states.

Table 7. Total Alaska Payroll Associated with Use of Bristol Bay Wild Salmon Ecosystems, 2005 (Thousand 2008 dollars)

| Sector | Local Resident | Non-Local Resident | Total Alaska Resident | Non Alaska | TOTAL |
|------------------------|----------------|--------------------|-----------------------|------------|------------|
| GRAND TOTAL | \$ 48,370 | \$ 67,467 | \$ 115,837 | \$ 79,859 | \$ 195,696 |
| TOTAL RECREATION | \$ 11,192 | \$ 23,931 | \$ 35,123 | \$ 5,692 | \$ 40,815 |
| sport fishing | \$ 7,963 | \$ 17,074 | \$ 25,037 | \$ 5,096 | \$ 30,133 |
| sport hunting | \$ 1,111 | \$ 2,677 | \$ 3,788 | \$ 66 | \$ 3,854 |
| sport viewing | \$ 2,118 | \$ 4,180 | \$ 6,298 | \$ 530 | \$ 6,828 |
| TOTAL COMMERCIAL | \$ 36,653 | \$ 42,353 | \$ 79,006 | \$ 74,167 | \$ 153,173 |
| commercial harvest | \$ 24,015 | \$ 28,555 | \$ 52,570 | \$ 48,367 | \$ 100,937 |
| commercial processing | \$ 12,638 | \$ 13,798 | \$ 26,436 | \$ 25,800 | \$ 52,236 |
| TOTAL SUBSISTENCE | \$ 525 | \$ 1,183 | \$ 1,708 | \$ - | \$ 1,708 |
| subsistence market | \$ 525 | \$ 1,183 | \$ 1,708 | \$ - | \$ 1,708 |
| subsistence non market | | | | | |

The preceding discussion has focused on a regional economic accounting framework. Table 8 introduces the net economic value measures for evaluation of the renewable Bristol Bay resources. Commercial salmon fishery net economic values are derived by annualizing permit values, which are exchanged in an open market and reported by the Commercial Fish Entry Commission. These are on the order of \$78,300 for a drift gillnet permit in 2008 in total, but have been as high as \$200,000 as recently as 1993. Subsistence harvests are valued based on the willingness-to-pay revealed through tradeoffs of income and harvest in choice of residence location (Duffield 1997).

The sportfish net economic value is based on original data collected for purposes of this study, as reported in Duffield et al. (2007). These estimates are consistent with values from the extensive economic literature on the value of sportfishing trips. Sport hunting and wildlife viewing values are based on studies conducted about fifteen years ago in Alaska, and which need to be updated. Direct use values total from \$96 million to \$178 million.

A major unknown is the total value for existence and bequest (also called passive use values). Goldsmith et al. (1998) estimated the existence and bequest value for the federal wildlife refuges in Bristol Bay at \$2.3 to \$4.6 billion per year (1997 dollars). There is considerable uncertainty in these estimates, as indicated by the large range of values. Goldsmith's estimates for the federal wildlife refuges are based on the economics literature concerning what resident household populations in various areas (Alberta, Colorado) (Adamowicz et al. 1991; Walsh et al. 1984; Walsh et al. 1985) are willing to pay to protect substantial tracts of wilderness. Similar literature related to rare and endangered fisheries, including salmon, could also be appealed to here. It is possible that from a national perspective the Bristol Bay wild salmon ecosystems and the associated economic and cultural uses are sufficiently unique and important to be valued as highly as wilderness in other regions of the U.S. Goldsmith et al's (1998) estimates assume that a significant share of U.S. households (91 million such households) would be willing to pay on the

order of \$25 to \$50 per year to protect the natural environment of the Bristol Bay federal wildlife refuges. The number of these households is based on a willingness to pay study (the specific methodology used was contingent valuation) conducted by the State of Alaska Trustees in the Exxon Valdez oil spill case (Carson et al. 1992). The findings of this study were the basis for the \$1 billion settlement between the State and Exxon in this case. These methods are somewhat controversial among economists, but when certain guidelines are followed, such studies are recommended for use in natural resource damage regulations (for example, see Ward and Duffield 1992). They have also been upheld in court (Ohio v. United States Department of Interior, 880 F.2d 432-474 (D.C. Cir.1989)) and specifically endorsed by a NOAA-appointed blue ribbon panel (led by several Nobel laureates in economics) (Arrow et al. 1993).

Goldsmith's estimates for just the federal refuges may be indicative of the range of passive use values for the unprotected portions of the study area. However, there are several caveats to this interpretation. First, Goldsmith et al. estimates are not based on any actual surveys to calculate the contingent value specific to the resource at issue in Bristol Bay. Rather, they are based on inferences from other studies (benefits transfer method). Second, these other studies date from the 1980's and early 1990's and the implications of new literature and methods have not been examined. Additionally, the assumptions used to make the benefits transfer for the wildlife refuges may not be appropriate for the Bristol Bay study area. This is an area for future research.

Table 8. Summary of Bristol Bay Wild Salmon Ecosystem Services, Net Economic Value per Year (Million 2008 \$)

| Ecosystem Service | Low estimate | High estimate |
|-------------------------------|---------------------|----------------------|
| Commercial salmon fishery | \$12.1 | \$24.3 |
| Sport fishing | \$12.5 | \$12.5 |
| Sport hunting | \$1.7 | \$1.7 |
| Wildlife viewing / tourism | \$2.0 | \$2.0 |
| Subsistence harvest | \$67.7 | \$137.2 |
| Total Direct Use Value | \$96.00 | \$177.70 |
| Existence and Bequest Value | Not estimated | Not estimated |

The estimates in Table 8 are for annual net economic values. Since these are values for renewable resource services that in principle should be available in perpetuity, it is of interest to also consider their present value (e.g. total discounted value of their use into the foreseeable future). Recent literature (EPA 2000; Weitzman 2001) provides some guidance on the use of social discount rates for long term (intergenerational) economic comparisons. A rate as low as 0.5% has been recommended by EPA (2000). Weitzman, based on an extensive survey of members of the American Economic Association, suggests a declining rate schedule, which may be on the order of 4 percent (real) in the near term and declining to near zero in the long term. He suggests a constant rate of 1.75% as an equivalent to his rate schedule. Applying this parameter to the net economic values shown in Table 8 results in a net present value of \$5.5 billion to \$10.2 billion for just the direct uses.

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