April 27, 2021

BY ELECTRONIC COMMUNICATION TO:

Jackie Ebert
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Division of Water
Wastewater Discharge Authorization Program
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RE: OBI Seafoods, LLC Comments to APDES Draft Permit No. AKG521000

Dear Ms. Ebert:

OBI Seafoods, LLC (OBI) hereby submits our comments for the draft APDES Onshore Seafood Processors General Permit (AKG521000). The comments are in addition to those submitted by Mr. Charles Blumenfeld on behalf of the Pacific Seafood Processors Association (PSPA) of which we are a member. We believe that both our comments and PSPA's will aid the Department in creating a permit with provisions that are reasonable and attainable for the many diverse facilities subject to it and to meet compliance. We anticipate that our comments will be seriously considered.

Request for Sufficient Time to Comply with New Permit Requirements

OBI requests that the period between the permit's issuance date and the effective date is extended considerably more than that of the Kodiak General Permit, or that the schedule of submissions in Table 1 is updated to allow for additional time to achieve compliance. We cannot overstate the importance of providing facilities with enough time to perform engineering reviews, construction, and prepare and submit the facility plan reviews for the major renovations that all our facilities require for compliance with this new permit.

OBI operates nine facilities that would be covered by this general permit, all of which require significant upfront investment to achieve compliance. The most expensive and onerous conditions of this permit are the inclusions of non-process wastewater, retort cooling water, boiler blow down, and catch transfer water as covered discharges. Our facilities must capture and either divert these waters to an existing outfall, or potentially be required to install an additional outfall if the existing outfall/waste conveyance system cannot handle the additional volumes of water to be captured, treated, and discharged.

Of the nine facilities that OBI would operate under this permit, eight would require thermal modeling to determine if effluent standards can be met at the MZ boundary granted under this permit. If any facilities are unable to meet WQS at the MZ boundary, options must be considered to either design and construct a passive or active cooling system, or to apply for a larger MZ.

For our Kodiak facility, the process of 1) having engineers gather facility information, 2) conduct thermal plume modeling, 3) assess alternative options to comply with effluent temperature requirements, 4) create a proposed facility design, and 4) submit a MZ application, antidegradation analysis, and 5) NOI based on this proposed design took over six months to complete. This extensive amount of work has required the use of three engineering firms to perform the needed modeling and design proposals.

An extended effective date timeline must also give serious consideration to time needed for the facility to be granted Approval to Construct by ADEC, and for any of the physical construction outlined in the proposed design needed to incorporate the newly covered discharges outlined above. For this upcoming permit, we will need to perform essentially the same amount of work as we are currently undertaking for our Kodiak facility, and we will need to do this work for up to eight (8) additional facilities, some of which operate in excluded areas and would need to undergo a public notice period which would further delay the timeline to be in compliance.

It is important to note for the timeline of permit implementation, subject facilities have significantly more constraints to engineering and construction timelines than those facilities affected by the new Kodiak General Permit. Six of our nine facilities to be covered under this permit are remote and/or short-season operations with harsh winter weather conditions that severely limit the work window including the reliance on barge company shipping schedules.

As an example, Bristol Bay facilities have significant snow and ice buildup on and under their docks that prevents construction work until thawing occurs. Construction on a facility's waste conveyance system can only occur when the facility is not in operation or no ice is present. It is important to consider that pre-installation biological surveys would be required during this same period if additional outfalls are required.

To this end, to ensure all the above actions necessary to achieve compliance are properly engineered, reviewed/permitted by ADEC, and construction completed, OBI requests that the effective date of this new permit begin on June 1, 2022, or 9 months after permit issuance, whichever is later. The extension of the current permit has already been lengthy, so allowing time to adequately comply with the requirements of this new permit while operating under the extended permit would not result in any "environmental harm." An extension would allow affected processors the time to successfully comply with the new requirements and minimize the need for processors to enter into Compliance Orders by Consent (COBC) in the event that companies are unable to comply with an earlier permit effective date.

Engineering Plan Review and Final Approval to Operate (FATO) Delays

It is our understanding that the ADEC Engineering Division is expected to receive a significant influx of plan review submittals from the subject facilities listed in **Appendix D**. Facilities must be able to operate during this waiting period and we would comply with the numerous new conditions of the permit to the best of our ability. We request that the Department issue a statement providing interim permit coverage until the FATO is received.

OBI is committed to maintaining compliance with environmental permits, however, failure to provide enough time to attain compliance once the permit has been issued would potentially result in the undesirable option of a COBC.

This comment goes to further our request for a permit effective date as described above. Similar to the other Alaska seafood processors severely impacted by COVID-19, OBI spent over $8.6 MM in CY2020 in order to operate. Even with the new vaccines, these expenses and the burdensome requirements to keep the local communities and our employees safe will continue through CY2021. Many of the projects that were planned since our June 1, 2020 merger have been postponed due to our closed campus policy and State mandates/advisories which have severely limited our ability to perform the above-mentioned modifications for the new permit.

Waiver Option for the Annual Discharge Limit

The Department has omitted the waiver option and rescinded the waiver for facilities with existing discharge limit waivers such as OBI Excursion Inlet (AKG52-0059) and OBI Petersburg (AKG52-0303). With the waiver, these two facilities have consistently maintained the ZOD below a half-acre or have no presence of a ZOD, respectively.

OBI strongly disagrees with EPA's October 2010 opinion and the Department's current opinion that this discharge limit waiver should be rescinded. The opinion is arbitrary and based on assumptions that have been proven false over the last 30 years in certain areas of operation. There are several locations where there is no negative ecological impact on the sea bottom from the discharge of seafood wastewater. The 10-MMlbs limit should not be applied to hydrodynamically energetic waters and a mechanism should be included for a facility in one of these locations to seek a waiver from this limit. The draft Fact Sheet lists 'flushing and mixing characteristics of the receiving water' in consideration for project area ZODs but these characteristics were evidently not considered for the existing annual discharge limit waivers.

Submitted with these comments are discharge and pile size data from seafloor surveys conducted at OBI Seafoods' Excursion Inlet and Petersburg facilities ("OBI Production and Pile Size – Excursion Inlet and Petersburg.pdf"). These data show no correlation between waste discharged and ZOD pile size at either facility, supporting EPA's decision to grant 10-MMlbs discharge waivers to both facilities. We urge the Department to rely on available physical data instead of outdated modeling to make scientifically-sound regulatory decisions.

Outdated/Faulty Modeling for ZOD Size Determination

There is industry and agency consensus that the 10-MMlbs annual discharge limit is based on outdated and erroneous modeling results. The input data were also faulty about tidal current velocities and other assumptions. The Department and consultants have acknowledged that there are more appropriate models available today for determining conservative discharge limits to reduce ZODs to under one acre, however, **Section 4.4.5** of the draft Fact Sheet provides extensive details about the history behind the 10-MMlbs limit and continually references the computer modeling conducted in 1993-1994.

Section 1.11.1 of the draft Fact Sheet states: 'Cumulative discharges to waterbodies and discharge sites increases the probability that greater than a 1.0 acre deposit of seafood waste would form on the seafloor if the total cumulative seafood waste discharge is greater than 10 million pounds to a single waterbody.' This is simply untrue, and the assumption cited, again references the erroneous modeling.

We are aware that TetraTech was previously contracted by the Department to investigate contemporary modeling software options, and it is our understanding that the project ended with no final determination and/or lack of funding. If this is the case, why is the Department unable or unwilling to revisit this plan? The Department has had oversight of this general permit since October 31, 2008 and the seafood industry has consistently offered to provide funding in support of such studies.

The Department also acknowledges in **Section 3.2.3** of the draft Fact Sheet that 'DEC continues to rely on the 1993 modeling in order to authorize discharge volumes and ZODs.' And in **Section 4.4.5** of the draft Fact Sheet, the Department states: "During the permit cycle, DEC will likely contract to have further modeling performed and staff trained to complete the newest ZOD formation modeling…During the AKG521000 permit cycle, DEC will continue to rely on the 1993 modeling."

OBI finds this position objectionable and indicates a lack of good faith on the part of the Department for such an important requirement. For numerous, important reasons in our comments below, facilities that have a ZOD under one acre or no existing ZOD, and meet AK WQS must be able to maintain this existing waiver. Seafloor surveys provide evidence that there is no correlation between the annual discharge quantity and size of the ZOD in certain areas of operation. We request the Department to provide their reasoning behind ignoring this evidence and continue to permit this waiver option.

The 10-MMlbs discharge waiver was previously allowed because EPA and the Department know that the modeling results were flawed and granted facilities the ability to discharge more than this amount if it can be shown that higher annual discharges do not increase the extent of the ZOD, if any is present. If the Department is planning to perform updated modeling during the next permit cycle, we believe that discharge waivers should be left in place until the updated modeling is completed. This allowance would provide the Department with the ability to improve the permit conditions with current science and modeling while allowing facilities to continue to fully operate with safeguards in place in the form of periodic seafloor surveys and ZOD size restrictions.

Devastatingly Severe Negative Impacts on Local Economies

Despite supporting seafloor survey data and the initial rationale used to grant waivers to the 10-MMlbs discharge limit, an indiscriminate decision by the Department to not include the existing waivers for OBI Excursion Inlet and OBI Petersburg could very well result in premature cessation of fishing, fish landings, and supporting processing operations. In turn, this would result in severe economic harm done to these communities and negatively impact the well-being of hundreds of Alaskans that depend on these fisheries to support their livelihood.

Petersburg is a community where commercial fishing is the mainstay of the local economy. Petersburg is ranked as the 25th most active U.S. fishing port by weight and as the 24th port by value with landings of over 35.3 million pounds of seafood worth over $44 million. Over 23% of Petersburg's population make a living associated with commercial fishing and it is the largest private sector employer in the community. Operating about nine months a year, the OBI Petersburg's workforce is totally comprised of residents until the summer salmon processing season occurs in June-September when additional workers are needed.

The recent UAA report, *Commercial Fisheries & Local Economies*[1] (attached) empirically demonstrates the local community's economic benefits from commercial fishing and processing through direct, indirect, and induced effects. The report shows direct and spillover effects from Alaskan commercial fisheries on local wages, employment, and income; providing solid, empirical evidence demonstrating that commercial fisheries contribute to significantly to local economies.

The report shows that commercial fisheries in communities like Petersburg and Juneau have significant, positive direct effects including but not limited to:

- Additional fishing and processing crew are hired;
- Processed harvests produce more value added products;
- Evidence of employment spillovers from commercial fishing into non-fishing sectors; and
- Local permit ownership creates an opportunity for fishery earnings to be spent locally on goods and services, in addition to hiring local crew members; who in turn, are more likely to spend their earnings locally.

A 10% increase in a community's annual fishery earnings leads to a 0.3% increase in employment, which translates to 7.12 jobs per million dollars of fishery earnings, and a corresponding increase in resident income. An increase of one dollar in fisheries earnings results in an increase of total income by 1.54 dollars, with primary economic spillover positively affecting the earnings of local commercial fishing permit owners.

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[1] Commercial Fisheries & Local Economies. Watson, Brett* et.al., January 21, 2021. Institute of Social and Economic Research, University of Alaska Anchorage. *Corresponding Author. Post-Doctoral Researcher. Email: bwjordan2@alaska.edu. This document is attached with our comments.

The importance of the fisheries to the economies of Juneau and Petersburg cannot be underestimated. The 2021 salmon forecast for southeast Alaska is the largest since 2015. As cited in the UAA report, 71% of fish harvesters are Alaskan residents; the mean earnings (ex-vessel value) of southeast Alaska salmon are $61.25 million dollars annually, second only to Bristol Bay salmon.

Local small and large businesses in these Alaska communities continue to face unprecedented challenges during the COVID-19 pandemic. This action by the Department potentially adds to Alaskan's economic hardship by further restricting economic opportunities through eliminating these previously approved waivers. An arbitrary and capricious decision to not honor discharge waivers is not in the best interest of Alaskans.

Operational Limitations and Increased Cost

For the OBI Petersburg facility which discharges into Wrangell Narrows, the list below provides additional information in support of the discharge limit waiver option.

- Tidal currents at the discharge terminus are more than 5 knots and occur four times per day. When not operating the meal plant, there has never been solids accumulation on the sea bottom and periodic dive surveys and anecdotal information provide verification.
- The meal plant is operated whenever the design throughput is reached during salmon season. It cannot be operated during the shoulder seasons. We do not have the option of storing by-product due to odor and quality issues.
- When the maximum design input rate for the meal plant is reached, the ground excess by-product is discharged through the outfall. The design input rate for Petersburg is 350,000 lbs/day or about 1,500,000 round pounds of salmon/day depending on the products being produced. For example, canning produces more by-product. In the last ten years, we have exceeded the design capacity which is why we are raising this issue.
- We expect future high forecasts for pink salmon runs and we would rely on the limit waiver to avoid additional costs to discharge at sea. Discharging at sea is problematic for several reasons:
  - The tender's round trip would be about 8 hours requiring a second vessel to haul out or we would struggle to operate;
  - At least two contracted vessels would be required to apply for an APDES or EPA Offshore Seafood Discharge General Permit;
  - We do not own any tenders and tender owners may elect to perform other types of work and not be available requiring others to go through the permitting process;
  - A tender moored alongside our limited dock space would block space that would otherwise be used to service the tenders delivering seafood;
  - Tender vessel costs are expensive and are usually over $4,500 per day plus fuel per vessel; and
  - Having to travel this route to discharge the by-product at sea is more damaging to the environment than discharging through our outfall, including potentially less dispersal in the offshore discharge zone.

- Should operations be shut down because of struggling to keep up with discharging at sea, the impacts would be felt on our mostly local fleet since about 85% are from Petersburg. The negative impacts due to a drop in commerce would decrease the raw fish tax and hurt the other southeast Alaska towns, our local workforce, and the town of Petersburg.

For optimal rendering plant operation, a daily byproduct feed rate of approximately 100,00-300,000 lbs is necessary, depending on finished product (oil and/or meal). These discharge waivers enable the facility to remain in operation in the event of a prolonged rendering plant shutdown during a high-volume year. Excursion Inlet and Petersburg are OBI's largest facilities and must be able to operate at full capacity as they were originally designed. In the event that pink salmon runs return at full strength, and if we are unable to operate the rendering facilities, the loss of the waiver would place these facilities at a competitive disadvantage with average-sized seafood processing facilities.

For all the above reasons, OBI requests our existing waivers for the 10-MMlbs discharge limit be retained and honored under this new permit.

Facility Responsibility for Vessel Actions and Discharges

There are stipulations throughout the permit for facilities to implement BMPs to regulate vessel activities and to monitor and report vessel activity that may violate AK WQS. While facilities can provide recommended BMPs to vessels while at our docks, we must continue to remind the Department that they do not have the authority to require permitted facilities to monitor or control the actions of vessels delivering seafood to facilities, and therefore cannot be held responsible or liable for their discharges. These vessels are not owned by OBI and we have no legal authority over their actions. It is important to recognize that the processing facilities covered by the draft Permit do not own, operate, or control the fishing vessels that deliver to them. We do not necessarily object to providing to seafood delivery vessels a BMP educational document as described in **2.5.6.7.25.1 through 2.5.6.7.25.7**— a simple "Do's and Don'ts" list for example. However, as mentioned we object to any inference by ADEC that permittees are accountable for monitoring or controlling a vessel's compliance/non-compliance with the BMP list provided or for any other actions of the vessel, whether or not it is related to their discharge, the methods/materials/chemicals they use on-board, how a vessel's domestic-use wastewaters are plumbed, etc.. It is not within ADEC's authority to hold permittees responsible for this.

Furthermore, OBI will continue to assert that (1) fish hold transfer water returned to fishing/tender vessels is not a discharge to waters of the United States and, therefore, not subject to regulation under the Clean Water Act; and (2) the discharge of fish hold water from these vessels is an "incidental discharge," specifically exempt from permitting under the Vessel Incidental Discharge Act of 2018 (VIDA). Reasoning behind our stance has been thoroughly detailed in comments made to the Department by OBI, by Perkins Coie (representing multiple seafood firms operating in Alaska), and by other industry representatives.

The comments also apply to a vessel's live tank water used by regulation for holding live crab, which the Department has chosen to include in the definition of "catch transfer water" despite this water never being used to transfer crab to the facility. Live tank water is an incidental discharge from the vessel and exclusively part of the normal operation of the vessel.

From a safety standpoint, the vessels must fully press (fill up) their RSW holds for stability as they travel from the fishing grounds to the processor. Once at the dock, discharge is necessary so that facility personnel can enter the live tanks and off load the crab by hand into brailer bags that are then lifted by crane onto the facility dock. Some of this water cannot be pumped by the processor and must be discharged overboard. The practice of hand picking also applies when offloading black cod (sablefish) and halibut due to the fragile nature or shape of the fish.

Byproduct Utilization

OBI requests that the Department provide clarifying conditions or definitions under **Section 2.1.12** to outline metrics that would ensure a permittee to "fully utilize to the extent practicable all by-product production processes available at the facility." This stipulation is concerning from both compliance and enforcement perspectives because the term "practicable" is vague and varies greatly by facility.

Seafood Processors Discharging to Estuarine Rivers

By varying discharge depth requirements for marine and estuarine discharges, the Department has acknowledged that discharges into estuaries are typically much more shallow than marine discharges, however, the Department has yet to acknowledge the challenge this puts on these same facilities to meet AK WQS within the 100-foot MZ. As demonstrated by discharge depths outlined in **Appendix D-4**, estuarine MZs have significantly less water volume available to dilute discharges to meet effluent limitations.

OBI expects that all canneries operating in estuarine waters under this permit would struggle to meet effluent temperature requirements within their MZ boundaries and would either need to design and construct a passive or active cooling system or apply for a larger MZ. When considering the effective date of the permit, OBI again requests that the Department acknowledges the length of time it would take for processors to perform MZ modeling, consider alternative options to meet temperature requirements, complete design proposals, public notice applications, receive Approval to Construct, and physically complete any new construction.

Devastatingly Severe Negative Economic and Operational Impacts

Please review the attached recent study in support of our comments:
"Final Economic Benefit of Bristol Bay Salmon_3.17.21"

Section 2.1.5.3.1 of the draft Permit states that facility operations shall cease in extreme negative tide conditions that result in a "no-water" condition at the outfall terminus. Our three estuarine river facilities operate 24 hours a day during peak production, and they can barely keep up with processing and vessel deliveries at this time. These facilities regularly have extreme negative tide conditions that would force routine closures of the facility during peak production and some of the shortest fishing seasons in Alaska.

At these facilities, outfall extensions are not an option as the shallow water conditions would result in outfall damage from vessels, further limiting the production and economic prosperity of the surrounding communities. Furthermore, decades of sea surface, shoreline, and seafloor monitoring at these facilities indicate no adverse short or long term effects on water quality in these areas when discharging in "no-water" conditions.

It is important to remember that a vessel's ability to catch and deliver seafood to a facility is based upon fishery escapement determined by Alaska Fish & Game, not by the seafood companies. As Alaska Fish & Game dictates the amount of time that areas are open to fishing, vessels must be able to quickly offload their catch for processing and return to the grounds as quickly as possible.

By implementing the limitation under **2.1.5.3.1**, facility production must stop as these facilities because they do not have the space to hold large amounts of seafood during a process shutdown. Such lengthy production interruptions would result in 1) delivered fish becoming putrid if there is no way to process and no room to store until able to process at the next tide cycle, 2) no practical means to dispose of putrid fish in remote locations as cited in **1.4.1** of the draft Permit, 3) facilities being forced to turn away vessels putting the fishermen on catch limits which is the worst possible outcome during a short fishing season, and 4) if fish cannot be offloaded because of production bottlenecking, putrid fish would result. Fishing vessels can have seafood pumped out using large pumping systems, but they are unable to pump their own catch overboard.

For these rational and practical reasons, OBI insists that permit condition **2.1.5.3.1** must be removed from the draft Permit.

Annual Discharge Increases

Section 1.8.2.3 details conditions for discharging in excluded areas that requires notice to the Department at least 60 days prior to implementing the change. As written, these conditions include "material changes at the facility, including…significant increases in amount of pollutants discharged (greater than a 25% increase in the four-year annual average amount (weight) discharged)." It is unclear if notice must be given if a greater than 25% increase in the four-year annual average amount discharged occurs that is <u>not</u> due to material changes at the facility, such as a large run during a specific year. If so, it is unclear how a facility discharging in an excluded area is expected to proceed if it is approaching 125% of its four-year average discharge. OBI requests that the Department provide clarification to this section.

OBI also requests that the Department consider the devastating economic impacts that would be caused from such unreasonable and arbitrary forced shutdowns of facilities due to poor four-year average discharges. In these circumstances, we would expect this to force many facilities – especially the smaller businesses – to permanently close.

Comments and Objections to Certain Effluent Monitoring and Receiving Water Quality Monitoring Requirements

OBI requests that with the exception in **Sections 2.1.6.1.1 and 2.3.2**, the requirements for effluent analyses under **Sections 2.2.4, 2.2.5 and 2.2.6** be eliminated from the draft Permit. As stated in **Sections 3.1.2 and 3.3** of the draft Fact Sheet, the intent behind collecting additional effluent information for a "grind and discharge" BCT permit should be to determine whether the discharge is a risk for violations of the AK WQS. Under the draft Permit, this is assessed through Receiving Water Quality Monitoring required under **2.3.2**.

Until the receiving water quality monitoring study is completed, and the Department can determine if processors are able to comply with the AK WQS at the MZ boundary, it is premature to force additional effluent monitoring onto permittees during this permit cycle. The additional data would not indicate whether the discharge complies with AK WQS at the edge of the MZ or project area ZOD.

Facilities discharging into an estuarine river are disproportionately affected by MZ requirements such as less volume and currents during slack tide to dissipate pollutants beneath AK WQS at the edge of the MZ. Receiving water monitoring at these locations also poses a safety risk for the samplers due to heavy vessel traffic and for the sampling vessel to hold its position in varying currents at the 100-ft MZ boundary with any degree of accuracy.

Timeline for Reductions in Monitoring

The Department has updated **Section 2.2.6.3** to state that at the agency's discretion, monitoring frequencies may now be reduced after two years instead of one year. There is no explanation or basis for increasing this timeline if it is already at the agency's discretion to reduce monitoring frequency. Furthermore, it remains unclear if monitoring frequencies can only be reduced for criteria that have effluent limitations referenced in the permit (temperature and pH) and AK WQS (DO, residues, turbidity, TRC), or if other parameters can also be reduced following low detection results. We request that parameters that are eligible for reduced monitoring be listed in the Permit or Fact Sheet and that **2.2.6.3** be reverted to the previous one-year period for monitoring reduction eligibility.

Receiving Water Quality Monitoring

Time restrictions provided in **Sections 2.3.2.2 and 2.3.2.3** are too restrictive for some processing facilities due to the short duration of their season. As an example, OBI Naknek's 2020 operating season was from June 22 to July 20, only 4.5 weeks. For facilities with such short processing seasons, the requirement for samples to be taken at least 4 weeks apart is actually less representative of typical effluent conditions at these locations as these samples would need to be taken at the beginning and end of the processing season, which typically are periods of lowest production. Modifying this requirement would provide the Department with more relevant water quality information and would reduce the burden on processing facilities with shorter seasons.

Section 2.3.2.9 states that sampling coordinates must be accurate to ±30 feet. For consistency, we request that this be updated to ±50 feet as stipulated for coordinates submitted as part of the NOI's Area Map **(1.7.1.1)** as well as conditions of the Offshore Seafood Processors Wastewater Discharge General Permit (AGK523000) (2.3.2.4).

Receiving water monitoring at these locations also poses a safety risk for the samplers due to heavy vessel traffic and for the sampling vessel to hold its position in varying currents at the 100-ft MZ boundary with any degree of accuracy.

Noncompliance for Sample Holding Time Exceedances

Section 2.1.4.8.6 outlines requirements for delivering samples to an accredited laboratory. For each sample that arrives outside of analytical method holding times, **Section 2.1.4.8.6** states that the permittee must submit a noncompliance notification. Many facilities do not operate in locations with laboratories nearby and must ship samples by air to Anchorage. Many facilities are remote, accessible only by small prop land and/or float planes. In all cases, flight schedules are dictated by weather and are frequently delayed or cancelled with minimal notice.

Holding time exceedances due to flight delays and cancellations have been well documented by our facilities. Facilities with a record of sample shipment attempts cannot be deemed non-compliant for shipment delays beyond their control. Some parameters are not being analyzed to determine compliance with current effluent limitations, therefore, exceeded holding times should not be considered as a noncompliance event.

OBI proposes that additional clarification be added similar to that in the Offshore Seafood Processors General Permit and Fact Sheet which state:

> *"2.2.5 DEC may grant a waiver from required monitoring in Table 3, Table 4, and Table 5 if the permittee can demonstrate they have historically been unable to perform sampling onboard by demonstrating through multiple (3 or more) shipping attempts that the samples cannot arrive within required hold times. Waivers from monitoring require an annual reapplication to provide for changes in operations or if DEC is able to determine that similar vessels are able to conduct monitoring."*

Failure to add similar allowances to this general permit penalizes facilities in remote locations and disfavors such locations in small communities that have historically been supported by the fishing industry.

Grind Size Monitoring

While the 0.5-inch grind size and reporting requirements remain intact during the upcoming permit cycle, OBI would like to emphasize the language of the 2018 Omnibus Appropriations Bill, which reads:

> *"Fish Grinding.-Under a Clean Water Act general permit, onshore seafood processors in Alaska are allowed to grind and discharge seafood waste. The permit requires that all seafood waste be ground to a size of no more than one-half inch in any dimension. <u>Unfortunately, in some instances, the best available technology is unable to achieve a half inch grind dimension on a consistent basis due to the malleable nature of fish waste. The Agency should develop a policy to ensure that fish processors using the best available technology and/or best conventional practice will be considered in compliance.</u> Additionally, processing vessels operating in waters off-shore of Alaska are subject to the same one-half inch grinding requirement even though there are no documented water quality issues that require such grinding. The Agency should exempt offshore processing vessels from the requirement."* (Statement of Managers, Page 57)

We are aware that the 2019 renewal of the EPA Offshore Seafood Processors in Alaska General Permit omitted the 0.5-inch grind size limit except for vessels discharging greater than 10-MMlbs/year in Steller sea lion critical habitat. OBI acknowledges that this is a directive for policy development at the federal level and that the Department does not have the ability to implement these policies without approval from EPA.

Our purpose in highlighting this text is for the Department to ensure that ADEC's APDES seafood inspectors and enforcement staff are fully informed about this issue during the upcoming permit cycle, with the intent that the Department's Compliance Enforcement Division continues to use discretion when issuing Notices of Violation solely for grind size exceedances. It is common knowledge that grind size exceedances are not a reflection of the performance of a facility's grinding system. The industry has tried every available grinder type used in the food processing sector and none have been shown to grind seafood scraps to ≤0.5-inch 100% of the time.

<u>Sea Surface and Shoreline Monitoring</u>

Section 2.3.1.3.1.1 stipulates that a permittee shall meet all AK WQS at the boundary of an authorized MZ. Many facility outfalls are located beneath the path of vessels arriving and leaving facility docks. It is unclear if a permittee is out of compliance if foam, sheen, or residues originating from the outfall have been transported out of the MZ from vessels moving through the area. We request clarification be added to the draft Permit or Fact Sheet and statements included in the Fact Sheet denoting enforcement discretion for these conditions.

<u>Nuisance Species</u>

As previously commented, nuisance species are referenced in **Section 2.1.11.3.1** as criteria for determining a nuisance discharge, however, these species (or characteristics of the species) are not defined in the draft Permit nor the draft Fact Sheet. The Department continues to avoid clarifying this issue, as there is no clear definition within this draft Permit or draft Fact Sheet, nor in the Kodiak General Permit or Fact Sheet. There must be clear guidelines in place for facilities and inspectors to objectively decide if any fish or wildlife present near an outfall should be considered an undesirable or nuisance species.

Outfall Inspection

Section 2.1.7.2 discusses "Severed, Failed, or Damaged Systems," and states that "The permittee shall report any failure of the discharge system to DEC in accordance with Appendix A, Part 3.4 (Twenty-four Hour Reporting)." OBI requests this wording be revised to remove the telephone and written report requirements if the failure of the discharge system is discovered and repaired at a time when no processing or discharges are occurring.

Pipes often break during the winter or a seismic event when facilities are not processing and are discovered when staff return to the facility to prepare for the season. Repairs are made in-kind before processing begins. We request clarification for these types of routine repairs and that they not be categorized as "failures" and would not be reportable as a violation. The repairs would be documented in the facility's Pre-Operational Inspection Log which can be provided to the Department upon request or submitted with the Annual Report.

Seafloor Survey Monitoring Requirements

Based on our extensive historical records of seafloor survey results across all our facilities, OBI believes that the monitoring frequency described in **Section 2.3.5 and Table 7** of the draft Permit are excessive and financially burdensome and should be reduced when there is evidence that no deposition exists on the estuarine river or sea bottom. Specifications must be included for facilities discharging ground solids in dynamic estuarine river or sea conditions where dispersal of ground solids prevents any seafloor deposition.

OBI is familiar with EPA's January 2011 opinion about waste piles and that seafood discharge must not cause a sludge, solid or emulsion to be deposited on the seafloor, and we also understand the Department's concern about antibacksliding. Furthermore, we understand the importance of the survey requirements, but firmly believe that allowances must be made to reduce seafloor survey occurrences for facilities with the seafloor at discharge locations visible from above water, environments with strong tidal influence, and with historical data available to show no evidence of seafloor deposition.

If the Department requires an initial survey, and the survey indicates no presence of deposition from the seasonal operation, subsequent surveys should not be required until the next permit cycle. As outlined above, we also believe that an increase in production of >125% is arbitrary and has no basis for the shorter seasonal operations.

The cost for a diving company to travel to Alaska from Seattle or an Anchorage office is very expensive. Costs often range of $30,000-$50,000 or more per survey depending on the characteristics of the waterbody and remoteness of the location. Contractors working on any project in Alaska bill the facility for mobilization costs including travel, weather delay standby days, lodging and meals. The diver survey cost is based on a day rate per diver including the insurance cost required for commercial divers that is passed onto their clients. Depending on depth, a hyperbaric chamber may be required on board the support vessel which adds to the cost for ensuring diver safety. Processing the survey data and report preparation adds to the final cost. With the increased scope and requirements outlined in **Appendix E-3,** we have been advised by dive companies that the costs of performing seafloor surveys may increase by as much as 250%.

Table 7 Survey Requirements

Footnote 'e' of Table 7 states: "Survey is only required if the actual amount discharged is equal to or greater than 125% of the previously authorized discharge amount." Survey history indicates that such increases in production are not expected to raise the probability of bottom deposition in a hydrodynamically active estuarine river or bay, which supports our position that allowances must be made for facilities that meet certain requirements. Since this is unsupported by fact and prior survey history, the provision/footnote should be removed.

It is unclear if the "previously authorized discharge amount" means that new authorizations will be granted to a facility each year based on their four year discharge average, and if so, if a new NOI will be required each year based on updated four-year discharge averages. We request that additional clarification is added to the permit, as there is very little information about conditions for additional surveys.

Pre-Biological Survey After 12 Months of No Discharge

OBI requests that instead of a pre-biological survey outlined in **Table 7**, an outfall integrity check be implemented for facilities that have not discharged in at least 12 months. OBI sees no clear basis for a mandatory seafloor survey to be performed after 12 consecutive months with no processing. Our historical survey data indicates that ZODs diminish in size over time, likely due to currents, storms, seismic activity, and other naturally occurring conditions, especially for our seasonally operated facilities that will be covered under this permit. We understand the value and need to routinely perform outfall line integrity inspections, especially after extended periods of no use, however our historical seafloor data does not support the Department's view that a complete pre-discharge biological survey will reveal any significant data on water quality or permit compliance that the already onerous seafloor survey schedule would not already provide.

Living Substrates

We request clarification of **Section 2.1.3.1** as it implies that facilities with an outfall in "living substrates" is required to perform a pre-discharge survey if the facility has not operated for the past 12 consecutive months. It is unclear if this applies to a facility's outfall not located in "living substrates."

Postponement of Seafloor Surveys due to No Production

OBI also requests that conditions be added to the permit to allow companies to postpone a seafloor survey if a facility does not operate for the calendar year that a survey is required per **Table 7**.

Project Area ZOD

We disagree with the Department's comparison between wood waste and seafood waste in draft Fact Sheet **Section 4.4.3** and the proposed requirements related to the concept of the project area ZOD, especially for facilities with a ZOD less than one acre or with no bottom deposition. The increased complexity of the seafloor survey for the divers to cover so much ground underwater to account for insignificant deposits of discontinuous coverage is unwarranted, especially when considering the proposed increased survey frequency.

We also disagree with the concept of a ZOD forming at the dock due to fish transfer water discharges as described in Fact Sheet **Section 4.4.3**. We know of no such example where the amount of seafood potentially discharged overboard would create bottom deposition, and request that these two references be removed from the fact sheet.

Timeline for Seafloor Survey Completion

Section 1.8.4.2.5 outlines the requirement for seafloor surveys to be completed within 60 days of the completion of processing, and **2.3.5.5.1** adds that if a survey cannot be completed during this period due to surveyor scheduling, the facility must show that a surveyor was contacted at least three months prior to the scheduled survey date. This is an unreasonable requirement from a logistical standpoint for both the facility and the dive companies.

While end-of-season dates can be approximated based on typical environmental conditions, there are many environmental and operational variables which dictate when a facility stops processing. Most seafood processing facilities operate at maximum for 3-4 months each year, with processing duration often shortened or extended each season based on operational and environmental considerations.

In addition, the Department must not realize that there are very few dive companies with the skills and equipment capable of properly performing the detailed surveys required by the draft Permit. According to **Appendix D** of the draft Permit, 72 or so facilities would be required to conduct the survey, therefore, it will be impossible for all of the anticipated 72+ facilities covered by this permit to have the survey conducted within 60 days of terminating operations.

Photographic Log Requirement

Divers must have the ability to record video in place of a photo log. We have spoken to the dive companies and they have emphasized the use and value of video versus a still photograph every few feet whether there is deposition present or not. Most importantly, from a safety standpoint, this is unreasonable to require the divers to take still photographs which greatly increases the time they must remain in the water often under harsh and cold conditions. The Department would be much better served to receive a video file versus hundreds to thousands of still photographs showing bare sand. Some areas have high turbidity, and nothing would be gained using still photography.

Beggiotoa as an Indicator of Seafood Deposits

Appendix E-3 erroneously includes *Beggiatoa spp.* and other types of bacterial mats **(Part I, Section 3(c))** as solely related to deposition of seafood waste on the seafloor. The discussion in the draft Fact Sheet ignores the fact that *Beggiatoa spp.* mats are naturally occurring in sediments and are found in areas where no seafood deposits are found. Therefore, it is unreasonable to include these mats in the calculation of "continuous coverage."

Seafloor ZOD Sediment Coring

Appendix E, Part II.4.j. requires additional data be collected during the survey but states: 'Coring may be required to determine the actual thickness…greater than three feet deep…' This reads as though dive companies are expected to contact the Department and ask whether coring is required. We request this requirement be revised to clarify diver expectations.

Coring past three feet has very little to no value outside of remediation projects, yet significantly increases the cost for a routine survey with deposition less than three quarters of an acre. Coring is an entirely different type of survey from a remediation design/project survey, and requires different equipment, therefore it is wholly unfeasible to combine these two survey methodologies in this General Permit for an authorized ZOD.

Similar to our comments regarding effluent monitoring at remote facilities, holding time exceedances for seafloor survey core samples from our remote facilities will result in the diver returning return to the facility to pull additional samples, resulting in an incredible cost to the processor for reasons often outside of their control. Such requirements for a non-remediation project type of seafloor survey is both unreasonable and cost prohibitive.

For these reasons, we request that the coring and 'marked stick' measuring requirements be removed for authorized ZODs as ZODs are limited by areal extent and not by volume of measured deposition.

Collection of Gas Samples

If the release of gases from the deposition is observed, **Part II.4.l.** requires collection of water samples or gas monitoring be performed including the seafloor where no waste deposition is observed. We object to the new sampling requirements on the basis that they are excessive and unnecessary for an authorized ZOD.

Technical Amendments Requested

As previously commented, **Section 2.6.4.2.2.1** states that in Annual Reports, processors must "report the number of days of processing and the raw product (pounds) processed (for sampling days and total monthly) for each commodity line…" We request that this stipulation be removed because it appears to be an erroneous carryover from the AKG528000 Kodiak General Permit. Though the term "commodity line" is used throughout this draft Permit, neither the draft Permit nor draft Fact Sheet provide a definition of commodity lines and do not include reporting by commodity line in **Table 3** (Table 4 in AKG528000). Furthermore, nowhere in this draft Permit does it state that records must be kept for the number of days that each commodity line is processed, nor the amount of each commodity lines' raw pounds processed. This stipulation would lead to significant confusion for all processors, especially those that do not operate a facility in the City of Kodiak and are not familiar with these requirements.

As previously commented, **Table 3, Footnote b** continues to note that "Waste discharged = raw product – finished product." This does not account for any spoiled or putrid waste that cannot be discharged per **Section 1.4.1** and must be disposed via landfill or barge.

We request that **Section 1.3.7** be revised from "Discharge of seafood waste and wastewaters by vessel" to "Discharge of seafood waste and wastewaters by non-permanently moored craft and barges." This revision would match wording used in **Section 1.1.2** and clarify that "permanent vs. non-permanent" is the differentiating factor instead of "moored craft and barges versus vessel."

Section 2.1.8.7 states: "This shall include the discharge of live tank waste and catch transfer water that often contain large solid pieces of seafood (e.g., small fish, fish heads, and internal organs)." This underlined section is an assertion by the Department that does not clarify any permit regulation or intent and adds no value to the permit. We request that this section be removed.

Sections 2.2.2 and 2.6.5.5 require that the data provided in the monthly DMRs be summarized in the Annual Report. These data are readily available to the Department; therefore, we request that this burdensome and duplicative task be removed from the draft Permit's reporting requirements. The requirement for double data entry increases the risk for error and requires additional time to proof prior to submittal. The Department and EPA are expected to have the necessary IT resources to generate NetDMR data reports as needed for Department review.

We appreciate the opportunity to provide these comments during the public notice review process. Please do not hesitate to contact us if you have any questions.

Sincerely,

OBI Seafoods, LLC

Joe Frazier
Vice President - Food Safety, QA and Regulatory Affairs

Commercial Fisheries & Local Economies

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Abstract

Commercial fisheries are often presumed to contribute meaningfully to local economies, despite a lack of supporting empirical evidence. We address this gap by estimating local economic effects from commercial fishing activity in Alaska. Using exogenous variation in fish stocks and prices, we find that a 10% increase in a community's annual resident fishery earnings leads to a corresponding 0.7% increase in resident income. This translates to an increase of 1.54 dollars in total income for each dollar increase in fisheries earnings. Our results demonstrate the potential for local benefits from commercial fishing through direct, indirect, and induced effects into other sectors. Moreover, our findings demonstrate the importance of local resource ownership for generating benefits for local economies.

JEL Classification: R12, R23, O11, Q22

Keywords: Renewable resources; Fisheries; Shift-share instrument; Leakage; Spillovers.

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1 Introduction

Do commercial fisheries contribute to local economies? The answer to this question is often presumed to be yes and plays an influential role in the decisions of policy makers, despite little empirical evidence to support this claim. This is surprising since natural resources are generally not guaranteed to contribute significantly to local economies (van der Ploeg, 2011; James and Aadland, 2011). Indeed, it is not uncommon to find resource-rich regions lacking the pre-conditions required for resources to contribute to local economies in a meaningful way (Tiebout, 1956; Swales, 2005; Kilkenny and Partridge, 2009). In this paper, we estimate direct and spillover effects from Alaskan commercial fisheries on local wages, employment, and income using a community-level panel dataset of commercial fishing and formal-sector employment records. We exploit exogenous variation in fish stocks and prices, and adapt the empirical methodology of Moretti (2010) by employing a shift-share instrument (Bartik, 1991) to address potential endogeneity concerns. Given the size and importance of the commercial fishing industry for coastal economies, empirical verification of the local economic benefits from commercial fisheries is long overdue.[1]

We provide empirical evidence demonstrating commercial fisheries contribute to local economies. We find that commercially exploited fish stocks have positive direct effects: additional fishing and processing crew are hired, and processed harvests produce more value added. We also find statistical evidence of employment spillovers from commercial fishing into non-fishing sectors: a 10% increase in annual fishery earnings leads to a 0.3% increase in employment, which translates to 7.12 jobs per million dollars of fishery earnings. Overall, we find an increase of one dollar in fisheries earnings results in an increase of total income by 1.54 dollars. Our empirical results also suggest that the primary channel through which spillover effects take place is the earnings of local commercial-fishing permit owners, as opposed to the delivery (or landing) of fish to local businesses for value-added processing.

Our findings have important implications for resource development policies. First, local economies can benefit from resource development, even if they lack ideal conditions for resources to contribute in a meaningful way. Indeed, while the size of the commercial

[1] In the United States, for instance, commercial fishing is a $150B industry and contributes more than 1% to the GDP of 12 coastal states (National Marine Fisheries Service, 2017).

fishing sector in Alaska is significant, spillover benefits may still come as a surprise, given that a large portion of intermediate inputs used in the production of seafood is imported, Alaskan residents make up only half the crew and one-third of the processing labor force, and Alaskan-owned fishing and processing permits account for only a small fraction of the value of processed and harvested fish. Nevertheless, the fraction of resource rents accruing to local owners does provide spillover benefits to local economies. Local permit ownership creates an opportunity for fishery earnings to be spent locally on goods and services, in addition to hiring local crew members—who in turn, are also more likely to spend their earnings locally. This creates an induced effect in the local economy. In contrast, the wage and ownership earnings from seafood processing tend to accrue to non-residents, who are less likely to spend their money locally, resulting in leakage from the local economy.

More broadly, policies aimed towards increasing local resource-extraction activities may not reinforce local economies if either (*i*) the local labor force is comprised primarily of non-resident/migrant workers, or (*ii*) residents do not have an ownership stake in their local resources. The former implication has considerable theoretical (e.g., Moretti, 2011; Kline and Moretti, 2014) and empirical (Partridge et al., 2009; Wrenn et al., 2015; Guettabi and James, 2020) support. The latter implication, while intuitive, has only recently gained attention. Indeed, while the local economic effects of non-renewable resource sectors have received considerable attention in the literature, the vast majority of this work investigates the economic effects of resource-extraction activities, as opposed to the economic effects from resource ownership (Marchand and Weber, 2018). One exception is a recent study by Brown et al. (2019), which demonstrates that royalty payments from oil and gas leases account for a large share of the total income effect of extraction. Indeed, Brown et al. (2019) find that that a one dollar increase in oil and gas royalties is associated with an increase of 1.49 cents in total income for the royalty owner's county. This is similar to the increase of 1.54 cents of total income we find are associated with a one dollar increase in local permit-owner earnings.

Finally, our findings add support to the idea that place-based policies—regardless of whether their focus is on resource development—must be tailored to local conditions (Bartik, 2020). That is, broad-based policies that treat local economies uniformly are not likely to perform well if local economies are heterogeneous. For example, our results demonstrate that conventional policies whose goal is to redirect the value of commercial fisheries landings to local economies—such as allocating individual processing quotas (Matulich et al., 1996; Matulich and Sever, 1999), imposing restrictions to deliver fish to particular ports (Cojocaru et al., 2019), and restricting the trade of individual fishing quotas (Kroetz et al., 2015)—may not produce their intended benefits. Indeed, heterogeneous effects suggest that communities with higher rates of local processor ownership and more dependence on the commercial fisheries sector are more likely to experience benefits from local commercial fishing landings. Thus, depending on local conditions, some communities may benefit from policies that favor local processing businesses and/or enhance forward-and-backward linkages across sectors, while others may benefit from policies aimed to attract or retain resident fishery permit owners. In other words, context matters when designing policy.

The remainder of the paper is organized as follows. In Section 2, we discuss the relevant literature, the nature of cross-sector spillovers, and details of the commercial fishing industry in Alaska. Section 3 describes our data and our empirical strategy. We present our results in Section 4, including extensions to test for heterogeneity and robustness. We conclude with a discussion of the implications and limitations of our work, in addition to opportunities for future research.

2 Conceptual Framework and Background

Local economic effects from natural resource development—such as oil and mineral extraction, commercial fishery catches, or agricultural harvests—are often described by their direct impact to the shocked sector, and spillover effects into other sectors via indirect and induced effects. We draw on this terminology and adapt it for our analysis. We consider direct effects to be changes within the resource sector. For example, direct effects from larger fish stocks include changes in wages and employment for fishing and processing crew, earnings for the owners of fishing and processing permits, and fisheries-tax revenues for local governments. We consider indirect effects to be changes in the sectors from which the resource sector purchases intermediate goods and services (i.e., backward linkages) and the sectors that use outputs from the resource sector as inputs (i.e., forward linkages). For fisheries, backward linkages include bait, fishing gear, and vessel repair/maintenance services while forward linkages include seafood wholesalers and retailers. We consider induced effects to be impacts to local firms from supplying goods and services to the beneficiaries of the direct and indirect income effects. For example, increased fishing crew and processing wages, permit-owner earnings, and government tax revenue from larger fish shocks are spent on local goods and services, thereby inducing a demand shock for local suppliers. The total effect of resource development is thus the sum of the direct effects and the spillovers from indirect and induced effects.

Generally speaking, the size of direct and spillover effects relies on a number of preconditions (Tiebout, 1956; Swales, 2005; Gunton, 2009; Kilkenny and Partridge, 2009). First, the resource sector must be large relative to the size of the economy as a whole in order to stimulate employment and wage growth that is large enough to spillover into other sectors through indirect and induced effects. However, even if a shock is large, the direct benefits for local residents may be small if in-migration or commuting is relatively easy and/or local residents lack the skills and expertise demanded by the shocked sector (Moretti, 2010). Second, the size of the indirect effect depends on the presence and strength of linkages between the resource sector and upstream and downstream firms in the area. The indirect effect is likely to be smaller if most of the inputs are imported from outside the region (Partridge et al., 2009). Third, the size of the induced effect depends on whether the beneficiaries of direct and indirect effects purchase locally produced goods and services.

Overall, communities that experience higher relative shocks, have significant inter-industrial linkages, and have several opportunities to spend earnings locally are the most likely to experience significant gains from natural resource development. Unfortunately, it is not uncommon to find examples—especially in developing countries—where local labor markets are thin, resource extraction firms are not locally owned, few backward or forward linkages exist, and almost no taxes are collected by the local government from resource extraction operations (van der Ploeg, 2011).

Determining whether commercial fisheries have direct and spillover benefits for local economies has implications both for communities considering effective economic development and for fisheries management tasked with balancing conservation and economic considerations. Much of the past work on this topic has been based on input-output (I/O) models, many of which report large effects of fishing activity into non-fishing sectors (for a review, see Seung and Waters, 2006).[2] The limitations of these models, however, have been well documented (e.g., West, 1999; Seung and Waters, 2006). To overcome these limitations, more sophisticated simulation methods have estimated multipliers for fisheries—e.g., Social Accounting Matrices and computable general equilibrium (CGE) models. For example, Seung and Waters (2010) and Seung et al. (2014) use a CGE framework to estimate the direct and multiplier effects of the seafood industry in Alaska. However, even more sophisticated simulations rely critically on assumptions around elasticity estimates drawn from the literature.

The discussion thus far suggests that the impact of the commercial fishery sector on local economies is largely an empirical question; however, retrospective econometric investigations of local economic impacts of commercial fisheries are relatively scarce. Instead, considerable attention has been paid to the local economic effects of non-renewable resource sectors, such as oil/gas production and mining.[3] However, local economic effects from commercial fisheries may differ from those of non-renewable resources for several reasons.

First, the physical processes that determine fluctuations in the resource stock are quite different. For example, fish stocks vary considerably both within and across years; thus, commercial fishing can be highly seasonal, which makes it difficult to support year-round jobs. It also means that commercial fishing earnings can be highly uncertain, which may dampen investment in upstream and downstream industries that rely primarily on the commercial fishing sector. At the same time, unlike non-renewable resources, fisheries can produce rents in perpetuity if managed sustainably, which may bolster investment in upstream and downstream industries.

Second, commercial fishing may attract workers from different labor markets than non-

[2] See Jacobsen et al. (2014) for a review of other studies using the I/O methodology to estimate multiplier effects from the fishing industry.

[3] Notable examples include Corden and Neary (1982); Carrington (1996); Black et al. (2005); Moretti (2010); Weber (2012); Loayza et al. (2013); Aragón and Rud (2013); Fleming and Measham (2014); Weber (2014); Weinstein (2014); Lee (2015); Munasib and Rickman (2015); Fleming and Measham (2015); Paredes et al. (2015); Jacobsen and Parker (2016); Komarek (2016); Tsvetkova and Partridge (2016); Feyrer et al. (2017); Maniloff and Mastromonaco (2017); Agerton et al. (2017); Weinstein et al. (2018). See Marchand and Weber (2018) for a recent comprehensive survey of this literature.

renewable sectors, who may have a different elasticity of supply. For example, there is a relatively high degree of geographic mobility of commercial fishing laborers, which means that labor tends to be fairly elastic; for instance, migrant workers often comprise a significant portion of the commercial fishing labor force in Alaska.

Finally, there are differences in the institutions that govern the exploitation of the resource stock. For example, in contrast to severed mineral rights, regulations that govern many commercial fisheries often require that the permit owners be on board the fishing vessel, which could reduce the incidence of absentee ownership and increase the potential for non-wage income to be spent locally. Thus, the local economic effects of commercial fisheries may be different from those of non-renewable resource sectors, and are likely context dependent.

While econometric investigations of local economic impacts of commercial fisheries are relatively few, there are two notable exceptions: Roy et al. (2009) and Seung (2008), both of which use time series approaches to assess the economic impacts of commercial fishing at rather large levels of aggregation. Seung (2008) estimates long-run employment impacts from the seafood-processing sector, focusing on two fishery-dependent regions in Alaska. Estimated impulse response functions indicate that shocks to seafood-processing labor have relatively small effects on non-seafood employment in the two study regions. Seung (2008) attributes the small impacts to the large proportion of labor, goods, and services imported by the seafood processing industry from outside the region. Roy et al. (2009) test the economic-base hypothesis (North, 1955; Tiebout, 1956) for the fishing industry in Newfoundland and finds that it is indeed an economic base, but the elasticity of the direct effect is not large. Our paper builds on Roy et al. (2009) and Seung (2008) by estimating the economic effect of commercial fishing empirically.

Our analysis differs by employing a panel data approach adapted from the regional economics literature (Moretti, 2010). Panel data allows us to analyze the economic effects of commercial fishing using both temporal and cross-sectional variation while controlling for unobservable year- and place-specific fixed effects that may be correlated with both commercial fishing activity and local economic outcomes. Further, the panel structure of our data allows us to examine heterogeneous effects across relatively smaller geographic units (i.e., communities).

Alaska provides a useful setting for estimating local fishing economic effects for several reasons. The size of the commercial fishing sector in Alaska is significant: Alaskan fisheries produced approximately $4.4 billion in sales in 2015, ranking first in the U.S. in terms of production (National Marine Fisheries Service, 2017). Commercial fishing also plays a large role in the state economy, particularly in many Alaskan coastal communities.[4] However, Alaska also serves as an example of a resource-rich state that may lack the pre-conditions for resources to contribute to local economies in a meaningful way. For example, Guettabi and James (2020) demonstrate that while total employment increases with resource extraction activities in the oil-rich North Slope borough in Alaska, local residents receive little to none of these benefits. A similar story may be true of Alaska's fisheries. While Alaskan fishers represented 71% of permit owners in 2015, they earned only 33% of the total value of catch. (See Table B.1).[5] Further, only 65% of the wholesale value from commercial fisheries can be attributed to a processor based in Alaska.[6] Thus, a large portion of the value of commercial fisheries in Alaska may never enter into local economies.

There are also reasons to believe that the spillover benefits from commercial fishing activities that do enter local economies may be small. A large portion of intermediate inputs used in the production of seafood is imported to Alaska communities due to their remoteness—most goods and services used as intermediate inputs are imported primarily from Washington State (Seung, 2008). This means that an increase in demand from positive shocks to commercial fishing will induce imports rather than local impacts. Another reason relates to the residency status of factor payment recipients (e.g., fishing crew and processing labor) and the processing owners to whom profits are accruing. In fact, the fraction of Alaskan-owned fishing permits, crew and processing labor, and Alaskan-owned fishing firms

[4]For instance, commercial fishing was the state's largest employer in 2016: approximately 29,200 workers (8.8% of total non-farm employment) were directly employed in the commercial fishing sector, totaling $824 million in labor income (McDowell Group, 2017). According to National Marine Fisheries Service (2017), Alaska was ranked fourth in seafood-industry employment, which includes the commercial harvesting and processing sectors, with approximately 60,000 employed. For comparison, California ranks first in terms of fishing employment with approximately twice as many workers as Alaska; however, this difference is striking when considering that California's economy is roughly 50 times larger than Alaska's.

[5]The largest share of earnings were owned by residents of Washington State (50%), who represented around 15% of permit owners.

[6]The rest of the wholesale value can largely be attributed to catcher processors, which catch and process fish on board the vessel while at sea.

that work and operate in the state is relatively small (Table B.1). Only half of the total crew jobs in Alaska accrue to local residents. Similarly, Alaskans are also in the minority of fish processing labor (just under 30% employees), earning just 35% of the wages paid to these positions. Finally, while Alaskans own the majority of fishing business licenses (nearly 80%), many of these are smaller catcher/seller operations. Only half of the processor permits are owned by Alaskans, and these businesses account for only 26% of the total wholesale value generated by Alaska fisheries. If most of the non-resident earnings leave the region, the induced and indirect effects of commercial fishing in local economies can be expected to be small. Altogether, Alaska provides an opportunity to test for local economic effects from a large and valuable resource sector, even if the ideal conditions are lacking for the resource sector to act as an economic base.

3 Empirical Strategy

Our estimation strategy and data allow us to distinguish the channels through which activity from a variety of fisheries around Alaska enter a community, how these activities spillover into other sectors of the local economy, and who is impacted from the direct and spillover effects. To understand how fishing activity enters a community, we separately estimate the effect of "resident earnings," or the revenues of local permit-owners from commercial fishing, and "local landings," or the value of received deliveries to local fish processors. We consider different forms of direct effects fishing activity may have on fishing crew, processing labor, and the value added from processing. To understand how activities spillover into other sectors, we measure impacts on different economic outcomes, such wages, employment, and income across different sectors of the local economy. Finally, to understand who benefits from commercial fishing, we are careful to identify if those impacted by commercial fishing are local residents or commuters/migrants.

3.1 Estimation and Identification

Our empirical strategy is adapted from Moretti (2010), who tests for labor impacts from shocks in the traded sector to the non-traded sector. In similar fashion, we test for effects from shocks in commercial fishing earnings and landings on the fishery sector itself and other industries in both the traded (e.g., manufacturing or fish processing) and non-traded (e.g., restaurants, retail, etc.) sectors. We estimate the model:

$$\Delta\, ln\, y_{ct} = \beta \Delta\, ln\, x_{ct} + \tau_t + \alpha_c + \epsilon_{ct} \tag{1}$$

where $\Delta\, ln\, y_{ct}$ is the change in the log outcome variable of interest for community c from year $t-1$ to year t, $\Delta\, ln\, x_{ct}$ is the annual change in the log value of fisheries activity (catch by residents or landings to local processors) in community c, τ_t is an annual fixed effect, and α_c is a community fixed effect.[7] A given community may harvest or receive deliveries from a number of fisheries across different species and areas, so when considering total resident catch or total local landings measured by x_{ct}, we aggregate across all fisheries. The coefficient β reflects the percentage change in a given outcome stemming from a one-percent change in the measure of commercial fisheries value. An estimate of zero implies that commercial fisheries have no effect in the sector of the local economy represented by the outcome variable y.

One possible concern with estimating Eq. 1 using ordinary least squares is that commercial fishing activity measured at the community level may be endogenous: fishing decisions, such as how much to harvest or where to deliver harvest, may depend on community- and time-specific unobservable factors that are correlated with local economic outcomes, thereby creating a simultaneity bias in our estimate of β. For example, higher wages in the non-fishing sectors driven by unobservable factors may result in capital purchases in the fishing industry (e.g., gear and entry permits), thereby creating a positive simultaneity bias in the estimate of β. On the other hand, these same non-fishing shocks also increase the opportunity cost of commercial-fishing participation, thereby creating a negative simultaneity bias in β. Non-fishing economic shocks may also affect the amount of fish landed in a community if such shocks influence processing costs, and in turn, the prices that fish processors are able to offer fishers. While the inclusion of community fixed effects and annual fixed effects par-

[7] For example, one such annual fixed effect is the annual lump-sum distribution of the Alaska Permanent Fund Dividend. Recent work on the impacts of the dividend include investigations of its effect on the labor market (Jones and Marinescu, 2018; Bibler et al., 2019) and its effect on crime (Watson et al., 2020).

tially addresses these endogeneity concerns, they do not address any potential endogeneity stemming from community- and annual-specific unobserved factors.

We address these concerns by recognizing that the two most important factors influencing overall commercial fishing earnings and landings are stock levels (the total volume of fish biomass) and global fish prices, both of which are exogenously determined from the perspective of an individual community. By employing a shift-share instrumental variable (IV) strategy, we isolate exogenous variation in commercial-fishing outcomes that stems from changes in overall fish stocks and prices, thereby disposing of any endogenous variation in commercial-fishing outcomes that stems from fishing decisions. The shift-share (or Bartik, 1991) instrument is a popular approach for dealing with potential endogeneity issues when attempting to identify a causal relationship between two variables at the regional level—e.g., local labor-market effects from immigration (Card, 2001), trade (Autor et al., 2013), or total factor productivity (Hornbeck and Moretti, 2019) shocks. The underlying motivation behind the shift-share instrument is a simple accounting identity that allows a sector's regional growth rate to be decomposed into a nation-wide sectoral growth rate and an idiosyncratic sector-regional growth rate. Under the assumption that nation-wide growth rates are exogenous from the perspective of a region, a sector's nation-wide growth rate can be used as an instrument for a sector's regional growth rate.

We exploit the fact that, just as the growth rate of a community's economy is derived from multiple sectors, the growth rate of a community's commercial fishing earnings (or landings) is derived from multiple fisheries, each of which differs by species, geography, and gear, and experiences shocks from fluctuations in biological stocks and global prices. Thus, the growth rate of commercial fishing earnings (or landings) in community c at time t can be expressed as $\Delta x_{ct} = \sum_j w_{cjt} \Delta x_{cjt}$, where Δx_{cjt} is the growth rate of earnings in fishery j in community c at time t, and w_{cjt} is the share of community c's commercial fishing earnings attributable to fishery j at time t. To address the potential endogeneity of Δx_{cjt}, we make use of the accounting identity to decompose fishery-community earnings growth as $\Delta x_{cjt} = \Delta x_{jt} + (\Delta x_{cjt} - \Delta x_{jt})$, where $\Delta x_{jt} = \sum_c \Delta x_{cjt}$ is the fishery-wide component of earnings growth from fishery j (across all communities) and the term in the parentheses is the idiosyncratic component of fishery-community earnings growth. The shift-share instrument is a weighted sum of the fishery-wide component of the growth rates with fishery-community shares as weights: $z_{ct} = \sum_j w_{cj0} \Delta x_{jt}$, where we follow standard practice and fix fishery-community shares at their pre-sample levels.[8] In essence, we use the overall growth rate that would have occurred in a community if its earnings from a given fishery grew at the fishery's overall growth rate. Our instrument is therefore exploiting variation in the overall growth rate for each fishery (the "shift"), weighted by a fishery's historical importance to a community's commercial fishing earnings (the "share").

We estimate Eq. 1 by two-stage least squares, with the first stage specified by:

$$\Delta\, ln\, x_{ct} = \gamma\, ln\, z_{ct} + \tau_t + \alpha_c + \epsilon_{ct}, \tag{2}$$

where γ is the first-stage relationship between the shift-share instrument z_{ct} and fishing activity growth $\Delta\, ln\, x_{ct}$, while τ_t and α_c are time and community fixed effects, respectively. We also estimate Eq. 1 by OLS for reference. Recent work provides more rigorous scrutiny of the identification assumptions underlying the Bartik instrument (Goldsmith-Pinkham et al., 2020; Borusyak et al., 2018). In Section 4.5, we discuss our instrument's identifying assumptions in the context of this recent work and present evidence for its validity.

Finally, annual commercial fishery measures are more variable for those communities with relatively small amounts of fishing activity. To address such heteroskedasticity in the first-stage regression of our IV estimator, we weight each observation by their place-specific sample average of commercial-fishing activity. For example, for analyses using resident earnings at the community level, the sample average of resident earnings for each community is used as the regression weight. This places relatively larger weight on those communities where commercial-fishing activity is greater and variation in aggregate fishing outcomes is more systematic.

[8] Since our sample of economic outcome data begins in 2000 we define the pre-sample period for the community-specific weight, w_{jc0}, as the average over 1998-2000. A three-year period is likely long enough to smooth across fishery-related shocks that occurred in a particular year, but short enough to exclude structural changes that may have occurred in earlier years.

3.2 Data

We assemble a dataset of economic and commercial fishing variables for all Alaskan communities that engaged in commercial fisheries in some form over the period 1998-2015. Data on received earnings from permit-owners come from the Alaska Commercial Fisheries Entry Commission (CFEC) Basic Information Tables for the years 1998-2015. These data provide near-comprehensive coverage of permit-owner harvests and earnings across commercial fisheries in the state, reported annually for each community-fishery pair. Alaskan commercial fisheries are stipulated by species, fishing district, and gear type. Any individual that partakes in commercial-fishing activity requires a fishery-specific permit issued by the CFEC. In 2010, 20,275 CFEC permits were issued across 205 fisheries in Alaska.[9,10] A permit-owner's community is determined based on the address listed on a fisher's permit. Data on the value of received deliveries to a local processor are aggregated from individual deliveries reported as a part of the Alaska Department of Fish and Game's (ADF&G) fish tickets and eLandings systems.

We use several outcome variables to investigate the local economic effects of commercial fishing activity. We test for the direct effect of commercial fishing activity on three outcomes: harvesting crew which catch fish at sea; processing labor which cleans, fillets and packs the fish; and processing value added, which measures the net value of the products. We also test for spillover effects of fishing activity using outcomes on wages, employment (disaggregated to traded and non-traded sectors), and new hiring in non-fishing sectors of the economy. Finally,

[9] CFEC data do not include harvests and earnings in fisheries for which the harvest is not landed in an Alaskan port. The number of such fisheries across the state are few and are dominated by large out-of-state catcher-processors (CPs) that process their catch at sea; thus, their direct impact on the economies of most Alaskan communities is likely limited due to the lack of landings that take place and the lack of permit-owners that reside in Alaska. Of the $4.2B in first wholesale value of Alaska-region fisheries, $1.3B was generated by CP vessels (McDowell Group, 2017). Nevertheless, the main ports that service such CPs (e.g., Dutch Harbor, Atka, and Akutan) are likely positively impacted by this fleet, and previous work has demonstrated that the CP sector is an important contributor to the Alaskan economy (Waters et al., 2014); thus, our estimates are likely biased downwards.

[10] Note that for a small subset of community-fishery observations, earnings values are censored to protect confidentiality. Censoring occurs when fewer than four fishers participate in a given fishery. In the case where only one fishery in a community is censored, earnings values for other fisheries are also censored so that a community total can be reported. For the 18,940 fisher-community-year triads, 1,851 are censored in this way. These censored observations represent less than 1% of total earnings. When earnings values are censored, we impute them with one of three methods based on the nature of uncensored observations available. For robustness, we also estimate our models by dropping the censored observations and find that the results are similar. See Appendix A for more details.

we estimate the total effect (direct plus spillover effects) of commercial fishing activity using gross income. Data available to measure these outcomes varies in geographic aggregation. Many outcome variables are available at the community level (e.g., fishing crew, employment, wages, and value added) while several others are available only at higher levels of geographic aggregation, such as the borough level (e.g., gross income) or regional level (e.g., processing labor). Boroughs are Alaska's county equivalent and regions are a collection of boroughs defined by Alaska Department of Labor and Workforce Development (AKDOL) for the purpose of maintaining confidentiality.[11]

To measure direct effects, data on the number of registered crew licenses at the community level is recorded by ADF&G and were obtained from NOAA's Alaska Fisheries Science Center's (AFSC) Community Profiles and Snapshots. To our knowledge, there is no comprehensive available data on the wages earned by crew members in the commercial fishing industry.[12] Data on the number of processing laborers come from the Alaska Department of Labor and Workforce Development Research and Analysis Section. These data are only available at the regional level. Data on the wholesale value of seafood products at the community level come from ADF&G's Commercial Operator's Annual Reports (COAR).[13]

To measure spillover effects, we collect data on local economic outcomes from the AKDOL's Alaska Local and Regional Information (ALARI) database. These data cover the years 2000-2015. Commonly used data on annual wages and employment in rural areas often do not report statistics below the level of the county, but ALARI reports data for each of Alaska's 344 communities. This match is enabled by AKDOL linking unemployment insurance records—the same records that are used by the Bureau of Labor Statistic's (BLS) Quarterly Census of Employment and Wages (QCEW)—with other administrative data collected by the state.

Unlike QCEW, however, ALARI reports wages and employment by the employee's place of residence rather than their place of work. However, AKDOL does not publish wages

[11] A map of these eight regions and the boroughs they nest are available on the AKDOL website live.laborstats.alaska.gov/seafood/

[12] There are some exceptions for a subset of the fisheries in Alaska—e.g., the nine rationalized crab fisheries, two of which were investigated by (Abbott et al., 2010).

[13] Fish ticket/eLandings and COAR data are confidential and were obtained as part of a cooperative agreement between the University of Alaska Anchorage and NOAA's AFSC.

and employment by community of work to maintain confidentiality for employers. ALARI also identifies the number of new hires in each community in a given year, defined as an employee who was not working for the employer in any of the four previous quarters. Further, ALARI usefully reports employment by industry, which we aggregate into traded sectors (agriculture, natural resources and mining, and manufacturing) and non-traded sectors (all other industries).

In addition, we can test for spillover effects both at the place-of-residence and for place-of-work; however, place-of-work data come from BLS's QCEW and are only available at the borough level. For comparison, we aggregate place-of-residence wage and employment data from the ALARI community-level data to the borough level.

Finally, to capture the total income effect of commercial fisheries on local economies, we use adjusted gross income data from the Internal Revenue Service (IRS) county-level database—which includes income for individuals without wage and salary earnings—into our analysis. Note, however, that taxable income will not include under-the-table cash payments or barter arrangements, which may be used in the informal economy of our setting.

It is important to note both ALARI and QCEW are based on unemployment insurance records. Commercial fishers and crew engaged in harvesting are mostly self-employed or contract workers, and therefore, are not included in these measures. Additionally, wages for other upstream/downstream proprietors and self-employed individuals are also not covered by unemployment insurance. In contrast, wage and employment records for workers employed by commercial processors are included in ALARI and QCEW measures as part of the traded-sector. This distinction is important when differentiating between direct- and spillover-induced effects on wages and employment. It is also worth noting that our measures of fishing crew, processor labor, and employment measured in ALARI account for the number of workers, not the number of full-time equivalent (FTE) jobs. The seafood industry in Alaska is mostly seasonal (with a summer peak between June and September), with many workers only working a few months out of the year. This is important for comparing our estimates to other studies that use FTE jobs as their dependent variable of interest.

Because our analysis is based on relative changes year-over-year, communities or boroughs which did not harvest catch in the state or receive landings at a local port for at least two consecutive years (141 in communities and 4 boroughs) were excluded from the sample. The omitted communities are generally inland and small, with an average population of 340. In total, 200 communities and 25 boroughs have sufficient data over the sample period to estimate the economic effect of fishery permit-owner earnings. Likewise, 69 communities and 18 boroughs had sufficient data to assess the economic effect of commercial-fishery landings. Across communities and boroughs, there is considerable variation in both the economic outcome variables and the measures of fishing activity. Table B.2 presents summary statistics for the main variables used in the analysis. The average community and year have wages of just over \$54 million per year and with approximately 1,350 persons employed. These jobs are heavily weighted toward the non-traded sector and vary considerably across communities.

Year-to-year shocks to fisheries value can be quite large in magnitude due to shifts in prices and the biological stocks of individual species over space. Figure B.1 illustrates this variation. Figure 1 shows the spatial variation of catch and landings averaged over the period 2000-2015 at both the community and borough levels. At the community level (Panels a and b), fishing activity is concentrated in Southeastern Alaska, on the Kenai Peninsula south of Anchorage, and across the Alaska Peninsula between Anchorage and the large port town of Unalaska (Dutch Harbor). Revenues from catch and particularly landings are more sparse along the western coast, the area of the state with a number of smaller communities. Looking at per-capita activity at the borough level (Panels e and f), shows a similar distribution of activity.

4 Results

We estimate Eq. 1 using several different dependent variables, which vary by their geographic aggregation (community, borough, or region) due to data availability. Whether our estimated effect represents a direct effect, spillover effect, or total effect depends on the dependent variable. The β's estimated for each outcome by Eq. 1 are elasticities, but as in Moretti (2010), we transform the estimated elasticities and their associated 95% confidence intervals into level changes. The units of these level changes are in terms of dollars-per-dollar or jobs-per-dollar (denoted $\Delta Y/\$$ in the tables below), depending on the dependent variable y.

This transformation takes the form $\Delta Y/\$ = \hat{\beta}\frac{\overline{y}}{\overline{x}}$, where $\overline{y}$ and $\overline{x}$ are the sample mean values of outcome y and fishery activity x, respectively.

We first present estimates of direct effects of commercial fishing and processing sectors. We then test for spillover effects of commercial fishing activity into other industries. Next, we show the effect of commercial fishing on total income (both fishing and non-fishing). We then explore the potential mechanisms for these effects by testing whether direct and spillover effects from commercial fishing are different for resident and non-resident workers. We also test for heterogeneous effects by narrowing our sample on communities with locally-owned processing capacity and for "fishing-dependent" communities. Finally, we assess the validity of our instrument and robustness of our findings across different model specifications.

4.1 Direct effects of commercial fishing

We first focus our attention on estimating direct effects from commercial fishing. Direct effects are represented by: fishing crew employment, which is a primary input into fishing production; processing labor, which is a primary input into processing production; and the value-added (wholesale revenue minus ex-vessel revenue) of local processing plants. Crew labor and processor value added data are available at the community level, but processor labor is only reported at the aggregated region level. There are only eight of these regions, which notably reduces the sample size and reduces statistical power.

We find that local crew license registrations increase by 0.27% and 0.18% in response to a 1% increase in the value of resident catch and local landings, respectively, providing evidence that resident permit owners are responsive to increases in harvest opportunities by hiring local crew (Table 1). These elasticities imply that a \$1 million increase in resident catch or local landings results in additional local crew hires of 3.4 and 1.36, respectively. We also find that the value added from processors increases by 0.75% and 0.60% in response to a 1% increase in the value of resident catch and local landings. In levels, each dollar of landings creates an additional \$0.49 of value added. Processing labor increases by 0.46% for a 1% increase in local landings, which is approximately 9 jobs for every million dollars landed locally. We note that crew effects are larger where permit-owners live (resident catch) as opposed to where harvest is landed (local landings). Conversely, and intuitively, processing labor is not statistically responsive to where permit-owners live, but instead, where they land their harvest.

4.2 Spillover effects of commercial fishing

How do the direct effects to the commercial fishing industry in Table 1 translate to spillover effects in other sectors? Table 2 presents estimates of commercial-fishing effects on wages, employment (overall, traded sector, and non-traded sector) and new hires for resident workers at the community level. Resident workers include all employees who lived in a community in a given year and participated in unemployment insurance. Non-resident employees, either those who reside outside Alaska or in a different Alaska community, are not represented in these estimates. We find statistically significant employment impacts from resident catch earnings: a 1% change in the value of resident catch leads to a 0.03% change in resident employment. We find similar results for the value of local landings: a 1% change in local deliveries values leads to a 0.04% change in resident employment. Translated to jobs-per-dollar, these equate to 7.2 and 2 resident jobs created for every million dollars of resident catch or local landings, respectively. Effects on wages and new hires are statistically insignificant for both resident catch earnings and local landings.

We note that these outcome variables are inclusive of all employment covered by unemployment insurance, which does not include employment in the harvesting (captain and crew labor) sector, but does include employment in the fish processing sector. However, despite the fact that traded-sector employment includes resident processing employment, our estimates of traded-sector employment effects are virtually zero for both resident catch earnings and local landings.[14] Instead, our estimated resident employment impacts for are driven by the non-traded sector, suggesting that the total employment estimates are not driven by direct effects from resident processing labor.

A lack of resident wages and traded-sector employment impacts could be due to the processing sector crowding out labor from other traded industries, like mining. It is also possible that resident workers shifting from unemployed to employed in processing are offset

[14]Fish processing is a subset of manufacturing, and we classify that sector as part of the larger traded good sector.

by resident workers shifting from processing to harvesting (where their labor is uncovered by unemployment insurance used to measure employment here). However, as we discuss in more detail in Section 4.4, the null effect for resident wages and trade-sector employment is likely driven by our finding that the primary processing-labor response is driven by non-resident workers.

Interestingly, our empirical estimates of spillover effects are consistent with previous CGE simulation investigations of Alaska's commercial fisheries. Seung et al. (2014) finds that for a 1% increase in the volume of catch, employment in non-fishing sectors increases by 0.03%. Note that Seung et al. looks at shocks to the volume of catch, while we look at the value of catch. Also, Seung et al. consider total catch and employment from any residency status, whereas our estimates are for residents only.

Our estimates of employment spillover effects are also similar to those found for non-renewable resources. For example, the 1.98 jobs per million dollars of local landings we find is comparable to the 2.35 jobs per million dollars of natural gas production found by Weber (2012) for Colorado, Texas and Wyoming, and the 0.85 jobs per million dollars of oil and gas production found by Feyrer et al. (2017) at the national level. In contrast, our insignificant estimate for wage spillover effects from local landings (and resident earnings) differ from those found by Weber (2012) and Feyrer et al. (2017): 0.09 and 0.07 dollars per dollar of oil and gas production, respectively. However, the estimates of employment and wage effects in Weber (2012) and Feyrer et al. (2017) are not perfect comparisons to ours given that (*i*) they include jobs for both residents and non-residents (as opposed to just residents), (*ii*) they include jobs created in both the directly and indirectly impacted sectors (as opposed to just indirectly impacted sectors), and (*iii*) the estimates are at the county level (as opposed to the community level). Together, these suggest that the number of jobs created from local fishing activity, particularly from resident earnings, could be considerably larger than those found for non-renewable resource production.

4.3 Total effects of commercial fishing

To estimate the total effect (direct plus spillover effects) from commercial fishing, we use taxable income at the borough level, reported as adjustable gross income (AGI) by the IRS, as our dependent variable. Included in AGI is fisher earnings, crew wages, and processing wages for residents, as is any income generated by borough residents through spillover activities into upstream or downstream industries. The total effect estimate therefore reflects the total income effect to all residents in a borough. As shown in Table 3, we find a 0.07% increase in AGI from a 1% increase in the value of resident catch. In contrast, we do not find any statistical evidence of a total effect on resident income from commercial fishery landings. Each dollar increase of resident catch results in an increase of 1.54 dollars of AGI for the borough. A value greater than one implies the presence of spillovers from fishing into the broader economy. Since AGI is net of certain tax deductions, this estimate represents a lower bound on the multiplier effect (i.e., the accounting relationship where the same dollar is on the right- and left-hand sides of an equation).

For comparison, our estimates for catch-induced income effects are similar to the CGE simulation results reported by Seung et al. (2014): a 1% increase in catch increases income by 0.06%, which is comparable to our estimated elasticity of 0.07. Examining the total effects of royalty payments from oil and gas leases on county income, Brown et al. (2019) finds that one dollar of royalty payments generates 1.49 dollars of AGI in the lease-owner's county of residence (but not necessarily where the oil and gas production occurred), which is comparable to our estimate of 1.54 dollars of AGI per million dollars of resident catch. Looking at the location of the activity, as opposed to the residency of the owner, Feyrer et al. (2017) finds that one dollar of additional oil and gas production results in 0.18 dollars of AGI in the producing county, which is comparable to the (insignificant) 0.07 dollars of AGI per million dollars of local landings.

4.4 Exploring Mechanisms

Distinguishing between the location of resource extraction and the location of resource ownership appears to be an important factor in explaining the effects of natural resource sectors on local economies, both for commercial fisheries and non-renewable resources. In this section, we explore possible explanations for this result. A key finding is local landings do not appear to create additional processing jobs for residents; rather, they tend to create processing employment for non-resident workers, who may take their earnings home at the end of the season, rather than spending them locally. We also find suggestive evidence that communities with processing facilities owned by an Alaskan resident are more likely to hire local workers. Finally, we show that communities with more economic dependence on commercial fisheries tend to experience larger spillover effects, both from local landings and from resident earnings.

We first explore whether direct effects of fishing activity differentially impact residents and non-residents. The only direct effect for which this differentiation is possible, due to available data, is processing labor at the regional level. Table 4 presents these estimated effects. We find that additional catch or landings have no significant effect for the number of residents hired for processing in that region. However, we find that additional landings do generate significant non-resident processing labor jobs. This pattern in processing-labor residency could have negative implications for local induced effects from fisheries landings if non-residents (particularly seasonal workers) save their earnings to take home outside Alaska, rather than spend them in the local economy.[15]

While non-resident workers can stunt spillover effects, so can non-resident owners. By construction, resident catch earnings are all owned locally, but there is varying resident ownership in capital for processors. We explore whether direct and spillover effects are influenced by resident ownership of seafood processing plants. Resident-owned processors may have different preferences for sourcing labor and other inputs locally, and could have a larger induced effect if business earnings are spent on local goods and services. From the COAR database, we can differentiate between businesses registered to Alaskan owners versus those owned outside the state. We subset our data by communities in which 100% of processors are Alaska-owned versus those with some out-of-state ownership, which splits the sample roughly in half. Intuitively, processor ownership has negligible influence on the impacts resulting from resident catch; however, we find suggestive evidence that processing activities from local landings generate larger employment impacts in communities where processors are resident owned (Figure 2).[16]

[15]We also test for residency-specific spillover effects by measuring wages and employment by both place-of-work and place-of-residence. However, because data limits such an analysis to the borough level, we find there is a lack of sufficient power to detect meaningful economic effects. Full details are provided in Appendix Section C.

[16]Note that the sub-sample of communities with 100% resident ownership of processors tend to have

Local economies may also vary in their degree of dependence on commercial fisheries, reflecting differences in economic structures across communities. Fisheries-dependent communities could exhibit greater forward and backward linkages between the fisheries sector, which could lead to larger indirect effects. Further, shocks to the fisheries sector could be larger relative to the size of the local economy for such communities.

We explore how our estimated direct and spillover effects differ across a community's dependence on commercial fishing. For this analysis, we use two different definitions of dependence: (1) an index of fishing engagement, and (2) the ratio of resident commercial catch revenue to total formal employment wages. The fishing-engagement index was constructed by Himes-Cornell and Kasperski (2016), and measures a community's fishing dependence on a 0-5 scale, with 5 being the most dependent and 0 the least. The score is derived from summing 5 binary indicators which measure engagement in commercial, recreational, and subsistence fishing. We estimate our model on different sub-samples of our data, progressively dropping lower-scoring communities and concentrating the sample on more fishing-dependent communities. For the most fishing-dependent communities (those with scores of 4 and 5), there is some evidence of larger wage and employment effects (Figure 3). There is also some evidence of smaller direct effects of resident catch and local landings on fishing crew jobs in more fishing-dependent communities, which suggests that any spillover effects in these communities are likely not being driven by increased crew opportunities for residents.

Results using our second measure of fishing dependence (i.e., the ratio of fishing revenue to total wages) are quite similar to those presented above.[17,18]

Altogether, our results here suggest that context matters for understanding how commercial fisheries contribute to local economies. Indeed, our finding that local landings have relatively small spillover and total effects (Tables 2 and 3) may not have anything to do with the seafood-processing production technology itself, but rather be due to the residency of the

smaller and more variable amounts of resident catch and landings. As a result, the first stage regressions for this sub-sample have poorer fit, and in turn, confidence intervals for the IV estimates are considerably larger than corresponding estimates using the full sample.

[17]Results using our second measure of fishing dependence are presented in Appendix Figure B.2. To subset our sample for this heterogeneity analysis, we drop communities progressively below certain decile thresholds of this dependency measure (50th, 60th, 70th, 80th).

[18]We also explored other dimensions of heterogeneity but found no compelling evidence for such effects. These included differentiation by urban and rural communities and degree of fishery seasonality.

laborers and owners of the processing facilities. Thus, communities with higher rates of local processor workers/owners and more dependence on commercial fisheries may in fact benefit from policies directed towards increasing the value of commercially landed harvests. Moreover, our results here confirm the importance of worker and owner residency for generating spillover benefits in local economies.

4.5 Robustness and Instrument Validation

To assess the robustness of our findings, we systematically estimate a number of different model specifications for both resident catch and local landings. Figure D.3 shows the robustness of the community-level results to eight alternative model specifications: fixed effects (none, community only, annual only), unclustered standard errors, unweighted regressions, dropping outliers with annual changes in fishing activity larger than 200% or larger than 100%, and the use of a Van Dijk (2018) correction to the shift-share instrument.[19] Generally speaking, the results are qualitatively similar across these outcomes and specifications, with two exceptions. First, the van Dijk shift-share instrument correction reduces the first-stage fit for local landings, because a given fishery's landings tend to be more concentrated in the number of ports that receive deliveries. As a result, the precision of our second-stage estimates is reduced, as reflected in the large confidence intervals. In addition, our estimates tend to increase considerably in (absolute) size. Second, unweighted regressions also tend to reduce the first-stage fit, which is to be expected given that relatively more weight is now placed on communities with less systematic variation in fisheries activity. In turn, our second-stage estimates are less precise (particularly for local landings), and result in notably larger effects for crew labor and smaller estimates for wages and employment.

We also conduct a falsification test, described in more detail in Appendix Section D.2, to provide evidence that we are correctly interpreting the causal direction of our estimated effects. We adopt the spirit of the falsification test used by Autor et al. (2013) in their study of the effect of contemporaneous Chinese imports on contemporaneous US manufacturing

[19] Van Dijk (2018) proposes an alternative formulation of the shift-share instrument, which leaves out a location's own contribution to the shift instrument to address any endogeneity concerns that could arise if a region's growth rate makes up a significant portion of the national growth rate. The van Dijk correction is the preferred specification for our borough-level total income results.

employment. In their setting, Autor et al. (2013) are concerned that the fall in US manufacturing employment could have caused the rise in Chinese imports, or that there exists some unobserved common factor responsible for both. To address this concern, Autor et al. (2013) estimate the effect of *past* manufacturing employment on *current* Chinese imports as a falsification test. In our setting, we may also be concerned that our results are not capturing contemporaneous effects of fishing activity on local economic activity, but rather some long-run common causal factor behind both. Following Autor et al. (2013), we regress past economic activity on current fisheries activity. We find that past (and future) economic outcomes correlate poorly to current fishing activity (Figures D.4 and D.5), which provides additional evidence for our interpretation of the causal direction of our estimates.

To demonstrate the validity of our instrument, we refer to recent work that provides more rigorous scrutiny of the identification assumptions underlying the Bartik instrument, particularly with respect to the properties for exogeneity of the "shares" component (Goldsmith-Pinkham et al., 2020) and the "shifts" component (Borusyak et al., 2018) of the instrument. An important insight from this work is that exogeneity of one component (shares or shifts) can be sufficient for the validity of the overall shift-share IV approach. In particular, Borusyak et al. (2018) demonstrate that the shift-share instrument is valid when shocks are quasi-randomly assigned to industries (fisheries in our case), when the number of independent shifts gets large relative to the sample, and when variation in the shift-share instrument is not driven by a finite set of industries (fisheries). Given the large number of fisheries in our setting (205), all of which incur large and stochastic shocks, we focus on exploiting exogeneity in the shifts as the primary source of identification.

In consideration of the source of variation in our 205 shift instruments, approximately 60% of the variation in the total value of fishing earnings or landings comes from variation in prices, while 40% comes from variation in harvest quantities. The variation in prices is driven by national and global demand factors, such as national income and exchange rates, as well as the global markets for substitute products.[20] But prices vary mostly across species and over time, rather than across regions within Alaska. Variation in harvest quantities is both regional and temporal, and is driven principally by biomass shocks to a fishery's target

[20] Approximately two-thirds of Alaskan seafood is exported internationally (McDowell Group, 2017).

species. An individual community has a negligible influence on a species' biomass growth rate, as each individual community represents only a small portion for each fishery's overall earnings. In fact, as we show in Appendix Table B.1, out-of-state fishers account for 66% of total earnings from Alaska's fisheries. Thus, from the perspective of an Alaskan community, shocks to an overall fishery's value, either through prices or quantities, can be considered quasi-randomly assigned.

Appendix Section D.3 describes in detail validation assessments for the instrument. To determine whether variation in our shift-share instrument is driven by a small number of shift instruments, we plot the cumulative density function of each fishery's share of community earnings in Figure D.6 and conclude that a diverse group of species make up most community's fishery portfolios—i.e., a small hand-full of fisheries do not drive the earnings for most communities. In fact, in the most extreme case of portfolio concentration, only 10% of communities receive more than 50% of their total earnings from a single fishery (the halibut longline fishery for vessels under 60'). Each of the shift instruments also display a considerable amount of variation and tend to be relatively uncorrelated with each other, as shown by plots of the coefficient of variation and pair-wise correlation coefficients between fisheries in Figure D.7. Finally, to verify that no single fishery dominates variation in the shift-share instrument or single-handedly influences our estimated elasticities, we investigate the sensitivity of our first- and second-stage estimates to iteratively dropping the 10 highest-value fisheries from the analysis (Table D.4 and Figure D.8). Altogether, our shift-share instrument exhibits properties consistent with those outlined in Borusyak et al. (2018), and we interpret our estimates as stemming from exogenous variation in stock levels and global seafood prices.

5 Conclusion

We evaluate how variation in a valuable renewable resource affects local economies in Alaska. Despite the sizable literature that estimates the direct and spillover effects of non-renewable resources, such as oil and natural gas, this paper makes a first attempt of providing retrospective and econometric estimates of local direct and spillovers from commercial fisheries using panel-data methods. We adapt a shift-share instrument approach to a commercial fisheries setting, which allows us to exploit exogenous variation in fishery earnings and landings from 205 different fisheries. We find that direct effects and spillovers occur as a result of fluctuations in commercial fishing activity, despite the fact that industrial linkages are few and that the non-resident labor force is high in many communities.

Our results document an important pattern of how resource extraction activity enters a community. We show that outcomes for local residents are more closely tied to the location of resource and capital ownership, as opposed to the location where activity takes place. This is similar to the pattern documented by Brown et al. (2019) for oil and gas drilling. While delivering landings to processors in a community does boost processing labor there, these workers are mostly non-residents of Alaska. Consequently, we also show smaller spillover and total effects from local landings than for resident-owned catch. However, when more processing capital is owned locally, we find larger spillover effects. Together, these findings suggest fishery and development policy aimed at increasing economic opportunity for local residents should consider the residency of resource and capital owners, not simply the presence of activity.

There are some issues our analysis is not able to address. First, our estimated effects are local to the variation in fish stocks that we observe in our sample, which likely represents fluctuations around a steady state. However, fluctuation in fish stocks is projected to become more extreme in the long run as a result of climate change and corresponding changes to ocean conditions and habitats. Our analysis is therefore limited in answering questions that are more short-run in nature. For example, the question of how much worse-off a community would be if a fishery permanently collapsed is one our analysis does not address. The most notable example of such a collapse is the indefinite closure of the North Atlantic cod fisheries in the early 1990s, which largely remain closed today (Rose and Rowe, 2015). Similarly, our analysis does not estimate the effects of a "fisheries boom" or the case where a natural resource is newly discovered or exploitable, which is more frequently addressed by papers related to non-renewable resources. Our analysis also has some limitations that would benefit from future research. Our study estimates the effect of commercial fishing activity, omitting important recreational and subsistence activities. Future work that examines other forms of fishing activities and incorporates impacts on these sectors would be able to provide a more comprehensive outlook on the contribution of fish stocks to local economies.

Finally, our results provide guidance for economic development for small fishing communities in particular, but also rural communities more generally. While many Alaskan fishing communities are rural and isolated, they are not unrecognizable from small communities in other locations. Our results suggest that while increasing activity in the economic base sector has the potential for short-term benefits, governments, management institutions, and economic development organizations must tailor policies and practices to local conditions (Bartik, 2020). The heterogeneity of results across communities suggest that development policies will not necessarily be effective for all communities. Indeed, depending on the residency of local workers and resource owners, some communities may benefit from policies that favor local extraction firms and/or enhance forward-and-backward linkages across sectors, while others may benefit from policies aimed to attract or retain local workers and resource owners.

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Tables

Table 1: Direct Effects of Fishing Activity

	Resident Catch					
	Community				Region	
	Resident Crew		Value Added		Processing Labor	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Elasticity Catch	0.152***	0.273***	0.375***	0.752***	0.008	0.163
	(0.040)	(0.060)	(0.125)	(0.176)	(0.156)	(0.422)
$\Delta Y/\$$ Catch	1.89	3.40	0.44	0.88	0.22	3.17
95% CI	[0.9,2.87]	[1.94,4.85]	[0.15,0.73]	[0.48,1.29]	[-8.67,9.11]	[-12.95,19.28]
First-stage F		92.82		109.87		13.66
N Places	197	197	59	59	8	8
Observations	2,310	2,310	610	610	106	106
	Local Landings					
Elasticity Landings	−0.042	0.183***	0.069	0.599***	0.149**	0.460**
	(0.036)	(0.071)	(0.103)	(0.202)	(0.059)	(0.184)
$\Delta Y/\$$ Landings	-0.31	1.36	0.06	0.49	4.13	9.20
95% CI	[-0.83,0.21]	[0.33,2.39]	[-0.11,0.22]	[0.17,0.82]	[0.95,7.31]	[1.99,16.41]
First-stage F		41.61		56.57		13.98
N Places	69	69	52	52	8	8
Observations	929	929	566	566	106	106
Place Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes
van Dijk	No	No	No	No	No	No

Note: *p<0.1; **p<0.05; ***p<0.01. Errors clustered at the community level. Elasticities are estimated β coefficients from Eq. 1; $\Delta Y/\$ = \hat{\beta}\frac{\overline{y}}{\overline{x}}$, where $\overline{y}$ and $\overline{x}$ are the sample mean values of outcome y and fishery activity x, respectively. Resident crew are the number of licensed crew members who reside in a community. Value added is the difference in wholesale value created by processors in a community and ex-vessel value of landings in a community. Processing labor is the total of annual processing jobs in a region. Units for the $\Delta Y/\$$ estimates for crew and processing labor are jobs per million dollars of fishing activity. Units for the $\Delta Y/\$$ estimates for value added are dollars of value added per dollar of fishing activity. Regressions weighted by average fishing activity by community across time. Sample period is 2001-2015. Pre-sample period for IV construction is 1998-2000. van Dijk first-stage correction subtracts own-catch from fishery earnings in first-stage.

Table 2: Spillover Effects of Catch and Landings at the Community Level

	Resident Catch									
					Employment					
	Wages		Employment		Traded		Non-Traded		New Hires	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Elasticity Catch	0.017**	0.015	0.015**	0.027*	0.027	−0.002	0.019***	0.028*	−0.010	−0.016
	(0.007)	(0.011)	(0.006)	(0.016)	(0.030)	(0.060)	(0.007)	(0.015)	(0.029)	(0.058)
$\Delta Y/\$$ Catch	0.19	0.17	4.08	7.12	0.54	-0.04	4.62	6.97	-0.84	-1.38
95% CI	[0.03,0.35]	[-0.08,0.42]	[0.7,7.46]	[-1.22,15.45]	[-0.63,1.72]	[-2.41,2.33]	[1.22,8.02]	[-0.35,14.29]	[-5.73,4.04]	[-11.18,8.43]
First-stage F		101.09		101.09		101.09		101.09		138.39
N Places	200	200	200	200	200	200	200	200	200	200
Observations	2,496	2,496	2,496	2,496	2,496	2,496	2,496	2,496	2,161	2,161
	Local Landings									
Elasticity Landings	0.012	0.003	−0.001	0.042**	−0.045	−0.047	0.011*	0.040**	−0.034	0.056
	(0.009)	(0.028)	(0.008)	(0.019)	(0.029)	(0.071)	(0.006)	(0.017)	(0.025)	(0.094)
$\Delta Y/\$$ Landings	0.02	0.00	-0.05	1.98	-0.32	-0.34	0.42	1.61	-0.50	0.84
95% CI	[-0.01,0.05]	[-0.09,0.1]	[-0.77,0.66]	[0.18,3.77]	[-0.72,0.08]	[-1.33,0.65]	[-0.05,0.9]	[0.27,2.94]	[-1.23,0.22]	[-1.94,3.62]
First-stage F		39.93		39.93		39.93		39.93		31.48
N Places	69	69	69	69	69	69	69	69	69	69
Observations	995	995	995	995	995	995	995	995	861	861
Place Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
van Dijk	No	No	No	No	No	No	No	No	No	No

Note: *p<0.1; **p<0.05; ***p<0.01. Errors clustered at the community level. Elasticities are estimated β coefficients from Eq. 1; $\Delta Y/\$ = \hat{\beta}\frac{\overline{y}}{\overline{x}}$, where $\overline{y}$ and $\overline{x}$ are the sample mean values of outcome y and fishery activity x, respectively. Wages are the total wages of community residents. Employment is the total number of unique jobs held by community residents. Traded and non-traded employment is employment decomposed into these respective sectors. New hires are the number of newly created positions that community residents were hired into. Units for the $\Delta Y/\$$ estimates for wages are dollars per dollar of fishing activity. Units for the $\Delta Y/\$$ estimates for employment and new hires are jobs per million dollars of fishing activity. Regressions weighted by average fishing activity by community across time. Sample period is 2001-2015. Pre-sample period for IV construction is 1998-2000. van Dijk first-stage correction subtracts own-catch from fishery earnings in first-stage.

Table 3: Total Income Effects of Fishing Activity

	Resident Catch	
	Borough	
	IRS AGI	
	OLS (1)	IV (2)
Elasticity Catch	0.064***	0.069**
	(0.020)	(0.027)
$\Delta Y/\$$ Catch	1.44	1.54
95% CI	[0.55,2.32]	[0.37,2.72]
First-stage F		89.43
N Places	25	25
Observations	327	327
	Local Landings	
Elasticity Landings	0.019	0.011
	(0.014)	(0.062)
$\Delta Y/\$$ Landings	0.12	0.07
95% CI	[-0.05,0.29]	[-0.69,0.83]
First-stage F		20.51
N Places	18	18
Observations	239	239
Place Effects	Yes	Yes
Year Effects	Yes	Yes
van Dijk	Yes	Yes

Note: *p<0.1; **p<0.05; ***p<0.01. Errors clustered at the borough level. Elasticities are estimated β coefficients from Eq. 1; $\Delta Y/\$ = \hat{\beta}\frac{\overline{y}}{\overline{x}}$, where $\overline{y}$ and $\overline{x}$ are the sample mean values of outcome y and fishery activity x, respectively. IRS AGI is the adjusted gross income reported in tax filings by residents of a given borough. Units for the $\Delta Y/\$$ estimates are dollars per dollar of fishing activity. Regressions weighted by average fishing activity by borough across time. Sample period is 2001-2015. Pre-sample period for IV construction is 1998-2000. van Dijk first-stage correction subtracts own-catch from fishery earnings in first-stage.

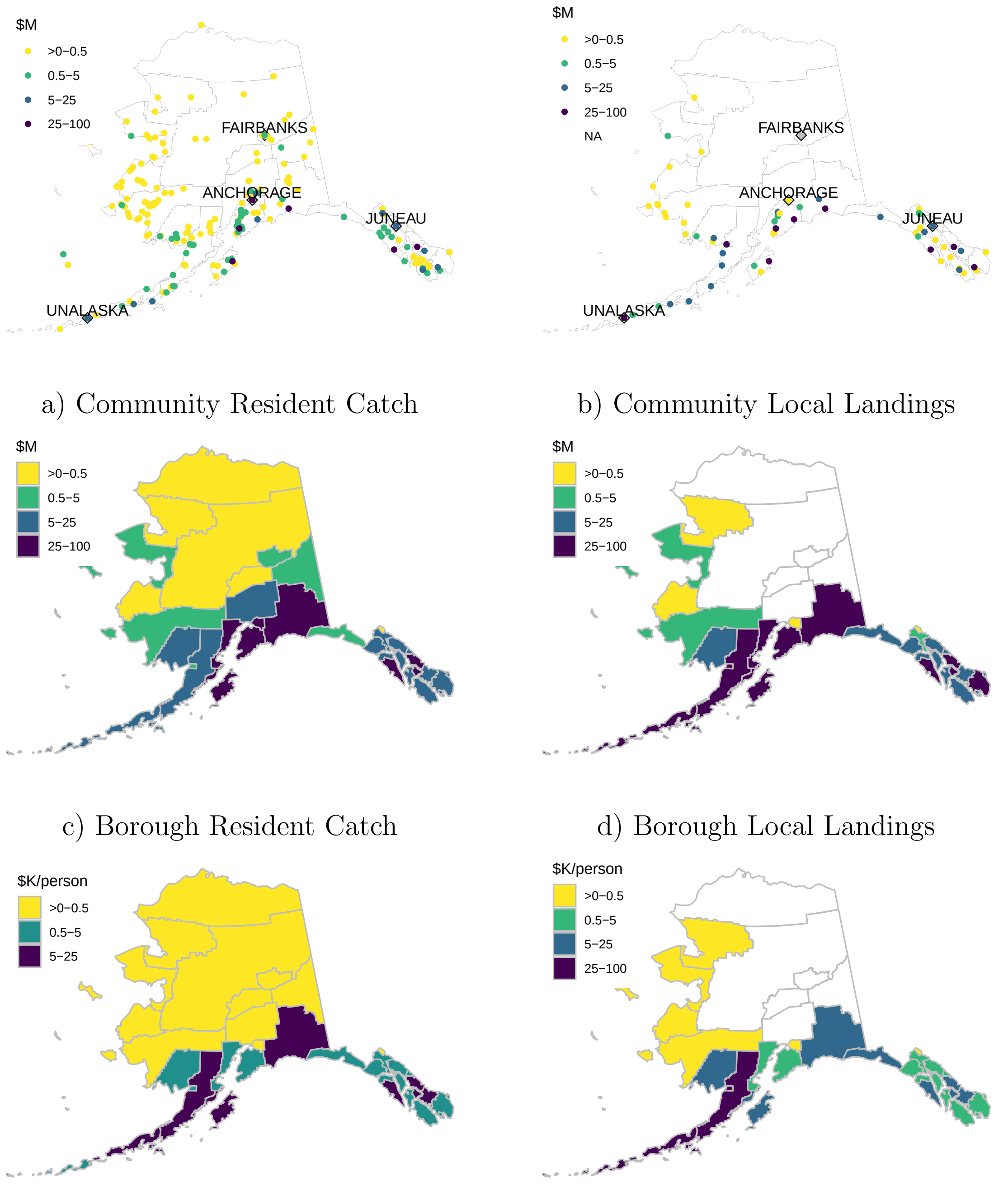
Table 4: Processing Labor Effects by Alaska Residency

	Resident Catch			
	AK Resident		Non-Resident	
	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)
Elasticity Catch	−0.029	−0.440	−0.029	0.493
	(0.147)	(0.410)	(0.211)	(0.585)
$\Delta Y/\$$ Catch	-0.24	-11.76	-1.37	5.27
95% CI	[-3.01,2.53]	[-35.23,11.71]	[-9.47,6.73]	[-5.99,16.52]
First-stage F		13.66		13.66
N Places	8	8	8	8
Observations	106	106	106	106
	Local Landings			
Elasticity Landings	−0.051	0.077	0.221***	0.572**
	(0.045)	(0.126)	(0.083)	(0.241)
$\Delta Y/\$$ Landings	-0.38	2.65	4.24	4.61
95% CI	[-1.07,0.31]	[-4.51,9.8]	[0.92,7.56]	[0.75,8.47]
First-stage F		13.98		13.98
N Places	8	8	8	8
Observations	106	106	106	106
Place Effects	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes
van Dijk	No	No	No	No

Note: *p<0.1; **p<0.05; ***p<0.01. Elasticities are estimated β coefficients from Eq. 1; $\Delta Y/\$ = \hat{\beta}\frac{\overline{y}}{\overline{x}}$, where $\overline{y}$ and $\overline{x}$ are the sample mean values of outcome y and fishery activity x, respectively. Units for the $\Delta Y/\$$ estimates for fish processing are jobs per million dollars of fishing activity. Regressions weighted by average fishing activity by region across time. Sample period is 2001-2015. Pre-sample period for IV construction is 1998-2000.

Figures

Figure 1: Average Fishing Activity Across Alaska



a) Community Resident Catch

b) Community Local Landings

c) Borough Resident Catch

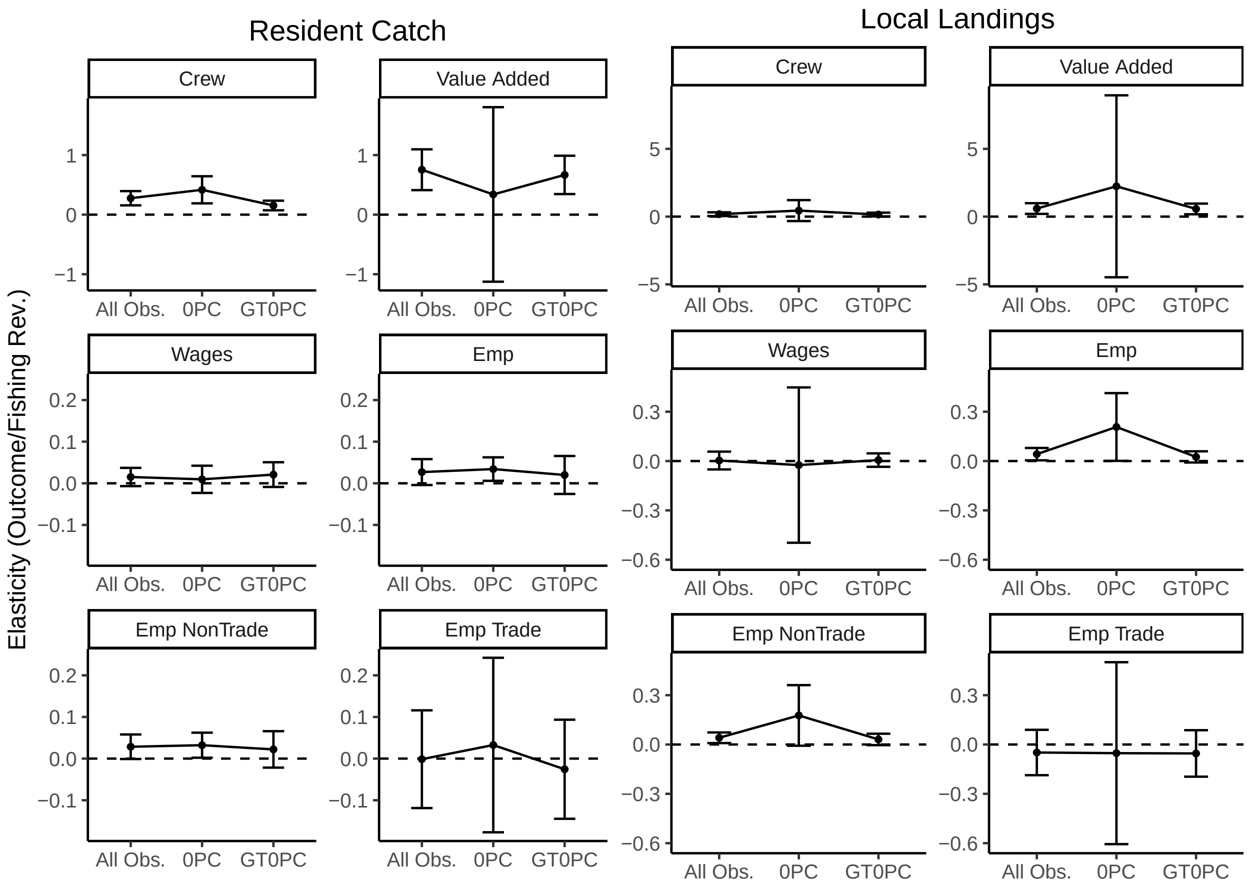
d) Borough Local Landings

e) Borough Resident Catch Per Capita

f) Borough Local Landings Per Capita

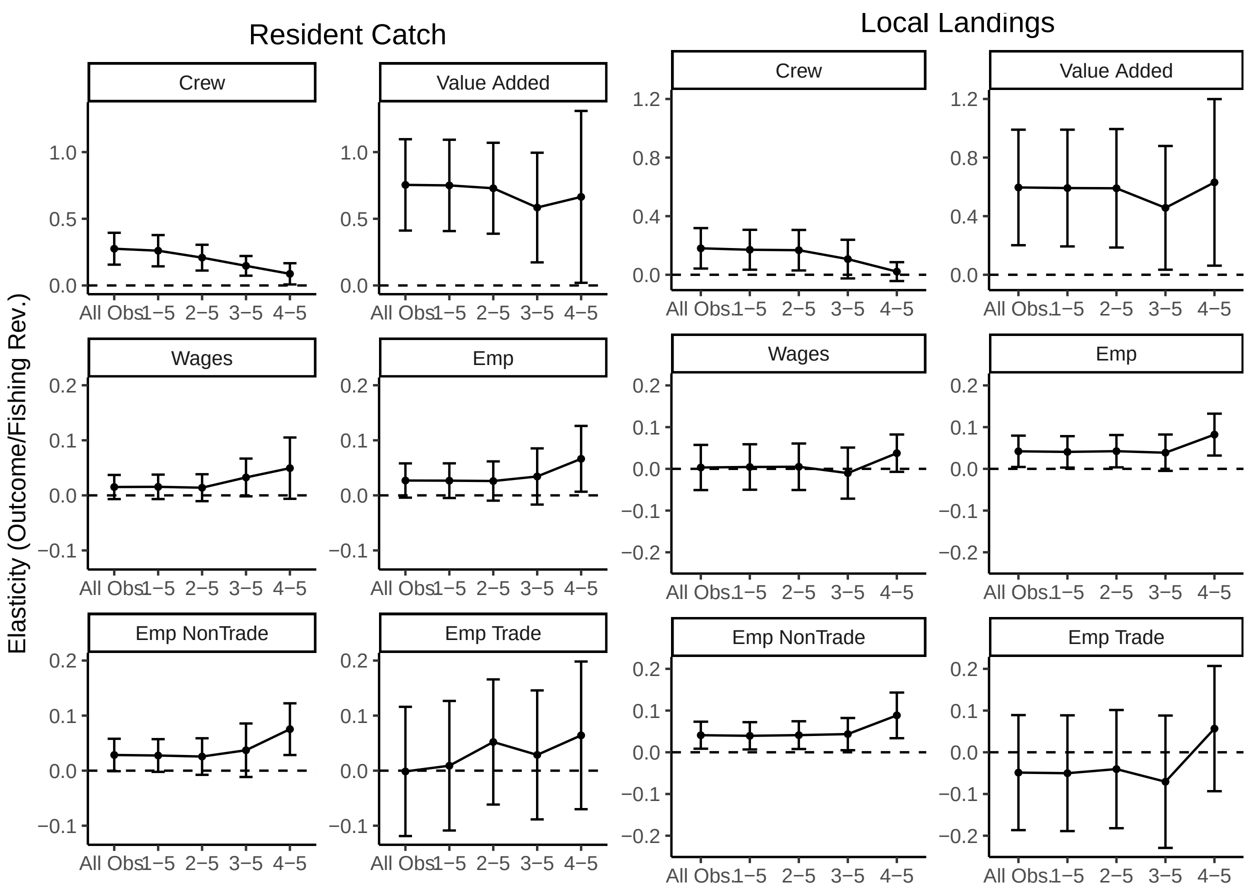
Map shows the annual average fishing ex-vessel values at the community and borough level. Community-level of aggregation is shown in upper panels (a) and (b). Borough-level aggregation is shown in panels (c) through (f). Resident catch in left panels (a), (c), and (e) is the total ex-vessel value of harvest from permit holders residing in the community or borough. Local landings in right panels (b), (d) and (f) are the total ex-vessel value of fish landed at a processor or fish buyer in a community or borough.

Figure 2: Heterogeneity by ownership of local processors



Coefficient estimates and 95% confidence intervals are estimated by 2SLS from Eqs. 1 on three subsets of the data. All observations contains the full sample; "0PC" denotes communities with zero percent out-of-state processor ownership; "GT0PC" denotes communities for which there is greater than zero percent out-of-state ownership.

Figure 3: Heterogeneity by community dependence on the fishing industry



Coefficient estimates and 95% confidence intervals are estimated by 2SLS from Eqs. 1 on subsets of the data. From left to right, we gradually drop less fishery-dependent communities. Fishery dependency indices are calculated by Himes-Cornell and Kasperski (2016), and are a scale of 1 (least dependent) to 5 (most depednent).

Appendix A Data Imputation

For a small subset of community-fishery observations, earnings values are censored to protect confidentiality. Censoring occurs when fewer than four fishers participate in a given fishery. In the case where only one fishery in a community is censored, earnings values for another fishery are also censored so that a community total can be reported. When catch values are censored we impute them with one of three methods based on the nature of uncensored observations available. First, even when annual earnings values are censored, we still observe the number of fishers in a community who fished that year. Our imputation calculates average per-fisher earnings, then multiplies this by the number of fishers. If data are not available for a more data-intense imputation for a given observation, we use the next-most data intense method. From least to most data intense these imputations are:

1. Average earnings-per-fisher for the fishery in a given year. Calculated based on CFEC's total earnings for the fishery in a given year divided by the number of fishers who fished. This assumes that a given community's earnings per fisher are the same as other communities.

2. When at least one community-fishery observation is uncensored, we can improve the imputation in (1) by adjusting the simple average with a community-specific production factor. We use available earnings observations to calculate the ratio of a community's earnings-per-fisher to the average earning-per-fisher for the entire fishery. We multiply (1) by this ratio.

3. When censored observations are infrequent over time for a community, we average the imputation developed in (2) with a lead and lag of the missing observation. This allows us to capture single period shocks and community-specific trends.

For robustness, we also estimate our models by dropping the censored observations and find that the results are similar.

Appendix B Supplemental Tables and Figures

Table B.1 describes the residence status (Alaskan or non-Alaskan) of various fishing activity. It highlights that a majority of ex-vessel earnings for fishers and processor wholesale value is owned by non-residents of Alaska.

Table B.2 presents summary statistics on the fishing activity and economic outcomes aggregated at the community and borough levels, the primary geographic units of analysis.

Year-to-year shocks to fisheries value can be quite large in magnitude due to shifts in prices and the biological stocks of individual species over space. Figure B.1 illustrates this variation. In a given year, some communities experience positive shocks, while others experience negative shocks. The large, heterogeneous shocks across time and across space provide useful variation for identification, given that fisheries shocks can be separated from common macro-economic trends.

In Section 4.4 we investigated how fisheries-dependent communities could exhibit greater forward and backward linkages between the fisheries sector, which could lead to larger indirect effects. In main text Figure 3 we show such effects using a fishing-engagement index constructed by Himes-Cornell and Kasperski (2016). Here we present an alternative for measuring fisheries dependence based on relative wages to fishing income. First, we calculate the ratio of unemployment insurance-eligible resident wages to the total fishing earnings in a community. We then group communities using decile bins across this ratio. Results using our second measure of fishing dependence are presented in Figure B.2. To subset our sample for this heterogeneity analysis, we drop communities progressively below certain decile thresholds of this dependency measure (50th, 60th, 70th, 80th). Results are consident with those we present in the main text.

Table B.1: Fishing Activity by Residency Status

	Alaskan Residents	Non-Residents	Total	% Alaskan
Harvest[1]				
Fishers (who fished)	6,923	2,838	9,761	71%
Earnings (Million $)	602	1,213	1,815	33%
Crew Licenses	9,566	8,328	17,894	53%
Processing Labor[2]				
Workers	7,875	19,086	26,961	29%
Worker Wages (Million $)	146	267	413	35%
Downstream Ownership[3]				
All Fishery Business Licenses	890	251	1141	78%
Processing Licenses[4]	152	150	302	50%
Wholesale Value (Million $)[5]	655	3,518	4,173	16%

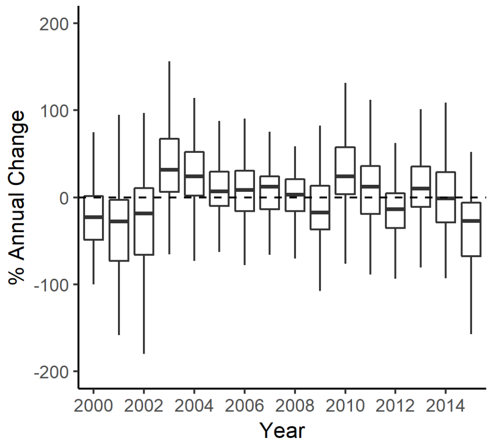
[1] Fisherman number and earnings from CFEC basic information tables (totals for all fisheries), 2015 data. Crew license data from Tide (2007).
[2] Processing labor from "Seafood Processing Workforce" report, Alaska DOL Research and Analysis Section, 2015 data.
[3] License ownership data from Alaska DFG, "Commercial Permit and License Holders Listing," 2015 data.
[4] We define processing licenses as Shore-based Processors, Catcher/Processors, Floating Processors, and EEZ Only.
[5] Wholesale value reported as part of "Commercial Operator's Annual Reports Data." This value includes both shore-based and vessel processing.

Table B.2: Summary Statistics

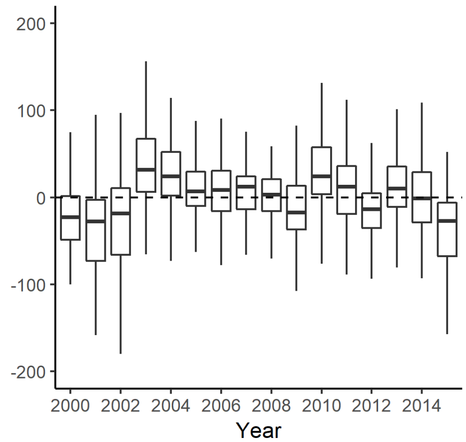
	N	Mean	St. Dev.	Min	Max
Community Level					
Total Wages (2015 $1k)	2,496	54,193	435,488	44	6,336,780
Employment	2,496	1,346	9,837	5	131,962
New Hires	2,496	452	3,281	0	48,658
Employment: Traded	2,496	96	549	0	7,582
Employment: NonTraded	2,496	1,251	9,300	4	124,364
Crew Licenses	2,310	67	152	0	1,420
Wholesale Value Added (2015 $1k)	2,282	7,996	30,143	0	322,496
Total Resident Catch (2015 $1k)	2,496	3,187	11,347	0	122,715
Total Local Landings (2015 $1k)	2,496	4,492	15,306	0	198,306
Catch/Wages (%)	2,496	37	110	0	1,560
Landings/Wages (%)	2,496	65	482	0	12,610
Borough Level					
Gross Income (AGI) (2015 $1m)	392	695	1,769	9	11,909
Total Wages, Residents (2015 $1k)	425	376,793	962,601	6,808	6,336,780
Employment, Residents (1,000)	425	11	24	0	132
Total Wages, Workers (2015 $1,000)	392	531,419	1,361,501	9,034	8,782,783
Employment, Workers (1,000)	392	12	28	0	154
Crew Licenses	425	367	397	0	1,959
Wholesale Value Added (2015 $1k)	282	31,451	72,396	0	402,468
Total Resident Catch (2015 $1k)	425	17,774	25,261	1	132,320
Total Local Landings (2015 $1k)	425	23,780	32,616	0	154,571

N is the number of non-NA observations for each variable. Total wages and employment at the community level and total wages and employment for residents (res) at the borough level are from AKDOL's ALARI database. New hires and sectoral employment are also from ALARI. ALARI data correspond to formal sector employment where the employer files unemployment insurance. Total resident catch is total ex-vessel value of commercial fish harvested by residents. Total local landings are the total ex-vessel value of fish landed at a processor or fish buyer in a community or borough. Gross Income is adjusted gross income of residents of the borough from the U.S. IRS. Employment and Wages by place of work come from the U.S. BLS's QCEW. Crew licenses are the number of registered commercial fishing crew living in a jurisdiction; these data come from NOAA's Alaska Fisheries Science Centers Community Profiles and Snapshot. Wholesale Value Added is the difference between wholesale value produced from processors (as reported by ADFG COAR) and the ex-vessel value of landings.

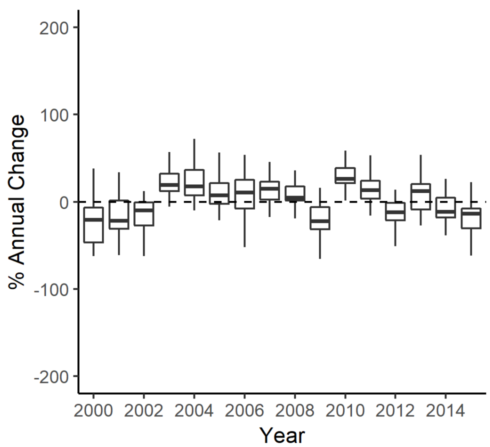
Figure B.1: Variation in Ex-vessel Value of Resident Catch and Local Landings at the Community and Borough Level



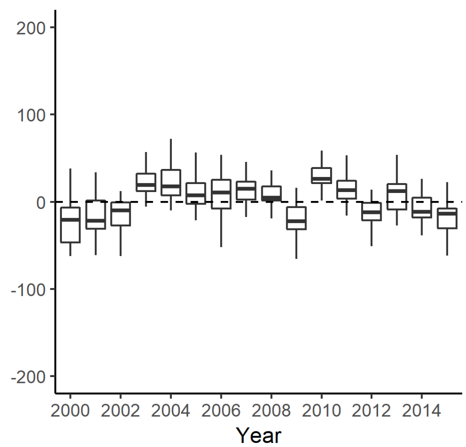
a) Community Resident Catch



b) Community Local Landings



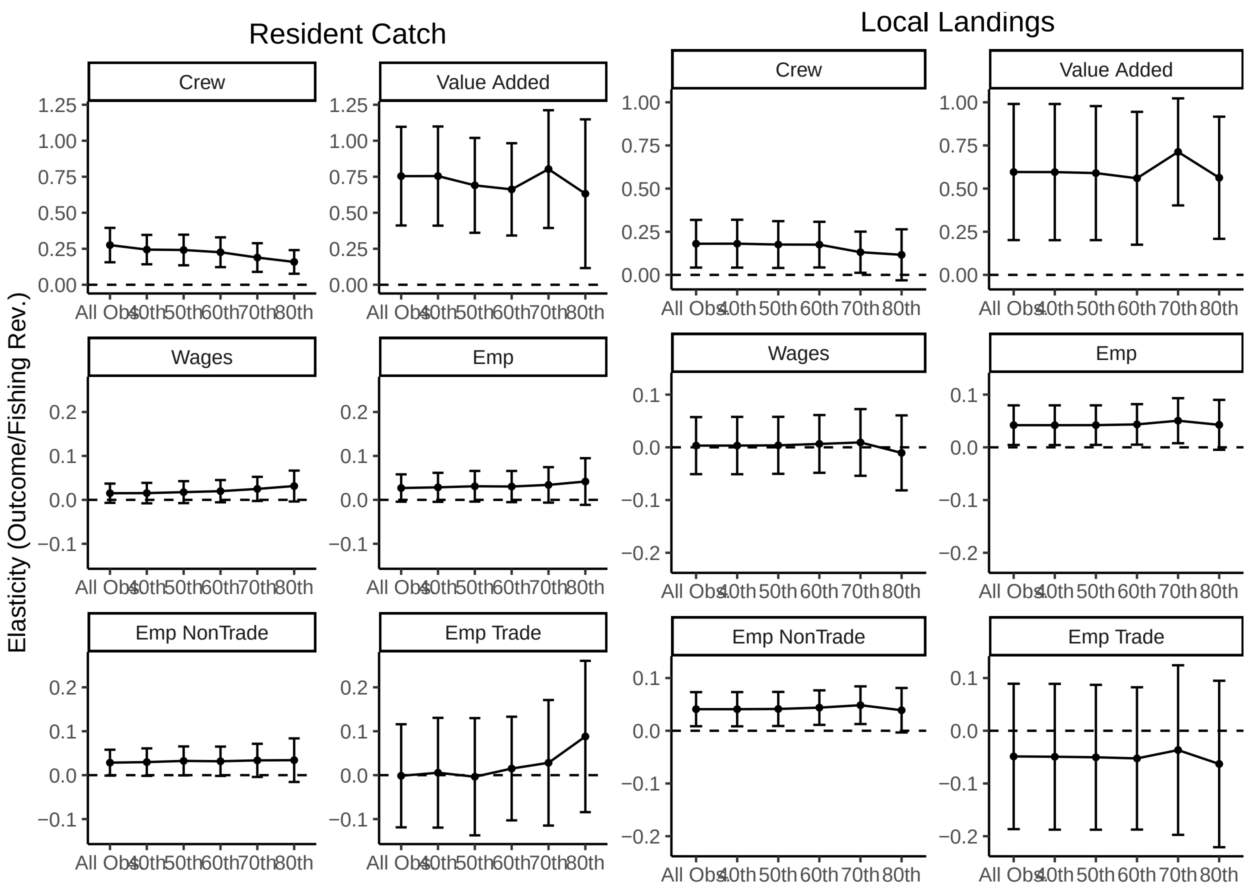
c) Borough Resident Catch



d) Borough Local Landings

Box and whiskers showing the distribution of the % change in total ex-vessel values from the previous year. Whiskers extend to 1.5x the inter-quartile range (i.e., the distance between the first and third quartiles). Community-level aggregation is shown in upper panels (a) and (b). Borough-level aggregation is shown in lower panels (c) and (d). Resident catch in panels (a) and (c) is the total ex-vessel value of harvest from permit holders residing in the community or borough. Local landings in panels (b) and (d) are the total ex-vessel value of fish landed at a processor or fish buyer in a community or borough.

Figure B.2: Heterogeneity by fishing dependence (catch/wages)



Coefficient estimates and 95% confidence intervals for model estimated on subsets of the data. From left to right, we gradually drop less fishery-dependent communities. Fishery dependency indices are calculated by the ratio of fishing income to wages in a community, and indexed based on deciles. The rightmost estimate in each panel corresponds to the communities in only the top two deciles of the ratio of fishing income to wages.

Appendix C Spillover Effects by Residency

In Table C.3, we compare estimated effects on non-fishing wages and employment measured by place-of-residence and place-of-work at the borough level. Estimated effects that are larger for place-of-work would suggest that spillover benefits from commercial fishing are accruing to non-resident workers. The lack of statistically significant results for both place-of-residence and place-of-work measurements, however, suggests that neither residents nor non-residents experience wage or employment effects from commercial fishing in non-fishing sectors at this level of aggregation. One potential concern here is a lack of sufficient power to detect meaningful economic effects at the borough level. Indeed, a post-hoc power analysis indicates that we are only able to detect place-of-residence employment effects larger than 0.22 and 0.45 for resident catch and local landings, respectively, with 95% confidence.For comparison, at the community level, we are able to detect place-of-residence employment effects larger than 0.058 and 0.068 for resident catch and local landings, respectively, with 95% confidence. Power analyses for wage effects reach similar conclusions. Thus, our analysis may not powered enough to detect meaningful place-of-residence and place-of-work effects at the borough level.

Table C.3: Indirect Impacts of Catch and Landings at Borough Level

	Resident Catch							
	Place-of-Residence				Place-of-Work			
	Wages		Employment		Wages		Employment	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Elasticity	0.028**	0.003	0.006	−0.004	0.019	0.036	−0.011	−0.007
	(0.011)	(0.007)	(0.008)	(0.016)	(0.020)	(0.029)	(0.012)	(0.062)
$\Delta Y/\$$	0.44	0.05	1.80	-1.19	0.23	0.43	-3.17	-1.94
95% CI	[0.09,0.79]	[-0.17,0.28]	[-3.5,7.1]	[-11.2,8.81]	[-0.24,0.7]	[-0.25,1.11]	[-10.15,3.81]	[-37.56,33.68]
First-stage F		89.43		89.43		89.43		89.43
N Places	25	25	25	25	25	25	25	25
Observations	327	327	327	327	327	327	327	327
	Local Landings							
Elasticity	0.001	−0.022	−0.011	−0.016	0.012	−0.137*	0.009	−0.143
	(0.006)	(0.015)	(0.010)	(0.021)	(0.017)	(0.073)	(0.015)	(0.122)
$\Delta Y/\$$	0.00	-0.09	-1.05	-1.46	0.04	-0.48	0.86	-13.21
95% CI	[-0.05,0.05]	[-0.21,0.03]	[-2.85,0.75]	[-5.34,2.42]	[-0.08,0.16]	[-0.99,0.03]	[-1.88,3.61]	[-35.42,9.01]
First-stage F		20.51		20.51		20.51		20.51
N Places	18	18	18	18	18	18	18	18
Observations	239	239	239	239	239	239	239	239
Place Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
van Dijk	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

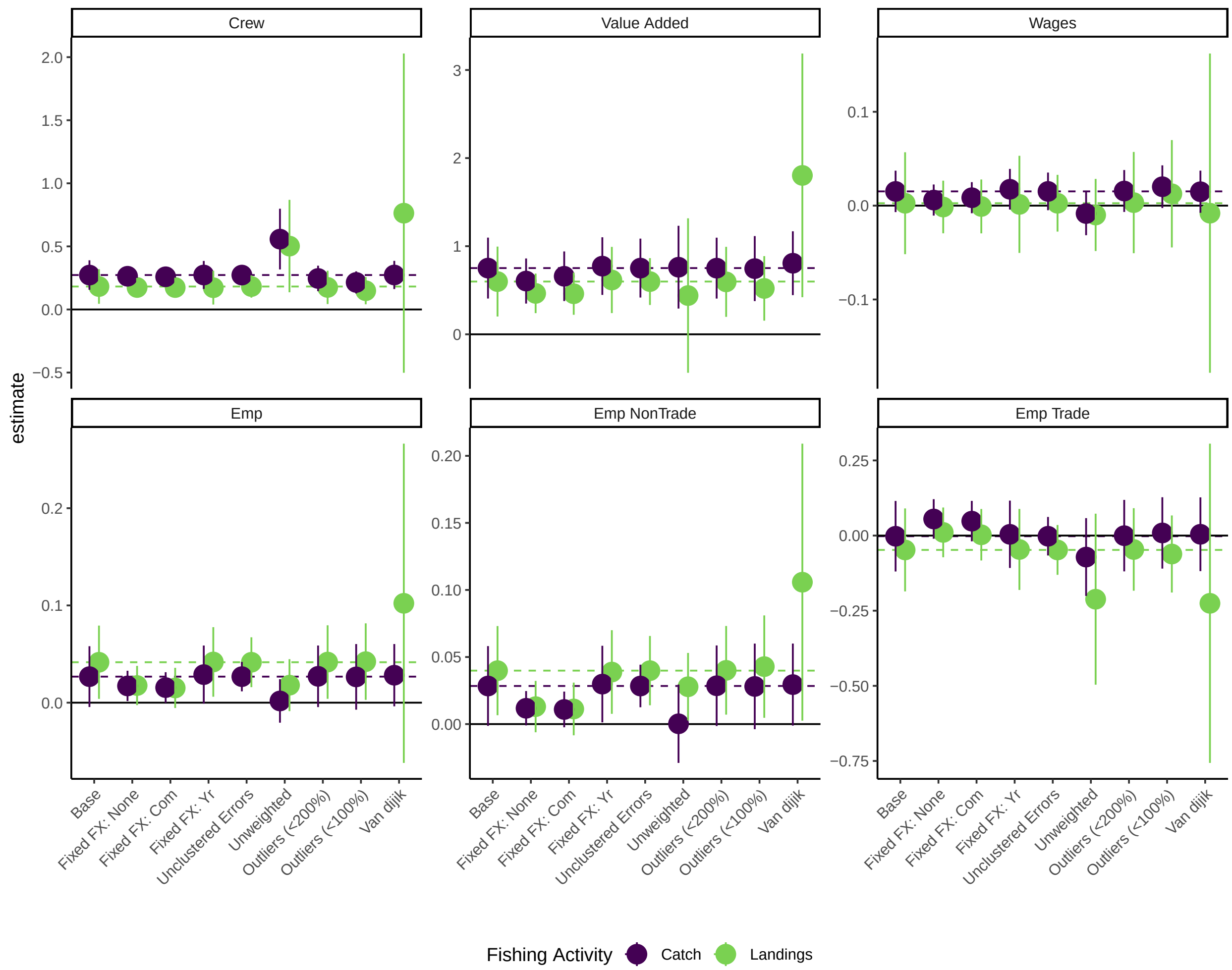
Note: *p<0.1; **p<0.05; ***p<0.01. Errors clustered at the borough level, however, number of clusters is less than conventional thresholds leading to underestimated standard errors. Unadjusted standard errors lead all results to be statistically insignificant estimates for all outcomes. Regressions weighted by average fishing activity by borough across time. Sample period is 2001-2015. Pre-sample period for IV construction is 1998-2000. van Dijk first-stage correction subtracts own-catch from fishery earnings in first-stage.

Appendix D Robustness and Instrument Validation

D.1 Robustness to Specification

Figure D.3 shows the robustness of the community level results (six outcomes) to a number of alternative specifications for both community catch and local landings. Alternative specification of fixed effects (none, community only, annual only), unclustered standard errors, unweighted regressions, dropping outlieres of annual changes in fishing activity larger than 200% or larger than 100%, and Van Dijk's 2018 leave-out-own correction to the instrument. Generally speaking, the results are qualitatively similar across these outcomes and specifications with two exceptions. The Van Dijk correction for landings reduces the first-stage fit of the instrument, thereby increasing the error in the second stage. Unweighted regressions also tend to reduce the first-stage fit, which is to be expected given that relatively more weight is now placed on communities with less systematic variation in fisheries activity. In turn, our second-stage estimates are less precise (particularly for local landings). Unweighted regressions strengthen the results for crew, but attenuate the effects on wages and employment.

Figure D.3: Robustness to Model Specification



Coefficient estimates and 95% confidence intervals for the base (preferred specification) and alternative specifications. Dashed lines are the level of the base specification for reference. The alternative specifications include: no fixed effects, community fixed effects only, year fixed effects only; unclustered errors; dropping outlier observations with very large changes in catch/landings or the instruments of such of either $> 100\%$ change or $> 200\%$ change; and use of the Van Dijk correction.

D.2 Falsification Test of Results

We adopt the spirit of the falsification test used by Autor et al. (2013) in their study of the effect of contemporaneous Chinese imports on contemporaneous US manufacturing employment. These variables are measured as decade-over-decade changes. As a falsification test for their findings (particularly for reverse causality), they test for the effect of *past* manufacturing employment on *current* Chinese imports. We conduct a similar falsification test (past outcomes regressed on current determinants) noting a few important distinctions in our exercise. Our analysis exploits year-to-year fluctuations, while Autor et al. (2013) uses decade-on-decade changes. Autor et al. (2013) also have a much longer time series (37 years compared to the 16 years in our analysis), which makes it easier for their test to argue for "sufficiently deep" lags. Finally, their falsification is motivated by the major structural changes to Chinese trade relations. In our setting, there is no obvious structural change that would provide an intuitive pre-exposure period, as people have fished Alaskan waters for millennia. With these distinctions noted, the falsification test we specify still provides some validation that we are correctly interpreting the causal direction of the effect we find.

Our main specification in Eq. 1 estimates the relationship between current economic outcomes and current fishing revenues, where both variables are measured as percent annual changes. Because of the three issues we note above, it is unclear how many lags are sufficient to qualify as a "pre-exposure" period. Because a pre-exposure period is unclear, we opt to test each possible lag of the economic outcome. We also test each lead order for good measure (this is a test of long run effects or persistence). The falsification specification takes the form

$$\Delta y_{ct-L} = \beta \Delta x_{ct} + \tau_t + \alpha_c + \epsilon_{ct},\ \forall L \in \{-14, -13, -12...12, 13, 14\}, \tag{D.1}$$

where Δy_{ct-L} is the year-over-year change in the logged outcome variable y, for community c, in year $t - L$, where L is a lag order going from -14:14. Δx_{ct} is the year-over-year change in logged fishing revenue generated by fishers residing in community c in year t. τ and α are year and community fixed effects, respectively. ϵ is the econometric error. Eq. 1 is estimated by 2SLS, where we instrument Δx_{ct} with the shift-share instrument described in the main text, Eq. 2.

We estimate the equation for each of the 28 lags and leads across eight outcome variables. These outcomes are: IRS AGI, total wages, employment, traded-sector employment, non-traded sector employment, new hires, crew licenses, and processor value added. When $L = 0$, the falsification-test specification is equivalent to the main specification in the text. We plot each of these results in Figure D.4 for resident catch and Figure D.5 for local landings. The vertical dashed line is $L = 0$, our main specification. Estimates of β and associated 95%

confidence intervals are plotted for each lag specification.

Our causal interpretation of current fishing activity leading to changes in current economic activity would be confounded if past economic activity caused current fisheries activity. Such endogeneity would be particularly evident in the figures if there were observable pre-trends or structure in the lead-up to the contemporaneous shock. The third panel of Figure D.4 plots the falsification test for the result we highlight in the abstract of the paper, that a \$1 increase in resident catch results in and increase of 1.54 in AGI for residents of the borough. Each of the 14 lags tested are statistically insignificant and smaller in magnitude than the true effect. In other words, we find no evidence that past AGI influences future instrumented catch earnings. We also find no compelling evidence that the effect is measured in the wrong period; as leads are small in magnitude and generally insignificant. Instead, we observe a strong break in the series at $L = 0$, the period of the contemporaneous shock. Similarly, we do not observe a pattern or trend in the lags for the other seven outcomes, with one possible exception: we find that at $L = -1$, there is a statistically significant negative relationship between crew labor and next period resident catch earnings. However, our contemporaneous result at $L = 0$ represents a strong deviation away from the relatively noisy trend in the lag and lead years.

Figure D.5 plots the local landings elasticities for the aforementioned eight outcomes. Again, we observe no trend leading into our significant findings for crew, employment, and non-traded sector employment. Looking at $L = 0$ for employment, for which we obtain statistically significant effects (particularly in the non-traded sector), our results represent a strong break away from the noisy trends in the data. No lag order has statistically significant effects for crew, employment, or non-traded sector employment.

Overall, these falsification results supports the causal interpretation of the effects we describe in the paper.

D.3 Instrument Validation

Borusyak et al. (2018) demonstrate two necessary conditions for shift-share instrument validity: (*i*) variation in the shift-share instrument cannot be driven by a finite set of industries (fisheries), and (*ii*) variation in the shift-share instrument must stem from a large number of independent shifts relative to the sample.

With respect to the first condition, we plot the cumulative density function (CDF) of each fishery's share of community earnings in D.6. Each panel contains the fisheries associated with a particular species, and each curve corresponds to a gear and area specification to describe a unique fishery (205 in total). The CDF describes the fraction of communities which have a given share of their fisheries revenue from that particular species. Most of the CDF curves have a distinct "hockey-stick" shape, indicating that many communities (e.g., greater than 75%) have fisheries that make up less than 25% of there revenue. In other words, a small hand-full of fisheries do not drive the earnings for most communities. In fact, in the most extreme case of portfolio concentration, only 10% of communities receive more than 50% of their total earnings from a single fishery (the halibut longline fishery for vessels under 60').

For the second condition, each of the shift instruments also display a considerable amount of variation and tend to be relatively uncorrelated with each other, as shown by plots of the coefficient of variation and pair-wise correlation coefficients between fisheries in Figure D.7. This is also true for the largest five fisheries in the state (by gross value).

To test the robustness of the instrument, we iteratively drop the 10 highest-value fisheries from the analysis to verify that no single fishery dominates the estimated effect. Fishery value is determined by the mean ex-vessel earnings in the sample time-frame. Table D.4 summarizes these fisheries and the changes to the first-stage regression from excluding them from the analysis. Figure D.8 shows the estimated β coefficients and associated 95% confidence intervals estimated after dropping a given fishery from the analysis.

Generally, the results are robust to dropping any of the top-10 fisheries from the analysis. First-stage coefficient estimates for resident catch and landings change only modestly from the full sample estimates, and first-stage F-statistics remain above the conventional

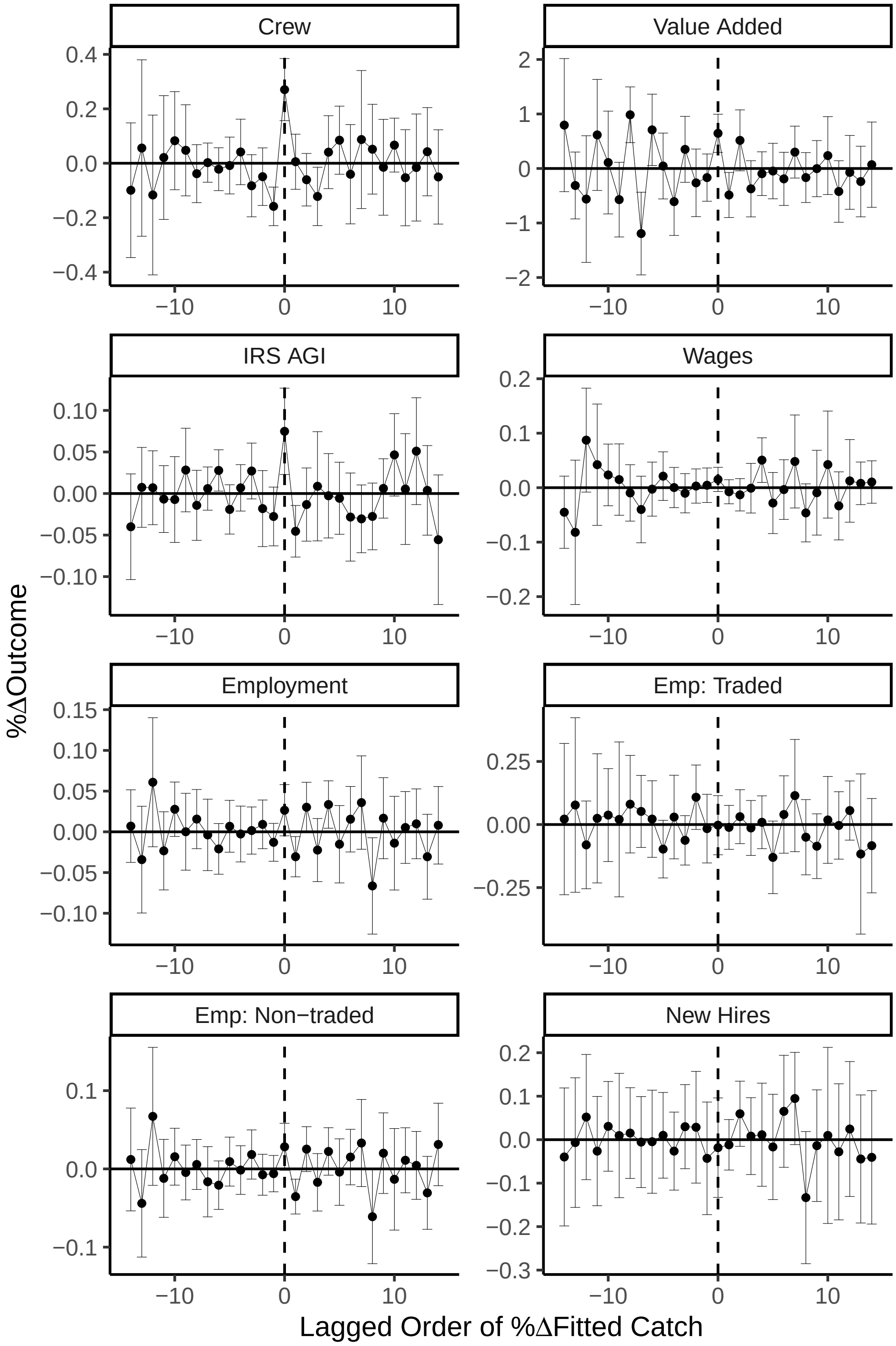
Table D.4: Robustness to Inclusion of Top-10 Fisheries by Value

Characteristics of Dropped Fishery				Catch			Landings		
Code	Description (Species, Gear, Area)	Mean Earnings ($m/y)	Mean Permits	# Places	1st Stage γ	F-stat	# Places	1st Stage γ	F-stat
None	Full Sample			200	0.75	107.73	69	0.63	16.22
B06B	Halibut, Longline <60', Statewide	122.80	2,202	196	0.80	100.09	68	0.64	14.86
S03T	Salmon, Driftnet, Bristol Bay	106.78	1,845	196	0.71	80.64	67	0.62	15.02
T91Q	Tanner Crab, Pots >60', Bering	90.35	134	200	0.76	110.28	69	0.64	15.93
S01A	Salmon, Seine, Southeast	61.25	375	200	0.77	105.81	69	0.60	15.41
B61B	Halibut, Longline >60', Statewide	53.29	249	200	0.74	115.31	68	0.64	17.16
C06B	Sablefish, Longline <60', Statewide	47.54	504	199	0.76	104.28	69	0.63	15.66
S03E	Salmon, Driftnet, PWS	38.69	537	199	0.76	156.89	69	0.67	26.28
S01E	Salmon, Purse Seine, PWS	36.81	263	200	0.75	70.47	69	0.57	11.94
S15B	Salmon, Power Troll, Statewide	29.55	962	200	0.74	102.48	69	0.64	15.90
S01K	Salmon, Seine, Kodiak	28.10	368	200	0.76	109.28	69	0.64	15.46

Code is the CFEC fishery identifier. Mean earnings are the average annual ex-vessal value of fish caught in the dropped fishery from 2000-2015. Mean pemits are the average number of permits over the same time period. # Places are the number of communities that remain in the sample after dropping a given fishery from the analysis. 1st Stage γ is the estimated coefficient value in the first stage, and F-stat is the associated first-stage F-stat value.

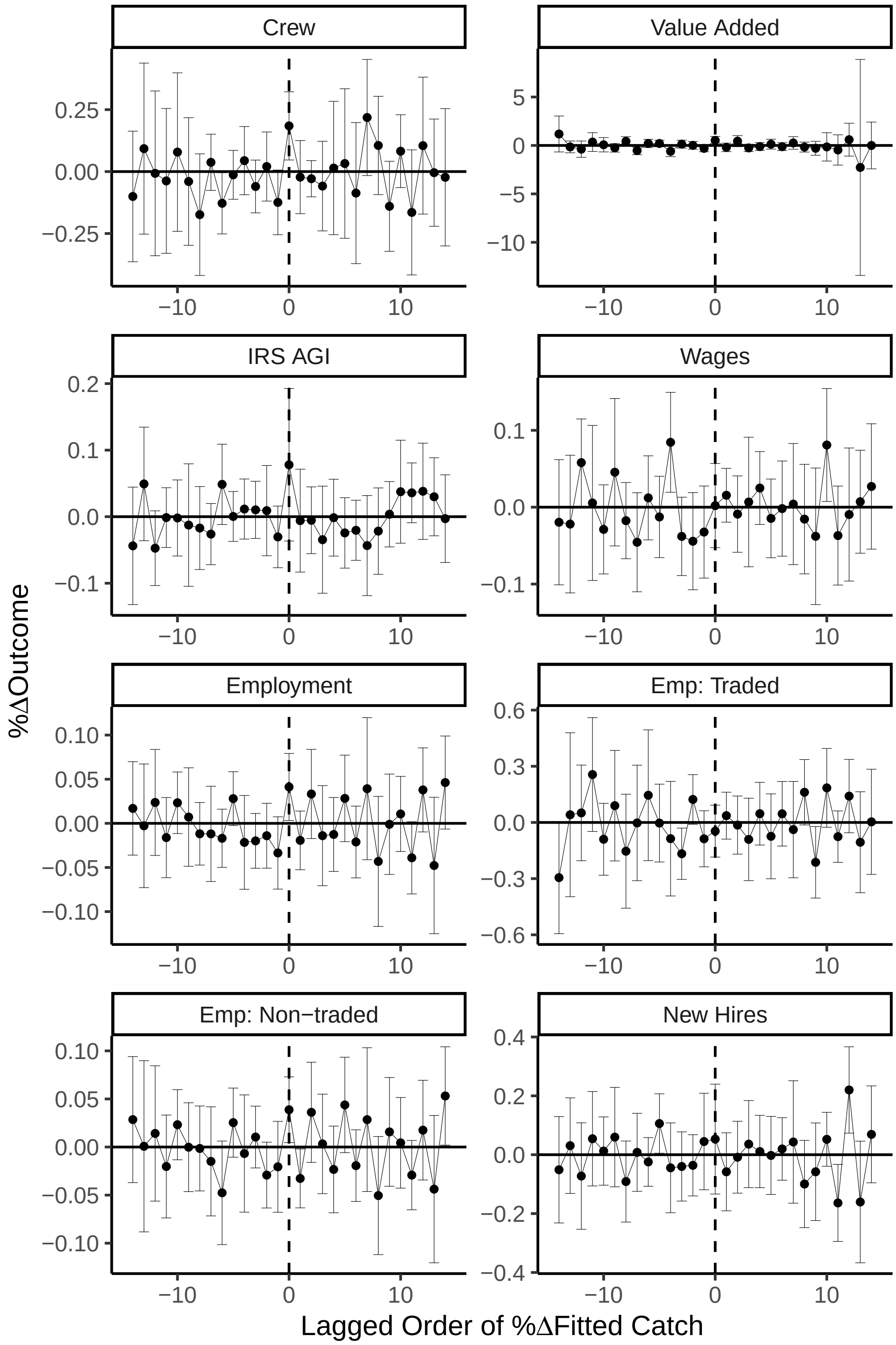
threshold level. In the second stage (Figure D.8), no inference for any outcome changes with respect to excluding a given species' resident catch from the analysis. For landings, excluding landings for S 03T, the Bristol Bay drift gillnet fishery, has a somewhat appreciable effect, as the employment change is statistically indistinguishable from zero with this fishery's local landings excluded.

Figure D.4: Falsification Test Using Outcome Lags and Leads, Resident Catch



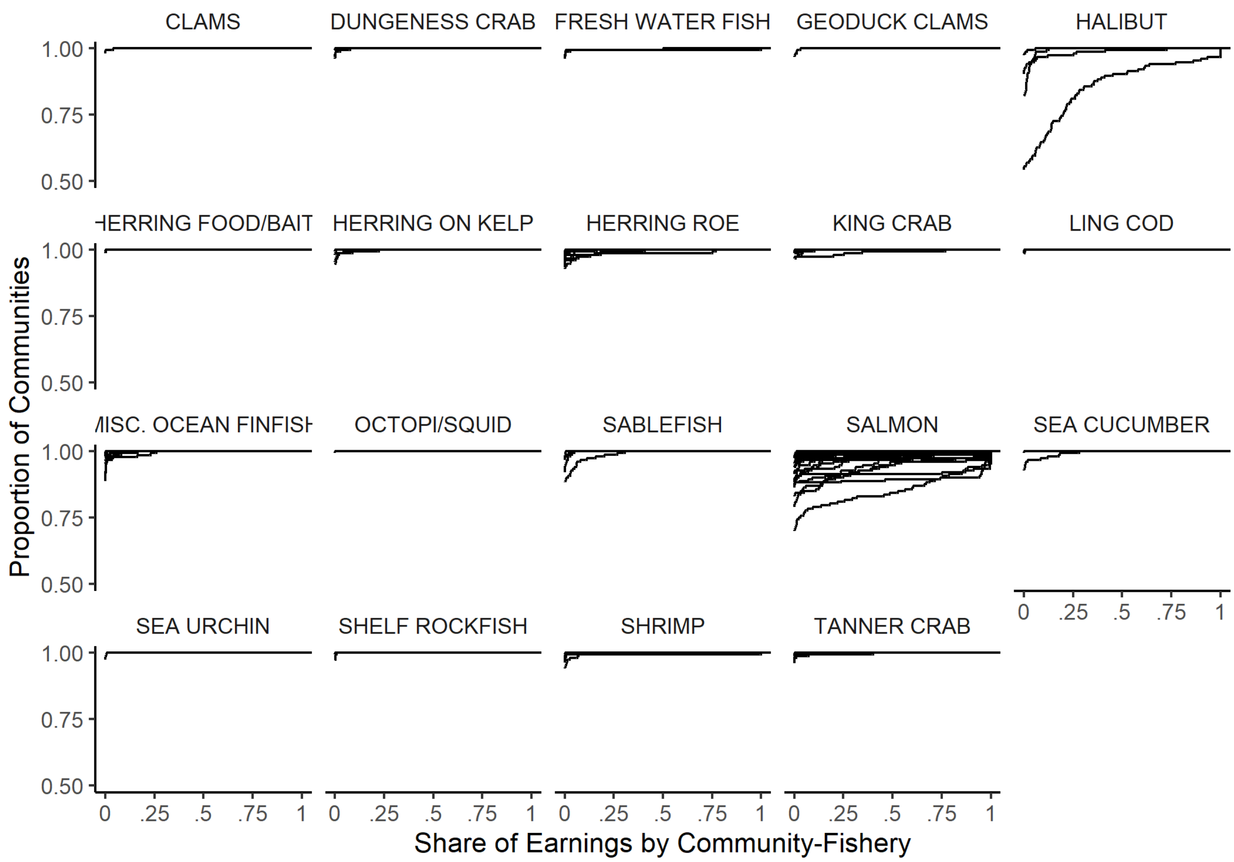
Coefficient (elasticities) and 95% confidence intervals estimated by Eq. D.1. The x-axis is the lag (lead) order of the specified outcome variable, -14:14. L=0 is equivalent to our main specification in Eq. 1. Each panel is one of 8 local economic outcomes measured at the lowest level of spatial aggregation where data are available. All are measured at the community level, except for IRS AGI which is measured at the borough level.

Figure D.5: Falsification Test Using Outcome Lags and Leads, Local Landings



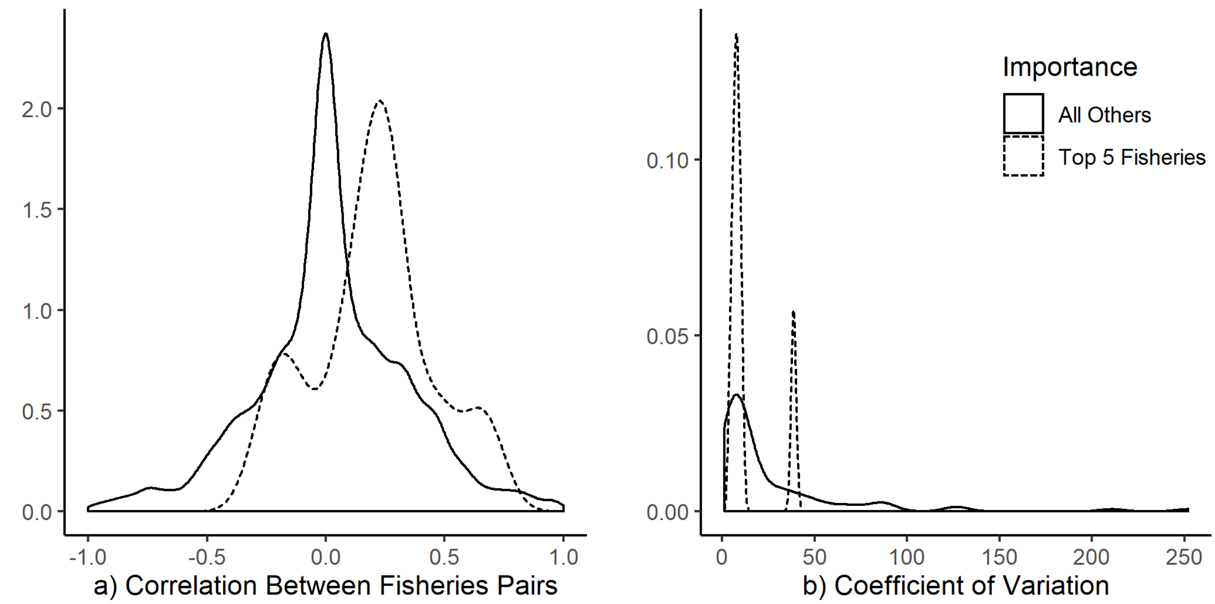
Coefficient (elasticities) and 95% confidence intervals estimated by Eq. D.1. The x-axis is the lag (lead) order of the specified outcome variable, -14:14. L=0 is equivalent to our main specification in Eq. 1. Each panel is one of 8 local economic outcomes measured at the lowest level of spatial aggregation where data are available. All are measured at the community level, except for IRS AGI which is measured at the borough level.

Figure D.6: Cumulative Density Functions, by species



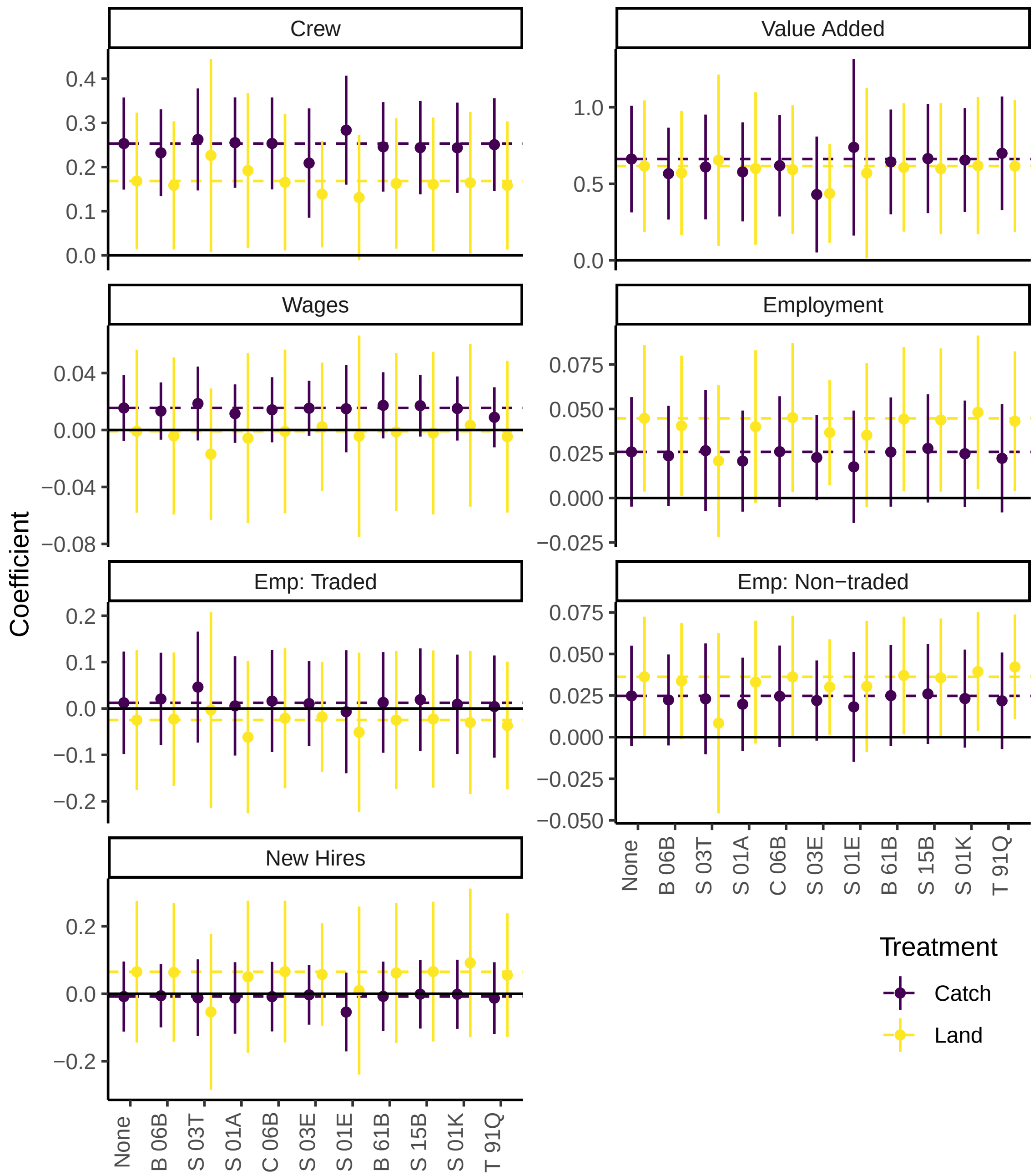
Are certain fisheries dominant in the portfolios of community fishery earnings? Each line plots the cumulative density function of a particular fishery's share of community fishery earnings, grouped by species of fish. The most extreme case is found for a particular halibut fishery (longline gear with vessels under 60'). Eighty-percent of communities receive less than 25% of their total earnings from this halibut fishery, and 90% of communities receive less than 50%.

Figure D.7: Density of correlation between fisheries and variation within fisheries



Panel a) plots the density of the correlation in annual earnings growth rates between each unique combination of fishery pairs. A majority of pairs have a correlation of less than 0.25, highlighting the independence between shocks to fisheries. The top five fisheries by value exhibit a similar pattern of low correlation between them and other fisheries, with 60% of these correlations below 0.25. Panel b) plots the density of the coefficient of variation (CV) of each fishery's annual earnings growth rates. The typical fishery shows a high degree of variation with a CV of 14. Among the top five fisheries, the CV ranges from 5.2 to 38.7, with a median CV of 8.1; these values are still quite large. Having highly variable and independent fisheries shocks provides validation for the shift-share instrument.

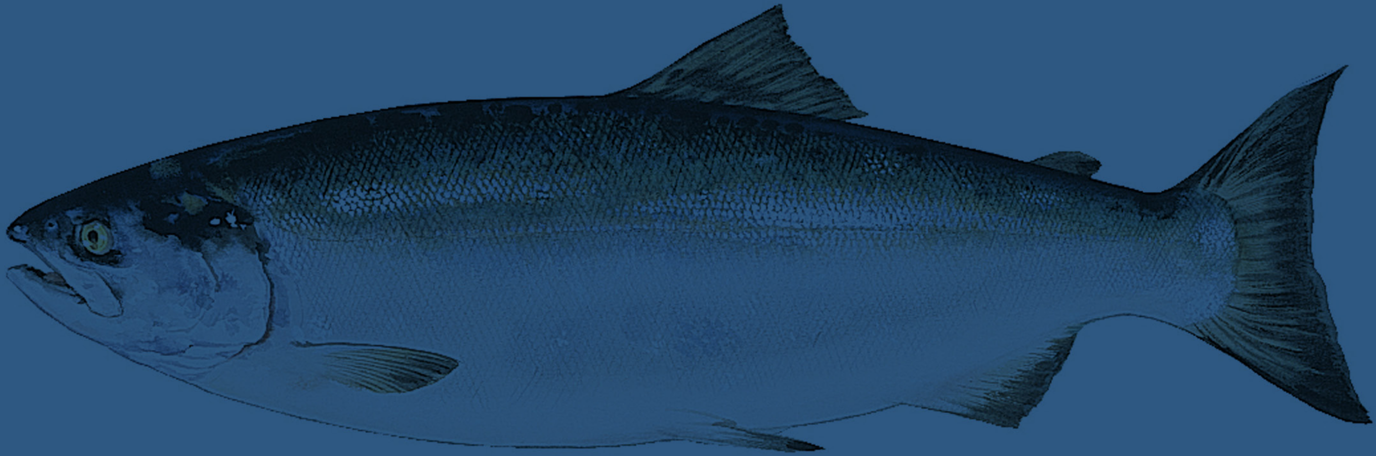
Figure D.8: Robustness to Inclusion of Top-10 Fisheries by Value



Coefficient (elasticities) and 95% confidence intervals estimated by Eq. 1. The x-axis denotes which of the top-10 fisheries (by mean annual value) is dropped from the sample (see Table D.4 for fishery code descriptions). Each panel is one of 7 local economic outcomes measured at the lowest level of spatial aggregation where data are available. All are measured at the community level. Dashed horizontal lines correspond to the estimated elasticity for the full sample.

THE ECONOMIC BENEFITS OF BRISTOL BAY SALMON

FEBRUARY 2021



PREPARED FOR:

BRISTOL BAY DEFENSE FUND

PREPARED BY:

McKINLEY RESEARCH GROUP, LLC

Formerly McDowell Group

THE ECONOMIC BENEFITS OF BRISTOL BAY SALMON

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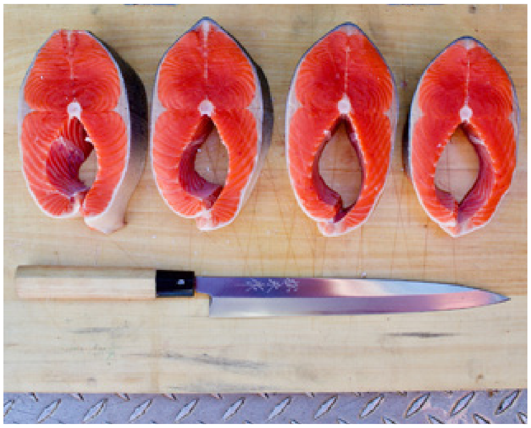


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Abbreviations and Terms

ADF&G	Alaska Department of Fish and Game
ADOR	Alaska Department of Revenue
AMR	Annual Management Report
ASFDB	Alaska Subsistence Fisheries Database
CFEC	Alaska Commercial Fishery Entry Commission
COAR	Commercial Operators Annual Report (Alaska Department of Fish and Game)
ADCCED	Alaska Department of Commerce, Community and Economic Development
ADOLWD	Alaska Department of Labor and Workforce Development
NOAA/NMFS	National Oceanic and Atmospheric Administration, National Marine Fisheries Service
QCEW	Quarterly Census of Employment and Wages

Other terms used in the report:

Ex-vessel value: The value at the point of sale from commercial harvester to a buyer – most often a seafood processor. In most cases this value is inclusive of post-season price adjustments.

Fisherman/Fishermen: Alaska seafood harvesters – both men and women – largely refer to themselves as fishermen. Though the gender-neutral term "fishers" has been adopted in some regions, our report uses the terms "fishermen" or "harvesters" in consideration of Alaska's cultural norm.

First wholesale value: Alaska law requires that seafood processors report the value of the product they have purchased and processed at the first point of sale. This value is known as the "first wholesale" value.

Photos in this report are provided by the Alaska Salmon Digital Image Library and the Alaska Seafood Marketing Institute, except where noted.

Executive Summary

Overview

Bristol Bay, Alaska encompasses 27.5 million acres of land and 12 million acres of marine ecosystem. The area Is home to more than half a dozen major river systems, with hundreds of connected lakes, rivers, and streams that feed into a saltwater bay in the southeastern corner of the Bering Sea.

In recent years, more than 50 million salmon returned annually to Bristol Bay rivers. This return drives commercial and sport fisheries and underpins a significant economic, nutritional, and cultural engine that supports people throughout Alaska, the United States, and the world.

This wide-ranging system and associated dependent economic activities provide an annual recurring value to participants. All combined, the economic value of Bristol Bay's wild salmon resource in 2019 exceeded $2.0 billion. Impacts occur within Alaska and spread from there through the Pacific Northwest and beyond.

Cultural and Harvest Values of Subsistence

- **Subsistence salmon harvest provides a significant amount of food with a high replacement value for Alaska residents.**
  - Alaskans requested **1,100 Bristol Bay subsistence salmon permits** and harvested **116,303 salmon in 2017**, the most recent year for which complete data are available.
  - The 2017 harvest equates to an estimated **503,890 pounds of usable fish** with a **replacement value of $5 million**, assuming a cost of $10 per pound to replace the protein source. Replacing subsistence salmon with commercially purchased equivalent would likely cost upwards of **$10 million.** This translates to about **$4,500 to $9,000 in nutritional value to each participating household**.
  - For many subsistence salmon harvesters, it would not be economically or logistically feasible to replace the quality and quantity of protein subsistence salmon provides.
- **Cultural values are even more significant, though hard to quantify.**
  - Subsistence salmon harvest is critical to the **health and well-being of communities** in the region, to **individual and community identities**, and to **cultural connectedness** and continuity.
  - Subsistence is the **oldest and most continuous use** of Bristol Bay salmon, dating back thousands of years.
  - Participation in harvesting, sharing, and consumption of subsistence foods **provides essential and high-quality nutrition**, supports **physical and mental health**, and **strengthens and maintains community and cultural connectedness**.

- **Salmon hold outsized importance as a subsistence resource in Bristol Bay**.
    - **Half to three-quarters of the Bristol Bay harvest, by pounds of usable food, is comprised of salmon**, about twice the proportion of salmon in statewide subsistence harvests.
- **The Bristol Bay subsistence salmon fishery is a statewide resource.**
    - Overall, **29% of the state's subsistence sockeye harvest** is caught in Bristol Bay.
    - Alaskans from outside the region harvested about 16% of the Bristol Bay subsistence salmon catch in 2017.

Seafood Industry and Impacts

- **Total direct, indirect, and induced impacts from the commercial fishery and related processing and support sector activity was $2.0 billion in 2019 and resulted in 15,000 jobs.**
    - This included approximately **$990 million in economic activity in Alaska, $800 million in the balance of the Pacific Northwest**, and the rest occurring across other regions of the United States.
    - **Scores of businesses and individuals** provide support sector services to the salmon-driven seafood industry in Bristol Bay, and harvesters and processors spend income and wages **throughout the nation**.
    - While direct harvesting and primary processing activity occurs in Alaska, **significant downstream activity occurs across the country**, following Bristol Bay permit holders and support sector businesses, as well as the distribution, retail, and dining businesses that provide Bristol Bay's wild salmon to consumers.
- **Bristol Bay salmon runs yielded an annual commercial harvest of 218 million pounds from 2015 to 2019, with an annual direct value to harvesters of $263 million**.
    - More than **8,000 harvesters are directly employed** in the fishery each year, including more than 2,000 residents of the Bristol Bay region, another 2,500 Alaska residents, and 4,000 residents of other U.S. states.
    - Alaska resident **fishermen earned $151 million** from Bristol Bay salmon in 2019, including **$50 million earned by residents of Bristol Bay region communities**. Non-resident fishermen earned an additional $192 million in 2019.
    - The Bristol Bay salmon run is a significant component of the overall Alaska salmon resource. The commercial harvest of 44.6 million salmon was **one-fifth of all salmon commercially harvested** in Alaska in 2019 and **more than half the ex-vessel value** of all Alaska salmon fisheries.

- Processed product from the Bristol Bay fishery averaged 137 million pounds between 2015 and 2019, with an average first wholesale value of nearly $540 million. The peak value, in 2019, was nearly $710 million.
    - Processors **employed 6,000 workers** in 2019 to transform the raw salmon harvest during the roughly 8-week harvest window from late June to mid-August.
    - Processing workers earned **$49 million in wages** in 2019.
- Within Alaska, direct, indirect, and induced labor income from the Bristol Bay salmon fishery totaled $375 million in 2019. Total associated economic output in the state was approximately $990 million.
    - Commercial fishing activity resulted in **$293.7 million** in labor income.
    - Processing activity generated **$80.8 million** in labor income.

Tourism Industry and Impacts

- Tourism in the Bristol Bay region produced more than 2,300 seasonal jobs in Alaska (annualized equivalent of 1,400) and $67.9 million in labor income in 2019.
    - Sportfishing and bear viewing are both important contributors, **generating $77 million and $20 million in visitor spending in Alaska**, respectively.
    - An estimated **40,000 to 50,000 people visited the region** annually to participate in these activities.
- More than 20,000 sportfishermen per year are estimated to have fished in Bristol Bay in the past five years.
    - This represents over **73,000 angler days** in the drainages of the Bristol Bay region
    - Harvest by sportfishermen totals **46,000 salmon annually** over the last 10 years.
- Roughly 90 lodges and camps in Bristol Bay cater to tourists, with a primary focus on sportfishing and bear viewing.
    - Average capacity in regional lodges is 14 guests, with **average daily rates of $1,125.**
    - Estimated visitor **spending by lodge and camp guests was $77 million** in 2019.
    - Sportfishing lodges and camps generate most tourism spending in the Bristol Bay region, most of which is generated by non-resident fishermen. Alaska residents also travel frequently to the region.
- Viewing bears who congregate to feed on migrating salmon is also an important tourist activity in the region, with the bulk of visitors making day trips from Anchorage or other communities in the Cook Inlet region.

- An estimated **20,000 people participated in bear viewing** during trips to Katmai National Park and Lake Clark National Park and Preserve in 2019.

- Total spending on these visitor trips is estimated at **$20 million**.

Total Impacts within Alaska

In aggregate, employment and labor income impacts in the state of Alaska from commercial fishing, seafood processing and the salmon-driven visitor industry totaled $442 million in 2019, with 16,900 seasonal jobs. Total economic output was $1.1 billion.

Economic Impacts in Alaska from Commercial Fishing, Seafood Processing, and Tourism, 2019

	Direct	Indirect & Induced	Total
Seafood Industry			
Commercial Fishing			
Employment: (Seasonal) and Annualized	(8,600) 2,570	1,100	3,670
Labor Income ($million)	$223.2	$70.5	$293.7
Seafood Processing			
Employment: (Seasonal) and Annualized	(6,000) 1,200	500	1,700
Labor Income ($million)	$57.7	$23.1	$80.8
Economic Output ($million)			$990.0
Visitor Industry			
Employment: (Seasonal) and Annualized	(2,300) 1,400	600	2,000
Labor Income ($million)	$43.7	$24.2	$67.9
Economic Output ($million)			$155.0
Total All Industries			
Employment: Total (Seasonal) and Annualized	(16,900) 5,170	2,200	7,370
Labor Income ($million)	$324.6	$117.8	$442.4
Economic Output ($million)			$1,145.0

Source: McKinley Research Group

- **Alaska Municipalities gain significant revenues through a combination of fishery taxes, local bed taxes, and property taxes generated in the Bristol Bay region.**
  - The State of Alaska passed more than **$5 million in fishery tax revenues through to 13 local municipalities** in the Bristol Bay region on average in the three fiscal years from FY2018-FY2020. The state retained a near-equivalent amount.
  - Local raw fish taxes are also levied in four regional municipalities. These generated an **additional $6.1 million per year** on average in the same period.

- Bed taxes, a significant portion of which can be assumed to be from salmon-related summer tourism and seafood activity, generated **$475,000 in revenue for regional communities** in FY2019.

Study Purpose

Salmon are the lifeblood of Bristol Bay. The teeming salmon runs that return to Bristol Bay rivers each year drive the regional ecosystem, economy, and way of life. Bristol Bay is home to the largest wild sockeye run in the world and supports the most high-value salmon fishery in the state of Alaska. The region draws visitors from all over the world for salmon and trout sportfishing, and for opportunities to view the brown bears that thrive on a salmon-rich diet. Salmon is also at the center of the region's enduring subsistence traditions, which provide essential nutrition and sustain community well-being and identity.

This study quantifies the economic impact of the Bristol Bay salmon resource, tracking its contribution through commercial fisheries and seafood processing, the visitor industry, and the region's subsistence way of life. The annual salmon returns, with wise stewardship, represent perpetual opportunities to benefit a broad group of stakeholders in Alaska and the United States. This study includes:

- An overview of the study region, including its history, the magnitude of its salmon resource, and key geographic and demographic features.
- Analysis of the value of the region's subsistence salmon harvest and use.
- Assessment of the commercial salmon fishing and processing industries.
- Analysis of the salmon-supported tourism sector in the region, including profiles of a sampling of lodges and camps, and bear-viewing providers.
- Quantification of the collective economic benefit of salmon in the region.

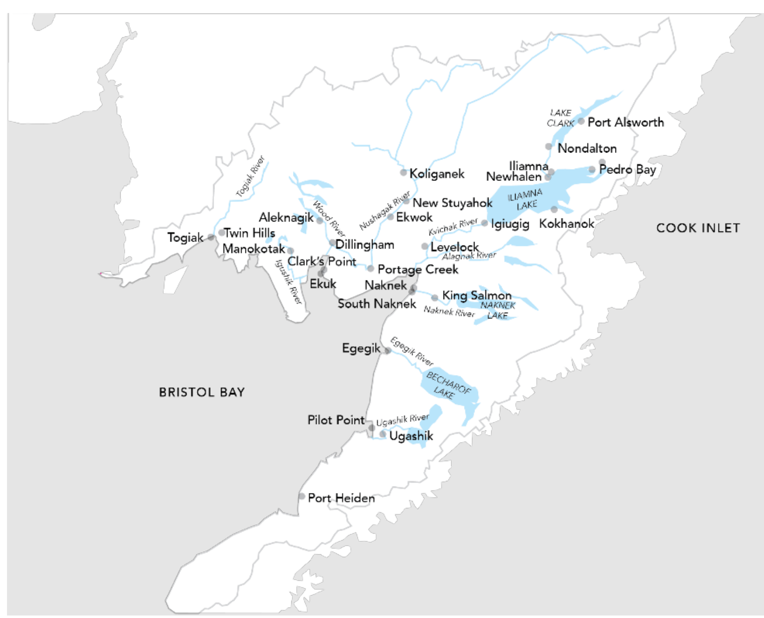
Study Region

This study considers the area of Alaska known as the "Bristol Bay region," defined as areas and associated communities whose water resources drain into Bristol Bay in Southwest Alaska.

The region includes more than two dozen communities spread across an area of about 40,000 square miles (27.5 million acres), an area the size of Ohio.

An estimated 7,000 people live in the Bristol Bay region. The largest community is Dillingham, with a population of 2,226 in 2020. The remainder of the region's inhabitants live in communities of fewer than 1,000 people.

Figure 1. Communities of the Study Region



Bristol Bay is home to Yup'ik, Dena'ina (Athabascan), and Alutiiq people belonging to 25 federally recognized tribes. Indigenous peoples comprise about two-thirds of the Bristol Bay population.

Bristol Bay communities include the following:

- Along the Wood River: Aleknagik, Dillingham
- On the north side of the Alaska Peninsula: Naknek, South Naknek, Egegik, King Salmon, Ugashik, Pilot Point, Port Heiden
- On the Nushagak River: Portage Creek, Ekwok, Koliganek, New Stuyahok, Clark's Point, Ekuk
- On the Lake Clark/Iliamna Lake/Kvichak River system: Iliamna, Igiugig, Kokhanok, Levelock, Newhalen, Nondalton, Pedro Bay, Port Alsworth
- West of Dillingham: Manokotak, Togiak, Twin Hills

Bristol Bay region landscapes inspired designation of three national parks and preserves, three national wildlife refuges, two national monuments, and one federally designated wild river. In addition, one of Alaska's largest state parks – Wood-Tikchik – lies within the region.

- Refuges: Togiak National Wildlife Refuge, Becharof National Wildlife Refuge, Alaska Peninsula National Wildlife Refuge
- National parks and preserves: Katmai National Park and Preserve, Lake Clark National Park and Preserve, Katmai National Park and Preserve
- National monuments: Aniakchak National Monument, Aniakchak National Monument and Preserve
- Federally designated wild river: Alagnak River

The Bristol Bay watershed supports a diversity of wildlife, including 29 fish species, more than 190 bird species, and more than 40 species of terrestrial mammals. The basin's extensive freshwater system includes nine major rivers, countless streams, and some of the largest lakes in the United States (Iliamna and Becharof Lakes). The major rivers – the Togiak, Igushik, Nushagak, Ugashik, Wood, Alagnak, Egegik, Kvichak, and Naknek Rivers – all support salmon runs; the Nushagak and the Naknek-Kvichak systems are the largest and most productive.

Bristol Bay Salmon

The Bristol Bay salmon resource is exceptional in scope, size, and impact, and includes the largest wild sockeye salmon run in the world. The region supports all five salmon species, and, with no hatcheries, the stocks are all wild. Returning salmon are the keystone for a rich ecosystem that transfers marine nutrients into upstream watersheds to fuel dependent animals ranging from small microorganisms to 1,500-pound brown bears.

The region's ecological diversity supported evolution of significant genetic diversity within sockeye and other salmon species that originate in the basin. Researchers note several hundred discrete populations of salmon in Bristol Bay watersheds.[1] These populations, with habitat-driven genetic adaptations to the unique stream conditions where they spawn, have developed unique characteristics and distinguishable genetics. Scientists point to a "portfolio effect," whereby the region's salmon populations have more resilience due to this local diversity.

A Salmon-Centric History

Subsistence Roots

Yup'ik, Dena'ina (Athabascan), and Alutiiq peoples have inhabited the Bristol Bay area for 10,000 years, living off the bounty of the lands and waters. Subsistence traditions center on salmon: almost three-quarters of wild food harvest in the Bristol Bay area is comprised of salmon, and the Southwest Region has the highest subsistence participation in the state.

This subsistence tradition has persisted through numerous changes and disruptions. In 1780, Alaska was claimed by Russia, and Russian explorers, fur traders, and missionaries were drawn to Bristol Bay. Russian cultures and traditions, including the Russian Orthodox Church, remain intermingled with Alaska Native traditions in the region.

Rise of Commercial Fisheries

The U.S. purchased Alaska from Russia in 1867, and in 1883, the first Bristol Bay salmon cannery opened at Naknek. More followed, signaling the start of a commercial fishery that soon accounted for more than half the state's commercial salmon catch.

In 1912, the largest volcanic explosion of the 20th century occurred at Katmai. Forewarned by days of rumbling, many fled nearby villages, and no one was killed, but the land and communities were deeply altered. The "Spanish flu" in 1918 devastated Bristol Bay, killing a majority of adults in many villages. The same year, the Bristol Bay salmon run crashed – from 25 million fish in 1918 to 6 million in 1919 – adding to the region's woes.

[1] https://www.scientificamerican.com/article/salmon-runs-portfolio/

The community of King Salmon became the site of a World War II airbase in 1941, and a village grew up around the base. The station went into caretaker status in 1993. Today, King Salmon's state-owned airport has the longest runway in the region, giving the village a key role in regional transportation and logistics.

Statehood and Limited Entry

Through the first half of the 20th century, federal regulators attempted to protect salmon escapement, with limited success: "By most accounts, enforcement of many of these regulations was negligible and the restrictions proved to be inadequate to achieve sufficient spawning escapements."[2] Federal legislation in 1924 meant to protect the fishery likewise faltered, and by the end of the 1920s there were indications of serious overfishing.

Concerns about unsustainable fisheries harvest in Bristol Bay and throughout the Territory of Alaska served as a core motivation for statehood. Outside interests were seen as decimating Alaska stocks for short-term gain, with little interest in conserving the resource for long-term benefit. Alaskans wanted to control their own resources, most notably fisheries. In 1959, Alaska became the 49th state, and a new era of fisheries management began.

The state's efforts to implement fisheries limitations ran into constitutional hurdles, leading to passage in 1972 of an Alaska constitutional amendment that authorized the state to limit entry into any fishery "for purposes of resource conservation, to prevent economic distress among fishermen and those dependent upon them for a livelihood and to promote the efficient development of aquaculture in the State."

Passage of the Alaska's Limited Entry Act (AS 16.43) followed in 1973. The act established the Commercial Fisheries Entry Commission to administer and adjudicate the limited entry system. Limited entry was implemented in 19 of the state's salmon fisheries in 1974, including the Bristol Bay salmon drift and set gillnet fisheries.

The State of Alaska's regulatory objectives for Bristol Bay salmon fisheries include managing for sustained yields, maintaining the genetic diversity and overall health of the escapement, providing an orderly fishery, helping to obtain a high-quality fishery product, and harvesting fish consistent with regulatory management plans. In 2016 the state announced the two-billionth salmon harvested in Bristol Bay's then-132-year commercial fishing history.

[2] Commercial Fisheries Entry Commission. https://www.cfec.state.ak.us/RESEARCH/salmon/CHPT2_10_21_04.pdf

Sportfishing and Tourism

In recent decades, Bristol Bay has become a sportfishing mecca, drawing visitors from across the globe seeking an unparalleled fishing and wildlife viewing experience in a spectacular and remote landscape. Visitors generally fly into full-service lodges, and tend to fish rivers and lakes, while commercial fishing is more ocean centered. Unlike other areas where sport and commercial fisheries interests have tangled, Bristol Bay's sport and commercial fisheries tend to occupy separate orbits and have coexisted peacefully.

More than 90 lodges, primarily catering to sportfishing and bear viewing, operate in the region. Many are accessible only through a network of "bush" plane operators with regional linkages to urban Alaska. While commercial fishing contributes a greater share of jobs and economic activity, sportfishing and related enterprises such as bear viewing help diversify the region's economy through sustainable resource use.

Subsistence Harvest

Subsistence is the oldest and most continuous use of Bristol Bay's remarkable salmon runs. The Alaska National Interest Lands Conservation Act of 1980 defines subsistence uses as "customary and traditional uses by rural Alaska residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools or transportation; for the making and selling of handicraft articles out of non-edible by-products of fish and wildlife resources taken for personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade."

Alaskans reported harvesting 116,303 salmon in Bristol Bay's 2017 subsistence fishery, the most recent year for which data are available, with a replacement value of between $5 million and $10 million, assuming one were to replace the protein pound for pound by purchasing store-bought alternatives. This translates to about $4,500 to $9,000 in nutritional value to each participating household.

But subsistence is far more than food; it is a critical underpinning of the health and well-being of communities in the region, of individual and community identities, and of cultural connectedness and continuity. A 2009 peer-reviewed study found participation in traditional subsistence activities to be higher in Southwest Alaska than in any other region of the state.[3] In the Bristol Bay area, the center of subsistence activity is salmon. As the U.S. Environmental Protection Agency wrote of indigenous peoples of Bristol Bay, "Salmon are integral to the entire way of life in these cultures as subsistence food and as the foundation for their language, spirituality, and social structure."

The Alaska Department of Fish and Game wrote in a 2015 report:

> *In an area that is world-renowned for its commercial fisheries and its recreational opportunities, subsistence uses of wild renewable resources remain the most consistent and the most reliable component of the local economy of Bristol Bay communities. … At the beginning of the 21st century, subsistence activities and values remain a cornerstone of area residents' way of life, a link to the traditions of the past, and one of their bases for survival and prosperity.*[4]

Salmon comprise almost three-fourths of wild foods harvested in Bristol Bay, in pounds of usable food. Statewide, about one-third of the wild food harvest is comprised of salmon, making salmon a disproportionately important resource for subsistence users in Bristol Bay. Sockeye is the most significant salmon species harvested in the area, accounting for 77% of the subsistence salmon harvest in 2017 by number of fish, a figure that has been consistent over time.

The Bristol Bay subsistence fishery also has outsize value to subsistence users in the rest of the state. Fourteen percent of Bristol Bay's subsistence salmon harvest is caught by Alaskans from outside the region. Overall, 29% of the state's subsistence sockeye harvest is caught in Bristol Bay.

[3] https://www.tandfonline.com/doi/abs/10.3402/ijch.v67i4.18346?src=recsys

[4] Special Publication No BOF 2015-04: An Overview of the Subsistence Fisheries of the Bristol Bay Area. https://www.adfg.alaska.gov/static/regulations/regprocess/fisheriesboard/pdfs/2015-2016/bristolbay/SP2_SP2015-004.pdf

Value of Bristol Bay Subsistence Salmon Harvest

Economic Value

In most Bristol Bay communities, subsistence is integral to the economy and way of life. ADFG describes rural Alaska's mixed "subsistence-market" economy:

> *Families invest money into small-scale, efficient technologies to harvest wild foods, such as fish wheels, gillnets, motorized skiffs, and snowmachines.... Successful families in these areas combine jobs with subsistence activities and share wild food harvests with cash-poor households who cannot fish or hunt, such as elders, the disabled, and single parents with small children.*

Replacement of Protein Source

It would cost between an estimated $5 to $30 per pound or more to replace subsistence salmon protein with a store-bought substitute, depending on the quality of the replacement, the location of the subsistence harvester, and timing. Even at the high end of this range, it might not be possible to purchase protein of equal nutritional and health value consistently. As ADFG notes, "It is unlikely that adequate substitutes for many subsistence foods produced in the region could be purchased."

Our research supports this observation. Calls to Bristol Bay groceries and suppliers indicate that animal-based protein sources can be found for about $5-6 per pound at the low end in Dillingham (e.g., for boneless chicken or ground beef) to $9-18 per pound or more for steak. These prices are not for organic meats, which have very limited availability. Of the six grocery stores in the region reached for this study (three in Dillingham, three in other communities), only one carried organic meat, and then only occasionally. One offered grass-fed ground beef for $11 per pound.

Not all protein sources are created equal, however. Alaska's salmon is prized for its unique nutritional quality. Compared to typical protein sources such as chicken and beef and even many other types of seafood, wild Alaska salmon is high in protein, Omega-3 fatty acids, and vitamins, while low in saturated fats and naturally free of pesticides and additives. While it may be possible to replace the quantity of protein in subsistence salmon harvests, it would be very difficult for subsistence harvesters to replace the quality. *The "replacement value" exercise is a way of illustrating one component of the value of subsistence salmon harvests, rather than a practical scenario.*

Within the region, Bristol Bay salmon is not broadly available for purchase at the six grocery stores reached for this study. One store carries imported farmed salmon (Nova Scotia smoked lox) for $17 per pound, and another offered smoked Alaska salmon for $25 per pound. The others said they did not have salmon for sale. While some independent sellers in Bristol Bay sell salmon direct to buyers, pricing and availability vary.

Outside Dillingham, animal-based protein sources tend to cost at least $1 to $2 per pound more than in Dillingham, and fewer products are available. If residents are able to plan ahead and purchase somewhat larger quantities from Dillingham, groceries can be shipped for about $0.50 to $1.00 per pound, depending on the carrier, the amounts shipped, and the carrier's pricing structure.

At the low end, assuming Bristol Bay subsistence salmon harvests could be replaced by non-organically non-salmon meats for about $5 per pound, the replacement value of the Bristol Bay subsistence salmon harvest would be $2.5 million based on 2017 harvest data. At the high end, assuming $20 per pound to more closely approximate the quality of subsistence salmon, the value would be $10 million.

The following table shows calculations assuming a hybrid $10 per pound replacement value. In this scenario, Alaskans would pay just over $5 million to purchase 503,890 pounds of protein. Attempting to replace subsistence salmon pound-for-pound with Bristol Bay salmon purchased on the market would cost an estimated $20. Again, it should be noted that this exercise is for illustrative purposes only, and is limited to one dimension of the value of subsistence salmon, notably its value as a protein source.

Table 1. Estimated Replacement Value of Bristol Bay Subsistence Salmon Harvest, 2017

	Chinook	Sockeye	Coho	Chum	Pink	Total
Number of fish	12,985	89,704	8,154	4,907	553	116,303
Pounds of usable fish	98,199	341,567	39,776	22,907	1,441	503,890
Usable fish, % of total by species	19%	68%	8%	5%	0	100%
Replacement value ($10/pound)	$981,992	$3,415,673	$397,762	$229,066	$14,411	$5,038,904
Replacement value ($20/pound)	$1,963,980	$6,831,346	$795,524	$458,140	$28,820	$10,077,800

Source: ADF&G and McKinley Research Group estimates.

Other Economic Benefits

There are also indirect household economic benefits of subsistence harvesting. As one Yup'ik woman in the region said, subsistence enables her to live and raise her two children while working as a self-employed artist with a limited cash income. Apay'uq Moore said subsistence provides her family high-quality food, and also saves her child care expenses because she is able to engage in subsistence activities with her children. In her view, which is supported by a growing body of research, subsistence also saves her family and the health care system in avoided mental health care costs, because subsistence practices and foods are healing and therapeutic. Subsistence also provides the inspiration for Moore's art, which in turn generates the cash she needs to supplement and support her family's subsistence lifestyle:

> *Subsistence has afforded me all sorts of things. Being able to have my kids with me … I work from home and I'm a single mom. Without working for anyone else I'm able to do everything. It's difficult quantifying it all into dollar figures, to nitpick and say what is it saving me.*

Other economic benefits derive from dollars circulated in the local economy in support of subsistence activities. For example, subsistence harvesters may spend money on boats, fuel, and other equipment. This includes subsistence harvesters who live in the region as well as those who travel from other parts of Alaska. Thus, the replacement value of subsistence salmon should be viewed as a low estimate of the economic value of subsistence salmon in Bristol Bay.

Health, Social, and Cultural Values

While there is significant tangible economic value to subsistence salmon in Bristol Bay, as Moore suggests, the value of subsistence activity goes much deeper than dollars. As the National Park Service notes, subsistence involves more than food:

It involves the fundamentals of identity and culture, including the customs, traditions, values and beliefs that make Alaska Native peoples and rural communities unique. The subsistence way of life is rooted in a strong sense of place that extends back through the generations. It involves the social and economic ties that bind families and communities together. And, most importantly, it endures over time through the passing of traditional knowledge from one generation to the next.[5]

The State of Alaska likewise acknowledges the multiple values of subsistence practices:

The harvest and processing of wild resources for food, raw materials, and other traditional uses have been a central part of the customs and traditions of many cultural groups in Alaska, including Aleut, Athabascan, Alutiiq, Euro-American, Haida, Inupiat, Tlingit, Tsimshian, and Yupik for centuries. The Alaska legislature passed the state's first subsistence statute in 1978 and established subsistence as the priority use of Alaska's fish and wildlife. The law defined subsistence as "customary and traditional uses" of fish and wildlife and highlighted the unique importance of wild resources, and the continuing role of subsistence activities in sustaining the long-established ways of life in Alaska.[6]

These broader benefits and roles of subsistence have indirect and likely significant economic benefits, but they are difficult to quantify. We describe them briefly in qualitative terms:

Health: Subsistence salmon are more nutritious than most store-bought equivalents, without the chemical additives. Wild salmon are rich in healthy fats and protein and are lower in unhealthy fats than typical store-bought meat.[7] Studies also point to the health benefits of increased physical activity associated with harvesting and processing subsistence foods.[8] There is also growing acknowledgment of the mental health benefits of participation in subsistence harvest and consumption.

Social and cultural benefits: Sharing is integral to subsistence values. A study of community sharing in six Bristol Bay/Alaska Peninsula communities found that 96% of households in the communities used subsistence salmon; 80% received salmon from other households; and 56% gave salmon to other households. Sharing alleviates potential economic distress among vulnerable residents and strengthens community relationships. "Sharing plays a critical role in community cohesion," study authors noted. Subsistence participation is also a way of teaching, learning, and practicing Alaska Native ethics and values.[9] Subsistence participation – in harvest, sharing, and consumption – builds individual and community resilience. A growing body of research finds participation in subsistence activities strengthens cultural connections and helps protect individuals against adverse health impacts of trauma. A study of 3,830 Alaska Natives in three regions of the state, including Southwest Alaska, found subsistence is integrally linked to culture:

Both traditional food and physical activity were associated with greater tribal self-identification, speaking a Native language at home, using traditional remedies and participating in or attending traditional events.[10]

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[5] https://www.nps.gov/subjects/alaskasubsistence/subsistence-learn.htm
[6] https://www.adfg.alaska.gov/index.cfm?adfg=subsistence.definition
[7] http://www.adfg.alaska.gov/static/regulations/regprocess/gameboard/pdfs/2018-2019/se/rcs/rc012_ADF&G_Subsistence_Food_security_whitepaper.pdf
[8] https://www.tandfonline.com/doi/abs/10.3402/ijch.v67i4.18346?src=recsys&
[9] https://www.poa.usace.army.mil/Portals/34/docs/civilworks/currentproj/APPXBSubsistenceFINAL012512.pdf?ver=2017-04-07-203156-967
[10] https://www.tandfonline.com/doi/abs/10.3402/ijch.v67i4.18346?src=recsys

This study found participation in traditional subsistence activities higher in Southwest Alaska than any other region of the state. The study also found salmon was the top subsistence resource consumed, followed by moose and *agutak* (a mixture of berries and fat).

Subsistence Salmon Harvests

Bristol Bay and Statewide Harvests

In 2017, the most recent published regional and statewide data, Bristol Bay subsistence salmon harvests totaled 116,303 fish, based on 1,000 returned subsistence permits with harvest data.[11] This harvest represents a significant portion of the statewide subsistence salmon harvest. Statewide, 7% of subsistence salmon permits returned to ADF&G reported Bristol Bay catch, and almost 14% of subsistence salmon, by number of fish, were harvested in the Bristol Bay Management Area. The Bristol Bay subsistence harvest comprised 29% of the state's subsistence sockeye harvest, and 16% of the state's subsistence Chinook harvest. Returned permits represent 90% of the 1,110 subsistence salmon permits requested for the Bristol Bay Management Area. ADF&G's Subsistence Division extrapolates total harvest numbers based on returned surveys.

The harvest figures below do not include fish removed for home use from commercial catches. In addition, ADF&G reports that fish caught later in the season, such as coho and spawning salmon, are probably not documented as consistently as Chinook and prespawn sockeye. Thus, these figures may underestimate the subsistence harvest.

Table 2. Bristol Bay Management Area and Statewide Subsistence Salmon Harvests, 2017

	Permits Returned	Reported Salmon Harvest by Number of Fish					
		Chinook	Sockeye	Coho	Chum	Pink	Total
Bristol Bay	1,000	12,985	89,704	8,154	4,907	553	116,303
Statewide	14,044	82,198	308,421	92,359	325,446	54,506	862,930
Bristol Bay as % of Statewide Harvest	7%	16%	29%	9%	2%	1%	14%

Source: ADF&G Division of Subsistence ASFDB 2018 (ADF&G, 2019).

Salmon holds unique importance in Bristol Bay as a subsistence and personal use resource. On average, Bristol Bay Borough residents in 2017 harvested 202 pounds of wild salmon per capita for home use, nearly ten times the statewide figure. Salmon comprised nearly three-quarters (73%) of all wild foods harvested in Bristol Bay, by weight, double the statewide average of 37%.[12] Bristol Bay Borough was second only to Lake and Peninsula Borough – most of which lies in the Bristol Bay drainage – in the amount of wild salmon harvested per capita.

[11] Each year, a subsistence permit is mailed to any household that returned a completed permit the previous year. Permits are also available by request in person, by phone, or by mail from ADFG. All permit holders are required to record their harvest on the permit, listing areas shed by date and salmon harvested by species, and return the permit, regardless of whether they shed, no later than February 1 of the year following when the permit was issued (5 AAC 01.530(c)).

[12] https://www.adfg.alaska.gov/static-sub/CSIS/PDFs/Estimated%20Harvests%20by%20Region%20and%20Census%20Area.pdf

Table 3. Per-capita Bristol Bay Borough and Statewide Wild Food Harvests for Home Use, 2017

	Salmon (lbs.)	Total (lbs.)	Salmon as % of total wild harvest
Bristol Bay Borough	202.0	275.8	73%
Statewide (rural and urban)	22.8	61.6	37%

Source: ADF&G Division of Subsistence, 2019.

Historical Trends

Subsistence salmon harvests are trending downward in Bristol Bay, as they are statewide. The harvested number of subsistence salmon in 2017 was 8% below the previous five-year average, and 19% below the historic average. Harvested numbers of sockeye, the most significant subsistence species, show similar trends. The Alaska Board of Fisheries in 1993 determined that between 157,000 and 172,121 salmon is the amount "reasonably necessary" to provide for subsistence uses. Amounts for specific species or stocks were not established.

Table 4. Bristol Bay Management Area Subsistence Salmon Harvests, 2017 and Historical Averages

	Permits Returned	Reported Salmon Harvest by Number of Fish					
		Chinook	Sockeye	Coho	Chum	Pink	Total
2017	1,000	12,985	89,704	8,154	4,907	553	116,303
5-year average (2012-2016)	1,016	15,000	96,805	7,074	4,935	2,060	125,873
Historical average (1983-2016)	966	14,769	112,386	8,136	6,251	2,306	143,849

Source: ADF&G Division of Subsistence, ASFDB 2018 (ADF&G, 2019). Harvests are extrapolated for all permits issued, based on those returned.

A 2015 special report on subsistence in Bristol Bay found that declines in the subsistence salmon harvest since the 1990s are due to lower harvests per permit rather than less fishing effort. Since 1996, the analysis found, harvest per day was down 26% in years of escapements under 2 million fish, compared to the previous 13-year average.

Community Harvest Data

Under state regulations, all Alaska residents are eligible to participate in subsistence salmon fishing in the Bristol Bay Area. In Bristol Bay in 2017, local residents caught 84% of the subsistence salmon harvest, while other Alaska residents harvested 16%. The table below shows subsistence salmon harvests reported for each Bristol Bay community.

Table 5. Bristol Bay Area Subsistence Salmon Harvests by Community and Species, Alaska Residents Living Outside Bristol Bay, 2017

	Permits Returned	Reported Salmon Harvest by Number of Fish					
		Chinook	Sockeye	Coho	Chum	Pink	Total
Aleknagik	21	984	1,706	176	50	0	2,916
Clarks Point	7	111	326	387	29	0	853
Dillingham	293	5,935	17,330	3,685	2,470	166	29,587
Egegik	2	0	27	63	1	1	92
Ekwok	14	540	691	164	227	0	1,622
Igiugig	5	11	853	0	0	0	864
Iliamna	17	5	3,388	0	0	0	3,393
King Salmon	70	130	5,130	203	28	30	5,520
Kokhanok	14	7	6,030	11	3	1	6,052
Koliganek	13	709	1,171	183	192	32	2,286
Levelock	2	1	168	0	0	0	169
Manokotak	22	191	2,018	153	14	24	2,400
Naknek	92	400	9,769	781	142	47	11,140
New Stuyahok	27	2,143	2,160	651	812	19	5,785
Newhalen	11	0	3,402	0	0	0	3,402
Nondalton	10	0	6,548	0	0	0	6,548
Pedro Bay	13	0	1,773	0	0	0	1,773
Pilot Point	2	0	0	0	0	0	0
Port Alsworth	42	0	3,834	28	0	2	3,864
South Naknek	14	49	1,274	157	50	26	1,554
Togiak	56	870	4,901	539	503	131	6,943
Twin Hills	8	89	262	6	42	0	398
Ugashik	6	6	376	113	4	1	499
Total Bristol Bay Resident	761	12,179	73,136	7,300	4,565	480	97,660

Source: ADF&G Division of Subsistence, ASFDB 2018 (ADF&G, 2019). Note: Harvests are extrapolated for all permits issued, based on those returned. Due to rounding, the sum of columns and rows may not equal the estimated total. Of 1,100 permits issued for the management area, 1,000 were returned (90.1%).

Per-capita wild resource harvests are generally higher in the smaller communities of the Bristol Bay area than in the larger regional centers of Dillingham and King Salmon-Naknek. This is significant because these smaller communities typically have low household cash income, making subsistence particularly important to residents' well-being. In a 2015 report, the ADF&G Subsistence Division estimated that wild food harvested in smaller communities of Bristol Bay totaled 426 pounds of foods per person per year, with a household average of 1,541 pounds. Salmon comprised more than half of the total harvest in pounds. Given the low cash income and high cost and often limited selection of store-bought food in the region, subsistence is a critical component of food security in many communities in the region.

Since 1990, by State regulation all Alaskans are eligible for subsistence fishing in Bristol Bay, subject to limitations and with a permit.[13] In 2017, Bristol Bay subsistence salmon drew Alaskans from 27 communities outside the region, ranging from Ketchikan to Barrow. Of 239 Alaskans residing outside the area who reported harvesting subsistence salmon in Bristol Bay in 2017, 48% were from Anchorage, 15% from Wasilla, 7% from Homer, and 6% from Fairbanks. Alaskans from outside the region harvested 16% of the Bristol Bay subsistence salmon catch by number of fish. Communities with one permit returned are Barrow, Copper Center, Cordova, Girdwood, Healy, Kasilof, Ketchikan, Kotzebue, Paxson, Seward, Sitka, and Willow.

While estimates of spending in Bristol Bay by nonresident subsistence participants are not publicly available, it is reasonable to assume these visitors spend money on lodging, transportation, food, and other goods and services while in the borough, and pay to ship their catch home.

Table 6. Bristol Bay Area Subsistence Salmon Harvests by Community and Species, Alaska Residents, 2017

Community	Permits Returned	Reported Salmon Harvest by Number of Fish					
		Chinook	Sockeye	Coho	Chum	Pink	Total
Anchorage	115	298	8,134	588	96	23	9,138
Big Lake	2	2	434	0	0	0	436
Chugiak	8	64	530	0	9	1	604
Eagle River	5	2	621	0	2	0	625
Fairbanks	13	74	1,142	25	73	19	1,333
Homer	16	32	813	35	22	1	903
Juneau	4	49	195	0	3	0	246
Kenai	5	64	418	31	7	2	522
Kodiak City	6	30	309	0	8	0	348
Nikiski	3	3	99	0	7	0	109
Palmer	12	24	739	74	21	12	870
Seldovia	2	1	49	0	0	0	50
Soldotna	2	19	185	0	22	0	226
Talkeetna	2	23	143	0	29	0	195
Wasilla	32	47	1,999	71	25	5	2,145
Communities with 1 permit returned	12	74	758	30	19	11	892
Total Other Alaska Resident	239	806	16,567	854	343	73	18,643

Source: ADF&G Division of Subsistence, ASFDB 2018 (ADF&G, 2019). Note: Harvests are extrapolated for all permits issued, based on those returned. Due to rounding, the sum of columns and rows may not equal the estimated total. Of 1,100 permits issued for the management area, 1,000 were returned (90.1%).

[13] Note that the National Park Service since 2001 enforces local-only restrictions within park boundaries.

Harvest by Location

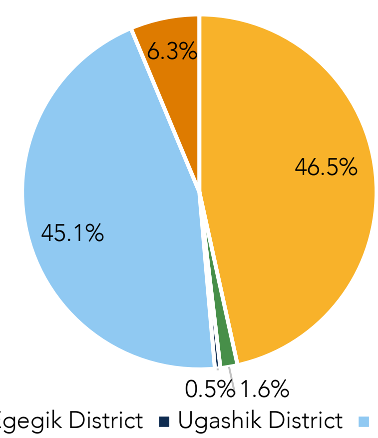
The vast majority (93%) of the Bristol Bay subsistence salmon harvest is associated with two river systems: the Naknek-Kvichak and the Nushagak. The Naknek-Kvichak system produces 57% of the area's subsistence sockeye salmon harvest, while the Nushagak produces 86% of the subsistence Chinook harvest.

Table 7. Bristol Bay Area Subsistence Salmon Harvests by District Fished, 2017

Area and River System	Permits Issued	Reported Salmon Harvest by Number of Fish					
		Chinook	Sockeye	Coho	Chum	Pink	Total
Naknek-Kvichak District	447	757	51,544	1,346	320	157	54,125
Egegik District	23	129	1,243	430	13	6	1,821
Ugashik District	15	18	444	113	5	2	581
Nushagak District	563	11,122	31,310	5,720	4,026	257	52,434
Togiak District	70	959	5,163	545	544	131	7,341
Total	1,110	12,985	89,704	8,154	4,907	553	116,303

Source: ADF&G Division of Subsistence, ASFDB 2019 (ADF&G, 2020). Note: Harvests are extrapolated for all permits issued, based on those returned and the area fished as recorded on the permit. Due to rounding, the sum of columns and rows may not equal the estimated total. Of 1,100 permits issued for the management area, 1,000 were returned (90.1%). Sum of sites may exceed district totals, and sum of districts may exceed area total, because permittees may use more than one site.

Figure 2. Bristol Bay Area Subsistence Salmon Harvests by District Fished, 2017



Source: ADF&G Division of Subsistence, ASFDB 2019 (ADF&G, 2020).

Commercially Caught Salmon Retained for Home Use

Bristol Bay commercial fishermen often retain salmon for personal use. Data is incomplete on the amount of salmon kept for personal use, or "homepack" in the region. The State subsistence division does not systematically collect this data. Data reported to the commercial fisheries division is considered an undercount, and the amount of salmon retained for home use likely significant for Bristol Bay commercial fishermen. In 2019, 4,924 commercially harvested fish were reported retained for personal use, of which 61% were sockeye and 36% Chinook. The majority (81%) were harvested in the Nushagak and Naknek-Kvichak districts.

Table 8. Salmon Taken in Commercial Salmon Fisheries but Not Sold, Bristol Bay Management Area, 2019

	Chinook	Sockeye	Coho	Chum	Pink	Total
Number of fish	1,778	2,999	90	41	16	4,924

Source: ADF&G. These figures are incomplete and should be considered minimums.

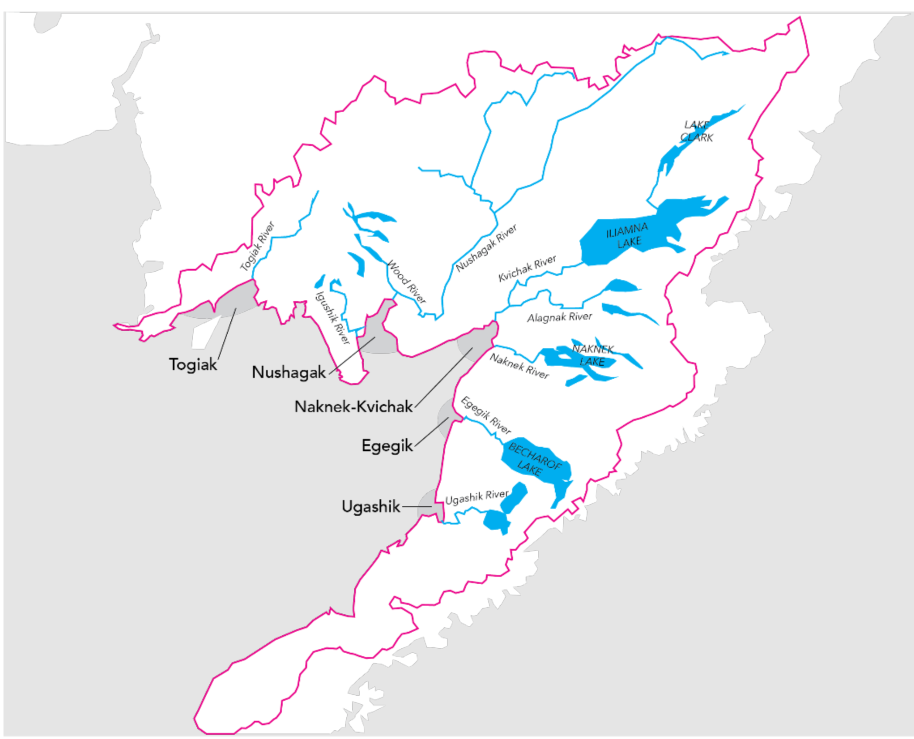
Commercial Salmon Harvest and Industry

Most economic activity and value generated by the Bristol Bay salmon resource results from the summer commercial fishery. The relatively small communities of Bristol Bay, which have a collective year-round population of just over 7,000, surge to at least triple their size with people and activity during the two-month fishery. People come from around Alaska, the United States, and beyond to participate directly in harvesting or processing salmon, or to provide the myriad services – from net building to hydraulic servicing to equipment expediting – that support the fishery.

The condensed timeframe – from late June to late July – in which the bulk of the fishery occurs has been likened by some to the turning off and on of a powerful hose. Most of the harvest – as much as 75% percent – can be caught in a three-week period, or even more quickly. Thus, the commercial fishing Industry in the region is geared for an intense pulse of fish, with harvesting, processing, and the support sector all built around "peak" volumes that typically arrive in the first weeks of July. Processing capacity and logistics, in particular, are managed around maximum daily volumes of fish.

Salmon are harvested in five different fishing districts, the Nushagak, Naknek-Kvichak, Egegik, Ugashik, and Togiak districts. Each district is fed by rivers of the same name. Commercial fishery managers moderate harvest activity in the districts in relation to "escapement," a count of fish that pass by commercial harvesters and move into the upriver systems. As escapement is reached in each river system, commercial harvest opportunity in the corresponding fishing district may be increased.

Figure 3. Bristol Bay Drainages and Fishing Districts



Bristol Bay's sockeye salmon provide the majority of global sockeye production. That proportion has increased in recent years, corresponding with record salmon returns in the Bristol Bay system.

Table 9. Bristol Bay Contribution to Global Sockeye Production (millions of fish)

# of Sockeye	2015	2016	2017	2018	2019	5-Yr Average
Bristol Bay	36.1	37.6	38.7	41.9	43.0	39.5
Global	74.3	75.2	71.0	75.1	75.6	74.2
% of Global	**49%**	**50%**	**55%**	**56%**	**57%**	**53%**

Source: McKinley Research Group Estimates

Commercial Harvest Volumes and Values

In 2019, the total run size for Bristol Bay was 58.6 million fish, including approximately 44.5 million harvested in the commercial fishery and 14.1 million fish that moved into river systems to spawn and seed the next generation of salmon.[14]

Table 10. Bristol Bay Salmon Run, 2019 (millions of fish)

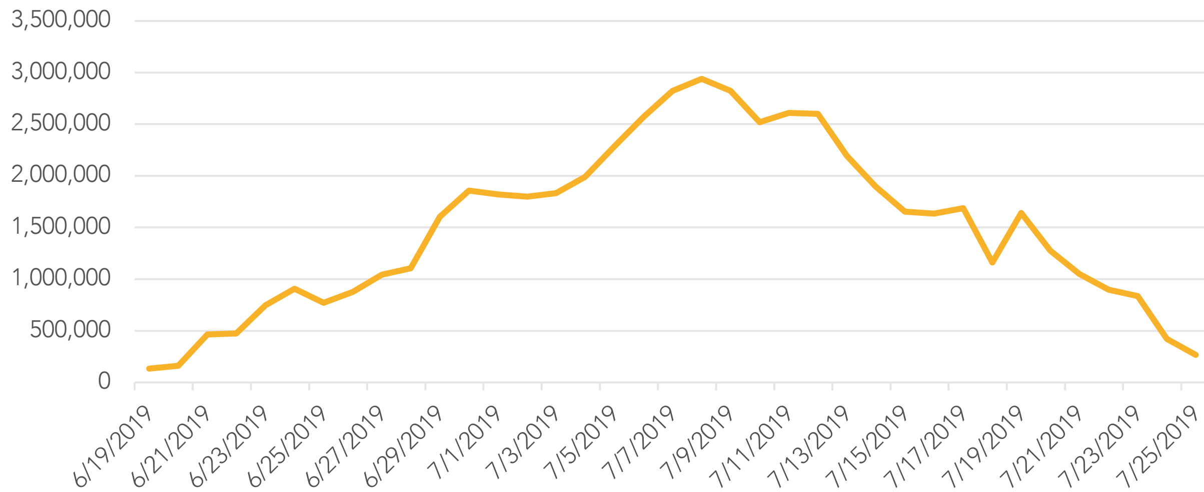
	2019
Commercial Catch	44.5
Escapement	14.1
Total Run Size	58.6

Source: ADF&G 2019 preliminary season summary reports.
Notes: Subsistence and Sport Harvest data are not included, due to different fish accounting systems. These are preliminary season estimates.

Of the total run, more than half was harvested or escaped into river systems in just 12 days, between July 3 and July 14, 2019. Peak harvest and escapement in 2019 occurred on July 8, when 2.6 million fish were harvested and an additional 386,000 escaped into river systems.

[14] Fishery management and fish accounting is primarily driven by the commercial fishery, which accounts for the very great majority of harvest. Relatively small numbers of salmon taken in sport and subsistence fisheries are not accounted for in the metric of commercial cast and escapement, though nearly all sport fish and many subsistence fish are harvested up-river of the escapement enumerations.

Figure 4. Daily Run Counts, Including Commercial Harvest and Escapement, 2019 (number of fish)



Source: ADF&G Daily Run Summary
Note: Daily Run totals combine commercial harvest, escapement counts and in-river estimates.

Sockeye salmon account for most of the Bristol Bay salmon harvest, at 95% of the average harvest and 98% of average value over the last five years. While the commercial catch in some other parts of Alaska includes a significant contribution from hatchery production, the entirety of the Bristol Bay harvest is from wild, un-enhanced systems.

Sockeye typically command the second-highest price for fishermen of Alaska's five salmon species (after the prized but far more limited Chinook). Though less plentiful in numbers and pounds than pink salmon statewide, the higher per-pound price means sockeye represent approximately one-half to two-thirds of the total salmon harvest value in Alaska in recent years. Bristol Bay itself represents one-quarter to one-half of that statewide value.

The Bristol Bay salmon fishery, like all wild harvest fisheries, is subject to annual variation in abundance. Sockeye salmon returns in Bristol Bay have reached record levels in recent years. The 10-year run average, from 2010 to 2019, totaled 45.5 million sockeye, with a low in 2013 of 24.4 million fish. The 5-year average from 2015 to 2019 is more than 20% higher, at 57.5 million sockeye.

Table 11. Bristol Bay Sockeye Salmon Run, 2010-2019 (millions of fish)

	Sockeye Commercial Catch	Sockeye Escapement	Total Sockeye Run
2010	29.1	11.6	40.6
2011	22.1	8.5	30.6
2012	20.9	9.4	30.4
2013	15.4	8.7	24.4
2014	29.1	12.0	41.1
2015	36.7	22.4	58.8
2016	37.6	14.1	51.7
2017	38.8	18.8	57.6
2018	41.9	21.0	63.0
2019†	43.0	13.4	56.3
5-Year Average	39.6	17.9	57.5
10-Year Average	31.5	14.0	45.5

Source: ADF&G AMR.
*Subsistence and Sport Harvest data are not included due to different fish accounting systems.
†2019 data are preliminary.

In addition to historic peaks in volume, recent years have also brought record market pricing for the fishery. Prior to the COVID-19 pandemic, these peak market conditions combined to drive record total values for Bristol Bay salmon. The Bristol Bay commercial fishery produced an average 181 million pounds of fish over the 10-year period from 2010 to 2019. The average ex-vessel value of salmon for that time frame was approximately $215 million. The wholesale value of all commercial salmon in Bristol Bay averaged about $465 million from 2010 to 2019, with $450 million (about 97%) coming from sockeye salmon. In 2019, first wholesale value topped $700 million.

Per-pound value of salmon to fishermen also trended higher over this period. As a result, the ex-vessel value nearly doubled in the five years from 2015 to 2019, while the run size increase was a more modest 16%. This meant 200 million pounds yielded a value of $125 million in ex-vessel value in 2015, while 230 million pounds generated an ex-vessel value of $370 million in 2019.

Table 12. Ex-Vessel Value and Volume and First Wholesale Value of Bristol Bay Salmon, 2010-2019 (millions of pounds and dollars)

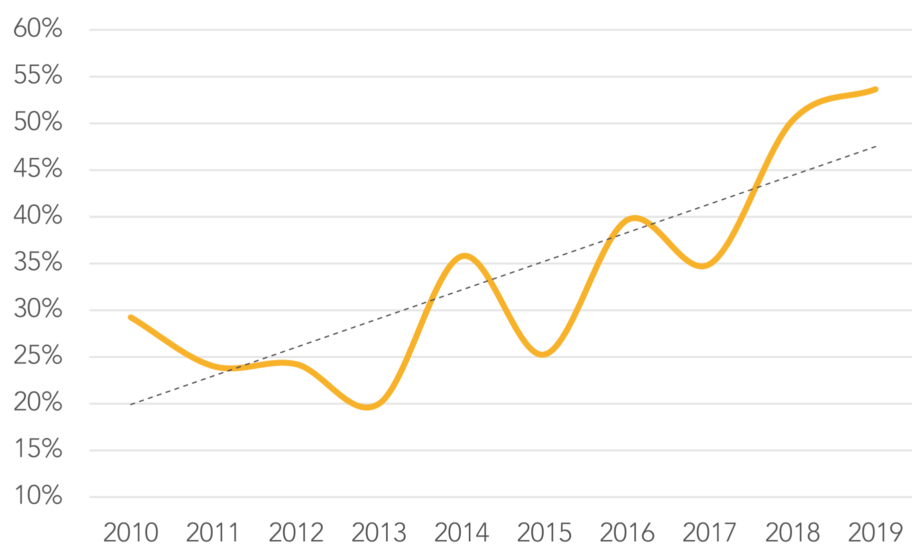
Year	Ex-Vessel Volume (lbs.)	Ex-Vessel Value	First Wholesale Value
2010	181.2	$165.2	$403.9
2011	139.7	$158.9	$363.5
2012	127.1	$142.7	$299.3
2013	100.6	$151.4	$323.0
2014	171.4	$221.5	$408.2
2015	199.7	$124.9	$381.5
2016	210.8	$192.4	$482.1
2017	219.4	$275.5	$563.5
2018	228.5	$349.6	$717.4
2019	232.4	$372.0	$709.9
5-Year Average	218.1	$262.9	$570.9
10-Year Average	181.1	$215.4	$465.2

Source: ADF&G COAR.

Contribution of Bristol Bay to the Total Alaska Salmon Industry

Bristol Bay's contribution to the total Alaska salmon industry increased markedly over the decade from 2010 to 2019. While noting that the relative contribution oscillates on a two-year cycle linked to pink salmon abundance elsewhere in the state, increasing harvest volumes and strong prices have combined overall to drive Bristol Bay's contribution from approximately 20% at the start of the decade, to over 50% in each of the last two years of the decade.

Figure 5. Bristol Bay Salmon Harvest Value as Percent of Alaska Total Salmon Harvest Value, 2010-2019



Source: ADF&G.

The significant contribution of Bristol Bay in overall salmon fishery value in Alaska also is apparent in the earnings of fishermen in many of Alaska's boroughs and census area, as noted later in this report.

Characteristics of the Fleet

Two types of salmon fishing operations are employed in Bristol Bay – driftnets and setnets. Driftnets are operated from self-contained boats, which have a regulatory length limit of 32 linear feet. Fishermen use hydraulics to reel the nets on and off a drum on board the vessel. Drift fishermen launch their boats at the start of the season or drive them to Bristol Bay from other regions of the state. Drifters typically remain on their boats for the duration of the season, going ashore only in unusual circumstances such as breakdowns. Their fish are delivered to larger boats, called tenders, that transport the catch to shoreside or floating processors.

Setnet operations are shore-based. Setnets are secured to shore at one end and are worked by hand by fishermen in skiffs. These fishermen typically spend the season in camps, cabins, or homes on land.

Both fisheries are subject to a regulatory structure that constrains total participation to a limited group of permitted harvesters.

Participation

About 2,500 commercial salmon permits were actively fished in Bristol Bay in 2019, representing almost 90% of total Bristol Bay permits. Half of all salmon permits in Bristol Bay are held by Alaska residents, with one-quarter held by Bristol Bay residents (half of all Alaska resident permit holders). Driftnet permit holders are more likely to reside outside Alaska (just over half of all driftnet permit holders). Only 17% of fished driftnet permits were held by Bristol Bay residents. One-third of setnet permit holders who actively fished are from the Bristol Bay region; two-thirds are Alaska residents.

About 8,500 total fishermen take part in the salmon harvest, a number that includes about 6,000 crew members (70% of total Bristol Bay fisherman). About half of all fishermen are Alaska residents, with half of those (or a quarter of all fishermen) residing in the Bristol Bay region.

Of the just over 230 million pounds of salmon harvested in 2019, just under half was captured by Alaska residents, including 15% harvested by fishermen from the Bristol Bay region.

Fishermen residing outside Alaska account for more than half of annual harvest volumes and value. In 2019, non-residents captured 56% ($191.8 million) of total value, with 44% ($150.7 million) going to Alaskans, including $49.7 million earned by Bristol Bay region residents. The driftnet fleet drives the bulk of production, with nearly 78% of the harvest in 2019, and the remaining 22% taken by the setnet fleet.

Table 13. Resident and Non-Resident Permit Ownership, Fishery Participation, and Ex-Vessel Value, 2019

	All Permit Holders	All Alaska Resident	Bristol Bay Resident	Other Alaska	Total Nonresident
Total Number of Bristol Bay Salmon Permits	2,827	1,477	663	814	1,350
Number of Permits Actively Fished	2,495	1,334	598	736	1,161
Driftnet Permits Actively Fished	1,605	744	274	470	861
Setnet Permits Actively Fished	890	590	324	266	300
Total Number of Estimated Fishermen	8,567	4,598	2,070	2,528	3,969
Estimated Number of Crew Members	6,072	3,264	1,472	1,792	2,808
Total Salmon Harvest Volume (millions of lbs.)	234.7	104.8	35.7	69.1	129.9
Driftnet Salmon Harvest Volume	183.8	73.8	20.0	53.8	110.0
Setnet Salmon Harvest Volume	50.9	31.0	15.7	15.3	19.9
Total Ex-Vessel Salmon Earnings ($million)	$342.5	150.7	$49.7	$101.1	$191.8
Driftnet Ex-Vessel Earnings	$272.0	108.1	$28.3	$79.8	$163.9
Setnet Ex-Vessel Earnings	$70.6	42.7	$21.4	$21.3	$27.9

Source: CFEC and McKinley Research Group estimates.
Note: There is a small discrepancy in reported ex-vessel value between ADF&G COAR reports and CFEC reporting.

Permit Ownership by Alaska Region

Alaskans from nearly every borough and census area are invested in Bristol Bay region fisheries, spreading the value of the fishery throughout the state. In 2019, 1,454 permits were held by residents of all but two boroughs/census areas. Ownership is concentrated in communities in the Bristol Bay watershed (including the Dillingham Census Area, Bristol Bay Borough, and Lake and Peninsula Borough), with 661 permits held by regional residents, and an average of nearly $47 million in ex-vessel earnings between 2017 and 2019. The Municipality of Anchorage follows, with 254 permits held in 2019 and ex-vessel earnings of $21 million. An additional 218 permit holders live In the Kenai Peninsula with earning of nearly $7 million. The fishing communities of the Kodiak Island Borough and Petersburg Census Area also have high concentrations of Bristol Bay permits (59 and 34, respectively), as does the Bethel Census Area at 38.

Table 14. Number of Bristol Bay Permit Holders, by Alaska Borough/Census Area, 2019 and 2017-2019 Averages

	2019	3-Year Average (2017-2019)	Ex-vessel Value, 3-Year Average (2017-2019*)
Aleutians East Borough	1	2	$120,506
Aleutians West Census Area	1	1	$146,324
Anchorage Municipality	254	250	$20,923,751
Bethel Census Area	38	39	$2,601,811
Bristol Bay Borough	149	151	$8,433,238
Denali Borough	2	2	$127,122
Dillingham Census Area	439	444	$33,802,178
Fairbanks North Star Borough	22	23	$2,170,884
Haines Borough	0	2	$244,236
Hoonah-Angoon Census Area	3	2	$146,324
Juneau City and Borough	17	16	$1,829,098
Kenai Peninsula Borough	218	207	$27,882,437
Ketchikan Gateway Borough	6	7	$589,192
Kodiak Island Borough	59	56	$7,921,085
Kusilvak Census Area	2	3	-
Lake and Peninsula Borough	73	78	$4,577,444
Matanuska-Susitna Borough	98	97	$11,879,217
Nome Census Area	0	1	-
North Slope Borough	1	1	$46,059
Northwest Arctic Borough	1	1	$188,459
Petersburg Census Area	34	33	$5,390,665
Prince of Wales-Hyder Census Area	4	5	$438,973
Sitka City and Borough	8	8	$647,577
Southeast Fairbanks Census Area	7	5	$484,607
Valdez-Cordova Census Area	15	18	$3,036,035
Wrangell City and Borough	1	1	$188,459
Yukon-Koyukuk Census Area	1	1	-
All Alaska Resident Permit Holders	1,454	1,455	$133,815,684

Source: CFEC.
Notes: Permit ownership reveals investment in the Bristol Bay fishery does not necessarily equate to fishery participation in any given year. Approximately 10% of all Bristol Bay permits were inactive in 2019.
* 2019 ex-vessel values are preliminary.

The relatively high value of the sockeye fishery also means that Bristol Bay contributes meaningfully to total fishing earnings in many Alaska communities – even those with abundant local fisheries. For example, Bristol Bay earnings represented one-third of all salmon earnings in the Kenai Peninsula Borough in 2019, and more than one-fifth of all salmon-related earnings in the Kodiak Island Borough. In the Municipality of Anchorage, "Alaska's largest fishing town," Bristol Bay earnings represented more than one-third of fishery earnings in the region, including 56% of all salmon-related earnings.

Table 15. Bristol Bay Salmon Contribution to Fishery Earnings in Selected Alaska Boroughs and Census Areas, 2019

	Bristol Bay as a Percentage of All Salmon Earnings	Bristol Bay as a Percentage of All Fishery Earnings
Anchorage Municipality	56%	34%
Kenai Peninsula Borough	33%	24%
Kodiak Island Borough	22%	8%
Petersburg Census Area	27%	10%

Source: CFEC

Alaska residents living outside the Bristol Bay region tend to capture a greater share of the total harvest and value than residents living within the region. The 55% of Alaska permits held by residents outside the region captured 67% of total Alaska resident earnings in 2019.

Ownership and Participation within the Bristol Bay Region

Of all permits held by Alaskans in 2019, 45% were held by residents of the Bristol Bay region. In 2019, about 30% of held and fished Bristol Bay salmon permits in Alaska belonged to residents of Dillingham, earning 22% of ex-vessel value. One tenth of permit holders hail from Bristol Bay Borough, earning 8% of ex-vessel earnings in Alaska. The remainder, about 4% of actively fished permits, are owned to residents of Bristol Bay communities within the Lake and Peninsula Borough, at about 3% of ex-vessel earnings.

Table 16. Permit Ownership, Fishery Participation and Earnings by Bristol Bay Region and Other Alaska Residents, 2019

	Number of Permits Held	Number of Permits Fished	Ex-vessel Earnings ($million)
Dillingham Census Area	442	411	$33.5
Bristol Bay Borough	149	129	$11.7
Lake and Peninsula Borough communities in the Bristol Bay region	72	58	$4.4
Alaska, other than Bristol Bay region	814	736	$101.1
Total	1,477	1,334	$150.7

Source: CFEC

Fishery Participation Beyond Alaska

Participants in Bristol Bay fisheries come from around the United States. Permit holders are particularly concentrated in Washington State, with 657 (26%) actively fished permits held by residents of the state in 2019. Washington permit holders earned more than $117 million in ex-vessel value in 2019. Residents of Oregon and California fished another 9% of active Bristol Bay permits in 2019 and earned over $34 million collectively.

Table 17. Permit Ownership, Fishery Participation and Earnings by non-Alaska Residents, 2019

	Number of Permits Held	Number of Permits Fished	Ex-vessel Earnings ($million)
Washington	761	657	$117.5
Oregon	124	110	$16.9
California	132	126	$17.8
Other states and countries	349	329	$45.3
Total	1,366	1,222	$197.5

Source: CFEC

Permits as Assets

Limited entry permits for Bristol Bay salmon are a valuable asset base for commercial harvesters. Permits are bought and sold in the marketplace. Possession of a permit is a requirement for fishery participation and has been since the early 1970s when the limited entry system was enacted by the Legislature.

Limited entry permits for Bristol Bay include driftnet permits and setnet permits. Driftnet permits make up the majority (86%) of the total assets value of limited entry permits in Bristol Bay, worth almost $326 million in 2019. Setnet permits were worth almost $53 million, or about 14% of the total value.

Alaska residents held just under half of Bristol Bay drift permit assets, with a value of over $147 million; Bristol Bay residents held 39% of Alaska-held driftnet assets (and 18% of all driftnet permits). The majority of setnet permit values are held by Alaska residents, at 65% of total setnet permit asset value in 2019. Of these Alaska-held setnet assets, more than half (53%) were owned by Bristol Bay residents (34% of all setnet asset value).

Table 18. Value of Permit Ownership by Residency, 2019

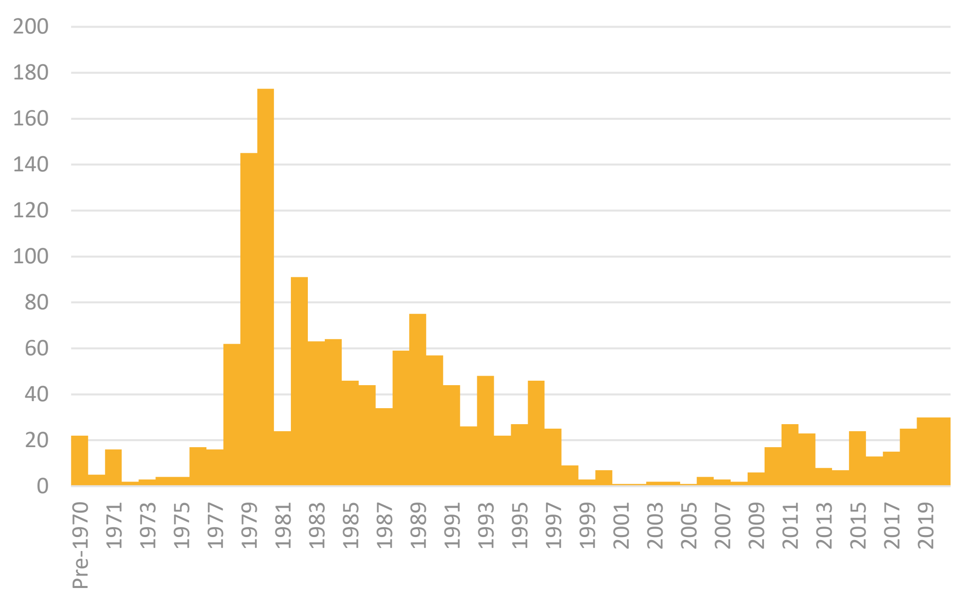
Residency	Driftnet Permit Value ($million)	% of Total Driftnet Permit Value	Setnet Permit Value ($million)	% of Total Setnet Permit Value	Total ($million)	% of Total Permit Value
All Limited Entry Permits	$325.9		$52.7		$378.5	
Alaska	$147.4	46%	$34.6	65%	$182.1	48%
Dillingham Census Area	$41.5	13%	$11.2	21%	$52.7	14%
Bristol Bay Borough	$10.0	3%	$5.0	9%	$15.0	4%
Lake and Peninsula Borough communities in the Bristol Bay drainage	$5.4	2%	$2.2	4%	$7.7	2%
Other Alaska	$90.5	28%	$16.2	31%	$106.7	28%
Nonresident	$178.5	55%	$18.0	34%	$196.5	52%

Source: CFEC

Commercial Fishing Fleet

Commercial fishing boats are another significant source of value in the Bristol Bay sockeye fishery. Over 1,500 drift gillnet boats are registered to fish in Bristol Bay. Most were built in the late 1970's and 1980's following Bristol Bay's designation as a limited entry fishery in 1975. A 2017 estimate placed the total value of Bristol Bay fishing vessels at $228 million[15], though approximately 100 new drift gillnet boats registered in Bristol Bay were reported built in the last four years. Boats can cost anywhere from $500,000 to $900,000 to build and represent a significant annual investment in the fishery.

Figure 6. Year of Build of the Bristol Bay Drift Gillnet Fleet



Source: Commercial Fisheries Entry Commission

[15] Wink Research & Consulting, "Economic Benefits of the Bristol Bay Salmon Industry," July 2018.

Regulations limit the size of Bristol Bay boats to 32 linear feet. As a result, the bulk of the Bristol Bay fleet is designed specifically for this fishery. Most of these vessels only fish in Bristol Bay and would have limited value in a different fishery or for other uses.

In addition to harvesting vessels, a large tender fleet supports the Bristol Bay fishery. Tenders transport salmon from the fishing grounds to processors, whether shoreside or floating. While a portion of the total tender fleet strictly limit their annual activity to the Bristol Bay region, others are used throughout the state in numerous fisheries each year. Estimates of tender value are not included in this report.

Seafood Processing Activity and Impacts

The number of Bristol Bay commercial operators purchasing salmon has grown over the last 20 years, with 33 operators reporting they purchased Bristol Bay sockeye in 2019, up from 26 in 2000. This count includes both on-shore and off-shore processers. Much of this growth is attributable to growth of new, small scale operations that depend on direct marketing of Bristol Bay sockeye.

In 2020, 26 shore-based seafood processing plants operated in Bristol Bay. These plants are located in seven different communities, with over 40% in Naknek. Of these 26 processors, ADF&G reports that the 15 largest account for 99.8% of the Bristol Bay sockeye salmon purchased in 2018. Together, Bristol Bay processors have capacity to process 2.54 million sockeye per day.[16] This is a 26% increase in the processing capacity reported in 2011[17].In addition to growth in both the number and capacity of Bristol Bay processors, additional investment has been made in existing processing facilities to produce higher value products and operate more efficiently.

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[16] https://www.adfg.alaska.gov/FedAidPDFs/SP19-08.pdf
[17] https://www.adfg.alaska.gov/static/fishing/PDFs/commercial/2011_bristolbay_sockeye_capacity.pdf

The remoteness of Bristol Bay and compressed timing of the massive salmon run mean that fish need to be processed quickly, and close to where they are caught, for maximum quality. It takes over 6,000 processing workers to produce 157 million pounds of processed salmon during a typical season. These workers earn an estimated $49 million in wages (5-year average) in this short time frame, and in turn process over half a billion dollars in salmon (at wholesale prices).

Table 19. First Wholesale Volume and Value of Bristol Bay Salmon, All Species, 2015–2019

	2015	2016	2017	2018	2019	Average
Volume (million lbs.)	141.5	148.0	150.8	167.0	177.6	156.9
Value ($million)	$381.5	$482.1	$563.5	$717.4	$709.9	$570.9

Source: ADF&G COAR

Product composition in Bristol Bay changed significantly in recent years as the processing fleet continued to invest and retool for greater headed/gutted (H&G) and fillet production, replacing a long-running reliance on canned production. Considering sockeye production only, canned salmon totaled more than 20% of total Bristol Bay production in 2015. That proportion fell to only 8% in 2019 despite a far larger harvest. H&G and fillet, together, represented 89% of Bristol Bay production in 2019.

Table 20. First Wholesale Volume of Bristol Bay Sockeye Products, by Form, 2015–2019

	2015	2016	2017	2018	2019	Average
Volume (million lbs.)	133.1	135.3	131.0	140.6	145.9	137.2
Headed/Gutted*	86.8	85.9	86.5	94.6	105.4	91.9
Canned	28.4	23.1	16.7	12.2	11.1	18.3
Fillets	13.3	21.0	23.2	29.0	24.3	22.2
Roe**	4.5	5.2	4.6	5.0	5.1	4.9
Volume by Percent						
Headed/Gutted*	65%	64%	66%	67%	72%	67%
Canned	21%	17%	13%	9%	8%	13%
Fillets	10%	16%	18%	21%	17%	16%
Roe**	3%	4%	4%	4%	3%	4%

Source: ADF&G COAR
*Includes Fresh and Frozen
**Roe includes roe bait, ikuro and sujiko.

Despite its preponderance in production volumes, H&G fish have a smaller proportion of the pack value. In 2019, H&G fish yielded 59% of total value, while fillets commanded a greater value relative to their proportion of the pack, at 28% of total value.

Table 21. First Wholesale Value of Bristol Bay Sockeye Products, by Type, 2015–2019

	2015	2016	2017	2018	2019	Average
Value ($ millions)	$371.5	$462.3	$527.8	$669.3	$656.7	$537.5
Headed/Gutted	$191.2	$243.7	$286.0	$367.6	$384.4	$294.6
Canned	$94.9	$78.6	$67.8	$69.0	$66.8	$75.4
Fillets	$68.6	$113.2	$144.0	$193.4	$181.0	$140.1
Roe**	$16.7	$26.8	$30.1	$39.4	$24.5	$27.5
Value by Percent						
Headed/Gutted*	51%	53%	54%	55%	59%	55%
Canned	26%	17%	13%	10%	10%	14%
Fillets	18%	24%	27%	29%	28%	26%
Roe**	5%	6%	6%	6%	4%	5%

Source: ADF&G COAR
*Includes Fresh and Frozen
**Roe includes roe bait, ikuro and sujiko

Workforce

The seafood processing workforce is scaled to match harvest volume. Processing labor is a significant portion of the overall cost of production and sizing the workforce to the actual run is critical to processor profitability.

Data on wages and residency of the seafood processing workforce show that more than 6,000 processing workers earned $58 million in total wages in Bristol Bay fisheries in 2019. This was higher than the 5-year average (2015-2019) of $49 million.

The processing workforce draws almost entirely from outside the Bristol Bay watershed. In fact, the 2019 processing workforce equated roughly to the combined populations of the Dillingham Census Area and Bristol Bay Borough. However, the approximately 100 local residents employed in the processing workforce in 2019 earned more than $800,000 combined.

Table 22. Seafood Processing Workforce, Totals and Local Resident, 2015 – 2019

Year	Total Processing Workers	Local Processing Workers	Percent Local	Total Wages	Local Wages	Local Wages Percent
2015	4,840	85	1.8	$39,481,050	505,828	1.3
2016	5,471	75	1.4	$45,699,854	504,542	1.1
2017	5,422	76	1.4	$46,284,981	637,367	1.4
2018	5,933	102	1.7	$55,852,313	802,504	1.4
2019	6,036	103	1.7	$57,693,133	807,382	1.4
5-Year Average	5,540	88	1.6	$49,002,266	651,525	1.3

Source: ADOLWD and McKinley Research Group estimates.
*Claimed residency in a Borough or Census Area within the Bristol Bay Region.

Most Bristol Bay salmon processing happens in the Bristol Bay Borough, where two-thirds of the region's processing workforce earned $30 million in wages in 2018 (the most recent year for which complete data are available). Of these workers, 20% had five or more years of experience, and 12% were Alaska residents.

Nonresident workers earned $55 million in wages in 2018, about 90% of wages in each area of the Bristol Bay region.

Just under 20% of processors worked in the Dillingham Census area, and 15% of these workers were residents. These workers earned $10.7 million in wages in 2018 (19% of total); about 16% of them had five or more years of experience.

Most processing workers in the Lake and Peninsula Borough are nonresident workers (94% in 2018), though they only make up about 7% of the processing workforce in the region. Of these workers, 20% had five or more years experience, and earned about 8% of total processing wages in 2018.

Table 23. Processing Workers in Bristol Bay Region, 2018

Borough or Census Area	Processing Workers	Percent Nonresident Workers	Processing Wages	Percent Nonresident Wages	Workers with 5+ Years Processing Experience	Average Quarterly Wage
Bristol Bay Borough	3,906	88%	$30,714,913	91%	767	$6,308
Dillingham Census Area	1,096	85%	$10,691,309	90%	178	$6,022
Lake and Peninsula Borough*	434	94%	$4,878,759	92%	88	$5,647
Bristol Bay Total	**5,933**	**86.7%**	**$55,852,313**	**89.5%**	**1,027**	**$6,193**

Source: Alaska Department of Labor and Workforce Development, Research and Analysis Section, Nonresidents Working in Alaska 2018 report.
*Includes all communities in Lake and Pen Borough, some of which lie outside the study region.
Note: Workers are being counted in any borough or census area where they worked in 2018. Therefore, the number of processing workers in each borough or census area will not sum to the total since some workers work in more than one borough or census area during any given year.

Support Industries

In addition to fishermen and processing plant workers, a significant number of skilled tradespeople and industry support service providers mobilize to the Bristol Bay region each summer. The diverse nature of these businesses and the widespread distribution of their "home" states requires intensive investigation of support activity on a state-by-state basis and is beyond the scope of this research. However, a census of the kinds of businesses and skilled tradespeople that operate seasonally in Bristol Bay includes:

- Air taxi/floatplane services
- Expeditors
- Refrigeration technicians
- Welders and parts fabricators
- Machinists
- Diesel mechanics

- Fiberglass specialists
- Net builders
- Marine surveyors
- Small engine repair technicians

Bristol Bay Salmon: Supply Chain Activity

The Bristol Bay salmon season is a complex web of activity starting well before salmon begin to return to their natal rivers, and extending far beyond the harvest of the season's last fish.

For both harvesters and processors, the work of preparing for the season's fishery starts months prior to its start. The logistical demands of getting supplies, equipment and people to Bristol Bay are significant, and require lead time and detailed planning. For processors, material inputs (such as cans, boxes, and other packing materials) as well as supplies needed to keep equipment and facilities in good condition must all be ordered many months prior to the fishery. Hiring also begins in winter months.

For fishermen, pre-season work can happen in various locations, depending on where boats and gear are stored between seasons. Pre-season preparations can also include Spring trips to the Bristol Bay region to prep boats, and skilled tradespeople often deploy to Bristol Bay well in advance of the actual fishing season.

Equipment, supplies, groceries, fuel, and other necessary inputs are all shipped to Bristol Bay in the months preceding the fishery. A variety of commercial shippers bring resources to the region's ports. Tenders sometimes carry additional freight as they deploy to Bristol Bay in advance of the season.

In the weeks preceding the fishery, the 6,000 processing workers and more than 8,000 commercial fishermen deploy to the region. There are several weeks of intense activity as boats are launched, shoreside setnet camps are opened up, and other support infrastructure is put in place. Tenders travel to the region from elsewhere in Alaska or the Pacific Northwest.

The waters of Bristol Bay quickly fill with vessels of all sorts. Fuel barges and ice barges arrive or are launched in advance of the season. As the season begins and fishing activity commences, large transoceanic tramper vessels arrive and anchor offshore, waiting to be loaded with containers of processed salmon for transport overseas. Domestic shippers also carry containers of processed fish south, primarily to Puget Sound.

Bristol Bay salmon receive primary processing at the facilities in the Bristol Bay region, but secondary processing and value-adding occurs at a network of facilities around the globe. Significant secondary processing infrastructure for Alaska seafood products is in China and other east Asian countries. Value-added processors in the Pacific Northwest also do secondary processing, particularly for North American markets. Salmon may be minimally processed and sold in a fillet or portion fillet form in grocery stores; or it may go into more value-added chains, emerging in ready-to-eat meals, packaged products, or under specialty labels.

Whatever the form, Bristol Bay salmon pass through a distribution network that brings them to the point of consumption, whether via a restaurant, retailer, or directly to the consumer.

Wild salmon is inextricably linked with Bristol Bay's tourism industry. The most obvious connection is through sportfishing, which draws tens of thousands of visitors from around the globe every year, along with millions of new dollars to the regional economy. In addition to directly fishing for salmon and trout, visitors also come to the region to view bears that congregate to feed on migrating salmon. This section provides an overview of the region's visitor industry and an estimate of associated spending.

Visitor Volume and Profile

Total annual visitor volume to the Bristol Bay region is estimated at 40,000 to 50,000 people. The most common purposes of people's trips are either overnight sportfishing, often at a lodge or camp, or day trips to see bears feeding on salmon. Estimates of total visitor volume and activities are based on past McKinley Research Group (formerly McDowell Group) research, including visitor research conducted for the State of Alaska in the summer of 2016, adjusted to reflect 2019 visitor traffic levels.[18]

Characteristics of Bristol Bay visitors are presented in the table on the following page, based on the 2016 study, which included a statewide survey of Alaska visitors. This profile includes visitors to the following communities and destinations: Brooks Camp, Brooks Falls, Dillingham, Ekwok, Iguigig, Iliamna, Katmai, King Salmon, Lake Aleknagik, Lake Clark, Naknek, Nondalton, Nushagak River, Port Alsworth, Port Heiden, Rainbow Basin, and Togiak.

- Two-thirds of visitors (65%) traveled for vacation/pleasure; 14% to visit friends or relatives; and 22% for business-related reasons.
- The most popular visitor activity in the region was wildlife viewing (59%) followed by fishing (49%) (33% guided fishing plus 19% unguided). Other common activities were hiking (25%), flightseeing (18%), camping (17%), and hunting (10%).
- Among these visitors, the most common region of origin was the Western U.S. at 42%, followed by Midwest at 20%, South at 14%, and East at 8%. Fifteen percent of visitors were international travelers.
- Bristol Bay visitors spent an average $1,861 per person while in the region. The bulk of this spending was attributable to lodge packages at $1,482 per person.
- Visitors reported an average age of 50 years old. They were more likely to be male than female (57% versus 43%). Average party size was 1.9 people, and average household income was $121,000.

[18] Data comes from the McDowell Group Alaska Visitor Statistics Program 7, published in May 2017. This proprietary research product is produced by McDowell Group, now known as McKinley Research Group.

Table 24. Bristol Bay Visitor Profile, Summer 2016

	% of Visitors
Trip purpose	
Vacation/pleasure	65%
Visiting friends/relatives	14%
Business	12%
Business/pleasure	10%
Top activities in Bristol Bay region	
Wildlife viewing	59%
Fishing	49%
Guided fishing	33%
Unguided fishing	19%
Hiking/nature walk	25%
Flightseeing	18%
Camping	17%
Hunting	10%
Average per-person spending in Bristol Bay region	
Lodge packages	$1,482
Tours/activities/entertainment	$114
Rental cars/fuel/transportation	$98
Food/beverage	$78
Lodging	$61
Total	**$1,861**
Region of Origin	
Western U.S	42%
Midwestern U.S.	20%
Southern U.S.	14%
Eastern U.S.	8%
International	15%
Demographics	
Average age	50 years old
Male/female ratio	57%/43%
Average party size	1.9 people
Average household income	$121,000

Source: McDowell Group Alaska Visitor Statistics Program 7, published in May 2017.

Sportfishing

The Bristol Bay region is a world-famous sportfishing destination, where anglers target all five species of Pacific salmon, as well as rainbow trout and Dolly Varden (which feed on salmon flesh and eggs). Visiting Bristol Bay anglers generally stay in all-inclusive lodges and fish camps, often only accessible by floatplane or boat. Due to remoteness and high transportation costs, most stays are five to seven days in length.

The trout fishing season starts in early June, before large volumes of salmon have entered areas rivers. From mid-June to mid-July, Chinook salmon return to the rivers to spawn. The Chinook run is followed by the massive sockeye salmon run in late June through early August. It is not uncommon for anglers to easily catch their daily limit of five sockeye per day early in the morning and spend the afternoons targeting trout. The sockeye run is followed by a coho salmon run in August.

While Bristol Bay salmon provide directed fisheries, their seasonal rhythm also impacts fall sportfishing activity. Spawning sockeye fill rivers with hundreds of millions of eggs and – after their deaths – their flesh. This creates a concentrated feeding opportunity for rainbow trout, many of the larger of which leave the lakes for the rivers to feed. Many lodges advertise this time as their "trophy season" with trout commonly over 30 inches in length.

Volume and Location of Anglers

Over the past five years, more than 20,000 anglers sportfished in Bristol Bay annually, representing more than 73,000 angler days. A similar number of anglers fished the three areas of Kvichak (6,249 anglers), Nushagak (6,912), and Alaska Peninsula (7,499), though some anglers may have fished in multiple areas.[19]

Table 25. Bristol Bay Sportfishing, Average Number of Annual Anglers, and Angler Days, 2015-2019

Sub-Area	# of Anglers	# of Angler Days
Kvichak	6,249	22,593
Nushagak	6,912	29,459
Alaska Peninsula (Bristol Bay drainage)	7,499	21,400
Total	20,660	73,452

Source: AF&G Alaska Sport Fishing Survey.
Note: Some anglers fish in multiple regions.

[19] Alaska Sport Fishing Survey database. Anchorage, AK: Alaska Department of Fish and Game, Division of Sport Fish (cited November 25, 2020). Available from: http://www.adfg.alaska.gov/sf/sportfishingsurvey/.

Though the program is now discontinued, the most recent 3-year data from the ADF&G freshwater guided harvest logbook program (2014-2016) showed a trend of steady year-over-year increases in guided angler days in the Bristol Bay region, with a 5% total increase over the period.

Sportfishing Species

Bristol Bay sportfishermen take about 46,000 salmon annually, primarily coho (37%), sockeye (36%), and Chinook (22%). Chum and pink make up just 4% and 1% of the total harvest, respectively.

Table 26. Salmon Sportfishing in the Bristol Bay Region, Average Annual Number of Fish by Species, 2010-2019

	# of Fish	% of Total
Coho	16,931	37%
Sockeye	16,745	36%
Chinook	10,094	22%
Chum	1,679	4%
Pink	497	1%
Total	**45,946**	**100%**

Source: AF&G Alaska Sport Fishing Survey.

A smaller portion of trout are harvested in the region, accounting for around 3,000 fish annually. (Note that trout are frequently released after catching so harvest figures underrepresent the total targeted.) Most harvested trout are Dolly Varden or Arctic char, at 58% of the total. Lake trout make up about 18%, and rainbow trout about one-quarter (24%).

Table 27. Trout Sportfishing in the Bristol Bay Region, Average Annual Number of Fish by Species, 2010-2019

	# of Fish	% of Total
Dolly Varden/Arctic Char	1,852	58%
Rainbow trout	763	24%
Lake trout	588	18%
Total	**3,203**	**100%**

Source: AF&G Alaska Sport Fishing Survey.

Sportfishing Lodges and Other Providers

Photo courtesy of Bob Waldrop

Lodge and fish camp spending constitutes the bulk of sportfishing economic activity in the Bristol Bay region, with most spending generated by non-residents. A 2005 study found that while non-residents accounted for only about 35% of total sportfishing trips, they accounted for almost 80% of sportfish spending, and that most non-resident spending was for trips to lodges and fish camps.[20]

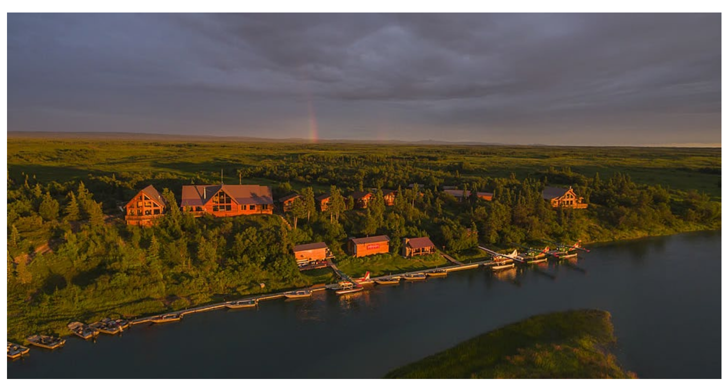
Of the approximately 90 sportfishing lodges and fish camps in the Bristol Bay region, spread from Togiak to the Alaska Peninsula, the majority are full-service providers. Providers range from simple tent camps on the side of the river to luxury lodges. They typically offer four-to-eight-day trips that include lodging, guided fishing, and meals. Many lodges and fish camps are remote and require air service from Bristol Bay communities. Sportfish providers either include flights as part of their package or help coordinate flights at an additional cost.

A 2019 analysis of sportfish providers in the region collected detailed information from 33 providers. Average annual revenues for the providers totaled $1.1 million each. Average guest capacity totaled 14; daily rates averaged $1,125; and operating season averaged 105 days. Total annual sportfishing lodge/camp guests are estimated at 14,000 annually, with total spending estimated at $77 million.

Lodging Experiences

The following lodges showcase the range of visitor experiences, rates, and offerings for visitors to the Bristol Bay area.

Alaska Sportsman's Lodge



Source: Alaska Sportsmen's Lodge.

The Alaska Sportsman's Lodge is a luxury fishing lodge located on the Kvichak River, four miles from Lake Iliamna.[21] The lodge accommodates up to 20 guests. The property includes a 3,500-square foot main lodge plus four cabins. Guests fish for salmon (Chinook, sockeye, and coho), rainbow trout, and Arctic char. The lodge offers both on-site and fly-out

[20] https://www.epa.gov/sites/production/files/2015-05/documents/bristol_bay_assessment_final_2014_vol3.pdf
[21] https://www.fishasl.com/kvichak

fishing in addition to river float trips and bear viewing. Amenities include five-star dining, massage services, and a sauna. Rates range from $1,700 (per person, per night) for a seven-night package, to $2,000 for a three-night package. All packages include a private charter flight from Anchorage. The lodge operates from early June to early October.

Enchanted Lake Lodge

Enchanted Lake Lodge is primarily a fly-fishing lodge, located on 54 acres of private land in Katmai National Park, on Nonvianuk Lake. The lodge consists of a main building plus six cabins, with capacity for 12 guests. While services focus on rainbow trout, guests also fish for Arctic char, Dolly Varden, grayling, and salmon. Guests primarily access fishing areas via floatplane. The lodge offers a seven-night package at $1,700 per person, per night. All packages include a flight to and from King Salmon. The lodge operates from early June through September.

Source: TripAdvisor.

Alagnak Lodge

Alagnak Lodge is located on the Alagnak River, 25 miles north of King Salmon.[22] The lodge offers 12 guestrooms of various sizes (there are no cabins). Guests fish primarily for salmon, and generally access fishing areas via boat (rather than floatplane). The lodge charges a base rate of $750 plus $750 per day. Guests can choose their length of stay. A seven-day stay costs $6,000, or about $850 per day, while four days costs $3,750, or about $940 per day. Packages include floatplane transport from King Salmon. Guests must pay extra for fly-outs.

Source: Alagnak Lodge.

[22] Alagnaklodge.com

Anderson's Outdoors Alaska Salmon Camp


Source: Alaska Salmon Camp.

The Alaska Salmon Camp is located below the East and West forks of the Nushagak River.[23] It consists of four, two-person cabins, a dining tent, and a shower facility. Guests fish for Chinook, sockeye, and chum salmon. The camp has several motorboats; fly-out fishing is not available. Rates are $700 per-person, per-night for a five-night package and $750 for a four-night package. All packages include floatplane transport to and from Dillingham. The camp operates from mid-June to mid-July.

Bear Viewing

Bear viewing in the Bristol Bay study area is concentrated in two areas: Katmai National Park and Lake Clark National Park and Preserve. An estimated 20,000 people participated in bear viewing at these two locations in 2019.[24]

Katmai National Park

Katmai National Park, located approximately 270 air miles southwest of Anchorage, is one of Alaska's premier bear viewing destinations. Bear viewing visitors are mostly concentrated near the mouth of the Brooks River, although they also view bears in more remote areas including Hallo Bay and Kulik River. Bear viewing occurs throughout the summer, with visitation peaking in July.

The bulk of bear viewing visitors to Katmai are on day trips from Anchorage. Those that overnight in the park have three options: staying at Brooks Lodge, which offers overnight packages; tent camping at a campground near the lodge; or backcountry camping. Katmai bear viewers spent an estimated $20 million combined on visits in 2019, including on lodging, camping, meals, tours, and air transportation.

Lake Clark National Park and Preserve

Lake Clark National Park and Preserve contains several world-class bear-viewing areas: Chinitna Bay, Crescent Lake, and Silver Salmon Creek. There are no lodging facilities located in the area, so most visits occur for the day from Anchorage, Homer, or area lodges. A small number of visitors participate in overnight camping, many on guided photography and wildlife tours. The National Park Service estimates about 8,000 bear viewing visitor-days in Lake Clark in 2019.

[23] https://andersonsoutdoors.com/
[24] National Park Service data and McKinley Research Group estimates.

Bear Viewing Experiences

The following sampling of bear viewing companies in the Bristol Bay area provides a range of costs and visitor experiences.

Brooks Lodge

Source: Brooks Lodge.

Brooks Lodge is a unique property in Alaska, offering lodging within walking distance of one of the world's premier bear viewing destinations.[25] According to the lodge's website, as many as 50 bears live along the adjacent 1.5-mile stretch of the Brooks River during salmon season. The property includes a main lodge plus 16 cabins with four bunk beds each, for a total capacity of 64 guests. In addition to offering bear viewing from elevated platforms, the lodge offers canoeing, kayaking, sportfishing (guided fly-out or unguided in the immediate area), and flightseeing and bus tours to the Valley of Ten Thousand Smokes, 22 miles away. Rooms cost $850 per night for one to four guests; meals and tours are not included. The lodge is open June 1 to September 18.

Regal Air

Source: Regal Air.

Regal Air operates day-long bear viewing tours from Anchorage to both Katmai National Park and Lake Clark National Park and Preserve.[26] Their Katmai tour lasts 10 hours, including 2.5 hours of flight time each way, and lands at either Brooks Lake or Naknek Lake. Flight capacity is five to nine passengers. The cost is $940 per person. The tour is offered June 20 to late September (depending on bear activity). The Lake Clark tour lasts 6.5 hours, including 75 minutes of flight time each way, and lands at either Chinitna Bay or Silver Salmon Creek. Flight capacity is five passengers. The cost is $795 per person. The tour is offered May 10 to mid-September. Each tour includes flightseeing, lunch, and guided bear viewing.

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[25] https://katmailand.com/

[26] https://regal-air.com/alaska-shore-excursions/alaska-bear-viewing/

AK Adventures

AK Adventures operates bear viewing tours out of Homer to Katmai National Park.[27] Standard day tours costs $875 per person and last eight hours, including the 1-hour flight each way to Katmai. A nine-hour tour geared specifically for photographers is also available. Multi-day bear viewing packages are offered at $850 per person, per night, with a two-night minimum; guests sleep in tents on-site. Tours operate June through August.

Source: AK Adventures.

Alaska Bear Adventures

Alaska Bear Adventures operates out of Homer and offers bear viewing to both Katmai and Lake Clark.[28] They offer several day trip options, varying in length from four to 10 hours, and ranging in price from $600 to $900 per person depending on length and group size. The price includes flightseeing, lunch, and guide services. They also offer custom multi-day packages.

Source: Alaska Bear Adventures.

[27] https://goseebears.com
[28] https://alaskabearviewing.com/

Economic Impacts of Bristol Bay Salmon

This report provides a range of data and information illustrating the economic impact of Bristol Bay salmon. These measures of industry – in seafood and tourism – plus the critical role of salmon to regional subsistence activity together clearly indicate Bristol Bay salmon are a major economic force. However, a complete picture of economic impacts requires analysis of direct, indirect, and induced impacts, i.e., the multiplier effects. Multiplier effects are defined as follows:

- **Direct impacts** include the jobs and income earned in commercial fishing, seafood processing, and visitor industry services in Bristol Bay.
- **Indirect impacts** are jobs and payroll generated in support sectors as Bristol Bay fishermen, seafood processors, and visitor industry businesses (mainly lodge operators) purchase a broad range of goods and services in support of their operations. These impacts spread across the region, the state and the nation.
- **Induced impacts** are generated as fishermen, processing workers, and visitor industry workers spend their wages in support of their personal and household needs. This spending flows widely throughout the service and support sector.

In this analysis, economic impacts are presented in terms of employment, labor income (net income earned by fishermen and wages earned by processing sector workers and visitor industry workers), and economic output, a measure of total economic activity. Multiplier effects occur at local, regional, statewide, and national levels.

Figure 7. Key Drivers of Economic Impacts of Bristol Bay Salmon

- **Commercial fisheries** with total **ex-vessel value at $372 million** and total **first wholesale value of $710 million** in 2019.
- **8,600 fishermen participating** in Bristol Bay commercial fisheries, including permit holders and crew. Participation includes an estimated **4,600 Alaskans and 4,000 non-residents**.
- Commercial fishery **limited entry permit values totaling $379 million**, including $326 million for driftnet permits and $53 million for setnet permits.
- **6,000 workers employed in seafood processing** in Bristol Bay, with total **annual wages of $56 million**.
- **Tens of thousands of visitors traveling to the region** annually to experience the region's rich natural resources, mainly for sport fishing and bear viewing and approximately **100 lodges** or other sport fishing operations.
- **$82 million in total annual spending by visitors** to the Bristol Bay region, supporting lodges, transportation providers, and other businesses.

National and Regional Impacts of the Seafood Industry

Most jobs associated with the Alaska seafood industry are connected to commercial fishing, processing, or other direct support sectors. Employment related to grocers and restaurants selling Alaska seafood (of all types) only accounts for about one third of the total direct employment created by the industry. Since most jobs associated with the Alaska seafood industry are related to catching, processing, and managing the resource, it has a much greater economic impact on the U.S. economy than imported seafood. These general factors are all true for Bristol Bay salmon, specifically.

Total Impact (National)

$2.0 billion in economic output and 15,000 jobs.

In addition to direct harvesting and processing, a robust support sector provides critical inputs to the Bristol Bay salmon fishery. As noted earlier in this report, these support sector roles can range from transportation and logistics, to fishing and processing equipment and gear, boats, groceries, and skilled labor such as welding or marine refrigeration technicians. Much of the support sector activity outside Alaska occurs in or is home-based in the Pacific Northwest, though the supply chain for these supplies and inputs is national and global. Induced economic impact follows the individuals who participate in harvesting, processing, and support sectors, and is therefore spread across the nation depending on their residency and individual spending patterns.

Across the United States, including all direct, indirect, and induced impacts associated with the seafood industry, Bristol Bay salmon created $2.0 billion in total economic output in 2019. This included $830 million in labor income and annualized employment of 15,000 jobs.

Table 28. Economic Impact of Bristol Bay Seafood Industry in the United States, 2019

	Total Employment (annualized)	Labor Income	Total Output
United States (total)	15,000	$830 million	$2.0 billion
Within Alaska	5,370	$375 million	$1.0 billion
Outside Alaska	9,600	$460 million	$1.0 billion
Pacific Northwest	7,700	$370 million	$0.8 billion

Source: McKinley Research Group.
Notes: All data is presented in annualized numbers. Numbers do not total due to rounding. Employment for harvesters and processing is reflected within Alaska, regardless of the residency of participant, because that economic activity occurs within the state. Indirect and induced impacts of those participants flow differently in regional estimates, as residency impacts the location of supporting expenditures and related economic activity.

Alaska Impacts of Commercial Fishing and Seafood Processing in Bristol Bay

Commercial harvest of Bristol Bay salmon generates a broad range of economic impacts. Those impacts accrue regionally, across Alaska, and around the country. As noted earlier a total of 8,600 fishermen, including 2,500 permit holders and 6,100 crew, earn income directly from the fishery. These fishermen received $372 million for their harvest in 2019. Approximately 60% of that harvest value, or $223 million, became net pay to fishermen (labor income), after expenses for fuel, gear, food, and a range of other supplies and services.

Within Alaska, direct impacts can be measured in ex-vessel earnings by harvesters, including crew payments. Indirect and induced impacts include labor income in support sectors, as well as the expenditures throughout the general economy supported by the direct and indirect earnings. Direct employment is presented both in terms of total participation and annualized employment. Annualizing commercial fishing employment estimates, while understating the number of people that earn income by commercial fishing, allows for consistent comparison to other sectors of the economy. Because commercial fishing in Bristol Bay occurs in a very concentrated season of about six weeks, annualized employment is well below total participation, however the very broad distribution of income is an important aspect of Bristol Bay commercial fishing's economic impact.

All harvesting employment and income is accounted within Alaska, as that is where the fishery occurs. The full economic impact of commercial harvesting, including multiplier effects, distributes throughout various regions of the United States depending on a number of factors. The primary factor is the residency of permit holders and crew. The modeling treats resident and nonresident fishermen differently, to account for lower multiplier effects among non-Alaskans participating in the fishery:

- Alaska resident fishermen likely spend more of their personal income in Alaska than their non-resident counterparts.
- Alaska resident fishermen likely secure a greater portion of their commercial fishing service and supply needs through in-state providers compared to non-resident fishermen.

Residency of the seafood processing workforce also is an important aspect of the economic impact of seafood processing in Bristol Bay. Approximately 90% of employment and wages earned in seafood processing in Bristol Bay are earned by non-Alaska residents, resulting in low induced economic impacts. However, the indirect impacts of seafood processing are important, including critically important tax revenues paid by the industry (raw fish taxes, shared state taxes, and property taxes), supporting local government employment and services in the region.

Including multiplier effects, commercial fishing in Bristol Bay accounts for $294 million in labor income in Alaska, earned by 8,600 seasonal fishermen and 1,100 workers in the support sector (annualized equivalent of 3,670 jobs). The total economic impact in Alaska of seafood processing in Bristol Bay is estimated at $81 million in total annual labor income earned by approximately 6,000 processing workers and 500 support sector workers (annualized equivalent of 1,700 jobs). Total economic output for the Bristol Bay salmon industry in Alaska is $990 million.

Table 29. Economic Impact in Alaska of Bristol Bay Commercial Fishing and Seafood Processing, 2019

	Direct	Indirect & Induced	Total
Commercial Fishing			
Employment: Total (Seasonal) and Annualized	(8,600) 2,570	1,100	3,670
Labor Income ($million)	$223.2	$70.5	$293.7
Seafood Processing			
Employment: Total (Seasonal) and Annualized	(6,000) 1,200	500	1,700
Labor Income ($million)	$57.7	$23.1	$80.8
Total Economic Output ($million)			$990.0

Source: McKinley Research Group.

Additional Salmon-Derived Benefits and Activities

Fishery Management

The State of Alaska Department of Fish and Game is responsible for regulating the salmon fisheries in Bristol Bay, and the state at large, to ensure that harvests provide for the sustainability of salmon. ADF&G sets escapement goals for river systems, conducts in-season counts of fish using a variety of tools ranging from sonar to hand counts at remote weir sites, and conducts in-season harvest monitoring and harvest management to allow adequate numbers of fish to enter the spawning grounds to ensure the resource continues for future years.

Alaska Department of Fish and Game workers, including 50 fish and wildlife technicians, two fish and game program technicians, three biologists, and one maintenance person, support the commercial fishing industry in Bristol Bay. All together, these 56 employees earn $5.3 million in wages including cost-of-living-allowances and premium pay.

Table 30. Bristol Bay Fisheries Management Workforce

	Dillingham	King Salmon	All Bristol Bay
Full-time workers and equivalents	3	1	4
Seasonal workers	18	34	52
Total Workers	21	35	56
Total Salaries	$3,589,721	$1,157,100	$4,746,821
Total Salaries with COLA and Premium Pay	$4,029,650	$1,274,781	$5,304,431

Source: Office of Management and Budget, State of Alaska FY2020 Operating Budget, Department of Fish and Game, Central Region Fisheries Management Component Budget Summary

FISHERY TAXES

The State of Alaska levies two primary fisheries-related taxes which are shared with the community or borough where seafood is landed or processed. The Fisheries Business Tax is a 1 to 5 percent tax on the ex-vessel value of seafood landed in Alaska within state waters. The Fishery Resource Landings Tax is a 1 to 3 percent tax levied on the ex-vessel value of seafood processed at sea, outside state waters, but moved through Alaska ports for transshipment. Funds are also distributed more broadly in the region via an ADCCED shared fishery tax community aid program.

The Fisheries Business Tax is typically the larger of the taxes. In the data presented below, Togiak is the only community to have received a share of the Fishery Resource Landing Tax. Shared fishery tax receipts can be an important source of revenue for Bristol Bay communities. For example, in Bristol Bay Borough in FY2019, shared fishery taxes contributed one-third of the borough's total revenues; for the City of Dillingham, the contribution was smaller, at 6%.

Fisheries taxes collected by the State of Alaska and distributed to municipalities in the Bristol Bay region generated more than $5.4 million in annual revenues from FY2018 to FY2020. In the peak year, FY2019, revenue exceeded $6.5 million. The state's annual retained portion averaged $5.1 million.

Table 31. Municipal Receipts of Shared Fishery Taxes, FY2018-2020

Municipality	FY2018	FY2019	FY2020	3-Yr Average
Boroughs				
Bristol Bay Borough	$3,829,195	$4,964,047	$3,195,031	$3,996,091
Lake and Peninsula Borough	$265,112	$266,057	$247,060	$259,410
Cities				
Aleknagik	$4,188	$7,784	$24,947	$12,306
Clark's Point	$263,328	$8,642	$17,090	$96,353
Dillingham	$462,555	$804,435	$585,198	$617,396
Egegik	$130,517	$192,797	$149,604	$157,640
Ekwok	$3,471	$6,168	$19,134	$9,591
New Stuyahok	$6,117	$10,888	$34,769	$17,258
Newhalen	$3,919	$7,703	$23,464	$11,695
Nondalton	$3,747	$6,703	$20,056	$10,169
Pilot Point	$6,630	$36,639	$40,784	$28,018
Port Heiden	$14,580	$0	$3,724	$6,101
Togiak	$173,859	$218,501	$203,725	$198,695
All Shared Fishery Tax Revenue	$5,167,218	$6,530,363	$4,564,587	$5,420,723

Source: ADOR, ADCCED.
Note: A very small portion of shared fish taxes received in the Lake and Peninsula Borough result from fishery activity in communities outside the Bristol Bay region.

Raw fish, or severance, taxes are also collected by a handful of the region's municipalities. They also generated significant revenue for the region, with a three-year average contribution of $6.1 million.

Table 32. Local Raw Fish Tax Revenues, FY2017-2019

	FY2018	FY2019	FY2020	3-Yr Average
Boroughs				
Bristol Bay Borough	$2,117,857	$1,758,141	$2,305,299	$2,060,432
Lake and Peninsula Borough	$1,638,335	$2,812,642	$1,714,986	$2,055,321
Cities				
Egegik	$1,230,569	$2,390,820	$1,048,978	$1,556,789
Manokotak	$-	$-	$100,479	$33,493
Pilot Point	$-	$1,080,508	$-	$360,169
Togiak	$-	$-	$133,239	$44,413
Total Local Raw Fish Tax Revenue	$4,986,761	$8,042,111	$5,302,981	$6,110,618

Source: ADCCED, Alaska Taxable.

Regional Spotlight: Economic Impacts of Seafood in the Pacific Northwest

Alaska's fishing industry has strong historical and contemporary ties to other states on the Pacific Coast, most notably Washington and, to a noteworthy but lesser extent, Oregon and California. Seattle and the greater Puget Sound region have long provided transportation and supply linkages between Alaska and the rest of North America. Puget Sound plays a crucial role as a gateway port for the Alaska seafood industry. The region boasts a wide range of port facilities and is home to many companies that manufacture and/or sell equipment to Alaska operations. Additionally, Pacific states fishermen have participated in Bristol Bay commercial fisheries in large numbers since inception. Particular linkages include:

- Significant numbers of Washington, Oregon, and California residents who participate in the Bristol Bay salmon fishery. These fishermen earned $152 million in ex-vessel value in 2019. Earnings by Washington permit holders accounted for 77% of that total value.
- The bulk of maritime shipping – both northbound for the transport of fishing gear, processing supplies, fuel, and other necessary industry inputs, and southbound for the transport of seafood – runs through the Puget Sound region.
    - Industry interviews suggest approximately 50% of Bristol Bay salmon on a round-pound basis (including nearly all of Bristol Bay's canned production, which was 8% of processed 2019 volume) moves through ports in Puget Sound.
    - As much as 80% of the H&G and fillet product that is shipped to the Puget Sound region reportedly receives secondary/value-added processing in regional facilities.
- Many of the seafood processing companies that do business in Bristol Bay operate corporate headquarters or major corporate offices in Washington State, and many employees of those companies relocate to Bristol Bay during the fishing season. These include major seafood companies such as North Pacific Seafoods, Icicle and Ocean Beauty Seafoods (recently combined to OBI Seafoods), Peter Pan Seafood, Trident Seafoods, Alaska General Seafoods, and Leader Creek Fisheries, as well as several smaller companies.
- Institutions of higher education have strong linkages to the Bristol Bay region. Examples include the University of Washington's Alaska Salmon Program, which has conducted research in Bristol Bay for more than seven decades.
- Most of the air transport into and out of Alaska routes through Seattle.

Marine servicing and support sector businesses in the Puget Sound region are critical to the Bristol Bay fishery. For example, regional cold storage companies, processing and fishing equipment companies, shipyards and boatbuilders, and financial institutions all provide key inputs for the harvesting and processing sectors. While it is beyond the scope of this research to detail all support sector businesses, previous McKinley Research Group (McDowell Group) studies provided a partial census of seafood industry support businesses in the Puget Sound region. That research identified nearly 70 support sector businesses, most of which are likely doing some business in support of Bristol Bay's seafood sector.

As noted above, the indirect and induced impacts of the Bristol Bay salmon fishery in the Pacific Northwest are estimated at approximately 7,700 annualized jobs, labor income of approximately $370 million, and $1 billion in total economic output.

Table 33. Economic Impact of Bristol Bay Salmon in Puget Sound, 2019

	2019
Employment: Annualized	7,700
Labor Income ($million)	$370
Economic Output ($billion)	$1.0

Source: McKinley Research Group.

Economic Impact of the Tourism Industry

Visitor spending creates jobs in many sectors of the economy, including hotels and lodges, tour companies, retail establishments, transportation providers, dining establishments, and a range of other businesses. Data from government sources does not provide a clear measure of jobs and wages in the visitor industry because jobs are so widely spread across the economy and because visitor-affected sectors are also impacted by resident travelers and resident spending. Tourism spending in Bristol Bay is a combination of sportfishing-focused visits and significant bear viewing traffic. This research limits the employment, wage, and total economic output assessment to Alaska only.[29]

Total Impact (Alaska)

$155 million in economic output and 2,300 jobs.

Bristol Bay visitor spending per trip ranges from under $1,000 for a day bear viewing to well over $5,000 for a multi-night stay at a sportfishing lodge. For visitors spending time at a sportfishing lodge, it is reasonable to attribute all spending in Alaska to their Bristol Bay experience (fishing in Bristol Bay is often the primary purpose of their trip to Alaska). For day-trippers, only the spending on the Bristol Bay excursion from a location within Alaska can be attributed to the region (and the salmon the watershed produces).

The best available data suggests that Bristol Bay region sportfishing lodge businesses and bear viewing generate approximately $97 million in total annual visitor spending within Alaska. That spending supported a total economic output of $155 million in Alaska in 2019, including approximately 2,300 jobs (1,400 annualized) and $67.9 million in direct, indirect, and induced labor income.

Table 34. Economic Impact in Alaska of Visitors to Bristol Bay Region, 2019

	Direct	Indirect & Induced	Total
Employment: Total (Annualized)	2,300 (1,400)	600	2,000
Labor Income ($million)	$43.7	$24.2	$67.9
Economic Output ($million)			$155.0

Source: McKinley Research Group.

[29] Non-Alaska expenditures, such as travel costs, are difficult to directly link to Bristol Bay with current available data. For example, out-of-state expenditures by a visitor who makes a 10-day trip to Alaska but spends 3 of those at a Bristol Bay lodge, or who flies to the region for 6 hours for bear viewing, cannot be entirely attributed to Bristol Bay. Future primary research could help allocate costs appropriately. Estimates are therefore conservative.

Additional Benefits: Municipal Bed Taxes

Another source of salmon-derived benefit that flows to communities is through municipal bed tax revenues. Not all bed tax can be attributed to salmon-driven economic activity. For example, people traveling for a broad range of business purposes or to visit family would not be included in an estimate of related spending. In certain communities, however, visitor overnights related to lodges and other tourism infrastructure are a more dominant part of total local activity. To the extent that bed taxes exist in communities, they can be a mechanism for capturing additional benefits from salmon-induced visitors.

Table 35. Local Bed Tax Revenues, FY2017-2019

Municipality	FY2017	FY2018	FY2019	3-Yr Average
Boroughs				
Bristol Bay Borough	$102,892	$111,871	$136,127	$116,963
Lake and Peninsula Borough	$108,896	$146,140	$240,746	$165,261
Cities				
Dillingham	$80,286	$76,052	$94,376	$83,571
Aleknagik	$139,209	$-	$-	$46,403
Manokotak	$-	$-	$3,466	$1,155
Nondalton	$-	$272	$91	$91
Total Bed Tax Revenue	**$431,283**	**$334,063**	**$474,987**	**$413,444**

Source: ADCCED, Alaska Taxable.

Historical Production and Discharge Data and Areal Extent of ZOD
OBI Petersburg Facility

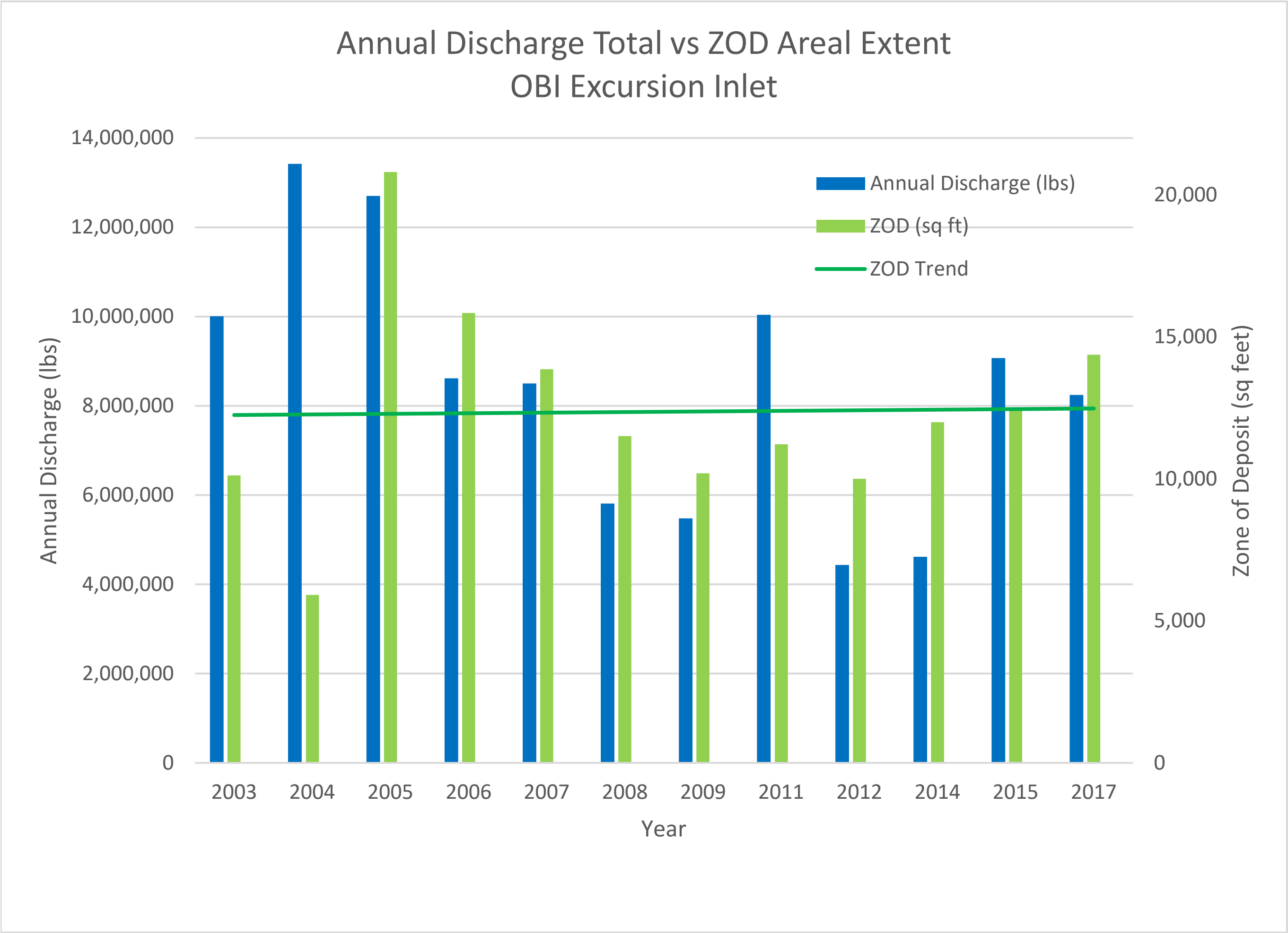
Processing Year	Raw (lbs)	Finished (lbs)	Discharged (lbs)	Pile Size (sq feet)
2009	33,851,285	23,779,669	4,115,526	0
2010	35,659,806	26,147,019	9,512,787	0
2011	58,914,894	43,292,069	4,898,584	0
2012	34,055,373	26,726,858	830,261	No Dive
2013	78,507,133	71,863,619	6,643,514	0
2014	40,639,540	39,033,662	1,605,878	0
2015	44,124,743	41,739,370	2,385,373	No Dive
2016	23,514,132	17,839,522	5,674,610	0
2017	39,404,669	27,221,407	1,764,801	0
2018	22,931,596	16,729,041	2,071,786	No Dive
2019	26,774,016	17,583,642	1,973,066	No Dive
2020	16,559,161	10,502,050	3,061,200	No Dive

The facility operates their Meal Plant only during salmon season when daily input reaches the estimated 350,000 lbs/day design threshold.

Historical Production and Discharge Data and Areal Extent of ZOD
OBI Excursion Inlet Facility

Processing Year	Raw (lbs)	Finished (lbs)	Discharged (lbs)	Pile Size (sq feet)
2001	N/A*	N/A*	N/A*	5,950
2002	N/A*	N/A*	N/A*	No Dive
2003	29,441,880	19,437,301	10,004,579	10,125
2004	36,808,193	23,385,499	13,422,694	5,917
2005	34,801,929	22,100,198	12,701,731	20,800
2006	25,001,735	16,388,053	8,613,682	15,840
2007	23,336,293	14,838,064	8,498,229	13,860
2008	17,650,236	11,836,798	5,813,438	11,500
2009	15,197,809	9,722,975	5,474,834	10,200
2010	10,755,512	7,264,772	3,490,740	No Dive
2011	28,575,603	18,533,977	10,041,626	11,220
2012	13,240,231	8,807,531	4,432,700	10,000
2013	36,392,166	23,636,176	12,755,990	No Dive
2014	16,048,775	11,433,539	4,615,236	12,000
2015	26,828,260	17,755,892	9,072,368	12,500
2016	10,408,751	7,635,867	2,772,884	No Dive
2017	26,980,863	18,740,125	8,240,738	14,375
2018	10,811,268	8,434,828	2,376,440	No Dive
2019	11,330,745	8,153,425	3,177,320	No Dive
2020	1,937,769	1,528,276	409,493	No Dive

* For CY 2001-2002, facility was owned and operated by Wards Cove Packing Co.



Annual Discharge Total vs ZOD Areal Extent
OBI Excursion Inlet
14,000,000
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
Annual Discharge (lbs)
20,000
15,000
10,000
5,000
0
Zone of Deposit (sq feet)
Annual Discharge (lbs)
ZOD (sq ft)
ZOD Trend
2003
2004
2005
2006
2007
2008
2009
2011
2012
2014
2015
2017
Year