Pacific Halibut Multiregional Economic Impact Assessment (PHMEIA): update for SRB018

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PURPOSE

To provide an update on the International Pacific Halibut Commission (IPHC) economic study, including progress on developing the economic impact assessment model, state of the collection of primary economic data from Pacific halibut dependent sectors, and most recent results on regional and community economic impacts.

BACKGROUND

Under the Convention, the IPHC's mandate is *optimum* management of the Pacific halibut resource, which necessarily includes an economic dimension. Fisheries economics is an active field of research around the world in support of fisheries policy and management. Adding the economic expertise to the IPHC Secretariat, the IPHC has become the first regional fishery management organization (RFMO) in the world to do so.

The goal of the IPHC economic study is to provide stakeholders with an accurate and all-sectors-encompassing assessment of the economic impact of the Pacific halibut resource in Canada and the United States of America. The intention of this update is to inform on the project's progress.

The economic effects of changes to harvest levels can be far-reaching. Fisheries management policies that alter catch limits have a direct impact on commercial harvesters, but at the same time, there is a ripple effect through the economy. Industries that supply commercial fishing vessels with inputs, generally referred to as *backward-linked industries*, rely on this demand when making decisions related to their production levels and expenditure patterns. For example, vessels making more fishing trips purchase more fuel and leave more money in a local grocery store that supplies crew members' provisions. More vessel activity means more business to vessel repair and maintenance sector or gear suppliers. An increase in landings also brings more employment opportunities, and, as a result, more income from wages is in circulation. When spending their incomes, local households support local economic activity that is indispensable to coastal communities' prosperity.

Changes in the domestic fisheries output, unless fully substituted by imports, are also associated with production adjustments by industries relying on the supply of fish, such as seafood processors. Similarly to the directly affected sector, any change in production by the *forward-linked industry* has a similar ripple effect on its suppliers. The complete path of landed fish, from the hook to the plate, also includes seafood wholesalers and retailers, and, in the case of highly-prized fish such as Pacific halibut, services. Traditionally, the vast majority of Pacific halibut is consumed at white-tablecloth restaurants. Any adjustment in gross revenue generated by these industries resulting from a change in the supply of directly affected fish is further magnifying the economic impact of management decisions altering harvest levels.

Similar effects are attributed to the recreational fishing sector. By running their businesses, charter operators generate demand for fuel, bait fish, boat equipment, and fishing trip provisions. They also

create employment opportunities and provide incomes that can be spent locally, supporting various local businesses. What is more, anglers themselves contribute to the economy by creating demand for goods and services related to their fishing trips. A number of sectors support tourism relaying on the Pacific halibut fishing, both guided and unguided. These include lodging, local retailers, or restaurants.

Besides shaping a complex combination of local effects, the industries' interlinked nature is generating cross-regional impacts. Economic benefits from the primary area of the resource extraction are leaked when inputs are imported, when wages earned by nonresidents are spent outside the place of employment, or when earnings from quota holdings flow to nonresident beneficial owners. At the same time, the inflow of economic benefits to the local economies from outside is occurring when products are exported or local businesses are bringing tourism cash to the region.

Understanding the multiregional impacts of changes to fisheries sectors is now more important than ever considering how globalized it is becoming. Fish harvested on the other side of the globe can be easily found on the shelf or on the menu in the United States or Canada, competing with domestically produced seafood. The United States and Canada imported seafood worth over USD 28.8 billion (CAD 37.4 billion) in 2018 (Statistics Canada, 2020a; US Census, 2020). On the production side, the origin of inputs to any sector is increasingly distant, implying a gradual shift of economic activity supported by fisheries and seafood industries abroad. While generally cost-effective, such high exposure to international markets makes seafood accessibility fragile to perturbations, as shown by the covid-19 outbreak (OECD, 2020). Fisheries are also at the forefront of exposure to the accelerating impacts of climate change. A rapid increase of the water temperature of the coast of Alaska, termed *the blob*, is affecting fisheries (Cheung and Frölicher, 2020) and may have a profound impact on Pacific halibut distribution. Thus analyzing the sector in a broader context is crucial.

A good grasp of the multiregional impacts is also fundamental to correctly assess the impacts the resource such as Pacific halibut has on communities. Some of the local communities particularly rely on fishing-related economic activities. A good understanding of localized effects is pivotal to policymakers that are often concerned about community impacts, particularly in terms of impact on employment opportunities and households' welfare. Fisheries policies have a long history of disproportionally hurting smaller communities, often because potential adverse effects were not sufficiently assessed. For example, in a system based on transferable quotas, small remote fishing communities are more likely to sell their quota. What follows is a disproportional economic impact on the spatial scale. Loss of fisheries opportunities in small indigenous communities can be an unintended consequence of quota systems (Carothers, Lew, and Sepez 2010; Szymkowiak, Kasperski, and Lew 2019).

Update on the model development

Economic impacts are typically estimated with the use of an input-output (IO) model. The traditional IO model is used to investigate how changes in final demand affect economic variables such as output, income and employment or contribution to the region's gross domestic product (GDP). This is known as impact analysis. With an adjustment for the shock type, the model can also demonstrate the magnitude of changes in supply-constrained industries such as total allowable catch (TAC) constrained

fisheries. Adopting a multiregional approach, the model accommodates the cross-regional trade. The IO model can also be extended to the so-called social accounting matrix (SAM). Adopting SAM, the calculated effects account for labor commuting patterns and residency of beneficial owners of production factors, and as a result, the flow of earnings between regions.

The Pacific halibut multiregional economic impact assessment (PHMEIA) model is a multiregional SAM model describing economic interdependencies between sectors and regions developed to assess the economic contribution of Pacific halibut resource to the economy of the United States and Canada. The adopted methodology is an extension from the multiregional SAM model for Southwest Alaska developed by Seung, Waters, and Taylor (2019) and draws on a few decades' worth of experience in developing IO models with applications to fisheries (for review of relevant literature, please refer to the economic study section on the IPHC website, subsection *Review of economic impact assessment models focused on the fisheries sector*).

The PHMEIA model accounts for three economic impact (EI) components. The **direct EIs** reflect the changes realized by the direct Pacific halibut resource stock users (fishers, charter business owners). The **indirect EIs** are the result of business-to-business transactions indirectly caused by direct the EIs. The indirect EIs provide an estimate of the changes related to expenditures on goods and services used in the production process of the directly impacted industries. In the context of the PHMEIA, this includes an impact on upstream economic activities associated with supplying intermediate inputs to the direct users of the Pacific halibut resource stock. Finally, the **induced EIs** result from increased personal income caused by the direct and indirect effects. In the context of the PHMEIA, this includes economic activity generated by households spending earnings that rely on the Pacific halibut resource.

The model reflects the interdependencies between eleven major sectors and two Pacific halibut-specific sectors. These include the Pacific halibut fishing sector, as well as the forward-linked Pacific halibut processing sector.[1] In addition, the extended model (referred here as PHMEIA-r) introduces to the SAM also the Alaskan saltwater charter sector that is disaggregated from the services-providing industry.[2] The list of industries considered in the PHMEIA and PHMEIA-r models, as well as the primary commodities they produce, is available in **Table 1**.

The model accounts for interregional spillovers. These represent economic stimulus in the regions other than the one in which the exogenous change is considered. This allows accommodation of increasing economic interdependence of regions and nations. The model considers three primary Pacific halibut producing regions, as well as residual regions to account for cross-boundary effects of fishing in the Pacific Northwest:

- Alaska (AK)
- US West Coast (WC – including WA, OR and CA)

[1] As noted by Steinback and Thunberg (2006), there is a number of seafood substitutes available to buyers. Thus including impacts beyond processors and wholesalers in the SAM framework could be misleading considering that it is unlikely that supply shortage would result in a noticeable change in retail level gross revenues. Alternative approaches to assess these effects are beyond the scope of the project at this time. Data limitations preclude the inclusion of wholesale buyers from the assessment of forward-linked effects.

[2] The inclusion of the British Columbia and US West Coast charter sector is underway, pending data collection.

- British Columbia (BC)
- Rest of the United States (RUS)
- Rest of Canada (ROC)
- Rest of the world (ROW)[3]

By accounting for the economic linkages among these six regions, the study shows the importance of multiregional approaches to measuring economic impacts more accurately. This is particularly important in the context of shared resources and joint management, such as the case of collective management of Pacific halibut by the IPHC. The economic metrics derived from the PHMEIA model range from total economic impact on output along the value chain to impacts on employment and incomes, as well as contribution to the GDP and households' prosperity.

The model adopts a recently published multiregional generalized RAS (MRGRAS) updating technique (Temursho, Oosterhaven and Cardenete, 2020) to develop an up-to-date model that can incorporate partial information on its components while continuing to conform to the predefined balanced structure. This technique can make the multiregional model consistent with aggregated national data[4] and include up-to-date estimates from a limited number of focus sectors. For more details on the methodological approach, please refer to the article *Method for efficient updating of regional supply and use tables* (*Journal of Economic Structures*, In Review) and economic study section on the IPHC website (subsection Methodological annex).

The current version of the model is based primarily on secondary data sources.[5] As such, the results are conditional on the adopted assumptions for the components for which data were not available. In order to improve the accuracy of the assessment, the IPHC intends to increasingly rely on the primary economic data collected directly from members of Pacific halibut dependent sectors (see *Identification of available data sources and primary data collection*), applying the so-called partial-survey method (Miller and Blair 2009, pp. 303). **The subsequent revisions of the model incorporating IPHC-collected data will bring a better characterization of the Pacific halibut sectors' economic impact**.

The model is operational and available for 2014, 2016, 2018, and 2019. For more details on the SAM application to the assessment of the impact of the Pacific halibut resource on the economies of Canada and the United States, please refer to the economic study section on the IPHC website (subsection *PHMEIA model*).

[3] The ROW region in the model is considered exogenous. This implies that the trade relations with the ROW are unaffected by the changes to the Pacific halibut sectors considered in this project. While the full inclusion of the ROW component allows for assessment of impact outside Canada and the United States if trade with ROW was to be considered responsive to changes in Pacific halibut sector activity, this is not typically seen in the literature.

[4] For example, data from the National Economic Accounts (NEA). NEA data provide a comprehensive view of national production, consumption, investment, exports and imports, and income and saving. These statistics are best known by summary measures such as gross domestic product (GDP), corporate profits, personal income and spending, and personal savings.

[5] That is data collected by other parties, not the IPHC.

Table 1 Industries and commodities considered in the PHMEIA and PHMEIA-r models.

	Industry	Primary commodity produced
1	Pacific halibut fishing	Pacific halibut
2	Other fish and shellfish fishing	Other fish and shellfish(1)
3	Agriculture and natural resources (ANR)	Agriculture and natural resources
4	Construction	Construction
5	Utilities	Utilities
6	Pacific halibut processing	Seafood
7	Other fish and shellfish processing	Seafood
8	Food manufacturing (excluding seafood manufacturing)	Food (excluding seafood) (2)
9	Manufacturing (excluding food manufacturing)	Manufactured goods (excluding food)
10	Transport	Transport
11	Wholesale	Wholesale
12	Retail	Retail
13	Services (including public administration)	Services (including public administration)
14	Saltwater charter sector(3)	Saltwater fishing trips

Notes: (1)In the case of Canada, other fish and shellfish commodity includes, besides wild capture production, also aquaculture output produced by the aquaculture industry that is a part of the ANR industry. Other fish and shellfish processing industry in the USA component, on the other hand, draws more on the ANR commodity that includes aquaculture output. However, this misalignment between model components is not concerning as linking these is based on the trade of aggregated seafood commodity. (2)There is a slight misalignment between model components related to the allocation of beverage and tobacco manufacturing products that, in some cases, are considered non-durable goods and lumped with the food commodity. In the case of the USA component, this misalignment is corrected with the use of additional data available from the Annual Survey of Manufactures (ASM) (US Census, 2021b). No correction is performed for the ROW component, but the global production of beverage and tobacco products is considered of minor importance compared to other food commodities. (3)Saltwater charter sector extension included in PHMEIA-r model, currently applied only for Alaska. The Pacific halibut charter sector is assumed to account for 22.4% (2019) of the Alaskan saltwater charter sector. This is calculated as a share of Pacific halibut effort reported by Webster & Powers (2020) in total effort reported by the Marine Recreational Information Program (NOAA, 2021c).

Identification of available data sources and primary data collection

The current version of the model is built using a broad set of secondary data sources. These include region-specific commercial fishing outputs in terms of value (DFO, 2021; NOAA, 2021a), including detailed landing data from eLandings system for Alaska (ADFG, 2021a), wholesale value[6] (AgriService BC, 2018; COAR, 2021), employment and wages[7] (AK DLWD, 2020; Statistics Canada, 2021), out-of-state employment (Kreiger and Whitney, 2021), seafood trade (NOAA, 2020; Statistics Canada, 2020a). Lew & Lee (2019) report on costs, earnings, and employment in the Alaska saltwater sport fishing charter sector in 2017. Additional data are available on recreational harvest and participation in recreational angling (ADFG, 2020; RecFIN, 2020; Webster and Powers, 2020; NOAA, 2021c), subsistence and research harvest (IPHC, 2020a). More details on fisheries-related secondary data sources can be found in the economic study section on the IPHC website (subsection *Fisheries-related economic statistics*).

The social accounting matrix, even if built with the purpose of assessing a limited number of sectors (i.e., Pacific halibut dependent industries in this case), also requires input on supply and use by all industries in the economy, as well as supplementary data on household accounts to provide insight into

[6] Not available for the US West Coast (confirmed with NOAA NWFSC, personal communication).
[7] Not available for the US West Coast (confirmed with NOAA NWFSC, personal communication).

the demographics of the workforce that builds the market for supply and demand of labor and trade data to link model components. The following sources serve as a base for the up-to-date estimates (list not exhaustive):

- US Bureau of Economic Analysis (BEA) industry accounts supplemented by BEA Regional Data resources (BEA, 2020) - the USA model component
- United States Census Bureau's Annual Survey of Manufactures (ASM) (US Census, 2021b) – complementary statistics on manufacturing establishments
- Provincial-level supply and use tables published by Statistics Canada (Statistics Canada, 2020b) – the Canadian model component
- US Trade provided by the U.S. Census Bureau (US Census, 2020)
- Canadian International Merchandise Trade Database (Statistics Canada, 2020a)

More accuracy of the results can be achieved by incorporating into the model primary economic data collected directly from members of Pacific halibut-dependent sectors. An essential input to the SAM model is data on production structure (i.e., data on the distribution of revenue between profit and expenditure items). Currently, the model uses estimates from the species-based NOAA model for Alaska for 2014 (Seung, Waters and Taylor, 2019), as well as Pacific halibut sector estimates for the West Coast provided directly by the authors of the NOAA input-output model for the Pacific Coast fisheries (Leonard and Watson, 2011; Pacific halibut estimates not published). No equivalent detail model is available for British Columbia, although some partial statistics are derived from Edwards and Pinkerton (2020).[8]

A series of surveys to gather information from commercial fishers and processing plant operators has been announced at the AM96. To expand the model's scope, a survey aimed at charter business owners has been announced at the IM96. The web-based survey forms are available:

- Here, for Pacific halibut commercial harvesters;
- Here, for Pacific halibut processors;
- Here, for Pacific halibut charter business owners.

IPHC stakeholders are encouraged to fill the relevant survey form and contribute to the assessment of the importance of the Pacific halibut resource to the economy of Canada and the United States of America.

Primary data collection in the time of the crisis

Recent perturbations in the markets caused by covid-19 serve as an additional argument for considering the broader economic dimension of Pacific halibut's contribution to regional economies. The widespread closure of restaurants, the Pacific halibut's biggest customers, diminished the demand for fish, particularly high-quality fresh fish that fetch higher prices. Lower prices, down in 2020 by up to 30% compared with the previous year (Stremple, 2020; **Table 2**), caused a slow first half of the season

[8] Edwards and Pinkerton (2020) provide estimates of average operational and fixed costs. These are used to derive value added related to Pacific halibut fishing used in the model.

(Ess 2020). Less harvest activity has repercussions in the economy beyond the harvest sector as it affects also harvest sector suppliers and downstream industries that rely on its output. Outbreaks of covid-19 in fish processing plants (Estus, 2020; Krakow, 2020) also affect economic activity generated regionally by this directly related to the Pacific halibut supply sector. Moreover, seafood processors incur additional costs associated with protective gear, testing, and quarantine accommodations (Ross, 2020; Sapin and Fiorillo, 2020; Welch, 2020).

The pandemic turned out to be also a major impediment to successful primary data collection in 2020. The survey's announcement happened shortly before the covid-19 outbreak that shifted the focus of participants to the Pacific halibut fishery. An intensified effort to reach out to commercial vessel operators was made starting July when the IPHC fisheries data specialists (ports) distributed a paper version of the survey. To this date, however, too few responses have been received to make reliable estimates for full model calibration, and the Secretariat continues efforts to improve the response rate. Meanwhile, the survey results are used to inform the model on a number of parameters for which no other estimates are available (e.g., the workforce composition).

The preliminary survey results are available to all contributors and prospective participants for comparison with regional and local averages here:[9]

http://iphcecon.westus2.cloudapp.azure.com:3838/srApp/.

As a reminder, the participants to the Pacific halibut fisheries (commercial and charter sector) are encouraged to fill the form for 2020, but also retrospectively submit information for 2019. Responses are accepted on a rolling basis and used to update the results app periodically. The benefits of filling the survey for both years are as follows:

- Data for 2019, covering pre-covid-19 operations, can be considered a baseline suitable for drawing conclusions under normal circumstances and using for predictions.
- Data for 2020, covering an abnormal year of operations, can be used to assess losses incurred by the Pacific halibut sectors, but also sectors' resilience to unfavorable exogenous circumstances. If the project continues and data for 2021 are collected, the project could inform on the response to the crisis and undertake an analysis of the path to recovery.

[9] At this stage, the estimates are based on a limited sample and should not be considered necessarily reflective of the whole indicated sector. The main intention of sharing this app at this time is to demonstrate the potential of the survey to provide a comparison of a broad set of economic statistics across regions and years.

Table 2 Pacific halibut commercial landings by IPHC Regulatory Area – 2019 vs. 2020.

IPHC Regulatory Area	Value [USD] 2019	Price [USD] 2019	Value [USD] 2020	Price [USD] 2020
2A	5,015,314	3.64	NA	NA
2B	34,988,780	5.02	NA	NA
2C	17,305,677	5.67	12,547,601	4.32
3A	43,214,560	5.65	28,027,417	4.37
3B	8,410,477	5.46	6,130,597	4.19
4A	5,947,111	4.46	4,438,663	3.80
4B	4,079,609	4.41	3,229,892	3.67
4C	1,991,117	4.23	242,879	3.76
4D	4,452,681	4.49	5,162,180	3.94
4E	348,426	5.42	280,031	3.94
SUM AK (2C-4E)	85,749,658	5.35	60,059,259	4.21

Notes: NA – not available. Data for 2A based on (NOAA, 2021a), and data for 2B based on (DFO, 2021). Estimates for Alaska based on data from eLandings system (ADFG, 2021a), limited to harvest landed under IFQ and CDQ management program and reported sold. Value calculated based on average price per ticket and landings allocated based on ADFG grid converted to IPHC regulatory areas. For border areas, the first reported area was assigned.

Pacific halibut value along the supply chain

The complete path of landed fish, from the hook to the plate, includes, besides harvesters and processors, also seafood wholesalers and retailers, and in the case of highly-prized fish such as Pacific halibut, services when it is served in restaurants. Any change in gross revenue generated by these industries as a result of a change in the supply of directly affected fish is further magnifying the economic impact of management decisions altering harvest levels.

Isolating data on Pacific halibut wholesale and retail is challenging as no relevant statistics have been identified. However, it is important to note that there are many seafood substitutes available to buyers. Thus, including economic impacts beyond processors and wholesalers could be misleading when considering that it is unlikely that supply shortage would result in a noticeable change in retail level gross revenues (Steinback and Thunberg, 2006).

Recreational sector in the PHMEIA model – PHMEIA-r

There are two components to consider when attempting to assess the full scope of the Pacific halibut resource's economic impact occurring as a result of recreational fishing activities. The first is the contribution to the economy by the charter sector that provides service to anglers. These include services directly related to angling, for example, providing a boat, trip supplies and guides, but also not directly related, for example, hospitality services in case of fly-in lodges that specialize in serving customers interested in Pacific halibut fishing. The economic impact is generated by the sector's demand for inputs from other industries, including manufacturing, professional services (accounting, marketing, etc.) and demand for labor.

The second component is the contribution of anglers who create demand for goods and services related to their fishing trips. This includes expenses related to the travel that would otherwise not be incurred

(e.g., auto rental, fuel cost, lodging, food, site access fees), as well as money spent on durable goods that are associated with recreational fishing activity, e.g., rods, tackle, outdoor gear, boat purchase, etc. This component applies to both guided and unguided recreational fishing. Assessment of anglers' contribution to the economy typically requires surveying private anglers on their fishing-related expenditures and fishing preferences.

The extended PHMEIA-r model introduces to the SAM the Alaskan saltwater charter sector.

Economic impact assessment of subsistence fishing

Previous research suggested that noncommercial or nonmarket-oriented fisheries contribution to national GDP is often grossly underestimated, particularly in developing countries (e.g., Zeller, Booth, and Pauly 2006). Subsistence fishing is also important in traditional economies, often built around indigenous communities. Wolfe and Walker (1987) found that there is a significant relationship between the percentage of the native population in the community and reliance on wildlife as a food source in Alaska. However, no comprehensive assessment of the economic contribution of the subsistence fisheries to the Pacific northwest is available. The only identified study, published in 2000 by Wolfe (2000), suggests that the replacement value of the wild food harvests in rural Alaska may be between 131.1 and 218.6 million dollars, but it does not distinguish between different resources and assumes equal replacement expense per lb. Aslaksen et al. (2008) proposed an updated estimate for 2008 based on the same volume, noting that transportation and food prices have risen significantly between 2000 and 2008, and USD 7 a pound is a more realistic replacement value. This gives the total value of USD 306 million, but the approach relies upon the existence of a like-for-like replacement food (in terms of taste and nutritional value), which is arguably difficult to accept in many cases (Haener *et al.*, 2001) and ignores the deep cultural and traditional context of the Pacific halibut in particular (Wolfe, 2002). A more recent study by Krieg, Holen, and Koster (2009) suggests that some communities may be particularly dependent on wildlife, consuming annually up to 899 lbs per person, but no monetary estimates are derived. Moreover, although previous research points to the presence of sharing and bartering behavior that occurs in many communities (Wolfe, 2002; Szymkowiak and Kasperski, 2020), the economic and cultural values of these networks have yet to be thoroughly explored.

Economic impact assessment results

This section summarizes the most recent outcomes of the PHMEIA and PHMEIA-r models. It is important to note that these are based on **the current version of the model incorporating primarily secondary data sources**. As such, **the results are conditional on the adopted assumptions for the components for which up-to-date data were not available** (summarized for Alaska in Appendix 1 Assumptions on the Pacific halibut sectors in Alaska) **and are subject to change**.

The current results incorporate the following changes in comparison to the results presented at the AM97:

- The model uses an updated set of data, and estimates are now available for 2019 (previously up to 2018);

- The report includes preliminary estimates of community effects – it incorporates county-level results for Alaska;
- The extended model (PHMEIA-r) provides preliminary estimates for the charter sector (limited to guided fishing in Alaska);
- The estimates fully incorporate described flows of earnings related to all Pacific halibut sectors (fishing, processing, and charter/Alaska only).

Economic impact of Pacific halibut commercial fishing

The model results suggest that Pacific halibut commercial fishing's total estimated impact in 2019 amounts to USD 194.2 mil. (CAD 257.7 mil.) in earnings[10] (including estimated USD 42.5 mil / CAD 56.4 mil in earnings in the Pacific halibut fishing sectors), USD 134.3 mil. (CAD 178.2 mil.) in compensation of employees (including estimated USD 26.6 mil / CAD 35.3 mil in wages in the Pacific halibut fishing sectors), 4,326 in jobs, USD 178.4 mil (CAD 236.7 mil.) in households income and over USD 665.2 mil. (CAD 882.6 mil.) in output. This is about 5.3 times the fishery output value of USD 126.4 mil.[11] (CAD 167.7 mil.) recorded for 2019 (DFO, 2021; NOAA, 2021a). The estimate is the total economic impact, the sum of the direct, indirect, and induced effects from changes to the Pacific halibut fishing sector, as well as indirect and induced effects associated with forward-linked industries (Pacific halibut processing sector).

Table 3 Estimated economic impact of Pacific halibut commercial sector in 2019.

	Value [mil. USD / mil. CAD]	Value per 1 USD of output
Value of landings	126.4 / 167.7	-
Economic impact – output	665.2 / 882.6	5.26
Economic impact – compensation of employees	134.3 / 178.2	1.06
Economic impact – earnings	194.2 / 257.7	1.54
Economic impact - employment	4326 jobs	34.22
Economic impact – households	178.4 / 236.7	1.41

The results suggest that the revenue generated by Pacific halibut at the harvest stage accounts for only a fraction of economic activity that would be forgone if the resource was not available to fishers in the pacific northwest. Besides supporting production by other industries, the sector also contributes to the GDP of Canada and the United States and has a considerable impact on employment in both countries. Understanding such a broad scope of impacts is essential for designing policies with desired effects depending on regulators' priorities.

Moreover, the results suggest that incorporating Pacific halibut-specific outflows has a considerable impact on results. Error! Reference source not found. shows the estimates of economic impact on households in Alaska from the final model contrasted with estimates from the model that does not account for cross-regional flows of earnings. While 1 USD of Pacific halibut output in Alaska could generate USD 0.71 USD for Alaskan households, out-of-state employment, flows related to beneficial

[10] Earnings include both employee compensation and proprietors' income.
[11] For Alaska, the model only includes harvest landed under IFQ and CDQ management program that was marked as sold.

ownership of Pacific halibut fishing rights in Alaska (i.e. quota holdings) and corporate interests of processing sector entities cause this estimate to drop to USD 0.58.

Table 4 Effect of incorporating Pacific halibut specific outflows - impact on households per 1 USD of Pacific halibut output in Alaska (2019).

	Model with no Pacific halibut specific outflows	Model with Pacific halibut specific outflows
Households in Alaska	0.71	0.58
WC households	0.11	0.21
RUS households	0.41	0.42

Notes: Impacts on households in Canada omitted.

Community impacts in Alaska

Besides providing economic impact estimates for broadly-defined regions, the PHMEIA model results can inform the community impacts of the Pacific halibut resource throughout its range and highlight communities particularly dependent on fishing-related economic activities.

Based on the 2019 PHMEIA model, Pacific halibut commercial output in Alaska of USD 85.7 mil.[12] generated through Pacific halibut directed commercial fishing and directly forward-linked Pacific halibut processing about USD 28.2 mil of earnings, of which USD 19.8 mil. (70.2%) was retained in Alaska.[13]

The earnings were not evenly distributed (**Table 5**, **Figure 1**). The highest earnings are estimated for Kenai Peninsula, Kodiak Island and Petersburg counties. The most direct earnings per dollar landed are estimated for Ketchikan Gateway, Petersburg and Sitka countries, while the least for Aleutians East, Yakutat and Aleutians West counties. Low earnings per 1 USD of Pacific halibut landed in the county are a result of the outflow of earnings related to vessels' home base, vessels' ownership and quota ownership, processing locations and processing companies' ownership.

The last column of **Table 5** represents the distribution of the total economic impact of Pacific halibut industries on households in Alaska by county (USD 49.6 mil. in total for 2019). The remaining economic impact on households representing indirect and induced EIs is evaluated based on local exposure[14] to the region's Pacific halibut economic impact, using calculated multiplier effects. It is important to note that these estimates assume the use of imported commodities in the same proportions by each county and no cross-county trade in commodities,[15] which in turn implies that intra-Alaska indirect and induced economic effects retention within the county.

[12] Limited to harvest landed under IFQ and CDQ management program and reported sold.

[13] Community effects assessment is currently limited to Alaska. The feasibility of a similar assessment for other regions is currently under investigation. For example, Canadian quotas (L fishery), which are vessel-based, can be allocated based on vessel owner's residency, searchable in the Canadian Register of Vessels available through Transport Canada's Vessel Registration Query System.

[14] Local exposure assessed as a county's share in the total value of Pacific halibut landed in Alaska. Values were assigned to counties based on the registered homeport of the vessel landing Pacific halibut.

[15] This assumption implies that all commodities used in the production that are not imported from another state or country are sourced from the county where the production process occurs. This applies to all industries in the economy. For example, if the Pacific halibut fishing industry in Aleutians East county uses USD 1,000 of food commodity as an input to production and, on average, Alaska imports from other US states and abroad 30% of food commodity it uses for production,

The updated PHMEIA app translates these effects directly based on changes in harvest allocations by IPHC Regulatory Area using eLandings data that include the harvest location (PHMEIA app release 2.0).

Table 5 Economic impacts estimates for Alaskan counties - 2019.

County	Estimated earnings from Pacific halibut commercial sectors (fishing and processing)	Earning per 1 USD of Pacific halibut landed in the county	Change in % value of landings vs. % estimated earnings	Estimated economic impact of Pacific halibut commercial fishing on households[(1)]
Aleutians East	0.32	**0.067**	-	0.86
Aleutians West	1.45	**0.129**	-	4.35
Anchorage	0.53	NA	+	0.81
Bristol Bay	c	NA	+	c
Dillingham	c	c	c	c
Fairbanks North Star	c	NA	+	c
Haines	0.19	NA	+	0.39
Hoonah-Angoon	0.40	0.201	-	1.09
Juneau	1.65	0.237	+	5.13
Kenai Peninsula	**4.69**	0.182	-	**11.25**
Ketchikan Gateway	0.39	**0.502**	+	0.85
Kodiak Island	**3.23**	0.369	+	**8.31**
Lake and Peninsula	c	NA	c	c
Matanuska-Susitna	c	NA	+	c
Nome	0.22	0.288	+	0.52
Petersburg	**2.83**	**0.437**	+	**7.50**
Prince of Wales-Hyder	0.22	0.362	+	0.59
Sitka	1.04	**0.432**	+	2.48
Skagway	c	NA	+	c
Southeast Fairbanks	c	NA	+	c
Valdez-Cordova	0.82	0.175	-	2.04
Wrangell	0.56	0.223	-	1.19
Yakutat	0.67	**0.118**	-	1.54

Notes: Counties with no Pacific halibut landings or earnings from Pacific halibut sectors omitted. c – masked to preserve confidentiality; NA – not applicable (no landings reported for the given county). [(1)]Assumes intra-Alaska indirect and induced economic effects retention within the county, i.e. no cross-county trade in commodities.

the model assumes that USD 700 of food commodity demanded by the Pacific halibut fishing industry is sourced from within the Aleutians East county, not other Alaskan counties. The same rule is applied to the workforce. Available statistics suggest a considerable movement of workers between Alaskan counties (see summary in Appendix 3 Intra-Alaska workplace commuting flows summary). Further research on the impact of cross-county flow of commodities and wages on the presented results is recommended.

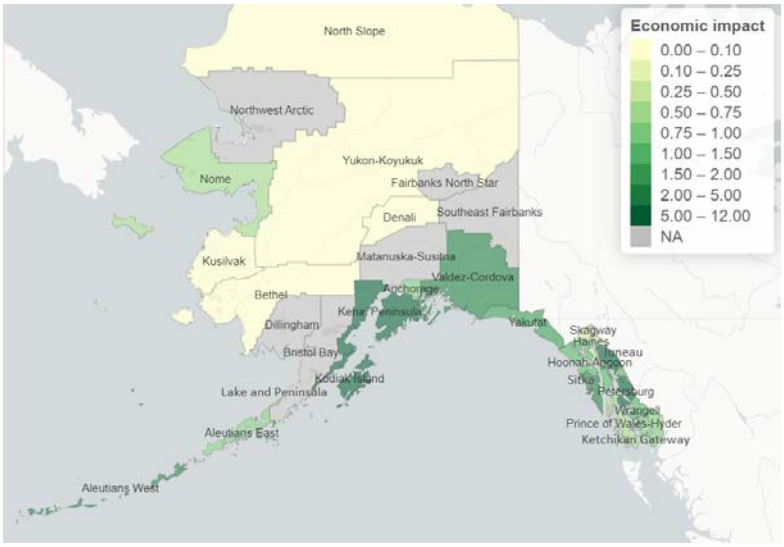

Figure 1 County-level economic impact estimates for Alaska – 2019.

Economic impact of Pacific halibut charter fishing in Alaska

Assuming that the economic impact of Pacific halibut charter fishing in Alaska is equivalent to estimating the total economic loss resulting from the saltwater charter sector therein shrinking by share of Pacific halibut effort in total effort (22.4% in 2019), the total economic impact of Pacific halibut charter sector in Alaska is assessed at USD 87.7 mil for 2019.

It is more meaningful, however, to analyze the Pacific halibut charter sector in terms of its contribution to households, particularly to local households. **Table 6** summarizes the results, also providing a comparison with the economic impact on households of commercial fishing in Alaska. Not surprisingly, the economic impact per 1 USD of output is higher for the commercial vs. the charter sector. The commercial sector is producing an intermediate input that is not only supporting suppliers to the harvesting sector, but also the forward-linked processing sector. However, the economic impact of 1 lbs of Pacific halibut removal counted against TAC in the stock assessment is 66% higher for the charter sector when compared with the commercial sector.

It should also be noted that this assessment accounts for only a fraction of the Pacific halibut contribution to the economy through recreational fishing. The analysis, at this time, does not account for the impact of anglers spending money on durable goods they use on the charter trips (e.g., fishing equipment) and expenditures by private anglers.

Table 6 Results for the Pacific halibut charter sector in Alaska and comparison with the commercial sector in Alaska (2019).

	Unit	Charter	Commercial
Economic impact on households	Total in mil. USD	27.08	105.45
Economic impact on households in Alaska	Total in mil. USD	14.2	49.56
Economic impact on households	USD per 1 USD of output	1.05	1.23
Economic impact on households in Alaska	USD per 1 USD of output	0.55	0.58
Economic impact on households	USD per 1 lb of removals	9.54	5.75
Economic impact on households in Alaska	USD per 1 lb of removals	5.01	2.70

Final remarks

The study's main contribution is the first consistent estimation of both backward and forward-linked effects of fisheries supply changes in a multiregional setup tracing the transmission of impacts internationally.[16] By linking multiple spatial components, the model offers a better understanding of the impacts of changes in shared stock supply.

The complexity of Pacific halibut supply-side restriction in the form of region-based allocations suggests the need for a tool enabling regulators to assess various combinations of TAC allocations. To address this, the results are complemented by an interactive web-based application allowing users to estimate and visualize joint effects based on custom changes simultaneously applied to all IPHC-managed Pacific halibut producing areas. The tool is available at:

http://iphcecon.westus2.cloudapp.azure.com:3838/ModelApp_azure/.

Release 2.0 of the tool (expected by May 20, 2021) accounts for the commercial sector and the charter sector in Alaska. Inclusion of the recreational component for other regions is underway. The updated version of the tool also translates changes in harvest allocations by IPHC Regulatory Area to county-level economic impact estimates for Alaska, informing on community impacts of changes to Pacific halibut regional allocations. See *Appendix 2 Harvest translated into landings by county* for example of the translation table.

The updated PHMIA model translating the changes in harvest allocations by IPHC Regulatory area directly to economic impact is also well adapted to use with the Pacific halibut management strategy evaluation (MSE) framework (IPHC, 2020b). Economic performance metrics presented alongside already developed biological/ecological performance metrics would bring the human dimension to the MSE framework, adding to the IPHC's portfolio of tools for assessing policy-oriented issues (as requested by the Commission, IPHC-2021-AM097-R, AM097-Req.02).

Lastly, while the quantitative analysis is conducted with respect to components that involve monetary transactions, Pacific halibut's value is also in its contribution to the diet through subsistence fisheries and importance to the traditional users of the resource. To native people, traditional fisheries constitute a vital aspect of local identity and a major factor in cohesion. One can also consider the Pacific halibut's

[16] While a study analyzing the impact of Pacific salmon fisheries on the economy of both the USA and Canada using the IO approach was identified (Gislason *et al.*, 2017), the models therein are disconnected and do not offer the consistency of an integrated multiregional model.

existence value as an iconic fish of the Pacific Northwest. While these elements are not quantified at this time, recognizing such an all-encompassing definition of the Pacific halibut resource contribution, the project echoes a broader call to include the human dimension into the research on the impact of management decisions, as well as changes in environmental or stock conditions.

OBJECTIVES

Table 7 summarizes the progress to date against the IPHC economic study objectives.

Table 7. The study objectives – summary of progress

Objective	Status*
Item 1: Survey of previous studies and existing information	**---**
Item 1.a: Literature review	**COMPLETED**
Item 1.b: Description of ongoing regular data collection programs	**COMPLETED**
Item 1.c: Collection of primary data – commercial sector survey	**IN PROGRESS**
Item 1.d: Collection of primary data – charter sector survey	**IN PROGRESS**
Item 2: Comprehensive qualitative structural description of the current economics of the Pacific halibut resource	**---**
Item 2.a: Description of the economics of the Pacific halibut commercial sector	**COMPLETED**
Item 2.b: Description of the economics of the Pacific halibut recreational sector	**COMPLETED**
Item 2.c: Description of the economics of other Pacific halibut sectors (bycatch, subsistence, ceremonial, research, non-directed)	**IN PROGRESS**
Item 3: Quantitative analysis of the economic impact of the directed Pacific halibut fishery	**---**
Item 3.a: Methodology – a model of the economy	**COMPLETED**
Item 3.b: Methodology – inclusion of the commercial sector in the SAM	**COMPLETED(1)**
Item 3.c: Methodology – inclusion of the recreational sector in the SAM	**COMPLETED(1)**
Item 3.d: Methodology – economic value of the subsistence use	**IN PROGRESS(2)**
Item 4: Account of the geography of the economic impact of the Pacific halibut sectors	**---**
Item 4.a: Visualization of region-specific economic impacts	**COMPLETED(1)**
Item 5: Analysis of the community impacts of the Pacific halibut fishery throughout its range, including all user groups	**---**
Item 5.a: Community impacts assessment of the Pacific halibut fishery	**COMPLETED(1)**
Item 6: Summary of the methodology and results of the IPHC study in comparison to other economic data and reports for the Pacific halibut resource, other regional fisheries, and comparable seafood industry sectors	**---**
Item 6.a: Putting results into perspective	**IN PROGRESS**

* All items marked as COMPLETED are subject to updates based on the direction of the project and evolution of the situation in the Pacific halibut fisheries. (1)Subject to changes based on the data collected through the IPHC Economic survey. (2)Subject of collaborative research proposal with NOAA Alaska Fisheries Science Center.

Suggested extensions beyond the 2-year time frame

Expanding the static SAM model to a computable general equilibrium model

Relaxing the assumption of fixed technical coefficients by specifying these coefficients econometrically as a function of relative prices of inputs is one of the most compelling extensions to the static IO or SAM models. Such models, generally referred to as computable general equilibrium (CGE) models, require however extensive research to develop credible functional relationships between prices and consumption that would guide economic agents' behavior in the model.

The CGE approach is a preferred way forward when expanding the model usability and considering applying it in conjunction with the Pacific halibut management strategy evaluation (IPHC, 2020b). The dynamic model is well suited to analyze the impact of a broad suite of policies or external factors that would affect the stock over time.

Improving the spatial granularity of the SAM model

Extending the community analysis beyond a simplified approach described in section *Community impacts in Alaska* to a full community level (or any other spatial scale) SAM-based model requires significant investment in identifying the economic relationships between different sectors or industries (including both seafood and non-seafood industries) within each broader-defined region, this including deriving estimates on intra-regional trade in commodities and flow of earnings. It is an appealing extension of the current model, but not a feasible avenue for the project with its current time frame.

Study of recreational demand

It is important to note that while it is reasonable to assume that changes in harvest limits have a relatively proportional impact on production by commercial fishers (unless these are dramatic and imply fleet restructure or a significant shift in prices), the effects on the recreational sector are not so straightforward.

A separate study estimating changes in saltwater recreational fishing participation as a response to the changing recreational harvest limits is necessary if the stakeholders are interested in assessing policy impact rather than snapshot economic impact. Such studies typically require surveying recreational fishers.

There is scope for collaboration here with the NOAA Alaska Fisheries Science Center, where there is ongoing work on estimating the marginal value of a Pacific halibut from the charter fishing sector in Alaska. If the project was to continue beyond two years, the IPHC could consider surveying recreational fishers. The charter owners who participated in the charter survey pilot implied willingness to help with, e.g., distributing a link to the IPHC survey inquiring about their customers' fishing preferences. How to reach private anglers partaking in unguided fishing was not researched at this time.

Assessment of the economic impact of other sources of Pacific halibut mortality

All-sectors-encompassing assessment of the economic impact of the Pacific halibut resource necessitates the development of a methodological approach for the remaining sources of Pacific halibut mortality, including subsistence fishing, bycatch, and research catch. Methods adopted for the commercial and charter sector are not adequate for this portion of the harvest.

RECOMMENDATIONS

That the SRB:

1) **NOTE** paper IPHC-2021-SRB018-09 which provides an update on the IPHC economic study, including progress on the development of the economic impact assessment model, state of the collection of primary economic data from Pacific halibut dependent sectors, and the most recent set of results on regional and community impacts;

2) **RECOMMEND** the use of the PHMEIA model results as supplementary performance metrics in the MSE framework;

3) **RECOMMEND** improvements to the PHMEIA and PHMEIA-r framework, including methodological approach and model assumptions.

4) **NOTE** that improving the accuracy of economic impact assessment of the Pacific halibut resource depends on broader stakeholders' active participation in developing the necessary data for analysis and **RECOMMEND** additional outreach activities.

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Appendix 1 *Assumptions on the Pacific halibut sectors in Alaska*

Workforce flows in the Pacific halibut commercial fishing sectors

The Alaska Department of Labor and Workforce Development (ADLWD) data suggest a considerable share, in a range of 61-68% (2014-2019), of out-of-state employment in the fisheries sector in Alaska (Kreiger and Whitney, 2021).[17] However, the preliminary results from the IPHC economic survey focused on the Pacific halibut fleet suggest more local employment in this part of the fishing sector. Consequently, the model assumes the following composition of the labor force (in terms of wages) in the Pacific halibut fishing sector: 78% Alaska residents, 20% residents of the US West Coast and 2% residents of other US states. Due to the currently low sample size, the adopted estimates on the cross-state flow of wages in the Pacific halibut fishing sector are subject to change.

The ADLWD also reports on the nonresident workers in the seafood processing sector, noting that this industry has had the highest number and percentage of nonresident workers every year since data collection began (Kreiger and Whitney, 2021). The latest available estimates for 2019 suggest that nonresidents constituted 68.3% of the workforce in terms of wages. The model adopts the same share to Pacific halibut processing, assuming there is no significant difference in the operations of processing plants depending on the species. The nonresident origin is assumed to follow the general trends reported by the Internal Revenue Service (IRS, 2020).

In the assessment of the county-level economic impacts, the resident workforce is allocated based on vessel homeport county, as reported by the Commercial Fisheries Entry Commission CFEC (CFEC, 2021b), and matched using vessels ADFG number.

Proprietor income flows in the Pacific halibut commercial fishing sectors

While the Pacific halibut commercial harvest limits are allocated between IPHC Regulatory areas and can be categorized according to landing location using logbook data, the economic analysis of the sector calls for tracing the monetary flows beyond the harvest and landing stage. Profits from Pacific halibut commercial fishing and processing can be spatially allocated based on a combination of various other parameters: (1) residence of the vessel owner, reported by the CFEC (2021); (2) residence of the quota owner, reported by the CFEC (2021a); (3) location of the harvest buyer, reported in the ADFG's Commercial Permit and License Holders Listing (ADFG, 2021b); (4) location of processing, including custom processing[18] if ordered; and (5) location of the processing company owner or business headquarters. The headquarters are assumed to be synonymous with the location of the final beneficiary of the processing profits.

According to 2020 data (details in **Table 8**), the county of landing matched the county of vessel owner residence for about 48.5% worth of harvest. When it comes to the residence of the permit owner, it matched the county of landing for 46.1% harvest value. Vessel homeport matched about 50.0% worth of landings. This suggests a considerable flow of benefits related to the harvest of Pacific halibut between Alaskan counties, as well as an outflow of the benefits from Alaska to other US states. The

[17] Historical reports are available at: https://live.laborstats.alaska.gov/reshire/reshist.cfm.
[18] Custom processing is when another entity is processing the fish on behalf of the buyer.

direction of the flow of benefits from the landing area to vessel owner residence, quota holder residence and vessel homeport location is depicted in **Figure 2**. Here, the inner circle represents the county where the fish was landed, and the outer circle represents the county where (1) the vessel owner resides, (2) where the quota owner resides, and (3) the vessel homeport is located. The width of the ring section represents the estimated value of landings.

Table 8 Cross-regional and cross-county flow of benefits related to residence of the vessel owner, the permit owner, and vessel homeport.

	Landing value	Value by the residence of the vessel owner	Change vs. landing value	Value by the residence of the quota holder	Change vs. landing value	Value by vessel homeport location[(1)]	Change vs. landing value
Aleutians East	5.69	0.62	-89.2%	0.67	-88.3%	1.23	-78.4%
Aleutians West	7.04	1.44	-79.6%	1.81	-74.3%	4.52	-35.9%
Anchorage	0	0.77	+	1.42	+	0.37	+
Bristol Bay	c	0	NA	0	NA	0	NA
Dillingham	0.05	0.06	25.7%	0.06	25.7%	0.06	25.7%
Fairbanks North Star	0	c	+	c	+	0	+
Haines	c	1.02	NA	0.72	NA	0.38	NA
Hoonah-Angoon	1.64	0.76	-53.7%	0.65	-60.6%	0.97	-40.9%
Juneau	5.81	2.96	-49.1%	2.87	-50.5%	6.04	4.0%
Kenai Peninsula	16.81	12.50	-25.6%	10.44	-37.9%	11.69	-30.5%
Ketchikan Gateway	0.82	0.81	-0.9%	0.89	9.3%	1.05	27.8%
Kodiak Island	6.29	6.97	10.7%	5.74	-8.8%	8.30	31.9%
Lake and Peninsula	0	c	+	c	+	c	+
Matanuska-Susitna	0	2.01	+	1.30	+	c	+
Nome	0.57	0.57	0.0%	0.57	0.0%	0.49	-13.8%
Petersburg	3.79	6.32	66.6%	6.58	73.5%	7.15	88.5%
Prince of Wales-Hyder	0.51	0.52	1.9%	0.55	7.8%	0.61	18.4%
Sitka	1.07	1.92	79.1%	1.79	67.7%	2.04	91.2%
Southeast Fairbanks	0	1.14	+	1.04	+	c	+
Skagway	c	0	NA	c	NA	0	NA
Valdez-Cordova	3.53	1.26	-64.2%	1.95	-44.9%	1.78	-49.6%
Wrangell	1.16	1.25	7.7%	1.15	-1.1%	1.10	-5.3%
Yakutat	3.68	1.95	-47.0%	1.83	-50.1%	1.61	-56.3%
WC	1.57	14.22	803.4%	14.33	810.7%	10.34	556.7%
RUS	0	0.96	+	3.60	+	0	+

Notes: c – confidential, represents less than three vessels; + represents a positive flow when the landing base was zero. [(1)]Vessel homeport was not identified for about USD 228,600 worth of landings.

(1) Landing area vs. vessel owner residence (2) Landing area vs. permit owner residence (3) Landing area vs. vessel homeport location

Figure 2 Direction of the flow of benefits from the landing area to (1) vessel owner residence, (2) quota holder residence, and (3) vessel homeport location.

The majority of the Pacific halibut buyers in 2020 were located in Alaska (97.8% in terms of value); 2.2% worth of harvest went to out-of-state buyers and could not be traced further. Within Alaska, 99.7% of buyers were shorebased processors. Processing typically occurs in the buyer's location. Only about 10.9% of the harvest in terms of landing value went through custom processing, of which 23.9% in the place different to the location of the buyer, typically right where it was landed (100%). The remaining harvest (i.e., not going through custom processing) matched the landing county for about 91.4% of landings in terms of value, with the remainder going through buying stations located at the landing location.

Following the flow of revenues further, about 58.9% worth of harvest purchased by shorebased processors was purchased by shorebased processors that listed as a point of contact a county other than the location of the processing facility. Assuming that the contact point location is associated with the business owner or business headquarters, this suggests substantial monetary flows related to profits from the processing. What is more, 96.3% of the above value can be traced to processors with headquarters on the US West Coast. Note that the share here was calculated based on the original landing value and does not account for variation in wholesale value dependent on the type of produced outputs.

Figure 3 depicts the flow of revenue from the harvest location to the processing profit beneficiary. Here, nods represent spatial aggregation:

- Blue – harvest by IPHC Regulatory Areas;
- Red – county of the landing site;
- Yellow – if ordered, county of the custom processing;
- Green – county of the reported buyer (location of the buying station not included in the figure);
- Purple – location of the Fisheries Business License holder (based on the contact address).

Ribbons represent flows in terms of the estimated value of landings (mil. USD) (i.e., landing value, not adjusted for value added through processing):

- Blue ribbons represent the flows from harvest grounds to landing sites in Alaska;
- Grey ribbons represent the flows between nodes that are located in the same Alaskan county;
- Orange ribbons represent the flows between nodes that are located in different counties;
- Red ribbons represent the flows out of Alaska.

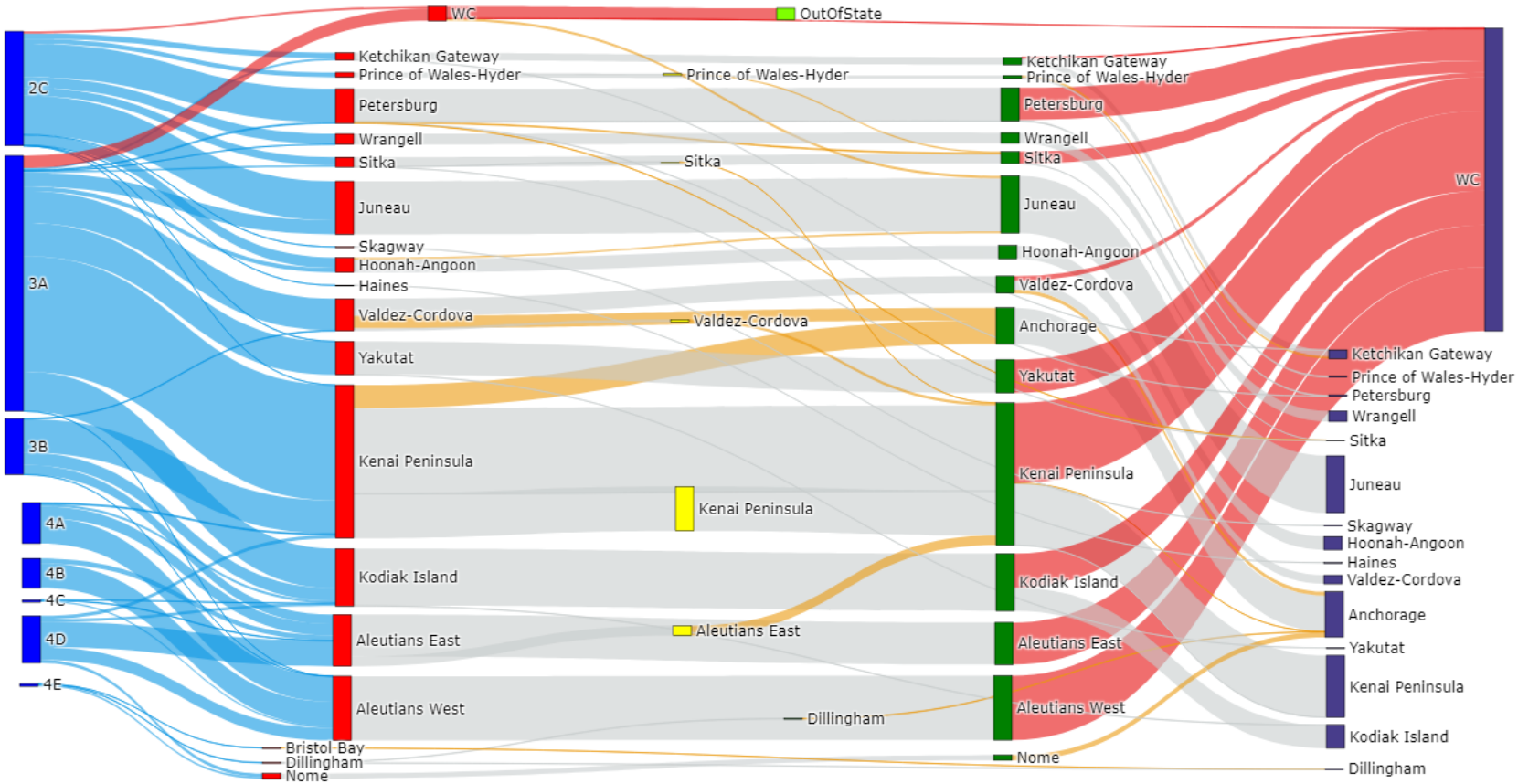


Figure 3 Flow of Pacific halibut harvest from harvest location to buyer's headquarters (2020).

Production structure of the Alaskan saltwater charter sector

Assuming no structural changes to the Alaskan saltwater charter sector from 2017 to 2019, using values reported in Lew & Lee (2019) adjusted for inflation[19] and effort changes (NOAA, 2021c), the model (PHMEIA-r) introduces to the SAM a new sector disaggregated from services with the production total of USD 115.2 mil. This includes USD 75.8 mil in operating costs and USD 16.3 mil in labor expenses. The distribution of the sector's expenditures is based on data reported by Seung & Lew (2017).

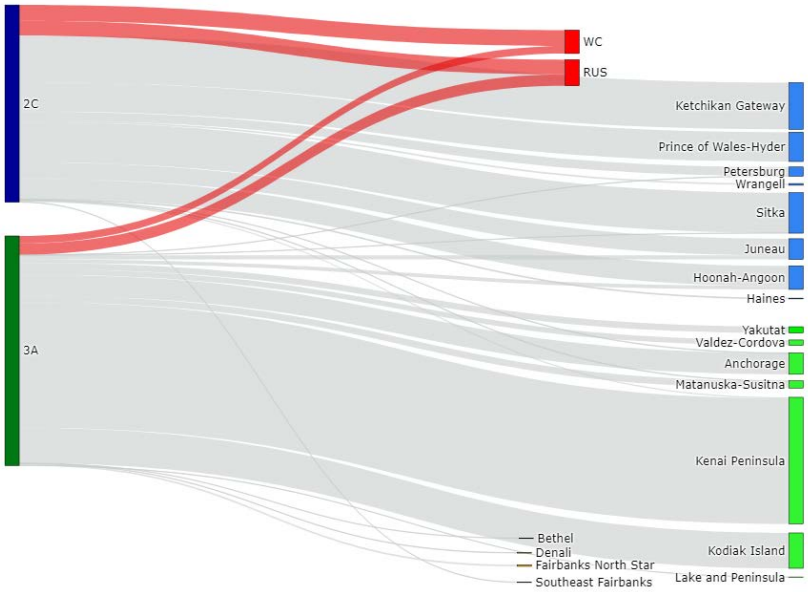
Pacific halibut charter sector is assumed to account for 22.4% (2019) of the Alaskan saltwater charter sector (USD 25.8 mil.). This is calculated as a share of Pacific halibut effort reported by Webster & Powers (2020) in total effort reported by the Marine Recreational Information Program (NOAA, 2021c).

Flows in the Alaskan Pacific halibut charter sector

NOAA (2021b) reports on ownership of Charter Halibut Permits (CHPs). The cross-regional flows related to proprietors' income were assessed using permit holder addresses and the number of endorsed anglers associated with each permit. These flows in 2020 are depicted in **Figure 4**. Outflows related to the workforce in the charter sector are set to 10% for the US West Coast, 40% for the rest of the USA, and 15% for the rest of the world, and are based on the IPHC economic survey responses.

The charter sector also assumes "export" of Pacific halibut fishing trips (i.e., offering services to nonresidents) based on out-of-state participation statistics (NOAA, 2021c) allocated between regions following estimates reported by Southwick Associates (2014).

[19] Using consumer price index, available here: https://data.bls.gov/cgi-bin/cpicalc.pl.



Note: Flows in terms of the number of endorsed anglers. Red ribbons represent outflows from Alaska. Source: NOAA (2021b).

Figure 4 Proprietors income flows for Alaska charter sector (2020).

Appendix 2 *Harvest translated into landings by county*

Table 9 Harvest (in terms of value) translated into landings by county (2020).

	2C	3A	3B	4A	4B	4C	4D	4E	SUM	Total USD
Aleutians East	0	0	1.7%	2.1%	0.9%	0.1%	4.6%	0	9.5%	5.7
Aleutians West	0	c	0.0%	4.7%	4.5%	0.3%	2.3%	0	11.7%	**7.0**
Bristol Bay	0	0	0	0	0	0	0	c	0.0%	c
Dillingham	0	0	0	0	0	0	0	0.1%	0.1%	0.1
Haines	c	0	0	0	0	0	0	0	0.0%	c
Hoonah-Angoon	1.9%	0.8%	0	0	0	0	0	0	2.7%	1.6
Juneau	**7.1%**	2.6%	0	0	0	0	0	0	9.7%	5.8
Kenai Peninsula	c	**21.1%**	**6.1%**	0.2%	0	0	0.6%	0	28.0%	**16.8**
Ketchikan Gateway	1.0%	0.4%	0	0	0	0	0	0	1.4%	0.8
Kodiak Island	0	**7.3%**	2.3%	0.4%	0	c	c	0	10.5%	**6.3**
Nome	0	0	0	0	0	0	0.6%	0.4%	0.9%	0.6
Petersburg	**6.1%**	0.2%	0	0	0	0	0	0	6.3%	3.8
Prince of Wales-Hyder	0.9%	0	0	0	0	0	0	0	0.9%	0.5
Sitka	1.5%	0.3%	0	0	0	0	0	0	1.8%	1.1
Skagway	c	0	0	0	0	0	0	0	0.0%	c
Valdez-Cordova	0	5.8%	c	0	0	0	0	0	5.8%	3.5
Wrangell	1.9%	c	0	0	0	0	0	0	1.9%	1.2
Yakutat	0.1%	6.1%	0	0	0	0	0	0	6.1%	3.7
West Coast	0.4%	2.3%	0	0	0	0	0	0	2.6%	1.6
SUM	**20.9%**	**46.7%**	10.1%	7.4%	5.4%	0.4%	8.1%	0.4%		60.1

Notes: c – confidential, represents less than 3 vessels. Numbers in grey do not sum to the total for the landing county/IPHC Regulatory Area due to confidentiality restrictions.

Appendix 3 *Intra-Alaska workplace commuting flows summary*

Table 10 Intra-Alaska workplace commuting flows summary (2019).

	Outflow to other AK countries	Inflow from other AK counties	Intra-Alaska net flow	Flow as % of total workforce	Nonlocal wages (private)	Nonresident wages (private)
Aleutians East	3	51	48	0.35%	11.4%	73.8%
Aleutians West	7	146	139	0.71%	10.4%	47.1%
Hoonah-Angoon	101	79	-22	-0.31%	19.6%	31.4%
Juneau	150	376	226	0.17%	10.7%	20.6%
Kenai Peninsula	1836	341	-1495	-0.83%	7.3%	13.2%
Ketchikan Gateway	63	156	93	0.17%	7.0%	18.8%
Kodiak Island	75	83	8	0.02%	8.0%	19.6%
Nome	16	105	89	0.34%	15.0%	14.4%
Petersburg	123	101	-22	-0.17%	8.6%	25.3%
Prince of Wales-Hyder	74	87	13	0.08%	5.7%	38.1%
Sitka	58	45	-13	-0.04%	6.8%	25.4%
Valdez-Cordova	92	662	570	1.46%	18.6%	28.0%
Wrangell	40	9	-31	-0.45%	10.1%	21.6%
Yakutat	7	11	4	0.18%	11.5%	32.9%

Notes: Columns 2-4 based on the American Community Survey, Residence County to Workplace County Commuting Flows for the United States and Puerto Rico Sorted by Residence Geography: 5-Year ACS, 2011-2015 (US Census, 2021a). Total workforce as reported in BEA table CAEMP25N. Nonlocal wages are wages earned by AK residents who commute for work to different county. Nonresident wages are wages earned by nonresidents, defined as persons not eligible for the Alaska Permanent Fund Dividend. Nonlocal and nonresident wages based on Kreiger & Whitney (2021). Table includes only countries with Pacific halibut landings typically over USD 100,000. (ADFG, 2021a).