ECONOMIC LITERATURE REVIEW

PREPARED BY: IPHC SECRETARIAT (B. HUTNICZAK; 9 FEBRUARY 2021)

REVIEW OF ECONOMIC IMPACT ASSESSMENT MODELS FOCUSED ON THE FISHERIES SECTOR

There is a few decades' worth of experience in developing input-output models with applications to fisheries. Seung and Waters (2006) provide an excellent overview of studies available up to 2006, starting with papers published as early as 1967 (Rorholm et al. 1967). The majority of these studies consider a single region with one exception. Butcher et al. (1981) offer an early example of multiregional analysis applied to the Alaska shellfish fishery. An early example of a supply-driven model for fisheries is available in Leung and Pooley (2002), who use the IO modeling technique to assess the impact of the reduction in fishing areas adopted in order to protect certain turtle populations. The majority of earlier models are using the demand-driven approach.

More recent models offer ever more complex mathematical depictions of the economy comprised of hundreds of interlinked sectors that are built with the purpose of assessing the economic effects of fishery management policies that alter seafood sectors. The majority of these models, developed for various regions of the United States, rely on adaptations to the widely distributed commercial regional input-output modeling system known as IMPLAN (IMPLAN Group LLC. IMPLAN 2020. Huntersville, NC. IMPLAN.com.). Currently, IMPLAN data contains 546 sectors representing all private industries in the United States classified based on the U.S. Census Bureau's North American Industry Classification System (NAICS). It includes three sectors that are directly related to the seafood supply chain: commercial fishing (sector 17), seafood product preparation and packaging (sector 92), and wholesale - grocery and related product wholesalers (sector 398). There is also an animal production sector that includes aquaculture (sector 14). IMPLAN is a widely-used tool for academic and professional economists for the estimation of economic impact in a variety of sectors.

One of the earlier examples of IMPLAN adaptations to fisheries is the Northeast Region Commercial Fishing Input-Output Model (Steinback and Thunberg 2006). The model covers 24 regions in the Northeast and focuses on refining fishing-related sectors by disaggregating them into more detailed subsectors. The modifications include splitting the commercial fishing sector based on gear type and vessel size class, detaching seafood wholesalers from a more general wholesale category, and adding seafood dealer sectors for each coastal region. Given the high spatial granularity, the model makes a number of simplifying assumptions on the industries' structure. Harvesters are assumed to sell all of their output to wholesale dealers via direct sales or through fish exchanges/auctions. Wholesale dealers are assumed to sell their output to final consumers, intermediate demand industries (including seafood processors), and businesses located outside of the Northeast region (export). Seafood dealer sectors and fish exchanges/auctions are treated as margin sectors. This means the value of their sales excludes the cost of the sold goods, i.e., the sales include only the value added to the sold product, and impacts that may accrue beyond the processor level are not incorporated. The model is only partially multiregional as it accounts for the interconnections only between the fishing-related businesses (commercial harvesters, wholesale seafood dealers, bait suppliers, and seafood processors). The non-fishing effects are estimated jointly and appropriated to regions according to their relative importance to the total Northeast economy. Due to its extensive data requirements, this model was difficult to keep up-to-date and is not maintained anymore (Steinback, personal communication).

The US-wide application of the IO modeling technique to commercial fishing and seafood industry is a model developed for the National Marine Fisheries Service (NMFS) by Kirkley (2009). Economic impacts are expressed in terms of employment (full-time and part-time jobs), personal income, and output (sales by US businesses), separately for 18 categories of species of fish defined by the model, as well as for seafood processors, wholesalers/distributors, grocers, and restaurants. Geographically, the model estimates impacts for the US as a whole and for 23 coastal states. At the state level, estimates for each sector are based on fishery products harvested in that state or imported to that state from a foreign source. The model serves as a base for producing annual fisheries impacts estimates for the Fisheries Economics in the United States report, published since 2006 and available here. The latest report is available for 2016 (NOAA 2018).

IMPLAN customization for the US Pacific Coast has been developed by Leonard and Watson (2011), largely following the approach by Steinback and Thunberg (2006). The model distinguishes 19 vessel categories that produce 32 unique species and gear commodity outputs. These include three groundfish sectors (large groundfish trawlers, small groundfish trawlers, other groundfish fixed gear) that harvest Pacific halibut. Data used to build the custom fishing sectors were obtained from Pacific Fisheries Information Network (PacFIN) fish ticket data maintained by the Pacific States Marine Fisheries Commission, the Northwest Fisheries Science Center's (NWFSC) cost earnings surveys, moorage rates from ports along the West Coast, and collection statistics for the Washington Enhanced Food Fish Tax used to estimate the flow of fish landings to wholesalers. Default IMPLAN 2006 data were used for the regional non-fishing economy, as well as the various institutions in the region such as households and the government.

Periodically, the National Oceanic and Atmospheric Administration (NOAA) also provides an assessment of the economic contribution of marine angler expenditures in the United States (Lovell et al. 2016; Lovell, Steinback, and Hilger 2013; Steinback and Gentner 2008). The latest estimates (based on data from 2014), limited to the contribution of expenditures on durable goods (excluding trip cost, covered in the report from 2013), suggest that at the national level, marine anglers spent USD 28 billion on fishing equipment and durable goods (e.g., fishing rods, tackle, boats). These expenditures are assessed to generate an estimated USD 49.6 billion in total output, added USD 29 billion in contribution to GDP, contributed USD 18 billion to personal income and supported more than 358 000 jobs across the United States. No estimates specific to subsectors defined based on target species are available.

BC Stats (Sun and Hallin 2018) provide estimates of direct, indirect, and induced effects arising from the economic activities of industries within the fisheries sector in British Columbia, including capture fisheries, seafood processing and sport fishing. The assessment is based on the British Columbia input-output model built using information from the 2014 IO tables for the province available from Statistics Canada (Statistics Canada 2019). The results suggest that for every dollar of output in capture fishery, aquaculture, and fish and seafood processing combined, an additional CAD 0.386 is generated in the province by industries supplying goods and services used by the commercial fishing, aquaculture, fish processing, and sport fishing industries. This model, however, does not provide Pacific-halibut specific estimates and analyses economic impact only within the region of the resource extraction, omitting impacts outside British Columbia.

The fisheries sector is often fixed on the supply side as fisheries policies usually target output by setting total allowable catch (TAC) limits. Supply-driven approach applications have been applied in a variety of settings, for example, to study backward and forward linkage effects of Alaska fisheries (Seung and Waters 2009) or to assess the economic impacts of restricting catch of Pacific cod and Atka mackerel in the Aleutian Islands in order to protect Steller sea lions (Seung and Waters 2013), Chinook salmon fishery failures (Seung 2017) and catch limits on Alaska pollock fishery (Seung 2014).

The most advanced multiregional economic analysis focused on fisheries, applied at borough level to the seafood industry in Alaska, is a social accounting matrix developed at the NOAA Alaska Fisheries Science Center (AFSC) by Seung, Waters, and Taylor (2019). The model allows for analysis of the impacts on individual fishing-dependent communities rather than broad administrative areas (e.g., the entire state), serving as a useful tool to fishery managers interested in more localized impacts of exogenous shocks, either natural or policy-induced. The model uses the results of a detailed survey of fish harvesting vessel owners and interviews with key seafood business stakeholders from six boroughs and census areas in the Southwest Alaska region. The survey, designed specifically to account for cross-regional effects, collected information on the geographic distribution of expenditures. A detailed survey description is available in Waters, Baker, and Taylor (2016). An earlier, three-region version of this model (Alaska, West Coast, and rest of USA) has been used for several economic impact assessments in the pacific northwest, including Alaska head and gut (H&G) fishing fleet (Waters et al. 2014). The full description of this model, accompanied by a manual to a web-based application for custom estimates, is available in Seung and Miller (2018).

No models focused on fisheries connecting the economies of the United States and Canada were identified. Although (Gislason et al. 2017) analyze the impact of Pacific Salmon fisheries on the economy of both countries using the IO approach, their models are disconnected and do not offer the consistency of an integrated multiregional model.

The IO approach can also be used to assess the impact of the reduced number of recreational fishing trips. A multiregional CGE model developed by Seung and Lew (2017) assesses the economic impact of restrictions imposed on saltwater sport fishing in Alaska, considering a variety of limit changes to Pacific halibut, chinook salmon, and coho salmon. The findings suggest that although adverse economic impacts of reduced bag limits on Alaska can be to some degree compensated for by increases in economic activities in the other regions or other sectors, the cost of one fewer Pacific halibut allowance can still decrease the economic activity in Alaska by USD 4.7-9.0 mil. The model uses fishing participation changes arising due to changes in the limits predicted from a stated-preference model.

REFERENCES

Butcher, Walter, Joanne Buteau, Kenneth Hassenmiller, Glen Petry, and Samith Statieh. 1981. “Economic Impacts of the Alaska Shellfish Fishery: An Input-Output Analysis.” *NOAA Technical Memorandum NMFS F/NWC* 9.

Gislason, Gordon, Edna Lam, Knapp Gunnar, and Mouhcine Guettabi. 2017. *Economic Impacts of Pacific Salmon Fisheries*.

Kirkley, James E. 2009. *The NMFS Commercial Fishing & Seafood Industry Input/Output Model (CFSI I/O Model)*.

Leonard, Jerry, and P. Watson. 2011. “Description of the Input-Output Model for Pacific Coast Fisheries.” *NOAA Technical Memorandum NMFS-NWFSC* 111(April).

Leung, Pingsun, and Sam Pooley. 2002. “Regional Economic Impacts of Reductions in Fisheries Production: A Supply-Driven Approach.” *Marine Resource Economics* 16(4):251–62.

Lovell, Sabrina J., James Hilger, Scott Steinback, and Clifford P. Hutt. 2016. “The Economic Contribution of Marine Angler Expenditures on Durable Goods in the United States, 2014.” *NOAA Technical Memorandum NMFS-F/SPO* 165.

Lovell, Sabrina J., Scott Steinback, and James Hilger. 2013. “The Economic Contribution of Marine Angler Expenditures in the United States, 2011.” *NOAA Technical Memorandum NMFS-F/SPO* 134.

NOAA. 2018. “Fisheries Economics of the United States, 2016.” *NOAA Technical Memorandum NMFS-F/SPO* 187.

Rorholm, N., H. C. Lampe, N. Marshall, and J. F. Farrell. 1967. “Economic Impact of Marine-Oriented Activities: A Study of the Southern New England Marine Region.” *Agricultural Experiment Station Bulletin* 396.

Seung, Chang K. 2014. “Estimating Effects of Exogenous Output Changes: An Application of Multi-Regional Social Accounting Matrix (MRSAM) Method to Natural Resource Management.” *Regional Science Policy & Practice* 6(2):177–93.

Seung, Chang K. 2017. “A Multi-Regional Economic Impact Analysis of Alaska Salmon Fishery Failures.” *Ecological Economics* 138:22–30.

Seung, Chang K., and Daniel K. Lew. 2017. “A Multiregional Approach for Estimating the

Economic Impact of Harvest Restrictions on Saltwater Sportfishing." *North American Journal of Fisheries Management* 37(5):1112–29.

Seung, Chang K., and S. Miller. 2018. "Regional Economic Analysis for North Pacific Fisheries." *NOAA Technical Memorandum NMFS-AFSC* 380.

Seung, Chang K., and Edward C. Waters. 2006. "A Review of Regional Economic Models for Fisheries Management in the U.S." *Marine Resource Economics* 21(1):101–24.

Seung, Chang K., and Edward C. Waters. 2009. "Measuring the Economic Linkage of Alaska Fisheries: A Supply-Driven Social Accounting Matrix (SDSAM) Approach." *Fisheries Research* 97(1):17–23.

Seung, Chang K., and Edward C. Waters. 2013. "Calculating Impacts of Exogenous Output Changes: Application of a Social Accounting Matrix (SAM) Model to Alaska Fisheries." *The Annals of Regional Science* 51(2):553–73.

Seung, Chang K., Edward Waters, and Michael L. Taylor. 2019. "Developing a Multi-Regional Social Accounting Matrix (MRSAM) for Southwest Alaska Fisheries." *NOAA Technical Memorandum NMFS-AFSC* 399.

Statistics Canada. 2019. "Provincial Symmetric Input-Output Tables." Retrieved (https://www150.statcan.gc.ca/n1/en/catalogue/15-211-X).

Steinback, Scott, and Brad Gentner. 2008. "The Economic Contribution of Marine Angler Expenditures in the United States, 2006." *NOAA Technical Memorandum NMFS-F/SPO* 94.

Steinback, Scott R., and Eric M. Thunberg. 2006. "Northeast Region Commercial Fishing Input-Output Model." *NOAA Technical Memorandum NMFS-NE* 188.

Sun, Debbie, and Lillian Hallin. 2018. *British Columbia's Fisheries and Aquaculture Sector, 2016 Edition*.

Waters, Edward C., Janet R. Baker, and Michael L. Taylor. 2016. *Collecting Borough and Census Area-Level Data for Regional Economic Modeling of Southwest Alaska Commercial Fisheries*.

Waters, Edward C., Chang K. Seung, Marcus L. Hartley, and Michael G. Dalton. 2014. "Measuring the Multiregional Economic Contribution of an Alaska Fishing Fleet with Linkages to International Markets." *Marine Policy* 50:238–48.