

## RETROSPECTIVE ECONOMIC ANALYSIS OF FRASER RIVER SOCKEYE SALMON FISHERY MANAGEMENT

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### Technical Appendix: Derivation of variable cost of fishing

#### Labour cost

We take the wage rate that a fisherman could reasonably expect to make if s/he were not fishing for sockeye salmon as the social opportunity cost of labour for that fisherman. Since the sockeye fishery is a small portion of the total fishery, we assume that people fishing sockeye would be able to fish other species and/or work in other resource industries if they were not fishing sockeye, i.e., the other industries would be able to absorb the labour from the sockeye fishery with little change on wages. We obtained wage data from two sources:

- 1950-1984: The Government of Canada [1] published annual data from income tax returns showing the total number of fishermen in British Columbia, and their total income. Dividing the latter number by the former gives the average annual income of fishermen in BC.
- 1986-2002: Statistics Canada's CANSIM II database [2] includes a table (number 202-0107; obtained from the Survey of Labour and Income Dynamics) of earnings of individuals, with a series (number V25718758) for "British Columbia; forestry; fishing, mining; oil and gas; average earnings." While these data are not specifically for fisheries, they (1) give a reasonable indication of earnings in resource industries in general, and (2) match quite closely with the trend seen in the fisheries data from before 1985.
- To obtain a value for the single missing year (1985) we took the average of the three preceding and three following years.

From these overall average earnings we also needed to estimate the greater earnings of skippers as compared to deckhands. Canada's census data from 1980, 1985 and 1990 give average annual earnings for each of these two groups. We took the average earnings (in real dollars) for each group over the three census years (\$45,249 for captains, \$27,497 for deckhands), and calculated the ratio between this value and the average from the above data sets of overall average earnings over the period 1976-1994 (overall average \$40,029). The ratio is therefore 1.13 for captains and 0.687 for deckhands. For each year during 1950-2002, we then multiplied the overall average wage by the appropriate ratio to estimate annual earnings for captains and deckhands. We divided these annual average wages by 260 to obtain a rough daily wage.

The crew size (captain plus deckhands) on salmon boats during different periods was obtained from a variety of economic studies of the BC fishing fleet [3, 4, 5, 6, 7, 8]. In years for which we lacked data, we (1) interpolated along a straight line between the nearest data points, (2) extrapolated along a flat line for 1950-51, and (3) extrapolated along a linear regression conducted on 1976-1995 data to obtain estimates for 1996-2002. The resulting estimated crew size for each fleet was then multiplied by the appropriate wage rates to estimate the labour cost per vessel-day.

#### Other variable costs

The other variable cost data that we needed were those associated with operating the vessel for sockeye fishing, not those that would be incurred for fishing other species. We had three sources of raw data for this purpose.

- 1953, 1954: Buchanan and Campbell [3] estimated, based on surveys of four types of fishermen (gillnetters, trollers, seine captains and seine assistants), an accounting of average operating expenses. Of the items that they list as operating expenses, we included the following in our estimate of variable cost of fishing: fuel and oil; bait and ice; and rentals. Items not included, i.e., those that we considered fixed with respect to the amount of fishing effort directed at sockeye, are: gear material and repairs; gillnet purchases; hull painting and repairs; engine and

equipment repairs; fish clothes; wages paid; taxes, license fees, etc; insurance; interest; and other. These data are provided along with the average number of days afloat for fishermen of that type, allowing us to calculate the variable cost per fisherman-day. Data on gillnetters and trollers describe costs for the vessel as a whole (since during this period these fishermen did not typically hire an assistant), but seiner costs are distributed between captains and assistants. We took the average number of seine assistants per vessel to be five, as given in several subsequent reports [3, 5, 6, 7]. We multiplied these average crew sizes by the cost per crew member, and added the result to the captain's costs, giving the (non-labour) variable cost per vessel-day for seiners for 1953 and 1954.

- 1968: Campbell [9] provided data on costs for each fleet. We included the following in our calculation of variable cost: fuel and lubrication; and ice and bait. We excluded: hull and engine maintenance; other maintenance; insurance; wharfage and slip charges; food; hull, engine and electronic equipment; gear; marine insurance; and wages. For each fleet Campbell [9] estimated these costs for typical vessels of three different sizes, with different levels of gross income; we used the cost values given for the size/income level closest to the average observed in that fleet, as given by Campbell [9]. From the same report we have the total number of days fishing or number of deliveries of fish to processors (the latter being a reasonably close proxy for days fishing), and the number of vessels in each fleet, which allows us to calculate the average number of days fishing for each vessel. This then allows calculation of variable cost per vessel-day.
- 1976-1995: Gislason [4] estimated variable costs over a 20-year period based on several economic surveys conducted on the BC salmon fleet. His variable cost data include estimates of fuel and "food and other" costs, of which we use only fuel. Gislason's effort data are in weeks fished, so we obtained days fishing or deliveries of fish from government fisheries statistics for the same period [10]. Gislason included the total number of vessels in the fleet in his report. This combination of data allowed us to calculate variable costs per vessel-day.

The data as described above were then compiled and converted to real 2000 dollar values. The real variable cost per day for each fleet showed a reasonably smooth trend over the 53-year time period, tending toward an exponential relationship. This is consistent with the trend in the fishery toward larger, more powerful vessels, which cost more to run.

We ran regressions of these variable cost values versus the year, and used the value predicted by the regression as the non-labour variable cost per vessel-day for our simulations, even in years for which we had raw data from the sources listed above. We took this approach because we consider the scatter around the exponential relationship to be more attributable to data quality than to true variation in operating costs.

The total of labour cost and other variable cost per vessel-day was then taken to be the total variable cost per vessel-day of fishing,  $c_{f,t}$ .

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