

Profitability and Productivity Analysis for the Southeastern Alaska Salmon Fishery

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INTRODUCTION

The purpose of this paper is to provide knowledge of profitability and productivity of the various types of fishing vessels in the southeastern Alaska salmon fishery. Specifically, the paper provides information regarding: 1) costs and returns of fishing enterprises, 2) factors affecting profitability, 3) production functions of the fishery, and 4) average and marginal productivities of resources.

This information is important to commercial fishers and policy makers. The major management task of each commercial fisher is to organize his or her resources into the most profitable operating fishing unit. Knowledge of profitability and productivity can help fishers in the efficient use of resources to achieve their goals. In addition, for a commercial fishery management program to be effective, policy makers require some knowledge of fisher's operations and performance in the fishery.

DATA SOURCES AND VESSEL CHARACTERISTICS

Data Sources

Data were derived from a survey of fishers designed to determine average costs and characteristics of vessels engaged in the various Alaska fisheries in 1973. The sample for this survey was randomly drawn from a population of Alaska commercial salmon fishers. The skippers were personally interviewed and questioned about fishing costs, revenues, and vessel characteristics. A total of 122 samples were used in this analysis.

In addition to data from the survey,

information from "fish ticket files" of the Alaska Department of Fish and Game were also used. These files are a computerized information data gathering system containing data on vessel number, species and amount caught, gear used, date landed, and management area.

Vessel Characteristics

Purse seine vessels are, on the average, larger and older than other fishing vessels in the southeastern Alaska area. The average purse seine vessel is 47 feet in keel length, and the main engine, normally a diesel, averages about 193 horsepower (Table 1).

Drift gill netters have a much smaller investment than purse seiners. Drift gill net vessels average 31 feet in length. The vessel is usually handled by a crew of one or two.

The skippers of hand troll and power troll vessels are alike in age. Hand troll vessels are smaller than power troll vessels. Hand troll vessels have an average market value of \$5,567, while

power troll vessels average \$30,757. A second crew member is sometimes used in both types of trolling.

Surprisingly, hand trollers spend an average of only 5 weeks fishing in the southeastern salmon fishery and 2 weeks in the halibut fishery. Thus, they spend an average of 7 weeks fishing. This is in contrast to purse seiners, drift gill netters, and power trollers who spend 18 weeks fishing. Weeks fished in the southeastern salmon fishery are 9 and 12 for power trollers and drift gill netters, respectively.

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Table 1.—Mean characteristics of southeastern Alaska fishing vessels by gear type, 1973.

Characteristic	Southeastern purse seine	Southeastern drift gill net	Southeastern hand troll	Southeastern power troll
Sample size	19	45	37	21
Age of vessel (yr)	37	16	14	25
Keel length (ft)	47	31	22	35
Engine horsepower	193	160	108	110
Market value of vessel and gear (\$)	67,132	22,573	5,567	30,757
Number of crew on vessel	6.5	1.4	1.3	1.7
Age of skipper	50	48	43	45
Weeks spent fishing in				
Southeastern salmon fishery	6.9	12.2	4.9	9.1
Halibut fishery	1.0	1.0	2.0	3.0
Out of state fishery	9.0	2.0	0.0	1.0
Others	1.2	2.7	0.0	5.1
Total weeks fished in all fisheries	18.1	17.9	6.9	18.2

PROFITABILITY ANALYSIS

Costs and Returns in Commercial Fishery

Gross returns is money received from salmon landed in the southeastern Alaska management area during the survey year. The estimated gross returns from purse seining was considerably higher than fishing income from other types of salmon fishing (Table 2). The gross returns of hand

vessels. This indicated that only hand trollers, on the average, experienced an economic loss.

Although the average gross returns less total costs were positive for purse seine, drift gill net, and power troll vessels, not every vessel had made profits. Four percent of drift gill net vessels and 11 percent of purse seine vessels had total costs greater than gross returns. In contrast 68 percent of hand troll vessels and 24 percent of

vessel than a small vessel. Keel length and engine horsepower were the proxy for vessel size. Weeks fished and number of crew members on the vessel are indicators of fishing effort, and variable costs are a measure of overall size of the business. Fishing experience has been hypothesized as a determinant of profit. Unfortunately, age of skipper was the only factor available that could be used as a proxy for experience. It was also hypothesized that profits and gross returns are highly correlated. The correlation analysis was used and results are presented in Table 3.

The correlation between the profit and age of the purse seine vessels was negative and statistically significant. This indicated that the older the vessel, the less profit that may be realized from it. Variables with positive and statistically significant coefficients observed for this fishery were engine horsepower, weeks fished, and gross returns. These variables had a positive impact on profit of purse seine fishing.

For the drift gill net vessels, weeks fished and gross returns were the variables affecting profits, while gross returns were the only variables which had positive effects on the profit of power troll vessels.

For the hand troll vessels, negative and significant coefficients for engine horsepower and variable costs were observed. This indicated that capital investment in hand troller equipment did not bring profits to the vessel owners. Gross returns had a positive impact on profits of hand troll vessels.

PRODUCTIVITY ANALYSIS

This section deals with the estimation of production functions and resource productivities. The production function is a technological

Table 2.—Costs and returns based on fishing in southeastern salmon fishery by gear type, 1973.

Financial indicators	Southeastern purse seine	Southeastern drift gill net	Southeastern hand troll	Southeastern power troll
Investment ¹	\$28,496.1	\$15,627.9	\$4,964.2	\$18,112.8
Cost and returns				
Gross returns	\$42,244.8	\$16,254.1	\$939.4	\$7,949.8
Variable costs ²	14,812.8	3,747.2	821.8	2,886.5
Fixed costs ³	2,932.2	1,444.3	459.5	1,433.4
Gross returns less total costs	24,499.8	11,062.6	-341.6	3,629.9
Returns to labor and management ⁴	21,935.2	9,656.0	-788.7	1,999.7
Returns to investment ⁵	7,601.9	4,560.9	-717.7	449.9
Percent of vessels with gross returns less than total costs	11	4	68	24

¹The market value of the vessel was prorated to the fishery, based on the amount of time fished.

²Costs that vary with fishing effort (may include fuel, boat repair, gear repair, crew's share, etc.).

³Costs that do not vary with fishing effort (may include insurance, license fees, association assessments, etc.).

⁴Gross returns less total costs less opportunity cost of investment, i.e., 9 percent of investment.

⁵Gross returns less total costs less opportunity cost of skipper's labor and management, i.e., 40 percent of gross return.

troll vessels was only \$939, which was lower than their past 5-year average gross returns of \$1,290.

Production costs are categorized as either variable or fixed costs. The variable costs comprise all cost items that are incurred only if the vessel is actually used for fishing. The fixed costs contain cost items that do not vary with fishing days. The variable costs of purse seine vessels were \$14,813 but were only \$822 for hand trollers. The fixed costs were \$2,932 and \$460 for purse seiners and hand trollers, respectively. Total production costs for purse seine vessels were \$17,745 which were 14 times higher than production costs of hand trollers and four times higher than power trollers.

Gross returns less total costs is the amount left to cover interest payments, to provide personal needs, and to improve the fishing business. Gross returns less total costs were: -\$342 for hand troll vessels, \$24,500 for purse seine vessels, \$11,063 for the drift gill net vessels, and \$3,630 for power troll

power troll vessels encountered total costs greater than gross returns. Thus, both types of trolling had not only lower profits but also a higher probability for operating at a loss.

Factors Affecting Profitability

An attempt has been made to identify some factors that might be associated with profitability of vessels fished in the southeastern Alaska salmon fishery. Age of the vessel was chosen because most people would consider older vessels less productive, ceteris paribus, than new vessels. Vessel size could influence profit because it costs more to run a large

Table 3.—Correlation coefficients of profits and business factors of fishing in southeastern salmon fishery by gear type, 1973.

Factors	Southeastern purse seine	Southeastern drift gill net	Southeastern hand troll	Southeastern power troll
Age of vessel (yr)	-0.62**	-0.19	0.06	-0.09
Keel length (ft)	0.29	-0.12	-0.20	0.22
Engine horsepower	0.80**	0.10	-0.44**	0.24
No. of crew on vessel	0.15	0.20	-0.04	-0.31
Weeks fished	0.70**	0.69**	0.27	0.23
Gross returns	0.92**	0.92**	0.64**	0.92**
Variable costs	0.34	0.29	-0.54**	0.08
Age of skipper	0.10	-0.12	-0.30	-0.05

**Significant at 1 percent probability level.

Table 4.—Production functions of southeastern salmon fishery by gear type, 1973.

Equation	Gear type		Vessel capital X_1	No. of crew X_2	Weeks fished X_3	Operating capital X_4	
(1)	Southeastern purse seine	$Y = 3.166 - 0.002X_1 - 0.051X_2 + 1.381X_3 + 0.067X_4$	(4.258)*** (-0.012)	(-0.019)	(5.180)***	(0.480)	$R^2 = 0.81$ D-W = 1.94 N = 19
(2)	Southeastern drift gill net	$Y = 2.412 + 0.127X_1 + 0.362X_2 + 1.134X_3 - 0.010X_4$	(6.607)*** (1.235)	(1.943)*	(8.418)***	(-0.112)	$R^2 = 0.84$ D-W = 2.23 N = 45
(3)	Southeastern hand troll	$Y = 1.228 - 0.233X_1 - 0.337X_2 + 1.436X_3 + 0.483X_4$	(2.587)** (-1.347)	(-0.593)	(4.867)***	(2.683)**	$R^2 = 0.64$ D-W = 2.23 N = 37
(4)	Southeastern power troll	$Y = -0.606 + 0.441X_1 - 0.422X_2 + 0.882X_3 + 0.525X_4$	(-0.588) (1.893)*	(-0.959)	(1.754)*	(1.599)	$R^2 = 0.84$ D-W = 1.52 N = 21

Where $Y = \log Y_i$, $X_j = \log X_j$.

Figures in the parentheses are *t*-statistics.

*** Significant at 1 percent probability level.

** Significant at 5 percent probability level.

* Significant at 10 percent probability level.

D-W = Durbin-Watson statistic.

N = sample size.

relationship between output and a set of factor inputs. Marginal productivities of resources are derived from the production functions.

Production Functions

The following form of production function was employed:

$$\log Y = \log a + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4$$

where: Y = gross returns in dollars,
 X_1 = vessel capital in dollars (i.e. vessel + gear values prorated to the salmon fishery based on weeks fished),

X_2 = number of crew members on the vessel,

X_3 = weeks fished in the fishery, and

X_4 = operating capital in dollars (i.e. variable costs less crew shares).

The first equation in Table 4 is the production function for the purse seine vessels. The elasticities of production (regression coefficients) indicate the percentage in gross returns that would be forthcoming with one percentage increase in the indicated resource. For example, weeks fished had a statistically significant coefficient of 1.381. This indicated that an increase in weeks fished by one percent would bring about an increase in gross

returns by 1.381 percent, holding other input constant. The estimate of the coefficient of multiple determination (R^2) in the equation was 0.81. Thus, about 81 percent of the variation in gross returns was explained by the variables in the equation.

In all equations estimated, weeks fished were statistically significant. Overall, weeks fished appeared to be quite important, as fishers would expect. Fishers frequently say that "if you're not out fishing, you'll not catch fish." Vessel capital was significant in only power troll vessel equations. Similarly, operating capital was signi-

ficant for hand troll vessels and number of crew members on the vessel for drift gill net vessels.

Resource Productivities

The marginal productivity of a resource is simply the addition to gross returns associated with the addition of one unit of a given resource. The marginal productivity of operating capital was \$0.24 for hand troll vessels (Table 5). In other words, the spending of one more dollar beyond the mean quantity per vessel in the hand troll sample, would add only 24 cents to gross returns. This implies that hand

Table 5.—Mean quantities of production, resources, and productivity of specified resources based on southeastern salmon fishery by gear type, 1973.

Item	Southeastern purse seine	Southeastern drift gill net	Southeastern hand troll	Southeastern power troll
Mean value of production per vessel (Y)	\$42,244.8	\$16,254.1	\$939.4	\$7,949.8
Mean resources per vessel				
Vessel capital (X_1)	28,496.0	15,627.8	4,964.1	18,112.8
No. of crew (X_2)	6.5	1.4	1.3	1.7
Weeks fished (X_3)	6.9	12.2	4.9	9.1
Operating capital (X_4)	10,432.7	2,970.6	767.2	2,432.3
Average product at resource means				
Vessel capital (X_1)	1.48	1.04	0.18	0.44
No. of crew (X_2)	6,499.2	11,610.1	722.6	4,676.4
Weeks fished (X_3)	6,122.4	1,332.3	191.7	873.6
Operating capital (X_4)	4.05	5.47	1.22	3.27
Marginal product at resource means				
Vessel capital (X_1)	-0.01	0.09	0.02	0.15*
No. of crew (X_2)	-86.1	2,973.6*	-99.3	-1,559.1
Weeks fished (X_3)	7,465.4***	1,068.9***	112.2***	608.8*
Operating capital (X_4)	0.24	-0.04	0.24**	1.40

*** Significant at 1 percent probability level.

** Significant at 5 percent probability level.

* Significant at 10 percent probability level.

troll vessels should not increase their operating capital. Similarly, the same can be said for the vessel capital of power troll vessels. The significant marginal productivity of number of crew members for drift gill net vessels showed the potential value in using more crew in drift gill netting.

Marginal productivity of weeks fished was \$7,465 for purse seine, \$1,069 for drift gill net, \$609 for power troll, and \$112 for hand troll vessels. The substantially greater marginal productivity of weeks fished for purse seine vessels was probably due to the higher factors ratio of operating capital/weeks fished and number of worker/weeks fished. Weeks fished could be increased to yield greater gross returns to fishers. However, this opportunity may not always exist because of the high variation in commercial salmon runs and regulation of the fishing season.

The average productivity of resources is measured by gross returns/resource used. Hand troll vessels

produced much lower average productivities of all resources than others.

SUMMARY AND CONCLUSIONS

Purse seine vessels had gross returns of \$42,245, total costs of \$17,745, and gross returns less total costs of \$24,500. The average gross returns of the drift gill net vessels were \$16,254, while their average costs were \$5,191. Similarly, the power troll vessels received gross returns of \$7,969 and spent \$4,319 for production costs. In contrast to these vessels, hand troll vessels experienced low gross returns of \$939 and encountered an economic loss in 1973. There were 68 percent of hand troll vessels with total costs greater than gross returns. This was due to the fact that 1973 was a poor year for the hand troll salmon fishery.

The correlation analysis was employed to determine correlation between profitability and socio-economic factors. The gross returns had the highest level of correlation

with profits among the variables studied. This implied that gross returns is the most important factor related to profit.

To determine factors affecting gross returns, the production functions for each fishery were estimated. The results indicated that weeks fished was the most important variable for all gear types. Therefore, week fished could be increased to yield greater returns to fishers in the salmon fishery.

The extent for spending additional weeks in salmon fishery to raise gross returns depends on the marginal productivity of weeks fished. The marginal productivity of weeks fished was about \$7,464 for the purse seine vessels, about \$1,069 for the drift gill net vessels, about \$609 for the power troll vessels, and \$112 for hand troll vessels.

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