THE FACTORS BEHIND THE DIFFERENT GROWTH RATES OF U.S. FISHERIES

by

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The Factors behind the Different Growth Rates of U.S. Fisheries

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Economics has recently changed its emphasis from countercyclical fiscal policy to programs designed to increase the rate of growth in the general economy. Lagging sectors are viewed with alarm and government programs are designed to ameliorate the conditions contributing to this problem; therefore, it is important, if not imperative, that we know more about the factors producing differing growth rates among and within sectors of the U.S. Economy. The U.S. fishing sector as a whole has shown no appreciable growth over the last ten years in spite of increasing expenditures by the Bureau of Commercial Fisheries. Of course this does not mean that BCF expenditures have been ineffective. It can always be argued that these expenditures are necessary to avert a large decline in total U.S. landings of fish products. To more adequately explore this area, it may be instructive to analyze the factors behind the different growth rates among U.S. fisheries.

Why do landings in one fishery increase while landings in another fishery decline? For example, why have annual shrimp landings increased by 2.5 percent while annual menhaden landings have declined by 3.1 percent

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over the last ten years? The purpose of this paper is to explore a relatively unexplored area: the differential growth rates of the U.S. fisheries. Hopefully, the model presented here may be used to evaluate Bureau performance in allocating funds across fisheries. This will, of course, be very useful to Planning, Programming and Budgeting. To be sure, the economics of harvesting a fishery resource is a complex process involving biological yield; demand and cost-effort functions. These relationships interact to generate a path of expansion or decline for a fishery.

The Model

The purpose of the model is to specify what factors will produce differing growth rates among the fisheries of the U.S. Obviously, many variables, some not quantifiable, are at work to produce different results for each fishery. However, it may be instructive to test some major variables which are often associated with expansion or decline. An hypothesis was formulated that the annual growth rate for the i'th fishey is dependent upon (1) income elasticity; (2) annual growth rate of imports; (3) productivity of the resource base and (4) government expenditures or

$$(1)\quad \left[\frac{\Delta Q}{Q}\right]_i = a + b\,E_i - c\left[\frac{\Delta I}{I}\right]_i + d\left[\frac{MSY-L}{MSY}\right]_i - eB_i$$

where,

$\frac{\Delta Q}{Q}$ = Annual percent change in the i'th fishery of landings over the 1957-67 period;

E = The income elasticity for the i'th fishery or the percent change in quantity consumed divided by the percent change in income;

$\frac{\Delta I}{I}$ = Annual percent change in imports competitive with the i'th fishery over the 1957-67 period;

$\frac{MSY-L}{MSY}$ = The difference for the i'th fishery between MSY (maximum sustainable yield) and actual landings in 1957 expressed as a percent of MSY;

B_R = Ranking with respect to BCF expenditures for the i'th fishery (1 = highest rank; 17 = lowest rank)

B_E = Actual BCF expenditure by fishery for one year, 1967.

The growth of a fishery is a complicated process. Referring to equation (1), we should expect that higher income elasticities would be associated with higher growth rates. Shellfish generally have higher income elasticities than those for finfish; therefore, the demand for shellfish expands more rapidly. This places pressure on the industry to supply more of the high income elastic good. A higher growth rate of imports should depress prices and tend to slow down the rate of growth in U.S. fisheries. We must also look on the supply side. No matter how fast demand is growing for a fishery product, it may be impossible to expand landings since the fishery is either at or beyond maximum substainable yield. If landings are small, (MSY-L)/MSY will be close to 1. As the fishery approaches MSY, the ratio approaches zero. Hence, we should expect a positive relation between the growth rate of the i'th fishery and (MSY-L)/MSY. Finally and probably more important, the expenditure pattern of the BCF should be related to the growth of the fishery. Research expenditures on gear, equipment, fish finding and economic analysis may help to lower fishing cost, thereby expanding the fishery. Two variants of BCF expenditures were employed. Only recently, has the BCF broken down expenditures by fishery; therefore, we ranked the fisheries on the basis of the 1967 expenditure pattern which probably was roughly indicative of the expenditure pattern over the 1957-67 period. We also used actual expenditures for 1967 in order to get an idea on the dollar payoff of government expenditures. We should expect a negative relation between growth rate of the fishery and a <u>ranking</u> of Bureau expenditures (1 = highest rank).

<u>The Results</u>:

Equation (1) was estimated using least-squares:

$$(2)\quad \left[\frac{\Delta Q}{Q}\right] = -2.745 + \underset{\substack{(.91)\\ 3.189}}{2.91}\, E_i - \underset{\substack{(.060)\\ 1.152}}{.069} \left[\frac{\Delta I}{I}\right]_i + \underset{\substack{(4.703)\\ 1.753}}{8.246} \left[\frac{MSY-L}{MSY}\right]_i - \underset{\substack{(.356)\\ 1.073}}{.382} \left(B_R\right)_i$$

$R^2 = .707$ $\qquad$ $F = 7.24$

and

$$(3)\quad \left[\frac{\Delta Q}{Q}\right]_i = -7.339 + \underset{\substack{(.952)\\ 3.347}}{3.186}\, E_i - \underset{\substack{(.057)\\ .942}}{.054} \left[\frac{\Delta I}{I}\right] + \underset{\substack{(4.524)\\ 1.893}}{8.564} \left[\frac{MSY-L}{MSY}\right] + \underset{\substack{(1.040)\\ 1.184}}{1.232} \left(B_E\right)_i$$

$R^2 = .707$ $\qquad$ $F = 7.24$

For cross-section work, the results were very encouraging. That is, all the signs of the estimated parameters were consistent with our hypotheses. The equation as a whole "explained" 70 percent of the variation in the growth rates for 17 major U.S. fisheries. All coefficients are larger than their standard errors.

In general, those fisheries which have high income elasticities; low growth of imports; greatly removed from MSY and enjoy higher expenditures by BCF are growing more rapidly than those fisheries having opposite characteristics. Of special significance, equation (3) tells us that a one-million dollar increase in BCF expenditures will increase the annual growth rate of the fishery by approximately 1.232 percentage points. If the average fishery is worth 22 million dollars, then the increase in value of 1.232 percentage points will allow us to compute the following benefit cost ratio for BCF expenditures or

$$\frac{B}{C} = \frac{.0123\ (\$22{,}000{,}000)}{\$1{,}000{,}000} = .27$$

It must be emphasized that these calculations are tentative and are based upon actual BCF expenditure patterns for 1967. The other variables are annual changes over the 1957-67 period. At any rate, we can state that large BCF expenditures are associated with higher growth rates for U.S. fisheries holding all other variables constant. Another aspect of the problem is whether the BCF must expend $1,000,000 per year on the example fishery to maintain the growth rate at a higher level than without this expenditure. This is what the analysis implies. It should be pointed out that the B/C ratio is only the primary effect of government expenditures. A 22 million dollar fishery is usually worth approximately 66 million dollars at the retail level. If we assume an income multiplier of 2.5 to 1, the total income generated by government expenditure would possibly yield the following benefit cost ratio:

$$\frac{B}{C} = \frac{(66{,}000{,}000)(2.5)(.0123)}{\$1{,}000{,}000} = 2.10$$

Table 1

Variables Used to Explain

Differing Growth Rates

Among U.S. Fisheries

Fishery	Annual Percent Change in U.S. Landings 1957-67 (1)	Income Elasticities (2)	Annual Percent Change in Imports (1)	MSY-L / MSY (3)	B_R (3)	B_E Mill. Dols (3)
King + Dung Crab	21.12	4.00	-6.51	.801	6	1.1
Clams	7.16	2.80	0.00	.800	8	.5
Flounder	3.85	1.76	12.97	.300	6	1.1
Tuna	3.43	2.50	8.77	.677	2	3.0
Blue Crab	2.73	2.00	-6.51	.432	9	.4
Shrimp	2.50	1.43	19.09	.179	3	1.7
Pacific Gafish	.71	.50	10.16	.833	3	1.7
Anad Herring	- .56	-.50	0.00	.299	12	.1
N.Lobster	-1.11	1.05	-2.99	.245	10	.3
Halibut	-1.81	1.00	1.70	.000	11	.2
Oysters	-1.95	.25	50.22	.522	5	1.3
Salmon	-2.25	-1.80	-4.38	.239	1	4.6
Haddock	-2.62	1.14	- .69	.000	4	1.6
Menhaden	-3.10	1.39	65.82	.000	7	.7
Sea Scallops	-5.14	2.07	29.70	.167	6	1.1
Atlantic Herring	-5.71	.06	5.19	.432	8	.5
Mackeral	-14.71	- .25	0.00	.000	13	0

Source: (1) Fishery Statistics of United States, 1957-66
(2) Demand Conference, BCF
(3) Program Memorandum, BCF

Let us now look at the predictive accuracy of the equation. To do this, we shall rank the fisheries by growth rates and see how well the equation did in predicting observed values.

	Actual	Predicted by Equation (2)
King + Dung. Crab	+21.12	+ 13.66
Clams	+ 7.16	+ 8.95
Flounder	+ 3.85	+ 1.66
Tuna	+ 3.43	+ 8.74
Blue Crab	+ 2.73	+ 3.55
Shrimp	+ 2.50	+ .43
Pacific Gdfh.	+ .71	+ 3.73
Anad Herring	- .56	- 6.32
N. Lobster	- 1.11	- 1.28
Halibut	- 1.81	- 4.15
Oysters	- 1.95	- 3.09
Salmon	- 2.25	- 6.09
Haddock	- 2.62	- .90
Menhaden	- 3.10	- 5.92
Sea Scallops	- 5.14	+ .32
Atlantic Herring	- 5.71	- 2.43
Mackeral	-14.71	- 8-44

In only one instance did the equation fail to predict the direction of change for the fishery, (i.e., Sea Scallops).

Let us consider two fisheries when our predictive power was very high: clams and N. Lobsters. The reason for the fast growth in clams and the slow growth in Northern Lobsters is the following

Predicted Growth	Clam	N. Lobster
Causal Factors (why)	+ 8.95	-1.28
E	2.800	1.050
$\Delta I/_I$	.000	-2.990
$MSY-L/_{MSY}$	.800	.245
B_E	.500	.300

In this case the higher income elasticity for clams combined with being a relatively unexploited fishery and also enjoying more expenditures by the Bureau combined to produce a higher growth rate for the clams relative to Northern Lobsters despite the effect of declining imports of lobsters.

Conclusion:

This preliminary exercise has uncovered a fertile area of possible research. The benefits of this approach are many. First, we can take a long look at our fisheries in cross-section. We shall never obtain an optimal allocation of government expenditures unless we know why one fishery performs differently from another. Second, we have shown in a rather crude way that BCF expenditure patterns can be combined with other fundamental variables such as income elasticity to assess the impact on fishery growth rates.

In summary, growth rates differ among fisheries because of different income elasticities; different growth rates of imports; different points on the biological yield curve and different BCF expenditures. Only the income elasticity was statistically significant at the one percent level while $\Delta I/_I$; (MSY-L)/MSY and B_R were statistically significant at the 25; 10; and 30 percent respectively level for equation (2).

Finally, government expenditures are important and do affect the growth rates of fisheries. The regression analysis does indicate that BCF expenditure patterns are effective and that a reallocation of expenditures among fisheries will produce different growth rates.

(continued from inside front cover)

14. A Price Incentive Plan for Distressed New England Fisheries by A. Sokoloski and E. Carlson.

15. Demand and Prices for Shrimp by D. Cleary.

16. Industry Analysis of Gulf Area Frozen Processed Shrimp and an Estimation of Its Economic Adaptability to Radiation Processing by D. Nash and M. Miller.

17. An Economic Evaluation of Columbia River Anadromous Fish Programs by J. A. Richards.

The goal of the Division of Economic Research is to engage in economic studies which will provide industry and government with costs, production and earnings analyses; furnish projections and forecasts of food fish and industrial fish needs for the U. S.; develop an overall plan to develop each U. S. fishery to its maximum economic potential and serve as an advisory service in evaluating alternative programs within the Bureau of Commercial Fisheries.

In the process of working towards these goals an array of written materials have been generated representing items ranging from iterim discussion papers to contract reports. These items are available to interested professionals in limited quantities of offset reproduction. These "Working Papers" are not to be construed as official BCF publications and the analytical techniques used and conclusions reached in no way represent a final policy determination endorsed by the U. S. Bureau of Commercial Fisheries.