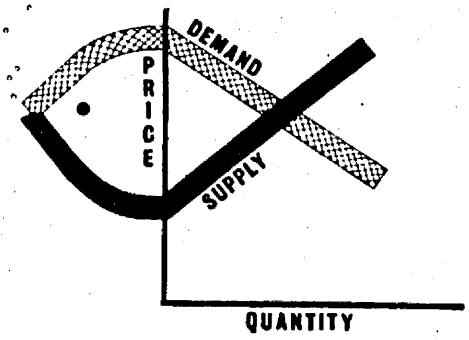


FOR REVIEW ONLY

# BENEFIT-COST ANALYSIS

# AS APPLIED TO COMMERCIAL FISHERIES PROGRAMS

by

Frederick W. Bell, Chief
Division of Economic Research
Bureau of Commercial Fisheries

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(continued on inside back cover)

# Benefit-Cost Analysis as Applied to Commercial Fisheries Programs

by Frederick W. Bell, Chief
Division of Economic Research
Bureau of Commercial Fisheries

## Introduction

On May 15, 1962, President Kennedy approved the application of policies, standards and procedures for the formulation, evaluation, and review of plans for water and related land resources projects. These procedures were published in Senate Document No. 97.[1] The principal thrust of this document is to outline the application of benefit-cost analysis to government projects. The purpose of benefit-cost analysis is to assess the economic characteristics of a particular project; to determine which of a number of projects result in the largest ratio of benefits to costs and finally to determine which of a great variety of projects confer the largest net benefit on the economy as a whole. Since the advent of Senate Document 97, each government

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1. Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources, 87th Congress, 2nd Session, Senate Document 97, 1962. U.S. Government Printing Office, Washington, D. C.

agency has asked the following question: How does benefit-cost analysis apply to the programs of the agency in question? This paper attempts to seek the answer to this question for one government agency, the Bureau of Commercial Fisheries. An answer to this question will enable the Bureau of Commercial Fisheries to move ahead in the development of its Master Plan as well as conform to the standards established by the Bureau of the Budget for program evaluation. As we shall shortly see, the commercial development of fishery resources poses many problems where benefit-cost analysis can be helpful in evaluating the role of government. Before considering the specific program areas of the BCF, let us briefly survey the literature for the various definitions of economic benefits.

## "Economic Benefits" from Government Programs

After an exhaustive survey of the literature in the field of benefit-cost analysis, nine possible definitions of economic benefits emerged.

1. General Statement in Senate Document 97

> "Benefits: "Increases or gains, net of associated or induced costs, in the value of goods and services which result from conditions without the project. Benefits include tangibles and intangibles and may be classed as primary or secondary."

"Tangible benefits: Those benefits that can be expressed in monetary terms based on or derived from actual or simulated market prices for the products or services, or, in the absence of such benefits, the cost of the alternative means that would most likely be utilized to provide equivalent products or services. This latter standard affords a measure of the minimum value of such benefits or services to the users. When costs of alternatives are used as a measure of benefits, the costs should include the interest, taxes, insurance, and other cost elements that would actually be incurred by such alternative means rather than including only costs on a comparable basis to project costs as is required when applying the project formulation criteria under paragraph V-C-2(d)."[2]

2. Specific Statement on Fish and Wildlife in Senate Document 97

"Benefits also result from the increase in market value of commercial fish and wildlife less the associated cost"[3]

"Associated Costs: The value of goods and services over and above those included in project costs needed to make the immediate product or services of the project available for use or sale. Associated costs are deducted from the value of goods and services resulting from a project to obtain primary benefits."[4]

3. Bureau of the Budget Circular No. A-94, June 26, 1969

"Expected Yearly Benefits: The dollar value of goods and services expected to result from a program or project for each of the years it is in operation. Estimates of expected yearly benefits will be based on established definitions and practices developed by agencies for program and project evaluation."

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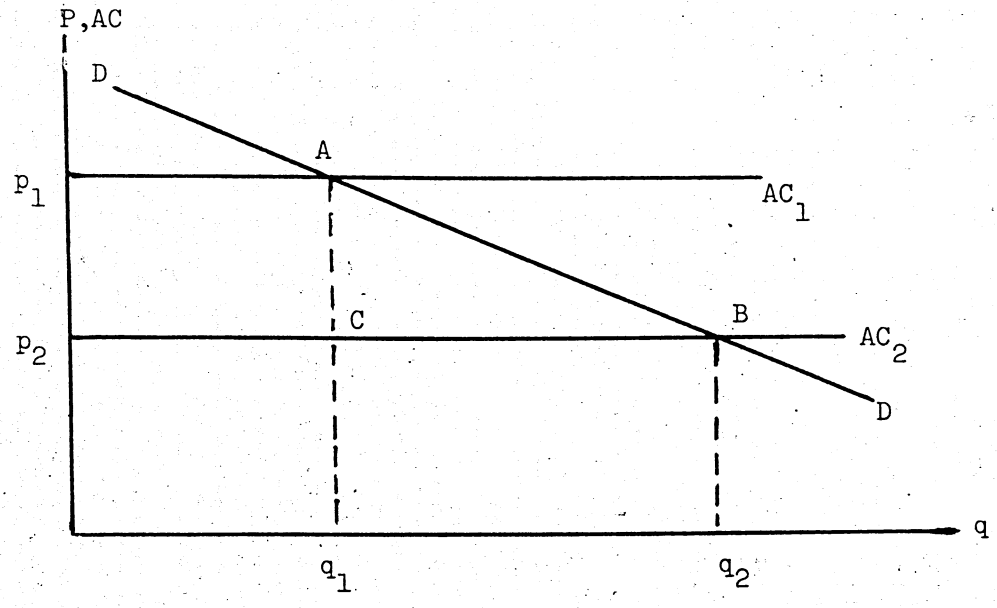
2. Ibid., p.8
3. Ibid., p.11
4. Ibid., p.11

4. Welfare Economics (Social Benefits)

Government projects that result in technological improvement would result in a reduction in industry cost. Much of the BCF's research program is designed to reduce harvesting costs.

Diagram 1

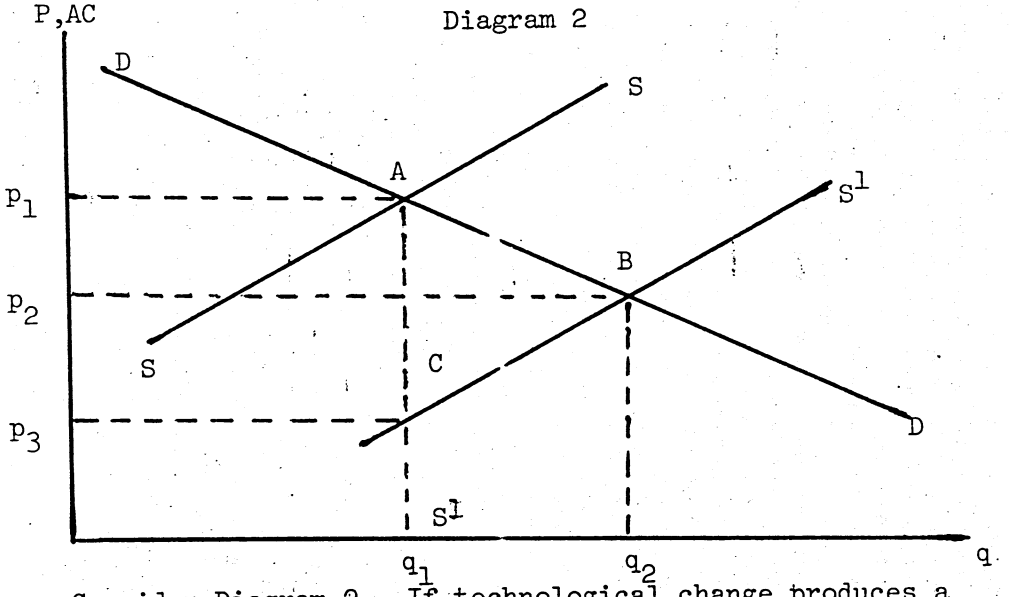



Consider Diagram 1. If the initial average cost was $AC_1$ with $p_1$ charged in the market and $q_1$ produced, a reduction in average cost to $AC_2$ would result in increase in consumers' surplus or $p_2p_1$ AB. Therefore, welfare economics would define economic benefits as "the increase in consumers' surplus resulting from a government program of technological change." Consumers' surplus is defined by Marshall to be

"the excess of the price which he [the consumer] would be willing to pay rather than go without the thing, over that which he actually does pay."

In the case of an increasing cost industry such as fishing, the concept of producers' surplus may also be included in a definition of economic benefits.

Diagram 2




Consider Diagram 2. If technological change produces a shift in the supply curve from SS to S'S', then consumer surplus is increased by the area $p_2p_1$ AB. Producers' surplus is increased by the area $p_3p_2$ BC. Producers' surplus is defined as the "excess of actual earnings from a given quantity of output over the amount the firm would accept rather than

refuse to market its product altogether." Economic benefits may be defined as the sum of producers' and consumers' surpluses.

Of course, one of the assumptions behind the measurement of consumers' surplus from a Marshallian demand curve is that real income must remain constant. In reality, real income increases along a Marshallian demand curve as price falls. Therefore, an unambiguous measure of consumers' surplus can be derived only from something like a marginal valuation curve that holds real income constant by slowing all units purchased separately at their full marginal prices. For fishery products, we can reasonably conclude that the change in real income is inconsequential.

5. Resources for Tomorrow - Guide to Benefit-Cost Analysis

"The benefits of a fisheries project are represented by the net increase in the income that results from the project. Direct benefits, i.e., the net value of production, may be measured by the price received by fishermen less the costs involved in obtaining the catch. Cost of fishing includes allowances for fixed and operating capital, fuel, bait, and so forth, as well as the actual imputed value of fishermen's labor (based upon what they would earn if employed in some alternative occupation). These should be subtracted from the estimate of total direct benefits."[5]

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5. W.R.D. Sewell, J. Daws, A.D. Scott and D.W. Ross, A Guide to Benefit-Cost Analysis (Resources for Tomorrow) (Ottawa Queen's Printer, 1962)

6. Crutchfield on Valuation of Benefits

Crutchfield states that the calculation of gross market values or benefits for the products of a commercial fishery calls for no special procedures. However, the calculation of net benefits presents conceptual difficulties because of the common property nature of the fishery resources. As long as the fishery is open to all, no net yeild can be developed. Crutchfield states that the net yield from a fishery should be estimated on the assumption that the fishery is managed with the objective of maximizing income from the property right.[6]

7. Traditional or Naive Approach

The traditional or naive approach to the definition of economic benefits has resulted in merely estimating the expected output as a consequence of the government program and multiplying by current prices. Future price changes as a result of the expanded output or changes in consumer income are ignored.

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6. James A. Crutchfield, "Valuation of Fishery Resources," Land Economics, Vol 38, 1962

8. A Less Naive Approach

A modification of definition 7 is to multiply expected change in output by a forecast of future prices in order to obtain economic benefits.

9. Pure Reduction in Industry Costs

Some have argued that economic benefits for programs involving technological advancement should be defined as the cost savings alone.

## Choosing Between Alternative Definitions

It is indeed difficult to select just one of the definitions discussed above for fishery benefit-cost analyses. Definitions 1, 2 and 5 may be interpreted as identical if associated cost is defined as total cost of harvesting. If associated costs are merely the cost of implementing the technological improvement then the definitions are not the same. Also, if definitions 1, 2 and 5 are identical, then they make no economic sense as indicated by Crutchfield under definition 6. In the long run, net economic benefits are zero in an unregulated and competitive fishery. Crutchfield's definition is also unrealistic since it fails to deal with the reality that many fisheries are unregulated and therefore we cannot define benefits as

recognizable rents. There is also some question of whether rents are the real economic benefits because this ignores the field of welfare economics under definition 4. Definition 7 is too naive to take seriously. Hence, definitions 2, 5, 6, 7 probably can be ruled out as good candidates. Definitions 1 and 3 are so general that they do not have clear applicability. For examples, definitions 3 and 8 may be interpreted as identical. Finally, definition 9 ignores market adjustments to cost reductions. That is, the demand relation is not considered at all.

It is recommended that definitions 4 and 8 are excellent candidates and would conform to both Senate Document 97 and Bureau of the Budget Circular No. A-94. From a theoretical point of view, this writer is prepared to endorse definition 4 as optimal. Armed with our various definitions of economic benefits from government programs, let us briefly review the various program areas of the BCF.

## BCF Program Areas: Their Scope and Impact

In FY 1970, the BCF expressed the following objectives: To increase the net contribution of Aquatic Living Commercial Resources to the Nation's economy or more specifically,

-- to increase efficiency so that the economic status of those engaged in the fishing industry is improved;

-- to provide for the growing and diversified demands of the American people for fish and shellfish products whether in the form of edible foods or other products, from efficient and economical sources;

-- to seek means of bringing more of the world's aquatic resources into economic commercial production for the benefit of all mankind;

-- to contribute to man's understanding and control of aquatic living resources and the environment.

In essence, most of these goals are economic in nature or imply some short or long run economic pay-off. Is it possible to specify general categories of BCF programs which lead to the attainment of the above objectives? If so, can these programs be evaluated in terms of their economic pay-off? Answers to these questions will enable us to more adequately use benefit-cost analyses.

In general, other than service programs, there are three basic program areas of the BCF:

1. Programs Designed to Reduce Costs or Increase Productivity (i.e., lower the cost per pound of fish landed and increase supply to the market).

Examples: 1] All biological research which has the principal objective of improving or initiating a fish forecasting system. Population dynamics, life cycle studies, environmental studies, etc., are in the main designed to pinpoint fish stocks, forecast movements and abundance and explain change in abundance;

2] All gear research which improves the efficiency of existing gear or suggests new types of gear;

3] Fish forecasting systems themselves which utilize previously completed studies;

4] Exploratory fishing;

5] Vessel design studies which raise overall vessel productivity;

6] Economic studies which evaluate the above and suggest other cost cutting methods through economic feasibility studies;

7] All marketing research studies;

8] 1959 Fishing Fleet Improvement Act;

9] Maintenance and Repair Loans;

10] Mortgage Insurance.

2. Programs Designed to Increase the Demand or Consumption of Various Species of Fish

Examples: 1] All direct marketing and advertising promotion;

2] FPC program.

3. Programs Designed to Regulate Fisheries

The BCF is also responsible for Federal aid to the states under the Fisheries Research Development Act. These research funds can easily be classified under the three general program areas. It must be pointed out that the above program areas are not meant to be inclusive. However, they are designed as a convenient classification system for a large percentage of BCF programs. The principal thrust of the BCF is embodied in these program areas.

Now that we have generally defined the BCF program areas, it is necessary that we explore their economic impact using the best definition of benefits as discussed above. Although it is recognized that certain noneconomic benefits may accrue from such programs, these shall not be studied here. If these are to be justified, a completely different approach must be used.

## Benefit-Cost Analyses as Applied to Various Case Fisheries

Program 1: A Reduction in Harvesting Cost: The impact of program 1 is to shift the industry average cost curve downward. It should be pointed out that it is not realistic to assume that any cost reduction program will have immediate pay off. Harvesting costs may only be reduced after a long period of research. In addition, the cost of implementing (i.e., associated cost) the technological improvement must be subtracted from the gross benefits to derive net benefits. Let us consider how economic benefits are measured for program 1 when it is applied to the various cases of fisheries listed in Table 1.

Case 1: A. Domestic

B. Near or beyond MSY

C. Unregulated

A program of technological change applied to Case 1 fisheries will always produce negative benefits. Consider Diagram 3.

Diagram 3

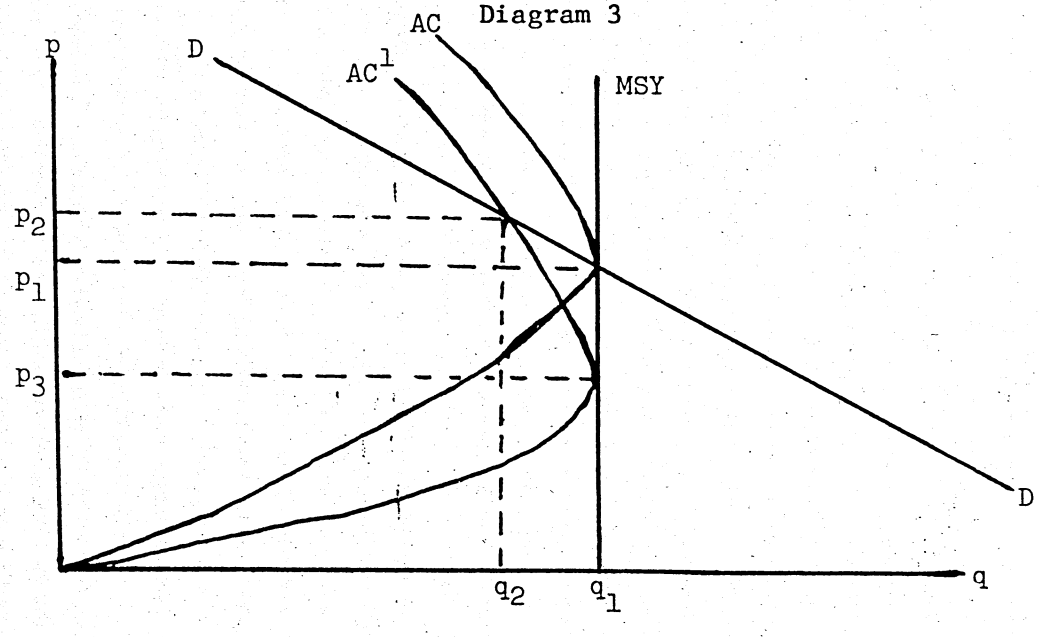


Table 1 Major Groupings of U. S. Fisheries

| | Percent U. S. Catch of Total | Percent Total Catch of Sustainable Yield | Percent Imports of Total Supply to U. S. |
|---|---|---|---|
| **Case 1 Fisheries:** (A. Domestic B. Near or Beyond MSY C. Unregulated) | | | |
| Northern Lobster - Pot Fishing | 100 | 100.0 | 38.1 |
| Menhaden, Atlantic-Gulf | 100 | 85.3 | 61.9 2/ |
| Shrimp - Atlantic | 100 4/ | 100.0 | 55.6 |
| **Case 2 Fisheries:** (A. Domestic B. Below MSY C. Unregulated) | | | |
| A. Established | | | |
| Blue Crab, Atlantic and Gulf | 100 | 83.0 | 3.5 |
| North Lobster - trawl | 100 | 75.8 | 38.1 |
| Anadromous Herring | 100 | 62.0 | 0.0 |
| Trawl Fishery, Industrial | 100 | 47.5 | 0.0 |
| Oysters, Atlantic, Pacific, Gulf | 100 | 37.0 | 19.2 |
| Clams, Atlantic and Gulf | 100 | 34.6 | 3.0 |
| Mackerel, Atlantic, Gulf, Pacific | 100 | 32.1 | 3.3 |
| Snapper, South Atlantic and Gulf | 100 | 20.5 | 1/ |
| Other established fish | 100 | 15.8 | 1/ |
| B. Latent | | | |
| Calico Scallop, anchovy, thread herring, Tanner crab | | | |
| **Case 3 Fisheries:** (A. International B. Near or beyond MSY C. Unregulated) | | | |
| Salmon, Pacific | 78.1 | 130.0 | 2.3 |
| Groundfish, North Atlantic | 8.7 | 101.7 | 79.0 3/ |
| Marine Herring, Atlantic | 10.6 | 101.1 | 63.7 |
| Sea Scallop - North Atlantic | 47.3 | 93.5 | 44.7 |
| Shrimp, Gulf | 75.0 | 100.0 4/ | 55.6 |
| King Crab, Alaska | 75.0 | 95.0 | 3.5 |
| **Case 4 Fisheries:** (A. International B. Near or beyond MSY C. Regulated) | | | |
| Tuna, Yellow Fin - Pacific | 80.0 | 100.0 | 53.2 |
| Halibut, Pacific | 54.4 | 101.4 | 45.6 |
| Fur Seals 5/ | 100.0 | 100.0 | 1/ |
| **Case 5 Fisheries:** (A. International B. Below MSY C. Unregulated) | | | |
| A. Established | | | |
| Shrimp, Pacific | 32.1 | 14.3 | 55.6 |
| Dungeness Crab, Pacific | 72.6 | 44.9 | 3.5 |
| Groundfish, Pacific | 8.3 | 52.2 | 79.0 |
| Tuna, all but Yellow Fin | 81.9 | 34.8 | 53.2 |
| Great Lakes | 56.5 | 71.7 | 1/ |
| B. Latent | | | |
| Pacific Hake, herring | | | |

All species of crabs grouped together, as are tuna, groundfish, shrimp.

1/ Data not available.
2/ Supply and imports of fish meal.
3/ Supply and imports of fillets, steaks and blocks of groundfish and ocean perch.
4/ Refers to catch as percent of maximum yield.
5/ Value of catch distributed by International Agreement.

The reduction in the cost of harvesting for this case fishery at MSY ($q_1$) will create short run economic rents. This will produce an expansion in units of effort and output will fall from $q_1$ to $q_2$. Economic benefits can be defined in the following manner as applied to Case I fisheries.

Definition 4: The Change in Consumers' Surplus Only

"Net Economic benefits are equal to the change in consumers' surplus less associated costs"

or approximated mathematically,

$$NEB_4 = -p_1 q_1 \left[k + \frac{nk^2}{2(1-k)}\right] - I$$

where k = percentage reduction in price due to technological improvements

$p_1 q_1$ = present economic value of the fishery (i.e., value of imports plus domestic landings) before technological advance

n = price elasticity

I = associated costs

Definition 5: Value of Change in Output

"Net economic benefits are equal to the change in output multiplied times the final equilibrium market price less associated costs"

or

$$NEB_8 = p_2 (q_1 - q_2) - I$$

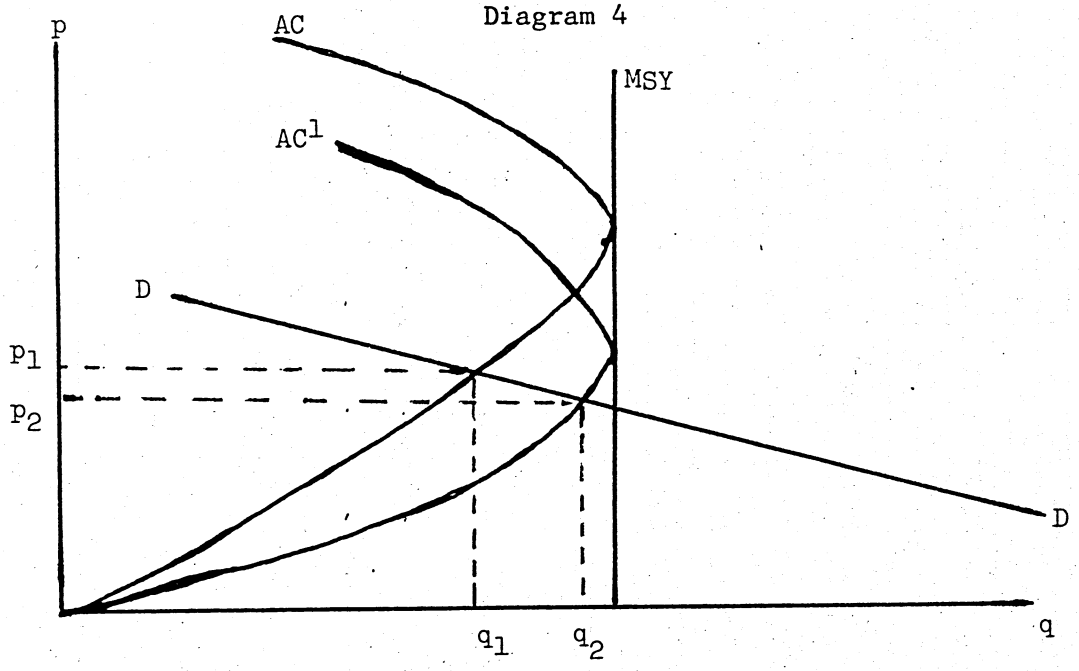
Under both definitions the NEB are negative for program 1 applied to case 1 fisheries

Case 2: A. Domestic

B. Below MSY

C. Unregulated

Diagram 4



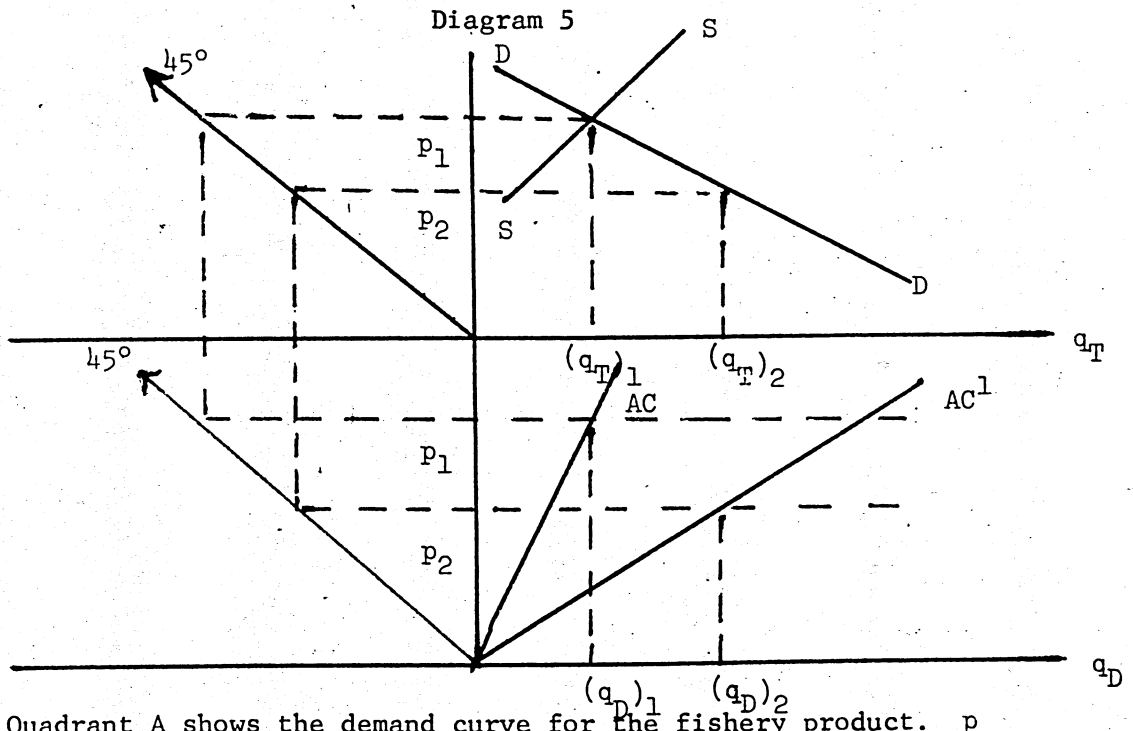

$$NEB_4 = p_1 q_1 \left[k + \frac{nk^2}{2(1-k)}\right] - I$$

$$NEB_8 = p_2 (q_2 - q_1) - I$$

Both definitions of economic benefits will be positive for Case 2 fisheries.

It should be pointed out that some theoretical problems emerged when the domestic fishery supplies only part of the total U. S. consumption. Consider Diagram 5.

Diagram 5




Quadrant A shows the demand curve for the fishery product. $p_1$ is the market price while $[q_T]_1$ is total U. S. consumption. Quadrant D shows the average cost curve for the domestic fishery (AC). $[q_D]_1$ is the domestic supply to the U. S. market. $[q_D]_1$, plus imports $[I]$ equals $[q_T]_1$. Assume that a program of technological change is introduced which shifts the domestic average cost curve downward to AC'. Rents will be created which will expand effort for the domestic fishery. This will increase the supply to the U. S. market. The market price will drop to $p_2$. The expansion of the domestic fishery will

take place to the $\bar{q}_{D_2}$ level of output. This analysis assumes that (1) foreign imports remain unchanged by the decline in market price; (2) that the technical advance only takes place in the domestic fishery. The economic benefits would then be measured as before. If technical advance is completely diffused throughout the world, then we can assume that the average cost of production will be lowered for all suppliers. In this case, the increase in imports must be taken into account when calculating economic benefits.

Case 3 - 5 Fisheries: A detailed analysis of cases 3-5 fisheries will not be discussed here. The analysis will critically depend on the impact of technological change on the domestic producer and just how fast this technological improvement is diffused to other international competitors.

Program 2: An Increase in Demand: Economic benefits from this type of program may critically hinge on the following two assumptions:

Assumption 1: Capital and Labor Are Unemployed:

This assumption can be viewed statically at a point in time or temporally over a long horizon. In other words, vessels and fishermen are presently idle or resources (i.e., capital and labor) presently unemployed could be easily adapted to fishing activity.

Viewed temporally, resources of a general nature will become available over a specified time horizon and the program in question may utilize these resources. There is some foundation for this view in Senate Document 97.[7]

> "Formulation and evaluation shall normally be based on the expectation of an expanding national economy in which increasing amounts of goods and services are likely to be required to meet the needs of a growing population, higher levels of living, international commitments, and continuing economic growth. Such an environment will necessitate relatively high and efficient levels of resource employment and a pattern of production in balance with the anticipated demand for goods and services.
>
> Formulation and evaluation of plans or alternative plans shall be accomplished in such a way as to permit timely application of standards appropriate to conditions of: (a) Less than "full employment" nationally, and (b) chronic and persistent unemployment or underemployment in designated areas. Standards appropriate to (a) shall be those adopted at the time of existence of such condition and authorized by the President. Standards appropriate to condition (b) shall be used where an area has been so designated under the Area Redevelopment Act of 1961 (75 Stat. 47) or other authorized procedures relating to resource underemployment. In condition (b) project benefits shall be considered as increased by the value of the labor and other resources required for project construction, and expected to be used in project operation, project maintenance, and added area employment during the life of the project, to the extent that such labor and other resources would -- in the absence of the project -- be unutilized or underutilized. Such benefits should be clearly identified as redevelopment benefits for the purposes of cost allocation, cost-sharing procedures, and to indicate their significance for project justification."

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[7] Op.cit., Senate Document 97, p.5.

Assumption 2: Capital and Labor are Employed:

If capital and labor are gainfully employed at the present time, then the government program may result in a reallocation of capital and labor at full employment. The benefits as we shall seebelow may be drastically different depending on whether assumption A or B is used.

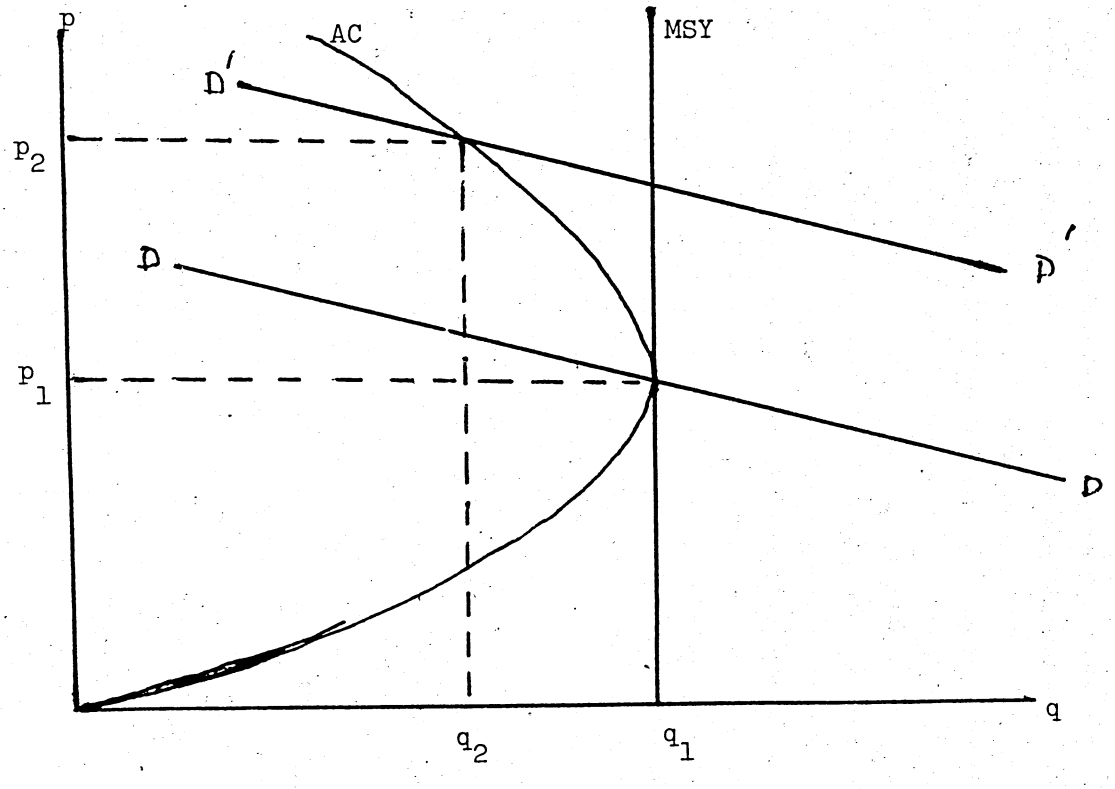
Consider Case 1 Fisheries

Case 1: A. Domestic

B. Near or beyond MSY

C. Unregulated

Diagram 6



Consider Diagram 6. If the domestic fishery is at MSY or $q_1$, an expansion in consumer demand will reduce the catch and increase prices. Using definition 8, economic benefits, they will be negative or

$$NEB_8 = p_2 (q_2 - q_1) - C_1$$

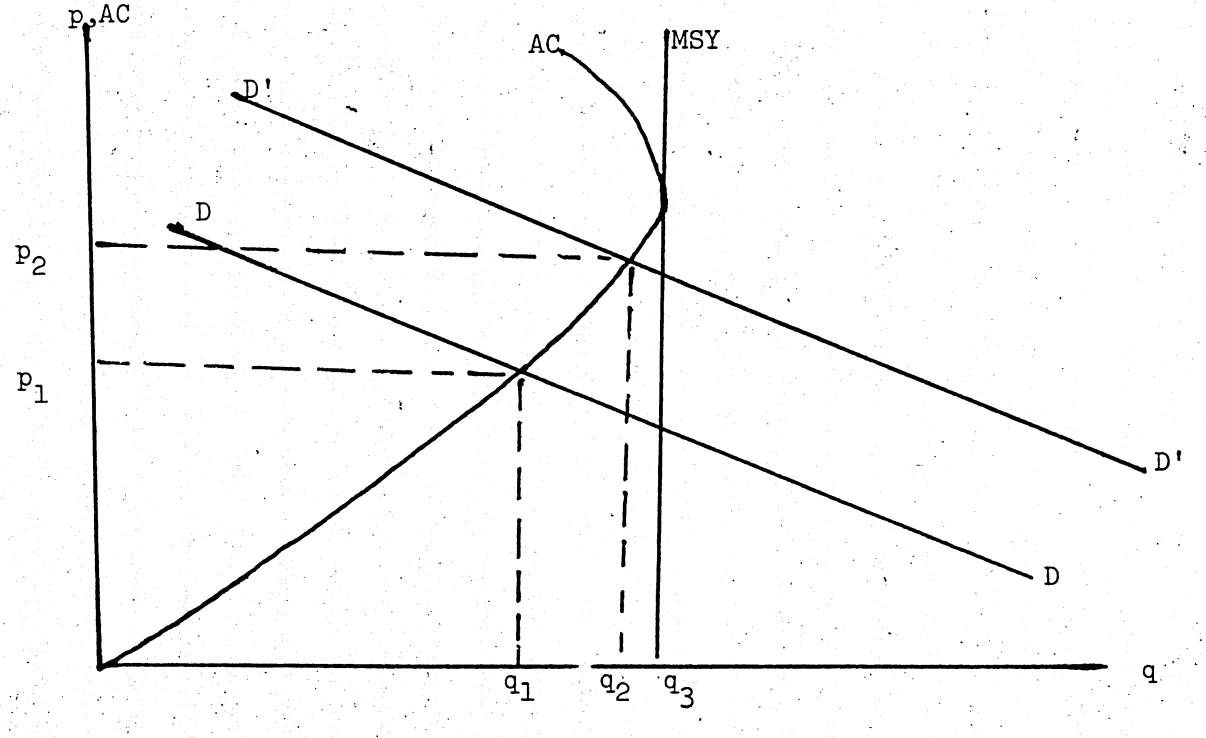
Even though output is reduced, more resources will be drawn into the fishery. This will certainly have a positive employment effect if resources are idle (assumption 1) but is undesirable from society's standpoint. The change in consumers' surplus (definition 4) is not directly applicable to Program 2.

Case 2: A. Domestic

B. Below MSY

C. Unregulated

Diagram 7



In this case, the expansion in demand will create positive economic benefits if assumption 1 holds (i.e., resources are idle). If assumption 2 holds, no net economic benefits may be created. An exception of this is where vessels and labor are transferred from an overfished to an underfished fishery. Economic benefits will then emerge in both fisheries.

Case 3 - 5 Fisheries: The analysis here will depend on the share of the total domestic market expected by domestic producers after an expansion in demand.

Program 3: Fishery Regulation: The final program area is extremely critical since we have seen the disadvantageous aspects of a free entry fishery. The benefits from Program 3: Regulation of Fisheries, will depend upon the nature of the regulation. Optimal regulations should limit the number of operating units to the fishery and provide for the taxation of excessive economic rents. Also, optimal regulation combined with the above programs may turn negative benefits into positive benefits. For example, a program of technological change for a fishery at MSY under optimal regulations will reduce the number of operating units to the fishery. Therefore, benefits can be calculated on the release of resources for other productive pursuits.

Table 2

Bureau Programs and Economic Benefits[1]

| | | Bureau programs yielding positive benefits | Bureau programs yielding negative benefits |
|---|---|---|---|
| Case 1. | Fisheries | | |
| | a) domestic | | |
| | b) near or beyond MSY | | |
| | c) unregulated | | |
| I. | Less than full employment conditions | 3 | 1, 2* |
| II. | Full employment | 3 | 1, 2* |
| Case 2. | Fisheries | | |
| | a) domestic | | |
| | b) below MSY | | |
| | c) unregulated | | |
| I. | Less then full employment conditions | 1, 2* | |
| II. | Full employment | 1, | 2* |
| Case 3. | Fisheries | | |
| | a) international | | |
| | b) near or beyon MSY | | |
| | c) unregulated | | |
| I. | Less than full employment conditions | 3 | 1, 2* |
| II. | Full employment | 3 | 1, 2* |
| Case 4. | Fisheries | | |
| | a) international | | |
| | b) near or beyond MSY | | |
| | c) regulated at MSY, but not entry | | |
| I. | Less than full employment conditions | 3 | ? |
| II. | Full employment conditions | 3 | ? |
| Case 5. | Fisheries | | |
| | a) international | | |
| | b) below MSY | | |
| | c) unregulated | | |
| I. | Less than full employment conditions | 1, 2* | |
| II. | Full employment | 1, | 2* |

* Definition 8 of economic benefits used.

1. Economic benefits are defined as the change in consumer surplus less associated costs.

## The Calculation of Benefit-Cost Ratios for Commercial Fisheries Programs

Once "economic benefits" accruing from government programs have been determined, we can specify the numerator and denominator for benefit-cost ratio as the following (Using $NEB_4$ and Program Area 1)[8]

$$PVNEB = \sum_{t=1}^{v} \left[ \frac{(P_1 q_1)_t \left[ k + \frac{nk^2}{2(1-k)} \right] - I_t}{(1+r)^t} \right]$$

where,

PVNEB = Present Value of Economic Benefits stream of earnings;

$(P_1 q_1)_t$ = Market value (at retail) of fishery before impact of Program Area 1 (i.e., economic forecasts);

v = period (in years) economic benefits will accrue to U.S. economy;

k = Percentage reduction in harvesting cost due to Program Area 1 (i.e., technical advances);

n = Price elasticity

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8. Our approach to measuring benefit-cost ratios is almost identical to the one used by Griliches in a classic article evaluating the social benefits from agricultural programs. See Zvi Griliches, "Research Costs and Social Returns: Hybrid Corn and Related Innovating," Journal of Political Economy, Vol. LXVI, October 1958.

I = Implimentation costs

r = discount rate

t = time

$$PVRC = \sum_{t=1}^{c} \left( \frac{(RC)_t}{(1 + r)^t} \right)$$

where

PVRC = present value of government research cost (i.e., could include private research cost if applicable).

RC = Estimated research cost in dollars;

c = Period over which research costs will be incurred.

Hence, the final benefit-cost ratio is

$$B/C = \frac{PVNEB}{PVRC}$$

## The Appropriate Discount Rate

For fisheries programs, it is recommended that we comply with the guidelines specified by the Joint Economic Committee: [9]

> "In this report, the Subcommittee on Economy in Government presents its conclusions on the application of discounting procedures in federal government bureaus and agencies and submits its recommendations on this matter. The subcommittee accepts without qualification the proposition that consistent discounting procedures and appropriate interest rate

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9. Economic Analysis of Public Investment Decisions: Interest Rate Policy and Discounting Analysis, Joint Economic Committee, 90th Congress, Second Session (1968).

policy must be adopted throughout the Federal Government if wise and economic investment decisions are to be made. Testimony presented to the subcommittee demonstrated that such consistency is not now present. The subcommittee recommends that no public investment be deemed "economic" or "efficient" if it fails to yield overall benefits which are at least as great as those which the same resources would have produced if left in the private sector. Currently, the rate of return on alternative minimum-risk private spending is at least 5 percent. Indeed, some of the economists appearing before the subcommittee argued for substantially higher interest rates--rates in the 7 to 12 percent range.

On the basis of the testimony presented, the subcommittee recommends that--

1. The Bureau of the Budget insist on the adoption of consistent discounting procedures by all agencies;

2. The Bureau of the Budget, in conjunction with an appropriate Government agency, immediately undertake a study to develop a method for estimating the weighted-average opportunity cost of private spending displaced by Government investment. This method should recognize that the financing of the Federal Government entails a reduction in both private consumption and private investment spending:

3. An appropriate Federal agency undertake the ongoing publication of this weighted-average opportunity cost interest rate as guidance to those agencies applying discounting analysis to public investment decisions. This interest rate calculation and publication should be pursuant to and based upon the above-mentioned study;

4. The proposal of the Water Resources Council which ties the interest rate to the yield on Government securities with long terms to maturity be adopted. The subcommittee judges that the yield on long-term Federal Government securities is the lowest possible rate consistent with the minimum-risk opportunity cost of displaced private spending;

5. The Bureau of the Budget and the program evaluation staffs of all Federal agencies intensify their efforts to formulate accurate monetary estimates of the benefits and costs of pbulic investments; and

6. The Congress review, with the purpose of relaxing, existing legal and institutional constraints on agency efforts to implement sound economic evaluation of proposed investments. These constraints are especially severe in the area of transportation investments.

This report, then, deals with optimum discounting procedures to be used in evaluating the economics of public investments. It does not argue that the democratically chosen representatives of the people should ignore the noneconomic impacts of public spending or refrain from placing a high value on them. The subcommittee, however, does urge that when and if a program warrants funding because of these noneconomic effects, the cost of attaining these other objectives be clearly recognized. It is only with the accurate evaluation of the real national economic impacts that the costs of securing these other social objectives can be recognized and appraised."

Four alternative interest rates are currently discount the future benefits and costs to assure adequate recognition and evaluation of the sensitivity of the interest rate on the magnitude of the benefit/cost ratios. The four interest rates are as follows: [10]

(1) 4-7/8% - the minimum rate for public sector program evaluation.

(2) 6% - the rate for minimal risk conditions.

(3) 12% - the rate for normal risk undertakings.

(4) 20% - the rate for new high-risk ventures.

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10. USDI, Handbook for PPBS, Rev. 1/23/69, pp. IX 11-12.

The writer must conclude from the discussion of the discount rate that for fisheries programs a high rate of discount be employed. As pointed out by the Joint Economic Committee, the discount rate should be selected on the basis of that return accruing to such finds in comparable private sector activities. As pointed out by Griliches, the return on R and D is extremely high for the private sector, probably over 30 percent.[11] For example, the annual rate of return on the innovation of hybrid corn was computed by Griliches to be 700 percent.[12]

## Simplified Guide to Evaluation of Economic Benefits from BCF Research and Development Programs: An Example Problem

### A. The Problem

Let us assume that BCF scientists would like to do research on the improvement and refinement of the hydraulic dredge and other mechanical devices for the clam fishery. The scientists would first like to review all existing methods of harvesting clams and then engage in research on increasing the productivity of existing equipment. Before the research is undertaken, the scientists must estimate the economic benefits to society from this research. Not

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11. Op. cit., Griliches

12. The high risk involved in R and D makes it necessary to obtain fairly high returns. This is true of BCF research and development. Hence, the BCF should use category 4 (20 percent or higher) of the PPBS handbook.

being economists, they ask the Division of Economic Research to aid in this endeavor.

B. Information from the Scientists

The Division of Economic Research asks the scientists for information on this prospective program.

1.

Q: Of the BCF's three broad program areas, under which category does your proposed research fall (i.e., cost reducing, demand expanding, fishery regulations)?

A: Cost Reducing Program.

2.

Q: Estimate the technological impact of your research assuming you are successful. That is, by how much do you estimate output per fisherman will improve as a result of your research? Be conservative.

A: Ten percent reduction in harvesting costs or a ten percent increase in output per fisherman.

3.

Q: Assume your research starts tomorrow, in what year will it be useful to the fishing industry: That is, when could the individual fishermen adopt the new technology?

A: FY 1971

4.

Q: Estimate the implementation cost of adopting the new technology for the average fishing unit.

A: $300 per fishing unit.

5.

Q: Estimate annual cost of your research program?

A: Annual Costs (in thousands of dollars)

| | |
|---|---|
| FY 1970 | 100 |
| 1971 | 80 |
| 1972 | 20 |
| 1973 | 10 |
| 1974 | 1 |
| 1975 | 1 |
| Total Cost | 212 |

6.

Q: Estimate how may years it would take before private industry would develop the new technology you propose in your research program.

A: 1976

C. Information Supplied by Economists

1.

Q: Assuming there is no technological change over the course of the next six years (i.e., 1970-75), project the demand for the fishery product to the year 1975. Furnish the projected retail market value for each year over the 1970-75 period.

A: Projections (in thousands of dollars)

| | |
|---|---|
| FY 1970 | 79,257 |
| 71 | 80,275 |
| 72 | 81,314 |
| 73 | 82,314 |
| 74 | 83,352 |
| 75 | 84,391 |

2.

Q: Estimate the relation between a percentage change in quantity consumed to a 1 percent reduction in price (i.e., price elasticity).

A: Log clam consumption per capita = 2.92972 - 1.17609* log (Ex Vessel Price Clams/Consumer Price Index) - .64652 log Per Capita Income
Price Elasticity = 1.17609

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* Statistical significant at 5 percent level.

Table 3

Hypothetical Social Benefits and Cost to a
Bureau of Commercial Fisheries Clam Research Program

(thousand dollars)

| Year | Trend in Value of Output with Current Technology (Projected) [1] | Cost of Technical Research ($C_t$) | Gross Economic Benefit (GEB) [2] | Implementation Costs (I) [3] | Net Economic Benefit (NEB) [4] |
|---|---|---|---|---|---|
| 1970 | 79,257 | 100 | 0 | 4,938 | -4,938 |
| 1971 | 80,275 | 80 | 2,007 | 0 | 2,007 |
| 1972 | 81,314 | 20 | 2,033 | 0 | 2,033 |
| 1973 | 82,314 | 10 | 2,058 | 0 | 2,058 |
| 1974 | 83,352 | 1 | 2,084 | 0 | 2,084 |
| 1975 | 84,391 | 1 | 2,110 | 0 | 2,110 |
| | | 212 | 10,292 | 6,584 | 5,354 |

1/ Based on consumption of .341 pounds per capita and the current retail price of $1.128 per pound multiplied by the projected U.S. population over the 1970-75 period.

2/ See text for formula for GEB. n=1.17609; k=10 percent at ex vessel level or 2.5 percent at retail level; $(p_1q_1)_t$ = projected market value series; GEB = .025 $p_1q_1$

3/ Costs of $300 per fishing enterprise multiplied by 5,486 enterprises in 1970.

4/ NEB = GEB - I

D. The Benefit-Cost Ratio from R & D in Clam Research

Table 3 shows the computations of gross and net economic benefits. If we employ a discount rate of 27 percent, the discounted stream of net economic benefits equals $347,217. The present value of research cost discounted at 27 percent is equal to $108,961. Hence the benefit cost from the clam research program is the following:

B/C = $347,217/$.80,961 = 1.9

We may also ask the question: What is the rate of return on clam R and D funds? Calculations reveal that the economic benefits from clam research in our example results in an annual rate of return of 30.4 percent.

## Conclusions and Recommendations

On the basis of the above analyses, the writer recommends that the BCF adopt the following:

1) For those program areas which involve research and development to improve harvesting technology or distribution technology, it is recommended that the change in consumers' surplus be used as a definition of economic benefits. It is further recommended that the producers' surplus be ommitted since it is difficult to calculate (i.e., little is known about the industry supply

function) and without it the total calculated economic benefits will be on the conservative side.

2) For those program areas which involve increasing the demand for fishery products, it is recommended that the increased output multiplied by the final equilibrium price be used as the definition of economic benefits. The calculated benefits should be related to the level of national and or regional unemployment. Shifts of capital and labor among fisheries should be considered in calculating benefits from consumer demand programs.

3) For R and D Programs, it is recommended that a fairly high discount rate be used in calculating present value of benefits. Comparable R & D activities in the private sector would certainly yield high returns. This recommendation is consistent with the discount rate procedure sponsored by the Joint Economic Committee.

4) It is recommended that the rate of return on R & D investment be computed as part of the benefit-cost procedure.

5) The majority of BCF programs probably (i.e., technological change, demand creating) yield negative benefits for cases 1 and 3 fisheries. No specific calculations are necessary for these fisheries since the direction of benefits is obvious.

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(continued from inside front cover)

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In the process of working towards these goals an array of written materials has been generated representing items ranging from interim 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.