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**APPLYING COST/BENEFIT ANALYSIS TO THE FISHERIES
ENHANCEMENT PROGRAM IN ALASKA:
EVALUATION OF LEISURE AND CHENIK LAKES
ENHANCEMENT PROJECTS**

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ABSTRACT

Since the Alaska fisheries enhancement program is a state-supported investment, a central question facing policy makers is whether or not government's actions represent an efficient use of resources. Cost/benefit analysis may be applied to address this issue from (1) a broad perspective, focusing on the net effects of a movement on the supply and demand curves related to entire output of the statewide enhancement program, or (2) from a project-level perspective where a movement on the supply and demand curves for several alternative projects are compared to determine optimal investment strategies.

In this study, we address the project-level question, "If efficient distribution of resources between projects is the primary goal, which investment schemes produce the largest net benefits to society?" To evaluate these questions, trade-offs between and within projects must be considered. Cost/benefit analysis is a powerful tool with which to address these trade-offs.

Many cost/benefit studies involving fisheries will either formally apply a bioeconomic model or apply relevant components of a bioeconomic model to address a policy question. Applying bioeconomic reasoning to a fishery enhancement investment requires use of (1) a population size/population growth estimate for the fishery, (2) a demand model, (3) a fishing cost model, and (4) a project cost function.

These four components are applied to two related Fisheries Rehabilitation, Enhancement and Development (FRED) Division sockeye salmon enhancement projects in lower Cook Inlet called Leisure Lake and Chenik Lake. A discussion of additional economic issues are included along with the results of several simulations that estimate the present value of the net benefits for the projects. The analysis details how fishery harvests are influenced by projecting a with-project and without-project case. The analysis further projects the change in total revenue to the commercial fishing fleet through the use of a linear-demand model. An ad-hoc fishing cost model is applied to the lower Cook Inlet seine fleet to account for cost of fishing trade-offs (including rate of rent dissipation) with and without the project. Sensitivity analysis is applied to important variables in the analysis. Finally, a discussion of technical problems in the application of cost/benefit analysis to evaluate the effects of fishery enhancement are included.

WHY APPLY COST/BENEFIT ANALYSIS TO FISHERY ENHANCEMENT?

The Alaska Department of Fish and Game has demonstrated a growing interest in economic information and economic models pertaining to the resources under its management and regulatory authority. To date, however, little investment in applied analysis of resource use trade-offs have occurred. Even less frequently have economic models been applied to assist managers in making day-to-day management decisions.

Faced with a large choice set of enhancement projects and an interest in understanding the consequences of its salmon program, the FRED Division has initiated a preliminary economic evaluation process for some of its investments. In particular, cost/benefit analysis has proven useful for explaining the benefits and costs of altering salmon abundance in specific areas of the state. It also has been helpful for revealing which alternative projects would yield the greatest net improvements in the welfare of the commercial fishing fleet. Increasingly, fishery enhancement projects that occur on federal lands are mandated to follow the National Environmental Protection Agency (NEPA) process which encourages the use of cost/benefit analysis.

The application of cost/benefit analysis to the statewide fishery enhancement program has involved a number of constraints. One constraint is simply the limited resources that government has made available for evaluating the program. A second constraint is that as a state treasury investment, the program is obscured by other enormous programs. Little interest is generated by exploring the efficiency implications of a program requiring between 0.5% and 0.7% of the annual state operating budget. A final constraint is a decision-making audience that is unfamiliar with economic theory and an entrenched public interaction and political process that does not weigh cost/benefit analysis heavily.

These constraints are not confined to only this analysis. They tend to impact how government economists approach economic modeling. The models tend to be simple, made with available information, and are designed to be understood by a lay audience. These features are consistent with the models presented in this paper.

FOCUS OF THIS PAPER

Many cost/benefit studies involving fisheries will either formally use a bioeconomic model or apply relevant components of a bioeconomic model to the policy question being addressed. Bioeconomics involves modeling linkages between species, habitats, resource users, and management. It is an attempt to describe interactions between economic forces and biological processes that collectively determine the ultimate production (supply) and valuation (demand) of fishery resources. The components of these models often are estimated simultaneously (Matulich and Donnelly 1989).

While it is not necessary to include all of the dynamic components of a formal bioeconomic model, the reasoning used in bioeconomics is reflected in the first five of six sections addressed in this paper. The sections are as follows:

1. Biological and fishery projections for the Leisure and Chenik Lakes projects, including population size and population growth assumptions.
2. Economic issues and assumptions, including the cost of labor, accounting stance, and appropriate market level.
3. Demand model.
4. Fleet behavior and fishing costs in lower Cook Inlet.
5. Project cost function.
6. The results of simulations and conclusions.

BIOLOGICAL AND FISHERY PROJECTIONS FOR LEISURE AND CHENIK LAKES

Both Leisure Lake and Chenik Lake are located in the lower Cook Inlet management area, which includes the waters west of Cape Fairfield, north of Cape Douglas, and south of Anchor Point. There are five commercial fishing districts in the management area, four of which are important to the salmon fishery: (1) Southern, (2) Outer, (3) Eastern, and (4) Kamishak Bay. There are approximately 79 seine and 34 set-net permits in the lower Cook Inlet commercial fishery. It is primarily the seine fishery that targets on the sockeye salmon produced from these two lakes.

Description of Fishery Enhancement Activities at Leisure Lake and Projections of Future Harvests

Historically, Leisure Lake had no salmon production because a large falls below the lake prevented upstream migration. The lake had little alternative use for recreation because of its inaccessibility and near-sterile productivity. It was visited infrequently by recreationalists and the enhancement activities do not appear to be mutually exclusive with any other uses. An experiment was initiated in 1980 involving the annual stocking of hatchery-produced sockeye salmon fry to determine the optimal stocking levels prior to and after lake enrichment through fertilization. Preliminary results from those studies concluded that a stocking rate of 2 million fry, augmented with lake fertilization, produced adult returns at a biological maximum. Catches of returning adults from the site reached over 90,000 adult salmon in 1988.

Description of Fishery Enhancement Activities at Chenik Lake and Projections of Future Harvests

Chenik Lake project history differs from Leisure Lake in that it was once a significant lower Cook Inlet sockeye salmon producer. A dramatic production decline occurred in the 1940s as the fishery became more powerful (Fig 1.). In the early 1950s, emergency management actions were taken to protect weak populations in the Chenik Lake system, which led to a shutdown of the sockeye salmon fishery from Chenik Lake. The complete removal of

directed fishing pressure from the stock has led to no appreciable increase in recruitment. This was attributed to three reasons, including (1) a series of velocity barriers and falls seriously impeded sockeye salmon migration, (2) abundant predator populations in the lake, and (3) fishery biologists expected that the habitat constraints at the site could not withstand even light fishing pressure.

The FRED Division took three actions to improve the run. The first action involved construction of a fish pass. The second action involved sockeye salmon fry planting, and the third action involved fertilization of the lake. By 1988 these activities had resulted in harvests of over 160,000 sockeye salmon. Biologists project that with continuation of the lake fertilization, harvests should increase to approximately 200,000 sockeye salmon per year. Without enhancement through fry plants and fertilization, the lake would not be expected to sustain a small fraction of its present smolt production. This is supported by FRED Division's lake fertilization studies.

With continued maintenance of the fish pass, recruitment of spawners would be slow and a maximum population size of up to 15,000 fish could be maintained. Once the fertilization and fry planting is stopped, a gradual return to a harvestable stock of about 3,000 fish could be expected. Biologists project that this would occur in the mid-1990s (Fig. 2). With in-season aerial surveys, Chenik Lake sockeye salmon stocks are physically and temporally separated from most other stocks in the terminal fishery. For these reasons, the fishery interactions (through potential overharvesting) with other stocks are expected to be small.

Applying cost/benefit analysis to a real world trade-off involves constructing a with and without case from alternative management actions that the division has some control over, and then monetizing the present and future consequences of that trade-off. For example, managers cannot return to a former period in time and withdraw all the efforts spent on fishery enhancement on these two sites, just as a fishery manager cannot return to a former period and change fishing openings that have already occurred. In the real world of budget cuts, a critical policy question for the lower Cook Inlet salmon fishery has been, "If we removed the Chenik Lake and Leisure Lake projects from the list of enhancement activities in 1989, how would the welfare of lower Cook Inlet fishermen be affected?" In fact, these projects have been the subject of several proposed budget reductions in former years.

To address the policy question, it is necessary to simulate the net effects of removing both enhancement efforts. Since Leisure Lake is an enhancement project, termination of the project would eliminate all fish production and harvests in a matter of a few years. Lake productivity studies at Leisure Lake suggest that the carrying capacity of the lake is zooplankton-limited. Periodic fertilization, in a typical year, was estimated to produce returns and harvests of 120,000 sockeye salmon.

With continued fry planting, fertilization, and maintenance of the current fish pass, the Chenik Lake system would continue to increase sockeye salmon population and harvest in the long run. Sustained harvests of at least 200,000 sockeye salmon should be maintained from this project (Fig. 2). The biological production from the site is expected to last in perpetuity, but the economic life of the project is extended to only 2009.

If the Chenik Lake project was to be discontinued, as of 1988 catches would decline rapidly. Given proven poor recruitment capabilities of Chenik Lake without fertilization, enhancement, and funds for upkeep on the fish pass, harvests would be expected to be reduced to a few thousand fish per year, or less. This deterioration of the sustained population and harvests would occur throughout the 1990s. The combined net effects of Chenik and Leisure Lakes show a steady state of harvest occurring in the late 1990s. The catch of approximately 317,000 salmon per year (Fig. 3) are expected to be subject to annual variation from random events, such as ocean productivity and productivity of the early estuarine rearing environment. This cost/benefit analysis is about the net effects (or difference between) of these two time series of catches as they are converted into 1988 dollars.

Beyond the commercial fishery activity resulting from Leisure Lake, additional fishing opportunities have developed. Both a personal-use fishery and a recreational fishery have developed at the China Poot Bay estuary. While the effects of these activities are legitimately part of the net effects of these projects, they have not been considered in the analysis.

Precision of Catch Estimates and Assumptions of Biological and Fishery Interactions

Some enhancement projects in Alaska use coded-wire tagging and recovery programs to estimate returning adults and landings. These enumeration techniques have not been necessary to apply to Chenik and Leisure Lakes. Measurement of the historical harvests have occurred with a high degree of accuracy from these projects because of their isolation from other stocks. Adult salmon returning from Chenik Lake migrate into terminal harvest areas of lower Cook Inlet and are spatially and temporally isolated in the terminal area from other sockeye salmon stocks. Leisure Lake stocks are spatially separated in the terminal area; however, some fish are intercepted in nearby subdistricts. These interceptions are estimated and differentiated from other stocks through scale-pattern analysis.

There is little evidence of downward bending in a species-wide recruitment function, as evidenced by numerous years of near-record sockeye salmon catches in the last decade. Thus, biologists believe that measurements of gross increases in population represent net improvements in the statewide catch of sockeye salmon.

The following cost/benefit analysis treats these two projects as a single unit. They are targeted on the same fleet, enhance the same species of salmon, are augmented by fry plants from the same hatchery, apply the same general lake fertilization techniques, and have been plagued with the same budget problems.

ECONOMIC ISSUES AND ASSUMPTIONS

Accounting Stance

If the evaluation framework used here were to focus strictly on a national accounting stance, estimating the net benefits of a fishery enhancement project would clearly require the integration of consumer and producer surplus from a relevant supply-and-demand function. The extent to which the increased output of salmon from the enhancement program changes the integrated area above the price line and below the demand curve (the consumer surplus) is of interest to economists. While not endorsing a purely parochial view, I have observed that changes in consumer surplus from enhancement are of less interest to policy makers and commercial fishermen in the State of Alaska.

This view is prevalent among fishery managers for the following reasons:

1. All of the state's salmon harvest is exported outside of Alaska. In most cases, such as in the case of the statewide sockeye salmon fishery, it is exported out of the country.
2. Fishery enhancement investments in Alaska are made primarily with funds from the state treasury. Most policy makers are willing to forego some loss in national economic efficiency for the attainment of positive net returns to Alaskans from the state treasury.

Even if a narrow accounting stance is applied, such as one oriented to the residents of Alaska, construction of supply and demand models must still be made to estimate producer surplus to Alaskans. For the purposes of this study, the changes in benefits and costs of the fishery due to the implementation of an enhancement program, will be evaluated from a state-accounting perspective, which focuses on the residents of the State of Alaska.

Since the state's accounting perspective requires data on whether the benefits of the projects accrue to residents of the state, the Commercial Fisheries Entry Commission has provided estimates of residency fractions for commercial fisheries. The fraction represents the portion of fishermen in a management area that are residents of the State of Alaska. These constants are multiplied against the net benefits for a particular commercial fishery to determine economic profits from the state perspective (Focht 1984). For this analysis, we have assumed that our final computation of producer surplus can be adjusted by historical, average gross-earning fractions for resident license holders to arrive at a reasonable approximation of producer surplus to residents of the state.

Implications of a Regulated Fishery

The Alaskan salmon fleet, as well as other Pacific salmon fishing fleets, have been characterized as being largely overcapitalized (Crutchfield and Pontecorvo 1969; Pearse Commission Report, Pearse 1982). In short, the balance of literature on this subject points out that salmon fisheries have greatly expanded fishing power in recent years. But, because the quantity of fish harvested is essentially determined by factors which are independent

from fleet investment (such as annual fluctuations in salmon stock size), new capital investments in vessels, gear, and advanced technology added to the fleets have been largely wasted. In Alaska, one consequence of fleet capitalization has been an established ability of the fleet to harvest well beyond the 1978 to 1988 average harvest. The record 1985 harvest of 138 million salmon is considered by fishery managers to still be below the present harvesting capabilities of the Alaskan fleet.

Fleet rationalization measures that might reduce wasteful investment in fishing power are beyond the scope of this paper. The present approach to managing Alaska's salmon fishery does, however, place some constraints on investment as implied in the several hundred million dollars worth of entry permits that exist as transfer payments between fishermen. Schelle and Muse (1989) present an argument for the maintenance of significant long-run rents in Alaska's salmon fishery through a specific set of management actions. Empirical evidence for the existence of long-run rents include the relatively slow decay of entry permit prices (the market price for permits is expected to reflect much of the producer surplus of the salmon fishery). The authors suggest that a combination of limited entry permits, area licensing, and gear constraints have been effective in reducing the rate of capitalization in the fishing fleets.

While it is apparent that there are inefficiencies in the management of Alaska's salmon fishery, this cost/benefit analysis occurs under constraints of the existing fishery management policies. It does not assume that further and more aggressive fleet rationalization procedures will be applied within the life of the investments. The specific assumptions and models for estimating a supply function are discussed in depth in the Cost Model Section of this paper.

Accounting Identities For Cost/Benefit Analysis

In a publicly funded project, it is necessary that our accounting equations deal with both private and public benefits and costs (Equation [1]). The level of profitability for each investment alternative is determined using equations that calculate the Present Value of the Net Benefits (NPV) and benefit/cost ratio of those cases. The equations applied to this study are the conventional equations used by economists to conduct benefit/cost analysis on publicly funded projects (Randall 1981).

Equation 1. $B_{(pri)} - C_{(pri)} - C_{(pub)} =$ present value of the net benefits (NPV)

Where:

$B_{(pri)} =$ The present value of the benefits (change in revenue) to the private sector which results from a change in the amount or value of product harvested due to the enhancement project.

$C_{(pri)} =$ The present value of the costs to the private sector resulting from the enhancement project (e.g., cost of harvesting and/or processing, etc.).

$C_{(pub)} =$ The present value of the public costs resulting from producing and managing enhanced stocks of fish (e.g., operational, construction, and planning costs of the enhancement facility).

Social Cost of Labor

The variable costs of harvesting the enhancement-produced stock at Leisure and Chenik Lakes are expected to be negligible. This is discussed further in the fishing cost section of the manuscript. Variable fishing costs as well as fixed costs are counted at their full market price. No effort is made to compute the opportunity costs of labor. "The price paid for labor represents the full social cost of that labor - that is, the amount of other production lost if labor is shifted from some other gainful occupation to fishing" (Crutchfield et al. 1982). Social labor costs would be approximately equal to total costs in a full-employment economy only. Use of total labor costs in this analysis could result in an overestimate of the variable costs of fishing.

Choosing An Appropriate Market Level

In theory, the analyst may choose any market level to construct a supply and demand function for estimating producer and consumer surplus (Just and Hueth 1979).

The area behind a general equilibrium demand curve in an intermediate market does not measure benefits to buyers in that market alone, but rather measures the sum of rents to producers selling in all higher markets (assuming no intervening market has perfectly elastic demand) plus final consumer's surplus. Symmetrically, the area behind the general equilibrium supply curve in an intermediate market measures not only rents for producers selling in that market, but also rents for all producers selling in more basic markets (assuming no intervening market has perfectly elastic supply) plus initial resource supplier's surplus."

In practice, however, the market level chosen for welfare measures in fisheries depend primarily on their explanatory or predictive abilities in addressing a particular policy question. These predictive abilities, in turn, rely on the quality and length of the time series used to construct the models. The literature on salmon demand models, for example, concentrates on prices and production at three observed market levels: (1) landing (Muse 1984; Ronan 1988); (2) wholesale (generally at export from state-, province-, or country-landed) (Devortz 1976); and (3) from buyers selling to final consumers at the retail level (Anderson 1988). Literature on supply functions for salmon are limited but they primarily concentrate on fleet costs at the landed level or fleet and processing costs at the wholesale export level. In this analysis, supply and demand functions are constructed at the landed level.

Reasons for developing a demand and supply function at the landed level include a longer time series, more reliable information, and supply functions may be based on observable fleet behavior. One alternative is estimating a supply function at the wholesale level. This is problematic due to a lack of reliable data on production costs for processing firms in Alaska. Alaska is faced with poor quality information on the processing sector due to the lack of reporting requirements.

The Demand Model

As related earlier, a method of estimating prices that includes the effects of changing levels of harvest on prices may be required to apply bioeconomic reasoning to a fishery cost/benefit analysis. This is most important when it is expected that a significant variation in price may occur from an increase in harvest. Several demand models that have been used for economic assessment of United States and Canadian salmon management issues find that salmon landings are an important explanatory variable in the models (Devortz 1976; Muse 1984; Herrmann and Lin 1988).

Even a superficial treatment of salmon demand models are beyond the scope of this cost/benefit analysis. Some additional explanatory variables tested in salmon demand models include:

1. Landings of Alaskan salmon
2. Landings of salmon in other countries
3. Production of substitutes and prices of substitutes
4. Population growth in the market areas
5. Income in market areas
6. Exchange rates
7. Quality of salmon
8. Price elasticity of demand
9. Inventories

Some of these variables have been tested in the linear model developed for this analysis (Ronan 1989). If a model that included all of these variables was required for explaining the changes in historical sockeye salmon prices, it might become unwieldy and costly to generate a cost/benefit analysis for any enhancement project. As previously alluded, a highly valued attribute for models used in state government is simplicity. Even more attractive would be a simple model that has reasonable predictive abilities with variables that can easily be accessed and verified from the data available.

This criteria is largely satisfied by landed price forecasting models. The simple forecasting models for pink, chum, and sockeye salmon from Muse (1984, 1989) and Ronan (1988) have performed reasonably well for estimation of landed prices. These mathematical equations concentrate on projecting prices of fish paid to fishermen.

Initial testing of some of these models was undertaken by Ben Muse of the Commercial Fisheries Entry Commission in 1984. More recently, the FRED Division initiated a contract with the Institute of Social and Economic Research (ISER) for extending this initial work to develop ex-vessel demand models for sockeye salmon. Preliminary models tested by Nick Ronan of ISER have produced acceptable results. Updated through 1988, some of the models explain up to 70% of the variability in ex-vessel prices. It follows the trends in price reasonably well for the last 20 years and is particularly good after 1979 (Fig. 6).

Essentially, this simple model implies that despite the list of potential explanatory variables, the important variables for determining a statewide price for sockeye salmon are the currency exchange rates between the Japanese yen and the U.S. dollar, along with the

statewide sockeye salmon catch. It is a linear model that projects decreasing prices with either a substantial increase in sockeye salmon harvests or much stronger buying power for the U.S. dollar against the Japanese yen. Even with a much stronger dollar, sockeye salmon harvests must exceed 450 million pounds before the total revenues to fishermen are reduced.

Ronan tested two linear models to predict statewide sockeye salmon prices. These models used quantity of sockeye salmon caught statewide (Q_{sw}) and quantity of sockeye salmon caught statewide in the previous year ($Q_{sw}(t-1)$) as a proxy for inventories on-hand at the beginning of the season. Ronan hypothesized that the sockeye salmon price is related to the size of inventories on-hand at the beginning of the season. When $Q_{sw}(t-1)$ was used to replace Q_{bb} in the model (Q_{bb} was the quantity term for the Bristol Bay model originally developed by Muse in 1987), the results were as follows: the variable coefficients maintained their expected signs, increased in size, and both became significant at the 99% level. The constants remained insignificant. The standard error of the regression decreased slightly, but not significantly. The R squared increased from .67 to .70 indicating slightly better predictive powers. The lack of a predictive model for estimating future inventories negates the use of the inventory-based model. The functional form used for estimating statewide prices is expressed in Equation [2]:

Equation [2]

$$Pse = .2463169072 \cdot 0.0000000026 * Q_{sw} + 3.216 * J$$

Where: Pse = Statewide average price
 Q_{sw} = Quantity of sockeye salmon landings (lbs)
 J = Cents per yen

Additional Assumptions for Explanatory Variables in the Demand Model

1. Natural Stock Harvest

To project the change in total revenue, gross earnings from the statewide sockeye salmon harvest must be estimated with and without the enhancement production from Leisure and Chenik Lakes. Sockeye salmon harvests have fluctuated greatly during the period of full exploitation that started in the 1930s (Fig 5.). In the last decade, however, landings have stabilized at approximately 30 million fish per year (200 million pounds). While this is well above the 20- to 30-year average harvest, it is used as a point estimate in the analysis. Also tested, is a catch rate of 160 million and 240 million lbs.

2. U.S. Dollar and Japanese Yen

A discussion of exchange rate forecasting procedures are beyond the scope of this report, yet some assumptions must be arrived at since it appears to be an important variable in the models. The Japanese yen/U.S. dollar exchange rate has demonstrated several surges in growth over the last two decades (Fig. 4). It would be tempting to project future exchange rates that increase with time. This naive approach to creating a model would ignore any interactions with the economy. A

3, 5, or 10-year average, while incorporating no more knowledge of how currency markets might behave than a trend analysis, could also be applied. To prevent the implication of either of these two approaches providing more than an arbitrary guide, a point estimate of 0.65 cents per yen is used in the assessment. Additional testing of 0.60 and 0.70 cents per yen was also applied. A more rigorous method of projecting exchange rates would be desirable.

When the price forecasting model is used for estimating the change in total revenue to fishermen from the two enhancement projects ($P_2Q_2 - P_1Q_1$), the project results in a present value of approximately \$23.4 million (Fig. 7). This corresponds to a background harvest of 200 million lbs, exchange rate of 0.65 and real interest rate of 3%.

Technical Problems with Demand Model

1. At times history is a reasonable guide for model building and, at times, it may ignore variables that we expect will be important in the future. Variables that might affect future consumer behavior that are not accounted for in a demand model constructed from historical information should at least be identified. One variable that salmon demand modelers expect to change in the future is output from the growing salmon farming industry. While culture techniques for farmed sockeye salmon have not resulted in a harvestable-sized product as yet (and probably will not for several years), other species of salmon are widely available to domestic and foreign consumers, even in Japan. There is little evidence for farmed salmon to exist as a perfect substitute for sockeye salmon in the Japanese market. Prices for fresh farmed salmon are generally much higher in Japan than are prices for frozen sockeye salmon from Alaska. Imports of farmed salmon are extremely small compared to the imports of fresh, frozen salmon from Alaska. Demand modelers seem to agree that farmed salmon are a substitute for harvests of naturally produced salmon; they are less sure of how consumers will respond to farmed substitutes in the future.
2. While the demand model has fair explanatory power, the explanatory variables in the demand model itself cannot be estimated with much precision. A less naive, predictive methodology for estimating exchange rates would be an improvement over use of a multiple-year average. The forecast of the statewide sockeye salmon harvest could incorporate a habitat-related production function that considered potential habitat, fishing power, and management inputs.

FLEET BEHAVIOR AND FISHING COSTS IN THE LOWER COOK INLET SEINE FISHERY

The preceding discussion accounts for the change in total revenue of the fishing fleet that can be attributed to enhancement production. To determine the net economic benefits for lower Cook Inlet projects, an additional element must be brought into the computation; namely, the costs of harvesting the stock of enhancement-produced fish. These costs must be subtracted from the change in total revenue. Three types of costs are important to the fishery manager: (1) the variable costs of the fishermen that are incremental; (2) the capital costs of fish harvesting that are incremental; and (3) the social costs of the labor employed in the processes of harvesting the increment.

There are two possible (opposing) cases for projecting fishing costs that are attributable to the two projects. First, it is possible that additional salmon production will simply increase the density of the fish run. The increased harvest could then be taken with about the same amount of operating, travel, and labor costs as before the projects existed. Since the fleet has enough fishing capacity to easily harvest the lower Cook Inlet stock in a strong year, then no additional labor or capital will be required. This implies that no additional costs are involved and the change in total revenue to producers is approximately equal to the change in net revenues.

A second case results from the assumption that the case of the regulated common-property fishery will hold. In this instance, positive net benefits are reflected in increased profits. When profits are noticed, additional fishing power is applied to the available stock of fish. Additional vessels and capital may enter the fishery until costs have risen by as much as the increase in total revenues. While individual fishing operations become more technically efficient in catching fish, the fleet in aggregate becomes economically less efficient. This extreme process would apply regardless of whether the harvest had been increased by an enhancement project (such as a fish hatchery) or some management action that allowed for higher sustained harvests.

Interviews with fishermen, fishery managers, and the existence of positive permit prices lead me to believe that neither of these two extreme cases will hold in the lower Cook Inlet salmon fishery. Bruce Rettig (1985), an Oregon State University economist, presents a convincing argument for conducting sensitive analysis for estimating fishing costs for improvements in Oregon salmon harvests in that state's gillnet and troll fisheries. He recommends that net economic values can be estimated at 50%, 75%, and 90% of gross economic value. These three levels of fishing costs have been projected and used to estimate the present value of the change in revenue less variable and capital costs to the fleet, including net benefits.

A second case involves the assumption of incremental increases in fishing power where costs asymptotically approach potential gross revenues to the fleet. This approach to estimating costs is consistent with the common-property model, but the rate of rent dissipation reduces the present value of net benefits more rapidly than the constant cost model. Incremental rates chosen to be tested in this study are at 5%, 10%, and 25% of gross earnings. One at 10% per year and one at 25% per year. The Net Present Value is shown in Fig. 10.

The functional form for the constant cost model is simply:

Equation [3]

$$C = f[RA]$$

The functional form for the incremental rate of fishing cost is:

Equation [4]

$$C = f[(R - C_{n-1})A + C_{n-1}]$$

Where: C = incremental fishing costs from enhancement-produced stock
R = gross earnings to the fishing fleet from enhancement-produced stock
A = a constant expressing the rate at which costs from harvesting the enhancement-produced fish in a given period will occur

Fig. 8 demonstrates the dramatic differences that these two approaches have on net revenues in a simple and hypothetical fishery where a sudden improvement of \$1.0 million per year in gross revenues is realized.

Rettig also asserts that there is no clear-cut way to resolve this issue of how to model fishing costs without studying individual fisheries. It may be possible to develop a preliminary model of fishing costs in the lower Cook Inlet seine fishery from a survey of fishermen along with an interview with the area fishery biologists, or through the use of a travel cost model constructed from ADF&G fish ticket files. To compute these costs, it is relevant to relate some background information on how the lower Cook Inlet fishery behaves¹.

The lower Cook Inlet seine fishery is composed of a large portion of Alaska resident fishermen. In 1988, out of 79 permits, only one is registered to a nonresident fisherman. Additionally, 48.8% reside within the Homer city limits, 93.7% reside on the Kenai Peninsula, and the remaining 5% live in Anchorage. In 1988, 71 of the seine permitholders actively fished in lower Cook Inlet.

While over twenty fishermen have valid limited entry permits for other salmon fisheries, in the last few years, only a dozen participate in a second limited fishery. These permits are for salmon, most of which are in Prince William Sound and upper Cook Inlet. In a year of strong lower Cook Inlet salmon harvests less than 5% of the fishermen with other salmon permits overlap with the season in lower Cook Inlet. Of the 5% (four fishermen) of the fishing fleet who do have the choice of fishing in Prince William Sound or upper Cook Inlet, during the lower Cook Inlet seine opening in recent years (and during years of stronger sockeye salmon runs in lower Cook Inlet) none forego openings in lower Cook Inlet for an overlapping opening in Prince William Sound and upper Cook Inlet. In years of poor lower Cook Inlet harvests, considerable fishing effort may be drawn away from lower Cook Inlet to Prince William Sound or upper Cook Inlet. In the short run, a small increase in profitability in the Prince William Sound seine fishery and other upper Cook Inlet fisheries may result from continued strong catches in lower Cook Inlet.

This level of participation in alternative fisheries and non-fishing opportunities during the lower Cook Inlet seine season has important implications for estimating the cost of effort for certain levels of fish abundance. While the trade-offs in fishing capital and labor are predominantly related to the alternative fishing opportunities in the lower Cook Inlet seine fishery, in a more sophisticated model we may have to consider trade-offs outside of the fishery when developing a preliminary model.

¹ Tom Schroeder, Commercial Fisheries Biologist, ADF&G, Commercial Fisheries Division, 3298 Douglas Street, Homer, AK 99603-7942, personal communication.

Some technical problems with constructing a fishing cost model include:

1. Few surveys of the commercial fishery exist that are sufficient for building a cost model.
2. It is costly to measure fishing behavior.
3. A unit of effort may not remain constant because of increases in fishing power.

PROJECT PRODUCTION FUNCTION

The cost/benefit framework demands an accounting of all public resources foregone in the process of building, operating, and administering the enhancement facilities starting in 1988. Public capital resources from the state treasury included in this set of simulations are taken from the projected budgets of the management biologist, the enhancement biologists, the hatchery manager, and administrative staff. Where possible, estimates of costs are equivalent to the incremental cost of producing the output for the next 20 years.

As discussed in the preceding section, some labor resources for construction and operation of enhancement and rehabilitation facilities will clearly come from unemployed or underemployed ranks. Consequently, total labor costs used for the cost/benefit framework in this analysis might be overstated. Total costs for producing both enhancement projects are approximately ~~\$92,000~~ \$92,900 annually (Table 1).

Table 1. Costs of Government inputs to fishery enhancement from Leisure and Chenik Lakes.

Type of Cost	Chenik	Leisure
Incubation and Rearing	\$6,000	\$5,000
Planting	\$1,400	\$1,000
Marginal Management Cost FRED and Comm Fish	\$7,500	\$3,000
Biological Evaluation	\$27,000	\$11,000
Fertilization	<u>\$10,000</u>	<u>\$21,000</u>
Total	\$51,900	\$41,000
Grand Total	\$92,900	

RESULTS OF SIMULATIONS

The present value of the net benefits for each of the cost models tested represent the change in total revenue less the marginal fishing cost less the costs of government inputs. When the change in the total revenue to fishermen is computed, less fishing costs of 10%, 25%, and 50% of the change in total revenue, less the government inputs into the enhancement project, the present value of the net benefits for these projects is \$19.8 million, \$16.3 million, and \$10.4 million, respectively. Under these cost assumptions, fishermen will face large-scale loss in profits if the projects were immediately removed from lower Cook Inlet (Fig 9).

The application of the more stringent cost assumptions eventually forces net benefits of any of the alternatives to zero, if the life of the project is extended far enough into the future (Fig. 10). The first simulation applies the incremental rate of rent dissipation at 5% of the gross earnings captured by the fishing fleet for the first year (reflecting net revenues of 95% of the gross revenues in year one). The 5% incremental rate of rent dissipation produced an NPV of \$14.4 million, the 10% rate and 25% rate produced \$9.7 million and \$3.4 million respectively (Table 2). This range in outcomes between the constant cost model and the incremental cost model represents the amount of fog in estimating marginal fishing costs. If we assigned a probability distribution to each of the outcomes, we could make some statements about the most likely cases. I am willing to pick a favorite, and believe the incremental rate at 5% per year represents a most reasonable point estimate at this time.

For the 25% cost case, all the new potential profits are dissipated away, in approximately year 2000. Even in the extreme case, the fleet has captured \$3.4 million in profits. The 25% dissipation rate may greatly overstate capitalization in the lower Cook Inlet seine fleet. If rents from the limited salmon fisheries were dissipated at this rate, it would result in extremely low returns and expectations for returns to labor and capital. As evidenced by the average transaction price of fishery entry permits in a permit area and the number of permits in a permit area (presently over \$800 million at the current market clearing price), large-scale returns from the state's salmon fishery are anticipated by the fleet. Market prices for permits have generally increased and not decreased in recent years, presumably on the fleets' expectation of improved rents from larger harvests. In a few salmon fisheries whose catches have been dramatically reduced in recent years, some permit prices have decreased. There is little evidence to indicate that marginal permit prices are falling in fisheries that are experiencing stable gross earnings in recent years.

Conversely, the constant rate of rent dissipation of 10% of the gross earnings per year appears to be overly optimistic. The fixed rate adopts a functional form that is not consistent with the long run behavior of a regulated fishery with partially effective constraints. We have clearly observed some additional investment in the fishing fleet at the Chenik Lake site where specialized shallow draft boats are becoming popular for competing at low tide.

The 5% annual incremental rate of investment is a most likely rate for the analysis. It is consistent with the behavior of a regulated fishery with partially effective investment

constraints. It also reflects the expectation of low-variable fishing costs consistent with a fleet where minimal additional fleet effort is required, and small increases in fishing travel costs at one site which would be offset by a reduction in fishing costs to less accessible fishing areas.

The sensitivity of a number of other variables in the model have been tested, including real interest rates (between 3% and 8%), exchange rates, background levels of harvest in the natural stock, and increase in the production of substitutes. These cases are included in Table 3. through Table 8. In all the preceding cases, none of these tests reduced the NPV of the projects to zero.

Estimates of consumer surplus from the simulations are also offered in Table 2 through 8. The consumer surplus estimates represent the difference in the area above the price line and below the demand curve, with and without the projects in place. In the first simulation, Table 2. (assumptions include a 3% real interest rate, 0.65 U.S. cents/Yen, and 200 million background harvests), estimates of the consumer surplus are approximately \$10.1 million. Increases (decreases) in background catches, moving quantity to a more elastic (more inelastic) portion of the demand curve produce smaller (larger) increments in consumer surplus as observed in Table 3. through Table 8.

CONCLUSIONS

Three conclusions can be reached from this cost/benefit analysis. First: the reduction in the catch from eliminating the Chenik and Leisure Lakes projects would reduce net revenues to fishermen. The reduction in net benefits results from ~~from~~ less than a 1.0 % reduction in the statewide sockeye harvest (this equates to a steady state reduction of approximately 1.85 million lbs from eliminating the projects). Second: a marginal analysis that uses the type of reasoning available in fisheries bioeconomic models is essential to understanding the consequences of investments aimed at improving salmon harvests. Third: application of bioeconomic reasoning provides an improved understanding of the variables that affect the net benefits of public investments in fisheries. This study implies that forecasting ability could be improved further if scientists were to produce improved forecasts of the following important variables: The change in recruitment and harvest from the projects, the U.S. dollar Japan Yen exchange rate, baseline salmon harvests, and fishing costs.

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Fig. 1 **HISTORICAL CATCH AND ESCAPEMENT**
FOR CHENIK LAKE BEFORE AND AFTER ENHANCEMENT
FROM 1920 TO 1988

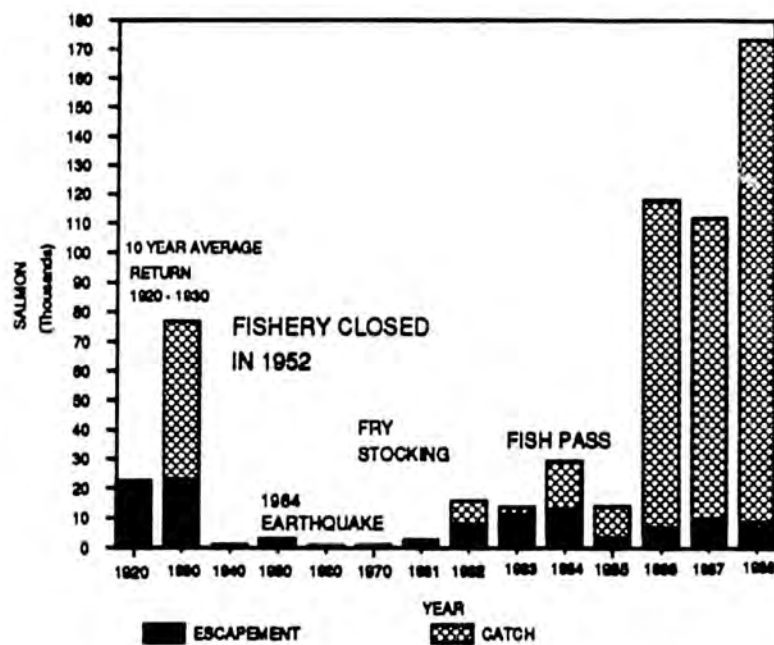


Fig. 2

**PROJECTED HARVEST FROM CHENNIK LAKE
WITH AND WITHOUT ENHANCEMENT**

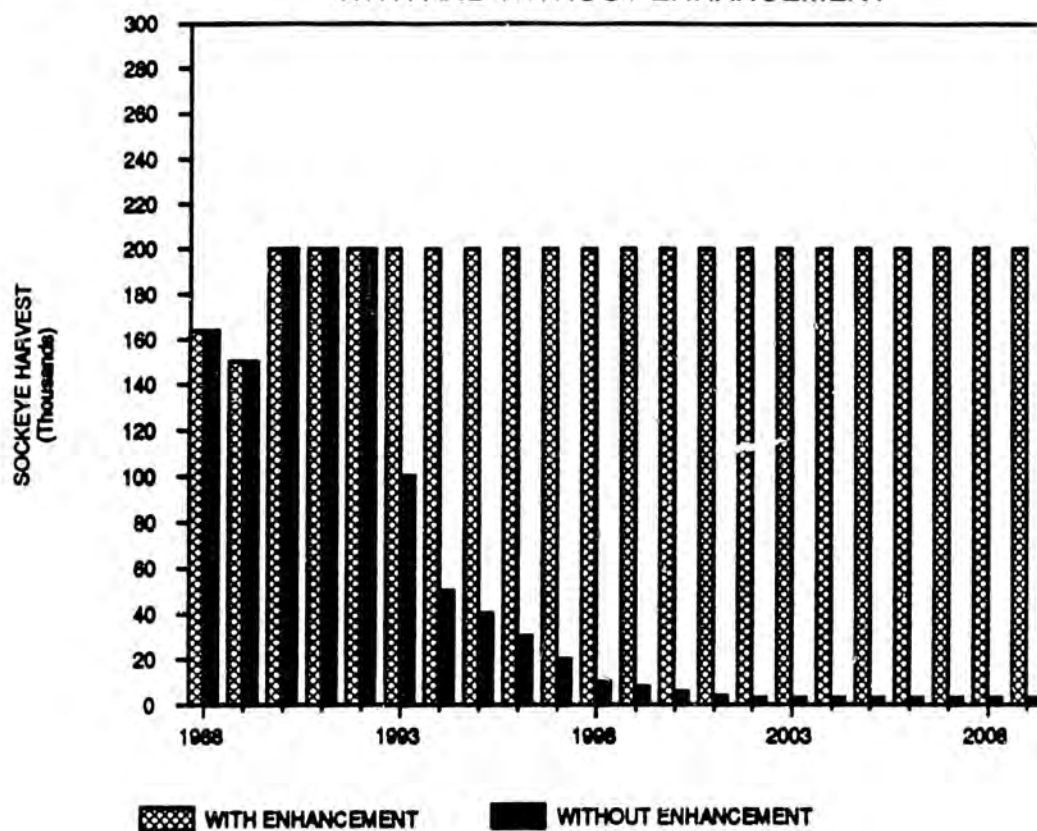


**Fig. 3 PROJECTED HARVEST FROM CHENIK & LEISURE LAKE
WITH ENHANCEMENT AND WITHOUT ENHANCEMENT**

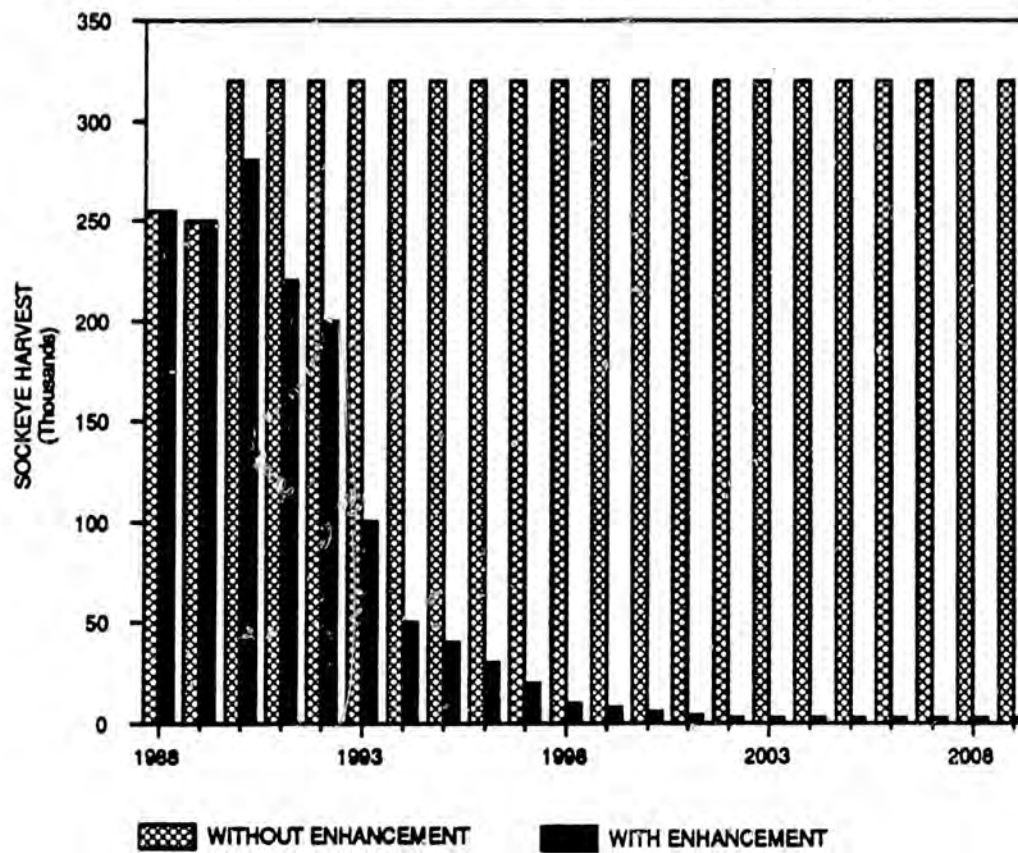


Fig. 4 **HISTORICAL TIME SERIES OF EXCHANGE RATE**
FROM 1969 TO 1988

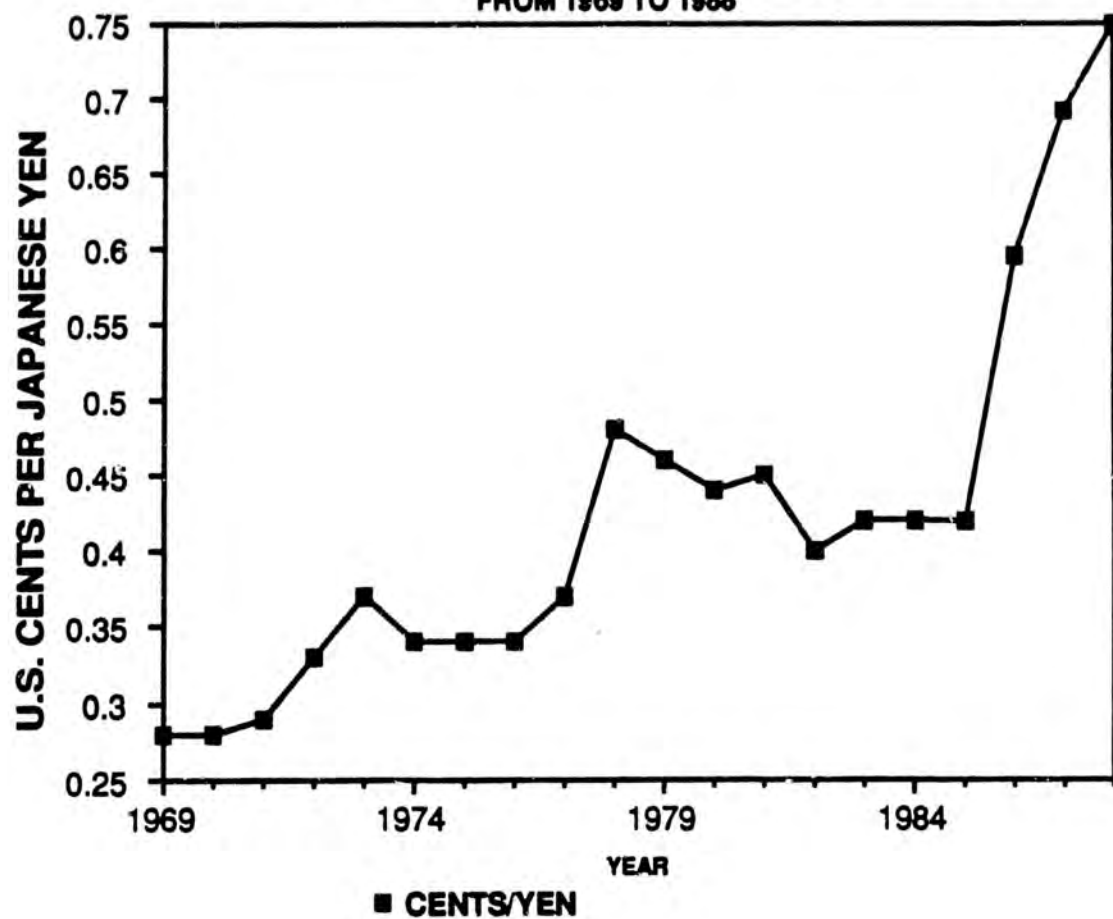


Fig. 5 HARVEST OF SOCKEYE SALMON BY REGION AND STATE WIDE FROM 1969 TO 1988

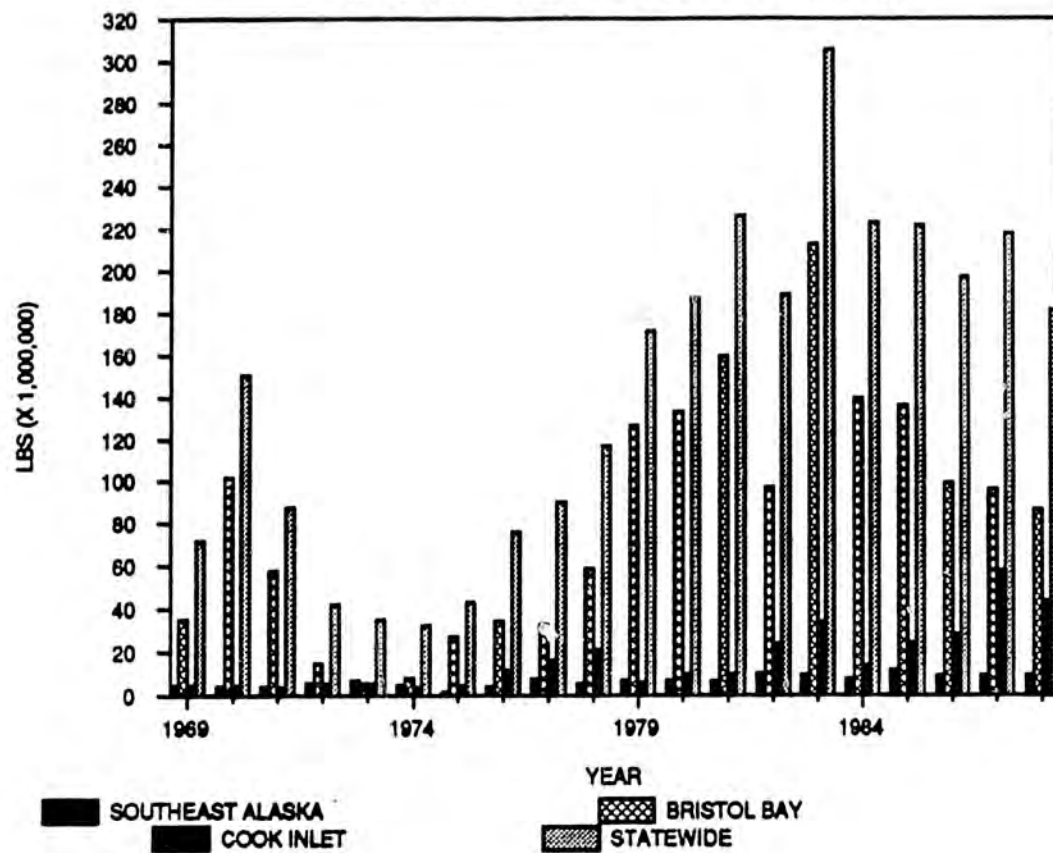


Fig. 6

REAL AND PROJECTED PRICES FROM SOCKEYE DEMAND MODEL

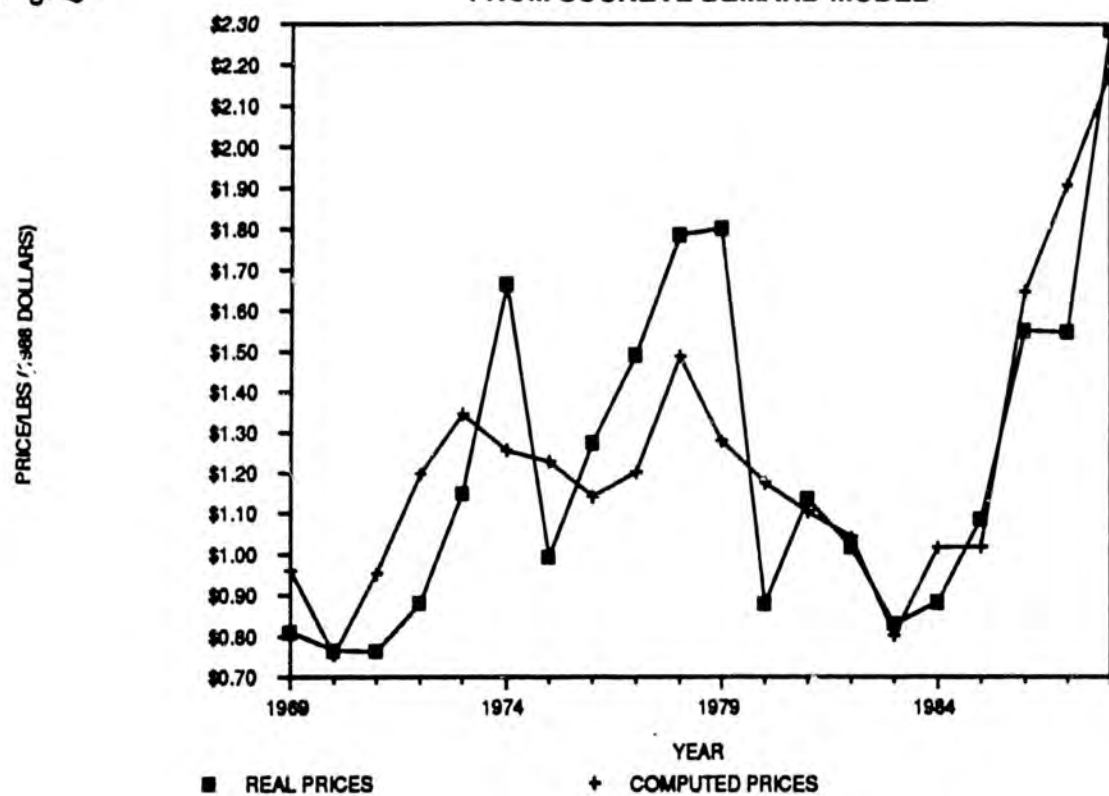


Fig. 7 ANNUAL PRESENT VALUE OF THE CHANGE IN TOTAL REVENUES,
FISHING COSTS (AT CONSTANT RATE OF 10%),
AND THE COSTS OF THE GOVERNMENT INPUTS

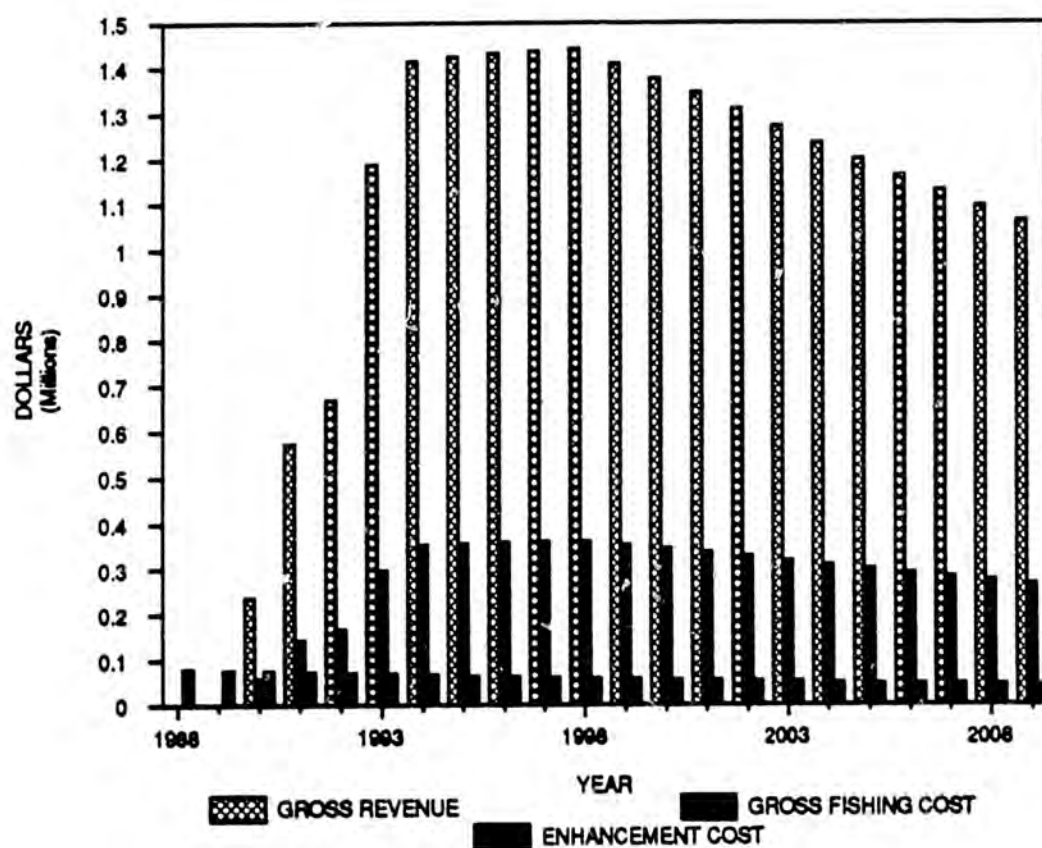


**Fig. 8 GROSS REVENUES AND NET REVENUE FOR A
HYPOTHETICAL FISHERY WITH AN INSTANTANEOUS
INCREASE IN HARVESTS, AND (1) NO FISHING COSTS,
(2) FISHING COSTS AT A CONSTANT 10% OF GR
AND (3), FISHING COSTS DISSIPATED ANNUALLY AT 10%**

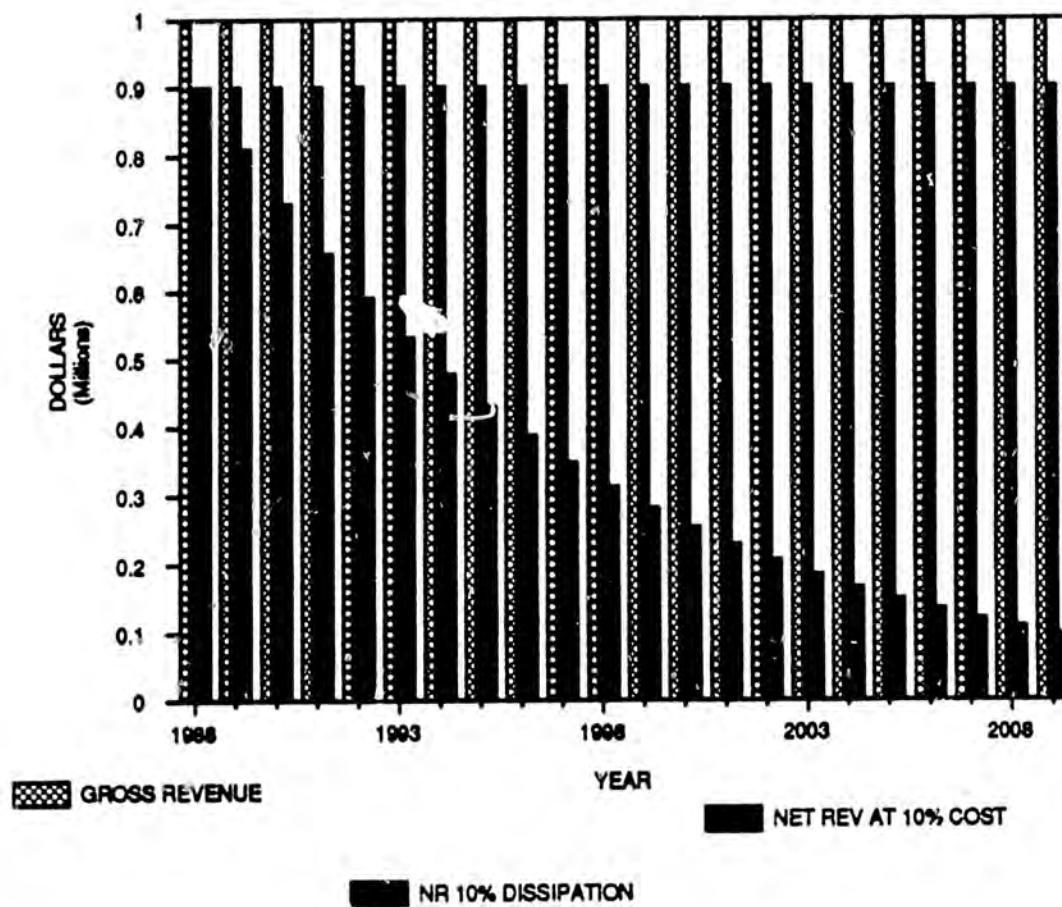
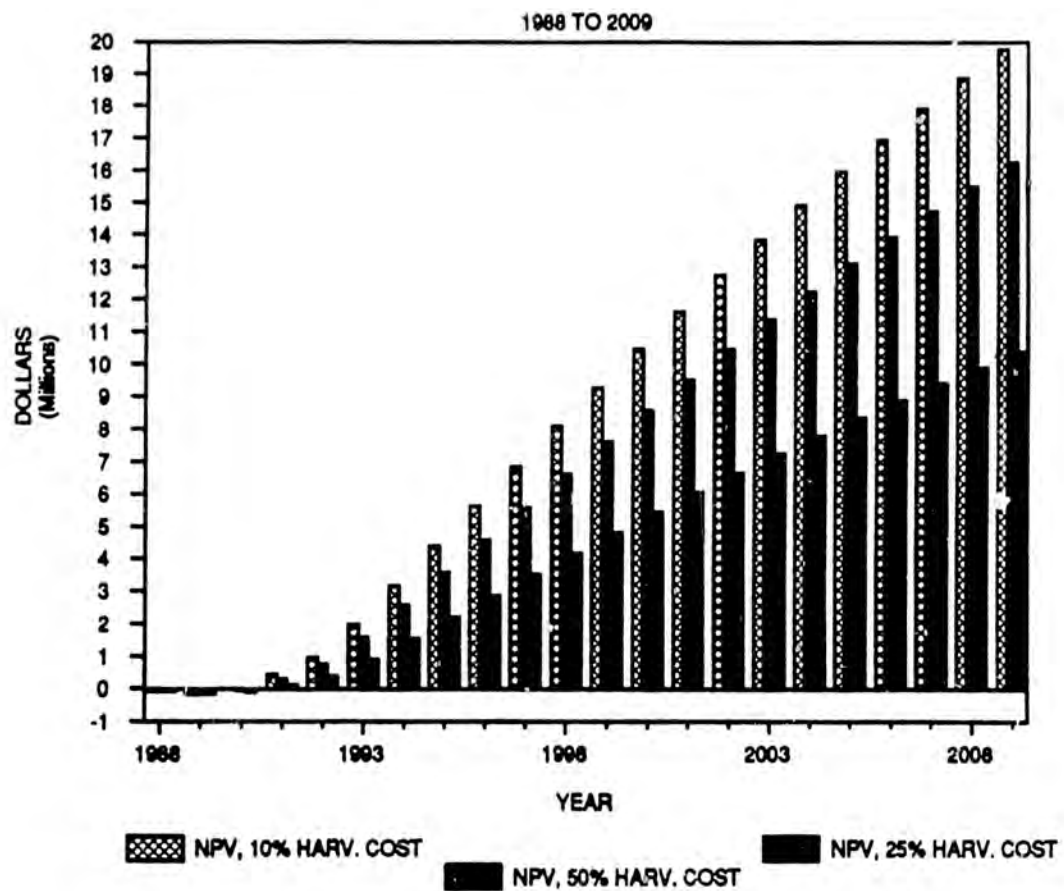


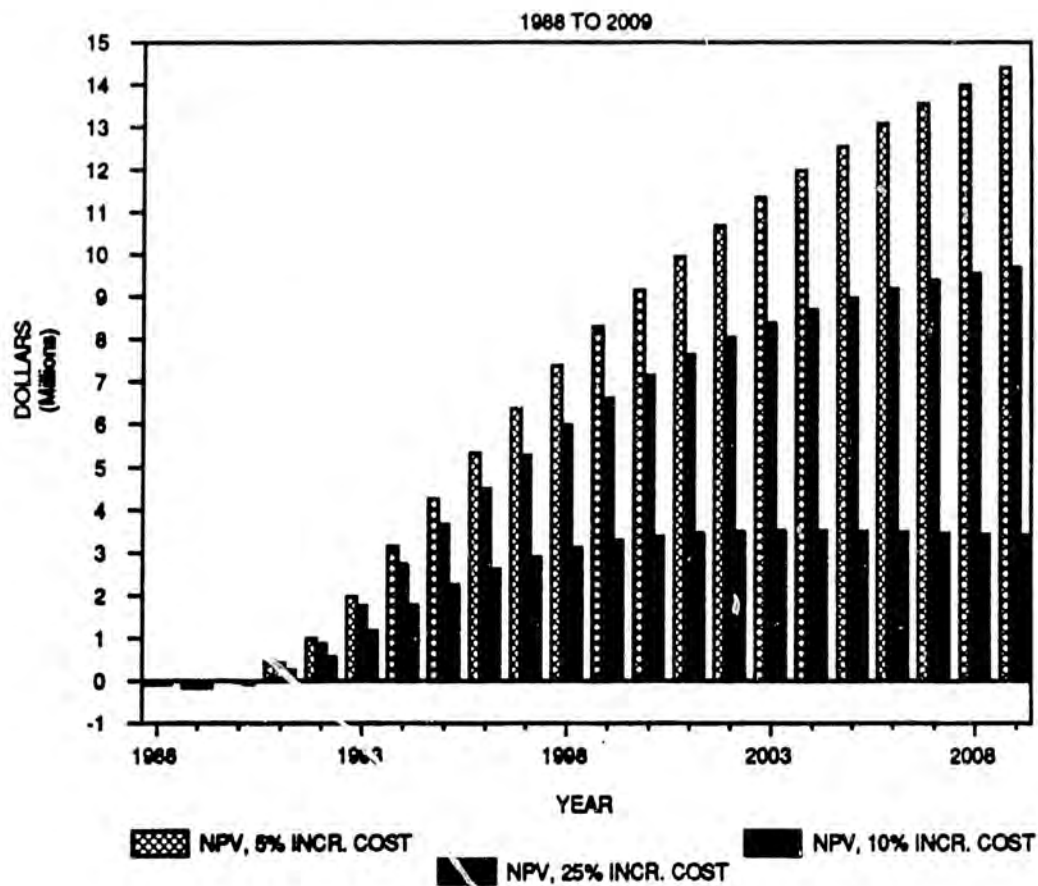
**Fig. 9 CUMULATIVE NET PRESENT VALUE
FOR LEISURE AND CHENIK PROJECTS
WITH REVENUE REDUCED BY 10%
OF CHANGE IN TOTAL REVENUE ANNUALLY,
25% OF REVENUE, AND 50% OF
REVENUES ANNUALLY**



Note: Net benefits are net of all costs including project inputs.

Fig 10.

CUMULATIVE NET PRESENT VALUE
FOR LEISURE AND CHENIK LAKE PROJECTS
WITH REVENUES DISSIPATED BY AN
INCREMENTAL RATE OF 5%
OF GROSS REVENUE, 10% OF GR,
AND 25% OF GR.



Note: Net benefits are net of all costs including project inputs

Table 2

RESULTS OF COST/BENEFIT ANALYSIS FOR LEISURE AND CHENIK LAKES.
NET PRESENT VALUE OVER ECONOMIC LIFE OF ENHANCEMENT PROJECT

KEY ASSUMPTIONS: -REAL INTEREST RATE = 3%
-EXCHANGE RATE (U.S. \$*100/JAPAN YEN) = 0.65
-SOCKEYE HARVEST = 200 MILLION LBS.

NET PRESENT VALUE OF PROJECTS
WITH CONSTANT FISHING COST MODEL
REDUCING RENTS FROM GROSS EARNINGS
AT A RATE OF 10%, 25%, AND 50% PER YEAR.

NET PRESENT VALUE OF PROJECTS
WITH INCREMENTED RENT DISSIPATION
REDUCING RENTS FROM GROSS EARNINGS
AT A RATE OF 5%, 10%, AND 25% PER YEAR.

NPV OF PRODUCER SURPLUS

90% REVENUE	\$19,777,233
75% REVENUE	\$16,265,170
50% REVENUE	\$10,411,731

NPV OF PRODUCER SURPLUS

95% REVENUE (DISS)	\$14,386,289
90% REVENUE (DISS)	\$9,682,051
75% REVENUE (DISS)	\$5,411,639

NPV OF PRODUCER AND CONSUMER SURPLUS

90% REVENUE	\$29,941,871
75% REVENUE	\$26,429,808
50% REVENUE	\$20,576,369

NPV OF PRODUCER AND CONSUMER SURPLUS

95% REVENUE (DISS)	\$24,550,927
90% REVENUE (DISS)	\$19,846,689
75% REVENUE (DISS)	\$13,576,277

Table 3

RESULTS OF COST/BENEFIT ANALYSIS FOR LEISURE AND CHENIK LAKES.
NET PRESENT VALUE OVER ECONOMIC LIFE OF ENHANCEMENT PROJECT

KEY ASSUMPTIONS: -REAL INTEREST RATE = 4%
-EXCHANGE RATE (U.S. \$*100/JAPAN YEN) = 0.65
-SOCKEYE HARVEST = 200 MILLION LBS.

NET PRESENT VALUE OF PROJECTS
WITH CONSTANT FISHING COST MODEL
REDUCING RENTS FROM GROSS EARNINGS
AT A RATE OF 10%, 25%, AND 50% PER YEAR.

NET PRESENT VALUE OF PROJECTS
WITH INCREMENTED RENT DISSIPATION
REDUCING RENTS FROM GROSS EARNINGS
AT A RATE OF 5%, 10%, AND 25% PER YEAR.

NPV OF PRODUCER SURPLUS

90% REVENUE	\$17,596,301
75% REVENUE	\$14,465,951
50% REVENUE	\$9,248,700

NPV OF PRODUCER SURPLUS

95% REVENUE (DISS)	\$12,952,056
90% REVENUE (DISS)	\$8,815,479
75% REVENUE (DISS)	\$3,200,007

NPV OF PRODUCER AND CONSUMER SURPLUS

90% REVENUE	\$26,655,776
75% REVENUE	\$23,525,426
50% REVENUE	\$18,308,176

NPV OF PRODUCER AND CONSUMER SURPLUS

95% REVENUE (DISS)	\$22,011,532
90% REVENUE (DISS)	\$17,874,955
75% REVENUE (DISS)	\$12,259,482

Table 4

RESULTS OF COST/BENEFIT ANALYSIS FOR LEISURE AND CHENIK LAKES.
NET PRESENT VALUE OVER ECONOMIC LIFE OF ENHANCEMENT PROJECT

KEY ASSUMPTIONS: -REAL INTEREST RATE = 5%
-EXCHANGE RATE (U.S. \$*100/JAPAN YEN) = 0.65
-SOCKEYE HARVEST = 200 MILLION LBS.

NET PRESENT VALUE OF PROJECTS
WITH CONSTANT FISHING COST MODEL
REDUCING RENTS FROM GROSS EARNINGS
AT A RATE OF 10%, 25%, AND 50% PER YEAR.

NET PRESENT VALUE OF PROJECTS
WITH INCREMENTED RENT DISSIPATION
REDUCING RENTS FROM GROSS EARNINGS
AT A RATE OF 5%, 10%, AND 25% PER YEAR.

NPV OF PRODUCER SURPLUS

90% REVENUE	\$15,709,555
75% REVENUE	\$12,909,548
50% REVENUE	\$8,242,869

NPV OF PRODUCER SURPLUS

95% REVENUE (DISS)	\$11,697,314
90% REVENUE (DISS)	\$8,047,935
75% REVENUE (DISS)	\$3,003,655

NPV OF PRODUCER AND CONSUMER SURPLUS

90% REVENUE	\$23,812,618
75% REVENUE	\$21,012,611
50% REVENUE	\$16,345,932

NPV OF PRODUCER AND CONSUMER SURPLUS

95% REVENUE (DISS)	\$19,800,377
90% REVENUE (DISS)	\$16,150,998
75% REVENUE (DISS)	\$11,106,718

Table 5

RESULTS OF COST/BENEFIT ANALYSIS FOR LEISURE AND CHENIK LAKES.
NET PRESENT VALUE OVER ECONOMIC LIFE OF ENHANCEMENT PROJECT

KEY ASSUMPTIONS: -REAL INTEREST RATE = 3%
-EXCHANGE RATE (U.S. \$*100/JAPAN YEN) = 0.65
-SOCKEYE HARVEST = 160 MILLION LBS.

NET PRESENT VALUE OF PROJECTS
WITH CONSTANT FISHING COST MODEL
REDUCING RENTS FROM GROSS EARNINGS
AT A RATE OF 10%, 25%, AND 50% PER YEAR.

NET PRESENT VALUE OF PROJECTS
WITH INCREMENTED RENT DISSIPATION
REDUCING RENTS FROM GROSS EARNINGS
AT A RATE OF 5%, 10%, AND 25% PER YEAR.

NPV OF PRODUCER SURPLUS

90% REVENUE	\$23,167,588
75% REVENUE	\$19,090,466
50% REVENUE	\$12,295,262

NPV OF PRODUCER SURPLUS

95% REVENUE (DISS)	\$16,909,451
90% REVENUE (DISS)	\$11,448,375
75% REVENUE (DISS)	\$4,169,042

NPV OF PRODUCER AND CONSUMER SURPLUS

90% REVENUE	\$31,306,924
75% REVENUE	\$27,229,802
50% REVENUE	\$20,434,598

NPV OF PRODUCER AND CONSUMER SURPLUS

95% REVENUE (DISS)	\$25,048,787
90% REVENUE (DISS)	\$19,587,711
75% REVENUE (DISS)	\$12,308,378

Table 6

RESULTS OF COST/BENEFIT ANALYSIS FOR LEISURE AND CHENIK LAKES.
NET PRESENT VALUE OVER ECONOMIC LIFE OF ENHANCEMENT PROJECT

KEY ASSUMPTIONS: -REAL INTEREST RATE = 3%
-EXCHANGE RATE (U.S. \$*100/JAPAN YEN) = 0.65
-SOCKEYE HARVEST = 240 MILLION LBS.

NET PRESENT VALUE OF PROJECTS
WITH CONSTANT FISHING COST MODEL
REDUCING RENTS FROM GROSS EARNINGS
AT A RATE OF 10%, 25%, AND 50% PER YEAR.

NET PRESENT VALUE OF PROJECTS
WITH INCREMENTED RENT DISSIPATION
REDUCING RENTS FROM GROSS EARNINGS
AT A RATE OF 5%, 10%, AND 25% PER YEAR.

NPV OF PRODUCER SURPLUS

90% REVENUE	\$16,386,877
75% REVENUE	\$13,439,874
50% REVENUE	\$8,528,201

NPV OF PRODUCER SURPLUS

95% REVENUE (DISS)	\$11,863,127
90% REVENUE (DISS)	\$7,915,727
75% REVENUE (DISS)	\$2,654,235

NPV OF PRODUCER AND CONSUMER SURPLUS

90% REVENUE	\$28,576,817
75% REVENUE	\$25,629,814
50% REVENUE	\$20,718,141

NPV OF PRODUCER AND CONSUMER SURPLUS

95% REVENUE (DISS)	\$24,053,067
90% REVENUE (DISS)	\$20,105,667
75% REVENUE (DISS)	\$14,844,175

Table 7

RESULTS OF COST/BENEFIT ANALYSIS FOR LEISURE AND CHENIK LAKES.
NET PRESENT VALUE OVER ECONOMIC LIFE OF ENHANCEMENT PROJECT

KEY ASSUMPTIONS: -REAL INTEREST RATE = 3%
-EXCHANGE RATE (U.S. \$*100/JAPAN YEN) = 0.60
-SCKEYE HARVEST = 200 MILLION LBS.

NET PRESENT VALUE OF PROJECTS
WITH CONSTANT FISHING COST MODEL
REDUCING RENTS FROM GROSS EARNINGS
AT A RATE OF 10%, 25%, AND 50% PER YEAR.

NET PRESENT VALUE OF PROJECTS
WITH INCREMENTED RENT DISSIPATION
REDUCING RENTS FROM GROSS EARNINGS
AT A RATE OF 5%, 10%, AND 25% PER YEAR.

NPV OF PRODUCER SURPLUS

90% REVENUE	\$17,156,227
75% REVENUE	\$14,080,998
50% REVENUE	\$8,955,617

NPV OF PRODUCER SURPLUS

95% REVENUE (DISS)	\$12,435,691
90% REVENUE (DISS)	\$8,316,547
75% REVENUE (DISS)	\$2,826,108

NPV OF PRODUCER AND CONSUMER SURPLUS

90% REVENUE	\$27,320,865
75% REVENUE	\$24,245,637
50% REVENUE	\$19,120,255

NPV OF PRODUCER AND CONSUMER SURPLUS

95% REVENUE (DISS)	\$22,600,329
90% REVENUE (DISS)	\$18,481,185
75% REVENUE (DISS)	\$12,990,746

Table 8

**RESULTS OF COST/BENEFIT ANALYSIS FOR LEISURE AND CHENIK LAKES.
NET PRESENT VALUE OVER ECONOMIC LIFE OF ENHANCEMENT PROJECT**

**KEY ASSUMPTIONS: -REAL INTEREST RATE = 3%
-EXCHANGE RATE (U.S. \$*100/JAPAN YEN) = 0.70
-SOCKEYE HARVEST = 200 MILLION LBS.**

**NET PRESENT VALUE OF PROJECTS
WITH CONSTANT FISHING COST MODEL
REDUCING RENTS FROM GROSS EARNINGS
AT A RATE OF 10%, 25%, AND 50% PER YEAR.**

**NET PRESENT VALUE OF PROJECTS
WITH INCREMENTED RENT DISSIPATION
REDUCING RENTS FROM GROSS EARNINGS
AT A RATE OF 5%, 10%, AND 25% PER YEAR.**

NPV OF PRODUCER SURPLUS

90% REVENUE	\$22,398,238
75% REVENUE	\$18,449,341
50% REVENUE	\$11,867,845

NPV OF PRODUCER SURPLUS

95% REVENUE (DISS)	\$16,336,887
90% REVENUE (DISS)	\$11,047,555
75% REVENUE (DISS)	\$3,997,170

NPV OF PRODUCER AND CONSUMER SURPLUS

90% REVENUE	\$32,562,876
75% REVENUE	\$28,613,979
50% REVENUE	\$22,032,484

NPV OF PRODUCER AND CONSUMER SURPLUS

95% REVENUE (DISS)	\$26,501,525
90% REVENUE (DISS)	\$21,212,194
75% REVENUE (DISS)	\$14,161,808