Southeastern Alaska Roe Herring Purse Seine Fishery

Optimum Number Report

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Commercial Fisheries Entry Commission
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Southeastern Alaska
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INTRODUCTION

INTRODUCTION

This report presents the results of a study to determine the "optimum number" of permits for the southeastern Alaska roe herring purse seine fishery. The Commercial Fisheries Entry Commission (CFEC) was directed to determine optimum numbers in the fishery by the Alaska Supreme Court in its decision in Johns v. State, CFEC, 758 P.2d 1256 (Alaska 1988). This study was undertaken in response to the Court's action.

Program Basics

Alaska's limited entry statutes (AS 16.43) were passed by the legislature in 1973. The statutes created the Commercial Fisheries Entry Commission (CFEC) as a quasi-judicial agency charged with the responsibility of implementing and administering the new program.

The statutes provide for a two-stage limitation process. In the first stage, CFEC limits a fishery by adopting a maximum number whenever it determines that limitation is needed to achieve the purposes of the chapter.[1] Historically, maximum numbers have reflected participation levels at the time of limitation. By recent court decision, maximum numbers must be no less than the highest number of units of gear to participate in a fishery in the four years prior to limitation.[2]

In the second stage of limited entry, the commission is directed to select an "optimum number" of permits for a fishery. The optimum number is to be based upon a "reasonable balance" of three general standards described in AS 16.43.290.

If the optimum number is less than the maximum, CFEC is directed to start a fishermen-funded buyback program to reach the optimum number within a ten year period.[3] If the optimum number is greater than the maximum number the commission

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1 See AS 16.43.240.

2 See Johns v. State, CFEC, 758 P.2d 1256 (Alaska 1988). Under AS 16.43.240 (a) the maximum number in a "distressed" fishery was designated as the highest number of units of gear fished in that fishery during any of the four years immediately preceding January 1, 1973. The maximum number rule for fisheries limited under AS 16.43.240 (b) was not specific. The Supreme Court's decision in Johns establishes the rule which the commission must now use.

3 See AS 16.43.310 and AS 16.43.320.

is directed to issue new permits at fair market value.[4] There is also a provision for revising the optimum number of permits in response to established long-term changes in a fishery.[5]

In an early draft of the limited entry statutes, limited entry was envisioned as a single-stage process, whereby "maximum" numbers would represent "optimum" levels rather than recent participation levels.[6] In that draft legislation, the maximum number was to be based upon a reasonable balance of four general criteria. The legislature eventually rejected the single stage process as too extreme, and settled upon the two-stage process in AS 16.43.

At the time the legislation was passed it was generally expected that the movement from maximum numbers to optimum numbers would result in further fleet reductions. The two-stage process was seen as a "fairer" way to reduce the size of the fleet. At the time of limitation, most persons who were substantially dependent upon the fishery would not be excluded in the initial allocation.[7] When optimum numbers are established, those opting to exit the fishery would be compensated by those opting to remain in the fishery through a fisherman funded buy-back program. Hopefully, under this provision, both fishermen remaining in the fishery and fishermen leaving the fishery would be able to benefit from the fleet reductions.

Optimum Number Developments since 1973

At the time of the passage of the limited entry act, optimum numbers, buy-back programs, and fleet reductions were expected to quickly follow the initial issuance of the maximum number of permits. The 1974 annual report of the commission indicated that the optimum number process had begun and that a buy-back program was expected by 1976. Economic studies were conducted on operating costs and net

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4 See AS 16.43.330.

5 See AS 16.43.300.

6 See Thomas A. Morehouse and George W. Rogers, "Limited Entry in the Alaska and British Columbia Salmon Fisheries." Anchorage: Institute of Social and Economic Research, University of Alaska, (1980), pp. 185-189.

7 Alaska's maximum number rule, as clarified by the Supreme Court, still represents a less "liberal" grandfathering rule than would a simple moratorium without exclusions. Due to turnover in a fishery, the number of those participating in the four years prior to limitation typically exceeds the maximum number. Because of this the statutes create an initial allocation mechanism known as a "point system" or "hardship ranking system."

returns[8] and Alaska Department of Fish and Game (ADFG) fishery managers were asked to provide estimates of "management" optimum numbers (Standard Two).[9]

Nevertheless, the process of establishing optimum numbers slowed. The initial allocation process proved to be more burdensome than originally imagined and the final classifications of more difficult applications could not be resolved without hearings and a long adjudication process. The commission had hoped to complete the initial allocation process prior to embarking upon the optimum number process.

Perhaps more importantly, conditions in the salmon fisheries began to change. Following the passage of the limited entry act in 1973 and the 200 mile limit in 1976, the state's salmon runs began to recover and improve. Hatchery production also developed and eventually became substantial in some areas. Gross earnings and permit values tended to increase reflecting these developments. Consequently, the Alaska legislature has become more concerned about the cost of entry, the ability of young Alaskans to get into the fisheries, and the potential loss of entry permits to non-residents.

In the late seventies the commission unsuccessfully tried to obtain some initial funding as start-up funds for fleet reductions. In 1979 the legislature chose to fund additional studies to determine what was happening under limited entry and to re-evaluate limited entry alternatives, particularly with respect to permit transfers.

In the eighties there was renewed interest in buyback from some commercial fishing associations. The commission conducted operating cost and net return studies in some fisheries to monitor changes in the fisheries and to obtain baseline data which could be used to help estimate the probable impacts of further fleet reductions.

In May of 1985, the commission received an Attorney General's Opinion that the buy-back portion of the statute was unconstitutional as written, chiefly because it required an unconstitutional dedicated fund. This event led the commission to re-examine the buy-back issue and to develop suggestions for revising the statutes to address the constitutional concerns and to provide a better investment option for fishermen.[10]

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8 See James E. Owers, "Cost and Earnings of Alaska Fishing Vessels -- An Economic Survey." Juneau: Alaska Commercial Fisheries Entry Commission. (1974).

9 See John B. Martin, "Optimum Numbers, A Report Submitted to the Commercial Fisheries Entry Commission." Environmental Services Limited (June 15, 1979).

10 See (1) Kurt Schelle and Ben Muse "Buyback of Fishing Rights in the US and Canada: Implications for Alaska," Juneau: Commercial Fisheries Entry Commission (1984), pp. 77; and (2) Ben Muse and Kurt Schelle, "Investments in Fleet Reductions: Suggestions of Revisions of Alaska's Buy-Back Statute," CFEC Draft Report 86-2. Juneau: Alaska Commercial Fisheries Entry Commission, (1986), pp. 99.

The suggestions developed by commission staff were oriented toward creating an efficient fleet reduction program which would be fair to the parties directly concerned. The buy-back program was to be funded by a state tax on permit holders. If fishermen were going to be taxed to fund the program, it seemed important that the program be turned into a good investment option.

In 1988, the Supreme Court's decision in Johns further dampened the outlook for using the current statutes to achieve fleet reductions. In their decision, the Supreme Court pointed to tensions between the limited entry clause in Alaska's constitution and the constitutional clauses which reserve fisheries for the common use of all of the people. The Court concluded:[11]

> *We suggested that to be constitutional, a limited entry system should impinge as little as possible on the open fishery clauses consistent with the constitutional purposes of limited entry, namely, prevention of economic distress to fishermen and resource conservation. Ostrosky. 667 P.2d at 1191. The optimum number provision of the Limited Entry Act is the mechanism by which limited entry is meant to be restricted to its constitutional purposes. Without this mechanism, limited entry has the potential to be a system which has the effect of creating an exclusive fishery to ensure the wealth of the permit holders and permit values, while exceeding the constitutional purposes of limited entry.* .

The Johns decision is an important one which may substantially impact the future of Alaska's limited entry program. In the decision, the Court appears to be saying that limiting the number of participants in a fishery to a certain level is only constitutional if it is needed for conservation reasons or to prevent economic distress in a fishery.

If neither of the stated constitutional purposes is satisfied, the commission is to increase the number of permits (under AS 16.43.330) in the fishery to the point where any additional participants would pose a conservation threat or cause "economic distress." Moreover, the Court appears to be saying that a loss in permit values due to new entrants may not qualify as economic distress to existing holders, even though many permit holders purchased their permits at fair market value. Under Johns, optimum numbers are seen as the only available adjustment mechanism in AS 16.43 to prevent the program from being unconstitutional.[12]

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[11] See Johns, p. 1266

[12] See Johns p. 1266

As noted above, when the statutes were first passed, optimum numbers were seen chiefly as a means to achieve fleet reductions. In light of the Attorney General's opinion in 1985, a buy-back program and fleet reductions would require some statutory changes to be constitutional.

Johns makes it more likely that optimum numbers will result in increases in the number of outstanding permits. Under Johns, fishermen-funded buy-back programs and fleet reductions would be even less attractive for any group of limited entry fishermen. Should fleet reductions result in improved returns, the Court (or the commission) might later decide that the fishery was too exclusive and force a revision in optimum numbers to increase the number of permits. Thus the state might decide to sell more permits after the state has taxed fishermen to reduce the number of permits.

While the commission has studied optimum numbers for several fisheries, to date, no optimum number regulations have been adopted. Should the commission propose optimum numbers for the southeastern Alaska roe herring purse seine fishery, it will be the first optimum number regulatory proposal made under AS 16.43.

The following chapters of this report examine the Southeastern roe herring purse seine fishery and the impact of numbers of permit holders on manageability and rates of return. Chapter I briefly reviews and analyzes the optimum number standards.

Chapter II provides a detailed review of the development of the fishery and its regulatory environment. It also provides some basic historical data on the fishery by area and thoroughly describes the current approach to managing the fishery.

The next two chapters examine rates of return in the fishery. Chapter III provides summary data and estimates pertaining to historical rates of economic return in the fishery. The chapter also provides a discussion of "reasonable" rates of return as they may apply to Standard One under AS 16.43.290. Chapter IV provides results from a bioeconomic simulation model. The model forecasts future economic returns in the fishery, under different scenarios, as a function of the number of fishing operations.

Chapter V reviews conservation concerns and management problems associated with the fishery. It includes rough estimates by ADFG on the number of units of gear actually needed to harvest the resource and the number of units which can be reasonably managed given different harvest quotas and the current regulatory environment. The chapter also provides a discussion of how these factors relate to Standard Two under AS 16.43.290.

Chapter VI briefly summarizes the report and provides the author's recommendations with respect to optimum numbers based on the results of the earlier chapters. The recommendations involve judgement as AS 16.43.290 requires the commission to seek a "reasonable" balance of the three standards in selecting an optimum number. A discussion of the rationale for the recommendations is also provided. The chapter also provides some additional thoughts about possible alternatives to optimum numbers should the Court remain concerned about the rates of economic return under the program.

CHAPTER I

OPTIMUM NUMBERS UNDER AS 16.43

CHAPTER I

Optimum Numbers Under AS 16.43

Under AS 16.43, optimum numbers are not simply a directive to choose the number of units of gear which will maximize the net economic benefits derived from the fishery. Under the law, optimum numbers are to be based upon a reasonable balance of three standards which contain conservation, management, efficiency and distributional objectives.

This chapter examines the optimum number standards in AS 16.43.290. A brief review of previous understandings of the standards and previous optimum number work by the entry commission is included. The rationale behind the concepts used in this report is also included.

Optimum Numbers under AS 16.43.290.

AS 16.43.290 reads as follows:

> ***Optimum number of entry permits.*** *Following the issuance of entry permits under AS 16.43.270, the commission shall establish the optimum number of entry permits based upon a reasonable balance of the following general standards:*
>
> *(1) the number of entry permits sufficient to maintain an economically healthy fishery that will result in a reasonable average rate of economic return to the fishermen participating in that fishery, considering time fished and necessary investments in vessel and gear;*
>
> *(2) the number of entry permits necessary to harvest the allowable commercial take of the fishery resource during all years in an orderly, efficient manner, and consistent with sound fishery management techniques;*
>
> *(3) the number of entry permits sufficient to avoid serious economic hardship to those currently engaged in the fishery, considering other economic opportunities reasonably available to them.*

AS 16.43.990. provides further clarification on Standard One by defining "economically healthy fishery" as follows:

> *(2) "economically healthy fishery" means a fishery that yields a sufficient rate of economic return to the fishermen participating in it to provide for, among other things, the following:*
>
> > *(A) maintenance of vessels and gear in satisfactory and safe operating condition; and*
> >
> > *(B) ability and opportunity to improve vessels, gear, and fishing techniques, including, when permissible, experimentation with new vessels, new gear, and new techniques.*

Previous Understanding Of AS 16.43.290.

The commission's staff did considerable work on optimum numbers over the 1974 through 1978 time period. These efforts were summarized by Martin.[13] Martin indicated that the commission understood the three standards in AS 16.43.290 to require the following:

> *The commission interpreted these standards as requiring independent determination of: (1) the economic optimum number of permits; and (2) the management optimum number of entry permits. The third criteria outlined in the statute was to be utilized to adjust the economic and management optimum numbers as required by local employment conditions.*

The Economic Optimum Number of Permits: Previous Work

From the beginning, CFEC researchers understood a reasonable average rate of economic return to mean an absolute amount of real dollars which would cover or exceed different costs associated with a fishing operation. The earliest work on optimum numbers was done by James E. Owers.[14]

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13 See Martin, "Optimum Numbers" (1979).

14 Owers produced three papers. The first, "Cost and Earnings of Alaskan Fishing Vessels- An Economic Survey" (CFEC, Juneau, AK. 1974) reported the results of a baseline survey on operating costs and net returns by salmon fishery. The second, "An Empirical Study of Limited Entry In Alaska

In each fishery, Owers calculated the average total gross revenue (in 1973 dollars) over the 1969-1973 time period and used that average as an estimate of average expected total gross revenue for the fishery in the future. He then used the estimate, coupled with sample data on average costs, to forecast how future average gross revenue per operator and future average net returns would change as the number of units of gear was reduced.

Owers' "costs" included all normal operating expenses, labor costs besides those of the operator, depreciation, and a minimum return on investment of about 10% (vessel, gear, and equipment used in multiple fisheries were prorated). Owers argued that a reasonable rate of return should just cover all of these costs, the opportunity cost of the permit, and a cost which would represent the opportunity costs of the skipper's time.[15]

Owers used three measures of the opportunity cost of a skipper's time and he calculated the approximate fleet sizes required to cover this cost so that the average permit holder just "broke even." Owers considered a reasonable rate of return to be breaking even after considering the opportunity cost of the skipper's time and the opportunity cost of the permit.

Salmon Fisheries," Marine Fisheries Review 37(7) (1975): 22-25; and third, "Income Estimates And Reasonable Returns in Alaska's Salmon Fisheries," Fishery Bulletin 75(3) (1977): 35-42, addressed the optimum number issue.

[15] Owers used a net earnings measure which subtracts off the opportunity cost of the permit. Under these conditions he decided that a "reasonable average rate of economic return" would be net earnings which would just allow the average permit holder to cover all other costs plus the opportunity cost of his time.

Owers erred in assuming that net earnings to the average permit holder, as he was measuring net earnings, should increase as he reduced the number of permits. In theory the permit's value is the present value of the future expected economic profit stream (where profits exclude the opportunity cost of the permit). As the number of participants are reduced, economic profits would increase, and the value of the permit would rise commensurately. A net earnings measure which subtracts off the opportunity cost of the permit should not rise significantly as the fleet size is reduced, as the permit's market value and the permit's concomitant opportunity cost would simply rise reflecting the increase in economic profits.

However, Owers did forecast a substantial increase in his average net earnings measure as he reduced the size of the fleet despite the fact that he was trying to subtract off the opportunity cost of the permit. This was likely due to an error in Owers' model. Owers understood that there should be a relationship between a permit's value and economic profits, but his model didn't adequately capture that relationship. In his model, Owers assumed an initial value for the permit, and then set the permit's value at approximately two times the average net earnings as he reduced the fleet's size. This was likely the faulty assumption that led to his forecast of increases in his net earnings measure as the fleet size was reduced.

For one of his "opportunity cost of time" measures, Owers used the average wage which could be earned in the same time period (as the fishery) if the permit holder worked in contract construction. For another measure, Owers considered the annual average nonagricultural wage and salary earnings in 1973 and the fisherman's income from all sources. He then calculated the fleet size required to bring the fisherman's total income up to that annual average. For Owers' last measure he surveyed fishermen and asked them what they would need to gross in order to earn a reasonable rate of return in the fishery.

Following Owers, the commission continued to conduct surveys and develop their optimum number methodology. In 1979, Martin (cited above) reviewed the work done by the commission to estimate past and future rates of return and to determine the number of units of gear which would result in a "reasonable" average rate of return for fishermen in a fishery. As an example, Martin chose the Bristol Bay salmon drift gill net fishery (S03T).

In the example, Martin took the average total costs from a CFEC survey of the fishery which covered the 1976 season. Martin assumed that these average costs in real terms would remain unchanged in all years, irrespective of actual earnings in the fishery. He then took domestic harvests over the 1952 to 1976 time period and added the Japanese high seas catch of red salmon over the period to arrive at time series estimates of what the domestic catch would have been in the absence of the Japanese interceptions.[16]

The estimated catch in each year was then valued at 1976 ex-vessel prices to give Martin a historical time series which could also serve as a subjective probability distribution of total gross earnings for the fishery.[17] This time series of total fishery

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[16] Following the passage of the FCMA in 1976, Japanese fishermen were excluded from fishing salmon within the 200 mile zone.

[17] Martin wanted to hold real prices constant so that he could make comparisons across years using the same "dollar units." Nevertheless, the procedure which he used to try to accomplish this was unorthodox. Some might question his procedure, as both nominal and real prices vary from year to year depending upon the overall supply of salmon, exchange rates, and other factors. A more common practice is to calculate the nominal gross earnings (as Owers did) in each year using the prevailing ex-vessel prices in the year (thereby allowing prices to vary naturally), and then convert those nominal gross earnings to the same units ("real dollars" of a given year) by using an appropriate price index. It is unclear why Martin chose the procedure that he did (he might have lacked data on actual ex-vessel prices for all years in his time series.) His estimates might have been different had he allowed nominal prices to vary in the same fashion that they had historically.

Martin also assumed that average total costs would not vary by year. Again, he appeared to be trying to get net earnings into the same "real" dollars for comparison purposes. Thus average total costs in "real 1976 dollars" was set equal to the sample average total cost in 1976. He then argued that all of his data were in 1976 dollars. He further argued that ex-vessel prices and costs would probably move proportionally mainly due to inflation.

gross earnings could then be used to derive time series estimates of average gross earnings per permit under different assumptions about the number of permits outstanding. These latter time series estimates then could be used as subjective probability distributions to forecast the future distribution of earnings given the number of operations.

Thus an estimated historical distribution of total gross earnings (as modified by Martin) was used to build a hypothetical series on average gross earnings which was a function of total gross earnings and the number of permits outstanding. These latter series were then used to forecast future outcomes as a function of the number of permits.[18]

Time series estimates on average net earnings as a function of the number of permits were then derived by subtracting 1976 survey average costs[19] from the average gross earnings calculated for the respective permit level in each year. These simulated "probability" distributions of net earnings given different permit levels were then the key input into the analysis of the permit level required to achieve a "reasonable rate of return."

Martin did not include the opportunity cost of the permit holder's time in the average total cost of the 1976 sample Bristol Bay fishery. To determine a "reasonable rate of return" he assumed that the opportunity cost of a skipper's time was $5,150 (1976 dollars), which he asserted represented a 1976 skipper share of 33 1/3% of average gross earnings. If the commission decided that it was "reasonable" for a permit holder to achieve that level 50% of the time, then his net earnings tables predicted that approximately 1,450 permits would achieve that result.

Again, there might be many reasons to question this estimating procedure. For one, some costs are paid as percentage shares and hence vary directly with gross earnings. While these percentage shares might gradually change if a dramatic increase in earnings occurs and persists, there would be no reason to expect the shares to change if the historical earnings patterns continued to persist and continued to be expected.

It is unclear whether or not Martin's 1976 "average costs" included the opportunity cost of a permit. If it didn't then he avoided the mistake which Owers made. If it did then he made no attempt to adjust that opportunity cost as the fleet size was adjusted and the permit became more valuable.

[18] While some of Martin's procedures were questionable, the fact that he looked at a long time series of catches to come up with his "probability distribution" for the future may have been an improvement over Owers who used the 1969 to 1973 time period to predict future harvests.

[19] The average cost figures used by Martin for the 1976 Bristol Bay survey were apparently preliminary or modified data. The CFEC report "Summary Of Cost And Net Return Information For The Bristol Bay Gill-Net Fishery" by June Baker and Ben Muse which was released in February, 1979 contained different figures (much higher) than those used by Martin. Martin does not indicate what costs he included in his "average cost measure" other than to note that it did not include the opportunity cost of the permit holder's time.

In summary, there are many problems with the previous works of Owers and Martin. Nevertheless, both researchers appeared to be attempting to define a reasonable rate of economic return as a return which would just cover all the costs of an average fisherman including the opportunity cost of the permit holder's time.[20]

The Management Optimum Number Of Entry Permits: Previous Work

Martin indicates the "management" optimum number was defined to be "a range bounded by: (1) the minimum number of units of gear adequate to harvest the highest runs anticipated in the next ten years; and (2) the maximum number of units of gear that can be effectively managed during the low run years."

ADFG managers were asked to help answer questions about management optimum numbers. They were further asked to assume that: (1) the Board of Fisheries regulations would remain at the status quo; (2) the catch would be divided among gear types as an average over the years since statehood, and (3) processing capacity would remain constant.

Martin indicates that the process became more complicated as ADFG managers wanted more explicit directions about assumptions and methodology. An effort was made to do this but it apparently wasn't entirely successful. In 1979 Martin indicated that reports had not been received from all areas as managers could not make the project a priority. Moreover, there were differences in methodologies from area to area and some of the reports received by CFEC were not very useful, according to Martin.

Understandings of Optimum Number Standards Used In This Report

In this report, the authors have borrowed some of the better methodological elements from previous CFEC researchers. We have again chosen to look at the three standards separately and then seek a "reasonable balance" among the standards given the nature of the fishery in question.

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[20] In an unregulated, open access fishery economic theory suggests that the marginal permit holder will just be "breaking-even." This implies that even in the absence of limited entry, the marginal permit holder will just be making enough to cover his other costs plus the opportunity cost of his time. A non-marginal permit holder will be making a positive economic profit (over and above his/her opportunity cost) on average.

a. Economic Optimum Numbers

In this report the authors also assume the legislature intended the "average rate of net return" to mean the average economic profits per permit holder in a year. Economic profits are defined to exclude the opportunity cost of the permit. As noted above, the permit's value and this measure of economic profits are related. The permit's value should rise and fall with the present value of future expected economic profits. If the opportunity cost of the permit was included in the measure of economic profits, economic profits would tend to zero for the marginal permit holder, irrespective of the number of permits in the fishery.[21]

An economic profit measure which excludes the opportunity cost of a permit should rise and fall appropriately as the number of entry permits are reduced or increased (as will permit values). Such a measure may also be consistent with what the Alaska Supreme Court said in Johns. The Court appears to be saying that an exclusive system designed to "ensure" permit values would exceed the constitutional purposes of limited entry.[22]

The economic profit measure used in this report attempts to account for the opportunity cost of the vessel and equipment used in the fishery, as well as the opportunity cost of the permit holder's time. The authors believe that this is entirely consistent with both Standard One[23] and with the Supreme Court's ruling in Johns.

b. Management Optimum Numbers

The readings of Standard Two under AS 16.43.290 (2) used in this report parallel the management optimum number analysis cited by Martin.[24] Recognizing the complexity of Standard Two, two basic concepts were used to "bracket" a range of possible meanings for the management optimum number.

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21 However, even if permit values were driven towards zero, average economic profits would still be positive, in theory, unless all fishermen are the same.

22 From the permit holder's perspective, the Supreme Court's decision cannot be comforting. Increasing the number of units of gear in a fishery will reduce economic profits and lower permit values. All permit holders will suffer capital losses. The permit holder who just "bought in" to the fishery could be placed into a "negative equity" situation where s/he owes more on the permit loan than the permit is worth.

23 In review, Standard One under AS 16.43.290 reads "the number of entry permits sufficient to maintain an economically healthy fishery that will result in a reasonable average rate of economic return to the fishermen participating in that fishery, considering time fished and necessary investments in vessel and gear." (emphasis added)

24 See Martin, "Optimum Numbers" (June 15, 1979).

The first concept of the management optimum number was the number of fishing operations (entry permits) actually needed (the minimum required) to harvest the allowable take in an orderly, efficient manner. The second concept was the number of fishing operations which could be reasonably controlled (the maximum allowable) while harvesting the resource in an orderly efficient manner and consistent with sound fishery management techniques.

Both concepts contained additional qualifiers, to take into account the complexities of managing roe herring fisheries in general and the southeastern Alaska roe herring purse seine fishery in particular. The choice of management optimum numbers in the southeastern Alaska roe herring purse seine fishery is further complicated by the potential for a fishery in two different areas, each with different outlooks with respect to the potential size of the herring stocks. In any given year, the fishery might occur in both areas, occur in only one of the areas, or not occur at all.

Again, the authors felt that the Alaska Department of Fish and Game (ADFG) was the best source of expert advice on management optimum numbers for the fishery. ADFG's fishery managers are assigned the responsibility of controlling and managing a successful fishery and are the only group with the expertise to know the actual problems which they have encountered when trying to carry out their responsibilities.

To address management optimum numbers, the Department and its managers were asked a wide range of questions about herring stocks, conservation issues, safety (orderliness) issues, and management concerns and strategies. The questions were sometimes difficult to answer due to the inherent uncertainties surrounding the stocks and in managing the fishery.

Despite, these uncertainties, ADFG made an effort to provide "professional judgements" and to answer all of the questions as best they could. In general, ADFG felt that the management optimum number varied to some extent with the amount of resource available for harvest. A thorough discussion of management optimum numbers is contained in Chapter V.

c. Optimum Number Standard Three

Standard Three may be the most nebulous of the optimum number standards. As noted above, Martin indicated that the commission's understanding of Standard Three was that it "was to be utilized to adjust the economic and management optimum numbers as required by local economic conditions."

To review AS 16.43.290 (3), the third optimum number criterion, reads as follows:

(3) the number of entry permits sufficient to avoid serious economic hardship to those currently engaged in the fishery, considering other economic opportunities reasonably available to them.

In this report, the third standard is understood to be applicable chiefly when the optimum number of units of gear is less than the maximum number. Under such situations, AS 16.43.300 through AS 16.43.320 call for the automatic implementation of a fishermen-funded buy-back program. The buy-back program is to be funded by a tax on the earnings of permit holders in the fishery of up to 7% of their gross earnings.[25]

Standard Three would most logically come into play when a buy-back program was being considered. Imposition of a buy-back tax might drive some participants from the fishery who could not profitably pay the tax and who have few other occupational alternatives.

Such individuals would arguably have low opportunity costs and therefore it might be in the State's best interest to let them stay in the fishery. Under such conditions, Standard Three would provide an indirect means for keeping such individuals in the fishery by adjusting the optimum number upward.

It seems unlikely (to these authors) that Standard Three could have been intended for situations where the optimum number appears to be greater than the maximum number. If Standard Three were applied to such situations, it would always argue for <u>not</u> putting more permits in the fishery, as all existing permit holders would suffer losses because of the addition of more permit holders.[26] It seems unlikely that this was the legislature's intent and such an interpretation would also appear to be inconsistent with the Supreme Court's ruling in <u>Johns</u>.[27]

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[25] A May 1985 Attorney General's Opinion from the Alaska Department of Law suggests that the buy-back portion of the law is unconstitutional as written because it requires the establishment of a dedicated fund. The Opinion recommends that the commission seek an amendment to the statutes to correct the problem before proceeding with a buy-back program.

[26] In terms of fairness, this "hardship" might seem more onerous for persons who "bought in" to the fishery than for initial issuees. Initial issuees were given the wealth created by limited entry, and would seem to have less of an argument if the State chose to reduce that wealth by issuing more permits. In contrast, persons who "bought in" to the fishery likely paid fair market value for their permit.

[27] See <u>Johns</u>, p. 1266 (footnote omitted).

> In <u>State v. Ostrosky</u>, 667 P.2d 1184 (Alaska 1983), we noted that there is a tension between the limited entry clause of the state constitution and the clauses of the constitution which guarantee open fisheries. We suggested that to be constitutional, a limited entry system should impinge as little as possible on the open fishery clauses

Summary

This chapter has examined the three optimum number standards stated in AS 16.43.290. Previous analyses of these standards have been reviewed and the concepts which will be used in this report have been outlined. Chapters III through VI provide an application of these standards to the southeastern Alaska roe herring purse seine fishery.

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consistent with the constitutional purposes of limited entry, namely, prevention of economic distress to fishermen and resource conservation. Ostrosky, 667 P.2d at 1191. The optimum number provision of the Limited Entry Act is the mechanism by which limited entry is meant to be restricted to its constitutional purposes. Without this mechanism, limited entry has the effect of creating an exclusive fishery to ensure the wealth of permit holders and permit values, while exceeding the constitutional purposes of limited entry. Because this risk of unconstitutionality exists, the CFEC should not delay in embarking on the optimum number process, except where there is substantial reason for doing so.

CHAPTER II

HISTORICAL REVIEW of the FISHERY and MANAGEMENT

CHAPTER II

Historical Review of the Fishery and Management

Introduction

In Alaska, utilization of Pacific herring sac roe began in the late 1960s when markets for the product developed. Historically, herring were used for bait in other fisheries, for human consumption, or for reduction to fish meal and oil. The reduction fisheries accounted for most of the catch in the decades from the early 1900s through the 1950s. By the time the Alaskan sac roe markets started in the late 1960s, the reduction fisheries had been discontinued and bait fishing accounted for most of the catch. Since 1972, sac roe fishing has made up the majority of the herring catch in southeastern Alaska.

Depletion of the Southeastern Alaska Herring Stocks

A review of the historical herring catch data reveals years of extremely high catches relative to recent years, especially in the 1930s. However, from the early 1900s to the 1960s, herring stocks in southeastern Alaska exhibited an overall decline in abundance, likely due to overfishing.

Rounsenfell (1935) reviewed factors which may affect the supply of herring in southeastern Alaska and which can make the documentation of early herring abundance difficult. He mentioned that early sources of data are often incomplete. Also, changes in the fishing seasons, the effects of regulations, changes in the individual fishing power of the vessels and gear, the effects of the use of herring impoundments, and the capacity of the herring plants and their markets all can skew catch data and the corresponding inferences of herring abundance. Likewise, good documentation of changes in catch per unit effort (CPUE) are difficult due to an inconsistent time series data base.

He also noted that when considering the early Southeastern catch statistics, one should consider the shift in the fishing grounds. The constant shift of the fishery to new grounds as the older grounds were depleted may have kept up the average size of the catch and can obscure and minimize any fall in abundance. The exploitation of new grounds did not prevent the fleet from continuing to fish on the few remaining herring that were left in the more traditional grounds. Thus, the traditional areas continued to be used, sometimes to the point of commercial extinction.

Blaxter (1985) also noted that in an overfished herring population CPUE does not necessarily fall initially since the surviving herring aggregate by schooling and the

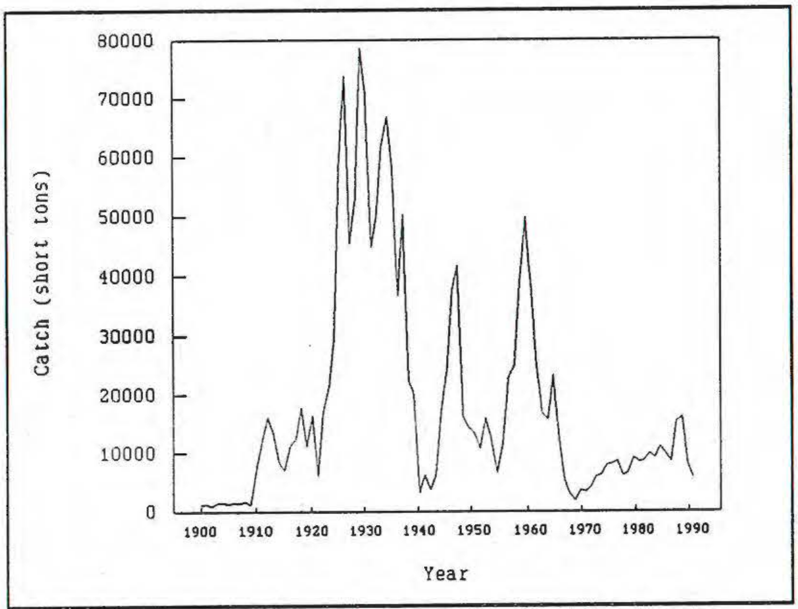

Figure 1. Southeastern Alaska historical herring harvest, 1900 to 1991.

searching power of the fishing fleet allows the fishermen to seek out the survivors on a contracted fishing ground.

Nevertheless, Rounsenfell concluded, after analyzing average weekly and monthly deliveries and factoring in the variables listed above, that southeastern Alaska herring populations had declined over time.

Rounsenfell supported his hypothesis of the decline by corroborating it with biological evidence of depletion. The relative decline in abundance of larger, older fish was documented and was determined to be separate from the natural falling off of older year classes.

Initial Sac Roe Fishing in Southeastern Alaska

The demise of the reduction fishery was caused by changing market conditions compounded with the depletion of the herring resource. By the mid-1960s, herring bait fishing was virtually the only viable herring fishery remaining in southeastern Alaska. Later, as markets developed and the demand for sac roe became greater, herring bait fishermen were sometimes encouraged by processors to fish longer into the springtime and closer to the herring spawning periods when roe quality is highest. Fish that were ostensibly caught for the bait or food markets were sometimes frozen whole and sent to Japan where the sac roe was extracted and sold. Some herring was processed in Alaska prior to export by allowing the fish to ripen in the open air for five to eight days, then the sac roe was removed by hand.[28]

When fishing in the springtime became more common, biologists expressed concern that harm could be done to the vulnerable spawning herring stocks, particularly to the smaller stocks. In 1970, the Board of Fisheries, at ADFG's request, enacted regulations that separated the sixteen Southeastern herring fishing districts into two categories: thirteen so-called "bait season" districts where springtime fishing was not

[28] Source: ADFG annual report for the Sitka district, 1970

normally permitted, and three other districts where fishing on spawning fish was allowed.

Regulatory seasons in the bait districts were from June 1 to February 28. Quotas were established by emergency order. Although these areas were set aside mainly for bait fishing, ADFG would occasionally extend the winter bait seasons into the spring if quotas had not been taken, and sometimes the focus of herring fishing then switched from bait to sac roe.

Districts 13 (Sitka), 11 (Juneau\Seymour Canal), and 10 (Frederick Sound\Lower Stephens Passage) were designated separately from the bait areas. Major stocks of spawning herring had been documented in these districts. Special regulations established no closed season; however, in Districts 10 and 11 a seasonal quota constrained how much herring could be caught during the period March 1 to May 31. In District 13 a total annual catch quota was implemented. Because of the year-round seasons, both directed bait and sac roe fishing occurred in these districts in 1970 and 1971.

By 1972, in Districts 13 and 11, most of the annual herring catch was used for sac roe. Fishing activity became intensive during the springtime.

Sac Roe Fishing Areas

As mentioned above, herring fishing effort in southeastern Alaska has been divided mostly between bait fishing and sac roe fishing since 1970. Since then, the regulations that define sac roe areas have changed -- some areas have been added and others removed -- but the three primary areas have historically been Sitka, Juneau\Lynn Canal, and Seymour Canal.

Prior to 1974, entire districts could be referred to as either "bait" or "bait and roe" depending upon whether or not the regulations permitted fishing from March through May (although, as noted above, roe fishing sometimes occurred during the extended seasons in the bait districts) However, in 1974, the regulations more explicitly defined sections and sub-sections of the sixteen districts as either sac roe areas or bait areas. Six total roe herring areas were specified. Allowable gear included purse seines, gill nets, and trawls.

The Board of Fisheries separated sac roe purse seine and gill net gear in 1976 when they created eight gill net areas and four purse seine areas. The Sitka and Seymour Canal sections were limited to seine gear only. The Juneau\Lynn Canal districts became a combined seine and gill net area with 25% of the total allowable catch allocated to the gill net fleet.

In 1980, the Seymour Canal fishery changed to a gill net fishery and the Juneau\Lynn Canal fishery became exclusively a seine fishery. Since 1980, the designated sac roe seine areas have remained as Sitka and Juneau\Lynn Canal.

Designated sac roe gill net areas have changed frequently over the years. Normally, when a new gill net area was specified, it was done by request of the gill net fleet to the Board of Fisheries. The "new" areas were usually locations where herring stocks had been previously utilized in the winter bait fishery. Production in most of these areas has tended to be small. The majority of these places remained as sac roe gill net areas for only a couple of years before they were removed from the regulations. In some of these locations herring were never taken because adequate amounts of good quality fish couldn't be found. Currently, the only designated gill net areas are Seymour Canal (section 11D) and Kah Shakes (section 1F).

Some sac roe fishing -- both gill net and seine -- has occurred in the tribal waters of the Annette Island Indian reservation. The tribal waters are not managed by the State of Alaska.

In practice, ADFG managers frequently use emergency orders to restrict the allowable fishing zones to smaller sections of the regulatory sac roe areas. Restricting the fishing area can perform several functions: it can be used to steer the effort to places where better quality fish are found (i.e., away from spawn-outs or immature fish); it can keep the fleet away from large numbers of fish that may be particularly vulnerable to fishing gear (which can result in overharvests); and it can allow more efficient monitoring of the fishery by the managers.

Conversely, sac roe areas have also been enlarged when good quality herring moved out of an area. Enlarging a fishing area that has already been defined in the regulations requires ADFG's Commissioner to promulgate emergency regulations. This occurred in the Juneau fishery in both 1973 and 1974.

Table 1 summarizes historical sac roe areas that have been defined in the regulations since 1970. The reader is reminded that prior to 1974 all of Districts 10, 11, 13, and 7 (1973 only) were set aside for both herring bait and herring roe fisheries. For those early years, the table lists the primary locations within those districts where sac roe fishing has been documented. Additionally, this table may not list areas where early sac roe fishing effort occurred if: (a) it happened outside of Districts 10, 11, 13, or 7 and, (b) the winter bait season was extended into the springtime.

Table 1. Southeastern Alaska historical sac roe areas; 1970 to 1992. Specific sac roe areas were defined in the regulations in 1974. In 1976 separate seine and gill net areas were established.

Area	Definition	Years
Sitka	All of District 13	1970
	Quota split between Section 13B and the remainder of the district	1971
	Quota split between Section 13B north of Goddard Hot Springs and the remainder of the district	1972 - 1973
	All of Section 13B (seine only beginning 1976)	1974 - 1977
	Section 13B, north of Goddard Hot Springs	1978 - 1980
	Section 13B, north of Aspid Cape except Whale and Necker Bays	1981 - 1992
Juneau \ Lynn Canal	All of District 11	1970 - 1971
	Sections 11A, 11B, 11C, and all of District 15	1972 - 1973
	Section 11A (Juneau) and 15C (Lower Lynn Canal)	1974 - 1975
	Section 11A, north of the Shrine of St. Therese (gill net and seine), 15C (seine only), and 15B (Berner's Bay -- gill net only)	1976
	Section 11A, north of the Shrine of St. Therese (gill net and seine), 15C (gill net and seine), and 15B (gill net only)	1977 - 1979
	Section 11A, north of St. Therese and 15C (seine only beginning 1980)	1980
	Sections 11A, north of St. Therese, 15C, and 15B	1981 - 1992
Seymour Canal	Was included in the entire District 11 seasonal quota	1970 - 1971

(con't)

where the rate increases as the population grows above the threshold.

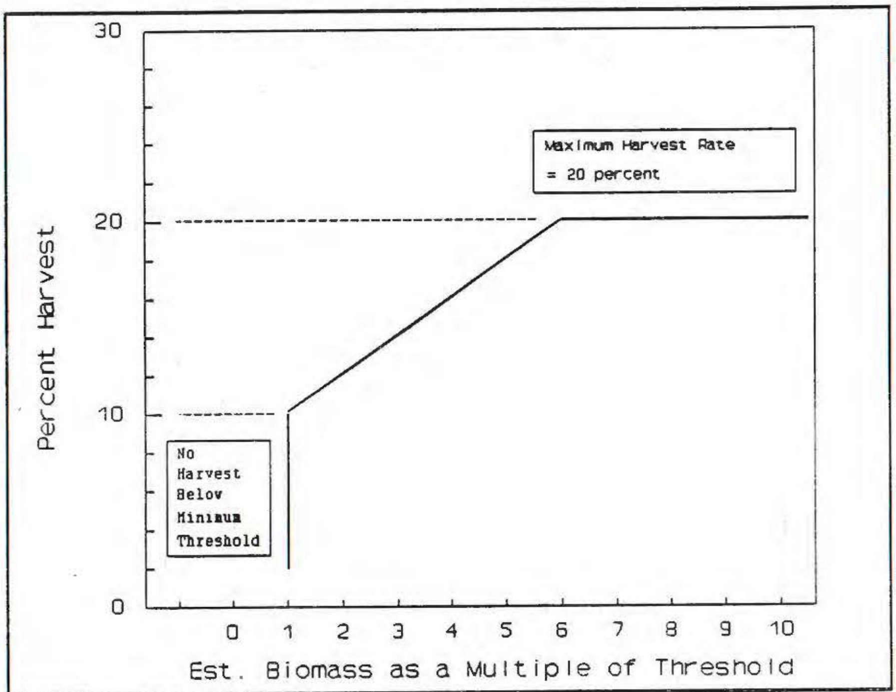

Figure 2. Harvest strategy for the southeastern Alaska herring fisheries. Harvest rates are adjusted upward by 2% for each multiple of the threshold that the biomass is assessed.

This harvest strategy is still used in the Southeastern sac roe and bait herring fisheries. It is based on a sliding 10 to 20% scale that provides a 10% harvest rate at the threshold population level and a maximum of 20% when the biomass is assessed at its highest levels. The harvest rate increases continuously from the 10% level at a rate of 2% for each multiple of the threshold that the biomass is assessed (i.e., a population with a 2,000 ton threshold provides for a quota of 200 tons if the pre-season biomass assessment comes in at 2,000 tons; if that same population is assessed at 4,000 tons -- two times the threshold -- the quota will be 480 tons, or 12% of the biomass).

e. Management for Quota

To stay within pre-set harvest quotas, ADFG managers rely mainly on time and area restrictions.

The amount of herring that can be caught during a given amount of time depends largely on how vulnerable the fish are to the fishing gear. Managers take this into account when they set both time and area restrictions. As mentioned above, an area that has large numbers of vulnerable herring oftentimes will be closed to fishing for risk of overharvest.

Shortening the amount of allowable fishing time can have limited effect. Due to the effectiveness of purse seine gear, large, 2-300 ton sets -- and several of them -- can occur by the fleet in as short a time as 20 minutes, which is basically the amount of time it takes for one boat to make one set. This can make managing for small quotas extremely difficult.

Management for small quotas can occur when the overall quota is small, or when the remainder of a quota needs to be caught after an initial fishery opening. In both cases, managers must employ a strategy where they try to keep the large fleet "off the fish."

Managing for large quotas can also present problems. When quotas are large the processing capacity of fish buyers becomes a consideration. Individual fishery openings will have to be necessarily short and spaced far enough apart to allow the buyers an opportunity to catch up. The catch up occurs, of course, during the limited time when quality is high and the fish are best available for harvest.

Other Regulations

The only significant gear restrictions apply to the nets: herring seines may not be more than 200 fathoms in length and 1700 meshes deep. There is no limit on the number of seine nets that a vessel may have on board.

Description of the Sac Roe Seine Fisheries by Area

a. The Sitka Fishery

The spawning herring stock in Sitka Sound has traditionally been the largest in southeastern Alaska. Since 1983, Sitka has been the only area where sac roe seining has occurred. The biomass estimation index that has the longest time series for the Sitka population is linear miles of spawn from aerial surveys. Based upon these observations and also upon the more recent indices of hydroacoustical estimates and spawning ground surveys, it is apparent that the Sitka herring populations recovered from a low level that was observed in the 1960s and 70s to a period of peak spawning biomass in 1988.

One theory suggests that the low numbers of herring in the 1960s and 70s were due to overfishing that occurred when the early reduction fishery removed large numbers of fish from the summer feeding grounds, but no conclusive evidence has been presented that substantiates this. Another theory suggests that the low recruitment during the time period was the result of undetermined environmental factors which cycle and can cause large shifts in herring abundance.

The population increased or "shifted" to a much higher level in 1979 when a large recruit year class of three-year-old fish entered. Interestingly enough, the Sitka herring stock has shown similar strong year class recruitment in regular four year cycles since then as large numbers of three-year-olds have again entered the spawning population in 1983, 1987, and 1991. Good recruitment has kept the Sitka population at relatively high levels since 1979.

Sitka herring in recent years have been especially small-at-age. When herring are young and/or small, their individual skeins of sac roe are also small and the product has less market value. A preponderance of young and small fish, especially when they are mixed with older, larger, and more marketable herring, has led to the development of non-competitive, shared-quota fisheries in Sitka during the 1979, 1988, 1989, and 1991 seasons. The decision to fish cooperatively has been an independent agreement among the permit holders to address the problems associated with searching for herring of acceptable quality. Without the pressure of having to race to harvest fish before the quota is reached, individual fishing operations have had more opportunity to prospect for better fish -- they have more time to make sets, test the catch for size and roe percentage, and either keep or release it.

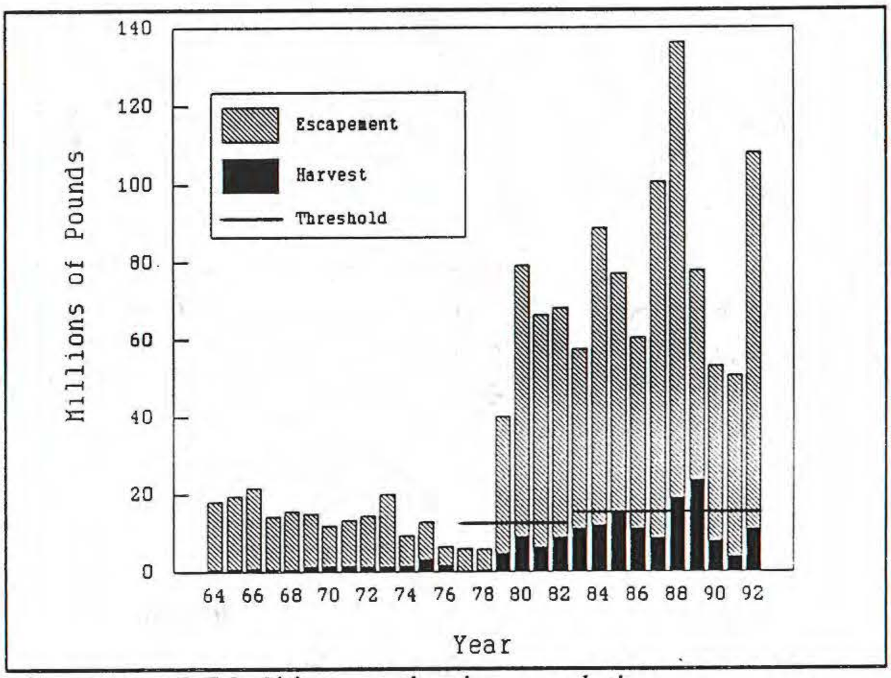

Figure 3. ADFG Sitka area herring population assessments; 1964 to 1992.

The 1991 fishery was particularly problematic. Marketable herring were especially scarce and industry standards for size and roe percentage couldn't be found despite repeated searching and test fishing. ADFG decided not to open the fishery when it became apparent that for fishermen to find good quality herring during a competitive fishery, intensive sorting and high-grading would necessarily occur, and handling (gear) mortality of the fish would be unacceptably high. Although test fishing and handling mortality is always a concern among managers, they have stated that under a non-competitive fishery, the likelihood of serious damage is lessened. When permit holders agreed among themselves to share in the quota and to limit the amount of fishing effort and handling, the Department believed the fishery could be safely opened.

The 1991 fishery was considered a failure among fishermen, however, as approximately 40 percent of the quota remained uncaught and less than half the fleet eventually made landings. Some fishermen were never able to find fish that would satisfy their processors and other fishermen left the area early to pursue other fisheries.

The spawning biomass of the 1991 Sitka herring stock was assessed at 46.9 million pounds (23,450 tons) which provided a 1992 harvest quota of 3,356 tons. The three-year-old herring that appeared in the 1991 fishery dominated the 1992 population as four-year-olds, and made up approximately 90% of the spawning population. They were still small for their age, averaging below the industry's normal minimum acceptable standards of 100 to 120 grams. Nevertheless, fish buyers agreed to purchase the fish and ADFG opened a competitive fishery. Because the herring were vulnerable and the fishing conditions were excellent, the fishery lasted only 1 hour and 23 minutes, which is the shortest on record for the Sitka roe fishery. Preliminary figures indicate a catch of 5,364 tons. The 60% overage of quota was largely due to the seine fleet's effectiveness on the vulnerable fish. Biologists noted that despite the fishery exceeding the quota, approximately 97 million pounds of spawning fish were observed, which is the second largest escapement recorded in Sitka.

Reports from fish processors indicate that the average price paid in the 1992 Sitka fishery was $269 per ton (which includes adjustments for roe percentages). In informal conversations with the authors, processors were pessimistic about the opportunities for selling the roe at a profit. They expressed strong concern about the continued poor quality of Sitka roe herring and about the future of the fishery in general. They felt that they would probably continue to have to offer low prices for the fish until the average sizes and roe percentages increased.[29]

b. The Juneau\Lynn Canal Fishery

Again, the indices that document the longest time series of data on herring populations in Juneau\Lynn Canal are the linear miles of spawn and the distribution of the spawning areas. From this, and from other indices, it appears that the Juneau\Lynn Canal herring stock has suffered a serious decline from which it has not yet recovered. The last fishery that occurred in Juneau was in 1982, and even in that year the fishery probably shouldn't have been allowed. Biologists have seen nothing in recent years that suggests to them that a recovery is imminent.

Before the decline, the Juneau\Lynn Canal area was generally considered, along with Sitka and Seymour Canal, to contain one of the largest spawning populations of herring in southeastern Alaska.

The demise of the Juneau\Lynn Canal herring stocks cannot be accounted for. Hypotheses include overfishing, ocean environmental factors, human development near some of the spawning grounds, heavy and\or abnormal predation, and natural cycles. Fishery biologists have noted that it is not unusual for populations of fish or animals to be "knocked down" to a level where recovery is difficult, if not impossible, and some fear that this may be the case in Juneau. Still others note that other herring

[29] Harold Thompson and Bruce Tullock, personal communication.

populations have suffered declines but have bounced back following a few years, or even one year, of good recruitment.

Biologists have described the distribution of pre-spawning herring in Juneau to be characteristically limited to only a few large, deep-lying schools; consequently, the opportunity for a lot of boats to find big schools of fish is limited. This pattern can present management biologists with both advantages and problems when trying to stay within pre-set quota limits -- it is easier for them to keep boats away from large concentrations of vulnerable fish, yet when boats do locate a main body of fish, very large sets can be made and the quota can be taken quickly. The history of the distribution of catches among the boats in Juneau illustrates this phenomenon -- there have in the past been many boats that were "skunked" or ended with small catches while a few other boats made very big landings (see Table 2).

As mentioned above, both gill net and seine gear were allowed in the Juneau\Lynn Canal districts through the 1979 season. Since the 1980 season, only purse seine gear has been permitted.

c. The Seymour Canal Fishery

Seymour Canal is the third area where sac roe seining occurred on a regular basis. Since 1980, it has been designated for only gill net gear. In that year a trade was made which removed gill net gear from the Juneau area and switched Seymour Canal from a seine to gill net area.

At the time the trade was made, the Seymour Canal stocks were at a low point. No gill net fisheries were allowed in 1980, 1982, 1983, and 1985 when threshold levels of spawning biomass were not found.

d. Other Sac Roe Seine Fishing

Records indicate that sac roe seine landings occurred from other areas of southeastern Alaska prior to the 1976 season. These areas have never been large producers of sac roe herring and landings from them were normally associated with boats that were making exploratory fishing efforts during the early days of the fishery. Examples of these areas include Farragut Bay and Lisianski Inlet. Other areas such as Nakat Bay and Earnest Sound were prospected for herring of acceptable quality but no sac roe landings were reportedly made.

Table 2 outlines the historical sac roe quotas, catches, and earnings for Sitka, Juneau\Lynn Canal, and Seymour Canal. The table includes information from a variety of sources, including CFEC surveys. A review of the data shows that some fishing operations participated in the fishery and, usually due to the short, intense seasons, never made a landing. Other operations may have recorded landings but may not have had earnings because they were unable to successfully market their catch following the season. Still other operations may have had earnings in the fishery (and showed them on CFEC surveys) but may not have recorded landings. This usually happened when two or more operations fished cooperatively and combined their catch on one fish ticket. Table 2 displays the totals and averages for operations that recorded earnings, irrespective of whether they recorded landings.

Table 2. Southeastern Alaska purse seine sac roe participation, harvest, and earnings for the three most significant seine areas; 1971 - 1992. Averages are only for operations that recorded earnings. There are operations that recorded earnings but did not record landings. Alternatively, there are operations that recorded landings but did not record earnings.

Area	Year	Permit Holders Who Registered	Permit Holders With Earnings	Harvest Quota (pounds)	Total Pounds Landed	Average Pounds Landed	Total Gross Earnings	Average Gross Earnings
Sitka	1971		3	1,500,000	1,492,784	497,595	$ 29,856	$ 9,952
	1972		6	1,700,000	1,176,224	196,037	$ 70,573	$ 11,762
	1973		7	1,200,000	1,228,575	175,511	$ 122,857	$ 17,551
	1974	25	22	1,200,000	1,334,352	60,652	$ 160,122	$ 7,278
	1975	28	22	1,100,000	2,967,717	134,896	$ 296,465	$ 13,476
	1976	38	33	1,560,000	1,589,400	48,164	$ 214,466	$ 6,499
	1977	37	0	-no fishery-	0	0	$ 0	$ 0
	1978	23	11		467,824	42,529	$ 244,728	$ 22,248
	1979	48	48	4,000,000	5,102,176	106,295	$ 5,119,728	$ 106,661
	1980	50	50	8,000,000	8,889,594	177,792	$ 1,859,763	$ 37,195
	1981	51	41	6,000,000	7,012,438	171,035	$ 2,134,294	$ 52,056
	1982	51	50	6,000,000	8,726,644	174,533	$ 2,859,403	$ 57,188
	1983	51	51	11,000,000	10,898,237	213,691	$ 4,962,867	$ 97,311
	1984	50	50	10,000,000	11,660,530	233,211	$ 3,500,076	$ 70,002
	1985	52	52	15,400,000	14,950,868	287,517	$ 7,810,118	$ 150,195
	1986	52	50	10,058,000	10,884,990	217,700	$ 7,457,570	$ 149,151
	1987	52	52	7,200,000	8,432,824	162,170	$ 4,407,661	$ 84,763
	1988	52	50	18,400,000	18,780,098	375,602	$ 4,168,292	$ 83,366
	1989	51	51	23,400,000	23,662,340	463,967	$ 1,181,650	$ 23,170
	1990	51	50	8,300,000	7,608,484	152,170	$ 1,955,359	$ 39,107
	1991	51	22	6,400,000	3,676,382	167,108	$ 205,876	$ 9,358
	1992	51	48	6,712,000	10,728,087	223,502	$ 1,444,028	$ 30,084
Juneau\ Lynn Canal	1971	2	0	1,500,000[a]	0	0	$ 0	$ 0
	1972		2	1,500,000	185,950	92,975	$ 5,578	$ 2,789
	1973		9	1,500,000	1,336,335	148,482	$ 120,270	$ 13,363
	1974		18	1,000,000	573,368	31,854	$ 68,804	$ 3,822
	1975		13	1,000,000	1,111,324	85,486	$ 113,661	$ 8,743
	1976	39	15	1,000,000	865,069	57,671	$ 117,719	$ 7,848
	1977	23	6	1,300,000	1,418,836	236,473	$ 342,591	$ 57,098
	1978	43	6	1,000,000	1,205,073	200,846	$ 601,254	$ 100,209
	1979		0	-no fishery-	0	0	$ 0	$ 0
	1980	46	20	1,200,000	1,951,765	97,588	$ 480,468	$ 24,023
	1981	49	16	1,500,000	1,507,453	94,216	$ 433,123	$ 27,070
	1982	40	21	700,000	1,102,580	52,504	$ 344,953	$ 16,426
Seymour Canal	1971		1	1,500,000[a]	69,200	69,200	$ 1,384	$ 1,384
	1972	2	2	600,000	986,000	493,000	$ 29,580	$ 14,790
	1973	15	11	1,000,000	1,012,391	92,036	$ 91,115	$ 8,283
	1974		20	1,600,000	1,801,643	90,082	$ 216,197	$ 10,810
	1975		0	-no fishery-	0	0	$ 0	$ 0
	1976	20	11	400,000	388,856	35,351	$ 52,610	$ 4,783
	1977	29	25	950,000	970,530	38,821	$ 257,707	$ 10,308
	1978		28	1,000,000	1,458,123	52,076	$ 642,047	$ 22,930
	1979	38	10	500,000	537,262	53,726	$ 607,106	$ 60,711

[a] This was the entire District 11 quota, which includes both the Juneau and Seymour Canal areas.

CHAPTER III

HISTORICAL RATES of ECONOMIC RETURN in the SOUTHEASTERN ALASKA ROE HERRING FISHERY

CHAPTER III

Historical Rates Of Economic Return In The Southeastern Alaska Roe Herring Purse Seine Fishery

As a first step in analyzing the relationship between rates of economic return and the number of units of gear in the fishery, an effort was made to estimate historical rates of return in the southeastern Alaska purse seine roe herring fishery. This chapter briefly reviews the methodology used to estimate historical rates of economic return, provides the results of those estimates, and compares those results with time series estimates of the market value of permits obtained through market transactions.

Direct Measures: The Evidence of Permit Values

The market value of a limited entry permit theoretically represents the present value of the future expected economic profit stream to the marginal fishermen from the fishery, where that economic profit stream is defined to exclude the opportunity cost of the permit. As such, the permit's value should provide direct market evidence of the anticipated profitability of a fishery.

The value of the permit to a particular fisherman represents the maximum value they would be willing to pay for that stream of ("above-normal") economic profits. In a certain world, fishermen would be able to precisely measure what a permit was worth to them.

A fisherman would purchase (or continue to hold) a permit or would sell (or not hold) a permit depending upon whether the price of the permit was below or above their personal valuation. The market price would be determined by the interaction of these demand and supply functions, and the marginal permit holder who purchases or sells at the market price would be just "breaking even."

In the real world, the future can be very uncertain. This is true in most commercial fisheries and particularly true in the southeastern Alaska roe herring purse seine fishery. As indicated in Chapters II and V, recruitment in herring stocks can be highly variable and can lead to fairly rapid changes in the size of the biomass and the total allowable harvest quota. Ex-vessel prices can also be highly variable depending on overall world supplies of roe herring products, exchange rates, and the quality of the roe harvest.

Table 3 provides time series data on average ex-vessel prices in the fishery, in both nominal and "real" or "constant-value" 1991 dollars. Table 4 provides time series data on harvests and gross earnings in the southeastern Alaska roe herring purse seine fishery over the 1975-1992 time period.[30] Total pounds, average pounds per operation (with earnings), total gross earnings, average gross earnings, and CFEC's average ex-vessel price are all reported.

Table 3. Roe herring purse seine average ex-vessel prices. Southeastern Alaska and statewide in nominal and real (1991) dollars.[a]

Year	SE Alaska Nominal $ Per Ton	SE Alaska Real (1991) $ Per Ton	Statewide Nominal $ Per Ton	Statewide Real (1991) $ Per ton
1975	$ 201.0	$ 481.3	.	.
1976	$ 270.6	$ 609.5	.	.
1977	$ 502.4	$ 1,058.7	.	.
1978	$ 948.4	$ 1,852.8	$ 490.0	$ 957.2
1979	$ 2,030.0	$ 3,650.9	$ 1,304.0	$ 2,345.2
1980	$ 431.8	$ 709.4	$ 330.0	$ 542.2
1981	$ 602.6	$ 899.7	$ 424.0	$ 633.0
1982	$ 652.0	$ 916.5	$ 420.0	$ 590.4
1983	$ 910.8	$ 1,230.4	$ 568.0	$ 767.3
1984	$ 600.4	$ 777.2	$ 462.0	$ 598.1
1985	$ 1,044.8	$ 1,303.8	$ 670.0	$ 836.1
1986	$ 1,370.2	$ 1,665.7	$ 794.0	$ 965.3
1987	$ 1,045.4	$ 1,231.5	$ 928.0	$ 1,093.2
1988	$ 444.0	$ 503.4	$ 970.0	$ 1,099.8
1989	$ 99.8	$ 108.4	$ 344.0	$ 373.5
1990	$ 514.0	$ 534.9	$ 658.0	$ 684.7
1991	$ 112.0	$ 112.0	$ 560.0	$ 560.0
1992	$ 269.2	$ 263.0	.	.

[a] Nominal dollars have been converted to 1991 "constant value" dollars using the Gross Domestic Product implicit price deflator published in the Survey of Current Business, 72-9 (Sept. 1992): p. 44

These data provide some indication of the difficulties a fisherman faces when trying to form accurate expectations about future returns, and consequently, the difficulties involved in estimating the value of purchasing or holding an entry permit. Pounds, ex-vessel prices, and gross earnings in the fishery have all been highly variable

[30] This table will differ slightly from standard CFEC reports on the fishery, as both earnings and harvest have been modified by information obtained during the CFEC survey process. The table only includes operations which had earnings greater than zero. Sometimes operations which participate in the fishery will fail to make landings of commercially salable product. This was especially common in the early years of the fishery and also in 1991, when many boats initially arrived and then decided that it would be more profitable to move to another fishery rather than to stay in Sitka. Still others participated but failed to find marketable herring.

historically. From 1975 through 1992 average earnings per permit holder varied both because average catch varied and because average ex-vessel prices varied.

Average pounds per permit holder with earnings ranged from a low of 78,981 in 1976 to a high of 463,967 in 1989.[31] Average pounds per permit holder with earnings tended to be lower during the 1975-1979 time period than the averages in the decade of the eighties.

From 1975 to 1979, catches were always below 200,000 pounds, and averaged 108,419 pounds (54.2 tons)[32] per operation (with earnings) per year over the time period. In contrast, average pounds per operation exceeded 200,000 pounds during the eighties in each year except 1982 and 1987. The overall weighted average pounds per operation per year for the decade was 258,471 pounds (129.2 tons).

Average catches in 1990 and 1991 again fell well below the 200,000 pound level. The weighted average catch per participating operation (with earnings) per year in these years was 156,734 pounds (78.4 tons). The average per permit during 1990 and 1991 would be much lower, as only 22 of 51 permit holders recorded landings in 1991.

Average ex-vessel prices ranged from lows of approximately $100 per ton in 1989 and 1991 to the high of approximately $2,030 per ton in 1979. In constant-value 1991 dollars the "real" highs and lows occurred in the same years. In real-terms, ex-vessel prices averaged $1,391 per ton over the 1977 through 1987 time period. In contrast, the real average ex-vessel prices over the 1988 through 1992 time period averaged $304 per ton.

The variation in ex-vessel prices led to a poor correlation between average pounds per permit holder and average gross earnings per permit holder over the 1975-1992 time period.[33] High average pounds did not necessarily mean high ex-vessel prices and high average gross earnings. For example, the highest average catch per operation occurred in 1989 when permit holders averaged 463,967 pounds (about 232

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[31] The overall average pounds per operation with earnings was 203,814 over the 1975-1992 time period.

[32] This represents a weighted average, where the average pounds per operation each year have been weighted by the number of operations with earnings.

[33] The simple bivariate correlation coefficient between average pounds and average gross earnings over the 1975-1992 time period was slightly positive (.18195) but insignificant. In contrast, there was a strongly positive (.80654) and highly significant correlation between average prices and average gross earnings over the same time period. The simple bivariate correlation between average pounds and average prices was slightly negative (-.25242) but insignificant. These results are striking, particularly the lack of a significant relationship between average pounds and average gross earnings. Of course, if prices were held constant, average pounds and average gross earnings would be directly related.

Table 4. Southeastern Alaska purse seine sac roe participation, harvest, and earnings for all seine areas combined; 1975 - 1992. Averages and catches are for operations that recorded earnings. There are operations that recorded earnings but did not record landings. Alternatively, there are operations that recorded landings but did not record earnings.

Year	Permit Holders With Earnings	Total Pounds Landed	Total Tons Landed	Total Gross Earnings	Average Pounds Landed	Average Gross Earnings	Average Price / Pound
1975	25	4,079,041	2,040	$ 410,126	163,162	$ 16,405	$ 0.101
1976	36	2,843,325	1,422	$ 384,795	78,981	$ 10,689	$ 0.135
1977	25	2,389,366	1,195	$ 600,298	95,575	$ 24,012	$ 0.251
1978	33	3,154,856	1,577	$ 1,495,895	95,602	$ 45,330	$ 0.474
1979	48	5,639,438	2,820	$ 5,726,834	117,488	$ 119,309	$ 1.015
1980	50	10,841,359	5,421	$ 2,340,231	216,827	$ 46,805	$ 0.216
1981	41	8,519,891	4,260	$ 2,567,417	207,802	$ 62,620	$ 0.301
1982	50	9,829,224	4,915	$ 3,204,356	196,584	$ 64,087	$ 0.326
1983	51	10,898,237	5,449	$ 4,962,867	213,691	$ 97,311	$ 0.455
1984	50	11,660,530	5,830	$ 3,500,076	233,211	$ 70,002	$ 0.300
1985	52	14,950,868	7,475	$ 7,810,118	287,517	$ 150,195	$ 0.522
1986	50	10,884,990	5,443	$ 7,457,570	217,700	$ 149,151	$ 0.685
1987	52	8,432,824	4,216	$ 4,407,661	162,170	$ 84,763	$ 0.523
1988	50	18,780,098	9,390	$ 4,168,292	375,602	$ 83,366	$ 0.222
1989	51	23,662,340	11,831	$ 1,181,650	463,967	$ 23,170	$ 0.050
1990	50	7,608,484	3,804	$ 1,955,359	152,170	$ 39,107	$ 0.257
1991	22	3,676,382	1,838	$ 205,876	167,108	$ 9,358	$ 0.056
1992	48	10,728,087	5,364	$ 1,444,028	223,502	$ 30,084	$ 0.135

tons). However, the average ex-vessel price in 1989 was about $100 per ton, a low for the time period.[34] As a result, average gross earnings per permit holder in 1989 fell to the lowest level since 1977. Figures 4 and 5 illustrate this graphically.

These types of variations can make future earnings in the fishery very uncertain. Other factors can make decisions about buying or selling an entry permit a relatively difficult task. The "thinness" of the markets and the lack of data on net returns from the permits are two examples. Another factor is the lack of a formal market to serve

[34] The spawning population in 1989 was characterized by poor roe quality.

both buyers and sellers.[35] These factors reduce the amount of information available to help make a more accurate valuation of the permit's worth.

Sales prices of a particular type of permit at a point in time can often vary greatly in value. This may be further evidence of the great uncertainty surrounding permit values. This type of contemporaneous variation may also partially reflect large differences in transaction costs across observations, as it can be costly for sellers and buyers to find each other and transact business.

CFEC data indicate that 60.5% of all transfers (all fisheries) over the 1980-91 time period represented transactions between persons who were friends, relatives, or business partners. Similarly, 64.6% of all transfers were between persons who were classified as the same resident-type.[36] These data may suggest the small localized nature of the permit markets and possibly the high transactions cost involved when sellers attempt to transact business at a distance with unknown buyers.[37]

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[35] The development of individuals and firms which provide permit broker services has reduced this problem. Such firms have become "market makers" who advertise through widely distributed commercial fishing magazines and newspapers. This increases the information on sellers' asking prices and reduces the cost of finding and transacting business with distant and unknown bidders. Brokers as intermediaries may make the "market" more efficient. Use of brokers for sales transactions (greater than $500) increased over the 1980-1991 time period from 6.7% to 43.9% of all sales transactions. (Source: Kurt Iverson's 11/30/92 memorandum to Kurt Schelle, see Appendix III).

[36] See the CFEC report "Changes In The Distribution Of Alaska's Limited Entry Permits, 1975-1991," (CFEC Report 92-17, Juneau, AK. 1992). Resident-types defined in the report are Alaska Rural Locals, Alaska Urban Locals, Alaska Rural Non-Locals, Alaska Urban Non-Locals, and Non-residents. Local/Non-Local distinctions are made relative to each limited fishery. For example, Alaska Rural Local refers to a permit holder who resides in a rural area which is considered "local" to the permit fishery.

[37] Transactions costs are believed to be lower between relatives, friends, and business partners because they can often find each other and negotiate without the need of an intermediary. While the transactions costs associated with a permit transfer may be substantial, particularly if it is negotiated between distant parties and requires an intermediary, a permit is generally considered to be more "liquid" than vessels and gear. Persons who utilize intermediaries hope to get a better price for their permit by advertising through a broader market, and hope that the additional proceeds will more than compensate for the cost of the intermediary.

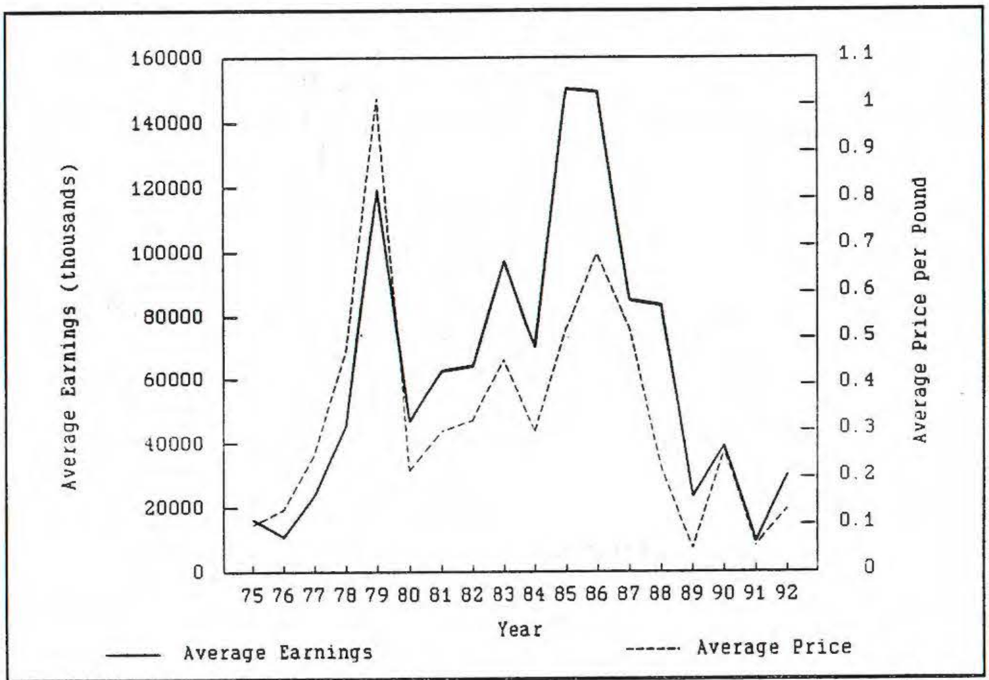

Figure 4. Average gross earnings and average price per pound of sac roe herring for the southeastern Alaska sac roe herring fishery, 1975 - 1992.

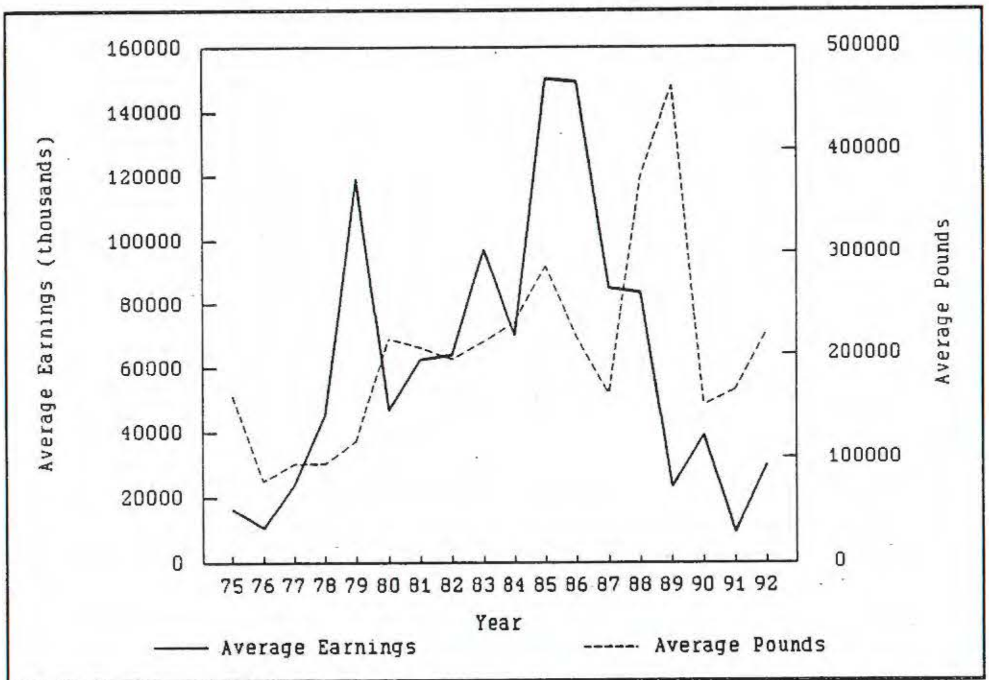

Figure 5. Average gross earnings and average pounds landed by the southeastern Alaska sac roe herring fleet, 1975 - 1992.

The southeastern Alaska roe herring purse seine fishery was limited in 1977. As of year-end 1991, 44 permanent entry permits had been issued in the fishery. Over the 1977-1991 time period, the number of transfers in the fishery on an annual basis roughly averaged 5% of the permits outstanding.[38] Over the 1977-1991 time period a total of only 32 transfers occurred. A mandatory permit transfer survey was implemented in 1980. Over the 1980-1991 time period, the surveys indicate that approximately 76.9% of the transfers were sales transactions.[39]

The thinness of the market and the small number of transactions makes it difficult to put great faith in a particular market transaction or "average" at a point in time. Nevertheless, market values do represent real gambles by buyers and sellers and do provide the only direct information on what individuals were willing to pay for a permit at any point in time.

Table 5 provides time series estimates of the market value of a southeastern Alaska roe herring purse seine permit. These estimates are based on permit transfer information and were especially derived for this report. Because of the small number of transactions, some of these prices had to be extrapolated using combinations of surrounding observations. The data in Table 5 should be regarded as only rough approximations of market values at points in time.

Table 5 also provides estimates of "real" market values where all nominal prices have been converted to 1991 dollars.[40] These permit price estimates show market valuations in nominal dollars tending to rise until after the 1987 season and then declining in the late eighties and early nineties. Measured in 1991 dollars, the real market value of the permit also rose until after the 1987 season and then declined. The current price in constant 1991 dollars is roughly at 1983-1985 levels in real terms.

In summary, the market value of a permit does provide direct evidence of what buyers believe a permit is worth. Nevertheless, there is much uncertainty associated with the fishery and consequently much uncertainty associated with the permit's value at any point in time.

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38 See "Changes in The Distribution Of Alaska's Commercial Fisheries Entry Permits, 1975-1991." Over the same time period, the statewide average for annual turnover of transferable permits was approximately 10%.

39 Twenty of the 26 transfer surveys which were completed over the 1980-1991 time period indicated sales transactions.

40 The conversion to "real" dollars will be dependent upon the price index of deflator utilized. For the data series used in this report the authors chose to utilize the U.S. GDP published in Survey of Current Business, 72-9 (Sept., 1992): p. 44.

Table 5. Estimated market values of Southeastern roe herring permits in nominal and constant-value (1991) dollars. (Rounded to the nearest $5,000) [a]

Last Season Completed	Next Season Upcoming	Est. Nominal Market Value	Est. Real (1991$) Market Value
1977	1978	.	.
1978	1979	.	.
1979	1980	.	.
1980	1981	.	.
1981	1982	$ 165,000	$ 245,000
1982	1983	$ 145,000	$ 205,000
1983	1984	$ 150,000	$ 200,000
1984	1985	$ 175,000	$ 225,000
1985	1986	$ 200,000	$ 250,000
1986	1987	$ 275,000	$ 330,000
1987	1988	$ 440,000	$ 520,000
1988	1989	$ 360,000	$ 410,000
1989	1990	$ 275,000	$ 300,000
1990	1991	$ 255,000	$ 265,000
1991	1992	$ 210,000	$ 210,000
1992	1993	$ 210,000[b]	$ 205,000

[a] Estimates were made using time-weighted price averages. Note that "." represents a missing value, or a year in which no estimate can be made.

[b] As of this writing no permits have been transferred since November 1991, thus the market value estimate has been kept at pre-season levels. This estimate may be too high, as the Dec. 1992 issue of Pacific Fishing lists estimates of the permit's current market value at $170,000.

Indirect Evidence: Time Series Estimates Of Net Returns

As discussed above, permit values provide market measures of the present value of future expected net returns (economic profits) in limited fisheries. Whether or not market values of permits are good predictors of future profits depends upon the accuracy of the expectations of buyers and sellers. Even if a permit's market value is a good predictor of the present value of future expected profits, it may be a poor predictor of actual profits in any particular year.

Expectations about future profits may be partially based upon historical experience and thus may change with each new year of experience. Market values can change quickly if expectations about future profits change quickly. Moreover, either sellers or buyers can easily be wrong about future events given the inherent uncertainties surrounding many aspects of the commercial fishery, some of which were noted previously. Being wrong can mean that you receive an unexpected capital gain or suffer an unexpected capital loss.

As a second approach to examining historical rates of return, the authors combined survey data with other data on the fishery to estimate annual net returns for fishing operations which participated in the fishery. These estimates were then summarized into time series estimates of average costs and net returns over the 1975-1992 time period.

In 1989 the commission's research staff surveyed participants in the southeastern Alaska roe herring purse seine fishery to obtain data on operating costs, investments in fishing equipment, gross earnings, and net returns in the fishery. These surveys were usually conducted with an initial telephone interview followed by a more detailed in-person survey. In some instances there were follow-up telephone interviews or additional meetings with bookkeepers or accountants to collect available data.

Interviewers tried to collect as much data as was readily available on each individual's operation. The amount of data varied by participant, but often included multiple years of settlement sheets and information from schedule C's and depreciation schedules on tax returns. Much information was also obtained directly from the personal interviews, including information on current and past investment in fishing vessels, gear, and electronics.

Despite the time requirements of the survey process, the staff was fortunate to get the cooperation and patient help of many participants. Data were obtained from 34 different individuals and for 217 operation-years.[41] These data were incorporated into data files and merged with other computerized information from permit, licensing, and commercial catch records.

The result of these efforts was an extensive data base on the fishery which allowed the staff to make estimates of historical average rates of economic return in the fishery. In some cases the survey information on an operation could be used directly. Where data were missing, models were derived from the survey data to predict the value of the missing variables. In that fashion, estimates of operating costs and net returns were made for all of the participating operations in a year. Greater detail on the methodology can be found in Appendix II.

a. Definition of Net Return Measures Used In This Report

The net return measures defined for this report are determined partially by the needs of the study and partially by the availability of data. These measures abstract from tax considerations, which can vary widely by fishing operation. Activities in other fisheries, non-fishing activities of the skipper, investments, depreciations schedules, etc. all differ by operation. While tax considerations may be important in the decision-making of every operation, the purposes of this study required concepts which could

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[41] An operation is defined herein as a permit holder / fishery / year combination.

be more readily measured and serve as a reasonable index for comparison purposes across operations.

For this report, three concepts of net returns have been defined and estimated. The first two, the settlement cash flow to the operation and net operating income, are intermediate measures which provide some perspective on how the gross revenues of an operation are distributed and what expenses are involved in the operation. The third measure, economic profits (excluding opportunity costs of the permit), is the theoretical concept which is most relevant for this study. Here, opportunity costs of capital, opportunity costs of labor, and depreciation (costs which may not directly impact cash flows) are taken into consideration. Chart A provides a rough schematic of how these measures are defined and are related.

Chart A
Net Return Definitions

GROSS REVENUES

Minus:
- Shared Expenses
- Basic Crew Share (excluding skipper)
- Specialized Crew Share

SETTLEMENT CASH FLOW TO OPERATION

Minus:
- Unshared Expenses
- Equipment Shares:
  - Vessel Shares
  - Skiff Shares
  - Nets Shares
  - Other Equipment Shares

NET OPERATING INCOME

Minus:
- Opportunity Costs plus Depreciation:
  - Vessel
  - Skiff
  - Nets
  - Pumps
  - Other Equipment
- Opportunity Cost of Skipper's Time

ECONOMIC PROFITS

b. Settlement Cash Flow

"Settlement Cash Flow To The Operation" is intended to provide a measure of what the typical operation has leftover after the distribution of gross earnings has been made at settlement time. In the typical operation the skipper owns the permit, vessel, and gear involved in the operation.[42] At settlement the skipper is responsible for paying the shared expenses (typically food and fuel) and paying the net crewshares (the amount actually paid to the crew which is net of any shared expenses) to the basic and specialized crew.[43]

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[42] While this is the typical operation there are many variations. For example, in some operations the permit holder appears to be crew rather than skipper. In such instances the permit holder receives both a crew share and a permit share from the skipper of the operation. In some cases the skipper will not own the vessel and\or gear, and will need to pay additional shares to the owners of the equipment.

[43] Typically the skipper does take a "crewshare". Nevertheless, that crewshare simply represents another portion of the gross earnings which goes to the skipper\boat owner. For that reason, skipper's crewshare was not subtracted in the "SETTLEMENT CASH FLOW TO OPERATION" measure used herein. However, a measure of the "opportunity cost of the skipper's time" is subtracted when calculating "ECONOMIC PROFITS".

The basic crew has typically averaged 5 to 6 persons including the skipper.[44] Specialized crew would typically be a spotter pilot,[45] although payments to other types of specialized crew do sometimes occur. For example, payments to cooks, tender operator skippers, sonar skiff operators, and others occurred in the sample. With the exception of shared expenses, the other expenses subtracted in settlement cash flow are usually "shares" and hence represent "costs" to the permit holder\skipper which tend to rise and fall directly with gross earnings.[46]

Table 6 provides 1975-1992 time series data on nominal gross earnings and net returns of those who recorded earnings in the fishery.[47] Note that the settlement cash flow to the operation, as defined herein, typically exceeds 50% of the gross earnings from the fishery. In years of low gross earnings, where shared expenses represent a much higher percentage of total gross earnings, settlement cash flow may fall below 50%.

Settlement cash flow tends to vary directly with gross earnings. With the exception of the shared expenses, the other "costs" subtracted from gross earnings are labor shares which tend to vary directly with gross earnings.[48] This direct variation

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[44] A table containing time series estimates of average crew sizes can be found in Appendix II.

[45] In many cases, the pilot was not considered as part of the crew but was seen as a completely independent operator who provided a service to the roe herring fishing operation. Some skippers were concerned about their potential liability if the pilot who was working for them had an accident. For accounting purposes, our definition counts all pilots as specialized crew.

[46] The data suggests some decline in net crewshares to the basic crew as a percentage of gross earnings over time. In part, this appears to be related to the addition of pilots and/or other specialized crew into the share system. A portion of the cost of these additional inputs appears to have been absorbed by the basic crew.

[47] Note that this only includes persons who recorded earnings in the fishery during the year. In some years, some vessels which participated in the fishery failed to record any earnings. Had these operations been included, measures of average gross earnings and net returns would have been somewhat lower than indicated herein.

[48] Labor shares were considered as "costs" in this study from the permit holder\skipper's perspective. The possibility exists that crewmen in the fishery obtained some of the returns associated with limited entry during the early to mid-1980s because the share system has been slow to change. Note that if conditions in the fishery permanently improved, the permit holder\skipper might be expected to alter the terms of the contract so that he would not be "overpaying" for his crew and would be capturing all the benefits of permit ownership.

The authors did find some evidence that the terms of the typical contract tended to change over the decade of the eighties when gross earnings were at relatively high levels. Nevertheless, the changes appear to be small and gradual. This type of gradual adjustment process could be due to a number of factors.

means that settlement cash flow tends to closely parallel the movements in average gross earnings. In nominal terms average gross earnings and settlement cash flow peaked in 1985. Both measures were lowest for the entire time period in 1991.

Table 7 provides the same data on average gross earnings and net returns in "real" or "constant value (1991)" dollars. In real terms, average gross earnings and settlement cash flow peaked in 1979. In the 1989 through 1992 time period, settlement cash flows were at the lowest levels seen since 1975 and 1976.

c. Net Operating Income

The settlement cash flow to the operation does not represent an economic profit to the permit holder\skipper. This is because there are many other costs associated with the operation which are not "shared" with the crew. In the "typical" owner operation, these expenses must be absorbed by the permit holder\skipper\vessel owner.

The second measure of net returns used in this report is "Net Operating Income." It is derived, as defined herein, by subtracting unshared expenses and any equipment shares or lease payments from the settlement cash flow to the operation. Net operating income gives a better picture of what the permit holder\skipper/vessel owner has left over after paying these additional costs.

Many unshared expenses can be absorbed entirely by the permit holder\skipper\vessel owner, including: insurance; maintenance and repairs on vessel, seine skiff, electronics, herring seines, and other gear; supplies; travel and freight; moorage and gear storage; permit fees; licenses and professional dues; and office and telephone expenses. Alternatively, if the skipper does not own the vessel or some of the gear which he is using, the skipper, as head of the operation, will still have to pay a share or lease payment for the relevant equipment.

While net operating income gives a better picture of the return to an operation, it is much more difficult to estimate than the settlement cash flow measure. This is

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One possibility might be that other contracts between skipper and crew, unseen by the authors, were changed resulting in monetary adjustments in other fisheries. In interviews with permit holders, some skippers indicated that they used Sitka to help maintain a full-time professional crew, implying that it would be difficult to keep the crew together for some fisheries without the opportunity at Sitka. This raises the possibility that some crew accept a below opportunity cost share in some fisheries in order to participate at Sitka.

Other possibilities also exist. For example, some crewmen are related to the skipper, or are friends or business partners which may increase the likelihood that a permit holder would pass on some of the rents. Perhaps a more likely possibility is that contracts adjust slowly and gradually simply because of the great uncertainty surrounding future earnings in the fishery.

because fishermen who participate at Sitka are diversified and usually fish in several fisheries during the year. Many of the expenses which they must absorb are of a more "fixed" nature (or come in "lumps") and often allow the operation to participate in several fisheries.

For example, engine maintenance and repair expenses are needed for all vessel activities and would be difficult to precisely associate with any particular fishery. Nevertheless, activities in a particular fishery obviously contribute to the expense. Therefore a method had to be developed to allocate a portion of the annual expense to the southeastern Alaska roe herring purse seine fishery when other information was not available from the sample.[49]

In the estimates contained in Tables 6 and 7, the average allocated portion of the annual expenses in a particular category is presented. The procedures used to make the estimate and allocation can be found in Appendix II. While the procedures are far from perfect, they do provide a means to recognize that a portion of the annual costs associated with the fishing operation result from fishing effort in the southeastern Alaska roe herring purse seine fishery.

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49 In some of the cases in the survey sample, the skipper was able to provide his estimate of what portion of the expense should be assigned to Sitka. This estimate was used whenever it appeared to be reasonable and appropriate.

ıble 6.

verage gross revenues, settlement cash flow, net operating income, and economic profits for the southeastern Alaska sa
ine fishery, 1975 to 1992. Average component costs, shares, and expenses are shown. Averages are for operations
corded earnings. Estimates are in nominal dollars.

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
ımber of Obs	25	36	25	33	48	50	41	50	51	50	5
g. Price \ lb.	.101	.135	.251	.474	1.015	.216	.301	.326	.455	.300	.52
g. Pounds	163,162	78,981	95,575	95,602	117,488	216,827	207,802	196,584	213,691	233,211	287,51
ross Revenues	**16,405**	**10,689**	**24,012**	**45,330**	**119,309**	**46,805**	**62,620**	**64,087**	**97,311**	**70,002**	**150,19**
ɛt Crew Shr	6,119	3,461	9,394	18,418	54,621	19,778	26,696	25,645	41,165	27,654	58,12
ared Expenses	2,200	2,758	2,404	2,739	2,483	2,965	3,127	3,032	2,505	2,388	2,64
ot Share	0	0	0	0	0	66	8	842	1,387	1,168	5,43
ender Share	0	0	0	0	0	0	0	0	0	636	38
ec. Crew Shr	- 0	- 0	- 0	- 0	- 0	- 0	- 0	- 0	- 0	- 189	- 56
ısh Flow	**8,086**	**4,469**	**12,214**	**24,173**	**62,205**	**23,996**	**32,789**	**34,568**	**52,255**	**37,967**	**83,03**
essel Shares	0	34	85	0	319	0	135	189	203	342	90
iff Shares	0	0	0	0	140	79	8	65	233	159	39
ine Shares	338	33	904	421	214	100	90	47	0	66	
her Eqp. Shr	0	0	0	0	0	0	0	0	0	0	
surance	676	1,019	1,525	1,339	1,524	1,645	2,011	2,176	2,232	2,327	2,50
epr. & Maint.	1,194	1,082	2,032	1,840	2,797	1,998	3,108	3,045	3,160	3,065	4,21
shing Gear	929	1,108	1,215	1,450	1,358	1,628	2,480	1,914	1,369	1,674	1,50
rav. & Enter.	130	227	258	205	248	279	286	392	366	354	46
reight & Trans.	178	221	263	260	255	290	328	373	351	321	36
oor & Storage	135	163	198	179	182	206	230	257	244	224	26
usiness Exp.	103	126	164	170	156	195	513	329	324	330	41
nip Stores	225	479	423	417	1,199	793	1,283	1,394	1,381	1,318	1,52
nemployment	283	169	361	527	1,208	648	754	776	1,132	836	1,33
ermit & Lic.	- 115	- 133	- 118	- 231	- 194	- 301	- 261	- 283	- 229	- 360	- 36
et Opr. Income	**3,778**	**-323**	**4,669**	**17,134**	**52,409**	**15,833**	**21,300**	**23,328**	**41,030**	**26,592**	**68,7**
essels Cost	1,028	1,591	2,270	1,576	2,444	4,566	6,186	6,368	5,886	6,922	6,5
kiffs Cost	192	114	149	335	757	921	961	1,440	1,328	1,345	1,3
ets Cost	749	775	1,073	693	1,828	3,931	3,662	3,965	3,340	3,979	3,7
umps Cost	0	0	158	166	220	254	319	233	321	294	2
th. Eqp. Cost	0	0	0	0	0	0	24	50	119	138	2
kipper Oppt.	- 2,284	- 2,428	- 2,595	- 2,799	- 3,040	- 3,328	- 3,662	- 3,890	- 4,048	- 4,224	- 4,3
stimated Profit	**-473**	**-5,230**	**-1576**	**11,566**	**44,121**	**2,833**	**6,487**	**7,383**	**25,989**	**9,691**	**52,1**

Table 6. (con't)

	1986	1987	1988	1989	1990	1991	1992
Number of Obs	50	52	50	51	50	22	48
Avg. Price	.685	.523	.222	.050	.257	.056	.135
Avg. Pounds	217,700	162,170	375,602	463,967	152,170	167,108	223,502
Gross Revenues	**149,151**	**84,763**	**83,366**	**23,170**	**39,107**	**9,358**	**30,084**
Net Crew Shr	56,095	29,897	29,207	7,058	13,642	2,027	10,120
Shared Expenses	2,743	2,728	3,340	3,266	3,409	3,638	3,492
Pilot Share	6,697	3,772	3,877	780	624	0	232
Tender Share	318	189	223	156	147	156	146
Spec. Crew Shr	- 791	- 342	- 1,019	- 477	- 448	- 477	- 447
Cash Flow	82,507	47,835	45,699	11,433	20,838	3,060	15,647
Vessel Shares	0	0	0	0	0	0	0
Skiff Shares	95	147	123	0	0	0	0
Seine Shares	0	0	0	0	0	0	0
Other Eqp. Shr	0	0	345	0	0	0	0
Insurance	2,816	3,016	3,063	3,480	3,501	3,812	3,734
Repr. & Maint.	4,223	4,205	4,513	5,015	4,946	5,471	5,401
Fishing Gear	1,990	1,540	1,873	2,061	2,103	2,418	2,188
Trav. & Enter.	470	494	563	471	477	580	501
Frght & Trans.	393	416	373	471	462	533	492
Moor & Storage	249	280	265	339	338	397	354
Business Exp.	428	463	489	510	525	612	574
Ship Stores	1,588	1,675	1,743	2,216	2,253	2,554	2,326
Unemployment	1,305	858	729	337	456	103	375
Permit & Lic.	- 370	- 366	- 390	- 397	- 400	- 497	- 374
Net Opr. Income	68,579	34,376	31,229	-3,865	5,378	-13,915	-672
Vessels Cost	5,206	6,184	6,098	6,775	6,951	6,969	5,577
Skiffs Cost	1,111	1,110	996	999	1,020	953	837
Nets Cost	3,011	3,091	3,014	3,408	3,477	3,262	2,892
Pumps Cost	352	328	410	362	366	353	330
Oth. Eqp. Cost	240	258	262	280	282	274	261
Skipper Oppt.	- 4,498	- 4,642	- 4,823	- 5,036	- 5,254	- 5,468	- 5,598
Estimated Profit	54,161	18,763	15,626	-20,724	-11,974	-31,194	-16,168

ble 7.

erage gross revenues, settlement cash flow, net operating income, and economic profits for the southeastern Alaska sac ne fishery, 1975 to 1992. Values are expressed in constant (1991) value dollars. [a] *Average component costs, shares, penses are shown. Averages are for operations that recorded earnings.*

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
mber of Obs	25	36	25	33	48	50	41	50	51	50	52
g. Price \ Lb.	.241	.305	.529	.926	1.826	.355	.450	.458	.615	.389	.652
g. Pounds	163,162	78,981	95,575	95,602	117,488	216,827	207,802	196,584	213,691	233,211	287,517
oss Revenues	**39,279**	**24,075**	**50,601**	**88,555**	**214,574**	**76,898**	**93,493**	**90,089**	**131,459**	**90,617**	**187,425**
t Crew Shrs	14,650	7,796	19,797	35,981	98,235	32,494	39,858	36,050	55,610	35,798	72,533
ared Expenses	5,268	6,213	5,065	5,351	4,466	4,872	4,669	4,262	3,384	3,091	3,304
ot Share	0	0	0	0	0	108	11	1,184	1,874	1,511	6,780
nder Share	0	0	0	0	0	0	0	0	0	823	486
ec. Crew Shr	- 0	- 0	- 0	- 0	- 0	- 0	- 0	- 0	- 0	- 244	- 708
sh Flow	**19,361**	**10,067**	**25,739**	**47,224**	**111,873**	**39,424**	**48,955**	**48,594**	**70,592**	**49,149**	**103,615**
ssel Shares	0	76	178	0	573	0	202	266	274	443	1,125
ff Shares	0	0	0	0	253	130	11	91	314	206	488
ne Shares	810	74	1,904	822	384	165	134	67	0	85	0
her Eqp. Shr.	0	0	0	0	0	0	0	0	0	0	0
urance	1,620	2,295	3,213	2,616	2,742	2,703	3,002	3,059	3,016	3,012	3,129
pr. & Maint.	2,859	2,437	4,281	3,595	5,031	3,283	4,641	4,280	4,269	3,967	5,257
hing Gear	2,224	2,495	2,561	2,833	2,443	2,675	3,703	2,691	1,850	2,167	1,883
av. & Enter.	311	510	544	401	447	458	428	550	495	459	583
eight & Trans.	426	498	555	509	459	477	490	525	474	416	453
oor & Storage	323	367	417	350	328	339	344	361	330	290	336
siness Exp.	248	284	345	332	281	320	766	462	438	427	518
ip Stores	540	1,078	892	814	2,157	1,303	1,916	1,960	1,865	1,706	1,909
employment	678	381	761	1,030	2,172	1,065	1,126	1,091	1,529	1,082	1,66
rmit & Lic.	- 276	- 300	- 250	- 451	- 349	- 494	- 390	- 397	- 309	- 466	- 45
t Opr. Income	**9,047**	**-728**	**9,838**	**33,473**	**94,256**	**26,013**	**31,802**	**32,793**	**55,428**	**34,424**	**85,81**
ssels Cost	2,460	3,583	4,784	3,078	4,395	7,501	9,235	8,952	7,951	8,961	8,13
iffs Cost	459	256	313	654	1,361	1,514	1,434	2,024	1,794	1,741	1,67
ts Cost	1,792	1,745	2,261	1,353	3,287	6,458	5,467	5,573	4,512	5,150	4,73
mps Cost	0	0	333	325	395	417	476	327	433	380	31
h. Eqp. Cost	0	0	0	0	0	0	35	71	161	179	37
ipper Oppt.	- 5,468	- 5,468	- 5,468	- 5,468	- 5,468	- 5,468	- 5,468	- 5,468	- 5,468	- 5,468	- 5,46
timated Profit	**-1,133**	**-11,781**	**-3,321**	**22,595**	**79,350**	**4,655**	**9,686**	**10,378**	**35,109**	**12,545**	**65,09**

Table 7. (con't)

	1986	1987	1988	1989	1990	1991	1992
Number of Obs	50	52	50	51	50	22	48
Avg. Price \ Lb.	.833	.616	.252	.054	.267	.056	.131
Avg. Pounds	217,700	162,170	375,602	463,967	152,170	167,108	223,502
Gross Revenues	181,321	99,850	94,519	25,156	40,696	9,358	29,385
Net Crew Shr	68,194	35,219	33,115	7,663	14,196	2,027	9,885
Shared Expenses	3,335	3,214	3,786	3,546	3,547	3,638	3,411
Pilot Share	8,141	4,443	4,396	847	650	0	227
Tender Share	387	222	253	169	153	156	143
Spec. Crew Shr	- 962	- 403	- 1,155	- 518	- 466	- 477	- 437
Cash Flow	100,302	56,350	51,813	12,413	21,684	3,060	15,284
Vessel Shares	0	0	0	0	0	0	0
Skiff Shares	116	173	139	0	0	0	0
Seine Shares	0	0	0	0	0	0	0
Other Eqp. Shr	0	0	391	0	0	0	0
Insurance	3,423	3,553	3,473	3,779	3,643	3,812	3,648
Repr. & Maint.	5,134	4,953	5,117	5,445	5,146	5,471	5,275
Fishing Gear	2,420	1,814	2,123	2,238	2,188	2,418	2,137
Trav. & Enter.	572	582	639	511	497	580	489
Freight & Trans.	477	490	423	512	481	533	481
Moor & Storage	302	329	301	368	351	397	346
Business Exp.	520	545	555	554	546	612	561
Ship Stores	1,931	1,973	1,977	2,405	2,344	2,554	2,272
Unemployment	1,587	1,010	826	366	475	103	366
Permit & Lic.	- 450	- 431	- 442	- 432	- 416	- 497	- 365
Net Opr. Income	83,370	40,495	35,406	-4,196	5,596	-13,915	-657
Vessels Cost	6,329	7,285	6,914	7,355	7,234	6,969	5,448
Skiffs Cost	1,351	1,308	1,129	1,084	1,062	953	818
Nets Cost	3,661	3,641	3,417	3,700	3,619	3,262	2,825
Pumps Cost	427	386	465	393	381	353	322
Oth. Eqp. Cost	292	304	297	304	294	274	255
Skipper Oppt.	- 5,468	- 5,468	- 5,468	- 5,468	- 5,468	- 5,468	- 5,468
Estimated Profit	65,843	22,103	17,716	-22,500	-12,461	-31,194	-15,792

[a] Constant-value (real 1991) dollars are calculated here using the Gross Domestic Product implicit price deflator published in the Survey of Current Business, 72-9 (Sept. 1992): p. 44.

Shares to other "leased" capital involved in the operation were also subtracted in the measure of net operating income. Some permit holders utilized vessels, skiffs, and/or nets belonging to other owners. For these, the actual owner of the equipment was generally paid a share and these shares would appear on settlement sheets.

As the estimates in Table 6 indicate, many of the unshared expenses associated with the fishery appear to have increased in nominal terms over the 1975-1992 time period. This is partially due to general price inflation[50] and partially due to real increases in the amount of capital and labor used in the fishery. The real increase in some of these costs, measured in constant 1991 dollars, can be seen in Table 7. Use of spotter planes, pilots and other specialized crew, and backup vessels were some of the ways that fishermen tried to gain a greater share of the harvest and in the process may have dissipated some of the potential rents from permit ownership by driving up total costs.

Table 8 provides time series estimates on the average value of fishing vessels used in the fishery, and data on other vessel attributes such as age, vessel length, and horsepower. Newer, more valuable, and more complex vessels may lead to higher real expenditures for insurance and maintenance and repairs. Other factors leading to higher repairs and maintenance costs were increased use of electronics in the fishery, redundant\backup electronics, multiple nets, and the use of backup vessels and skiffs.

d. Economic Profits

Economic profits excluding the opportunity cost of the permit appears to be the net return concept which is most consistent with the intent of AS 16.43 and the direction of the Supreme Court in Johns. The present value of the permit theoretically represents the present value of the "above normal profit" stream captured by the marginal permit holder in a limited fishery. If the opportunity cost of the permit were considered in the calculation, the marginal permit holder would be just "breaking even."[51]

As defined herein, economic profits are estimated by subtracting depreciation, the opportunity cost of capital used in the fishery, and the opportunity cost of the skipper\permit holder's time from net operating income. As in the case of most unshared expenses, annual depreciation and the opportunity cost of capital had to be

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50 The U.S. GDP index increased by approximately 145% over the 1975-1992(2nd quarter) time period.

51 While this definition may be consistent with the legislation and consistent with the Court's opinion, it cannot be comforting to permit holders, particularly those who bought into the fishery and have to make large payments on permit loans. From a private perspective, these persons will "break-even" only if they cover all of their costs plus the opportunity cost of the permit.

Table 8. Vessel characteristics for Southeast sac roe seine operations, 1975 - 1992. Both principal and backup vessel characteristics are shown. Backup vessels are boats used for fishing and/or tenders and are part of the operation; i.e. they are either owned by the skipper/operator or the operation pays a share for them to be present during the fishery. [a]

	Principal Vessel					Backup Vessel				
Year	Number of obs Ves #1	Avg. Value Ves #1	Avg. Length Ves #1	Avg. Horsepower Ves #1	Avg. Age Ves #1	Number of obs Ves #2	Avg. Value Ves #2	Avg. Length Ves #2	Avg. Horsepower Ves #2	Avg. Age Ves #2
1975	30	$ 119,535	49	246	22	.	.	.	.	.
1976	38	$ 165,314	49	259	19	.	.	.	.	.
1977	33	$ 186,917	48	244	16	.	.	.	.	.
1978	39	$ 164,606	48	243	19	.	.	.	.	.
1979	48	$ 190,962	48	258	17	1	$ 295,380	49	275	7
1980	53	$ 212,702	48	266	18	2	$ 590,978	58	312	5
1981	41	$ 233,561	47	262	17	2	$ 497,030	58	312	6
1982	51	$ 239,701	48	276	19	1	$ 694,754	67	349	3
1983	51	$ 294,658	49	273	18	1	$ 625,000	67	349	4
1984	50	$ 321,814	50	292	17	3	$ 450,919	56	551	9
1985	52	$ 298,507	49	301	17	3	$ 503,574	55	551	10
1986	50	$ 339,919	51	318	16	3	$ 285,543	48	490	21
1987	52	$ 365,303	49	342	15	5	$ 404,243	51	444	13
1988	51	$ 375,716	49	368	14	3	$ 578,232	58	355	11
1989	51	$ 429,961	50	405	16	9	$ 388,518	50	533	15
1990	51	$ 438,529	50	436	15	3	$ 579,508	57	763	7
1991	51	$ 419,386	49	444	15	2	$ 600,237	50	1295	3
1992	48	$ 429,765	50	461	16	.	.	.	.	.

[a] ADFG registration lists and CFEC surveys document the use of backup vessels. Both sources are incomplete; therefore, this table will under-report the actual number of backup vessels in the fishery.

prorated to apportion an amount to the fishery. The method used to do this is reviewed in Appendix II.

Depreciation was estimated in nominal terms for vessels, skiffs, pumps, and other equipment from sample and ancillary licensing data. Here, the concentration was on the loss of market value due to aging of the equipment. Over the time period covered, depreciation was often offset in nominal terms for vessels and skiffs by an increase in the market value of vessels with time due to general price inflation or other market factors. For nets, continual repairs and maintenance expenditures appeared to offset any depreciation in market value caused by wear and tear and aging.

The opportunity cost of capital was calculated by using a nominal interest rate measure multiplied by the estimated value of the capital. Here, the results could be dependent upon the interest rate chosen.[52] Fishing is typically considered a relatively risky business due to the variation in harvest levels and prices, the absence of clearly defined property rights, and a relatively hazardous work environment with high accident and fatality rates. These factors suggest that the appropriate interest rate should have a substantial risk premium over and above the riskless rate.

The rate used in this study was the average yield on bonds rated BAA by Moody's, the lowest rating for a bond considered "investment grade." Table 9 provides time series data on this rate, the nominal "riskless" rate of return, the inflation rate, the estimated real "riskless" rate of return, and the estimated real "risky" rate of return on BAA bonds.[53] The 3-month Treasury Bill interest rate was chosen as the nominal "riskless" rate of return.

Both depreciation and opportunity costs of capital had to be prorated for the southeastern Alaska roe herring purse seine fishery. Again, this was done by using reduction factors based on fishing time and/or gross earnings. A more thorough description of the reduction factors used can be found in Appendix II. While any such allocation of fixed costs requires rough assumptions, the procedures used herein do treat operations consistently and hopefully provide a reasonable index of average profitability.

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52 The reader should also note that natural variation in the interest rate chosen (both in real and nominal terms) is partially responsible for the variation in costs over the time period.

53 This was comparable to the interest rate initially chosen by Dr. Jon Karpoff in the report "Limited Entry Permit Prices" (CFEC Report 83-6, Juneau, AK. 1983). In that same report, Karpoff estimated the average risk premium over the time period which he examined (1975-1979) as being 5.05% above the 3-month T-bill rate (riskless), implying that the BAA rate might be a low estimate of the appropriate risky rate to be applied to commercial fishing investments and operations. If so, the opportunity costs of capital used in this report might be slightly underestimated and economic profits overestimated.

Table 9. Interest rates and rates of return (percentages), 1975 - 1992.

Year	BAA Bonds (risky)[a]	3-month Treasury (riskless)[a]	Inflation Rate[c]	Real Return (risky)	Real Return (riskless)
1975	10.61	5.84	9.58	0.94	-3.41
1976	9.75	4.99	6.30	3.24	-1.23
1977	8.97	5.27	6.88	1.95	-1.51
1978	9.49	7.22	7.87	1.50	- .60
1979	10.69	10.04	8.62	1.90	1.30
1980	13.67	11.51	9.47	3.84	1.86
1981	16.04	14.03	10.04	5.45	3.62
1982	16.11	10.69	6.21	9.32	4.21
1983	13.55	8.63	4.06	9.12	4.39
1984	14.19	9.58	4.36	9.42	5.00
1985	12.72	7.48	3.74	8.66	3.61
1986	10.39	5.98	2.65	7.54	3.25
1987	10.58	5.82	3.20	7.15	2.54
1988	10.83	6.69	3.90	6.67	2.69
1989	10.18	8.12	4.43	5.51	3.54
1990	10.36	7.51	4.33	5.78	3.05
1991	9.80	5.42	4.06	5.51	1.30
1992[b]	8.46	3.28	2.38	5.94	0.88
Means	11.47	7.67	5.67	5.53	1.92

[a] Source: Economic Report of the President, (Feb. 1992): p. 378
[b] 1992 average interest rates are through July, 1992. Source: Survey of Current Business, (Sept. 1992)
[c] The inflation rate was estimated as: $P_t - (P_{t-1}) / P_{t-1}$
Where: P_t = Gross Domestic Product implicit price deflator in year t
Source: Survey of Current Business, (Sept. 1992)

In calculating the opportunity cost of capital in this fashion, the authors are attempting to take a "longer-term" approach to a fisherman's available opportunities. To break even or make a profit over the longer term, individuals have to be covering all of their costs. Obviously, skippers have a better idea of their opportunities both for the resources they hold and their own labor. Some may well evaluate their opportunity costs differently than estimated herein.

In the short term, fishermen may evaluate their opportunity costs quite differently. Indeed, some fishermen, who have no other earning opportunities during the time of the year in which the fishery occurs may feel that their opportunity cost of participating and using their vessel and gear in the fishery is nearly zero. All fishermen will be looking at their immediate opportunities in any season. Survey data indicate that many fishermen have sablefish or crab as an alternative fishery during this time period, while others are trying to participate in a series of herring fisheries.

In the short term, these types of opportunity costs will have an impact on who will participate at Sitka and what equipment they will use. For example, in one year a fishermen may have an available back-up boat, while in another year the boat is participating in the sablefish fishery.

The opportunity cost of a skipper's time is another cost which could vary widely from permit holder to permit holder. During the survey process, some skippers were asked what they would be doing during the time of the roe herring fishery if they were not participating. Some skippers mentioned other fisheries like the Gulf of Alaska sablefish fishery or the southeastern Alaska brown king crab and Tanner crab fisheries. Some skippers mentioned preparing for other fisheries or working on their boat and gear. Others would be doing nothing or would be engaged in their off-season endeavors.

For purposes of this study, the authors decided that the survey data were inadequate to assign different opportunity costs to different skipper/permit holders. Instead, all skippers were assigned an opportunity cost of time equal to $5,468 in 1991 dollars. (The "nominal dollar" reports herein convert the "real dollar" figure to the "nominal dollars" of the year in question).

The $5,468 figure is the mid-point of two months of the average monthly wage in Alaska during 1991[54] and the average crew share in the fishery (in 1991 dollars) during 1988, which was the last year of positive economic profits.[55] This figure may underestimate the opportunity cost of time for some permit holders and overestimate it for others. In using the figure for all skippers the authors hope that it comes reasonably close to the actual "average" opportunity cost of time.

Again, Table 6 provides time series estimates of nominal annual average economic profits over the 1975-1992 time period and Table 7 provides the same estimates in "real" or constant 1991 dollars. Again, the reader should be aware that these are only "estimates" and great importance should not be placed on any particular number. The authors hope that the estimates provide a "reasonable index" of the profitability of the fishery over the time period.

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[54] Personal communication with Jo Donner, Alaska Department of Labor. Preliminary figures for the Quarterly Employment & Earnings Report - 4th Quarter 1991 indicate the average monthly wage estimate for "Nonagricultural Wage and Salary Employment" in Alaska during 1991 is $2,540. Two months of average wages would then be $5,080.

[55] A rough calculation of the net crewshare during 1988 (in constant-value 1991 dollars) is obtained by dividing the average (real) net crewshare by the average crew size as follows: $33,115 / 5.655 crew = $5,856.

Comparison of Permit Values With Economic Profit Estimates

Table 10 provides a summary time series on estimated permit market values and estimated average profits per fishing operation. As previously noted, both time series are estimates and both series must be viewed with some caution. Nevertheless, the numbers are interesting for comparative purposes. For example, are the rough estimates of permit market values (based on market transactions) consistent with the estimates of economic profits in the report?

As previously discussed, the permit's market value, in theory, should represent the present value of the future expected economic profits to the marginal permit holder. Of course, individuals may vary in how they form expectations about future profits, and this variation may be considerable because of the great uncertainties surrounding both the herring stocks and herring prices. Nevertheless, it is likely that future expectations are at least partially based upon past history.

Table 10. Estimated market values of Southeastern roe herring permits in nominal and constant-value (1991) dollars (rounded to the nearest $5,000) and estimated nominal and real average profits per operation.

Last Season Completed	Next Season Upcoming	Est. Nominal Market Value	Est. Real (1991$) Market Value	Est. Nominal Average Profit per Operation	Est. Real Average Profit per Operation
1977	1978	.	.	$ -1,576	$ -3,321
1978	1979	.	.	$ 11,566	$ 22,595
1979	1980	.	.	$ 44,121	$ 79,350
1980	1981	.	.	$ 2,833	$ 4,655
1981	1982	$ 165,000	$ 245,000	$ 6,487	$ 9,686
1982	1983	$ 145,000	$ 205,000	$ 7,383	$ 10,378
1983	1984	$ 150,000	$ 200,000	$ 25,989	$ 35,109
1984	1985	$ 175,000	$ 225,000	$ 9,691	$ 12,545
1985	1986	$ 200,000	$ 250,000	$ 52,167	$ 65,099
1986	1987	$ 275,000	$ 330,000	$ 54,161	$ 65,843
1987	1988	$ 440,000	$ 520,000	$ 18,763	$ 22,103
1988	1989	$ 360,000	$ 410,000	$ 15,626	$ 17,716
1989	1990	$ 275,000	$ 300,000	$ -20,724	$ -22,500
1990	1991	$ 255,000	$ 265,000	$ -11,974	$ -12,461
1991	1992	$ 210,000	$ 210,000	$ -31,194	$ -31,194
1992	1993	$ 210,000	$ 205,000	$ -16,168	$ -15,792

Table 11 below provides estimates of "implied" permit values assuming that expectations of future earnings are based entirely on the average real economic profits for the given time period. These "expectations" are discounted by the average real "risky" interest rate (assumed to be the yield on BAA bonds) prevailing over the time period.[56] The "implied" permit value is then compared to the permit's market value estimate at the end of the time period to see if the numbers are roughly comparable.[57]

The data suggest that estimates of "actual" market values (in 1991 dollars) prevailing[58] at the end of each season very roughly track the implied market values that would prevail if persons were forming their expectation of future earnings entirely on the basis of estimated average historical profits for the different time periods (periods that include the most recent season completed).

For example, the market value at the end of the 1992 season is approximately \$210,000 (1991 dollars).[59] "Implied" market values at the end of 1992 based on estimates of average historical profits (real 1991) range from \$282,026 to \$182,128 depending upon the time period utilized. Both the actual market values and the implied market values based on historical profits demonstrate falling permit valuations from the late 1980s through the present.

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[56] The "implied" permit values in the table were calculated as the present value of future expected earnings, where those future expectations were based upon the estimated historical average profits for the indicated time period. The present value was calculated simply by using the formula for an annuity as follows:

$$PV = E(\text{profits}) / E(r)$$

Where: PV = the present value of the permit (in real 1991 dollars)
E(profits) = the expected future profits (set equal to the average real profits over the historical time period)
E(r) = the expected future real risky interest rate (set equal to the average real risky interest rate over the historical time period).

[57] Note that this is a crude comparative test, as we do not know how buyers and sellers actually form their expectations about the future. The authors feel that past history does play an important role in the formation of future expectations, but empirically modelling the process, in this fishery, is difficult because few observations (and degrees of freedom) are available due to the short history of the fishery. Obviously, forecasts for the upcoming season (or longer) could also play a role in the formation of future expectations.

[58] Recall that the market values for each time period have been estimated using available data on market transactions.

[59] The December 1992 issue of Pacific Fishing estimated an average value for a southeastern Alaska roe herring purse seine permit at \$170,000 1992 dollars (approximately \$166,053 1991 dollars).

Table 11. Comparison of "Implied" and "Actual" permit values using different assumptions about future expectations (estimates in real 1991 dollars).

Historical Time Period	Real Estimated Average Profits[a]	BAA Average Real Risky Interest Rate	Real "Implied" Market Value	"Actual" End-Of-Period Real Market Value
1975-1987	$ 23,933	.0539	$ 444,026	$ 520,000
1978-1987	$ 32,736	.0639	$ 512,300	$ 520,000
1982-1987	$ 35,180	.0854	$ 411,944	$ 520,000
1975-1988	$ 23,489	.0548	$ 428,631	$ 410,000
1978-1988	$ 31,371	.0642	$ 488,645	$ 410,000
1982-1988	$ 32,685	.0827	$ 395,224	$ 410,000
1975-1989	$ 20,423	.0548	$ 372,682	$ 300,000
1978-1989	$ 26,882	.0634	$ 424,006	$ 300,000
1982-1989	$ 25,787	.0792	$ 325,593	$ 300,000
1975-1990	$ 18,368	.0550	$ 333,964	$ 265,000
1978-1990	$ 23,855	.0630	$ 378,651	$ 265,000
1982-1990	$ 21,537	.0769	$ 280,065	$ 265,000
1975-1991	$ 15,452	.0550	$ 280,945	$ 210,000
1978-1991	$ 19,923	.0624	$ 319,279	$ 210,000
1982-1991	$ 16,264	.0747	$ 217,724	$ 210,000
1975-1992	$ 13,717	.0552	$ 248,496	$ 205,000
1978-1992	$ 17,542	.0622	$ 282,026	$ 205,000
1982-1992	$ 13,350	.0733	$ 182,128	$ 205,000

[a] These averages were calculated by summing the estimates of real average profits in each year of the time period and dividing by the number of years in the time period. This weights the years equally irrespective of the number of operations making earnings. Different average profit measures would result from alternative procedures.

While both the "actual" permit values and the permit values "implied" if future expectations were based on historical average profits (for a particular time period) decline over the 1987-1992 time period, the implied values tend to be higher than the actual market values. Exceptions occur in 1987, which followed two years of very high profits, and in 1992, which follows several years of negative profits.[60] While such

[60] Note that 1992 would not be an exception if Pacific Fishing's Dec. 1992 market value estimate were utilized.

discrepancies aren't surprising given the nature of the estimates, there could be several possible explanations for the differences. The following are a few examples:

1. Future expectations may not be based upon simple averages of past profits. Simple averages "weight" each observation equally. While expectations of future profits may be based upon historical experience, some empirical models of expectation formation suggest that more recent historical experience tends to be weighted more heavily than data from the more distant past. For example, Karpoff modeled expected profits (rents) partially as a function of estimated profits in past years and empirically found that one-half of the "weights" assigned to past profits occurred in the most recent 2.56 years.[61]

   According to the economic profit estimates made in this report, 1987 through 1992 was a time period of low or negative economic profits. It is likely that if expectations of future profits were based upon "weighted" averages (where the more recent experience is weighted more heavily) rather than simple averages, the "weighted averages" for the time period would tend to be lower and the resulting "implied" permit values more in-line with actual market values.

2. Permit values, in theory, represent the valuations of marginal permit holders and not the valuations of average permit holders. A marginal permit holder may not expect to do as well as average with respect to profits and would value the permit at the (lower) profit levels which he does expect.[62] Thus implied permit values based upon average earnings may tend to overstate the value of a permit to a marginal permit holder.

3. Average gross earnings and economic profits estimated herein are based upon persons who actually recorded landings. In some years, some permit holders did not participate, or they participated and failed to harvest marketable catch. The year 1991 is a good example. If such persons were included in the analysis, average economic profits and "implied" permit value estimates would be lower.

4. It is possible that average economic profits are slightly overestimated herein, because of other factors. For example, this could occur if the opportunity cost of a skipper's time or the relevant risky discount rate have been

61 See Karpoff, "Limited Entry Permit Prices," (1983). Under his specification "weights" assigned to an observation were smaller the farther the observation was back into the past. Karpoff's analysis was done with combined cross section and time series data that used observations across many limited fisheries.

62 A marginal permit holder does not necessarily imply a poor fisherman. A marginal permit holder could be a consistent highliner who has high opportunity costs for his capital and labor. Because of these costs, the permit holder's economic profits are lower.

underestimated.[63] As noted above, the authors hope that the estimates contained herein represent a reasonable index of economic profits. Nevertheless, the absolute level of economic profits should be viewed with caution for all of the reasons previously discussed.

5. Expectations of future economic profits may only be partially based upon past experience. Other sources of future forecasts may also have an influence in expectation formation. For example, a credible forecast of a long-term downturn in roe herring prices might significantly impact expectations of future economic profits.

6. Given the paucity of observations on actual permit values, a market value in any particular year could represent the "mistakes" of particular buyers and sellers. Thus the average market price may be based upon overly optimistic or overly pessimistic expectations at any point in time.[64] This is more likely to occur in a "thin" market with very few actual transactions.

In summary, estimated "actual" permit market values and "implied" permit values based upon simple averages of estimated past profits were both trending downward over the 1987 through 1992 time period. This suggests that expectations about future economic profits in the fishery are at least partially based upon past profit histories in the fishery. The authors feel that the time series estimates of economic profits represent a reasonable index of profitability over time in the fishery. Moreover, estimated "actual" market values look fairly reasonable given estimated historical economic profits and considering the uncertainties surrounding future earnings in the fishery.

Estimated Rates of Return on a G01A Entry Permit

Another way to view rates of return in the fishery is to examine the percentage rate of return on the entry permit from period to period. Table 12 presents such estimates assuming that the permit holder fishes and earns the average economic profits (as estimated) during the time period and also obtains the estimated capital loss

63 A higher interest rate would lower both economic profits and the resulting estimated "implied" market value. A higher interest rate would lead to higher estimates of the opportunity cost of capital and it would lead to heavier discounting of the future expected profit stream.

64 In an uncertain world, over-optimism or over-pessimism can only be identified after the fact.

or gain associated with the permit for the time period.[65] The estimated economic profits, permit values, and rates of return in the table are all stated in nominal terms.[66]

Again, the numbers in the tables are only estimates and should be viewed with caution for all the reasons previously stated. Nevertheless, to the extent that the numbers are accurate they again show the wide annual variation in returns for a permit holder in the fishery. Over the time period observed, the rates of return appear to have been more variable than those observed on common stocks.

Table 12. Estimated one-period rates of return on a southeastern Alaska roe herring purse seine permit; 1982-1992 (nominal dollars and nominal rates of return).

Year	Economic Profits	Permit Value Before Season	Permit Value After Season	Capital Gain	Rate of Return
1982	$ 7,383	$ 165,000	$ 145,000	$ -20,000	-.0765
1983	$ 25,989	$ 145,000	$ 150,000	$ 5,000	.2137
1984	$ 9,691	$ 150,000	$ 175,000	$ 25,000	.2313
1985	$ 52,167	$ 175,000	$ 200,000	$ 25,000	.441
1986	$ 54,161	$ 200,000	$ 275,000	$ 75,000	.6458
1987	$ 18,763	$ 275,000	$ 440,000	$ 165,000	.6682
1988	$ 15,626	$ 440,000	$ 360,000	$ -80,000	-.1463
1989	$ -20,724	$ 360,000	$ 275,000	$ -85,000	-.2937
1990	$ -11,974	$ 275,000	$ 255,000	$ -20,000	-.1163
1991	$ -31,194	$ 255,000	$ 210,000	$ -45,000	-.2988
1992	$ -16,168	$ 210,000	$ 210,000	$ 0	-.077

Rates of return on holding and using the permit were very high over the 1983 through 1987 time period, ranging from 21.4% to 66.8%. The highest percentage return occurred in 1987 and was largely due to a big jump in permit value following

65 The one-period rate of return calculated herein is simply as follows:

$$r_f = (EP + CG)/ PB$$

where :

r_f = the one-period rate of return in the fishery
EP = Economic Profits During The Season
CG = Capital Gain or Loss on the Permit (PA-PB)
PB = Market Price of the Permit Before The Season
PA = Market Price of the Permit After The Season

66 These estimates have been restricted to the 1982-1992 time period because of a paucity market information prior to 1982.

the 1987 season. This was likely due to the large harvest anticipated in 1988. While harvests were large in 1988 and 1989 (peaking in 1989) prices plummeted due to roe quality (reaching approximately $100/ton in 1989). Profitability and permit values also plummeted resulting in negative rates of return on the permit over the 1988 through 1992 time period.

Rates of return over different time periods varied for holders of southeastern Alaska roe herring purse seine permits Table 13 below shows both arithmetic mean and geometric mean rates[67] of return on the permit over two different time periods, 1982-1988 and 1982-1992. The table also contains similar estimates on multi-period rates of return on BAA bonds.

The multi-period estimates again support the contention that returns on the entry permit were very good over the 1982-1988 time period. The nominal geometric return on the entry permit was approximately 24.6% compared to 12.6% on BAA bonds. However, over the longer 1982-1992 time period, the nominal geometric return on the entry permit was only 5.9% compared to an 11.5% return on BAA bonds.[68]

Table 13. Multi-period rates of return on a southeastern Alaska roe herring purse seine entry permit (nominal rates).

Time Period	Entry Permit Arithmatic Mean Rate	Entry Permit Geometric Mean Rate	BAA Bonds Arithmetic Mean Rate	BAA Bonds Geometric Mean Rate
1982-1988	.2825	.2460	.1262	.1261
1982-1992	.1083	.0592	.1111	.1154

Over the 1982-1992 time period, many alternative investments would have achieved a higher nominal rate of return than a southeastern Alaska roe herring limited entry permit.

67 The geometric mean rate of return may be a more realistic measure of the multi-period rate of return, particularly with dramatic swings in the asset's value over the time interval. Note that these rates of return measures are inaccurate to the extent that the economic profits during any particular time period are not being reinvested into something which conveys a similar stream of returns.

68 These tables have been estimated using nominal rates of return. If real rates of return are examined, similar contrasts emerge.

In summary, whether or not an investment in a southeastern Alaska roe herring purse seine permit looks "good" or "bad" depends on when it was purchased, the purchase price, and the holding period. Initial issuees are often the main beneficiaries of a limitation. In a "certain" world initial issuees would capture all of the benefits of limitation, and those who "buy in" to the fishery would be just "breaking even" after paying fair market value for the permit. In an uncertain world, those who "buy in" to a fishery may gain or lose depending upon the ultimate accuracy of their future expectations.

Reasonable Rate of Economic Return

In review, optimum number Standard One under AS 16.43.290 (1) reads as follows:

> *(1) the number of entry permits sufficient to maintain an economically healthy fishery that will result in a reasonable average rate of economic return to the fishermen participating in the fishery, considering time fished and necessary investments in vessel and gear;*

where "economically healthy fishery" is defined in AS 16.43.990 as follows:

> *(2) "economically healthy fishery" means a fishery that yields a sufficient rate of economic return to the fishermen participation in it to provide for, among other things, the following:*
>
> > *(A) maintenance of vessel and gear in satisfactory and safe operating condition; and*
> >
> > *(B) ability and opportunity to improve vessels, gears, and fishing techniques, including when permissible, experimentation with new vessels, new gear, and new techniques.*

A "reasonable" rate of return is not an expression defined by economic theory or AS 16.43. As noted in Chapter I, Owers appeared to be trying to define "reasonable" as a rate of return which would cover all costs including the opportunity cost of a permit holder's time and the opportunity cost of the permit. The irony of such a definition is that, in theory, this is the same rate of return (economic profits) which would be earned by the marginal permit holder in the absence of limited entry.

Owers tried to define a rate of return (economic profits) which covered the opportunity cost of the entry permit. The problem with Owers' approach is that the solution with respect to the optimum number of permits is not unique once the opportunity cost of the permit is considered. Increasing future expected economic profits by reducing gear levels will lead to a commensurate increase in both the market value of the permit and its opportunity cost. From a private perspective, once the "opportunity cost of the permit" is taken into consideration, the average rate of return (economic profits) would be approximately the same irrespective of the number of units in the fishery.

From a social perspective, limited entry increases the economic benefits from the fishery basically by lowering the total cost of harvesting the available surplus and by helping to contain the cost to the State of Alaska of managing the commercial harvest. Limited entry may also increase the economic benefits from a fishery if it allows for controlled harvests which otherwise would not occur. Limited entry may also help to stabilize a fishery and the communities that depend upon it. It removes one major source of uncertainty about economic profitability for participants and removes a source of uncertainty for fishery managers. As such, limited entry serves both conservation and economic stabilization objectives.

Nevertheless, the main beneficiaries of the program are the initial issuees. Any gains from limitation are captured in limited entry permit values which increase the wealth of the holders. As noted above, in a certain world initial issuees would be able to capture all of the wealth from limitation.[69] In such a world, persons who "buy in" to the limited fishery would just be "breaking even" after paying the fair market value for the permit.[70]

Thus Alaska's limited entry program may relieve "economic distress" for initial issuees but may not necessarily provide relief to subsequent purchasers of permits. If an unexpected improvement in profitability occurs after a permit purchase, then the purchaser will also receive gains. However, if unexpected declines in profitability occur the purchaser will suffer losses.[71]

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[69] Initial issuees can pass the wealth on to others through gifts or bequests. Such transfers of wealth occur frequently under Alaska's limited entry program.

[70] In an uncertain world, persons who purchase a permit could achieve real gains, real losses, or "break-even" depending upon the accuracy of their future expectations.

[71] After limited entry, profitability conditions in most fisheries have tended to improve over the late seventies and 1980s. This is mostly due to improvements in fish stocks and to some extent prices. Many of these improved conditions were unanticipated, consequently, most purchasers of limited entry permits also received gains from limited entry over the time period (the value of their permits grew beyond what they paid). However, if profitability conditions change unexpectedly downward (which may have occurred in some fisheries recently), those who purchased permits at high prices could suffer capital losses and be in "negative equity" situations. This occurred in some fisheries in 1991, as the prices

In Johns the Supreme Court may have been thinking only of initial issuees when it stated:

> *Without this mechanism* (referring to optimum numbers), *limited entry has the potential to be a system which has the effect of creating an exclusive fishery to ensure the wealth of the permit holders and permit values, while exceeding the constitutional purposes of limited entry.*

Increasing the number of units of gear in the fishery will lower permit values. While this will hurt all current permit holders, persons who paid high prices for their permits may be put into a particularly difficult position as average economic profits are lowered. For such persons, increasing the number of permits may indeed result in severe "economic distress."

Nevertheless, the Supreme Court appears to be thinking that there are levels of economic profits (excluding the opportunity costs of the permit) and permit values which are reasonable and levels of economic profits which are not. In theory, the permit's value can be driven to zero by adding participants and at a price of zero the number of participants will be roughly the same as would have been in the fishery under open access.

If the opportunity cost of the permit is ignored, it seems clear that over most of the historical time period since limitation, the southeastern Alaska roe herring purse seine fishery has been an "economically healthy fishery" under the definition provided in AS 16.43.990. Data have been presented which support the contention that vessels, gear, and electronics have all been upgraded over the time period. Moreover, wider use of herring pumps, backup vessels and gear, and spotter pilots has all resulted in increased fishing capacity over the time period. Thus ignoring the opportunity cost of the permit, the number of existing entry permits has been sufficiently low to result in an average rate of economic return over most of the time period which is at least "reasonable." Nevertheless, the Supreme Court appears to be concerned that the return may be higher than appropritate.

Chapter IV presents the results of a bioeconomic simulation model of the southeastern Alaska roe herring fishery. This model explores future economic returns in the fishery and how the present value of average economic profits will vary as the number of entry permits is changed. As such, the model will provide a rough indication of how the number of entry permits will impact permit values.

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of permits in several fisheries plummeted after poor seasons.

Summary

This chapter has reviewed estimates of historical economic profits, explored the impact of profits on permit values, and provided estimates of rates of return on a permit due to economic profits and capital gains and losses. In theory the value of a permit at any point in time is related directly to future expected economic profits. The data also suggest that future expectations are at least partially based upon past economic profits, and that historically permit values have changed as the economic profit picture for the fishery has changed. Ignoring the opportunity cost of the permit, the rate of economic return in the fishery appears to have been at least "reasonable" over most of the historical time period since limitation.

CHAPTER IV

FORECASTING FUTURE RETURNS: THE BIOECONOMIC SIMULATION MODEL

CHAPTER IV

Forecasting Future Returns: The Bio-economic Simulation Model

Economic optimum numbers

The economic criterion for optimum numbers is

> *the number of entry permits sufficient to maintain an economically healthy fishery that will result in a reasonable average rate of economic return to the fishermen participating in that fishery, considering time fished and necessary investments in vessel and gear. (AS 16.43.290(1))*

An economically healthy fishery

> *yields a sufficient rate of economic return to the fishermen participating in it to provide for, among other things, ... maintenance of vessels and gear in satisfactory operating condition; and ... ability and opportunity to improve vessels, gear, and fishing techniques, including, when permissible, experimentation with new vessels, new gear, and new techniques. (AS 16.43.990(2))*

As noted in Chapter III, in the past commission researchers have understood the reasonable average rate of economic return to be an absolute amount of real dollars which would cover or exceed the costs of an operation. This understanding is followed here, although the ultimate focus is on the present value of future net returns and a comparison of the present values associated with different numbers of permits.[72]

The estimates of the present values of future net returns have been made using a computer simulation model of the fishery. The model integrates what is known about the fishery into a coherent biological and economic picture of events. The model generates estimates of annual average net returns in the fishery. If the model is run for a sequence of 30 years the average net returns from all years are summarized by their present value at the start of the period.

If assumptions underlying the model are changed the present value will change. Thus, if the number of permits is assumed to change from 50 to 25 or to 75, the present value of the returns from the fishery to the average permit holder will change. The number of permits is of especial interest since this is the policy we are studying. It is also possible to change other assumptions; in this study particular attention is paid to the

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[72] The net return measure used in this chapter is the economic profit measure defined in Chapter III.

impacts of alternative assumptions about the U.S.-Japanese exchange rate and about the recruitment of new fish to the fish stock.

Biologists do not yet know much about the relationship between the parent stock and recruitment in this fishery, or about the impact of the environment on the number of recruits. Therefore recruitment is modeled, in part, as a random process. Since recruitment is partly random, recruitment patterns will be different each time a simulation is run. Because of this, the present values reported in this chapter are averages of the present values calculated from a large number of separate simulations.

Brief description of the model

The model follows each age cohort of fish through its life cycle. Fish are recruited at age three. In one version of the simulation recruitment is chosen at random so as to reflect the distribution of recruitment from 1971 to 1992; alternative simulations reflect the high recruitment since 1978 and the low recruitment of the early to mid seventies.[73] Each year the number of fish in the cohort gets smaller as some fish are harvested and others die of natural causes. Each year the weight of the average fish in a cohort increases as the fish age and grow. The final cohort is an age class of nine year old and older fish.

Although fish are assumed to be recruited to the population at age three, not all fish of all age classes are assumed to appear in Sitka and enter the spawning population. Twenty-four percent of the three year olds are assumed to do so, seventy percent of the four year olds, ninety-five percent of the five year olds, and almost all fish aged six and over.[74]

Each year the total weight of the fish available to the gear in all of the cohorts is the total fishable biomass of the stock. The harvest quota set by fishery managers in any year depends on the spawning biomass left following the harvest in the previous year. The actual harvest in a year is equal to the harvest quota plus or minus a deviation. The deviations are chosen at random from the distribution of percentage deviations observed since 1980.

Each year the total gross revenue earned by all fishermen is equal to the product

[73] An alternative recruitment model, in which recruitment depended on stock size in earlier years was also tried. While this model was promising, tests indicated that the simulation did not perform well when it was included. Harvests tended to be larger than historical harvests. The random models included here tended to reproduce historical harvests better. In addition, while the authors believe that recruitment is related to stock size, large random factors make it difficult to empirically identify the relationship. This issue is discussed in more detail in Appendix I.

[74] These assumptions are based on a personal communication from Dave Carlile of the ADFG. Details on these, and other assumptions, may be found in the appendix.

of the total weight of fish actually harvested and an ex-vessel price of fish. The ex-vessel price depends on the estimated average percent roe content of fish in the harvest, and on exchange rates and inventories.[75] The percent roe content depends on the average weight of the fish in the harvest. Average gross revenues are determined by dividing total gross revenues by the number of permits in the fishery. Revenues (and the costs discussed below) are all given in real, 1991, dollars.

The average net returns in each year are equal to the average gross revenues minus estimates of average operating costs. The average operating costs are equal to an average fixed cost of $33,440, and an average variable cost equal to about 47% of average gross revenues.

The most important output of the model is the average present value of net returns from the simulations conducted for each number of permits. Thus, for a given set of assumptions, such as a strong yen and high recruitment, 500 simulations are run for 25, 50, 75, and 100 permits. For each simulation the present value of net returns is calculated, and for each level of permits the average of the present values generated in the 500 simulations is also calculated. The average present values for different numbers of permits are then compared. The sensitivity of the results to changes in the assumptions can be examined by doing additional simulations with new assumptions.

The present value of net returns is calculated over 30 years using a real discount rate of 6% per year.[76] Present value is a means of comparing the values of different time patterns of income. A person will value $100,000 more if it will all be received now than if $25,000 were to be received now and $75,000 were to be received in three years. In present value calculations income received later is discounted more heavily than income received earlier.

Details on the use of random numbers

Recruitment and the annual aggregate harvest are both impacted by random processes. It is important to know how random numbers are used in the model in order to understand the model results.

The computer program used in the simulation contains a command that will generate a number between zero and one on request. These numbers are generated in such a way that they can be interpreted as being chosen at random. This "random number generator" has to be primed by being given a number called a "seed." The generator is primed with the seed at the start of the program, and will produce an apparently random number every time the program calls for it afterwards. These

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[75] Except in 1991, the base year for the simulation, when the historical price was used.

[76] 6% is an estimated real rate of interest for investments of similar risk. See Appendix I for details.

the yen strengthened to its current levels in 1986.[79] Exchange rate levels and recruitment levels from the recent past are shown in the figures on the previous page.

These assumptions in the simulation produced the following results:

Table 14. Mean present values of economic profits for 4 levels of permits and 3 revenue assumptions. 500 simulations were run at each permit level and revenue assumption. Revenue assumptions are based on different herring recruitment levels and US dollar/Japanese yen real exchange rates.

Number of permits	Low revenues	Baseline	High revenues
25	$-264,513	$ 878,216	$ 2,018,297
50	$-376,213	$ 195,151	$ 765,191
75	$-413,447	$ -32,537	$ 347,490
100	$-432,063	$-146,381	$ 138,639

Random number seed = 38425.32

The numbers are most comparable within a column. Within a column the only assumption that changes is the number of permits; the sequence of random numbers, the exchange rate assumption, and the assumption about recruitment levels are all unchanged. Between columns the assumptions about the levels of the exchange rate, and the levels of recruitment are different.

Net returns are negative for all permit levels under the low revenue assumptions and for 75 and 100 permits under the baseline assumptions. All net returns are positive under the high revenue assumptions and for 25 and 50 permits under the baseline assumptions. The average present value is about $195,000 with 50 permits under the baseline assumptions. If the high revenue assumptions turn out to be correct, a permit level between 75 and 100 permits would generate about the present value of net revenues associated with the 50 permit level under the baseline assumptions.

The figures reported in the tables are present values of time streams of future net returns, not the annual net returns themselves. If net returns per year increased by $10,000 during the 30 year life of the simulation, the present value of those net returns, evaluated with a six percent discount rate, would rise by about $146,000.

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79 Under the strong yen assumption it takes 100 yen to buy a dollar (in 1991 currencies). Under the moderate yen assumption it takes 134 yen to buy a dollar, and under the weak yen assumption it takes 184 yen to buy a dollar.

Simulation results under alternative assumptions

The sequence of random numbers used to calculate the average present value for each number of permits was the same. That sequence depended on the choice of an initial seed for the random number generator. A different seed would have produced a different sequence of random numbers and a different mean present value for each set of simulations.

To show the difference made in the results by the choice of a seed, the model has been run for alternative seeds.[80] The results are summarized below in Tables 15 and 16. The results in the low revenue column are essentially unchanged. The baseline results and the high revenue results also seem to be similar across all the simulations.

The low revenue present values may change little because recruitment at the levels observed in the seventies coupled with the Department of Fish and Game sliding scale system for determining harvest quotas leads to no harvest in many years.[81] This simulation result is consistent with Department of Fish and Game staff comments reported in Chapter V. That chapter reports that the Department has indicated the herring population level has fallen below the minimum spawning population threshold about 25% of the time in the 28 years ending in 1991, and was below that level from 1974 to 1978.

Harvests occur in less than half the years under the low recruitment assumption. In an experiment, the 30 year simulation was run 50 times using the low recruitment assumption. This produced 1,500 different estimates of annual harvest. In 933 of these simulated years, the harvest was zero. Even this understates the number of zero harvests under the low recruitment assumptions, since in many years with positive harvests, the harvests depended on recruitment in years before the simulated recruitment began.[82]

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[80] The seeds were not deliberately picked, but were generated by the computer's internal clock when the first runs were made for the construction of each table. The set of simulations with the intermediate baseline case results was put in Table 14.

[81] Historically there were harvests at low population levels in the seventies because the current sliding scale was not yet in effect.

[82] In this simulation all assumptions other than the recruitment assumption were from the baseline model. The random number seed was 38425.32.

Distribution of present values

The average present values provide information on the results of the simulations, however, an evaluation of the results of the simulation also depends on information about the nature of the spread of the simulation results around the average value.

Figure 8 on the next page summarizes the present values for 500 simulations run with 50 permits separately under the low revenue, baseline (or intermediate revenue), and high revenue assumptions. The random number seed used was 38425.32. These are distributions of some results summarized in Table 14.

The 500 baseline present values are distributed from the area of -\$250,000 to about \$750,000. They have a strong central tendency and a mean value of about \$195,000. The 500 low revenue present values have a very different distribution. They are heavily concentrated, and all fall in the range from -\$350,000 to -\$450,000. The mean value from these simulations was about -\$376,000. They are much less variable than the present values produced under the baseline or high revenue assumptions. The 500 high revenue present values are distributed from the area of \$50,000 to about \$1,750,000. Their mean value is about \$765,000.

The low revenue present values may be concentrated because, as noted earlier, under the low revenue assumptions, reflecting recruitment levels in the seventies, spawning populations are relatively small. With the small populations the model often sets the annual harvest at zero (this model uses the current Department of Fish and Game sliding scale and its threshold). The large number of annual harvests set to zero in all the simulations reduces the variation in the net returns among simulations.

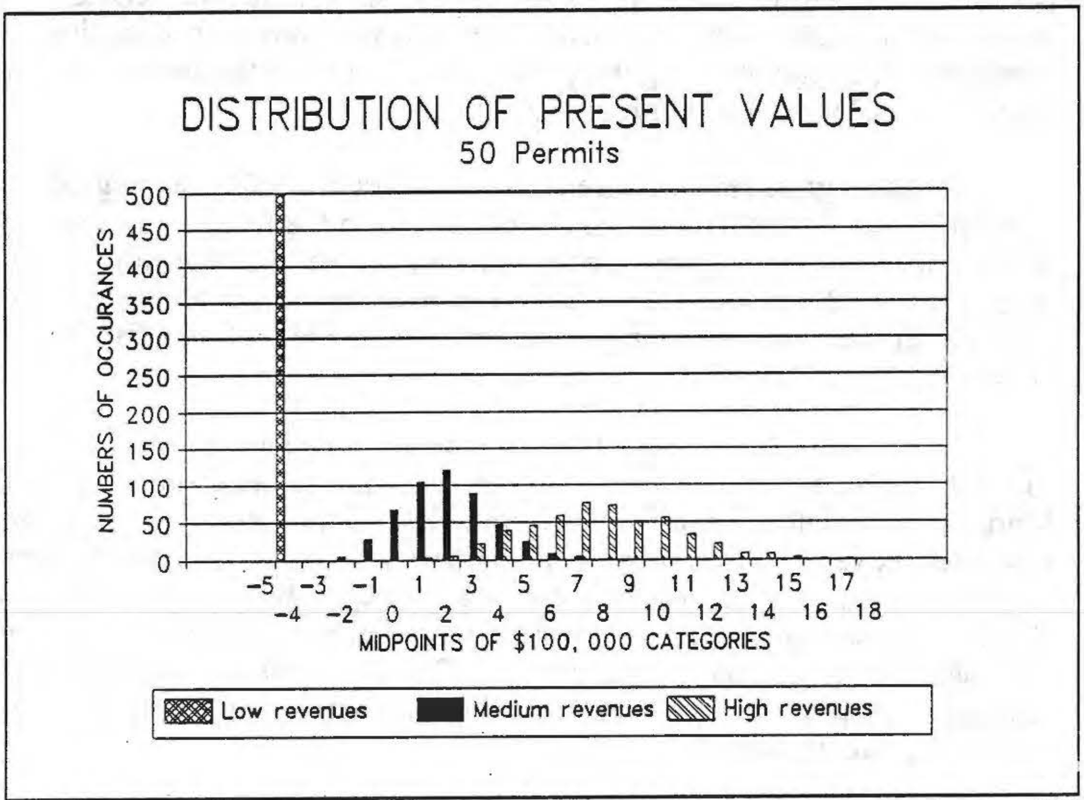

Figure 8. Distribution of present values from revenue assumptions. 500 simulations for each assumption. Random number seed was 38425.32.

Behavior of the model

The model appears to simulate the biology of the fish stock and the harvest of a certain amount of fish of a given weight and roe content fairly well. The simulated weight of the total annual harvest, the simulated average annual weight of a fish in the harvest, and the simulated average percentage roe content of the fish in the harvest, were all compared to actual historical values. These three variables were studied because they are important output variables which summarize the impacts of a large number of other variables working inside the model; they are "bottom line" variables for the biological and production models.

To test the biological and production components of the simulation the model was altered to allow it to run for 1,000 years using the baseline assumptions. The baseline assumptions included recruitment patterns reflecting recruitment from 1971 to 1992. This simulation produced an average total annual harvest equal to 3,879 metric tons. The actual annual harvest from 1971 to 1992 was 3,670 metric tons. The simulation also produced an average annual average fish weight equal to 0.238 pounds, while the actual average annual average fish weight for the period was 0.227 pounds.

Average percentage roe content figures are only available for the high recruitment period from 1978 to 1992. Thus, to test the simulation's roe content estimates, the model was run for 1,000 years using the high recruitment assumption. The average percentage roe content during this period was 10.45 while the average annual roe content from the 1,000 year simulation was 10.69.

Average gross revenues are equal to the product of the aggregate harvest and the ex-vessel price divided by the number of permits in the fishery. The aggregate harvests generated by the model have been discussed above, and the number of permits are determined by the model operator. The ex-vessel price is determined in the model, and depends in part on the average percent roe content of the fish in the harvest as generated by the model.

The ex-vessel price model was used to simulate annual prices for Sitka from 1978 to 1992 (excluding 1979, which wasn't used in the model estimation) based on actual historical values for the exogenous variables. The actual historical prices and the simulated ex-vessel prices were then compared. The average percentage error of the simulated price was 1.5 percent and the average absolute percentage error of the simulated price was 51 percent. These numbers suggest that the price model is relatively unbiased, but that it has a large variance. The large absolute errors were due to three relatively large percentage errors that occurred in 1990, 1991, and 1992 when the historical price was small.

Simulation results and permit prices

In theory when permit markets are in equilibrium a permit price will equal the value placed on the permit by the marginal permit holder or permit holders. That is, it will just equal the value placed on it by the permit holder or holders who just find it worth their while to continue to hold the permit.

The value placed on the permit by the marginal permit holder will be equal to the present value of the difference between the benefits and costs expected from holding the permit (expected net returns). Benefits and costs should be understood in the largest sense. They include the revenues expected from fishing the permit and the costs expected from continuing to hold the permit and go fishing. They may also include the values of less tangible advantages and disadvantages from holding the permit to the extent that such values exist. For example, in a small fishing community possession of a permit might confer status, and this status might be valued. If so, people would be willing to accept a lower cash revenue from the permit in exchange for the status it provides.

If some fishermen in a fishery are better than others, the average present value of net returns will be higher than the present value of net returns accruing to the marginal fisherman. This is because the returns to the marginal fisherman will be returns to the person who just finds it worthwhile to remain in the fishery while the average returns will include returns to better fishermen as well as returns to the person who just finds it worthwhile to continue. Since the permit price reflects the returns to the marginal permit holder, the average present value from the simulation should be above the permit price to the extent that there is diversity among the fishermen.

Chapter III indicated that the estimated price for this permit in 1991 was $210,000 and the estimated price in 1992 was $205,000 (both prices in 1991 dollars). The actual market value for these permits is unclear since there aren't many market transactions, and since the value estimates lag the market.[83] The 1992 estimate used in the report represents transactions which occurred prior to the 1991 season, as no transactions have occurred since that time. Hence the estimate may not reflect current market conditions. The simulated present value estimates are above the price of $170,000 reported in the December, 1992, issue of *Pacific Fishing* (Dec, 1992, dollars). As discussed, the simulation results would theoretically be expected to be equal to or above the market price.

[83] See Chapter III for a more extensive discussion of permit prices in this fishery.

CHAPTER V

MANAGEMENT OPTIMUM NUMBERS UNDER STANDARD TWO

CHAPTER V

Management Optimum Numbers Under Standard Two

Introduction

The second optimum number general standard under AS 16.43.290 (2) reads as follows:

> *(2) the number of entry permits necessary to harvest the allowable commercial take of the fishery resource during all years in an orderly, efficient manner, and consistent with sound fishery management techniques;*

This standard is concerned with resource conservation and appears to bring the concepts of manageability, orderliness (safety), and efficiency into the optimum number determination. "Sound fishery management techniques" are necessarily interconnected with the need for resource conservation. Optimum number Standard Two most closely addresses the conservation purpose of the limited entry amendment to Alaska's constitution.[84]

The precise meaning of Standard Two may be arguable. Previous commission understandings of the standard were briefly discussed in Chapter I. Martin reported that the commission understood Standard Two to be the "Management Optimum Number." The management optimum number was defined as a range of values.

This report builds upon the earlier commission understandings of the standard to "bound" the management optimum number within a range of values. Care has been taken to make sure that concepts used herein comport with the purposes of limited entry cited in the law and in the limited entry amendment to Alaska's constitution.

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[84] The purpose of limited entry act is stated in AS 16.43.010 (a) as follows:

> It is the purpose of this chapter to promote the conservation and the sustained yield management of Alaska's fishery resource and the economic health and stability of commercial fishing in Alaska by regulating and controlling entry into the commercial fisheries in the public interest and without unjust discrimination.

It is clear that the statute is intended to serve the conservation need cited in the limited entry amendment to Alaska's constitution. Promoting the "economic health and stability of commercial fishing" and an "economically healthy fishery" are the means by which the statute attempts to prevent economic distress among fishermen.

To derive values under this standard, CFEC staff relied heavily upon the expertise of ADFG and its fishery managers. It was felt that those charged with the responsibility of successfully managing a safe and orderly commercial fishery for resource conservation would best be able to outline the nature of the management problems which they face.

To accomplish this, CFEC staff interviewed ADFG managers about the southeastern Alaska roe herring purse seine fishery, southeastern Alaska herring stocks, conservation issues, safety (orderliness) issues, and management concerns and strategies. A formal set of questions was also sent to Commissioner Carl Rosier of the Alaska Department of Fish and Game. The questions and ADFG answers can be found in memoranda in Appendix III of this report.[85]

Questions about future harvest levels were often very difficult, if not impossible, to answer definitively due to the inherent uncertainties involved with this particular fishery and with herring fisheries in general. Nevertheless, to address the optimum number question, we needed the opinions of managers even if scientific evidence was poor or lacking. Because of this, many of the answers we received should be viewed as the "professional judgements" of those charged with the management tasks.

The commission's task is ultimately to produce a single optimum number which strikes a "reasonable balance" among the three standards. This chapter reviews materials related to Standard Two and provides a range of estimates for optimum numbers under the standard.

Concepts Used in This Report to Evaluate Standard Two

Following earlier CFEC research, two different concepts were used in this report to help "bound" the management optimum number under Standard Two. These two concepts also appear to bound the possible range of readings of the statutory standard.

Under current regulations, the southeastern Alaska roe herring purse seine fishery could occur in both Sitka and the Lower Lynn Canal area. A Lower Lynn Canal fishery has not occurred since 1982 because of the depressed stocks in the area. Nevertheless, the potential for a fishery in either or both areas and the range of possible quotas within both areas makes the selection of a "single" appropriate management optimum number a more difficult exercise.

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85 The questions are contained in a June 7, 1991 memorandum from Kurt Schelle, CFEC's Manager of Research and Planning to Carl Rosier, the Commissioner of ADFG. Mr. Rosier's responses are contained in a July 23, 1991 memorandum. These memoranda should be read together.

A number which might not pose a serious management or conservation threat under one set of conditions might pose major problems under another set of conditions. For this reason, the two concepts used to bracket the management optimum number question were asked for a range of quota values in both areas.

a. Concept Number One

The first concept was one close to "economic efficiency" as viewed in simple textbook models of limited entry in a common property fishery. In short, this concept is concerned with how many fishing operations are actually needed to harvest all of the available resource in all years in an orderly, efficient manner, and consistent with sound fishery management techniques.

This concept is roughly comparable to the lower bound of the range defined by Martin as "the minimum number of units of gear adequate to harvest the highest runs anticipated in the next ten years."[86] In this report, the authors were interested in the relationship between the size of the quota and the number of units of gear actually needed to harvest the resource. For that reason this question was asked for a range of quota sizes and for both the Juneau and Sitka fisheries.

b. Concept Number Two

The second concept utilized herein was concerned with how many units of gear the Department could reasonably manage and control, given available resources and their existing regulatory authority, without creating a serious risk of a substantial overharvest or a substantial underharvest. These numbers were expected to be higher than the numbers under the first concept.

This conception of Standard Two is similar to the upper bound defined by Martin as "the maximum number of units of gear that can be effectively managed during the low run years." Again, in the interviews we learned that the number of permit holders which could be reasonably handled was somewhat related to the size of the available quota or the remaining quota. For that reason, we asked the question for a range of quota values and for both the Lower Lynn Canal and Sitka fisheries.

Southeastern Alaska Herring Stocks:

Both concepts of the management optimum number question depend to some extent on the size of the stocks and the concomitant quota for the fishery. As a successful roe herring fishery must occur within a relatively short time period

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[86] See Chapter 1 and "Optimum Numbers" by John Martin (1979a).

immediately before spawning when the roe is ripe, a larger harvest quota may mean that more units of gear are needed if all of the available surplus is to be taken while the product is of premium quality. Similarly, ADFG's ability to manage the fishery in a safe orderly manner without a substantial overharvest or underharvest may depend upon such factors as the size of the remaining quota and the number of units of gear in the fishery.

In the course of this project, CFEC staff asked the Department of Fish and Game a number of questions about herring stocks in southeastern Alaska.[87] Herring stocks in the Sitka area were generally at higher levels during the decade of the 1980s relative to the decade of the 1970s while the herring stocks in the Lower Lynn Canal area collapsed to a low level. Nevertheless, the increase in the Sitka herring stocks was sufficient to contribute to improved earnings during most of the 1980s which, in turn, contributed to the rise in the permit's value.[88]

As optimum numbers under the statutes may be related to the size of the stock and earnings, the expected size of the harvest in the future is an important factor to consider. Will the higher stock levels observed in Sitka during the eighties continue into the future, will the stock levels grow even larger, or will stocks fluctuate upward and downward in a fashion comparable to historical experiences? Are southeastern Alaska stocks experiencing a long-term recovery from the reduction fishery? Will the Lower Lynn Canal stock recover and become substantially larger than historically observed ranges?

The Department's answers suggest that it is currently impossible to forecast the future course of herring abundance over the next twenty years with any degree of precision. The Department indicated that southeastern Alaska herring populations, like herring populations throughout the world, are subject to large annual variations in recruitment levels (probably due largely to unknown natural factors). In Sitka they note that variation in recruitment has caused variation in stock sizes of four to sixfold.[89]

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[87] Some of these questions were asked in informal interviews with ADFG staff. A formal set of questions was also sent to Commissioner Rosier and the Department provided answers in a memorandum. See questions 1 through 6 attached to the June 7, 1991 memorandum in Appendix III from Kurt Schelle to Carl Rosier and the answers to those questions in Commissioner Rosier's July 23, 1991 memorandum.

[88] As noted in Chapter III, the lower "real" prices over the 1988-92 time period contributed to the insignificant correlation between average pounds and average real net earnings over the 1975-1992 time period.

[89] See answers to herring stock questions 2 and 3 in Commissioner Rosier's 7/23/91 memorandum.

The Department indicated that the historical herring catch data and regulatory structure suggests that overharvest of herring stocks probably occurred during the years of the reduction fishery. They note that the peak catches which occurred in the 1920s and 1930s probably could not be sustained over time. Given current market conditions and the ADFG's current managerial approach, they would expect annual herring catches from all of southeastern Alaska to range from 4,000 to 40,000 tons over the next 20 years. This is roughly the historical range of southeastern Alaska harvest levels observed over the past 30 years.[90]

a. Sitka Stocks

In Sitka, the Department indicated that the decade of the eighties was one of very high abundance of herring, while the decades of the sixties and seventies represented lower abundance. ADFG estimates of <u>total</u> herring biomass in Sitka since 1964 range from 5.7 million pounds (2,850 tons) to 136.1 million pounds (68,050 tons). The highest estimated spawning biomass over the entire history of the fishery was 117.3 million pounds (58,650 tons) following the 1988 season.[91]

The Department felt that it was possible that over the next twenty years Sitka Sound stock levels could rise above those seen in the eighties. However, given the historical record, the Department felt that it was unlikely. Given the historical biomass estimates, their current management strategy, and historical harvest levels (since 1969), they expect that future Sitka harvests will tend to fall into the range of 0 to 12,000 tons in the future.

The subjective probability that no harvest will be allowed in some seasons over the next 20 years is significant. The current management strategy for Sitka requires a minimum spawning population threshold of 15 million pounds (7,500 tons) before a harvest is allowed.[92] ADFG noted that the herring population level has fallen below the minimum spawning population threshold in 7 of the 28 years (25% of the time) over the 1964-1991 time period. The population was believed to be below that level during the entire period from 1974 through 1978 and "it is quite probable that such a pattern could be repeated in the future."[93]

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90 See answer to herring stock question 1 in Commissioner Rosier's 7/23/91 memorandum.

91 See Chapter II.

92 The current management plan has been described earlier in Chapter II. At the minimum spawning population threshold (7,500 tons) a 10% harvest would be allowed (750 tons).

93 See answer to question 4b on Sitka herring stocks in Commissioner Rosier's 7/23/91 memorandum.

The Department did not want to forecast an average catch for Sitka over the next 20 years. To make an estimate for CFEC they pointed to the 1969-1991 harvest average of 3,329 tons.[94]

Table 18. Sitka area roe herring purse seine landings for permit holders who recorded earnings; 1969 to 1992

Year	Permit Holders w/Earnings	Total Pounds Landed	Total Tons Landed	Average Pounds Landed	Average Tons Landed
1969	4	1,146,000	573	286,500	143.3
1970	4	1,486,000	743	371,500	185.8
1971	3	1,492,784	746	497,595	248.8
1972	6	1,176,224	588	196,037	98.0
1973	7	1,228,575	614	175,511	87.8
1974	22	1,334,352	667	60,652	30.3
1975	22	2,967,717	1,484	134,896	67.4
1976	33	1,589,400	795	48,164	24.1
1977	0	0	0	0	0
1978	11	467,824	234	42,529	21.3
1979	48	5,102,176	2,551	106,295	53.1
1980	50	8,889,594	4,445	177,792	88.9
1981	41	7,012,438	3,506	171,035	85.5
1982	50	8,726,644	4,363	174,533	87.3
1983	51	10,898,237	5,449	213,691	106.8
1984	50	11,660,530	5,830	233,211	116.6
1985	52	14,950,868	7,475	287,517	143.7
1986	50	10,884,990	5,442	217,700	108.9
1987	52	8,432,824	4,216	162,170	81.1
1988	50	18,780,098	9,390	375,602	187.8
1989	51	23,662,340	11,831	463,967	232.0
1990	50	7,608,484	3,804	152,170	76.1
1991	22	3,676,382	1,838	167,108	83.6
1992	48	10,728,087	5,364	223,502	111.8

Based upon the Department's answers, these authors recommend that CFEC evaluate optimum number Standard Two using a safe and realistic forecast of the magnitude of Sitka stocks and harvests over the next twenty years. While it is possible that the highs in the eighties could be exceeded, there is no evidence to support such

94 See answer to question 4e on Sitka herring stocks in Commissioner Rosier's July 23, 1991 memorandum.

a forecast.[95] Based upon the Department's answers, we feel a realistic forecast should be something within the range of historical experience. This suggests harvests will usually fall within the range of 0 and 12,000 tons.

Given the historical average which the Department provided, this report assumes, for management optimum number purposes, that a "typical" Sitka harvest will fall in the 3,000 to 3,500 ton range (6 to 7 million pounds). Harvest levels were below that range during the decade of the seventies and in 1991. The Sitka harvest was consistently above the range during the decade of the eighties.

b. Lower Lynn Canal Stocks

Under current regulations, the southeast Alaska roe herring purse seine fishery can also occur in the Lower Lynn Canal Area. A roe herring fishery occurred in the area from 1972 through 1982 although harvests were always less than 1,000 tons. By Board of Fisheries regulation, the fishery has been exclusively a purse seine fishery since 1980.

The last Lower Lynn Canal fishery occurred in 1982. In that year, for the first time, herring found in Gastineau Channel were included in the hydroacoustic estimate of pre-spawning biomass. Including the fish found in Gastineau Channel put the total estimate at 8,000,000 pounds, which was the minimum spawning biomass threshold at the time; consequently, an 800,000 pound (400 ton) quota fishery was held. The actual harvest was 1,102,453 pounds (551.3 tons), or 38% over the quota.[96]

Following the fishery only 2.7 linear miles of spawn were observed. This provided first indications that the actual pre-spawning population had been much smaller than the threshold. Post-fishery spawn deposition surveys combined with catch data indicated a pre-spawning population of only 3,803,000 pounds rather than the 8,000,000 pounds estimated prior to the fishery.[97] ADFG notes that they

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95 Recall that 1991 was the worst year in terms of gross earnings in the fishery over the entire 1975-1992 time period. The Department only allowed a fishery when the participants agreed to a cooperative fishery with egalitarian shares. Only 35 permit holders chose to stay and participate in the fishery, the others found it more profitable to move on to another alternative. Of the 35 who stayed, 22 made landings. The others never found fish that the processors would buy.

96 The 400 ton quota was actually split into a 350 ton quota for the. roe herring seine purse seine fishery and a 50 ton quota for a bait pound fishery. The purse seine harvest of 551.3 tons was a 58% overharvest of the purse seine quota.

97 The Juneau area management biologist has indicated that spawn coverage typically is not as thick as it is in Sitka, and that 500,000 to 1,000,000 pounds of herring per mile-of-spawn "rules-of-thumb" might be overly optimistic in some years for the Lower Lynn Canal fishery.

overestimated the abundance of herring in 1982 and if they had accurately known the pre-spawning biomass they would not have allowed a fishery.[98]

Following the 1982 fishery, the stocks did not recover to a level which would allow for a commercial harvest. As a result, ADFG raised the minimum spawning herring threshold level for a commercial harvest from 8,000,000 pounds (4,000 tons) to 10,000,000 pounds (5,000 tons). The stocks still did not recover.

In 1985, ADFG management biologist Don Ingledue wrote a memorandum to Paul Larson, the management coordinator, about the status of the stocks in which he stated the following:

> *The present extreme low herring spawning population level in the Juneau area will make it difficult for the population to return to normal levels without extremely strong recruitment. The chance of this happening to a degree which will restore the population to normal size in the near future is very small. At the present spawning population size, it will take many years with good year class recruitment to return to a healthy level.*
>
> *The Juneau area herring threshold should be maintained at 10 million pounds considering that the previous 8 million pound threshold did not adequately protect the population from dropping to this present critically low level.*

From 1982 through 1992, a recovery of the stocks has not occurred. The Department is not particularly encouraged about stock recovery in the near future. They note that the miles-of-spawn observed over the 1970 through 1982 period averaged 9.6 miles. In contrast, the observed miles-of-spawn over the 1983 through 1992 time period has averaged only 4.3 miles. The Department has no data to indicate that the Lower Lynn Canal stocks will return to the former level of abundance in the next couple of years.[99]

The Department indicated that overharvest of a fishery resource can cause a serious long-term reduction of the sustained yield of a stock. However, the Department is uncertain to what extent fishing mortality and/or environmental factors

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98 See answer to herring stock question 5a in Commissioner Rosier's July 23, 1991 memorandum.

99 See answers to herring stock questions 5b through 5e in Commissioner Rosier's July 23, 1991 memorandum.

caused the Lower Lynn Canal stocks to decline and remain depressed. They indicate that the limited spawn in recent years suggests that a recovery to a threshold level may take a long time.

Table 19. Juneau\Lynn Canal area roe herring purse seine landings for permit holders who recorded earnings; 1971 to 1982

Year	Permit Holders w/Earnings	Total Pounds Landed	Total Tons Landed	Average Pounds Landed	Average Tons Landed
1971	0	0	0	0	0
1972	2	185,950	93	92,975	46.5
1973	9	1,336,335	668	148,482	74.2
1974	18	573,368	287	31,854	15.9
1975	13	1,111,324	556	85,486	42.7
1976	15	865,069	433	57,671	28.8
1977	6	1,418,836	709	236,473	118.2
1978	6	1,205,073	603	200,846	100.4
1979	0	0	0	0	0
1980	20	1,951,765	976	97,588	48.8
1981	16	1,507,453	754	94,216	47.1
1982	21	1,102,580	551	52,504	26.3

The Department again noted that they have no way of judging future trends in the Lower Lynn Canal fishery, except to view the historical record. Over the 1975-1991 time period they have observed from 2.5 to 15.9 miles of spawn. Over the 1972 through 1991 time frame, harvests ranged from 0 to 976 tons and averaged 579 tons in the years when fishing occurred.[100] In 1983, the minimum spawning population threshold was raised from 4,000 tons (8,000,000 pounds) to 5,000 tons (10,000,000 pounds). It is likely that the fishery will be opened less often in the future given the new minimum spawning population threshold.

Herring Management and Resource Conservation

One of the primary purposes of management is to conserve the resources managed. Resource conservation is also a primary purpose of the limited entry act

100 See answer to herring stock question 5f in Commissioner Rosier's July 23, 1991 memorandum. CFEC data indicate a 562.9 ton average.

and the constitutional amendment to Alaska's constitution which allows for limited entry.

Gordon Harrison, in his book Alaska's Constitution - A Citizen's Guide, indicates that the authors of Article VIII (the natural resources article) understood conservation in the traditional sense of "wise use."[101] This concept of conservation grew out of the of the ideas of Gifford Pinchot and the conservation movement which Pinchot helped lead in the early part of the twentieth century.[102]

Wise utilization through the prevention of waste appears to be embedded in Pinchot's concept of conservation. Pinchot was at least conceptually thinking that yields on renewable resources could be sustained through time by wise and careful use. In Pinchot's words:

> *The first duty of the human race on the material side is to control the use of the earth and all that therein is. Conservation means the wise use of the earth and its resources for the lasting good of men. Conservation is the foresighted utilization, preservation, and/or renewal of forests, waters, lands, and minerals, for the greatest good of the greatest number for the longest time.*
>
> *Since Conservation has become a household word, it has come to mean many things to many men. To me it means, everywhere and always, that the public good comes first.*
>
> *To the use of the natural resources, renewable or nonrenewable, each generation has the first right. Nevertheless no generation can be allowed needlessly to damage or reduce the general wealth or welfare by the way it uses or misuses any natural resource.*[103]

Many definitions of conserve and conservation used today continue to parallel the "wise use" concepts of Pinchot. Some common definitions used for "conserve" are

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101 See Harrison, page 71.

102 Harrison attributed the origin of the "wise use" concept to Pinchot and the conservation movement in a conversation with Kurt Schelle in November 1992.

103 See Part 13, Chapter 90 of Breaking New Ground by Gifford Pinchot, original copyright 1947.

"to keep from being damaged, lost, or wasted"[104] and "to keep in a safe and sound state; esp; to avoid wasteful or destructive use of <conserve natural resources>."[105] Thus definitions of "conserve" with respect to natural resources continue to incorporate several concepts, including prevention of waste and avoiding damage or permanent loss.

Definitions of conservation often include these same concepts. A common definition of conservation is "[t]he controlled use and systematic protection of natural resources, such as forests and waterways."[106] Another common definition is "the wise utilization of a natural product esp. by a manufacturer so as to prevent waste and insure future use of resources that have been depleted."[107] Thus definitions of conservation also point to the concepts of wise (controlled) use, through prevention of waste, and avoidance of the loss of the resources.

Prevention of waste is one of the concepts embedded in several definitions of conservation. There are many definitions of "waste" and "wasteful." For example, a common definition of waste, as a noun, is "the act or action of wasting: useless or profitless consumption or expenditure: loss without equivalent gain <this present era of efficiency ought. . . to avoid the waste of ability -C.H.Grandgent> <waste of time> <waste of money>." Other definitions of waste point to disuse of an available resource such as "an instance of wasting <thought it was economic waste to have a car sitting in the garage all day long -M.M.Musselman>." One definition of "wasteful" is "expending or tending to expend something valuable in a useless or extravagant manner."[108]

"Waste" or "Wasting," as a verb, has similar meanings. Common synonyms are "squander," "dissipate," or "fritter." Inefficient use is cited in some definitions such as "to allow to be used inefficiently or become dissipated or lost <heat wasted in the process>." A similar definition is "to spend or use needlessly, carelessly, or without valuable result: consume or employ to no purpose: SQUANDER <~ money> <~time> <~effort> <~sympathy>." Some definitions of waste point to the failure

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104 See Webster's New World Dictionary of The American Language. (The World Publishing Company, 1957).

105 See Webster's Ninth New Collegiate Dictionary, (Merriam-Webster, Inc., 1986).

106 See The American Heritage Dictionary, Second College Edition. (Houghton Mifflin Company. Boston, 1985).

107 See page 483 of Webster's Third New International Dictionary of The English Language -- Unabridged. (G. & C. Merriam Company, 1968).

108 Definitions in this paragraph were taken from Webster's Third New International Dictionary Of The English Language -- Unabridged. (G.&C. Merriam Company, 1968)

to use something valuable, such as "to let pass without taking advantage of <waste a golden opportunity>."[109]

Resource conservation is a primary purpose of fisheries management. As seen above, definitions of conservation contain several interrelated concepts. For purposes of this report, "conservation" will be defined to mean "the wise and controlled utilization of the herring stocks to prevent waste, avoid substantial overharvests which can damage the productivity of the resource, and preserve the stocks for the future." "Waste" will be defined to include "failure to harvest all or substantial portions of the available roe herring surplus," and "failure to harvest the roe herring resource when it is in its most valuable state."[110]

The authors think that this definition of conservation is consistent with both the limited entry statutes and Alaska's constitution. Moreover, the definitions appear to comport with the major concerns which fishery managers must face when attempting to manage a successful roe herring fishery for resource conservation.

Management of the Southeastern Alaska Sac Roe Seine Fishery

Chapter II reviewed the development of the southeastern Alaska roe herring purse seine fishery, the evolution of the regulations governing the fishery, and the current regulations and management strategy. As roe herring became the most valued use of the resource, it became important to harvest the product when it was at premium value, so that the resource wouldn't be wasted as a lower-valued or unsalable product.

Other conservation concerns surround the management of roe herring fisheries. As redundant fishing capacity increases and the quota or remaining quota decrease, two risks may increase. The first risk is that a substantial overharvest may occur if a harvest is allowed. The second risk is that the (remaining) available surplus will need

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109 All definitions in this paragraph were taken from Webster's Third New International Dictionary Of The English Language -- Unabridged. (G.&C. Merriam Company, 1968).

110 The waste associated with overharvest may be more important than the waste associated with not being able to harvest an available surplus or not being able to harvest the surplus when it is most valuable. However, both types of waste are pertinent to a conservation concept of wise use to achieve sustained yields. As the number of operations in the southeastern Alaska roe herring fishery increases, the risk of not being able to control the fishery may also increase. This may add to the risk of an overharvest should a fishery be allowed and also increase the risk that the fishery cannot be allowed and the available surplus (or portions of it) will have to be foregone. In parallel fashion, these conservation risks may be reduced with fewer units of gear in the fishery if use by fewer units can be more easily controlled.

to be foregone if a harvest is not allowed.[111] Both risks may increase as the number of fishing operations or fishing permits increase.

The original limitation of the southeastern Alaska roe herring purse seine fishery in 1977 was based primarily upon the Department's very real concerns about conserving the resource in the face of increasing effort in a short intense fishery. The potential for overharvest was present because of the fishing capacity of the boats that were present, and because of the vulnerability of the herring when they are concentrated and moving into shallow water to spawn. The potential for substantial "waste" was also present because of the way the fishery needed to be managed, and because a harvest might not be allowed if it could not be adequately controlled.

The following sections examine management issues and the question of management optimum numbers in both the Sitka and Lower Lynn Canal fisheries.

a. Sitka Fishery

The original concerns about conservation and manageability of the southeastern Alaska roe herring purse seine fishery were raised for the Sitka fishery. In an October 19, 1976 memorandum from David Cantillon (then an Area Biologist with ADFG) to Carl Rosier (then Director of the Division of Commercial Fisheries), Mr. Cantillon addressed the problems of managing the roe herring purse seine fishery in Sitka.[112] He recommended a maximum number (optimum number) of 25 boats[113] to "insure control of the herring openings." In one paragraph Cantillon stated the following:

> *In 1976 a record high of 41 purse seiners participated in the roe herring openings. Special care was taken to open the fishery when herring availability was limited by the depth the schools were at or the scattering of the schools along the shore. Control was maintained but some luck was involved because with 41 vessels fishing many sets are always in progress and if herring suddenly become readily available there is no way managers could do any more than close the fishery*

111 An available surplus cannot be entirely "banked" or carried over completely intact from one year to another due to the natural mortality rates on this relatively short-lived species. "Banking" arguments are usually applied to longer-lived species with lower mortality rates.

112 A copy of the memorandum can be found in Appendix III.

113 At the time of his memorandum, Cantillon thought that this would mean approximately 30 permits could be issued. This was likely due to the fact that, at the time, a small fraction of limited entry permit holders would not fish in a given year. As the fisheries became more valuable, this fraction has been reduced. In most years since 1980, all of the available permits in the southeastern Alaska roe herring purse seine fishery have been fished. 1991 was a notable exception.

and tally up the take. This is pretty much what happened in Sitka during the 1975 opening. The efficiency of the individual units of gear has increased tenfold with experience and the use of more sophisticated recorders and side looking sonar. To insure control of the roe herring openings I would recommend that a permit level be set that would allow a maximum of 25 boats to participate at any opening. This would probably mean about thirty permits could be issued.

Cantillon was concerned about the number of permits which the commission was considering for limited entry purposes. He went on to say:

If all past participants or all who have made landings in the last three years are given permits we might as well hang it up as 50-60 permits would be out. If this occurred a lottery system or some other method of limiting the number of units of gear at each opening would have to be considered. If we go on without limited entry there will be some large overruns of the harvest levels which will cancel what support we have for the fishery and further stir up our critics. Substantial overruns could damage the stocks.

Following Cantillon's memorandum, Carl Rosier sent a memorandum to CFEC commissioner Roy Rickey recommending that CFEC lower their proposed maximum number.[114] Rosier stated that the Board of Fisheries had recently issued a policy statement freezing the expansion of the roe herring fishery. Based upon this and their experience with the 1975 and 1976 fisheries Rosier said that ADFG was reducing its maximum number recommendation to CFEC from 35 to 25.

Rosier indicated that the 41 purse seiners that they had in 1976 was more than the Department felt that it could control when harvest levels were in the 200 to 700 ton range. He further indicated that the 1977 harvest was expected to be in the 1,000 to 1,500 ton range and that this wasn't a very good economic prospect for 35 permit holders. At that time, the Department had no evidence that any major increase in the harvest was going to occur in the near future. Rosier concluded:

We feel that for management purposes, and in view of the recent Board of Fisheries policy and the availability of the winter fishery for displaced fishermen with gear investments, that the maximum number of permits for the southeastern Alaska roe herring purse seine fishery be reduced to 25. If

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[114] See Commissioner Rosier's memorandum on maximum numbers to Roy Rickey, CFEC commissioner, dated February 2, 1977.

the number of permits cannot be reduced to this level the future of the fishery is certainly in doubt. With no room for expansion, a harvest too small to support the proposed fleet size, and a very real chance of exceeding desired harvest levels, the fishery will have little support from any quarter.

Despite Rosier's memorandum, CFEC adopted a maximum number of 35 permit holders. Because of the "significant hardship" point levels[115] adopted with the point system, the number of permits issued has exceeded the maximum number. To date, 44 entry permits have been issued and that number could be exceeded further as the final classification of 7 interim-use permits are determined.

ADFG's concerns about the number of operations was at least partially related to the size of the harvest quotas which they were trying to manage at the time. During most of the eighties ADFG was forced to manage 50 to 52 operations during the Sitka fishery but the harvest quotas were considerably higher than the quotas in the seventies.

Under the current management plan, a harvest will only be allowed in Sitka if the spawning population reaches or exceeds a minimum threshold of 7,500 tons. Using a 10% exploitation rate, a 750 ton quota would be set if the spawning population level was at the minimum threshold. Thus the minimum harvest level in Sitka (given that a harvest is allowed) will be 750 tons.[116] In contrast, ADFG suggests that 12,000 tons is the highest harvest level which they would expect to see in the future at Sitka and that the average harvest level over the 1969-1991 time period was approximately 3,329 tons.[117]

The first concept of the "management" optimum number Standard Two was "the number of fishing operations (entry permits) actually needed (the minimum required) to harvest the allowable take in an orderly, efficient manner." ADFG was asked to estimate the actual number of operations needed to harvest the lowest, average, and highest expected quota in the Sitka fishery over the next 20 years.[118] ADFG estimated that only 1 to 2 boats would be needed to harvest the minimum expected quota (750

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[115] Under AS 16.43.270, any person who has classified within a priority (point) classification specified under AS 16.43.250 (b) (the significant economic hardship point levels) automatically receives a permit, irrespective of whether or not the maximum number is exceeded.

[116] Again, the true minimum quota is zero. As noted earlier, ADFG indicated that the herring spawning population in Sitka was below the current 7,500 ton "minimum" spawning threshold in 7 of the 28 years from 1964 to 1991 (25% of the time).

[117] See answers to herring stock questions 4d and 4e in Carl Rosier's 7/23/91 memorandum.

[118] See question 8 in Kurt Schelle's 6/7/91 and ADFG's corresponding responses in Commissioner Rosier's 7/23/91 memorandum.

tons), 4 to 7 boats would be needed to harvest the expected average roe herring quota for the Sitka fishery (3,329 tons) and from 12 to 24 boats to harvest the maximum expected quota (12,000 tons).[119]

The second concept used to bound the "management" optimum number Standard Two was the "number of fishing operations which could be reasonably controlled while harvesting the allowable take in an orderly efficient manner and consistent with sound fishery management techniques."[120] ADFG indicated that this was a very difficult question to answer and that there may not be a (single) correct answer given all of the variables involved. The number of boats which could be handled could vary on a year-by-year basis depending both on stock levels and other conditions in the fishery.

A primary management strategy for controlling the fishery with excessive fishing power on the grounds is to try to put the fleet into a small area where there are relatively few fish thereby keeping the boats off of large biomass concentrations to prevent overharvest. Confining the fleet to such areas and short openings both slows the rate of harvest and allows ADFG to monitor the fleet more closely to reduce the risk of overharvest. The ability to do this successfully may depend upon conditions within the fishery in a given year.

With those caveats, ADFG suggested that they could typically handle 20-30 boats in Sitka for "small" quotas and that they could typically handle about 50 boats when quotas are average to large (3,329 tons plus).[121] ADFG went on to say that they may be able to handle more boats by being more restrictive with respect to time and area. Nevertheless, gear levels substantially above 50 boats would appear to be a concern even with large quotas for a number of reasons. Among those reasons are the following:

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119 In some years even fewer boats might be needed. The question implied that the harvest had to occur during the short time period when the roe were ripe prior to spawning. In some years this period might be more spread out and fewer units would be needed.

120 See herring management question 8b in Kurt Schelle's 6/7/91 memorandum to Commissioner Rosier and ADFG's answers in Commissioner Rosier's 7/23/91 response. The background to the question reads as follows:

> The number of fishing operations (entry permits) which can be reasonably managed (controlled) to harvest all the allowable take in an orderly, efficient manner, and consistent with sound fishery management techniques may depend upon the size of the allowable take. Sound fishery management techniques would presumably include trying to prevent situations where there is a serious risk of substantial overharvest and also trying to avoid situations where substantial portions or all of the quota must be foregone because of the risk of substantial overharvest.

121 See answer to question 8b on herring management in Commissioner Rosier's 7/23/91 memorandum.

1. Conversations with the fishery manager at Sitka indicated that controlling the harvest becomes more difficult at current gear levels when the quota or remaining quota falls into or below the 2,500 ton to 3,000 ton range. It is at these lower quota ranges where the strategy of keeping the large number of boats confined and away from concentrations of fish becomes very important. ADFG indicated that they have exceeded the quota in Sitka at current gear levels in some years when a relatively low quota was remaining for the last opening. The average harvest over the 1969-1991 time period was just slightly above this range. Thus raising the number of permits above the 50 permit level would appear to increase the likelihood that an overharvest might occur.

2. The strategy of confining the fleet to a small fishing area can cause more congestion and raises concerns about the safety and "orderliness" of the fishery. CFEC staff heard these concerns during interviews with fishermen. Accidents involving vessels, skiffs, and nets have occurred and in some instances have resulted in lawsuits over lost income and other damages. ADFG has not kept records of accidents involving vessels and/or gear but indicated that accidents have occurred and that it was reasonable to assume that the risk of accidents may increase as conditions become more crowded.[122]

3. Some fishermen expressed concerns about the potential for spotter plane accidents in the Sitka fishery as the fishery often occurs in areas adjacent to the local urban area. The nearness of the fishery to an urban area may increase the risk of "collateral" damage should an accident occur. Spotter plane accidents, often with fatalities, have occurred in other roe herring purse seine fisheries which do not take place near urban areas. ADFG is concerned about the potential for a disastrous plane crash when the fleet has to be tightly confined in a small area for conservation reasons. Nevertheless, they defer issues of airplane safety to the Federal Aviation Administration (FAA) and encourage the industry to develop and implement a safety program.[123] Again, everything else being equal, the number of airplanes are likely to increase with an increase in the number of fishing operations, causing more congestion and increasing the risks of spotter airplane accidents.[124]

4. The need to confine a large fleet to a small area and keep them off of the fish may mean that situations could arise where more valuable herring will need to

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122 See answer to herring management question 4c in Commissioner Rosier's 7/23/91 memo.

123 See answer to question 5d in Commissioner Rosier's 7/23/91 memorandum.

124 The use of spotter planes increased during the mid-eighties and then declined in 1989-92. Spotter planes are less likely to be used when the fishermen agree to a cooperative fishery and may be less likely in a competitive fishery when expected earnings are relatively low.

be foregone in order to protect the stocks. ADFG does not think that this has occurred to date, but says that it could occur in the future.[125]

5. ADFG indicates that they would not have allowed a competitive harvest in Sitka during 1991 despite an estimated biomass which exceeded the minimum spawning population threshold. The department only opened the fishery after fishermen agreed to a cooperative fishery which allowed the fishery to proceed with a lower level of handling mortality.[126] The Department has indicated that conditions such as those which existed in 1991 could occur again.

   The Department expressed the opinion that it has become more difficult in recent years for fishermen to agree to a cooperative fishery. The Department indicated that factors which seem to convince people to agree to a cooperative fishery do not seem to be particularly related to how many people participate. On the other hand, they felt that it was reasonable to assume that it may be more difficult to reach a consensus when more permit holders are involved in the process.[127] Thus, further increasing the number of permit holders may increase the probability that a harvest won't be allowed, even when the minimum spawning threshold is met.

6. In 1990, ADFG estimates it spent approximately $820,000 to manage the herring fisheries in southeastern Alaska, a number which represents approximately 9% of the average ex-vessel value of the fishery over the 1984 to

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[125] See the department's answer to herring management question 5b. in Commissioner Rosier's 7/23/91 memorandum.

[126] The cooperative or individual fisherman's quota fishery is believed to impose less handling mortality than a competitive fishery in situations where the stocks are such that many sets may have to be released because of inadequate roe content. Two reasons have been cited for this:

1. In a competitive fishery, sets are made as quickly as possible and the fish are pursed up tightly while the roe content of the set is tested. This puts the fish under greater stress than in a cooperative fishery where the fish aren't subjected to the same level of stress while testing for roe content.

2. In a competitive fishery, fishermen are less likely to share information with the entire fleet on the location of fish with high roe content. In a cooperative fishery they have more of an incentive to share such information. This reduces the number of sets which need to be made to fill the quota with marketable fish.

[127] See the Department's answer to herring-management question 6 in Commissioner Rosier's 7/23/91 memorandum. Note that "cooperative" roe herring fisheries occurred in Sitka in 1979, 1988, 1989, and 1991. While "coops" among small groups of fishermen occur in other roe herring purse seine fisheries, to date no other Alaskan roe herring fishery has resulted in voluntary agreement among all fishermen to take egalitarian shares. The other roe herring purse seine fisheries have more permit holders than Sitka.

1988 time period.[128] A significant portion of this is devoted to in-season monitoring of the fishery.

The Department does not expect to have additional monies to manage the fisheries in the near future. With a large fleet, in-season management of the fishery must necessarily be intensive and the Department indicated that the number of people and vessels needed to monitor the fishery increases as the intensity escalates.

If the amount of gear is increased and the amount of resources to manage the fishery are held constant, two scenarios arise: (1) Controlling the harvest may be more difficult with less fishery monitoring and overharvests of the quota will be more likely. (2) If managing for a quota becomes more difficult with more permits in the fishery, ADFG may have to manage the fishery more conservatively. This in turn may lead to leaving more of the available surplus unharvested.

7. While ADFG's management of the fishery has benefited from more years of experience, the Department has been facing increasing fishing capacity of individual fishing operations in the fishery. This increased fishing power has come from factors such as improved sonars and other electronics, redundant electronics, multiple herring seines of different sizes, newer vessels and gear, back-up vessels and skiffs, spotter planes, herring pumps, and etc. The Department indicates that they think this trend will continue.[129] Thus the excessive fishing power which the Department will have to manage likely will continue to grow even if the number of permits remains constant.

In summary, the Department of Fish and Game could not provide definitive answers to the management optimum number questions for the Sitka fishery. They felt that both the number of units of gear needed to harvest the resource and the number of units of gear which could be reasonably managed would tend to vary depending upon the size of the quota, and also would tend to vary depending upon year-to-year conditions in the fishery.

In Sitka, the Department estimated that only 1 to 2 boats would be needed to harvest the minimum expected quota for which a harvest would be allowed (750 tons), 4 to 7 boats to harvest the expected average quota (3,329 tons), and 12 to 24 boats to harvest the maximum expected quota. These numbers were estimates, and the actual number needed could vary from year-to-year depending upon other conditions in the

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128 See ADFG's answer to CFEC's herring management question 9 in Commissioner Rosier's 7/23/91 memorandum.

129 See the ADFG's answer to herring management question 2 in Commissioner Rosier's 7/23/91 memorandum.

fishery other than the size of the quota. However, it is clear that the number of units of gear actually needed to harvest all the available resource (in the Sitka fishery) in all years in an orderly, efficient manner is much less than both the maximum number (35) and the number of permits outstanding (44 permanent entry permits and 7 remaining interim-use permits). The first concept used as a lower bound of Standard Two under AS 16.43.290 (2),[130] would result in a management optimum number for Sitka below the current maximum number.

The concept used as an upper bound of management optimum numbers for Sitka was even more difficult for the Department to estimate. In review, the interpretation was the number of fishing operations which could be reasonably managed and controlled, given available resources and the Department's existing regulatory authority, without creating a serious risk of a substantial overharvest or underharvest. The Department indicated that for small quotas (below average) they could handle from 20 to 30 boats. For average to higher quotas (3,329+) they thought that they could typically handle about 50 boats. Thus for small quotas, the management optimum number (using the second concept) for Sitka would be below the current maximum number, while the manageable number for average to large quotas would be approximately the current sum of the number of permanent permits (44) and interim-use permits (7).

b. Lower Lynn Canal Fishery

The last commercial roe herring purse seine opening in Lower Lynn Canal occurred in 1982. A fishery has not occurred since that time since the minimum spawning population threshold of 5,000 tons has not been met. When the fishery has occurred the harvest has always been less than 1,000 tons. This suggests that future harvests, should they occur, will be somewhere in the 500 ton to 1,000 ton range. ADFG indicates that the harvest over the 1972-1991 time period ranged from 0 to 976 tons and averaged 579 tons in the ten years which were actually fished.[131] Based upon historical experience, it would appear that future Lower Lynn Canal harvests will only approach the lower end of the Sitka harvest range at best.

The Department indicates that the Lower Lynn Canal fishery may actually be somewhat more difficult to control than Sitka because of the way the fish tend to remain in large schools for longer periods of time just off the beaches and then move

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130 Recall that the actual wording of AS 16.43.290.(2) is as follows:

> The number of entry permits necessary to harvest the allowable take of the fishery resource during all years in an orderly, efficient manner, and consistent with sound fishery management techniques.

131 See ADFG's answer to herring stock question 5f in Commissioner Rosier's 7/23/91 memorandum. Again, CFEC data indicate an average of approximately 562.9 tons.

rapidly onto the spawning grounds.[132] This, combined with the small quota, makes the "management optimum number" question even more difficult than in Sitka.

The Department's answers to the management optimum number questions were appropriately more conservative for the Lower Lynn Canal fishery. Fishery managers in both Sitka and Juneau are more concerned about overharvest when the spawning population is near the minimum spawning threshold.[133] The concern is that substantial overharvests at relatively low population levels may make it difficult for the stocks to recover for a long period of time.

The quota in the Lower Lynn Canal fishery was exceeded by a substantial margin in some years when the fishery occurred. The roe herring fishery occurred in 10 years during the 1971 through 1992 time period. In 6 of those 10 years overharvests occurred. For examples, the Department cited the 1980 fishery where fishermen caught 976 tons in one day of fishing when the quota was 500 tons (63% overage), and the 1982 fishery where fishermen caught 550[134] tons in one day of fishing when the roe herring purse seine quota was 350 tons (58% overage of quota).[135] No fishery has been allowed since 1982 as the stocks have remained below the minimum spawning population threshold.

The first concept used as a lower bound for the "management" optimum number Standard Two was "the number of fishing operations (entry permits) actually needed (the minimum required) to harvest the allowable take in an orderly, efficient manner." ADFG was asked to estimate the actual number of operations needed to harvest the lowest, average, and highest expected quota in the Lower Lynn Canal fishery over the next 20 years.[136] ADFG estimated that only 1 to 2 boats would be needed to harvest any foreseeable quota in this fishery. This includes the minimum expected quota (500 tons), the expected average roe herring quota (historically 579

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132 See ADFG's answer to herring management question 7a in Commissioner Rosier's 7/23/91 memorandum.

133 See ADFG's answer to herring stock question 5.c.(2) in Commissioner Rosier's 7/23/91 memorandum.

134 This is the ADFG sac roe herring catch estimate as stated in Commissioner Rosier's 7/23/91 memorandum. It is likely a rounded number. CFEC data indicates a catch of 551.3 tons, which is 58% over the 350 ton seine quota.

135 See ADFG's answer to herring management question 7c. in Commissioner Rosier's 7/23/91 memorandum. ADFG indicated that they would not have allowed a lower Lynn Canal herring fishery in 1982 if they had known how small the spawning biomass actually was. The overharvest of the actual spawning biomass was much larger than the overharvest of the quota for the year.

136 See ADFG's answers to question 8 in Commissioner Rosier's 7/23/91 memorandum.

tons when a harvest occurs), and the maximum expected quota (1,000 tons) for the Lower Lynn Canal fishery.

The second concept used as an upper bound for the "management" optimum number Standard Two was the "number of fishing operations which could be reasonably controlled while harvesting the allowable take in an orderly efficient manner and consistent with sound fishery management techniques." Again, ADFG indicated that this was a very difficult question to answer and that there may not be a (single) correct answer given all of the variables involved. The number of boats which could be handled could vary on a year-by-year basis depending both on stock levels and other conditions in the fishery.

As noted above, a primary management strategy for controlling the fishery with excessive fishing power on the grounds is to try to put the fleet into a small area where there are relatively few fish thereby keeping them off of large biomass concentrations to prevent overharvest. Confining the fleet to such areas and short openings both slows the rate of harvest and allows ADFG to monitor the fleet more closely to reduce the risk of overharvest. The ability to do this successfully may depend upon conditions within the fishery in a given year.

With those caveats, ADFG suggested that they could typically handle 20-30 boats in the Lower Lynn Canal fishery.[137] The quota in the Lower Lynn canal fishery will always be "small" at best by Sitka standards. Again, the number of fishing operations that can be handled in any particular year might also depend upon factors other than the size of the quota.

In summary, the Department of Fish and Game could not provide definitive answers to the management optimum number questions for the Lower Lynn Canal fishery. They felt that only 1 to 2 boats would be needed to harvest any foreseeable quota which might be available in the fishery. It appears to be clear that the number of units of gear actually needed to harvest all the available resource (in the Lower Lynn Canal fishery) in all years in an orderly, efficient manner is much less than both the maximum number and the number of permits outstanding. Using the first concept of Standard Two under AS 16.43.290 (2),[138] would result in a management optimum number for the Lower Lynn Canal fishery well below the current maximum number.

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137 See answer to question 8b on herring management in Commissioner Rosier's 7/23/91 memorandum. Staff discussions with ADFG biologists suggests that the number is consistent with the number quoted for the Sitka fishery.

138 Recall that the actual wording of AS 16.43.290.(2) is as follows:

> The number of entry permits necessary to harvest the allowable take of the fishery resource during all years in an orderly, efficient manner, and consistent with sound fishery management techniques.

The second concept used as an upper bound for the management optimum numbers for Lower Lynn Canal was also difficult for the Department to estimate. In review, the second concept was the number of fishing operations which could be reasonably managed and controlled, given available resources and their existing regulatory authority, without creating a serious risk of a substantial overharvest or underharvest. The Department indicated that for the small quotas which are foreseeable in the Lower Lynn Canal fishery, they could typically handle from 20 to 30 boats.

Thus even under the second concept of management optimum numbers, the numbers suggested by the Department are well below both the current maximum number and the number of permanent permits outstanding. Indeed, CFEC records indicate that the Lower Lynn Canal fishery never experienced participation levels of fifty permit holders at any time in the history of the fishery.

Management Optimum Number Summary

This chapter has reviewed the second optimum number general standard under AS 16.43.290 (c) as it pertains to the southeastern Alaska roe herring purse seine fishery. This standard has been characterized as the "management optimum number" by previous CFEC researchers.[139]

ADFG could not provide definitive answers to questions about the stocks and about management optimum numbers. Nevertheless, they did provide some valuable insights about the stocks and the problems associated with managing the fishery. They also provided some helpful advice that can be used to help "bracket" ranges for management optimum numbers.

The number of units of gear or fishing operations needed to harvest any foreseeable surplus in either the Sitka or Lower Lynn Canal fisheries is smaller than the present maximum number in the fishery. One to two boats could harvest any foreseeable surplus in the Lower Lynn canal fisheries and "small quotas" in the Sitka fishery. Only 4 to 7 boats would be needed to harvest the average expected quota in Sitka, and from 12 to 24 boats to harvest the maximum expected quota at Sitka. If Martin's lower bound was to be used, 12 to 24 boats would represent "the minimum number of units of gear adequate to harvest the highest runs anticipated in the next ten years" in the southeast Alaska roe herring purse seine fishery.

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139 See "Optimum Numbers" by John Martin (1979)

The number of units of gear which could be reasonably controlled was a more difficult question for ADFG to answer.[140] Again, they felt that no single answer would be definitive, as the number might vary with both the size of the quota and other year-to-year conditions in the fishery. Nevertheless, they indicated that they could typically handle from 20 to 30 vessels in the Lower Lynn Canal fishery and the same numbers of vessels for "small quotas" in the Sitka fishery. For average or larger quotas (3,329 tons+) in Sitka they thought that they could typically handle up to 50 boats. If Martin's upper bound were to be used, 20 to 30 boats would be equivalent to "the maximum number of units of gear that can be effectively managed during the low run years."

Putting Martin's "bounds" together, the management optimum number for the southeastern Alaska roe herring purse seine fishery would fall somewhere in the 12 to 30 permit range. Nevertheless, the Lower Lynn Canal fishery has not occurred in recent years and there is considerable doubt about how soon it might be reopened. This may mean that the Sitka fishery may be the only one available to permit holders in the near future. The fact that ADFG has indicated that typically they can handle up to 50 vessels[141] when the Sitka quota is average or above average also should be a consideration in achieving a "reasonable" balance among the three optimum number standards under AS 16.43.290.

140 Again, this question meant controlled with their available resources and existing regulatory authority, without creating a serious risk of a substantial overharvest or a substantial underharvest.

141 Recall that overharvests have occurred in Sitka with quotas in this range, and a competitive fishery wouldn't have been allowed at all in 1991, despite the fact that the quota was in the range.

CHAPTER VI

SUMMARY and RECOMMENDATIONS

CHAPTER VI

Summary and Recommendations

This study was undertaken to determine optimum numbers, as defined in AS 16.43.290, for the southeastern Alaska roe herring purse seine fishery. CFEC was ordered to determine optimum numbers by the Alaska Supreme Court in Johns.

Previous chapters have reviewed the three optimum number standards in AS 16.43.290, understandings of those standards, historical information on the development of the fishery, estimates of historical economic returns in the fishery, forecasts of future returns in the fishery for different permit levels, and an evaluation of the relationship between permit levels and potential management and conservation problems.

The commission must select a single optimum number of entry permits for the fishery and not a different number each year as conditions in the fishery change.[142] Each standard in AS 16.43.290 may result in a different number or a different range of numbers. The final single optimum number chosen is to represent a "reasonable balance" of the three standards.

This chapter reviews the findings of the previous chapters and provides a recommendation for an optimum number based upon a reasonable balance of the three standards. It also provides a brief discussion of possible alternatives to optimum numbers should the Court still have constitutional concerns about Alaska's limited entry program.

Review of Optimum Number Standards and Study Results

The three standards cited in AS 16.43.290 and evidence which can be brought to bear on those standards were examined in previous chapters. If possible, the "reasonable balance" of the three standards should be a number that best satisfies all three standards. Hopefully, such a balance will also satisfy the concerns of Alaska's Supreme Court.

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[142]That single optimum number can be changed under AS 16.43.300, if there is a clearly established long-term change in the biological condition of the fishery and/or market conditions for the product that would justify altering the previous decisions made under AS 16.43.290.

a. Review of Standard One Results

Standard One under AS 16.43.290 (1) is concerned with achieving "a reasonable average rate of economic return." As noted previously, the standard reads as follows:

> *(1) the number of entry permits sufficient to maintain an economically healthy fishery that will result in a reasonable average rate of economic return to the fishermen participating in that fishery, considering time fished and necessary investments in vessel and gear;*

where economically healthy fishery is defined in AS 16.43.990. (2) as follows:

> *(2) "economically healthy fishery" means a fishery that yields a sufficient rate of economic return to the fishermen participating in it to provide for, among other things, the following:*
>
> > *(A) maintenance of vessels and gear in satisfactory and safe operating condition; and*
> >
> > *(B) ability and opportunity to improve vessels, gear, and fishing techniques, including, when permissible, experimentation with new vessels, new gear, and new techniques.*

Chapter III provided estimates of the average rate of economic return in the fishery, where the rate of economic return was defined as economic profits per year.[143] These estimates indicate that average economic profits in the fishery, as defined, turned positive in 1978, the first year after limitation. Average economic profits remained positive through 1988 before turning negative over the 1989-92 time period. In nominal terms, average economic profits per operation peaked in 1986 and turned lower or negative thereafter.

Permit market values appear to have adjusted as economic profits changed in the fishery. In theory the market value of a permit should reflect the present value of the future expected economic profits in the fishery to the marginal fisherman. The data in Chapter III of the report appear to support the contention that future expectations of economic profits are at least partially related to recent historical experience in the fishery.

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[143] The reader should recall that the economic profit measure calculated herein does not deduct the opportunity cost of the permit or any amount for debt service on a purchased permit.

The estimated permit market values reported in Chapter III peaked in 1987, one year after the peak in nominal average economic profits. Since that time, permit values have declined markedly probably reflecting changing future expectations due to the declines in economic profits in recent years. Measured in constant-value 1991 dollars, estimated permit values fell from approximately $520,000 to $205,000 over the 1987 through 1992 time period. As previously noted, industry sources suggest that the permit's actual market value has declined even further.

Chapters II, III, IV, and V all described aspects of the large variation in historical returns, and indicated the considerable uncertainty which surrounds future returns in the fishery. Both herring stocks and ex-vessel prices have shown large variations over the short history of the fishery.

Due to the wide fluctuation in both herring stocks and prices, future returns in the fishery remain very uncertain. The market price for the permit which appears to be emerging at the end of 1992 may provide the best information currently available on what fishermen expect the future to look like.

Chapter IV presents the results of a bioeconomic simulation model which attempts to forecast future returns in the fishery under different scenarios and predict how average rates of return in the fishery would change if the number of permits were changed. "High," "Low," and "Baseline (Intermediate)" scenarios were simulated.

The "High Scenario" assumes that recruitment over the next 30 years will reflect the high average levels observed after 1978 and that the yen will strengthen relative to the dollar to 100 yen per dollar (in real 1991 currencies). The "Low" scenario assumes that recruitment over the next 30 years will reflect the low levels observed in the 1970s and that yen will weaken relative to the dollar to the levels observed over the 1973-1985 time period.

The "Baseline Scenario," which the authors feel is most likely, assumes that recruitment over the next 30 years will reflect recruitment levels over the entire 1971-1992 time period and it sets the real yen/dollar exchange rate at recent levels. The average total harvest size in the baseline simulation roughly approximates the average total harvest size over the entire history of the fishery.

For each of the three scenarios, simulations were run using 25, 50, 75, and 100 permits. 500 simulations were run for each scenario and permit level. The mean present value of net returns (economic profits) per permit was then calculated from each set of simulations. Each set of simulations was repeated three times using different "random number seeds." The results were generally consistent across each set of simulations for the same scenario and permit level.

The results indicate that the mean present value of net returns will be negative at all permit levels under the "Low Scenario." Thus if recruitment returns to the low levels of the seventies (and the yen weakens as indicated), the present value of economic profits per permit would be negative even if only 25 permit holders were in the fishery.[144]

Under the "High Scenario" the simulation predicts that the mean present value of net returns will be positive at all permit levels. If the higher recruitment levels observed in the 1980s prevailed over the next 30 years (and the yen strengthens as indicated), the present value of net returns per permit would be substantially positive, even if 100 permits were in the fishery.[145] Moreover, the simulations suggest that at present permit levels, permit market values (in 1991 dollars) might exceed the highs observed so far over the historical period.

The "Baseline Scenario" is the case felt to be most likely by the authors. Here the yen-dollar real exchange rate would be set at recent levels, and recruitment over the next 30 years would reflect historical experience from both the low levels in the 1970s and the high levels in the 1980s.

The simulation results under the Baseline Scenario suggest results similar to those implied by currently prevailing permit market values at the end of 1992. At 50 permits, the mean present value of net returns to the permit holder falls roughly in the $194,000 to $202,000 range (1991 dollars). As noted in Chapter IV, these numbers roughly compare with current permit market values.[146] At permit levels of 75 and 100, the mean present value of net returns are negative under the Baseline Scenario.[147]

Thus if the Baseline Scenario and current market values are good indicators of the future, mean real economic profits over the next 30 years will fall roughly in the

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144 It is likely that if this occurs many permits will not be fished. Moreover, cost structures might change. The model does not account for these factors.

145 There was no factor in the simulation model which would stop harvests from occurring because 75 to 100 fishing operations could not be adequately controlled. Based upon ADFG's responses as reported in Chapter V, the simulation model likely overestimates the mean present value under the "High" scenario. This is because substantial portions of the available surplus might often have to be foregone or "wasted" when a controllable fishery would not be possible with 75 to 100 fishing operations.

146 These comparisons are very rough. Recall that the permit's value should represent the present value of net returns to the marginal permit holder. The mean present values reported as outputs from the simulations represent the present value of net returns to an average permit holder. The "marginal" and "average" permit holder valuations may be relatively close in this fishery, due to the small number of permits and the large random factors which can affect relative fishing success within a season.

147 The exception is one set of simulations under the baseline scenario where a factor was included to adjust costs annually as profits or losses occur. In these simulations, the mean present value was still slightly positive at the 75 permit level.

$11,640 to $12,120 range with approximately 50 permits in the fishery.[148] However, even if these "average forecasts" are accurate, nothing herein is intended to suggest that the wide variations in herring populations, ex-vessel prices, net returns, and permit market values which have prevailed over the short history of this limited fishery, will not continue over the next 30 years.

In Chapter III, the authors concluded that over most of the fishery's history, the existing number of permits has been sufficiently low to result in an average rate of economic return which is at least "reasonable," if the opportunity cost of the permit to the holder is ignored.

In Chapter IV, results under the "Baseline Scenario" suggest that the mean present value of net economic returns (economic profits) will be positive over the next 30 years at permit levels of 25 or 50 permits. The scenarios further suggest that a permit level of 50 permits will, on average, produce results roughly comparable to those implied by the market value of the permit at the end of 1992.

Most sets of simulations of the "Baseline Scenario" indicate that the mean present value of net returns will be negative over the next 30 years if permit levels are increased to 75 permits. All sets of simulations of the "Baseline Scenario" indicate that the mean present value of net returns will be negative at permit levels of 100 permits.[149]

In summary, results of Chapter III and IV suggest that the average rate of economic return, as defined herein, will be at least "reasonable" at permit levels of 50 or less. Nevertheless, the historical variations previously noted suggest that rates of economic return will continue to be highly variable from year to year in the future.

b. Review of Standard Two Results

Standard Two is concerned with resource conservation issues and brings concepts of manageability, orderliness (safety), and efficiency into the optimum number determination. To review, AS 16.43.290 (2) reads as follows:

> *(2) the number of entry permits necessary to harvest the allowable commercial take during all years in an orderly,*

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148 This estimate makes the rough assumption that real permit values will average in the $194,000 to $202,000 range (1991 dollars) and that a real interest rate assumption of approximately 6% is appropriate for the fishery and will prevail over the time period. It also assumes that these profits won't be gradually dissipated through over capitalization.

149 The results at these permit levels, with respect to average gross earnings, might be worse than indicated by the simulations as harvests or portions of harvests might sometimes have to be foregone because the available fishing capacity could not be adequately controlled.

efficient manner, and consistent with sound fishery management techniques;

As noted in Chapter I and in Chapter V, the second optimum number standard was called the "management optimum number" by previous CFEC researchers. To evaluate Standard Two, the authors relied heavily on the help and advice of those with the most expertise, the fishery managers at the Department of Fish and Game. As indicated in Chapter II and Chapter V, successful resource conservation management of an intensive roe herring fishery is a complex and difficult task.

Two concepts of the management optimum number standard were used in this study, to define a "range" of possible meanings for Standard Two. The first concept, which was a lower bound, was summarized as "the (minimum) number of fishing operations actually needed to harvest all of the available resource in all years in an orderly, efficient manner, and consistent with sound fishery management techniques."

With the qualifiers noted in Chapter V, ADFG roughly estimated that 1 to 2 fishing operations would be sufficient to harvest any foreseeable available surplus in the Lower Lynn Canal fishery (0 to 1,000 tons). In the Sitka fishery, 1 to 2 boats could handle low quotas, 4 to 7 boats could handle average quotas (approximately 3,329 tons), and 12-24 boats could handle the largest foreseeable available surplus (12,000 tons).

The second concept for management optimum numbers was used to define an upper bound. It was summarized to mean "the (maximum) number of units of gear which could be reasonably controlled while harvesting the allowable take in an orderly efficient manner and consistent with sound fishery management techniques." This concept was further refined to mean the number (maximum) of operations which the Department could reasonably manage and control, given available resources and their existing regulatory authority, without creating a serious risk of a substantial overharvest or a substantial underharvest. This second concept may come closer to the thinking of the Alaska Supreme Court in Johns.

With the qualifiers duly noted in Chapter V, ADFG made a rough estimate that 20 to 30 boats would be the maximum that could be consistently controlled in the Lower Lynn Canal Fishery given any foreseeable available surplus.[150] In Sitka, 20 to 30 boats would be the maximum which could be consistently controlled for "low"

150 Recall that these were very difficult questions for ADFG managers to answer. This was true for both the Sitka and Lower Lynn Canal fisheries. The number of units of gear which could be controlled can vary from year to year based upon both the size of the stocks, their location and movements, and other factors which make each year unique. ADFG's estimates should be considered very rough estimates, given these complexities.

quotas and approximately 50 boats could be typically controlled for quotas that are average or above (3,329 tons plus).[151]

Martin (1979a) indicated that CFEC had previously viewed the management optimum numbers to fall within a range bracketed by "the minimum number of units of gear adequate to harvest the highest runs anticipated in the next ten years" and "the maximum number of units of gear that can be effectively managed during the low run years." Applying Martin's definitions to the southeastern Alaska roe herring purse seine fishery, the management optimum number would fall somewhere in the 12 to 30 permit range.

Thirty permits, the upper bound of this range, is well below the current maximum number of 35, and below the 44 permanent permits which have already been issued. Nevertheless, reducing the number of permits would increase the average economic rate of return in the fishery[152] and might increase the Supreme Court's concerns about the degree of exclusivity in the fishery.

Not reducing the number to this level may increase the risk that substantial overharvests will occur in years of low quotas. It will also increase the risk that portions or all of the available surplus might have to be foregone in some years because the harvest cannot be adequately controlled. These risks could always be a problem in the Lower Lynn Canal fishery at current permit levels. These risks will be a problem in the Sitka fishery for "low" quota years and in cases where the remaining quota falls roughly in the 2,500 to 3,000 ton range or below.

c. Review of Standard Three Results

Optimum number Standard Three was only discussed briefly in this report. To review, AS 16.43.290 (3) reads as follows:

> *(3) the number of entry permits sufficient to avoid serious economic hardship to those currently engaged in the fishery, considering other economic opportunities reasonably available to them.*

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151 Recall that a competitive fishery would not have been allowed in Sitka during 1991 even though the quota was above average. The historical record in Sitka indicates that overharvests have occurred in Sitka when the remaining quota was in excess of 3,000 tons.

152 Although the "economic profits", as defined herein, would increase, the net present value of a fishermen-funded buy-back program might be negative or zero for any particular permit holder. The net benefits of buy-back would depend upon the cost of a buy-back program to fishermen. A 1985 Attorney General's Opinion suggests that the buy-back portions of AS 16.43 are unconstitutional as written. Statutory changes would be required for a buy-back program to occur.

This standard was reviewed in Chapter I. The authors concluded that Standard Three would only become applicable if it appeared that a reduction in the number of permits was called for and a mandatory fisherman-funded buy-back program would need to be implemented. In the case where the number of permits is to be increased, Standard Three would always argue for restraint as existing permit holders would always suffer losses from the addition of more permits.

Optimum Number Recommendations

As described above, Standard One indicates that average rates of economic return will be at least "reasonable" at 50 permits or less, and that Standard Two suggests that up to 30 permits can be reasonably managed in most years in both fisheries, even years with low quotas. Presently 44 permits have been issued in the fishery, and 7 more may be issued depending upon the outcome of cases still being adjudicated. The original maximum number in the fishery was 35 permits.

Adopting an optimum number above 30 permits will mean Standard Two, which is concerned with resource conservation, may not be met in all years. In the Lower Lynn Canal fishery, there may be a significant risk of a substantial overharvest or underharvest in many years where a potential harvest could be allowed. The same may be true in the Sitka fishery during "low" quota years, and in many openings where the remaining quota falls at or below the 2,500 to 3,000 ton range.

Nevertheless, reducing the fleet size to 30 permits would increase average rates of net return (economic profits) among remaining permit holders, increase permit market values, and might increase the risk that Alaska's Supreme Court would regard the fishery as "too exclusive." A "reasonable balance" of Standard One and Standard Two may mean that the number chosen will not satisfy Standard Two in all years.

In the opinion of the authors, an optimum number which falls somewhere in the range bounded by the 44 current permanent permits and 50 permits would represent a "reasonable" balance of the three optimum number standards. This optimum number would represent a compromise between Standards One and Two and may not satisfy the resource conservation concerns embodied in Standard Two in all years.

A number in this range would keep average rates of economic return and permit values roughly at the levels forecasted in Chapter IV under the Baseline Scenario, but (on average) would not cause further increases in these values over the long-term.[153] A reduction in the number of permits below this range would help reduce conservation risks (satisfying Standard Two) and would also lead to increases

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[153] Economic returns and permit values will likely continue to oscillate through time as conditions in the fishery change. This "long-term" average statement is based on the baseline simulations.

in economic profits and permit values. Nevertheless, it might increase concerns about the degree of exclusivity in the fishery.

An optimum number in the 44 to 50 range would keep conservation management problems roughly at current levels. It may create substantial risks of overharvests or underharvests in all years when a Lower Lynn Canal fishery occurs.[154] Nevertheless, ADFG feels that they typically can handle up to 50 permit holders for average to above-average quotas in the Sitka fishery, as they did over most of the 1980s.

The authors feel that an optimum number above 50 permits should be avoided for all of the reasons cited in Chapter V. While average rates of economic returns and permit values would fall from current levels, perhaps reducing concerns about the degree of exclusivity in the fishery, significant additional resource conservation risks and safety (orderliness) risks would be created.

Possible Alternatives To Optimum Numbers

Alaska's Supreme Court decision in Johns appears to imply that optimum numbers should be used to keep average rates of economic return from becoming "too high." The Court indicates that it is concerned about a "tension" between the limited entry clause in Alaska's constitution and the clauses which reserve fisheries for the common use of all people.[155] The Court noted that "to be constitutional, a limited entry system should impinge as little as possible on the open access clauses consistent with the constitutional purposes of limited entry, namely, prevention of economic distress and resource conservation."[156]

In Owsichek v. State, 763 P.2d 448 (Alaska 1988), Alaska's Supreme Court decided that exclusive use areas (EGAs) for hunting guides were unconstitutional because such areas violated the common-use clauses of the constitution. Alaska's constitution does not contain a "balancing" clause allowing for limited entry of hunting guides for purposes of resource conservation. In their decision, the Court agreed that there were resource conservation benefits from exclusive guide areas, but this apparently was not enough to make exclusive areas constitutional.

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154 However, recall that a Lower Lynn Canal fishery has not occurred since 1982, due to the depressed state of the herring stocks. ADFG is not optimistic that the stocks will recover in the near future. Moreover, even if a fishery is allowed, some permit holders may opt not to fish there.

155 See Johns, 758 p.2d

156 See Ostrosky, 667 P.2d at 1191.

In Owsichek, the Court stated that exclusive rights and privileges were not necessarily unconstitutional as long as the public trust (common interest) was protected. The Court (at p. 497) pointed to temporary exclusive use-privileges and payments of rent for those use-privileges as examples of exclusive privileges which would be constitutional.

> *Nothing in this opinion is intended to suggest that leases and exclusive concessions on state lands are unconstitutional. The statutes and regulations of the Department of Natural Resources authorize leases and concession contracts of limited duration, subject to competitive bidding procedures and valuable consideration. See AS 38.05.070 -.075 (authorizing leases and setting forth procedures); AS 41.21.027 (authorizing concession contracts in state parks); 11 AAC 14.200 - .260, 14.010 -.130 (establishing procedures for awarding concession contracts); see also Alyeska Ski Corp. v. Holdsworth, 426 P.2d 1006, 1009-11 (Alaska 1967) (discussing procedures required by law for leasing of state lands); CWC Fisheries V. Bunker, 755 P.2d 1115, 1120-21 (Alaska 1988) (stating in dictum that shore fisheries leasing program would not violate public trust, in part because leases were of finite duration and required annual rental). In contrast, EGAs are not subject to competitive bidding, provide no remuneration to the state, are of unlimited duration, and are not subject to any contractual terms or restrictions. Rather, as discussed above, they are granted essentially on the basis of seniority, with no rental or usage fee, for an unlimited duration, and are administered in such a way that guides may transfer them for a profit as if they owned them. In these respects the EGAs resemble the types of royal grants the common use clause expressly intended to prohibit. Leases and concession contracts do not share these characteristics.*

In Johns the Court looked at the optimum number process as the only mechanism in AS 16.43 to make needed adjustments so that limited entry in commercial fisheries remains consistent with Alaska's constitution. The Owsichek decision raises the possibility that a royalty or lease payment might be an acceptable alternative to increasing fleet sizes through the optimum number process.

CFEC already ties annual permit fees to permit values under the direction of AS 16.43.160. The permit fees collected vary directly with the value of the limited entry permit. As a practical matter, permit fees already rise and fall with the value of the exclusive use-privilege and permit holders are already charged an annual "rent" for their use-privilege.[157] Public comments often overlook this fact.

From the state's perspective, a royalty or lease payment for exclusive privileges seemingly would be preferred to increasing resource conservation risks, management costs, and fleet safety risks by putting more gear in the fishery through the optimum number process. From a permit holder's perspective, neither alternative is particularly attractive. Increasing the number of permits or increasing lease payments would both lower a permit holder's average rates of economic return.

Should the Court continue to be concerned about the degree of exclusivity in limited fisheries, the State might seriously consider other reasonable alternatives to increasing the number of units of gear under optimum numbers. If rent or royalty payments are used to reduce a permit holder's average rate of economic return, many of the benefits of limited entry would be preserved and support for the program might grow among the general public who would be receiving a portion of those benefits. As noted above, this is already happening to some extent with the annual fee provisions in AS 16.43.

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[157] See 20 AAC 05.240.

APPENDIX I

APPENDIX I

Description of the fishery simulation model

The Sitka sac roe model is a simple bio-economic simulation of the fishery. This appendix provides a detailed review of the simulation.[158]

How the Model Works

Herring are assumed to be recruited to the population at age three. Different model options allow for recruitment that is representative of periods of low, high, or overall recruitment between 1971 and 1992. Recruitment is selected at random from a low, high, or overall distribution.

The model follows each age cohort of fish through its life cycle. Each year the number of fish in the cohort gets smaller as some fish are harvested and some of those not harvested die of natural causes. Each year the weight of the average fish in a cohort increases as the fish age and grow. The final cohort is an age class of nine-year-old and older fish.

Although fish are assumed to be recruited to the population at age three, not all fish of all age classes are assumed to be equally available to the fishing gear. Not all fish that exist in a given age class appear in Sitka and enter the spawning population. Twenty-four percent of the three-year-olds are assumed to do so, seventy percent of the four-year-olds, ninety-five percent of the five-year-olds, and almost all fish aged six and over.

Each year the total weight of the fish available to the gear in all of the cohorts is the total fishable biomass of the stock. The model uses the Alaska Department of Fish and Game's sliding scale to relate the harvest quota in any year to the spawning biomass left following the harvest in the previous year. The actual harvest in a year is equal to the harvest quota plus or minus a deviation. These deviations are chosen at random from the distribution of percentage deviations observed since 1980.

Each year the total gross revenue earned by all fishermen is equal to the product of the total weight of fish harvested and an ex-vessel price of fish. The ex-vessel price depends on the estimated average percent roe content of fish in the harvest, and on exchange rates and inventories. The percent roe content is itself dependent on the average weight of the fish in the harvest. Average gross revenues are determined by dividing total gross revenues by the number of permits in the fishery. Revenues (and the costs discussed below) are all given in real, 1991, dollars.

[158] The simulation was written in Microsoft's QuickBasic 4.5. Use of a company's name does not constitute endorsement.

The average net revenues in each year are equal to the average gross revenues minus estimates of average operating costs. The average operating costs are equal to an average fixed cost of $33,440 and an average variable cost equal to about 47% of average gross revenues.

The most important output of the model is the average present value of net returns from the simulations conducted for each number of permits. Thus, for a given set of assumptions, such as a strong yen and high recruitment, 500 simulations are run for 25, 50, 75, and 100 permits. For each simulation the present value of net returns is calculated, and for each level of permits the average of the present values generated in the 500 simulations are also calculated. The average present values for different numbers of permits are then compared. The sensitivity of the results to changes in the assumptions can be examined by doing additional simulations with new assumptions.

The present value of net revenues is calculated over 30 years using a real discount rate of 6% per year. Present value is a means of comparing the values of different time patterns of income. A person will value $100,000 more if it will all be received now than if $25,000 were to be received now and $75,000 were to be received in three years. In present value calculations income received later is discounted relative to income received earlier.

Numbers of Fish Ages Four and Up

During each of the years of a simulation, the model estimates the number of fish at each age from three years to nine years and older. The numbers of one and two-year-old fish are not estimated for two reasons. First, they are not yet returning to Sitka in significant numbers and are not available for harvest or spawning (Collie, 1990, page 15). Second, biologists do not know for sure if larval or juvenile fish have a homing instinct similar to that of the older fish. It may be that the one and two-year-olds, will be partially recruited into another stock (See Collie's report of the discussion of stock discreteness and the member/vagrant hypothesis at the 1990 International Herring Symposium, Collie, 1991c).

Scientists believe that once herring are recruited to the Sitka stock they continue to return to Sitka each year (In separate analyses Collie assumes this for Sitka and Funk and Sandone make a similar assumption for Prince William Sound. Collie, 1990a, page 26; Funk and Sandone, 1990, page 11). Age classes get smaller each year, however, since some fish are harvested and others die naturally. In each year after the first year of the simulation, 1991, the number of fish in each age class (except for the three-year-olds) is equal to the number the year before minus estimates of the previous year's harvest and natural mortality.

Following Carlile the annual natural mortality has been set at 44% of the stock (pers comm.). Collie estimated average survival rates but found that although they appeared to "decrease with age...the survival estimates and trend are sensitive to the assumed age-specific vulnerabilities." Collie went on to use a constant mortality rate in his analysis of Sitka data (Collie, 1990, pages 9 and 23).

Because the herring are harvested during a short time during their spawning season, the model ignores interactions between harvest and natural mortality. A certain number of fish of each age class arrive in Sitka at the start of the model year, a part of each age class is harvested and, of the remainder, 44% in each age class die during the coming year.

Once a group of fish reach age nine they are lumped into a single, catchall age class category for age nine and older fish. This is the procedure used by Collie (1990, page 8-9) and Carlile (pers comm.). There are still fish older than nine being harvested, but their numbers are small.

The first year of the simulation is 1991, and the numbers of fish in each age class in this year are equal to those that were estimated to be in each age class in that year. These estimates were supplied by Carlile (pers comm.).

Part of the programming that calculates the number of fish by age class is shown below. The number of nine-year-old fish in a year (NumberNine!) is equal to the product of (a) the number of eight-year-olds surviving the harvest the year before (NumberEight! - HarvestEight!), and (b) the probability that an eight-year-old fish will survive between the fishery in one year and the next (1 - MortalityEight!). MortalityEight! is the annual natural mortality rate.[159]

```
NumberNine! = (NumberEight! - HarvestEight!) * (1 - MortalityEight!)
```

Numbers of Three-Year-Olds

Figure 9 shows estimated numbers of three-year-olds recruited into the Sitka Sound herring fishery in each year from 1971 to 1992. The estimates were made by Carlile using an age-structured model (Carlile, pers comm.). There appear to be two patterns of recruitment during this period. From 1971 to 1977 recruitment was low, with only one year standing apart from the others. From 1978 to 1992 recruitment appears to follow a four year cycle reaching much higher levels than during the seventies.

Future recruitment levels and patterns are uncertain in this fishery. Little is known about the underlying processes affecting recruitment. While it seems plausible that recruitment is related to the number of fertilized eggs and thus to the number, and

[159] Each year is modeled as a loop through the program. The program is written so that the variable "NumberEight!" has a value retained from the previous loop (and year) when it reaches this point. The number of eight-year-olds during the current year is calculated following this point in the program, and the variable "NumberEight!" is given a new value for the current year.

body weight, of spawning fish, environmental factors, such as water temperature, can be important. Also, as noted above, scientists don't know if fish that are spawned in Sitka Sound will return to spawn themselves in Sitka, even if they survive. It is possible that many fish stray and join other stocks. For example, fish that are spawned in Sitka may be carried by currents during their larval stage and may become attached to some other spawning stock. Similarly, fish that are spawned elsewhere may become attached to the Sitka spawning stock when they mature.

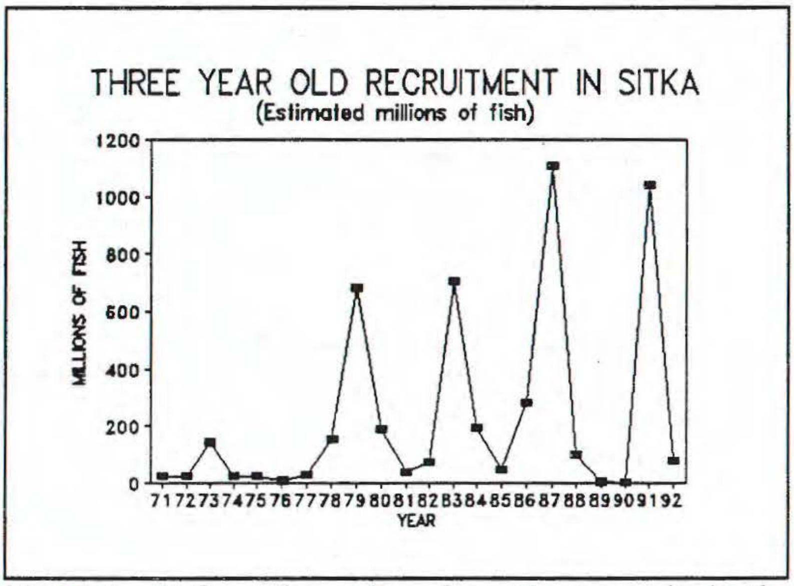

Figure 9. Estimated number of age-three recruits in the Sitka Sound herring population; 1971 to 1992. Estimates made by Carlile in age structured model.

Because of this uncertainty, and because recruitment is important to the model, low, high, and intermediate recruitment options are provided. The low recruitment model is a model of recruitment during the seventies when recruitment levels were low. The high recruitment model is a model of recruitment since 1978, a period of higher average recruitment. The intermediate recruitment model combines the low and high recruitment models and draws recruitment at random from a distribution based on the years from 1971 to 1992.

The low recruitment model assumes that future recruitment will be at the levels observed during the seventies when recruitment was small. Recruitment in this model is determined by a random number generator that gives an equal probability to each level of annual recruitment between 1971 and 1977. The numbers of three years olds recruited to the fishery in each of those years are taken from estimates provided by Carlile (pers comm.).

The programming that calculates the low recruitments is shown below. A random number is selected whose value can range between zero and one. The recruitment level, in millions of fish, from one of the years from 1971 to 1977 is chosen depending on the value taken by the random number. Each year has an equal chance of being chosen.

```
RandomNumber = RND
IF RandomNumber <= .1429 THEN NumberThree! = 21.18                    '71
IF RandomNumber > .1429 AND RandomNumber <= .2857 THEN NumberThree! = 22.09 '72
IF RandomNumber > .2857 AND RandomNumber <= .4286 THEN NumberThree! = 142.92 '73
IF RandomNumber > .4286 AND RandomNumber <= .5714 THEN NumberThree! = 22.48 '74
IF RandomNumber > .5714 AND RandomNumber <= .7143 THEN NumberThree! = 21.41 '75
```

```
IF RandomNumber > .7143 AND RandomNumber <= .8571 THEN NumberThree! = 8.5   '76
IF RandomNumber > .8571 AND RandomNumber <= 1 THEN NumberThree! = 26.87 '77
```

The intermediate and high recruitment models work the same way. The intermediate model determines recruitment using a random number generator that assigns an equal probability to each year's recruitment between 1971 and 1992, and the high recruitment model determines recruitment by assigning an equal probability to each year's recruitment between 1978 and 1992. All estimates of three-year-old recruitment were provided by Carlile (per comm.).

The importance of recruitment can be seen by running the model at low, intermediate, and high levels of recruitment, holding all other assumptions, including the level of the exchange rate, constant. The assumptions chosen for these runs were 50 permits, and all assumptions other than recruitment from the baseline model.[160] The average present value of the results from 500 runs for the low recruitment of the period 1971 to 1977 was -$250,365, the average present value in the intermediate case with recruitment from 1971 to 1992 was $195,151, and the average present value in the high recruitment case, where recruitment reflected the years 1978 to 1990, was $400,480.

Harvests occur in less than half the years under the low recruitment assumption. In an experiment, the 30 year simulation was run 50 times using the low recruitment assumption. This produced 1,500 different estimates of annual harvest. In 933 of these simulated years, the harvest was zero. Even this understates the number of zero harvests under the low recruitment assumptions, since in many years with positive harvests, the harvests depended on recruitment in years before the simulated recruitment began.[161]

The Random Number Generator

The language used to program the simulation[162] contains a command that will generate a number between zero and one on request. These numbers are generated in such a way that they can be interpreted as being chosen at random. Before random numbers are generated the "random number generator" has to be primed by being given a number called a "seed." The generator is primed with the seed at the start of the program, and will produce an apparently random number every time the program calls for it thereafter. These numbers are drawn in a unique sequence for each random number seed. The same seed will produce the same sequence of random numbers each time it is used; a different seed will produce a different sequence of random numbers.

[160] The seed used in the random number generator was 38425.32. This is the seed used for Table 14 in Chapter IV. The intermediate case result, reported in this paragraph, may be found in that table.

[161] In this simulation all assumptions other than the recruitment assumption were from the baseline model. The random number seed was 38425.32.

[162] Microsoft's QuickBasic 4.5. Use of a company's name does not constitute endorsement.

The results in this report were generated by running the program 500 times through a 30 year cycle for a given number of permits. For this example, assume that the program generates one random number to determine recruitment for each year. This results in a sequence of (500)*(30) = 15,000 random numbers. A single seed is used to generate the series of 15,000 random numbers.

The random numbers and recruitment patterns are different within each of the 500 thirty year simulations since the sequence of random numbers does not repeat every 30 years. Because of this, there will be a different present value associated with each 30 year simulation. Since there are 500 different present values it is necessary to summarize the simulation results with descriptive statistics.

The fact that each seed is associated with a unique sequence of random numbers is exploited in the analysis. If the same seed is used to evaluate two different levels of permits, perhaps 25 and 50, and assumptions about the recruitment model are unchanged, the same series of random numbers and recruitments will be generated by the model for each permit level. Because of this, differences in the average present value of net returns for different permit levels are due to changes in the number of permits and are not due to changes in the pattern of random numbers and recruitment.

When the program is started, it gives the user the option of supplying a seed for the random number generator, or of having the program select a seed. The program selects a seed by consulting the computer's internal clock. The user can thus duplicate previous results associated with a given seed, or can alter assumptions in the model while holding the random component constant.

Why a Stock-Recruitment Model Was Not Used

A stock-recruitment relationship was not used in the simulation model, despite the authors' belief that one exists. Although "useful" stock recruitment relationships have been found for other herring populations, particularly when environmental factors have been considered, only a "small proportion of recruitment variability is explained by egg production" in Sitka (Collie, 1991a, pages 470-471). Zebdi also points out that stock-recruitment relationships alone cannot explain the high variability observed in recruitment to herring populations, and devotes an article to examining possible environmental factors that may be correlated with Sitka recruitment (Zebdi, 1991, page 346).

At an early point in this research a stock recruitment model was developed for use in the simulation. The model included dummy variables to simulate the four year recruitment cycle. Versions of the model explained over 80% of the variation in the recruitment variable. This approach was not used in the simulation, however, since the simpler model actually used tended to produce average recruitments closer to historical averages. It was felt that it was much more important to duplicate the level of average annual recruitment during high recruitment years than to relate the stock to recruitment or mimic a recent four year cycle which may or may not be meaningful over the long run.

Weight of Fish at Each Age

The model assigns an average weight (in pounds) to fish at each age. In 1991 the fish are assigned the actual average weights reported for that year. In subsequent years they are assigned weights equal to the average weights for the period 1971 to 1992. The estimated weights (in grams) were provided by Carlile (pers comm.).

AGE CLASS	WEIGHT IN POUNDS, 1991	AVERAGE WEIGHT IN POUNDS, 71-92
3	0.1276	0.1606
4	0.1342	0.2046
5	0.1540	0.2486
6	0.2552	0.2882
7	0.2662	0.3256
8	0.2816	0.3674
9	0.4004	0.4004

In research on Sitka Sound herring stocks, Collie has found "weak" evidence that the growth of individual fish is related to the size of the fish stock (density dependent growth), however his analysis of the question was hampered by problems with the data on average weight by age (Collie, 1991a, page 468-469). Density dependent growth is sometimes advanced as a possible explanation for smaller fish in recent years. Despite the interest of this topic, models of density dependent growth were not used in the simulation analysis.

Harvest of Fish

Not all the fish in each age class are believed to be available to the fishery. This is particularly the case for three and four-year-old fish. The model assumes that only 24% of three-year-olds, 70% of four-year-olds, 95% of the five-year-olds, and almost all fish aged six and older are recruited to the Sitka fishery.[163] These percentages were

[163] Although seine gear is not highly selective, and in Sitka the age classes appear to be relatively mixed, fishermen may have some ability to target specific age classes. This is a difficult factor for biologists to disentangle from the non-appearance of parts of some age classes in the fishable stock. To the extent that fishermen are selective, this is captured by these availability factors.

suggested by Carlile (pers comm.).

In this fishery an annual harvest quota is set by the Alaska Department of Fish and Game using a "sliding scale" formula. The sliding scale sets harvest as a percent of the spawning biomass in the year before. The percent chosen depends on the estimated size of the spawning biomass in the previous year. The percent is zero if the spawning biomass the previous year is less than 15 million pounds. The percent can range between 10 and 20 percent of the spawning biomass the previous year when spawning biomasses are equal to or greater than 15 million pounds. The harvest percent rises as a continuous, linear, function of the previous year's spawning biomass divided by 15 million pounds. The function increases the harvest percent by two percent for every 15 million pound increase in the previous spawning biomass. The function is truncated so that it will not produce a harvest percent above 20% (see Chapter II for further discussion of the sliding scale).

The harvest quota in the current year is equal to the product of the harvest percentage, determined by the sliding scale, and the aggregate size of the spawning biomass used to calculate the harvest percentage. The Department of Fish and Game's current year harvest quota is therefore based entirely on the spawning biomass in the previous year.

Managers do not hit the harvest targets set with the sliding scale accurately each year. This model simulates these errors by attaching a random error term to the sliding scale results. Each of the misses between 1980 and 1992 has an equal chance of being chosen. Misses prior to 1980 were not used in this distribution to eliminate possible errors associated with learning during the early years of the fishery. These misses might have less long term significance. The deviations actually used are shown below in the sample programming.

In this model total harvest does not depend on the number of operations in the fishery or on the effort expended by each operation. Total harvests are determined by the spawning biomass the year before, by the sliding scale, and by the random error term. The harvest will be the same whether there are 25 or 100 vessels active in the fishery.

In reality, harvest size may depend on the number of vessels present. For example, as noted in Chapter V, when the ratio of permits to the harvest quota is large, the Department of Fish and Game might find it necessary to prohibit fishing altogther during a year. Otherwise there might be an unacceptably high probability that the fishermen would exceed the available harvest quota by large amounts. The harvest program in the model does not allow for this possibility. This may lead the model to overestimate average harvests. The overestimate of average harvest is likely to be greater the larger the number of permits assumed to be in the fishery.

On the other hand, the model's average harvest will be strongly affected by the number of operations in the fishery. Each doubling of the number of vessels will reduce the average harvest (and average gross revenues) by half. The greatest proportional reductions in average harvests and gross revenues will occur for increases in permit numbers between 25 and 50. Proportional reductions in average harvests and average gross revenues will be considerably less for increases in the number of vessels between 75 and 100.

The programming that calculates each year's harvest is listed below. The spawning biomass the previous year (SpawningBiomassL1!) is compared to the Department of Fish and Game sliding scale threshold (Threshold!) and the percent of the previous year's spawning biomass that is to form the current year's harvest quota (HarvestPercent!) is calculated. The product of this percentage and the previous year's spawning biomass is the harvest quota for the new year (HarvestQuota!).

```
HarvestPercent! = .08 + .02 * (SpawningBiomassL1! / Threshold!)
IF HarvestPercent! > .2 THEN HarvestPercent! = .2
IF HarvestPercent! < .1 THEN HarvestPercent! = 0
HarvestQuota! = SpawningBiomassL1! * HarvestPercent!
```

The weight of fish in each age class available to be harvested in the current year (AvailableThree!, etc.) is equal to the sum of the products of the biomasses of each age class (BiomassThree!, etc.) and the availability factors for those age classes (AvailThree!, etc.). The availability factor for three-year-olds is 0.24, for four-year-olds it is 0.7, for five-year-olds it is .95, for six year olds it is .99, and for all other age classes it is one.

```
AvailableThree! = BiomassThree! * AvailThree!
AvailableFour! = BiomassFour! * AvailFour!
AvailableFive! = BiomassFive! * AvailFive!
AvailableSix! = BiomassSix! * AvailSix!
AvailableSeven! = BiomassSeven! * AvailSeven!
AvailableEight! = BiomassEight! * AvailEight!
AvailableNine! = BiomassNine! * AvailNine!
```

The total weight of the available fish is the sum of the weights of the available fish in each age class.

```
TotalAvailableBiomass! = AvailableThree! + AvailableFour! + AvailableFive! + AvailableSix! + AvailableSeven! +
        AvailableEight! + AvailableNine!
```

Then a random number is drawn. The actual total harvest from all year classes (TotalHarvestBiomass!) is equal to the harvest quota times an adjustment factor that depends on the selection of the random number.

```
RandomNumber2 = RND
IF RandomNumber2 < .077 THEN TotalHarvestBiomass! = HarvestQuota! * 1.096          '80
IF RandomNumber2 >= .077 AND RandomNumber2 < .154 THEN TotalHarvestBiomass! = HarvestQuota! * 1.169 '81
IF RandomNumber2 >= .154 AND RandomNumber2 < .231 THEN TotalHarvestBiomass! = HarvestQuota! * 1.454 '82
IF RandomNumber2 >= .231 AND RandomNumber2 < .308 THEN TotalHarvestBiomass! = HarvestQuota! * .991 '83
IF RandomNumber2 >= .308 AND RandomNumber2 < .385 THEN TotalHarvestBiomass! = HarvestQuota! * 1.166 '84
IF RandomNumber2 >= .385 AND RandomNumber2 < .462 THEN TotalHarvestBiomass! = HarvestQuota! * .971 '85
IF RandomNumber2 >= .462 AND RandomNumber2 < .538 THEN TotalHarvestBiomass! = HarvestQuota! * 1.082 '86
```

```
IF RandomNumber2 >= .538 AND RandomNumber2 < .615 THEN TotalHarvestBiomass! = HarvestQuota! * 1.171  '87
IF RandomNumber2 >= .615 AND RandomNumber2 < .692 THEN TotalHarvestBiomass! = HarvestQuota! * 1.041  '88
IF RandomNumber2 >= .692 AND RandomNumber2 < .769 THEN TotalHarvestBiomass! = HarvestQuota! * 1.037  '89
IF RandomNumber2 >= .769 AND RandomNumber2 < .846 THEN TotalHarvestBiomass! = HarvestQuota! * .918  '90
IF RandomNumber2 >= .846 AND RandomNumber2 < .923 THEN TotalHarvestBiomass! = HarvestQuota! * .596  '91
IF RandomNumber2 >= .923 THEN TotalHarvestBiomass! = HarvestQuota! * 1.6          '92
```

The total percent of the available fish that are harvested (ExPostHarvestPercent!) is calculated.

```
ExPostHarvestPercent! = TotalHarvestBiomass! / TotalAvailableBiomass!
```

The number of fish harvested from each age class (HarvestThree!) is the product of the number in the stock of that age (NumberThree!), the percentage of fish of that age available to the fishery, and the percent of the available stock of fish that is harvested.

```
HarvestThree! = NumberThree! * AvailThree! * ExPostHarvestPercent!
HarvestFour! = NumberFour! * AvailFour! * ExPostHarvestPercent!
HarvestFive! = NumberFive! * AvailFive! * ExPostHarvestPercent!
HarvestSix! = NumberSix! * AvailSix! * ExPostHarvestPercent!
HarvestSeven! = NumberSeven! * AvailSeven! * ExPostHarvestPercent!
HarvestEight! = NumberEight! * AvailEight! * ExPostHarvestPercent!
HarvestNine! = NumberNine! * AvailNine! * ExPostHarvestPercent!
```

The total number of fish harvested is equal to the number of fish harvested in each age class.

```
TotalHarvestNumbers! = HarvestThree! + HarvestFour! + HarvestFive! + HarvestSix! + HarvestSeven! + HarvestEight!
                       + HarvestNine!
```

Prices Received for the Fish

The price the fishermen receive for their fish (PriceOfFish!) depends on the average percentage roe content of the fish (PercentRoeContent!), and assumptions about the level of herring sac roe inventories (Inventories!) the Japanese held at the start of the year and the exchange rate between the U.S. and Japan (RealYenDollarExchange!). Roe content is determined by the simulation model for each year, the inventories and exchange rate are based on assumptions.

```
PriceOfFish! = -.1865 - (.0849 * Inventories!) - (.0056 * RealYenDollarExchange!) + (.1723 * PercentRoeContent!)
IF PriceOfFish! < 0 THEN PriceOfFish! = 0
```

This equation is not used in the base year of the simulation, 1991, when the historical price of $0.056 per pound was used.

This price model was estimated in a regression analysis of 14 time series observations from the Sitka Sound sac roe herring fishery. Data came from the years 1978 to 1992, excluding 1979. The model explained about 77% of the variation in the price and all the coefficients except the intercept were statistically significant.

The ex-vessel price model was tested by predicting annual prices for Sitka from 1978 to 1992 (excluding 1979, which wasn't used in the model estimation) based on actual historical values for the exogenous variables. The actual historical prices and the simulated ex-vessel prices were then compared. The average percentage error of the simulated price was 1.5 percent and the average absolute percentage error of the simulated price was 51 percent. These numbers suggest that the price model is relatively unbiased, but that it has a large variance. The large absolute errors were due to three relatively large percentage errors that occurred in 1990, 1991, and 1992 when the historical price was extremely small.

The percentage roe content predicted by the model depends on the estimated average weight of the fish. The equation relating the percent roe content and the average weight was estimated using annual average data for the two variables over the period 1978 to 1982. Good average percent roe content data was not available prior to 1978. The coefficient on the weight variable was statistically significant and the model explained about 62% of the variation in the dependent variable.

PercentRoeContent! = 6.439 + (18.161 * AverageWeight!)

The average weights of the fish can be determined since the model calculates the number of separate herring harvested, as well as the aggregate weight of fish harvested.

The exchange rate is defined as the "real" exchange rate. That is, it is measured with real, inflation adjusted, yen and dollars. All calculations are in 1991 currencies. Figure 10 compares the real and nominal exchange rate series for the period from 1964 to 1992. The series indicate that generally over this period the number of yen required to buy a dollar has been dropping. The drop was especially rapid after the fixed exchange rate regime was abandoned by the Nixon administration in the early seventies.

Japanese herring sac roe inventories at the start of each year from 1977 to 1992 are shown in Figure 11. In the calculation of these figures, roe herring in inventory have been converted to sac roe equivalents. The spike in inventories in 1980 is probably due to a speculation crisis in 1979. In 1979 speculation in Japan drove sac roe prices very high. Consumers responded by reducing purchases to low levels. The collapse of the speculation left at least one Japanese firm bankrupt. The high 1980 inventories are probably due to the decrease in consumption in 1979. In the simulation, inventories are

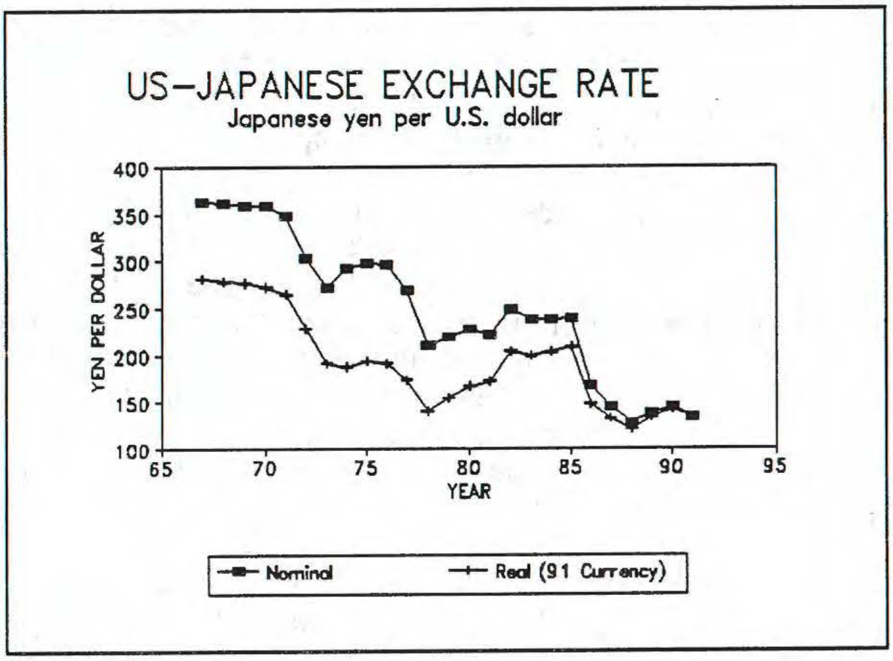

Figure 10.

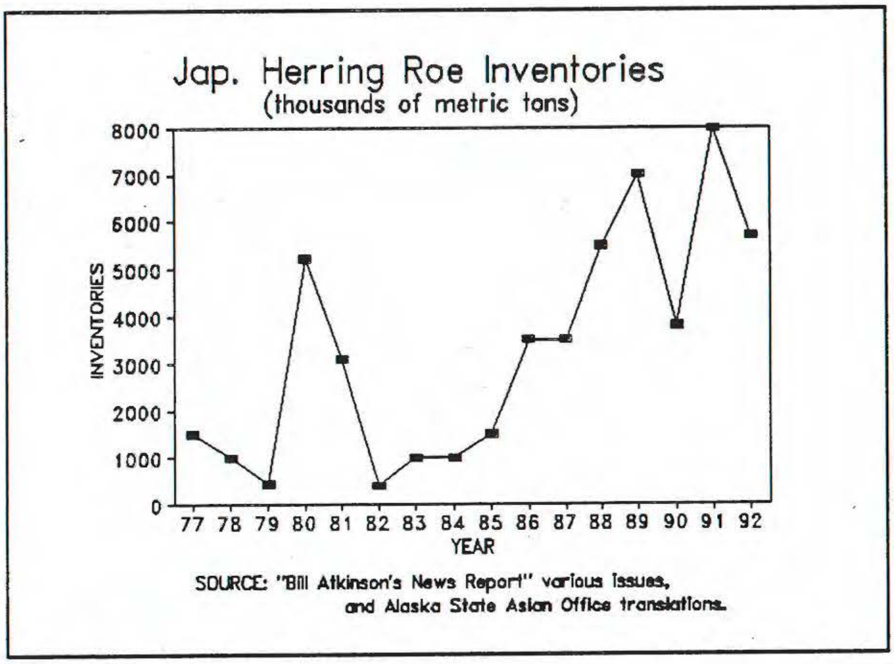

Figure 11.

Figures 10 and 11. The US/Japanese exchange rate and the Japanese inventory of herring sac roe were two dependent variables used in the model for sac roe ex-vessel prices.

assumed equal to the average of inventories from 1986 to 1992, 5,286 metric tons.[164]

Costs of Production

The model estimates average fixed and variable operating costs. The model does not examine the operating costs for each of the operations in the fishery, but instead uses an estimate of average fixed and average variable costs. The average variable costs for an operation in a year are equal to about 47% of the average gross revenues of an operation in the fishery in that year. The average fixed costs are equal to $33,440 in each year.

The model lets the analyst experiment with changes in fixed costs in response to profits and losses in the fishery. In common property fisheries one would often expect that profits would attract new investment or effort into a fishery while losses would lead to the withdrawal of investment or effort. These considerations may be modified under the conditions in this fishery. In this fishery the state places limits on the number of operators who may fish and on the gear that may be used. Thus, available margins for new investment or effort are constrained. In addition, while the profit and loss dissipation may hold for a fleet exploiting a single fishery, it does not necessarily hold for a fleet exploiting different fisheries at different points in time. In this case the measurable costs of operation in one fishery may not be related in a straightforward way to conditions in that fishery. For example, the fixed costs of a vessel may rise due to competitive activity in another fishery or may fall due to losses in that other fishery.

A simple method has been used to allow the analyst to experiment with different rates of profit and loss dissipation. If there are profits in a year, the total fixed costs the following year are increased by a percentage that may be determined by the analyst; likewise, if there are losses in a year the fixed costs are reduced by the same percentage in the following year.

This simple procedure makes changes in any year's fixed costs depend solely on the existence of profits or losses in the year before. In reality, fishermen would be considering the pattern of losses and profits in several preceding years, and would be taking account of other available information shedding light on the potential for profits or losses in the future. In addition, responses to profits and losses may be made at different speeds. The simple procedure here was used because little is known about the processes and speeds with which fishermen respond to profits and losses, and because over the long run it would approximate the responses desired.

The basic fixed and variable cost parameters (33,440 and 47%) are based on an analysis of annual operating costs. The operating cost estimates used in the analysis are

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164 Inventory estimates are made from information in various issues of the Bill Atkinson News Report and in State of Alaska Asian Office fishery translations. Inventories are estimates of starting inventories of Atlantic and Pacific roe in different product forms.

reported in Chapter III.

Gross and Net Returns

Fishery gross revenues are calculated by multiplying the harvest estimate by the price per pound. Average gross revenues equal fishery aggregate gross revenues divided by the number of permits in the fishery. Average net revenues are determined by subtracting the average fixed and variable costs, estimated using the cost model, from the average gross revenues.[165]

Net returns are those revenues in excess of the operation's fixed and variable operating costs. These include the explicit cash expenses of the operation, as well as the opportunity costs of labor and capital (except for the opportunity cost of the limited entry permit) used in the operation.

Present Value of Net Returns

The model's ultimate product is a schedule showing the present value of the average net returns in the fishery associated with different numbers of limited entry permits in the fishery.

The present value of the net returns in the fishery for a single simulation is:

$$\textit{Present Value of Net Returns} = \sum_{t=0-29} \frac{\textit{Net Returns}_t}{(1+r)^t}$$

where r is the real risk adjusted discount rate. The 30 years in the simulation are numbered 0 to 29. The results reported in Chapter IV are averages of the present values for 500 separate 30 year simulations.

A real discount rate of 6% has been used in the calculation of the present values. The discount rate was the mean of the real annual yields on bonds rated BAA by Moody's for the years 1975 to July, 1992. Inflation rates were calculated using the GDP price deflator for the period. The real rates were calculated using the following formula:

$$r = ((1+i)/(1+\pi)) - 1$$

[165] In the model the aggregate harvest is measured in millions of pounds. A units transformation is needed to produce average gross revenues measured in dollars.

where: r is the real rate of interest
i is the nominal rate of interest, and
π is the annual inflation rate.

The average value of 0.0553 for the period was rounded to 0.06.

APPENDIX II

APPENDIX II

Estimation of Catches, Earnings, and Costs in the Southeastern Alaska Roe Herring Fishery

I. Data Base Changes From the Fish Ticket File

One of our first tasks was to build a data base of fish ticket information that was as accurate as possible. After receiving an initial "catch file" from the CFEC Data Processing section, we made many changes and additions to it that made it more accurate. They were:

(1) We selected fish ticket records of landings that were made only in southeastern Alaska. The Data Processing catch file contained many records for landings that occurred outside of southeastern Alaska. Fishing for sac roe herring in early years required a statewide (type B) permit -- the same permit type was used to fish in Prince William Sound or Cook Inlet as in southeastern Alaska. The Data Processing file failed to take this into account; consequently, our original file was overinclusive. We corrected this by eliminating all records of landings that occurred outside of the CFEC Gross Earnings Area (G_AREA) "A".

(2) We corrected data entry errors. Most data entry errors that we corrected involved changes to the fish ticket "pounds landed" (F_POUNDS) field. Other changes included adding fish ticket records which were never originally entered, or deleting records of herring landings that were made with gill net gear.

(3) We created a correct species code. Before 1978, fish ticket records used the same species code (230) for both bait herring and sac roe herring. We developed computer code that searched the fish tickets to determine if landings were made during sac roe fishing efforts. We determined sac roe fishing effort by first selecting landings that were made between March 15 and June 1. We then used ADFG reports, ADFG regulations, and personal interviews with fishermen to determine if the fishing was directed at sac roe or bait herring during that time period.[166]

(4) We created a correct price variable. Because bait and sac roe landings were not separated by species code before 1978, the CFEC gross earnings file

[166] These methods helped determine if the fishing effort was directed at either sac roe or bait herring. It does not, however, account for sac roe landings that were of inferior quality and were sold at a bait price. We assume that the large majority of sac roe fishing effort before 1978 produced landings of sac roe quality fish.

used a weighted average *bait herring* price to estimate earnings for all herring catches before 1978. We established both weighted average bait and sac roe prices and applied them to the corrected pounds landed field.

Our original catch file contained fish ticket records from 1969 through 1988. When we updated the file to include records through the 1992 season we acquired fish ticket information directly from ADFG. The 1989 and 1992 season records came to us by computer diskette from the ADFG regional office. The 1990 and 1991 records of landings came to us from the Sitka office as paper copies of spreadsheets. The Sitka office created the spreadsheets to use as a daily record of herring roe landings. We made a computer file from the spreadsheet. The computer file could be merged into our original catch file. Although no large errors are expected on these updates, the data should at this writing be considered preliminary.

II. Reduction Factors

We used reduction factors in two places: (1) To allocate portions of annual fixed costs to the southeastern Alaska roe herring (G01A) fishery; and, (2) To establish a "fishery prorated value" to the operation's capital investments. Capital investments we included for part (2) were vessels, skiffs, nets, pumps, and other equipment.

a. Vessel Reduction Factors

The most frequently used reduction factor measures the activity of the vessels in the operation. This factor is used for allocating fixed costs to the fishery and to derive the fishery prorated value for the vessel.

We assigned the fishery vessel reduction factor as follows:

(1) We developed a list of boats that have participated in the G01A fishery. The list includes both principal vessels and backup/tender vessels. To accomplish this, we reviewed fish tickets, CFEC surveys, and ADFG registration lists. This list was the basis for a "vessel participated" data base.

(2) We then determined the G01A fishery/year combinations where the boat was used. Again, we reviewed fish tickets, CFEC surveys, and ADFG registration lists to decide this.

(3) We assigned a preliminary reduction factor to each vessel for each G01A fishery where it participated; i.e., there was a Sitka factor, a Juneau factor, a Seymour factor, and an Other factor for each vessel/year. The reduction factors were based upon:

$$\frac{VGE_{x,t}}{VMGE_{x,t}} * \frac{NM_{x,t}}{NM_t}$$

where:

$VGE_{x,t}$ = Vessel gross earnings in G01A fishery x in year t
$VMGE_{x,t}$ = Vessel gross earnings in all fisheries during the time period (month) when G01A fishery x occurred in year t
$NM_{x,t}$ = Number of months vessel was used in G01A fishery x in year t
NM_t = Number of months vessel was used in year t

Using this equation, if a boat didn't participate in a certain fishery/year the reduction factor was 0.

Our analysis of the preliminary vessel reduction factors suggested that adjustments were necessary:

(4) Some vessels were used in a fishery but they didn't record earnings or months fished (i.e., they were "skunked" in the fishery, or they were used as backup boats and their earnings, if any, never appeared on fish tickets, etc.). Also, some vessels were used out-of-state or other places where we couldn't document all the non-G01A activity and revenues that it acquired. When these situations arose, we assigned a reduction factor in the following manner:

a) We assigned the boat a reduction factor that was based upon the average factor for that boat in the other years that it was used in the fishery; OR

b) If (a) couldn't be calculated, we assigned the vessel a fishery reduction factor that was equal to the average of the vessels that were owned by Alaska residents.

(5) A constraint was imposed that kept the sum total of all reduction factors for all G01A fisheries in a year to be less than 1.0. If the factors did sum to greater than 1.0, they were proportionately reduced.

(6) An upper-end constraint was applied. The distribution of values was calculated for fishery reduction factors and extremely high estimates were constrained to the 90th percentile of all values.

(7) The mean fishery reduction factor for each year was adjusted so that it was the same in all years. We accomplished this by multiplying each vessel\year\fishery reduction factor by an adjustment ratio. The ratio was:

$$\frac{\mathbf{RF}}{\mathbf{RF_t}}$$

where:
RF = Mean reduction factor of all vessels over all years
RF_t = Mean reduction factor of all vessels in year t

By allowing the overall fishery means to be the same in all years we took out some of the annual average variation in fixed costs without greatly impacting the individual reduction factors for a vessel.

b. Other Reduction Factors

When we allocated the costs of other capital investments besides vessels, we chose a reduction factor that depended upon what we learned in our survey of G01A operators. Most of the other equipment -- skiffs, nets, pumps, and other -- was not used in all fisheries; rather, the equipment was more specialized for certain fisheries. Therefore, the type of fishing that the operator engaged in determined the reduction factor formula that we used.

If we were allocating capital investment costs to non-survey operations (and consequently we didn't know in which fisheries the item was used), we chose the modal reduction factor formula from our survey results.

Our analysis suggested that after we calculated the preliminary fishery reduction factors we should adjust them. Specifically, after we calculated the basic factor we:

(1) Filled in the "blanks" where we had missing reduction factors in certain fishery\years (due to lack of earnings information) with the operation's mean reduction factor in other years, or with the factor of the Alaska residents, as described above in (4a) and (4b), Vessel Reduction Factors.

(2) Imposed a constraint that kept the sum total of all G01A fishery reduction factors to be equal to or less than 1.0. If the factors did sum to greater than 1.0, they were proportionately reduced.

(3) Applied an upper-end constraint to the reduction factors, <u>unless</u> the operator told us that the item was owned and used specifically for G01A fishing, in which case the factor was set at 1.0.

b1. Seine Skiffs Reduction Factors

We chose one of three reduction factors for the seine skiffs, depending upon what the survey respondent told us about its use.

(a) $\dfrac{GE_{x,t}}{GGE_t}$ *OR*

(b) $\dfrac{GE_{x,t}}{HGE_t}$ *OR*

(c) $\dfrac{GE_{x,t}}{SGE_t}$

where:

$GE_{x,t}$	=	Permit holder gross earnings in G01A fishery x in year t
GGE_t	=	Permit holder gross earnings in all G01A fishing in year t
HGE_t	=	Permit holder gross earnings in all herring seine fishing in year t
SGE_t	=	Permit holder gross earnings in all herring seine and salmon seine fishing in year t

The modal reduction factor formula was (c) and was used for all non-survey observations.

b2. Seine Nets Reduction Factors

We chose one of two reduction factors for herring seine nets, depending upon what the survey respondent told us:

(a) $\dfrac{GE_{x,t}}{RGE_t}$ *OR*

(b) $\dfrac{GE_{x,t}}{HGE_t}$

where:

$GE_{x,t}$ = Permit holder gross earnings in G01A fishery x in year t
RGE_t = Permit holder gross earnings in all herring sac roe fishing in year t
HGE_t = Permit holder gross earnings in all herring seine fishing in year t

The modal reduction factor formula was (b) and was used for all non-survey observations.

b3. Herring Pumps Reduction Factors

The reduction factor for herring pumps was:

(a) $$\frac{GE_{x,t}}{HGE_t}$$

where:

$GE_{x,t}$ = Permit holder gross earnings in G01A fishery x in year t
HGE_t = Permit holder gross earnings in all herring seine fishing in year t

b4. Other Investments Reduction Factors

We chose one of two reduction factors for other capital investments, depending upon what the survey respondent told us about the use of the equipment:

(a) $$\frac{GE_{x,t}}{RGE_t}$$ *OR*

(b) $$\frac{GE_{x,t}}{HGE_t}$$

where:

$GE_{x,t}$ = Permit holder gross earnings in G01A fishery x in year t
RGE_t = Permit holder gross earnings in all herring sac roe fishing in year t
TGE_t = Permit holder gross earnings in all fishing in year t

The modal reduction factor formula was (b) and was used for all non-survey observations.

III. Opportunity Costs and Depreciation

We estimated both opportunity costs and depreciation. Opportunity costs are measured for both capital investments and for the skipper\permit holder's time. Depreciation is calculated for the capital investments. The items of capital for which we applied our estimates were vessels, skiffs, nets, herring pumps, and other equipment.

a. Opportunity Costs and Depreciation for Capital Investments

We proceeded as follows to determine opportunity costs and depreciation for the investments:

(1) For each operation in each fishery\year combination, we established how many investment items of each type were used by the operation -- how many vessels (and which ones), how many skiffs, nets, etc. When we had survey information that told us this, we used it. When survey information was not available we inserted an annual average number (based upon our survey) of investment items for that type.

(2) We assigned an estimated market value to each of the items for all years. Again, we used survey information to help us. We seldom had survey information that would tell us an item's value on a year-by-year basis. Typically, our survey data would give us the original purchase price of an item and then give us the current (1989 survey) estimated value of it, or the value when it was sold. In other records, our survey would provide us with only the original purchase price or sometimes only the value in the current year. When we estimated vessel values, we also used estimated value data that is present on CFEC vessel license files. After we put together the value information that we had, our task was to fill in the "blank" or interim years of missing value information.

Making estimates of the investment's market value in the missing years involved three steps:

a) We used linear models or constant depreciation rates (from the purchase price) to estimate a value for the item in all years that it existed.

b) We created an "adjustment ratio" which compared the results of our modeled estimates in (a) to any survey information we had for the item.

To calculate the ratio we used the years for which we had survey information: we summed the survey values and divided the total by the sum of the values that were derived from our modeled estimates.

c) To establish our final estimate of an item's value in each year, we used survey information when it was available. When survey information wasn't available we used our preliminary estimates in (a) and modified them with the adjustment ratio calculated in (b).

When we encountered operations where we had no survey information at all, we substituted average annual values. We multiplied these average values to the annual average number of items owned (see (1) above). The average annual values were based upon the survey estimates created in (2c) above.

(3) After we determined how many items an operation used in a fishery/year, and we assigned the value of those items in that year, we calculated a "fishery prorated value" for them. The prorated value was the portion of the item's investment which could be allocated to G01A fishing. We allocated the value of the capital investments using reduction factors that are outlined above.

(4) Opportunity costs were calculated. The formula for determining investment item opportunity costs in the year is:

$$\textbf{Investment Opportunity Cost} = OC_t = (PV_t * IR_t) - (RF_t * IF)$$

where:

PV_t	=	Fishery prorated value of the investment in year t
IR_t	=	Interest rate in year t
RF_t	=	Reduction factor for the investment in year t
IF	=	Inflation factor for the investment

We used interest rates from BAA "investment grade" rated bonds by Moody's.

The inflation factor was used to account for appreciation in market value due to inflation. It is the coefficient of a time variable used to model the value of the investment. Our survey data suggested inflation factors should be applied to the opportunity costs of vessels, skiffs, and nets. We did not apply an inflation factor to the opportunity costs of herring pumps and other equipment after we analyzed our survey data for those items.

5) Depreciation was calculated. The formulas for determining investment item depreciation in the year are:

a) $\textbf{Investment Depreciation} = DP_t = (AC * RF_t);$ *OR*

b) **Investment Depreciation = DP_t = $((AC + (2*A^2C*A_t)) * RF_t)$**; *OR*

c) **Investment Depreciation = DP_t = $(DR * RF_t)$**

where:

AC	=	Age (depreciation) coefficient of the investment. This coefficient is part of our linear model of the item's market value.
A^2C	=	Age squared (depreciation) coefficient of the vessel value model (see above)
A	=	Vessel age in year t
RF_t	=	Reduction factor for the investment in year t
DR	=	Constant depreciation rate of the investment.

We used formula (a) for seine skiffs, formula (b) for vessels, and formula (c) for herring pumps and other sac roe equipment.

Our survey information indicated that herring seine nets do not normally depreciate in market value. Repairs and maintenance expenses appear to entirely offset their depreciation.

b. Skipper Opportunity Costs

We measured the skipper's opportunity cost using a base of $5,468[167] for each fishery\year. We converted this amount to real (1991) dollars using a Gross Domestic Product implicit price deflator.[168]

In early years of the fishery, it was possible for a skipper/permit holder to participate in more than one southeastern Alaska roe herring (G01A) fishery. Most G01A fisheries occurred within one month of each other. We wanted to avoid overestimating the sum total of a skipper's opportunity cost in all G01A fisheries so we allocated a portion of the base figure to each of the fisheries that a skipper participated in during the year.

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167 This number is the mid-point between two months of the average monthly wage estimate for "Nonagricultural Wage and Salary Employment" in Alaska during 1991 (see Quarterly Employment & Earnings Report - 4th quarter 1991, Alaska Dept. Labor) and a rough calculation of the average net crewshare during the 1988 fishery (the last year of positive economic profits in the fishery). The two month nonagricultural wage is $5,080 and the estimated average crew share is $5,856.

168 The GDP index can be found in Survey of Current Business, 72 (Sept. 1992): p. 44

IV. Fixed Costs and Expenses

Our survey suggested we could divide the expenses of a Southeast sac roe operation into two groups, and within those groups we could distinguish several expense categories:

Unshared Expenses	Shared Expenses
Insurance	Food
Repairs and Maintenance	Fuel
Fishing Gear	Unemployment
Travel and Entertainment	
Freight and Transportation	
Moorage and Gear Storage	
Business Expenses	
Ship Stores	
Permit and Licenses	

Shared expenses are those costs normally split between the permit holder\vessel owner and the crew. Unshared expenses are costs that are normally absorbed solely by the permit holder\vessel owner and are "fixed" over several fisheries -- that is, they are costs that are incurred in keeping the operation working in all types of fishing during the year. We needed to allocate a portion of the unshared expenses to the Southeastern roe seine fishery. The methods we chose are outlined below.

a. Shared Expenses

Our estimation of shared expense for each observation[169] involved several steps:

(1) We received most of our shared expenses information from the accounting settlement sheets that our survey respondents provided us. From the survey, we derived linear models that estimated the amount of each of the different categories of shared expenses.

(2) We calculated an "adjustment ratio" for each observation. The adjustment ratio compared actual survey data with the model estimate calculated in (1). To calculate the ratio we used the years for which we had survey information: we summed the survey values and divided the total by the sum of the values that were derived from our modeled estimates.

169 An observation as defined herein is a year/permit holder/fishery combination

(3) We assigned a shared expense accordingly: If we had actual survey data, we used it; otherwise, we inserted the estimate from our model and modified it with the adjustment ratio.

b. Unshared Expenses

As mentioned, unshared expenses are normally costs that are incurred as a means to keep an operation fishing in several fisheries throughout the year.

Our first efforts were to establish estimates for each of the operation's annual unshared expenses. We accomplished this with similar steps as outlined in 1 - 3 above, using a combination of survey data and linear model estimators. After we established our best estimate of an operation's annual expense, we allocated a portion of it to the specific Southeastern roe fishery(s) that the operation was involved in. We achieved this by applying a "reduction factor" based upon the fishing activity of the vessel(s) in the operation. The determination of the reduction factors is outlined above. After we applied the reduction factor, we had estimates of both annual and fishery expenses.

c. Final Estimates of Expenses

We applied two adjustments to arrive at our final estimates of unshared and shared expenses.

(1) In the years prior to 1983, it was possible for an operation to participate in more than one Southeastern roe seine fishery during a year. To avoid overestimating the sum total of the expenses, we multiplied our annual fishery estimates by:

$$\frac{SL_t}{FP_t}$$

where:

SL_t	=	Season length in months in year t
FP_t	=	Number of Southeastern roe fisheries the permit holder participated in during year t

(2) The second adjustment was an upper-bound constraint. We calculated the distribution of our estimates. Inordinately high estimates were confined to the 90th percentile of the total distribution. We applied this constraint to both annual and fishery expenses.

V. Crew Sizes

We interviewed southeastern Alaska roe herring purse seine skippers regarding the sizes of their crews. The following table displays the annual averages. The 1989-1992 values were based upon the average over the 1983-1988 time period. We used crew size information to help calculate net crew shares and skipper shares.

Table 20. Average crew sizes by year for the southeastern Alaska herring sac roe seine fishery; 1975 - 1992.

Year	Number of Crew
1975	5.333
1976	5.5
1977	5.4
1978	5.667
1979	5.875
1980	5.636
1981	5.583
1982	5.381
1983	5.683
1984	5.65
1985	5.65
1986	5.727
1987	5.542
1988	5.655
1989	5.652
1990	5.652
1991	5.652
1992	5.652

APPENDIX III

APPENDIX III

Memoranda of Interest

Memoranda that follow this page:

1) Kurt Schelle to Carl Rosier; June 7, 1991

2) Carl Rosier to Kurt Schelle; July 23, 1991

3) Carl Rosier to Roy Rickey; February 2, 1977

4) David Cantillion to Carl Rosier; October 19, 1976

5) Kurt Iverson to Kurt Schelle; November 30, 1992

MEMORANDUM **STATE OF ALASKA**

TO: Carl Rosier
Commissioner
Dept. of Fish and Game
Mail Stop: 1100

DATE: June 7, 1991

FILE NO:

TELEPHONE NO:

FROM: Kurt Schelle KS
Mgr. of Research and Planning
C.F.E.C.
Mail Stop: 0302

SUBJECT: SE. AK. Roe Herring purse seine optimum numbers

The Commercial Fisheries Entry Commission (CFEC) requests the Department's assistance in determining the "optimum number" of permits in the Southeastern Alaska roe herring purse seine fishery. CFEC was ordered to determine optimum numbers by the Alaska Supreme Court in Johns v. State, CFEC, 758 P.2d 1256 (Alaska 1988). A copy of the decision is enclosed.

Under AS 16.43.290. (copy enclosed), the commission is directed to determine optimum numbers based upon a reasonable balance of three standards. The commission has spent some time estimating historical rates of return in the fishery, and developing a model which forecasts future returns under different scenarios. These estimates will be used to address standard one and to help address standard three.

Standard two requires the expertise of fishery managers. The standard reads as follows:

"(2) The number of entry permits necessary to harvest the allowable take of the fishery resource during all years in an orderly, efficient manner, and consistent with sound fishery management techniques."

We feel that standard two addresses the need to manage a fishery in a safe and efficient manner so that the resource can be conserved, large overharvests or underharvests can be avoided, and substantial waste does not occur. As the precise meaning of the standard may be arguable, we have provided a list of questions below which should help us "bound" an estimate of the number described under standard two.

Given the short and hectic nature of this fishery, we think that standard two will be very important in determining the final optimum number. Indeed, the Department's concerns about its ability to control this "derby" roe herring fishery were probably the main reason the fishery was originally limited.

I have attached a 1976 memorandum which Dave Cantillon (then Area Biologist) sent to you (when you were Director of Commercial Fisheries) and a 1977 memorandum which you sent to Roy Rickey (then a

CFEC commissioner). Both memoranda make recommendations about the maximum number for the SE roe herring purse seine fishery and recommend a level at 25 to 30 permits. Both memoranda point to concerns about the fishing power of herring purse seiners and the Department's ability to control the harvest, particularly when guideline harvest levels are in the 200 to 1,500 ton range. The maximum number recommendation reflected management's conservation concerns, which at the time included a concern that the fishery might have to be closed at current stock levels if the maximum number of 35 was adopted as proposed.

As you are aware, the commission eventually adopted a maximum number of 35 and because of the "significant hardship" point level[1] adopted with the point system have issued more permits than that number. To date, 44 entry permits have been issued and that number could increase further as the final classifications of seven interim-use permit holders still have to be determined. During the eighties the Department was often forced to manage the fishery with 50 to 52 seiners on the grounds. Fortunately, stock levels in the eighties were high relative to the mid-seventies.

Standard two is also very important because of the Supreme Court's Decision in Johns. The court concluded:

> "to be constitutional, a limited entry system should impinge as little as possible on the open fishery clauses consistent with the constitutional purposes of limited entry, namely, prevention of economic distress to fishermen and resource conservation . . . . The optimum number provision of the Limited Entry Act is the mechanism by which limited entry is meant to be restricted to its constitutional purposes. Without this mechanism, limited entry has the potential to be a system which has the effect of creating an exclusive fishery to ensure the wealth of permit holders and permit values, while exceeding the constitutional purposes of limited entry."

One of the primary purposes of management is resource conservation. It is also a primary purpose of the limited entry act. Because of the Supreme Court's constitutional concerns it is very important that we document, to the extent possible, how management's ability to allow a commercial fishery, management's ability to control a fishery to prevent overharvest, management's ability to maximize the gross value of the harvest, and the overall cost of management, can all be impacted by the amount of fishing capacity present on the grounds.

It is possible that the Board of Fisheries could take future

[1]Under AS 16.43.270, any person who was classified within a priority (point) classification specified under AS 16.43.250(b) (the significant economic hardship point levels) automatically receives a permit, irrespective of whether or not the maximum number is exceeded.

regulatory action to reduce the "efficiency" of individual operations. If so, it might be possible to control a greater number of fishing operations without increasing the risk of overharvest. Nevertheless, neither CFEC nor ADFG control Board decisions. For that reason, we would like to get answers to our questions under the assumption that the current regulations of the Board of Fisheries will remain substantially unchanged.

The Department's answers to the attached questions should help us do a better job of placing appropriate "bounds" under standard two. We realize that some of the questions may be too difficult to answer definitively. Nevertheless, the Department's biologists and fishery managers are the "experts" with respect to this fishery. When definitive answers are impossible, any guidance which can be provided as "professional judgements or opinions" would be very helpful to the commission. Feel free to qualify or clarify your answers in any fashion you think is appropriate.

cc:
Commission
Denby Lloyd
Paul Larson
Scott Marshall
Robert DeJong
Don Ingledue

Southeastern Alaska Roe Herring Purse Seine Fishery
ADFG Management Optimum Number Questions

Herring Stocks

1. Some have asserted that the herring stocks of Southeastern Alaska are undergoing a long-term recovery from years of overharvest during the reduction fisheries. This theory suggests that the herring stocks in Sitka and Lower Lynn Canal will tend to improve over time (an upward trend with year to year variations around the trend), and other smaller stocks will become large enough to support commercial fisheries. Does the Department expect herring stocks in Southeastern Alaska to grow larger over the next 20 years?

2. Can recruitment cycles cause large changes in biomass?

3. Can herring populations go up and down quickly due to natural variations in recruitment?

4. Sitka Stocks:

   At the beginning of the roe herring fishery in the 1970s, estimated herring spawning population levels of the Sitka stocks were relatively low (compared to the eighties). In 1977 a fishery was not allowed because the minimum spawning population threshold was not met. In the 1980s stock conditions improved (although there was considerable year-to-year variation) resulting in a peak biomass estimate of 117.3 million pounds following the 1988 season. Since then we've seen a decline in the herring spawning biomass.

   a. Over the next 20 years, would you expect the Sitka herring spawning population to ever return to the lower-levels observed in the mid-seventies?

   b. Is possible that Sitka stocks could fall below minimum herring spawning threshold levels and remain there for a long period of time?

   c. Over the next 20 years, do you think that Sitka herring spawning population levels will tend to be higher than the average level observed during the decade of the eighties?

   d. Over the next 20 years, what range of harvest levels and herring spawning population levels would you expect to observe in Sitka (minimums and maximums)?

e. Over the next 20 years, what would you expect the average harvest limit (quota) to be in the Sitka fishery?

5. Lower Lynn Canal Stocks

The Lower Lynn Canal roe herring fishery resulted in modest harvests through 1982. The harvests were always under 1,000 tons The roe herring fishery has been exclusively a purse seine fisher since 1980. Since the 1982 fishery, the fishery has remained closed as the spawning population has failed to rise above the threshold level required for a commercial harvest.

a. Was the harvest limit (quota) exceeded in 1982?

b. Since the 1982 fishery, the Lower Lynn Canal stocks have failed to rebound. As a result the minimum herring spawning threshold level for a commercial harvest was raised from 8,000,000 pounds (4,000 tons) to 10,000,000 pounds (5,000 tons). The stocks have not rebuilt above this threshold and a commercial fishery has not been held for the last nine years. Is it common for a herring stock to collapse to a lo level where it just barely maintains itself (without commercial exploitation) for a long period of time?

c. A 1985 memorandum from Don Ingledue to Paul Larson (see attached) indicated the following:

"The present extreme low herring spawning population level in the Juneau area will make it difficult for the population to return to normal levels without extremely strong recruitment. The chance of this happening to a degree which will restore the population to normal size in the near future is very small. At the present spawning population size, it will take many years with good year class recruitment to return to a healthy level.

The Juneau area herring threshold should be maintained at 10 million pounds considering that the previous 8 million pound threshold did not adequately protect the population from dropping to this present critically low level."

1. From 1983 through 1991 no purse seine roe herring fishery has been allowed on the Lower Lynn Canal stocks. Has the Department seen any signs that the stocks are rebuilding?

2. Does the experience with the Lower Lynn canal stocks imply that overharvest can be a serious threat when a herring resource is at lower population levels?

3. Are there examples in other herring fisheries where stocks have fallen to a low level and take a long-time to recover?

d. Do you expect the Lower Lynn canal stocks to recover to a level which will allow a commercial harvest in the near future?

e. Over the next 20 years, what range of harvest levels and biomass levels would you expect to observe in the Lower-Lynn Canal fishery (minimums and maximums)?

f. Over the next 20 years, what would you expect the average harvest limit (quota) to be in the Lower-Lynn Canal fishery?

6. ADFG reports to the Board on the Southeastern Alaska roe herring fisheries indicate that commercial harvests of herring remain controversial:

" The commercial utilization of Southeast Alaska herring resources is very controversial. Although the subsistence and personal use harvest levels are a minor portion of the annual take, these uses are considered important to local residents. The commercial harvesting is viewed by much of the public as having a great impact on the local availability of herring. Additionally, herring are a major forage fish; a high abundance is viewed as necessary to ensure an abundance of salmon and marine mammals."

These statements seem to imply that some members of the public think that the conservation impacts of overharvesting a herring stock may extend beyond the impacts on the stock itself and the economic consequences of overharvesting a herring stock may impact persons not directly involved in the commercial herring fishery.

a. Is there any evidence that some herring predator populations increase and decrease with the size of herring stocks ?

b. Does the potential for such interactions increase the perceived risks associated with overharvesting the resource?

Herring Management

1. ADFG reports to the Board on the Southeastern Alaska herring fisheries contain the following paragraph under <u>Management Strategy</u>.

Herring stocks with a spawning biomass of less than 4 million lbs., of which there are many, are not considered for harvesting in either the Southeast Alaska winter bait or sac roe fisheries. Under the current approach for setting seasonal harvest limits, herring stocks of 4,000,000 pounds of adult fish would allow for an annual harvest of 200 tons of herring. The region's current management capability, combined with highly competitive nature of these fisheries, makes it impossible to successfully manage the winter bait or sas roe fisheries for harvests of less than 200 tons. In the Yakutat Area, a winter bait harvest of 100 tons has been allowed. However, the Yakutat Area fishing effort has been sufficiently low to allow management for smaller harvests.

a. Does the above paragraph imply that if the number of fishing operations could be contained to a sufficiently low level anc ADFG had sufficient funds, commercial harvests on stocks less than 4 million pounds could be allowed in Southeastern Alaska?

b. Assuming ADFG had adequate funding for management, approximately how small would the number of fishing operations have to be before it was "safe" to allow a commercial opening with a harvest limit under 200 tons?

c. In general, do the number of fishing operations which can be "safely managed" tend to depend upon the size of the harvest quota?

2. We've been told that the fishing power of individual sac roe purse seine vessels has improved considerably (improved sonars and other electronics, redundant electronics, newer vessels and gear, backup vessels and skiffs, multiple herring seines of different sizes, spotter pilots, herring pumps, and etc.) since the fishery first began. Does the Department agree? Does the Department think that this process has peaked or will fishing power continue to increase in the Southeastern Alaska roe herring purse seine fishery?

3. In his 1976 memorandum to CFEC commissioner Roy Rickey, Carl Rosier indicated that ADFG felt that 41 purse seiners were more than typically could be controlled when attempting to maintain harvest levels in the 200-700 ton range. Dave Cantillon in his 1976 memorandum to Carl Rosier indicated that the Department maintained control of the fishery in 1976 but that some luck was involved. Carl Rosier recommended a maximum number of 25 for harvest limits in the 1,000 to 1,500 ton range.

a. Does the Department still feel that a 200 to 1,500 ton Sitka harvest limit would be difficult to manage consistently in a safe, orderly, and efficient manner (without risking a substantial overharvest or underharvest) when 41 purse seiners are involved in a competitive fishery?

b. Did these management considerations about controlling the harvest given the number of fishing operations have anything to do with the minimum spawning biomass threshold levels currently chosen for Sitka? (7500 s.tons, 750 s.ton quota)?

4. In 1991, the Sitka sac roe herring fishery had a 3200 short ton quota. 51 permit holders (44 permanent and 7 IUPs) could have participated in the fishery. An ADFG news release (4/15/91) indicated the following:

"A program of intensive test fishing prior to the fishery indicated a large recruitment of young, age-3 herring with low roe content in the population mixed with higher quality, older-age herring. Fishermen were informed that a competitive fishery would not be possible due to anticipated sorting and handling which would result in unacceptable mortality among released fish. Based on this information, fishermen elected to fish cooperatively (quota divided equally among participants) with a limit of seven fishermen fishing at any one time. Department personnel closely monitored the fishery as it progressed to ensure that excessive mortality did not occur".

Only 35 permit holders stayed to participate in the 1991 fishery and the fishery was closed after 1800 tons of herring had been harvested.

a. In 1991, the estimated size of the spawning stocks (going into the fishery) was approximately 22,750 short tons. This was more than three times the established 7,500 short ton minimum spawning threshold for a commercial fishery in Sitka. Nevertheless, the Department decided that a competitive commercial fishery was too risky and would pose a substantial conservation threat given the number of potential fishing operations involved. Would a competitive commercial fishery have been allowed if the number of units of gear had been substantially lower?

b. Approximately how low would the number of units of gear have to be before a competitive fishery would be allowed under 1991 conditions?

c. Given the current number of permit holders in the fishery (44 permanent plus 7 IUP holders) is it possible that the department will not be able to open the Sitka fishery in some future seasons, even though minimum spawning level thresholds have been met or exceeded (as in 1991)?

5. In his October 19, 1976 memorandum addressed to Carl Rosier (see attached), Dave Cantillon stated the following:

"Special care was taken to open the fishery when herring availability was limited by the depth the schools were at or the scattering of the schools along the shore. Control was maintained, but some luck was involved because with 41 vessels fishing many sets are always in progress and if herring suddenly become available there is no way that managers could do any more than close up the fishery and tally up the take."

From talking to the fishery managers in Sitka and Juneau we learned that this remains a primary management strategy for controlling the units of gear in these fisheries today. The strategy often involves putting the fleet into a small area where there are relatively few fish and keeping them off of large biomass concentrations to prevent overharvest. Confining the fleet to such an area both slows the rate of the harvest and allows ADFG to monitor the harvest more closely to reduce the risk of a substantial overharvest.

In Sitka, we understand that this strategy can be particularly important, when the quota or remaining quota is at or below the 2,500 to 3,000 short ton range, given the current number of fishing operations.

a. Have harvest limits (quotas) sometimes been exceeded in these fisheries despite this careful management approach?

b. Is it possible that the fleet may sometimes have to forego more valuable herring and harvest less valuable herring because of the need for this strategy of confining the fleet and keeping it off of the fish to prevent overharvest?

c. Have accidents involving vessels, nets, or other gear occurred in these fisheries under congested conditions when the fleet is confined to a small area for conservation reasons?

d. Spotter airplane accidents have occurred in some roe herring fisheries. A fatal accident occurred in the 1991 Prince William Sound fishery. In Sitka, the fishery must often be confined to areas adjacent to the urban population which may increase the potential damage and loss from a plane accident. We've been told by some Sitka fishermen that the potential liability from a spotter plane accident is an important concern among the fleet. Is the Department concerned about the increased potential for a disastrous plane accident when the fleet has to be tightly confined for conservation reasons?

6. The Sitka fishery was not opened in 1977. "Cooperative" or IFQ fisheries have occurred in 1979, 1988,1989, and 1991.

We've heard that the Department has viewed the cooperative or IFQ fishery option favorably when it will reduce conservation risks and increase the value of the harvest. Some say that a cooperative or IFQ fishery allows fishermen to work more slowly and make sets which put the herring under less stress. Presumably such sets can be tested and, if needed, released with lower handling mortality. To the extent that fishermen and processors have more of an incentive to share information, sets sometimes car be targeted toward herring with higher quality roe.
The fishermen who "like" the cooperative fishery think that it

allows the fleet to better use the quota to target herring with higher roe content. In doing so, the total value of the harvest is increased over what it would be under normal "fishing derby" conditions.

a. Was 1991 the first year that a fishery would not have been held at all unless the fishermen formed an acceptable agreement for a cooperative fishery ?

b. Has the Department actively encouraged fishermen to form such agreements in years other than 1991?

c. We've heard from some fishermen that they don't like it when the Sitka fishery has to be "co-oped" with egalitarian shares (the majority seem to like it). These persons generally feel that they are above-average, have better equipment, and would do much better in a derby-like competitive fishery. In order for a cooperative fishery to occur, each permit holder must agree (or at least acquiesce) to such an arrangement. We've heard that such negotiations are often heated and difficult. If the number of permit holders in the fishery were dramatically increased, is it likely that such agreements become more difficult to achieve?

7. According to CFEC records, the Lower Lynn Canal sac roe fishery (through the last opening in 1982) never had participation levels which approach recent levels in Sitka (50/52). The harvest in the fishery was always less than 1,000 tons. Under current spawning population thresholds, a fishery will occur if the spawning population reaches or exceeds a biomass of 5,000 tons. This suggests that if the Juneau-Lynn canal stocks recover sufficiently to provide for a commercial fishery, harvest limits or quotas will often fall within the 500 to 1,000 ton range.

a. Is the Lower Lynn Canal fishery easier to control than the Sitka fishery?

b. Given the current level of permit holders Southeastern Alaska roe herring purse seine fishery, is it possible that ADFG would not be able to open the Juneau-Lynn canal area to a competitive commercial fishery in some years even though the stock levels suggest a harvestable surplus of 500 to 1,000 tons?

c. When the Lower Lynn Canal fishery has occurred has the Department typically been able to contain the harvest within the established quota?

8. Consider optimum number general standard two under AS 16.43.290.(2):

"(2) The number of entry permits necessary to harvest the allowable take of the fishery resource during all years in an orderly, efficient manner, and consistent with sound fishery management techniques."

a. The number of fishing operations (entry permits) actually needed to harvest all the allowable take in an orderly, efficient manner, and consistent with sound fishery management techniques may be smaller then the number of fishing operations actually in a fishery. Approximately, ho many fishing operations (entry permits) would actually be needed (the minimum required) to harvest, in an orderly, efficient manner, the following allowable takes?

1. The smallest allowable harvest limit in Sitka (the "threshold" quota of 750 tons)?

2. The smallest allowable harvest limit in Lower Lynn Cana (the "threshold" quota of 500 tons)?

3. The highest foreseeable harvest limit (quota) in Sitka over the next 20 years? (see question 4d under Sitka stocks above)

4. The highest foreseeable harvest limit (quota) in Lower Lynn Canal over the next 20 years? (see question 5e under Lower Lynn Canal stocks above)

5. The average expected harvest limit (quota) in Sitka ove the next 20 years? (see question 4e under Sitka stocks above)

6. The average expected harvest limit (quota) in Lower Lyn Canal over the next 20 years? (see question 5f under Lower Lynn Canal stocks above)

b. The number of fishing operations (entry permits) which can b reasonably managed (controlled) to harvest all the allowable take in an orderly, efficient manner, and consistent with sound fishery management techniques may depend upon the size of the allowable take. Sound fishery management techniques would presumably include trying to prevent situations where there is a serious risk of substantial overharvest and also trying to avoid situations where substantial portions or all of the quota must be foregone because of the risk of substantial overharvest. Approximately, how many purse seine fishing operations can reasonably be controlled while harvesting the following allowable takes in an orderly, efficient manner and consistent with sound fishery managemen techniques?

populations in Sitka Sound to levels observed in the 1960s and 1970s.

b. The current threshold level for Sitka Sound is 15,000,000 pounds. Population levels have fallen below this threshold in 7 of the last 28 years since 1964. In the period 1974-78, the population is estimated to have been below this level; hence, it is quite probable that such a pattern could be repeated in the future.

c. As previously stated, we currently have no way of forecasting long-term trends in herring stock sizes except through the inference of historic catch and stock size data. The historic record indicates that the decade of the 1980s was one with a very high abundance of Sitka herring, while that of the 1960s and 1970s was much lower. While it is possible that abundance levels of the Sitka Sound stock could increase over that observed in the 1980s, there is no record of this stock reaching levels greater than that of the 1980s. Without a record of larger stock sizes, it is difficult to foresee such levels of abundance.

d. The current harvest strategy provides for a harvest rate of 10 percent of the estimated biomass once the spawning threshold is reached. The harvest rate is allowed to increase to 20 percent when the biomass reaches seven times the threshold. We do not foresee a change in this management approach. Since 1969 when the roe fishery began, we have harvested from 0 to 12,000 tons of herring in Sitka Sound, and we would expect to see this range in the future.

e. We have no way to forecast such long-term averages (over twenty years) other than using the historic average catches. During the period 1969-91, the average harvest in the Sitka sac roe fishery has been 3,329 tons.

5. Regarding Lynn Canal herring stocks:

a. The threshold for the Lower Lynn Canal stock in 1982 was 8,000,000 pounds. The estimated biomass in 1982, considering herring in areas from Gastineau Channel to Berners Bay, was estimated using sonar surveys to be about 8,000,000 pounds. The harvest in 1982 was 1,103,000 pounds. Subsequently, we observed spawning along only 2.7 nautical miles of beach. Scuba diver estimates of the relationship between miles of spawn and herring stock sizes indicated that a mile of spawn is roughly equivalent to 500,000 to 1,000,000 pounds. of spawning fish. Hence, it appears that our sonar surveys overestimated the biomass of fish that subsequently spawned in the lower Lynn Canal area. We believe that a combination of overestimation of abundance based on the sonar methods, coupled with the inclusion of the Gastineau Channel wintering stock, resulted in a harvest in excess of what we would have allowed given the subsequent spawn deposition information. Had we known that only 2.7 miles of spawn would have been observed, we would not have allowed a harvest in 1982.

b. The biomass of herring stocks can vary greatly. For several stocks, we have observed long periods of time when the biomass was quite low as compared to historic levels. Under the current management approach where we must have a minimum spawning biomass before we allow commercial exploitation, some stocks which used to be fished regularly are not currently fished. Three examples are the Deer Island, George/Carroll Inlet, and Lower Lynn Canal stocks. Hence, we believe that the record indicates that populations can decline below historic high levels and the biomass can remain lower than the level which would allow commercial exploitation under the current management strategy.

c. (1) The estimated number of miles of spawn for the Lower Lynn Canal stock from 1983 to 1991 has ranged from 2.5 to 7 miles of spawn, and averaged 4.3 miles. During the period 1970-82, the number of miles of spawn ranged from 2.7 to 15.9 miles of spawn and averaged 9.6 miles. Hence, the recent year's data do not indicate a trend of increasing stock size.

(2) Clearly, overharvest of a fishery resource can cause a serious long-term reduction of the sustained yield of a stock. We are uncertain to what extent environmental factors and fishing mortality have caused the Lower Lynn Canal herring stock to decline and remain depressed. Under our current management strategy, we would be more concerned about harvests in excess of the quota when the stock has just reached a level that will allow a commercial fishery than when a stock is at a level far in excess of its threshold.

(3) Yes, there are examples of lengthy stock recovery; see answer to question 5b.

d. We have no data that indicate that the lower Lynn Canal herring stock will return to the former level of abundance in the next couple of years.

e. We have no way of judging future trends for the next twenty years, except from the historic record. During the years 1970-91, we have observed from 2.5 to 15.9 miles of spawn. The limited number of miles of spawn in

6. a. Yes.

   b. No.

   c. It seems to us that it has become more difficult in recent years for the fishermen to agree to a cooperative fishery. Factors which seem to convince people to agree to a cooperative fishery do not seem to be particularly related to how many people participate. On the other hand, it seems reasonable to assume that the more people who participate in this process, the more difficult it may be to reach consensus.

7. a. No, the lower Lynn Canal fishery may actually be somewhat more difficult to control because of the way in which the fish tend to remain in large schools for longer periods of time just off the beaches and then move rapidly onto the spawning grounds.

   b. Unforeseen circumstances may preclude a competitive fishery as occurred in Sitka in 1991. Under more typical circumstances, we can usually find a place and time where limited numbers of fish are available that would permit a competitive fishery.

   c. We have exceeded the quota by a substantial margin in some years. For instance, in 1980 we had a quota of 600 tons but caught 976 tons in one day of fishing. In 1982, we had a quota of 350 tons and caught 550 tons in a day of fishing.

8. Single seine boats can probably harvest up to about 1,000 tons in a single day if the fish are available, but given practical considerations, an average of more like 500 tons per day seems more reasonable. The responses to question number 8 are based on these considerations as follows:

   a. (1) 1-2 boats.

      (2) 1-2 boats.

      (3) 12-24 boats.

      (4) 1-2 boats.

      (5) 4-7 boats.

      (6) 1-2 boats.

   b. This is a very difficult question to answer because many factors must be considered and no quantitative approach seems applicable. We do not believe that there is a correct answer given all the variables involved. With that qualifier, we believe that in Sitka, when we have small quotas, that we can handle 20 to 30 boats. When quotas reach average to high levels, our experience has demonstrated that we can handle about 50 boats. In Juneau, our experience is that we can effectively manage for 20 to 30 boats. However, by being more restrictive with regard to time and area, we may be able to handle more boats.

9. Regarding herring management costs:

   a. In 1990, the Southeast Region spent about $820,000 to manage the herring fisheries in southeast Alaska. From 1984 to 1988, the value of the Southeast herring fishery has averaged 9.4 million dollars. This represents a cost of about 9 percent of the exvessel value of the harvest. This ratio is typical of what the department spends to manage the Sitka stock. The current herring sac roe program includes:

      - Estimation of herring biomass through annual dive surveys of the herring spawn.
      - Preseason monitoring of herring population.
      - Inseason monitoring of prespawning herring populations to determine abundance, distribution, fish size, and roe maturity.
      - Inseason monitoring of fishery to maintain catch at established levels.

   b. As the intensity of the fishery increases, the number of people and vessels needed to monitor the fleet increases.

   c. No.

I hope these answers satisfy your questions. If you require additional information, please contact Denby Lloyd (465-4210).

cc: Scott Marshall
Denby Lloyd
Bob DeJong
Don Ingledue

STATE
of ALASKA

MEMORANDUM

TO: Roy Rickey, Commissioner
Commercial Fisheries Entry Commission

DATE: February 2, 1977

Carl L. Rosier by [illegible]

FROM: Carl L. Rosier; Director
Division of Commercial Fisheries

SUBJECT: Maximum Number of Entry Permits for Roe Herring Purse Seining in Southeastern Alaska

After careful consideration of the recent Board of Fisheries policy statement freezing expansion of the Southeastern Alaska roe herring fishery but not the winter bait fishery, the Southeastern staff and I are requesting that a lower maximum number of permits for roe herring seining be issued than we originally indicated to you.

In 1976 the 41 participating purse seiners were more than we felt could be controlled while attempting to maintain harvest levels in the 200-700 ton range. We were fortunate in being able to open the various areas when the herring were not overly vulnerable to the gear. This approach is an extreme measure to resort to and will not be possible at all times. The efficiency factor as related to fishermen experience and use of sophisticated sounders and side scanning gear has increased greatly and will continue to increase. Thirty or thirty-five boats equipped with limit seines and good searching gear can be awesomely effective. We had only 28 boats, which were less efficient that the present fleet, at Sitka in 1975 when we tripled the desired harvest level.

With only three areas in Southeastern available for purse seining for roe herring and no prospect for the addition of new areas, the economic prospects for a 35 boat fleet are pretty dim. We expect the 1977 roe herring take by purse seines to be only in the 1,000-1,500 ton range. This figure could increase or decrease in future years depending on stock condition, but we have no evidence that any major increase in harvest will occur in the near future.

If the winter fishery is left open for entry, fishermen will have a place to utilize their gear investment if excluded from the roe fishery. The winter markets for both food and bait have expanded and the number of winter herring fishermen will continue to increase. This situation would appear to ease the difficulty of cutting back gear levels for the roe herring fishery.

The proposed regulations presently being reviewed will actually include a point system lenient enough to allow some fishermen with only one year of fishing history to obtain a permit. We feel that for management purposes, and in view of the recent Board of Fisheries policy and the availability of the winter fishery for displaced fishermen with gear investments, that the maximum number of permits for the Southeastern Alaska roe herring purse seine fishery be reduced to 25. If the number of permits cannot be reduced to this level the future of the fishery is certainly in doubt. With no room for expansion, a harvest too small to support the proposed fleet size, and the very real chance of exceeding desired harvest levels, the fishery will have little support from any quarter.

of ALASKA

MEMORANDUM

RECEIVED
OCT 20 197
COMMERCIAL
HEADQUART

TO: Carl Rosier, Director
Division of Commercial Fish

DATE: October 19, 1976

10-29-76

FROM: David Cantillon
Area Biologist
Division of Commercial Fish
Department of Fish & Game - Juneau

SUBJECT: Optimum numbers of units of herring purse seine gear

The winter fishery does not present a problem from an overgearing standpoint as the fleet is presently limited by amounts of herring that processors can market. Most winter fishermen also participate in the roe fishery.

In 1976 a record high of 41 purse seiners participated in the roe herring openings. Special care was taken to open the fishery when herring availability was limited by the depth the schools were at or the scattering of the schools along the shore. Control was maintained, but some luck was involved because with 41 vessels fishing many sets are always in progress and if herring suddenly become readily available there is no way managers could do any more than close the fishery and tally up the take. This is pretty much what happened at Sitka during the 1975 opening. The efficiency of the individual units of gear has increased tenfold with experience and the use of more sophisticated recorders and side looking sonar. To insure control on the roe herring openings I would recommend that a permit level be set that would allow a maximum of 25 boats to participate at any opening. This would probably mean about thirty permits could be issued.

Although the highest number of vessels in any 1976 roe herring purse seine opening was 41, there are a number of fishermen around that fished in recent years, but not in 1976. If all past participants or all who have made herring landings in the last three years are given permits we might as well hang it up as 50-60 permits would be out. If this occurred a lottery system or some other method of limiting the number of units of gear at each opening will have to be considered. If we go on without gear limitation there will be some large overruns of the harvest levels which will cancel what support we have for the fishery and further stir up our critics. Extreme overruns could damage stocks.

I gather that due to the newness of the roe herring gillnet fishery that it will not be considered for limited entry. With over two hundred permits out in 1976, this fishery is already overgeared. We will not be able to provide enough herring to make gillnetting profitable without making inroads on the established winter fishing areas. The number of permits actually fished will be limited by the amount of herring made available. Control of the openings probably will not be a problem as long as the number of areas does not get too large.

The herring data you requested for 1976 is being held up by our need to get some information from tickets presently in key punching.

cc: Gunstrom
Blankenbeckler

MEMORANDUM STATE OF ALASKA

TO: Kurt Schelle
Project Leader, Research & Planning

DATE: November 30, 1992

FILE NO:

TELEPHONE NO:

FROM: Kurt Iverson
Research Analyst
Kurt

SUBJECT: 1980-1991 Permit transfers using brokers

I worked with Elaine to produce the table below. We determined whether a broker was used in the transfer of limited entry permits by using the "BROKER" field on the transfer survey data base. Because you were interested in true permit sales, we used the same exclusion criteria that we use for the average permit prices in the Transfer Survey report. Specifically, all transactions with a sales price of $500 or less were excluded from the statistics provided below:

Year	Number of Sales Using Brokers	Total Number of Sales	Percent Broker Use
1980	32	480	6.7
1981	51	602	8.5
1982	92	654	14.1
1983	119	675	17.6
1984	158	609	25.9
1985	211	690	30.6
1986	225	750	30.0
1987	224	698	32.1
1988	209	695	30.1
1989	161	506	31.8
1990	215	549	39.2
1991	233	531	43.9

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