Agenda #20 (a)
Nov. 2-3, '78

North Pacific Fishery Management Council

Clement V. Tillion, Chairman
Jim H. Branson, Executive Director

Suite 32, 333 West 4th Avenue
Post Office Mall Building

Mailing Address: P.O. Box 3136DT
Anchorage, Alaska 99510

Telephone: (907) 274-4563
FTS 265-5435

October 6, 1978

Mr. Jerry McCrary, Regional
Research Supervisor
Alaska Department of Fish & Game
P. O. Box 686
Kodiak, AK 99615

Dear Jerry,

I'll put the Katz proposal on the agenda for the November 2nd-3rd Council meeting and in the meantime distribute your letter and Katz's proposal to the Council and SSC.

It is an interesting proposal and appears to have merit. I'm sure the Council will listen carefully to the SSC recommendation.

Regards,

Jim H. Branson
Executive Director

STATE OF ALASKA

JAY S. HAMMOND, GOVERNOR

DEPARTMENT OF FISH AND GAME

DIVISION OF COMMERCIAL FISHERIES

P.O. Box 686
Kodiak, AK 99615

September 29, 1978

Jim Branson, Executive Director
North Pacific Fishery Management Council
P.O. Box 3136DT
Anchorage, Alaska 99510

Dear Mr. Branson:

Enclosed you will find a project proposal for king crab population modelling work entitled "Projection of Biological and Economic Impacts of Alternative Management Strategies for the Alaska King Crab Fishery" by Philip L. Katz, Principal Investigator, University of Illinois. The Alaska Department of Fish and Game endorses this work and is prepared to enter into a contract with the principal investigator (documentation also attached).

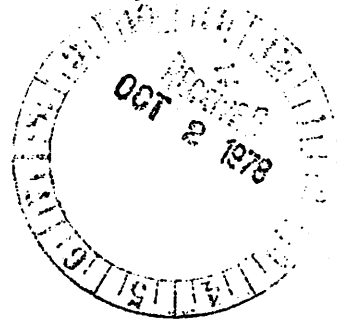
At the October, 1978 meeting of the Scientific and Statistical Committee, a brief overview of evolution of the proposed project was given by Alaska Department of Fish and Game. The SSC membership felt that the proposed work appears worthwhile and that it represents a continuation and extension of the short study undertaken by N.M.F.S. (at the Council's request) to examine the question of costs, if any, in managing king crab stocks to minimize fluctuations in annual catches. Additionally, the proposal addresses other knowledge gaps concerning the biological and economic optimization of king crab management strategies. Many of these knowledge gaps will be noted in the forthcoming draft king crab management plan.

National Sea Grant funding will be sought for this proposed work and the chances of funding would be greatly enhanced by an endorsement by the "Council". The SSC recommends that the "Council/SSC" review the proposed project for possible endorsement.

Sincerely,

Jerry McCrary
Regional Research Supervisor

Enclosures



COLLEGE OF ENGINEERING
BOX 4348, CHICAGO, ILLINOIS 60680
TELEPHONE: 996-3423

This is the same thing I sent to you in Juneau

September 12, 1978

UICE

Steve Pennoyer, Acting Director
Division of Commercial Fisheries
Alaska Department of Fish and Game
Subport Building
Juneau, AK 99801

Dear Steve:

My apologies for sending my proposal summary with incomplete budgetary information last week. Unfortunately the business office people, who saw the budget at the last minute, pressed for some revisions, and I couldn't accumulate the details soon enough to include them.

For stapling into the proposal, I now enclose:

1. A revised Funding Plan (budgetary summary) - Section I in the main body of the proposal,

2. Appendix A - (Detailed Budget) to replace the "dummy" budget page in the Appendices I sent you.

As regards the substance of the changes in budget:

1. There has been no change, obviously, in the 5000/yr ADFG figure for matching funds to be paid out.

2. The "expected to continue" second year of ADFG in-kind services and personnel has been revised upward 7% to allow for estimated inflation in your salaries in year 2. (If you have a more accurate estimate that you use for inflation, I can include it when the proposal goes to Washington, D.C.)

3. There have been upward revisions in the federal components due to increased overhead rates, and due to my error in the method of attributing overhead to the biometrician. This upward revision is $1825 over two years.

I hope that these late additions will not inconvenience you.

Sincerely,

Phil Katz

PK/lb

PROPOSAL SUMMARY

PROJECTION OF BIOLOGICAL AND ECONOMIC IMPACTS OF ALTERNATIVE MANAGEMENT STRATEGIES FOR THE ALASKA KING CRAB FISHERY

Philip L. Katz[1]
Principal Investigator

This is a proposal for research to be submitted to the National Sea Grant Program for funding, based on matching funds committed by the Alaska Department of Fish and Game.

No funds are requested of the North Pacific Regional Fisheries Management Council.

This is a request for formal endorsement of this proposal by the Scientific and Statistical Subcommittee, and then by The Council. The endorsement is sought on the grounds that the proposed research speaks directly to information gaps identified by the Drafting Team for the upcoming King Crab Fishery Management Plan.

[1]Department of Information Engineering, University of Illinois at Chicago Circle, P.O. Box 4348, Chicago, IL 60680. Tel (312)996-5140 (Lab); 996-3423 (Messages c/o Ms. Buford); (312)463-2270 (Home).

I. FUNDING PLAN[1]

A. Funds already committed or expected	
Alaska Department of Fish and Game - matching funds	
for FY78-79 - firm committment[2]	5,000
for FY79-80 - intent to continue[3]	5,000
TOTAL State of Alaska funds to be paid to contractor (2 years)	10,000
B. Value of services and personnel time to be supplied in-kind	
Alaska Department of Fish and Game - value of existing staff time expected to be spent interacting with the research	
for FY78-79 - committed[2]	19,492
for FY79-80 - expected to continue[3]	20,856
University of Illinois - value of principal investigator's time to be spent on this research while on U of I payroll (including overhead)	
for FY78-79 committed	7,914
for FY79-80 committed	8,468
University of Illinois - value of free computer time provided on a basis of 1 for 1 matching of outside-funded computer time (3000/yr x 2 yr)	6,000
TOTAL Alaska and Illinois matching, in-kind (2 years)	62,730
C. Federal funding to be sought from National Sea Grant	
for FY78-79	57,794
for FY79-80	39,297
TOTAL Federal share (2 years)	97,091
GRAND TOTAL Award to contractor (A+C)	107,091
GRAND TOTAL, Matching in kind (B)	62,730

[1]Appendix A is a detailed budget.

[2]Appendix B is the letter of committment and a draft version of the contract

[3]The letter of committment states ADF&G's intent to continue funding in FY79-80, subject to availability of funding and the first year's outcome.

II. WHY - NEED FOR THE RESEARCH, NOW

Historically the Alaska Department of Fish and Game (ADFG) has managed the Alaska king crab fisheries. Policy and management issues, having long-run implications, have historically faced the ADFG on a year to year basis. Under extended jurisdiction, long-run policy and in-season management will come under a cooperative effort by ADFG, the North Pacific Fishery Management Council (The Council), and the Secretary of Commerce (or designee, presumably National Marine Fisheries Service - NMFS).

The Council has been charged with developing a King Crab Fishery Management Plan. The ADFG has been designated lead agency for actually producing this management plan, a draft of which will be submitted to The Council in 1978. In developing present and future management plans, The Council will be requested to respond to inputs from various fishery participants and interested parties. Thus many policy and management issues, fairly well "settled" under State of Alaska jurisdiction, will be re-examined.

One of the specific knowledge gaps identified in the upcoming 1978 Draft Management Plan concerns optimizing fishery management strategy, biologically and economically. The costs and benefits of the present management policy are not fully understood. The research proposed herein will assist in evaluating the yield and economic impacts of present policy and potential alternatives which may be suggested. Thus the proposed research provides information essential to upgrading the king crab fishery management plan.

III. WHO - FINANCIAL SUPPORT, PARTICIPATION, AND REVIEW BY INTERESTED AGENCIES

A. Alaska Department of Fish and Game

1. Partial funding. The ADFG has committed $5,000 "seed" money for the first year of this research, and indicated intent to continue at that level for subsequent year(s), pending satisfactory progress. Appendix B contains a signed letter committing funds, and a draft contract produced by ADFG staff and myself.

2. Review. In June-August 1977 the Kodiak staff of ADFG reviewed an earlier version of this proposal. They sent me 5 pages of detailed reviews and I returned 10 pages of replies. In August 1978, preliminary results (Katz, Balsiger, et al 1978) were presented at the AAAS Alaska Science Conference, attended by ADFG personnel, followed by a subsequent 3-day working session in Kodiak between myself and ADFG personnel. Details of the seed money contract were formalized, and specifics of the research discussed.

B. National Marine Fisheries Service

1. Financial noninvolvement. In June 1977 and since, the Resource Ecology and Fisheries Management Division, NMFS Northwest and Alaska Fisheries Center (REFM-NAFC) took a position of noninvolvement in financial aspects of the proposed research.

2. Ongoing informal interaction with NMFS-NAFC researchers. This interaction has been extensive. James Balsiger (whose 1974 work provided the conceptual basis for mine) has repeatedly given access to his methods and data analysis; he is co-author of preliminary papers on the proposed research (Katz, Balsiger, et al 1977, 1978). Twice in 1977-78, Richard Marasco gave input on the economics component. My preliminary results were presented at NMFS-NAFC in May 1978, and discussed with Balsiger, Marasco, and Jerry Reeves.

3. Short study by NMFS-NAFC researchers. This year, NMFS-NAFC researchers were asked to undertake a short-term modelling study, assessing the impacts of multi-age-class management strategies upon Alaska king crab fisheries. That study (Marasco, Reeves, Balsiger 1978) will soon be reported to The Council. It is the concensus of its authors that it provides valuable insight in understanding management strategies, and develops measures for quantifying economic impact; nonetheless they believe that due to the brief time frame and limitations in the data base, many important questions remain uninvestigated.

4. Informal participation by NMFS-NAFC researchers in proposed research. Although formal assignment of their time to the proposed research seems unlikely due to other commitments, Balsiger, Marasco, and Reeves remain interested researchers in the area. They have agreed to participate informally in the following ways, subject to limitations upon their time: (a) providing first-stage peer review; (b) facilitating inclusion of relevant results and formulations from the NMFS-NAFC short study into the proposed research. (Where appropriate, this may result in co-authorship of results.); (c) making available updated Bering Sea king crab growth, molt, and natural mortality figures, as these become available from analyzing recent NMFS surveys.

IV. WHAT - THE GOAL OF THE PROPOSED WORK

The goal is to provide king crab fishery policy-makers with a tool (an interactive computer model) for projecting economic and biological consequences of various short and long run management policy alternatives. In so doing, the projection method will explicitly display its assumptions regarding the biological and economic condition of the fishery, and make these assumptions available to be modified by the policy maker/user.

Thus, as with any projection of the future, the results will depend on assumtions regarding incompletely-known conditions. The proposed tool will give the users/decision-makers control of the assumptions, so that they may observe their projections' sensitivity to their own assumptions.

The following sort of issues will be addressed by the projection method. This list, accumulated via conversations with regulatory officials and interested parties, is meant to be illustrative, not exhaustive. Other useful questions will undoubtedly arise in the course of the proposed work.

1. What are the biological and economic costs/benefits of management alternatives regarding size limits, and multi-year-class vs recruit fishing at any given size limit? What are the impacts of intermediate alternatives, such as an occasional year of recruit fishing in a normally multi-year class fishery?

2. What are the costs and benefits of managing for stability of yield, vs other possible management strategies? How does the level of cold-storage inventory tie in with this question?

3. At what size limit do yield and economic return losses, due to natural mortality, exceed gains due to growth?

4. To what extent do larger crabs command a higher price per lb than smaller crabs, and how does this bear on the questions in 1 and 2, above?

5. What are the biological and economic impacts of alternative methods of recovering from a poor year class due to natural causes or accidental overfishing (perhaps due to a year's misleading sampling data)? How do immediate cutbacks contrast with gradual cutbacks?

6. What would be the impacts of various fishery management strategies upon the standing brood stock (cf. Powell 1976)? To what extent can historical variation in recruitment be attributed to fluctuations in brood stock, if the yearly size and sex structure of that brood stock is taken into account?

7. Suppose question 6 cannot be answered well. If so, how heavily do the various computer projections depend upon the relative importance of stock size and environmental factors in determining recruitment?

8. To what extent do changes (from one stock to another) in size specific growth increments, molt frequencies, natural mortalities and catchabilities affect the various projections? In fact, how greatly do these parameters differ between Kodiak and the Bering Sea? Would these geographic differences mitigate for differing management strategies?

V. HOW (Part 1) - COMPONENTS OF THE COMPUTER PROJECTION

The computer projection is a combined biological and micro-economic simulation. It is dynamic not only in the sense of allowing inputs (e.g., fishing mortalities, size limits, U.S. disposable income) to vary from year to year, but in the sense of modelling dependence of future recruitment, population (by size) economic return, etc. upon present actions.

A. Biological Component

This part is a modification of Balsiger's (1974) king crab population model, sponsored by NMFS-NAFC. Balsiger assisted in the modifications. The biological component takes into account:

1. The population size and age structure from year to year;

2. Age-dependent growth, including age-dependent skip-molting;

3. Powell's (1965, 1968, 1969, 1972, 1974, 1976) results on dependence of reproduction on male and female relative sizes and upon the female/male ratios;

4. Age-dependent natural mortality.

Thus its projections adjust for changes in future recruitment, due to each year's fishing of adults, and allow projections of potential recruitment failure, due to overfishing of large males. An environmental (stochastic) component of recruitment may also be included.

Because age structrue and the details of the reproductive process are included (and because of the availability of a data base - cf Section IV), it is possible to address the sort of issues raised in the precious "Goal" section.[1]

B. Economics Component

This sector will extend the progress begun (Marasco, Reeves, Balsiger 1978) in the earlier short study (Section III.B.3 of this proposal). It will include:

1. A catch effort component. Annual catch is obtained from standing stock and allowed fishing mortality; effort (potlifts or boat-days) is back calculated via catchability coefficients.

2. Return to harvestor sector, based on model-projected catch and effort. Marasco's results will be used for price-to-fisherman, as a function of annual supply and U.S. disposable income. Size-dependence of price will be included if ADFG can produce quantitative evidence to confirm its qualitative observations on this point.

[1] This is not to say that it will be possible to predict absolute levels of catch, economic return, etc. Rather, a calibration procedure will adjust the model to portray present fishery conditions, after which changes resulting from potential management alternatives, will be projected.

3. Return to processing sector, based on average data for processing costs per pound or per crab, average percentage yields in sections or meats, and a processor's markup.

4. Consumer surplus, based on a wholesale demand curve.

5. A cold-storage component, if appropriate data can be obtained.

In addition to ongoing input from Marasco, input concerning Alaska shellfish economics will be provided by Don Collinsworth, by the ADFG staff economist, and by the ADFG staff, Kodiak.

VI. HOW (part 2) - MECHANISM FOR INTERACTING WITH USERS

Interaction with the user will be assured by ongoing review of the work as it develops. Coincident with making the computer projection operational, it will be programmed for interactive use (via a computer terminal) by fishery managers/policy makers without necessity of computer skills.

A. Interaction With Management Personnel as the Wrok Develops

1. The seed money contract specifies regular interaction (written, phone, or in person) between myself and ADFG (Kodiak) personnel, as the projection method is developed. Rich Peterson will focus the ADFG interactions, with Jerry McCrary supervising.

2. A substantial travel and phone budget is provided.

3. As detailed earlier, NMFS-NAFC researchers have indicated that they will provide informal review and facilitate incorporation of results from their earlier study.

4. Council and SSC members are invited to provide inputs if they so desire.

B. Interactive Use of the Computer Projection by Management Personnel

1. To facilitate management use of the computer projection method, it will be programmed for interactive use. That is, a computer terminal will ask the user questions (pre-selected in phase A, above), in a semblance of English, regarding management decisions and choices of biological/economic parameters. Having received these, the projection method will be run in the computer, and the results displayed immediately. Seeing the results, the user may modify the inputs and repeat the test. The user need not be a "computer jockey."

2. The projection method and its interactive code will be programmed to be machine-independent (portable from one computer to another). A documented copy of the entire package will be provided at the end of the work.

3. The ADFG seed money contract calls for the entire package to be made workable on the ADFG account in the University of Alaska computer.

VII. DATA BASE

A. Presently Available Data Base

The fact that work in king crab projection modelling could progress as far as it has (Balsiger 1974, Katz, Balsiger, et al 1977, 1978) is due to an exceptionally good data base as fisheries go. NMFS 1966-69 Bering Sea studies of size-dependent molt and growth have resulted in a growth (by size) matrix for adult males (Balsiger 1974). Size-dependent growth of immatures and females comes (Balsiger 1974) from Weber's (1965) and Gray's (1963) data. The reproductive process has been extensively studied (Eldridge 1975, Eldridge, Powell, and Chapman 1976, Powell et al 1965, 1968, 1969, 1970, 1972, 1974). Natural mortality estimates have been made (Balsiger 1974, Eldridge 1975). A range of size-specific fecundity data is available (Matsuura, et al 1972, Haynes 1968).

Despite this abundance of data, certain data barriers exist to producing projections that are believable and applicable to a specific stock of king crab.

1. Natural mortality is subject to conflicting estimates.

2. In order to assemble a complete population model, one must combine Kodiak and Bering Sea parameters, despite known growth differences between the two populations.

B. Data Base to be Available

1. Kodiak. There is no published growth matrix for the Kodiak stock, and Eldridge (1975) does not indicate a high degree of certainty in his Kodiak natural mortality estimates. Nonetheless Powell indicates that the raw data is there (indeed one analysis of it is in McCaughran and Powell 1977). Accordingly, this proposal includes a biometrician to work with Powell in analyzing his data.

2. Bering Sea. The most recent growth matrix for the Bering Sea dates from 1966-69, and the corresponding natural mortalities are widely believed to be "contaminated" by incidental catch mortality. NMFS Bering Sea survey data for more recent years is available, however, and Jerry Reeves indicates that analysis of it for molt, growth and natural mortality will proceed on a time schedule consistent with the proposed research.

Alaska Department of Fish and Game. 1975. Statement of Policy on Management of King Crab Resource (to avoid development of a "recruits only" fishery with its attendant boom or bust characteristics), Originally dated January 2, 1975. In Alaska Fishery Management Policy, Juneau, Alaska.

Balsiger, J.W. 1974. A Computer Simulation Model for the Eastern Bering Sea King Crab Population. Ph.D. dissertation, University of Washington. Seattle, Washington. 197pp.

Eldridge, P.J. 1975. An Analysis of the Kodiak Stocks of the Alaskan King Crab Paralithodes camtschatica. Ph.D. dissertation, University of Washington. Seattle, Washington. 270pp.

Eldridge, P.J., G.C. Powell, and D.G. Chapman. 1976. A Method to Estimate the Proportion of Sublegal Male King Crabs, Paralithodes camtschatica (Tilesius), That Mate in the Kodiak Island Alaska Fishery. Manuscript.

Gray, G.W. 1963. Growth of Mature Female King Crab Paralithodes camtschatica (Tilesius). Alaska Dept. of Fish and Game Info. Leaflet No. 26. 4pp. (Processed).

Haynes, E.B. 1968. Relation of Fecundity and Egg Length to Carapace Length in the King Crab Paralithodes camtschatica. Proc. Nat'l Shellfish Assoc. Vol. 58, pp. 60-62.

Katz, P.L. and L.J. Bledsoe. 1976. Alaska Shellfish Regulations: Present Impacts on Participants. Trans. Amer. Fish. Soc. Vol. 106, 1977, pp. 505-529.

Katz, P.L., J.W. Balsiger, and N.T. Hamilton. 1976. Maximizing Long Run Yield of Alaska King Crab as an Optimal Control Problem. Manuscript.

Katz, P.L., J.W. Balsiger, R.H. Schappelle, and T.R. Spinker. 1977. Economic Effects of Fluctuations in Catches and Population Levels, Upon a Population of Alaska King Crab. Proc. 9th Winter Simulation Conf. Gaithersburg, Maryland, pp. 323-329.

Katz, P.L., J.W. Balsiger, T.R. Spinker, and R.H. Schappelle. 1978. Beliefs About King Crab Biology Affect Projected Consequences of Management trategy. To appear, Proc. 29th AAAS Alaska Sci. Conf., Fairbanks.

Marasco, R., J. Reeves, and J. Balsiger. 1978. Assessment of Multi-age-class management strategies. Manuscript Draft. NMFS Northwest and Alaska Fisheries Center. Seattle, Washington.

Matsuura, S., K. Takeshita, H. Fujita, and S. Kawasaki. 1972. Reproduction and Fecundity of the Female King Crab Paralithodes camtschatica (Tilesius) in the Waters off Western Kamchatka, II. Bulletin of 6 July 1972. Far Seas Fish Res. Lab., Shimiya 424, Japan.

Powell, G.C. 1969. Review of King Crab Research. In: Haynes, E.B. and C. Lehman, eds. Minutes of the Second Alaskan Shellfish Conf., Alaska Dept. Fish Game Inf. Leaflet 135. Juneau.

Powell, G.C. 1976. Management Strategy of the Kodiak Island King Crab Fishery, Alaska. Presented at the Alaska Science Conference, Fairbanks, August 1976.

Powell, G.C., K.E. James, and C.L. Hurd. 1974. Ability of Male King Crab, Paralithodes camtschatica, to Mate Repeatedly, Kodiak Alaska 1973. Nat. Mar. Fish. Service, Fish. Bull., Vol. 72, No. 1, pp. 171-179.

Powell, G.C. and Lebida. 1968. Egg Production Success of Alaskan King Crabs Collected from the Aleutians, Kodiak Island, and Lower Cook Inlet, 1939-1968. King Crab Staff Report, Alaska Dept. of Fish and Game. Kodiak, Alaska. 7pp.

Powell, G.C. and R.B. Nickerson. 1965. Reproduction of King Crabs, Paralithodes camtschatica (Tilesius). J. Fish. Res. Board Canada, Vol. 22, No. 1, pp. 101-111.

Powell, G.C., B. Shafford, and M. Jones. 1972. Reproductive Biology of Young Adult King Crabs Paralithodes camtschatica (Tilesius), Kodiak Alaska 1971. Proc. Nat'l. Shellfish Assoc., Vol. 63, pp. 78-87.

Rothschild, B.J., G.C. Powell, J. Joseph, N.J. Abramson, J.A. Buss, and P. Eldridge. 1970. A Survey of the Population Dynamics of King Crab in Alaska, with Particular Reference to the Kodiak Area. Alaska Dept. Fish Game Leaflet 147. 149pp.

Smith, F.J. 1975. The Fisherman's Business Guide. International Marine Publishing Co. Camden Maine. 172pp.

Weber, D.D. 1965. Growth of the Immature King Crab Paralithodes camtschatica (Tilesius). Masters thesis, University of Washington. Seattle, Washington. 100pp.

APPENDICES for proposal

Projection of Biological and Economic Impact of Alternative Management Strategies for the Alaska King Crab Fishery

Philip L. Katz

Appendix A - Detailed Budget

Appendix B - Committment of funds
and draft contract with ADFG

Appendix C - Resume of Principal Investigator

APPENDIX A - DETAILED BUDGET

This Appendix includes:

Two year budget
First year budget
Second year budget

Note: The summary figures, found in the FUNDING PLAN section of the proposal, are obtained from the "Breakdowns by Source" on each page of the detailed budget.

TWO YEAR BUDGET

	"In Kind" Cost Sharing	Federal and State Award Sought
Principal Investigator P.L. Katz 5 mos, 100% time, 2 summers 18 mos, 20% time, 2 academic years	8,673	12,047
Alaska Dept Fish and Game, Staff time[0] in input and review	36,680	
Computer Research Analyst (18 mos 50%, 5 mos 100% time)		20,067
Biometrician (Grad student) First year only 6 mos in Kodiak at 1500/mo full time 5½ mos on campus at 600/mo half time		12,300
Secretarial (24 mos at 25% time)		5,693
Library Researcher (to perform searches at a major fisheries library - 200 hrs)		1,035
TOTAL Salaries and Wages - TWO YEARS	45,353	51,142
Computer time - 40 hrs at 300/hr	6,000	6,000
Equipment: LA36-K Discwriter storage for computer terminal		1,095
Travel[1]		4,968
Publication - Page charges and costs of tech. rep.		3,000
Long distance phone charges to Alaska		1,500
Xerox, office supplies, purchase of documents		1,000
TOTAL Direct Costs - TWO YEARS	51,353	68,705
Indirect Costs Plus Benefits University Employees[2,3] State of Alaska Employees[4]	7,709 3,668	38,386 0
TAL BUDGET, TWO YEARS	62,730	107,091
REAKDOWN BY SOURCE		
tate of Alaska	40,348	10,000
tate of Illinois - Salaries, Wages, Overhead	16,382	0
- Other	6,000	0
edl Funds	0	97,091
OT.	62,730	107,091

BUDGET - YEAR 1

	"In Kind" Cost Sharing	Federal and State Award Sought
Principal Investigator P.L. Katz		
2½ mos, 100% time, summer		5,820
9 mos, 20% time, academic year	4,190	
Alaska Dept Fish and Game, Staff time[0] in input and review	17,720	
Computer Research Analyst (9 mos 50%, 2½ mos 100% time)		9,694
Biometrician (Grad student)		
6 mos in Kodiak at 1500/mo full time		
5½ mos on campus at 600/mo half time		12,300
Secretarial (12 mos at 25% time)		2,750
Library Researcher (to perform searches at a major fisheries library - 100 hrs at 5.00/hr)		500
TOTAL Salaries and Wages - Year 1	21,910	31,064
Computer time - 20 hrs at 300/hr	3,000	3,000
Equipment:		
LA36-K Discwriter storage for computer terminal		1,095
Travel[1]		2,400
Publication - Page charges and costs of tech. rep.		1,500
Long distance phone charges to Alaska		750
Xerox, office supplies, purchase of documents		500
TOTAL Direct Costs - Year 1	24,910	40,309
Indirect Costs Plus Benefits		
University Employees[2,3]	3,724	22,485
State of Alaska Employees[4]	1,772	0
TOTAL BUDGET, YEAR 1	30,406	62,794
BREAKDOWN BY SOURCE		
State of Alaska	19,492	5,000
State of Illinois - Salaries, Wages, Overhead	7,914	0
- Other	3,000	0
Federal Funds	0	57,794
TOTAL	30,406	62,794

	"In Kind" Cost Sharing	Federal and State Award Sought
Principal Investigator P.L. Katz 2½ mos, 100% time, summer 9 mos, 20% time, academic year	4,483	6,227[5]
Alaska Dept Fish and Game, Staff time[0] in input and review	18,960	
Computer Research Analyst (9 mos, 50%, 2½ mos, 100% time)		10,373
Secretarial (12 mos at 25% time)		2,943
Library Research (to perform searches at a major fisheries library - 100 hrs at 5.35/hr)		535
TOTAL Salaries and Wages - Year 2	23,443	20,078
Computer time - 20 hrs at 300/hr	3,000	3,000
Travel[1]		2,568
Publication - Page charges and costs of tech. rep.		1,500
Long distance phone charges to Alaska		750
Xerox, office supplies, purchase of documents		500
TOTAL Direct Costs - Year 2	26,443	28,396
Indirect Costs Plus Benefits		
University Employees[2,3]	3,985	15,901
State of Alaska Employees[4]	1,896	0
TOTAL BUDGET, YEAR 2	32,324	44,297
BREAKDOWN BY SOURCE		
State of Alaska	20,856	5,000
State of Illinois - Salaries, Wages, Overhead	8,468	0
- Other	3,000	0
Federal Funds	0	39,297
TOTAL	32,324	44,297

Budget Footnotes

[0]Fractional time of existing staff, as estimated by ADFG

[1]Travel. This budget is large. Its size is based on the need to interact with fishery management personnel in Alaska. The budget is for 3 trips to Kodiak, Alaska annually. Stopovers in Juneau, Anchorage, and/or Seattle, if necessary, are free or $5.00 each.

Air Chicago-Anchorage-Chicago	423	
Air Anchorage-Kodiak-Anchorage	97	
5 days per diem, Alaska	250	
Airport Limos	30	
Total per trip	800	
Total for 3 trips, first year		2400
Total for 3 trips, second year (7% increase)		2568

[2]University of Illinois indirect costs and benefits
Indirect costs 72% on campus, 36% off campus
Retirement 11.93%, Health & Life Ins 4.2% (permanent personnel)
Workmen's Comp. 0.76%

The above total to 88.9% for principal investigator and secretary, 72.8% for the computer research analyst (non permanent), and 36.8% for the hourly library researcher (off campus).

[3]Indirect costs and benefits for the biometrician were calculated on the basis of a grad student at an institution having a program in fisheries biometrics. Such a student might be included either as an off-campus employee of University of Illinois or (more likely) as a subcontractor employed by his/her home institution. A typical such institution would be University of Washington. The figures here are based on indirect costs (55%) plus benefits (7%), totaling 62% for student employees there.

[4]State of Alaska overhead is 10% on all of their items.

[5]For salaries projected to continue 2 years, 7% inflation is included for the second year.

STATE OF ALASKA

JAY S. HAMMOND, GOVERNOR

DEPARTMENT OF FISH AND GAME

OFFICE OF THE COMMISSIONER

SUBPORT BUILDING
JUNEAU, ALASKA 99801

July 11, 1978

Dr. Phil Katz, Associate Professor
College of Engineering
University of Illinois - Chicago Circle
Box 4348
Chicago, Illinois 60680

Dear Phil:

I have discussed your proposal and your "mode of operation" letter of June 12 with various members of our Headquarters and Kodiak Regional staff. We are in agreement that your shellfish computer simulation modeling research project has substantial potential benefit to our consideration of alternative management strategies in our shellfish fisheries. We are willing to fund this project at the $5,000 per year level out of our General Fund appropriation starting this fiscal year.

I believe that both Jerry McCrary and I will be present at the Alaska Science Conference in Fairbanks in midAugust. At that time perhaps we can finalize contract content, duration, and the manner in which you, our agency and the National Marine Fisheries Service will function together in determining project objectives and monitoring its progress.

Thank you again for the time you have taken to explain your proposal to us and to convince us of its value. I'm sorry it took so long to come to a decision on whether we would fund you or not, even at this relatively modest level, but there was really no easy way to make this decision without some indication of our budget for the coming year.

I cannot legally commit funds for ensuing fiscal years, but pending the availability of funding and the outcome of our first year's contract, it is our intention to continue this cooperative agreement next year.

Sincerely,

Steve

Steve Pennoyer, Acting Director
Division of Commercial Fisheries

cc: Jerry McCrary
Don Collinsworth
Ivan Frohne

.H

CONTRACT

This contract, entered into the _____ day of _____, 1978, effective as of _____, 1978 between the State of Alaska, Department of Fish and Game (hereinafter called the "State) and the University of Illinois at Chicago Circle (hereinafter called the Contractor).

The principal investigator for the services supplied by the Contractor shall be Philip L. Katz, Associate Professor.

WITNESSETH that:

Whereas, the Contractor is the only source available for specific expertise in King crab computer projection research, no competitive bids were initiated by the State. In compliance with Alaska Statute 37.05.230 (1) (C) (i), which states "Competitive bids need not be required for contractual services where no competition exists".

Whereas the Contractor is willing to undertake the performance of this contract and possesses a particular combination of knowledge in (1) King crab population dynamics; (2) the operation of Alaska shellfish fisheries, including that for King crab; (3) complex dynamic systems, optimization, and computer modelling and (4) communicating with fisheries researchers and managers regarding the technical matters in (3);

Whereas, Alaska Statute 16.05.050 (5) states, "The commissioner has, but not by way of limitation, the following powers and duties: Collect, classify and disseminate statistics, data and information as in his discretion will tend to promote the objects of this chapter;"

NOW THEREFORE, the parties hereto agree as follows:

Article I. The Service to be Performed

The Contractor shall perform via computer simulation a comparative analysis of the consequences of several long-run King crab management strategies resulting from using specified biological parameter sets and management strategies. These consequences will include economic impacts and impacts upon the biological status of King crab stocks. The specific details of which impacts are to be analyzed, will be finalized in Article IVa.

Article II. The Period of Performance

The period of performance of this contract shall commence on _____, 1978 and expire on June 30, 1979. The expiration date may be extended by mutual consent of the State and the Contractor.

Article III. Consideration

In consideration of the Contractor's performance hereunder, the State shall pay the Contractor a total of $5,000.00. It is anticipated that the Contractor will seek

rovided to the State, of federal intent to commit full-scale funding sufficient to omplete the service. At such time the remaining $3,500.00 (of the $5,000.00 total) ill be made available to the Contractor.

In further consideration of the Contractor's performance hereunder and contingent po he full scale funding described in the previous paragraph, the State shall ommit 5 man-months per year valued at $19,492.00 including usual State mployee benefits and overhead (10%), in order to achieve the State's component of he program specifications in Article IV.

If the federal funding cannot or has not been obtained by the Contractor by ay 31, 1979, the research contract will be terminated without prejudice and the State hall not hold the Contractor responsible for producing research results.

If federal funding is obtained and contract progress is satisfactory, it is he intent of the State to continue this contract at the $5,000.00 per year level or a maximum of two additional years pending the availability of State funds.

rticle IV. Program Specifications

The Contractor will:

(a) Within two (2) months of the commencement of this contract, finalize the approaches to be taken by the Contractor and include any last minute changes. These will be accomplished by written and phone communication between the Contractor and ADF&G (Kodiak) personnel, and/or by the Contractor meeting with ADF&G personnel in Kodiak.

(b) Provide a biometrician to work with ADF&G (Kodiak) personnel in analyzing existing ADF&G data on growth and natural mortality of Alaska King crab in the Kodiak area. This biometrician will produce analyzed data in a form suitable for use by the fisheries moded in (c) below, and produce a publication describing the analyzed data.

(c) Incorporate and exercise the appropriate fisheries model via computer simulation using King crab biological parameter estimates and fishery management options as suggested by State.

(d) Provide the State with quarterly short summaries of progress, and an annual report within 3 months of the termination of the contract.

(e) Meet with ADF&G personnel near the end of the contract year to review model outputs, implications up to that date, and consider future efforts and funding.

(f) Make available to the State for review any document containing results and conclusions before submission of same to any other agency which may be included in joint funding of this study.

(g) Inform ADF&G personnel of Contractor's involvement in any usage of results stemming from this contract, which occur after termination of the contract.

(h) Make available if required by the State and on an appropriate computer system specified by the State, the fisheries model described in (c) above, including the following:

(i) The fisheries model shall be in final working form.

(ii) The fisheries model will be available from a computer terminal, using interactive language mutually agreed upon by the State and the Contractor.

(iii) A detailed operating manual shall be provided.

The State will:

(a) Make available to the Contractor biological parameter data it may have, which is necessary in exercising the fishery model. This will include, but not limited to, data on growth and natural mortality of King crab in the Kodiak area.

(b) Help develop, in conjunction with the biometrician provided by the Contractor, those biological parameters estimates required.

(c) Propose a set of King crab management strategies which will be evaluated via use of the model. This shall not be construed as preventing the Contractor from evaluating strategies outside this set.

(d) Decide whether the Contractor is to make available, on a computer specified by the State, a version of the model for the State's use. The cost of implementing this would be borne by the State.

(e) Coordinate with the Contractor any Contractor trips to Kodiak, to ensure staff availability.

(f) Review and respond in a timely manner on any questions or publication requests which the Contractor may send.

(g) Assign the time of appropriate ADF&G professional staff, for tasks of specifying the assumptions of the fishery model, familiarizing themselves with the operation of the models and reviewing the results of the model.

(h) Not interfere with the right of the Contractor to publish results arising from the contract. The State reserves the right to disclaim as valid any results of this effort, with which it disagrees. By mutual consent, the State's personnel may co-author publications arising from the contract.

Associate Professor, Department of Information Engineering, University of Illinois at Chicago Circle, Chicago, Illinois 60680, (312)996-5140, 996-3423 (messages)

Born 1942, married, one child
B.S. (Engineering Science-Chemical Engineering), Ill. Inst. of Tech., 1963
M.S.E. (Information and Control Engineering), University of Michigan, 1965
Ph.D. (Computer, Info., and Control Engineering), Univ. of Mich., 1970

Dr. Katz participated, during 1975-76, in the NORFISH research group (L.J. Beldsoe, Principal Investigator) of the Washington Sea Grant Program. His work involved developing the configuration and assembling the data base of a computer economic projection for the Western Alaska shellfish and potential groundfish fisheries. Specifically, he did the following:

1. made and continued contact with Alaska fisheries participants, to obtain fishery information;
2. collected, analyzed, and assimilated into the projection, information on: (a) number and type of shellfish vessels; (b) fishing capability and economic parameters of these vessels; (c) Alaska regulatory structure as it presently affects these vessels in the fisheries in question; (d) processor location, type, and throughput capacity; (e) stock locations and population dynamics;
3. interacted with programmers to approximate these aspects of the fishery by computer-coded submodels, based on real-life data and fisheries operation;
4. was principal or co-author of several publications, technical reports, and conference presentations, listed later in this resume.

The research proposed here is an offshoot of work begun at NORFISH.

PROFESSIONAL ACTIVITIES

Consultant in Computer Information Base Management, NOAA National Marine Fisheries Service, Kodiak, Alaska, 1978.

Faculty Associate, Argonne National Laboratory, 1977.

Visiting Associate Professor, Center for Quantitative Science in Fisheries, Forestry and Wildlife, University of Washington, 1975-76.

Research Assistant Professor, and Ford Foundation Visiting Lecturer, Center for Quantitative Science in Fisheries, Forestry, and Wildlife, University of Washington, July and February 1974.

Chairman of Session: Optimization in Ecological Systems, First International Congress of Ecology-Structure, Function, and Management of Ecosystems. The Hague, September 8-14, 1974.

Chairman: Third Annual Workshop on Dynamical Modeling of Great Lakes, 1973.

Reviewer: NOAA Sea Grant Program, 1978; National Science Foundation, 1976; Environmental Protection Agency, 1975-77; American Naturalist, 1973-78; Ecology 1972; 15th and 16th Conf. Great Lakes Research 1972, 1973.

Member: Amer. Assoc. for the Advancement of Science, Amer. Fisheries Soc., Amer. Soc. of Naturalists, Ecological Soc. of America, Int'l. Assoc. for Great Lakes Research, Institute of Electrical and Electronics Engineering, Nat'l. Shellfisheries Assoc., Pacific Science Assoc.

Katz, P.L., "Optimization of Long-Range Goals by Fishing Fleets of Several Nations in the Northwest Pacific," FY76 Sabbatical Year funding by NOAA National Marine Fisheries Service, Northwest Fisheries Center, and NOAA University of Washington Sea Grant, NORFISH Project, $14,500.

Katz, P.L. (with Silver, M.L., FY74; with Chung, P.M., FY75), "Dispersion of Pollutants in Lake Michigan, Predicted by a Computer Simulation Model," Funded by Illinois Water Resources Center, from Office of Water Resources Research, U.S. Dept. of Interior, FY1974, $9,000; FY1975, $9,700.

Katz, P.L., Balsiger, J.W., Spinker, T.R., and Schappelle, R.H., "Beliefs About King Crab Biology Affect Projected Consequences of Management Strategy," To appear, Proc. 29th AAAS Alaska Science Conf., Fairbanks, 1978.

Katz, P.L., Balsiger, J.W., Schappelle, R.H., and Spinker, T.H., "Economic Effects of Fluctuations in Catches and Population Levels, Upon a Population of Alaska King Crab," Proc. 9th Winter Simulation Conf. Gaithersburg, MD, 1977, pp. 323-329.

Bledsoe, L.J., Mesmer, K., and Katz, P.L., "Pragmatic Approaches to Fishery Management for Optimum Yield: Determination of a Supply Curve for a Domestic Alaska Pollack Fishery," in Report on the Concept of Optimum Yield in Fisheries Management, U.S. Dept. Commerce, Houston, TX, 1977.

Katz, P.L. and Bledsoe, L.J., "Alaska Shellfish Regulations: Present Impacts Upon Participants," Trans. Amer. Fisheries Soc., Vol. 106, 1977, pp. 505-529.

Bledsoe, L.J. and Katz, P.L., "Management Information for Regional Fishery Systems with Special Reference to the Northeast Pacific," NORFISH Tech. Rep. 62, 1976, Center for Quant. Sci., Univ. of Washington, 23pp.

Katz, P.L., Lee, K.C., and Bledsoe, L.J., "The Classification, Enumeration, Characteristics, and Economic Performance of Alaskan Fishing Vessels," NORFISH Tech. Rep. 61, 1976, 59pp.

Katz, P.L. and Lee, K.C., "Computing Annual Return to Vessel Investment in a Fisheries Economic Projection Model -- Demonstration of Method, Based on a Bering Sea King Crab Vessel," NORFISH Tech. Rep. 63, 1976, 10pp.

Bledsoe, L.J. and Katz, P.L., "A System for Projecting the Effects of Regulatory Structures in Northeastern Pacific Fisheries," Presented at 13th Pacific Science Congress, August 1975, Vancouver, B.C.

OTHER PUBLICATIONS

Katz, P.L., "Reachable Sets and Singular Arcs for Minimum Fuel Problems Based on Norm Invariant Systems," IEEE Trans. on Auto. Control, Vol. AC-17, No. 4, August 1972, 557-559.

Katz, P.L., "Closed-Form Solutions for Two Optimal Control Problems Having Nonlinear, Norm Invariant Systems," Int. J. Control, Vol. 18, 1973, 129-137.

Katz, P.L., Babcock, L.R., and Ryan, E.V., "A Generalized Computer Simulation of Urban Air Pollution, as Related to Energy Use," Proceedings of Sixth Hawaii International Conference on System Science, Honolulu, Hawaii, 1973, 39-40.

Katz, P.L., "Optimal Control Theory Applied to a Predator with Multiple Prey Species," Proceedings of Sixth Hawaii International Conference on System Science, Honolulu, Hawaii, 1973, 277-279.

Kizlauskas, A.G. and Katz, P.L., "A Two-Layer Finite Difference Model for Flows in Thermally Stratified Lake Michigan," Proc. of 16th Conference on Great Lakes Research, 1973, 743-753.

Michigan," Archiv fur Meteorologie, Geophysik, und Bioklimatologie (Vienna), Series A, Vol. 23, 1974, 181-197.

Katz, P.L., "A Long Term Approach to Foraging Optimization," The American Naturalist, Vol. 108, 1974, 758-782.

Katz, P.L., "A General One-Dimensional Search Algorithm, for Computing Approximate Solutions of Some Nonlinear Optimal Control Problems," International J. Control, Vol. 20, 1974, 655-672.

Katz, P.L. and Wachtor, T.E., "Optimal Solutions of a Nonlinear Minimum Fuel Problem and Minimum Time Orbital Transfer Problem, Computed Without Prior Knowledge of Singular Arcs' Existence," International J. Control, Vol. 20, 1974, 673-688.

Schwab, G.M., Katz, P.L., and Belytschko, T.B., "Mass-Conservative Simulation of Pollutant Dispersion in Large Water Bodies, Given Circulation-Pattern Inconsistencies," Proc. of 5th Annual Pittsburgh Modeling and Simulation Conference, Pittsburgh, PA, 1974, 187-192.

Katz, P.L., "Explanation of Weaver Birds' Weight Histories in Terms of Year-Round Demands of Non-feeding Activities," Presented at Animal Behavior Society Meeting, May 1974, Urbana, IL.

Katz, P.L., "Foraging Strategy of the Weaver Bird *Quelea quelea* Throughout the Year: Comparison of Recorded Behavior with a Dynamic Model," Presented at Annual Meeting of Ecol. Soc. of Amer., Amer. Inst. of Biol. Sci., June 1974, Tempe, AZ.

Schwab, G.M. and Katz, P.L., "A Model for the Study of Episodes in the Dispersion of a Conservative Pollutant in Lake Michigan," Proc. of 17th Conference on Great Lakes Research, 1974, 837-845.

Katz, P.L. and Bartnick, M.M., "Instantaneous (Static) vs. Long-Term (Dynamic) Optimization in Ecosystems," Proc. of First Int'l Congress of Ecology, The Hague, 1974, 395-400.

Katz, P.L., "A Geometric Computing Method for Nonlinear Optimal Regulator Problems with Singular Arc," Journal of Optimization Theory and Applications, Vol. 15, No. 3, 1975, 249-283.

Katz, P.L. and Schwab, G.M., "Modeling Episodes in Pollutant Dispersion in Lake Michigan," WRC Research Report No. 97, Illinois Water Resources Center, Urbana, IL, UILU-WRC-75-0097, 1975, 78pp.

Schwab, G.M. and Katz, P.L., "Nearshore Dispersion of Pollutants from the Calumet Region of Lake Michigan: Model and Data," Invited symposium paper, Div. of Environmental Chemistry, Amer. Chem. Soc. National Meeting, Philadelphia, PA, April 1975.

Katz, P.L. and Schwab, G.M., "Currents and Pollutant Dispersion in Lake Michigan, Modeled with Emphasis on the Calumet Region, WRC Research Report Illinois Water Resources Center, Urbana, IL, UILU-WRC-76-0111, 1976, 79pp.

Katz, P.L., "Dynamic Optimization in Animal Feeding Strategies, With Application to African Weaver Birds," Journal of Optimization Theory and Applications, Vol. 18, No. 3, March 1976, 393-422.

Katz, P.L. and Fretwell, S.D., "A Long-Run Optimization Explanation of Risk-Energy Tradeoffs by Dickcissels in Their Wintering Grounds Prior to Migration," Invited symposium paper, Amer. Inst. Bio. Sci. Meeting, June 1976, New Orleans, LA.

Fretwell, S.D. and Katz, P.L., "Winter Ecology of the Dickcissel," Invited symposium paper, Amer. Inst. Bio. Sci. Meeting, June 1976, New Orleans, LA.

Schwab, G.M., Saunders, K.D., and Katz, P.L., "A Three-Dimensional Multiple-Grid Model for Nearshore Circulation in the Calumet Harbor-Chicago Shoreline Region of Lake Michigan," Presented at 20th Conf. Great Lakes Research, Ann Arbor, MI, 1977.

October, 1978

A PROPOSAL FOR THE STUDY OF FISHING AS A WAY-OF-LIFE

By Charles Konigsberg
Research Associate
AEIDC

Vital decisions with respect to Alaskan fisheries will be made in the near future. These decisions must, of course, be founded on the most comprehensive and substantive possible data and information base, including biological, economic, socio-political, and cultural considerations.

Paradoxically, however, the State of Alaska, bordered by the largest combined fisheries of the United States, and perhaps of all the world, possesses a seriously incomplete data and information base. Management decisions reflecting such an inadequate base must necessarily be less than adequate, however unavoidable such a situation may be in the short run.

Nowhere in the range of relevant considerations is this more true than in regard to the cultural dimension of fishing or of a given fishery. While receiving an occasional passing nod in discussion and analysis, the cultural -- or way-of-life* -- perspective remains the weakest link in the information/data chain and has invariably, therefore, been given the least consideration in the decision-making process.

It would be the purpose of this study, then, to fill the gap -- to strengthen and elaborate the information/data chain -- by focusing research and producing a definitive study on fishing as a way-of-life as distinguished from fishing as primarily an economic activity, while recognizing, of course, that all relevant considerations are inextricably interrelated and interdependent.

What must also be recognized, however, is that any factor which so dominates the terms of discourse and analysis, as has economics in the contemporary period, invariably prejudices -- perhaps necessarily dictates -- the findings on which the decision-making outcome is based. It seems imperative, therefore, to fill the information/data gap as much to prevent distortion or destruction of the other inherent values as it is to insure a "proper balance" in decision making.

The end product of this study will be, then, a document (or documents)

---

*We distinguish way-of-life (individual or community) from life-style, the latter understood as a variation on the prevailing, conventional behavior and thought pattern in which economic considerations dominate; the former understood as primarily a function of (determined by) other-than-economic values; hence, in this case, fishing as a way-of-life as contrasted with fishing as an economic activity (the means by which income/profit are obtained to pursue the conventional life-pattern).

which will provide decision makers -- and fishermen -- the written basis for consideration of fishing as a way-of-life on at least equal basis with other factors such as the economic.

This indeed appears to be the intent of provisions of recent legislation such as NEPA, CZM, and The Fishing Conservation and Management Act of 1976 from which latter Act the following is drawn:

Sect. 302 (g) (1): "...the development, collection, and evaluation of such statistical, biological, economic, social, and other scientific information as is relevant to such Council's development and amendment of any fishery management plan."

Sect. 303 (b) (6): "...take into account -- (E) the cultural and social framework relevant to the fishery, and (F) any other relevant considerations..."

There is thus encouragement to hope that a study such as is herein proposed will receive active consideration and support.

- Project (Proposal) Development

  The Project and Schedule

  Organization and Personnel

  Budget

- Literature Search/Bibliography/Research

  Alaska

  U.S. on-going

  Foreign

- Research of On-going Projects/Programs

  Alaska

  U.S.

  Foreign

- Field Research: Case Studies

  Selected Communities in Alaska

- Synthesis and Integration

  Comprehensive Overview

- Editing, Graphics, Publication

Agenda Item #20 (3)
Nov. 2-3, '78

DRAFT

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98195

TO:	NORTH PACIFIC FISHERY MANAGEMENT COUNCIL
TYPE OF SUPPORT REQUESTED:	Contract
TITLE OF PROJECT:	Stock identification of troll-caught chinook salmon off southeastern Alaska by scale pattern analysis
PRINCIPAL INVESTIGATOR:	Donald E. Rogers, Research Associate Professor Fisheries Research Institute College of Fisheries, WH-10 University of Washington Seattle, Washington 98195 Telephone: (206) 543-7658
AMOUNT REQUESTED:	$36,679
DESIRED GRANT PERIOD:	October 1, 1978 - September 30, 1979
DATE:_____	_____ Principal Investigator
	_____ Robert L. Burgner, Director Fisheries Research Institute
	_____ Donald E. Bevan, Associate Dean College of Fisheries
UNIVERSITY OFFICE TO BE CONTACTED REGARDING GRANT OR CONTRACT NEGOTIATION:	Grant and Contract Services Room 1, Administration Bldg. AD-24 University of Washington Seattle, Washington 98195 Telephone: (206) 543-4043
UNIVERSITY OFFICE TO WHICH CHECKS SHOULD BE MAILED:	Same as above
OFFICIAL AUTHORIZED TO GIVE UNIVERSITY APPROVAL:	_____ Donald R. Baldwin, Director Grant and Contract Services

STOCK IDENTIFICATION OF TROLL-CAUGHT CHINOOK SALMON OFF SOUTHEASTERN ALASKA BY SCALE PATTERN ANALYSIS

INTRODUCTION

The 1978 Fishery Management Plan and Draft Environmental Statement for the High Seas Salmon Fishery off the Coast of Alaska East of 175 Degrees East Longitude concerns coho and chinook salmon in offshore waters under jurisdiction of the North Pacific Fishery Management Council. Chinook salmon landings from this offshore fishing area comprise about 15% of the total Alaska troll landings of chinook in numbers of fish, and nearly 99% of this offshore troll catch comes from the Fairweather grounds. The average size of chinooks in the Fairweather offshore fishery is considerably less than in troll areas south of Cape Spencer.

In this offshore fishery area chinook salmon from streams in southeastern Alaska intermingle with native and hatchery chinook from California, Oregon, Washington, and British Columbia. Declines in southeastern Alaska chinook populations are reported to have occurred primarily because of over-harvest. However, management of the troll fisheries to give consideration to southeastern Alaska stocks is hampered by inability to determine the area of origin of fish in the catches. An efficient method for identifying the origin of individual fish (e.g., Alaska vs. non-Alaska, hatchery vs. native) would allow more effective evaluation of the impact of fishing on local stocks, including perhaps elucidation of particular times and areas in which impact is greatest, and particular size and/or age groups most severely impacted. This would contribute to the capability to manage Alaskan as well as non-Alaskan stocks. Within southeastern Alaska the research requirements in the 1978 Fishery Management Plan identify the urgent need to establish the magnitude of contribution of the Situk, Alsek, Stikine, Taku, Chickamin, and Unuk rivers to the troll fishery in both Council and Alaska waters. The ability to identify southeastern Alaska fish in the troll landings is obviously a first requisite.

STOCK IDENTIFICATION BY SCALE PATTERN ANALYSIS

A number of recent developments in methodology and automation make discriminant function analysis of scale characters an efficient and feasible technique in routine stock separation studies (Cook and Lord, 1978; Krasnowski and Bethe, 1978; Marshall et al., 1978). Previous studies (Kissner, 1973) indicated that differences in freshwater growth zones of scales found to exist between chinook of Alaskan and non-Alaskan origin could provide partial separation of stocks in marine fishery areas.

Spring and fall chinook, of course, have very different freshwater growth patterns (reflected on their scales) owing to the differences in duration of freshwater residence. Native chinook in southeastern Alaska are predominantly spring chinook. Bohn and Jensen (1971) studied spring chinook in the Columbia River and found little yearly variation in circuli counts in the freshwater portion of the scale, and justified pooled year-class samples in their scale pattern analysis. They also determined that hatchery and native spring chinook could be separated quite well by the greater circuli counts of hatchery fish. Major, Murai and Lyons (1975) used first year marine growth characteristics of spring chinook scales to separate Asian and western Alaskan stocks by discriminant function analysis. They also mentioned that combined-year samples could be used. There were some indications from the above studies that freshwater and early marine growth patterns within a stock are similar regardless of sex and age at return.

For the southeastern Alaska problem, Kissner (1973) recommended an expanded study of scale patterns of chinook from river systems in Alaska, British Columbia, and Washington, which would include examination of circuli counts and measurements in both freshwater and first year marine portions of the scale.

OUTLINE OF PROPOSED WORK

1. Review past stock separation analyses of chinook salmon which have used age and scale growth patterns, from the standpoint of extension and improvement of methodology.

2. Assess the extent, condition, and availability of the present coastwise chinook scale collections and data bases relative to major stocks of chinook salmon.

3. Test the feasibility of stock separation of southeastern Alaska chinook salmon by use of our polynomial discriminant technique and automated scale processing equipment (being developed under a prior contract). The extent of such a feasibility analysis would, of course, depend on the availability of scales needed for "standard" (= "learning"), "test," and "unknown" samples.

4. Determine the adequacy of current scale and data collection programs from the standpoint of addressing management questions in the Fairweather grounds troll area.

5. If scale pattern analysis is deemed feasible and useful in assisting management of the fishery, a general plan and recommendation for a continuing stock separation program would be developed.

REPORTING

Progress and results of these investigations would be reported in three quarterly reports and in a project completion report.

REFERENCES CITED (to be completed)

Bohn and Jensen.
1971.

Cook, R. and G. Lord.
1978. Identification of stocks of Bristol Bay sockeye salmon, Oncorhynchus nerka, by evaluating scale patterns with a polynomial discriminant method. Fish. Bull., 76(2):415-423.

Kissner, P.
1973.

Krasnowski, P. and M. Bethe.
1978. Stock separation studies of Alaskan salmon based on scale pattern analysis. Alaska Dept. Fish and Game. Info. Leaflet No. 175. 37 p.

Major, R., S. Murai and J. Lyons.
1975. Scale studies to identify Asian and western Alaska chinook salmon. Int. N. Pac. Fish. Comm., Annu. Rep., 1973:80-91.

Marshall, S.L., C.K. Harris, D.E. Rogers and R.C. Cook.
1978. Investigations on the continent of origin of sockeye and coho salmon in the area of the Japanese landbased driftnet fishery. Final Report to the North Pacific Fisheries Management Council. Fish. Resh. Inst., Univ. Wash. FRI-UW-7816:152 p.

BUDGET

Salaries	
D. E. Rogers, Principal Investigator 1/2 mo. @ 100%	$ 950
Fishery Biologist III, 4 mos. @ 100%	6,400
Research Assistant, 7 mos. @ 50%, 3 mos. @ 100%	6,500
Student Helper, hourly	3,000
TOTAL DIRECT SALARIES	$16,850
Employee Benefits	
State Retirement, TIAA Premiums, Social Security, Medical Aid and Health Aid, Life Insurance Premiums	2,161
Equipment (on hand)	0
Travel and Per Diem	2,500
Supplies and Services	900
Computer Time	1,500
Cost Center	
Secretarial and editing services, furnished by a Cost Center according to actual usage	3,500
TOTAL DIRECT COSTS	$27,411
Indirect Costs (55% of direct salaries)	9,268
TOTAL BUDGET	$36,679

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98195

Agenda #20 (4)
Nov. 2-3, '78

TO:	North Pacific Fishery Management Council
TYPE OF SUPPORT REQUESTED:	Research Contract
TITLE OF PROJECT:	Investigations on the continental origin of sockeye and coho salmon in the area of the Japanese landbased fishery
PRINCIPAL INVESTIGATOR:	Donald E. Rogers, Res. Assoc. Prof. Fisheries Research Institute College of Fisheries WH-10 University of Washington Seattle, Washington 98195 Telephone: (206) 543-7628 or 543-4650
AMOUNT REQUESTED:	$ 58,000
DESIRED PERIOD:	October 1, 1978 - September 30, 1979
UNIVERSITY OFFICE TO BE CONTACTED REGARDING GRANT OR CONTRACT NEGOTIATION:	Grant and Contract Services 1 Administration Building, AD-24 University of Washington Seattle, Washington 98195 Telephone: (206) 543-4043

DATE: _____

_____
Principal Investigator

_____
Robert L. Burgner, Director
Fisheries Research Institute

_____
Donald E. Bevan, Associate Dean
College of Fisheries

OFFICIAL AUTHORIZED TO GIVE UNIVERSITY APPROVAL:

_____
Donald R. Baldwin, Director
Grant and Contract Services
1 Administration Building AD-24

INVESTIGATIONS ON THE CONTINENTAL ORIGIN OF SOCKEYE AND COHO SALMON IN THE AREA OF THE JAPANESE LANDBASED FISHERY

Introduction

Management of Pacific salmon throughout their migratory range under extended U.S. jurisdiction (P.L. 94-265) requires among other information reliable estimates of interception by foreign fleets on the high seas. The Japanese landbased driftnet fishery has operated during May in an area bounded by 45°N latitude to the north and 175°W longitude to the east. In June the northern boundary is 46°N latitude except between 160°E and 168°E where it is 48°N latitude. The International North Pacific Fisheries Commission (INPFC) treaty of 1978 moved the eastern boundary to 175°E longitude. Catch data for 1962 and 1972-1976 (Table 1) show that in recent years the majority (91%) of sockeye have been intercepted to the west of the new INPFC abstention line. The catches of coho in recent years have been almost equal on either side of the new abstention line. These data also illustrate the eastward shift in effort in recent years.

Under terms of the new INPFC treaty, we have three years from implementation to conduct investigations into the origins of salmon intercepted by this fishery. The Japanese have reserved the right to call for reinstatement of the abstention line at 175°W longitude at the end of this time if North American fish are not shown to be present. Clearly, for coho at least, time is of the essence in determining the origins of these fish.

Summary of Activities During FY 77-78

Project objectives in FY 77-78 were to gather, summarize, and report data of the fishery (e.g., catch and effort); to assess the feasibility of alternative methods for identifying the origins of sockeye and coho intercepted by the fishery; and to provide a critical review of Osako's

Table 1. Historic catches of sockeye and coho salmon by the Japanese landbased drift fishery. Catches are divided into those east and west of 175° E longitude

Year/month		SOCKEYE West of 175° E No.	%	East of 175° E No.	%	Total Number (thousands)	COHO West of 175° E No.	%	East of 175° E No.	%	Total Number (thousands)
1962	May	141	100			141	3	100			3
	June	5	100			5	40	100			40
	July	24	100			24	1184	100			1184
	August					0	3	100			3
	Total	170	100			170	1230	100			1230
1972	May	2381	90	274	10	2655	22	100			22
	June	665	93	50	7	715	94	20	388	80	482
	July	225	66	116	34	341	392	20	1525	80	1917
	Total	3271	88	440	12	3711	508	21	1913	79	2421
1973	May	2348	89	280	11	2628	1	50	1	50	2
	June	572	96	21	4	593	545	46	650	54	1195
	July	62	71	25	29	87	1303	50	1294	50	2597
	Total	2982	90	326	10	3308	1849	50	1945	50	3794
1974	May	2477	90	273	10	2750	54	12	372	88	446
	June	269	91	25	9	294	511	71	208	29	719
	July	99	89	12	11	111	1498	63	896	37	2394
	Total	2845	90	310	10	3155	2063	58	1496	42	3559
1975	May	2697	97	88	3	2785	161	96	6	4	167
	June	101	96	4	4	105	616	57	458	43	1074
	July	49	62	30	38	79	777	34	1532	66	2309
	Total	2847	96	122	4	2969	1554	44	1976	54	3550
1976	May	2437	88	318	12	2755	6	100			6
	June	445	99	3	1	448	499	77	152	23	651
	July	294	98	7	2	301	1348	64	747	36	2095
	Total	3176	91	328	9	3504	1853	67	899	33	2752
1972-76		3029	91[1]	300	9	3329	1543	48	1672	52	3215

[1] unweighted means

(1975) paper on the origins of sockeye based upon the age composition method. A final report on these subjects is in preparation. This section presents highlights of our findings germane to continued funding of the project.

Three methods for identifying the origins of sockeye salmon intercepted by this fishery were evaluated--tagging, the age composition methods of Fredin and Worlund (1974) and Osako (1975), and the polynomial discriminant function (PDF) method of Specht (1966) as applied by Cook and Lord (1978). Tagging from Japan Fishery Agency (JFA) research vessels was ruled out because too few fish could be tagged with the gear (longlines) employed aboard these vessels. Tagging from U.S. vessels is possible but would require a major funding commitment. Implementation of the age composition method is not possible at this time because we do not have the number by age-class of sockeye returning to Kamchatka. The PDF method proved to be the most acceptable because necessary samples are available (with some limited exceptions); the technique was successful in identifying North American and Asian fish; and its implementation cost is low in comparison with tagging.

The availability of coho salmon scales to serve as standards for North America and Asia in a PDF analysis was also assessed last year. We found that scales were available in very limited numbers and from only a few stocks. Implementation of the PDF technique at this time would require that we make two rather tenuous assumptions: (1) That differences between stocks in similar broad geographic regions are minor in comparison with differences between continents; and (2) that differences between years for stocks within broad geographic regions are insignificant in comparison with continental differences between years.

We believe that before we embark upon an analysis requiring that we make these assumptions, we should thoroughly explore the possibility of initiating a sampling program for 1979 that would provide all the needed data to conduct a more comprehensive study.

Our assessment of the feasibility of implementing the PDF method to either species included methods by which data would be captured, stored, and manipulated. The method presently employed was judged to be inefficient on account of high labor costs, low rates of data capture, and error-prone transcription. Our solution was to design a microcomputer based digitizing system. The system we designed projects a scale's image onto the surface of a digitizer where distance measurements are computed with the aid of a microprocessor. Count data and sample identification are entered via a numeric keyboard on the digitizer's free cursor and/or via a CRT keyboard. Data are formatted, stored, and checked for errors with the aid of dual-risk microprocessor. Data are transmitted over a 1200 baud line to the CDC main frame for analysis and for making auxiliary copies of the data (magnetic tape and punch card). This system allows rapid and accurate measurements of virtually any two-dimensional characteristics of scales, obviates the need for tedious and error-prone transcription of data, and circumvents costly and time-consuming keypunching. Components for this system have been ordered and we plan to have it operational this fall.

Summary of Methods and Preliminary Results of Identifying the Origins of Sockeye Salmon in the Landbased Fishery

Implementation of the PDF method requires three sets of scale data: Learning samples (standards), test samples, and unknowns. Learning and test samples are collected from each stock of interest when segregated.

A battery of scale characters is measured on the standards and those showing the greatest difference between stocks of interest are chosen to be measured on the unknowns. Test samples are used to evaluate the effectiveness of the method.

We defined two North American and one Asian standard. For North America, stocks originating from rivers terminating in Bristol Bay compose one standard and those emptying into the North Pacific Ocean from Chignik River east to Prince William Sound another. For Asia, the stocks of the Kamchatka Peninsula were used. The North American standards were compiled from catch and escapement samples. The number of scales representing each stock within an area was determined by that stock's abundance. Scales used to develop the Asian standard were collected off the southwest coast of Kamchatka by the research vessel fleet of the JFA, except that some scales for the Kamchatka River were provided by the Soviet Union. Scales to serve as unknowns were also provided by JFA. Sufficient data were provided to analyze only maturing fish intercepted in 1975. In order to maximize classificatory accuracy we conducted an analysis separately for each age class for which sufficient samples existed, i.e., ages 2.2, 1.3, and 2.3.

Characters selected for use in the PDF method are summarized for each age class in Table 2. Variability in discriminating power for a character between age classes produced some differences in characters selected for each age class.

Learning samples ($n \geq 75$) for each region were used to generate the discriminant functions. Subsequently, test samples ($n \geq 120$) for each region were used to determine the ability of the functions to identify the origins of the unknowns. This ability is shown in a classification

Table 2. Characters selected for use in identifying the origins of mature sockeye intercepted by the Japanese landbased fishery, by age, class, 1975. (A + indicates use of the character within an age class.)

Character	Age Class 2.2	1.3	2.3
Number fresh water circuli - - - - -	+		+
Size freshwater zone - - - - - - - -	+	+	
Number circuli in first half of first ocean zone - - - - - - - - -	+	+	+
Number circuli in second half of second ocean zone - - - - - - - -	+		
Size of first ocean zone - - - - -		+	+
Distance between circuli n_1 and n_2 of first ocean zone			
$n_1 = 0^1$ $n_2 = 3$ - - - - - - - - -		+	+
$n_1 = 0$ $n_2 = 6$ - - - - - - - - -	+		
$n_1 = 3$ $n_2 = 6$ - - - - - - - - -			+
$n_1 = 6$ $n_2 = 9$ - - - - - - - - -		+	
$n_1 = 12$ $n_2 = 15$ - - - - - - - - -		+	
$n_1 = 12$ $n_2 = 18$ - - - - - - - - -			+
$n_1 = 15$ $n_2 = 18$ - - - - - - - - -	+		

[1] 0 indicates the distance is measured from the outer edge of the last freshwater circuli

matrix. We evaluated the accuracy of classification in two ways. In the first method we assumed that only fish of Kamchatka and/or Bristol Bay origin would be present in the area. This was based on the origins of fish to the north of the landbased fishery reported by French, et al. (1976). Tables 3A,B,C summarize the classification arrays for each group. Entries on the diagonal are the number correctly classified while entries on the off-diagonal show the number of fish belonging to one area that were classified as belonging to another area. Overall accuracy is summarized by calculating the percent correctly classified. In the two-way comparison, these figures are 88.1, 88.1, and 85.3 for age classes 2.2, 1.3, and 2.3, respectively. Classification arrays were also calculated by assuming that sockeye from stocks originating in the Gulf of Alaska region may be present (Table 4A,B,C). Overall accuracy for the three-way classification matrices are 70.5%, 63.7%, and 67.5% for age groups 2.2, 1.3, and 2.3, respectively. The two-way comparison represents a substantial improvement over that reported by Anas and Murai (1969). Low accuracy for the three-way comparison will increase confidence intervals somewhat over the two-way comparison. The classification accuracies are satisfactory, however.

Analysis of unknowns is being conducted by stratifying the area into $2^{\circ}x5^{\circ}$ INPFC statistical areas by 10-day periods. As of this writing, all unknowns have been measured and we have estimated the uncorrected proportions of Asian, Bristol Bay, and Gulf of Alaska fish present in and contiguous to the landbased fishery area. Until the proportional estimates are corrected for misclassification error rates, no definitive statement can be made.

Table 3. Classification arrays for mature sockeye salmon of Kamchatka versus Bristol Bay origin, by age class, 1975

3A: Age 2.2[1]

Calculated decisions	Correct decisions	
	Kamchatka	Bristol Bay
Kamchatka	113	15
Bristol Bay	15	110

3B: Age 1.3[2]

Calculated decisions	Correct decisions	
	Kamchatka	Bristol Bay
Kamchatka	113	15
Bristol Bay	15	110

3C: Age 2.3[2]

Calculated decisions	Correct decisions	
	Kamchatka	Bristol Bay
Kamchatka	107	18
Bristol Bay	18	102

[1]Our limited information indicates that age class 2.2 is minor for stocks of east Kamchatka. The few samples we have are included in this analysis.

[2]Sufficient samples were not available to develop a separate standard for east Kamchatka as originally planned. We are attempting to assess the contribution of east versus west Kamchatka by conducting two analyses. In the first, the unknowns will be classified without east Kamchatka fish in the standard. In the second analysis they will be included. Classification arrays presented here do not include east Kamchatka fish.

Table 4. Classification arrays for mature sockeye salmon of Kamchatka vs. Bristol Bay vs. Gulf of Alaska origin by age class, 1975

4 A: Age 2.2[1]

Calculated decisions	Correct decisions		
	Kamchatka	Bristol Bay	Gulf of Alaska
Kamchatka	88	8	32
Bristol Bay	5	103	17
Gulf of Alaska	35	14	75

4 B: Age 1.3[2]

Calculated decisions	Correct decisions		
	Kamchatka	Bristol Bay	Gulf of Alaska
Kamchatka	85	18	22
Bristol Bay	15	77	28
Gulf of Alaska	25	25	71

4 C: Age 2.3[2]

Calculated decisions	Correct decisions		
	Kamchatka	Bristol Bay	Gulf of Alaska
Kamchatka	85	11	29
Bristol Bay	7	91	22
Gulf of Alaska	33	18	73

[1]Our limited information indicates that age class 2.2 is minor for stocks of east Kamchatka. The few samples we have are included in this analysis.

[2]Sufficient samples were not available to develop a separate standard for east Kamchatka as originally planned. We are attempting to assess the contribution of east versus west Kamchatka by conducting two analyses. In the first, the unknowns will be classified without east Kamchatka fish in the standard. In the second analysis they will be included. Classification arrays presented here do not include east Kamchatka fish.

Proposed Research

Sockeye Salmon

The primary objective of our proposed research is to determine the incidence of North American versus Asian sockeye salmon in and contiguous to the area of the Japanese landbased driftnet fishery. The PDF method of Specht (1966) as implemented by Cook and Lord (1978) will be used. Spatial stratification will be by $2^{\circ}x5^{\circ}$ INPFC statistical areas and temporal stratification by 10-day periods. Mature and immature fish for each age class will be analyzed separately. North American standards will be developed utilizing all major stocks west of Prince William Sound. Asian standards will include stocks of the Kamchatka Peninsula. In the development of standards, an effort will be made to weight a stock's representation by its abundance.

Before beginning the analysis, the number of unknowns by $2^{\circ}x5^{\circ}$ statistical area by 10-day periods for each age class and maturity by year will be determined. Concurrently, a tabulation of the number of scales by year, stock, and age class, to serve as Asian standards, will be compiled. These compilations will allow us to set priorities for analysis based upon completeness of the data sets by year.

Lack of experience with the new digitizing system and the absence of an estimate of the number of unknown scales available preclude the possibility of our making a definitive statement regarding the number of years' data that can be analyzed in the proposed one-year funding period. We will, however, realize a significant increase in ability to process data over the first year's work.

Coho Salmon

The lack of samples to serve as standards for both Asia and North America precludes a rigorous analysis of available coho salmon scales with the PDF method. To remedy this situation, we propose to attempt to organize a comprehensive scale collection program during 1979. For this program to succeed, data must be obtained from escapements to Alaska and Kamchatka and from JFA research vessels operating within the landbased fishery area in times and areas in which coho are being intercepted. Support for the program will be solicited from Mr. Kenji Takagi of JFA, Dr. S.M. Konovalov of TINRO, and regional sport and commercial fishery biologists in Alaska.

If a cooperative program can be organized it would be late 1979 before samples could be made available for analysis and mid-1980 before analysis could be completed. We have therefore incorporated into this budget only those funds necessary to attempt to set up the program. Funds for analysis will be requested upon receipt of the scale data.

Travel

The most significant problem we face in implementing the PDF method to identify the origins of sockeye and coho salmon in the area of the landbased fishery is that of obtaining scale samples to serve as standards and unknowns. We are therefore proposing to send project personnel to Japan and the Soviet Union for the purpose of explaining project objectives and methods and to solicit cooperation in providing us with required samples.

The Japanese, in particular, have requested that we provide detailed information regarding our methodology and results for the 1975 data before furnishing samples for other years. This trip would permit us to honor

this request and at the same time to make duplicate impressions of scales and accompanying biological data. This strategy would also eliminate delays that we have experienced in obtaining samples.

In regard to our proposed travel to the Soviet Union, the U.S. and the INPFC have had considerable trouble obtaining basic biological data on the salmon stocks of the Kamchatka Peninsula. We have recently developed a working relationship with Dr. S.M. Konovalov, Director of TINRO, following his visit to the U.S. However, correspondence with Dr. Konovalov has produced only limited success in providing samples. We believe that through personal contact it would be possible to obtain data (e.g., run size, timing, age composition, scale samples) that have been collected on the runs of Kamchatka. Concurrently, we would explore their willingness to participate in our coho salmon data collection program for 1979. We believe that such a large request for data and cooperation cannot be reasonably and tactfully made through correspondence.

Personnel

Drs. Donald E. Rogers and Robert L. Burgner will supervise the studies. Mr. Scott L. Marshall will be in direct charge of the data collection, analysis, and reporting. Mr. Colin K. Harris will assist in the formulation of experimental designs, computer programming, and analysis. Mr. Rodney C. Cook will conduct theoretical work on the discriminant function analysis. Two technicians will read the scales and record and verify the data.

Literature Cited

Anas, R.E., and S. Murai. 1969. Use of scale characters and a discriminant function for classifying sockeye salmon (Oncorhynchus nerka) by continent of origin. Int. North Pac. Fish. Comm. Bull. 26:157-192.

Cook, R.C., and G.E. Lord. 1978. Identification of stocks of Bristol Bay sockeye salmon (Oncorhynchus nerka) by evaluating scale patterns with a polynomial discriminant method. Fish Bull. 76(2):415-423.

Fredin, R.A., and D.D. Worlund. 1974. Catches of sockeye salmon of Bristol Bay origin by the Japanese mothership salmon fishery, 1956-1970. Int. North Pac. Fish. Comm. Bull. 30:1-80.

French, R., H. Bilton, M. Osako, and A. Hartt. 1976. Distribution and origin of sockeye salmon (Oncorhynchus nerka) in offshore waters of the North Pacific Ocean. Int. North Pac. Fish. Comm. Bull. 34, 113 pp.

Osako, M. 1975. Sockeye salmon (Oncorhynchus nerka) distributed in the Northwest Pacific (I). (Transl.) Int. North Pac. Fish. Comm., Doc. 1796, 20+ pp.

Specht, D.F. 1966. Generation of polynomial discriminant functions for pattern recognition. Stanford Univ., Tech. Rep. 6764-5, 127 pp.

BUDGET
October 1, 1978 - September 30, 1979

Salaries		
D. E. Rogers, Principal Investigator	1 mo. @ 100%	$ 1,900
S. L. Marshall, Project Leader	8 mos. @ 100%	12,000
C. K. Harris, Senior Fishery Biologist	1 mo. @ 100%	1,600
R. C. Cook, Predoctoral Research Assoc.	4 mos. @ 50%	2,160
Technicians, 2 for 10 mos. @ 50%		8,067
	TOTAL DIRECT SALARIES	$ 25,727
Employee Benefits		
State Retirement, TIAA Premiums, Social Security, Medical Aid and Health & Life Insurance Premiums		3,876
Supplies and Services		1,000
Computer Time		1,500
Travel		
Japan, Soviet Union, domestic		8,440
Cost Center		
Secretarial, editing and data processing services provided by a Cost Center according to actual usage		3,307
	TOTAL DIRECT COSTS	$ 43,850
Indirect Costs calculated @ 55% of direct salaries		14,150
	TOTAL BUDGET	$ 58,000