November 2-3, 1978

AGENDA ITEM: 17

ACTION REQUIRED: Informational (action required at next Council meeting)

SUBJECT: FINAL REPORT -- "Investigation on the Continent of Origin of Sockeye and Coho Salmon in the Area of the Japanese Landbased Drift Net Fishery", UofW/FRI.

SUMMARY: This report was received late and could not be distributed for advance review as anticipated. It is included now for study and comment at the November 30, December 1 meeting.

Final payment has been withheld pending formal receipt of the report by the Council.

COMMENTS: It is scheduled for review by the SSC and AP at their November 28th meeting.

Agenda Item #17
Nov.2-3,'78

COPY

September 13, 1978

Dr. Dayton L. Alverson
Northwest & Alaska Fisheries Center, NMFS
2725 Montlake Blvd., East
Seattle, WA 98112

Dear Lee,

We are attempting to refine our programmatic research budget for FY'79 and have a question concerning the FRI Salmon Continent of Origin Contract which you may be able to help with.

It appears that the contract will meet the objectives of developing methodology and determining the feasibility of using polynomial discriminate function analysis of scales for the determination of the continent of origin for coho and sockeye salmon taken in the Japanese landbased drift gillnet fishery. The final report is due shortly. The question is whether or not the North Pacific Council should now consider funding further data collection stock analyses from the Japanese high seas catch. The role of the Council in this type of a research project when the fishery is managed by INPFC appears marginal. It looks like one that should be picked up by NMFS, rather than the Council.

I would appreciate your comments. Perhaps this is a logical SSC agenda item for the September 27 SSC meeting in Sitka? I will await your response before I make any other moves on this subject.

Regards,

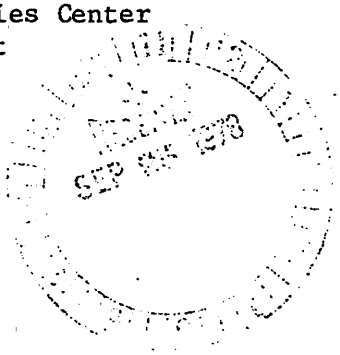
Jim H. Branson
Executive Director

Enclosures:
Contract 77-4
Interim Reports 1, 2 & 3

MIH

Agenda Item #17
Nov.2-3,'78

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest and Alaska Fisheries Center
2725 Montlake Boulevard East
Seattle, Washington 98112



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

Dear Jim:

I agree with your appraisal that the FRI Salmon Continent of Origin Studies should now be financed by other than Council sources. There was earlier justification for Council support inasmuch as the objective was to develop methodology or assess feasibility of a research approach which related to an FMP which was being considered in light of the uncertainties surrounding the future and status of INPFC.

A new INPFC protocol has been signed and the research under discussion directly relates to Article III 1 (a) and (d) of the Convention which specifically requires research to determine the continent of origin of salmon in Convention waters south of 46°N. latitude. As you presumed in your letter of September 13, 1978, this should be one which NMFS should pick up but so far there have been no funds allocated for this work. This notwithstanding, we reiterate our earlier view that it is now inappropriate for the Council to fund this FRI study.

Sincerely yours,

for Dayton L. Alverson
Center Director

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98195

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 $2^{o}x5^{o}$ 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 $2^{o}x5^{o}$ 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 $2^{o}x5^{o}$ 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