WASHINGTON
Department of
FISHERIES

ANALYSES OF CHINOOK STOCK COMPOSITION IN THE MAY 1982 TROLL FISHERY OFF THE WASHINGTON COAST: AN APPLICATION OF THE GENETIC STOCK IDENTIFICATION METHOD

1983

Technical Report 74

ERRATA

In "Analysis of Chinook Stock Composition in the May 1982 Troll Fishery off the Washington Coast: An Application of the Genetic Stock Identification Method," Washington Department of Fisheries, Technical Report 74, March 1983, there are two errors to be corrected:

1. Title Page--The line that reads "This study conducted in part with funds from the Bonneville Power Administration" should be omitted in its entirety.

2. Page 26--The following paragraph should be inserted between existing paragraphs three and four of the ACKNOWLEDGEMENTS:

> "The Pacific Northwest's power consumers, through the Bonneville Power Administration, made possible the development of the genetic stock identification method used in the study."

State of Washington
DEPARTMENT OF FISHERIES

TECHNICAL REPORT NO. 74

ANALYSIS OF CHINOOK STOCK COMPOSITION IN THE MAY, 1982 TROLL FISHERY OFF THE WASHINGTON COAST: AN APPLICATION OF THE GENETIC STOCK IDENTIFICATION METHOD

Marc Miller and Patrick Pattillo
Washington Department of Fisheries
Harvest Management Division

George Milner and David Teel
National Marine Fisheries Service

March 1983

This study conducted in part with funds from the
Bonneville Power Administration

John Spellman
Governor

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Ocean commercial troll and recreational salmon fisheries off the Washington coast were relatively unrestricted before 1977, when the first time/area closures were implemented in the traditional April 15-October 31 season to provide some measure of protection for both chinook and coho. Since then, each fishery has been progressively restricted in response to coho and chinook conservation or allocation requirements.

Specific regulations for reduction of troll chinook harvest rates north of Cape Falcon, Oregon, have included a reduction of chinook-only fishing season from April 15-June 15 to May 1-31 as well as an increased minimum size limit of 26 inches to 28 inches total length. In addition, chinook harvest rates have been reduced significantly during all-species troll season as a result of shortened season lengths implemented to meet coho conservation and treaty allocation requirements. The 1982 all-species troll seasons, for instance, lasted 8 days off the Columbia River mouth and 16 days north of Leadbetter Point (Figure 1).

Recreational seasons have also been reduced significantly since the mid-1970's. Additional chinook protection has been provided by bag limit reductions and size limit increases.

General intent of reduced chinook harvest rates has been to increase in-river returns of upper Columbia River chinook to provide increased treaty Indian harvest opportunity. Washington coastal fisheries harvest chinook of a population composed of many stocks uniquely defined by origin as well as age, maturity, growth, migration, and other characteristics. Juvenile marking and tagging studies have indicated that a high proportion of chinook contributing to the catch in Washington/Oregon coastal fisheries north of Cape Falcon are of Columbia River hatchery fall chinook stock. Lesser proportions are contributed by presently depressed stocks including upper Columbia River natural chinook.

While chinook harvest rates have been reduced in Washington coastal fisheries, coastwide chinook conservation problems have increased the need for more refined chinook stock information in the development of management plans. Comprehensive estimates of chinook stock composition in any given year, however, are logistically difficult using standard stock monitoring tools such as coded-wire tags (CWT). Costs associated with a program for representatively tagging all natural and hatchery chinook stocks contributing to this fishery

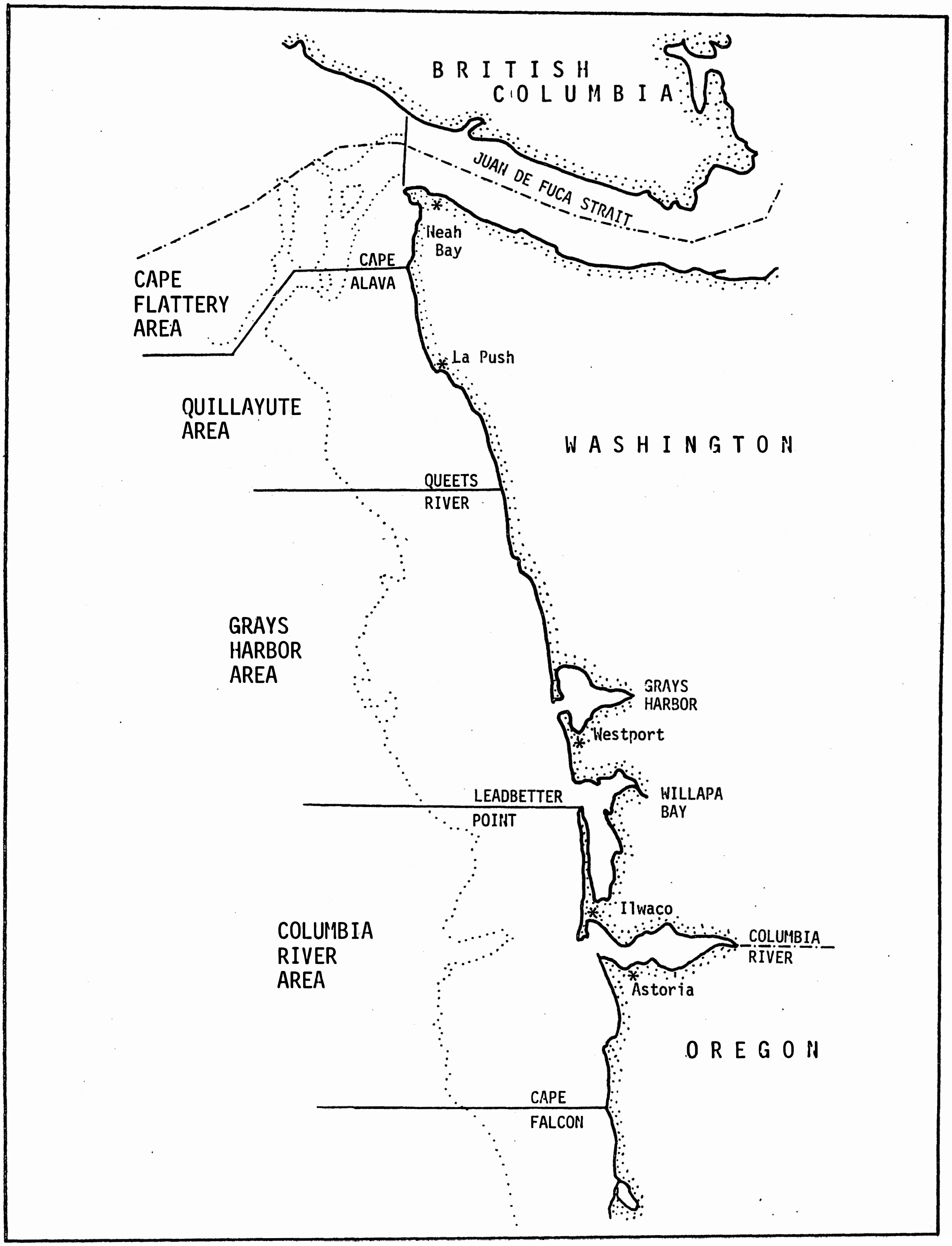

Figure 1. Commercial troll ocean salmon catch reporting areas north of Cape Falcon.

would be prohibitive. Techniques for genetic stock identification (GSI) developed by the National Marine Fisheries Service (NMFS) have been used to precisely estimate stock contribution in mixed-stock fishery situations (Milner et al., 1980 and 1981). The Washington Department of Fisheries (WDF) and NMFS conducted an experiment of these techniques in the 1982 May troll chinook fishery off the Washington coast with the purpose of evaluating the GSI method's application as a practical salmon management tool and to increase the collective information base with which the fishery is managed. The May troll fishery was selected since it represents the only significant target chinook harvest remaining off the Washington coast and because funding and manpower requirements beyond levels needed for regular monitoring of the fishery were available.

METHODS AND MATERIALS

Fishery Sampling

Troll fishery information including numbers and pounds caught by species and grade, date, area caught and days fished were recorded on standard WDF fish receiving tickets for each landing.

A crew of technicians was stationed at each major coastal port for the season. As catches were unloaded from randomly selected landings, each fish was examined for a missing adipose fin which indicated presence of an implanted CWT in the fish's snout. Snouts were removed and later dissected for tag removal and decoding to determine the fish's origination. Approximately 30% of the catch was sampled.

Technicians also removed scales from over 5% of the troll-caught chinook landed. Scale growth patterns were examined for determination of age and juvenile life history classification (yearling migrant/fingerling migrant).

Fish harvested during the May 1982 troll fishery were also sampled to estimate stock composition using the genetic stock identification method. A goal of over 2,000 tissue samples was established and trollers were solicited for participation in sample collection. Recent average catches in May indicated that 15 troll vessels would adequately supply this sample size. Troller participants were chosen according to preferred fishing areas in an attempt to distribute the sampling effort over the entire Washington coastline. WDF observers were placed on five of the vessels. The following fishermen volunteered their vessels and time:

Fisherman	Home Port	Boat Name
Al Armanino	Seattle	SUNUP
Dan Ashby	Westport	BILLY
Darius Bresee	Seattle	EMMA-C
Edwin Brown	Westport	MR. ED
Darby Dickerson	Indianola	STRANGER
Monty Davis	Sequim	SEHOME
Carl Finley	Aberdeen	PAMARO
Larry Hale	Westport	MAR-LAR
Chris Jones	Pt. Townsend	DUWAM
Gary Kozlowski	Seattle	KO-KO
David Maki	Ilwaco	NILE II
Alan Pazar	Westport	WAHOO
Paul Thomas	Pt. Townsend	HELEN H
Robert Williams	Westport	WILDCAT
Ed Wood	Elma	DELMA ANN

Because chinook salmon pricing differs by fish size or "grade", providing the potential for catch sorting, fishermen were asked to sample all fish of a trip. Exception was made when a troller found sampling of an entire trip's catch too restrictive. In this case, full catches from selected days were sampled.

Two tissues, heart and liver, were collected for subsequent GSI analysis. Tissues were cooled immediately and frozen at the end of each fishing day to prevent denaturing of proteins critical to the analysis. Since troll fishing trips last from 1 to over 7 days, ice chests and dry ice were provided for tissue sample storage.

Tissue samples were bagged and labeled, and pertinent data recorded at the time of cleaning. Observers collected tissues and sampled for CWTs, scales, and lengths. On boats without observers, the skipper tagged the fish with a number corresponding to each bagged sample. Biological data from these fish were collected dockside by WDF samplers. In either case, label numbers allowed subsequent identification of the age, length, date, and area caught of each fish sampled. Skippers also kept logbooks in which they recorded area and date of each tissue sample collected so in the event that labels were lost, assignment of samples to specific location and time of catch was possible.

Genetic Stock Identification

The GSI method is based on electrophoretically detected genetic variation (Milner and Teel, 1979; Milner et al., 1980 and 1981). Estimates of genotype frequencies were obtained for major stocks expected to contribute to the fishery catch; these data are referred to as baseline data. Genotype frequencies were also obtained from samples of the mixed fishery catch and the two sets of genotype frequencies were used to obtain maximum likelihood estimates of proportional stock contributions to the mixed fishery catch.

Genetically controlled protein variation was detected by starch gel electrophoresis coupled with histochemical staining (for details on procedures, see May [1975] and Milner et al. [1980]). Data from 14 polymorphic loci were used in this mixed fishery analysis.

The set of Columbia River drainage baseline stocks was developed through extensive and ongoing collection of genetic data samples (Milner and Teel, 1979;

Milner et al., 1980 and 1981). Where representation of a particular stock group was found to be inadequate, additional stocks/subpopulations were sampled and subsequently included in the total baseline data set, e.g., Deschutes River fall samples were recently included in the representative baseline for upper Columbia River falls. Baseline data representing stocks beyond the Columbia River are the product of extensive sample collection during the most recent two years. These samples include California, Oregon, Washington and British Columbia chinook stocks.

The total GSI baseline data set was adjusted to conform to the complexity of stock composition anticipated in the May troll catch, with the overall intention of improving estimate precision. The number of individual stocks included in the comprehensive baseline greatly exceeds the level of identification at which stock specific ocean management might realistically be applied, so baseline stocks were combined into management defined stock groups. Management definition of stock groups is not completely compatible with the genetic stock identification perspective. For example, uniqueness of lower Columbia River and Bonneville Pool fall stocks would be advantageous from a management perspective, but their distinction cannot be detected by the GSI method with an acceptable degree of precision.

Estimated precision is enhanced within a specific stock group by selecting the most representative stock or stocks among those having high levels of similarity and by removing stocks which show zero contribution in preliminary estimates. Contribution to the total 1982 May troll chinook catch was estimated using 49 stocks within 17 management stock groups (Tables 1 and 2). Additional grouping was necessary when deriving stock contribution estimates of comparable precision for individual catch areas.

An unbiased stock composition estimate for the total catch relies on stratification of samples to reflect distribution of the catch by area. Random subsampling of each area's mixed fishery sample in proportion to the catch provided the means of ensuring an unbiased result.

RESULTS

Fishery Summary

Catch and effort of the troll fishery during May 1982 were concentrated in

Table 1. Columbia River drainage baseline stocks included in management stock groupings used for 1982 May troll study.

Management stock group	Baseline stocks
Upper Columbia River summer	Wells McCall Johnson Creek - South Fork Salmon
Lower Columbia River (Cowlitz/Kalama) spring	Cowlitz Kalama
Lower Columbia River (Willamette) spring	Eagle Creek McKenzie
Upper Columbia River spring	Carson Little White Salmon Klickitat Warm Springs Round Butte Leavenworth Winthrop
Snake River spring	Red River - South Fork Clearwater Sawtooth - Upper Salmon Rapid River Valley Creek - Upper Salmon
Lower Columbia River/ Bonneville Pool fall	Big Creek Cowlitz Kalama Lewis Washougal Little White Salmon Spring Creek
Upper Columbia River fall	Deschutes brights Priest Rapids Ice Harbor

Table 2. Non-Columbia River drainage baseline stocks included in management stock groups used for 1982 May troll study.

Management stock group	Baseline stocks
California fall	Coleman late
	Mokelumne
	Nimbus
	Feather
	Coleman/Battle Creek
	Iron Gate
	Trinity
California spring	Feather
	Trinity
Oregon coastal fall	Chetco
	Elk
	Sixes estuary
	Coquille estuary
	Suislaw Bay
	Alsea Bay
	Fall Creek
	Siletz estuary
	Salmon
	Nestucca Bay
	Cedar Creek
	Trask
	Tillamook Bay
	Nehalem estuary
Oregon coastal spring	Cole River
	Rock Creek
	Cedar Creek
	Trask late
Washington coastal fall	Naselle
	Nemah
	Humptulips
	Quinault
	Queets
	Hoh
	Soleduck
Washington coastal spring/summer	Soleduck
Puget Sound fall	Elwha
	Hood Canal
	Deschutes
	Green River
	Samish
Puget Sound summer	Skykomish
	Skagit
	Nooksack
British Columbia fall	Big Qualicum
	Puntledge
	Quinsam
	Robertson Creek
	San Juan
	Capilano
Fraser River summer	Clearwater River
	Chilco River
	Stuart River

the Grays Harbor and Columbia River catch areas continuing the trend in distribution toward the south since 1979 (Table 3, Figure 2). Southern distribution of effort resulted primarily from high rate of success off Willapa Bay and Grays Harbor and preseason anticipation of greater southern area fishing opportunity. In summary, the 1982 fishery experienced a substantial increase in number of fish caught while little change in overall effort was observed:

Year	Days Fished	No. Chinook
1979	5,020	49,338
1980	4,970	52,503
1981	5,747	55,897
1982	5,456	73,196

During the May fishery, port technicians collected readable scales from 5,638 troll-caught chinook salmon (excluding genetic tissue samples) for age determination. Sample results from each catch area were applied to total catch estimates for their respective areas to produce age composition for the entire fishery (Table 4). Summarizing scale analysis results, 3-year-olds were the predominant age group throughout the fishery but comprised a particularly large proportion of the Grays Harbor and Columbia River area catches. Fingerling-type chinook (sometimes classified as fall race) contributed between 92 and 96 percent to the total catch in each area.

Genetic Stock Identification Analysis

Sampling of the fishery for GSI resulted in a total sample size of 2,508 fish with assignable catch areas. Distribution of the samples by catch area differed from the distribution of the catch. Subsampling of the total sample to correct for this bias resulted in an adjusted sample size total of 1,857 fish for estimating contribution to the total catch:

	GSI samples		Catch		Adjusted GSI samples	
	Number	Percent	Number	Percent	Number	Percent
Cape Flattery	448	17.9	3,250	4.4	82	4.4
Quillayute	143	5.7	1,730	2.4	45	2.4
Grays Harbor	1,414	56.4	48,405	66.1	1,227	66.1
Columbia River	503	20.1	19,811	27.1	503	27.1
	2,508	100.0	73,196	100.0	1,857	100.0

Table 3. Chinook catch and effort from 1982 May commercial troll fishery, by week and area.[1/]

	Week	Cape Flattery	Quillayute	Grays Harbor	Columbia River	Total
Effort (days fished)	5/1-5/2	0	0	119	55	174
	5/3-5/9	63	26	658	257	1,004
	5/10-5/16	120	36	763	472	1,391
	5/17-5/23	125	22	824	276	1,247
	5/24-5/30	54	11	599	210	874
	5/31-6/6	64	50	505	147	766
Total		426	145	3,468	1,417	5,456
Chinook (numbers)	5/1-5/2	0	0	2,030	532	2,562
	5/3-5/9	438	497	13,094	3,615	17,644
	5/10-5/16	1,115	542	9,515	7,876	19,048
	5/17-5/23	979	164	10,183	2,556	13,882
	5/24-5/30	244	38	6,984	2,518	9,784
	5/31-6/6	474	489	6,599	2,714	10,276
Total		3,250	1,730	48,405	19,811	73,196

1/ Non-Indian troll catch and effort represents combined Washington and Oregon landings.

Table 4. Age composition of 1982 May troll chinook salmon catch, by area.

	Age[1/]	Cape Flattery	Quillayute	Grays Harbor	Columbia River	Total
Catch	3_1	1,729	1,358	42,959	17,893	63,939
	4_1	1,214	193	2,977	630	5,014
	5_1	65	42	199	44	350
	3_2	4	7	361	165	537
	4_2	196	130	1,610	963	2,899
	5_2	42	0	299	116	457
Total		3,250	1,730	48,405	19,811	73,196
Percent	3_1	53.2	78.5	88.8	90.3	87.4
	4_1	37.4	11.2	6.2	3.2	6.8
	5_1	2.0	2.4	0.4	0.2	0.5
	3_2	0.1	0.4	0.7	0.8	0.7
	4_2	6.0	7.5	3.3	4.9	4.0
	5_2	1.3	0.0	0.6	0.6	0.6
Total		100.0	100.0	100.0	100.0	100.0

1/ Age group designations are 3, 4, and 5; subtypes are fingerling (1) and yearling (2) juvenile life history patterns, i. e. age at downstream migration

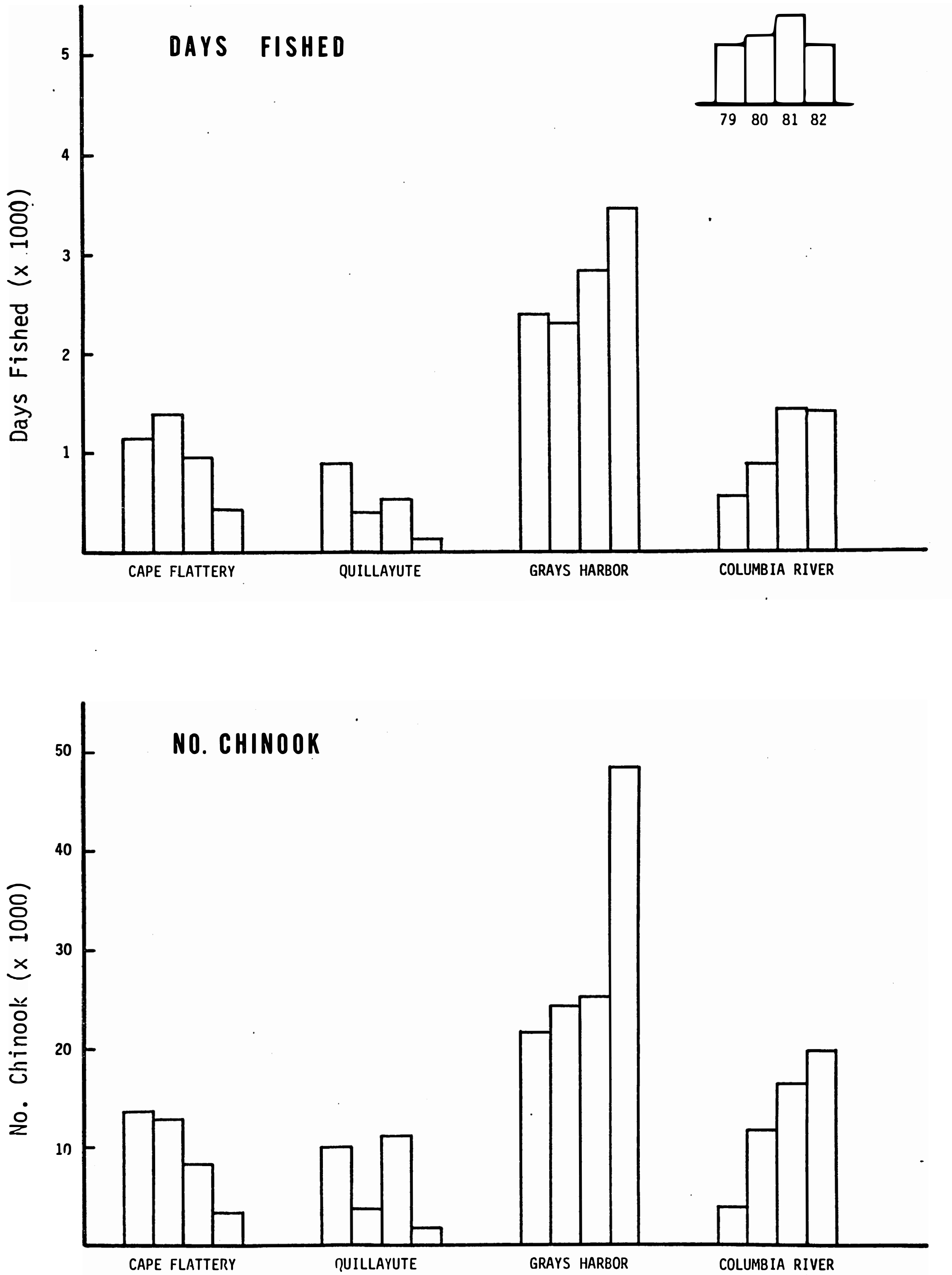

Figure 2. Catch and effort for 1979-82 May commercial troll chinook-only fisheries north of Cape Falcon, by area (excluding Indian troll).

Estimated stock composition of the total 1982 May troll chinook catch indicated that Lower Columbia River/Bonneville Pool fall is the predominant contributing stock group, comprising 76.5% of the total catch. All other individual stock group contributions are less than 6.0% (Table 5 and Figure 3).

To obtain maximum precision, stock contribution estimates for individual areas were made using all available samples. Sample sizes of 1917 and 448 were used to derive estimates for the combined Columbia River/Grays Harbor and the Cape Flattery catch areas respectively. A sample size of 143 was insufficient to make a comparably precise estimate for the Quillayute catch area. The total number of samples used in deriving area specific estimates was 2365 which exceeded the 1857 used to estimate composition of the total fishery. Therefore, for a given stock group, the sum of individual area contribution estimates may be greater or less than that estimated for the total fishery. The number of stock groups used in the area estimates was reduced from 17 to 11 in order to improve precision as discussed in the Methods section. Stock composition for the areas' catch revealed significant differences in relative contribution north to south (Table 6, Figure 4). Lower Columbia River/Bonneville Pool fall stock contributed 78.2% to the southern area's catch but only 45.6% to the Cape Flattery catch. Canadian stocks contributed at a comparatively high level in the northern area (22.0%), but were insignificant in the southern area catch (1.4%).

Table 5. Estimated management stock group contribution to the total chinook catch of the 1982 May troll fishery, based on proportionate subsampling of total GSI sample.

Management stock group	Percent of total catch	Catch	Standard deviation of catch
California fall	2.5	1,817	1,054
California spring	0.3	228	256
Oregon coastal fall	0.2	132	512
Oregon coastal spring	1.4	1,044	747
Lower Columbia River/Bonneville Pool fall	76.5	56,008	337
Lower Columbia River spring (Willamette)	1.9	1,368	146
Lower Columbia River spring (Cowlitz/Kalama)	5.1	3,722	578
Upper Columbia River fall	4.3	3,177	812
Upper Columbia River spring	2.4	1,736	285
Upper Columbia River summer	0.3	184	234
Snake River spring	0.4	257	132
Washington coastal fall	0.3	221	988
Washington coastal spring/summer	1.0	750	578
Puget Sound fall	1.6	1,199	644
Puget Sound summer	0.2	162	344
Southern British Columbia fall	1.4	1,059	425
Fraser River summer	0.2	132	190
Total	100.0	73,196	--

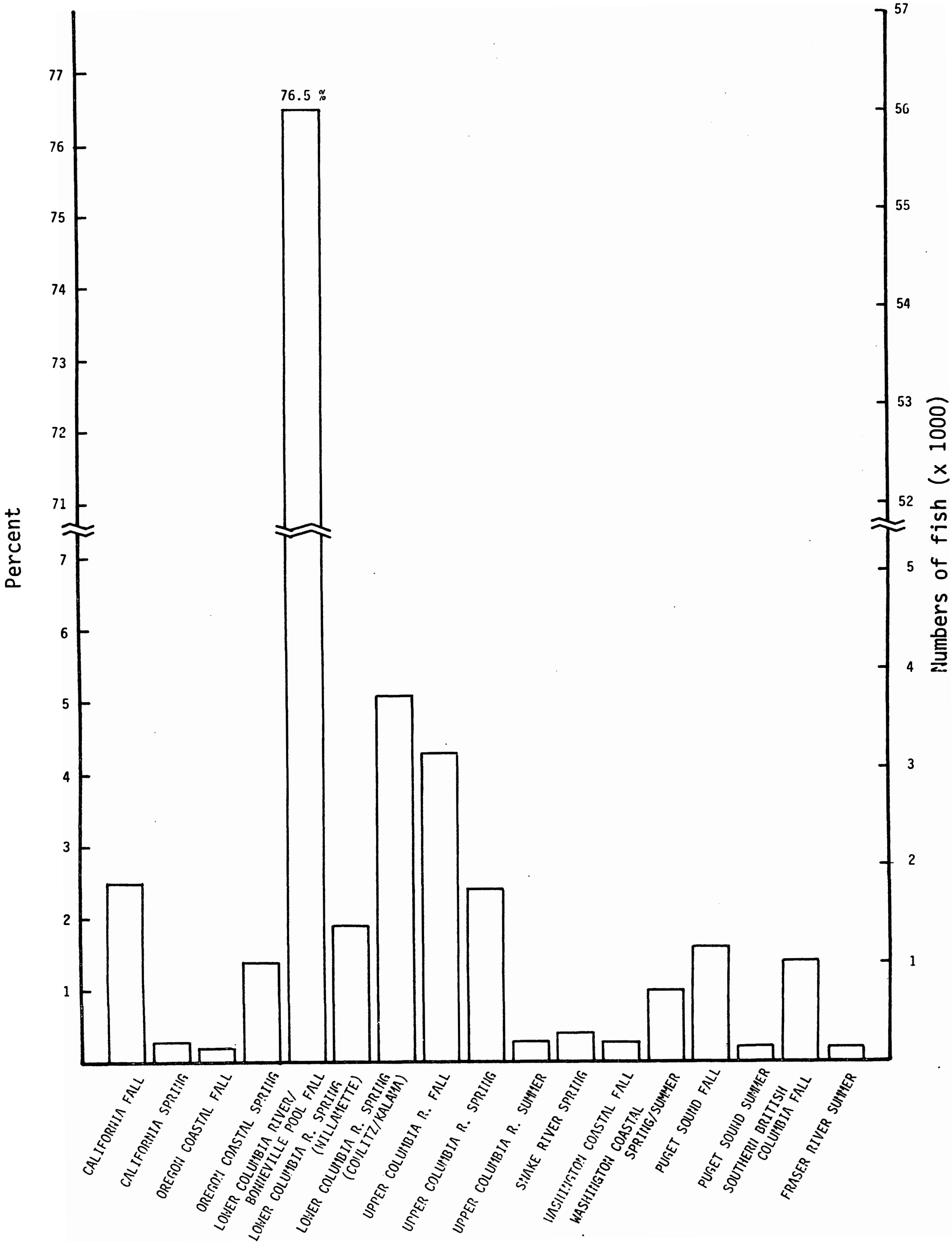

Figure 3. Estimated management stock group contribution to 1982 May commercial troll chinook catch north of Cape Falcon, in numbers of fish and percentages.

Table 6. Estimated management stock group contribution to Columbia River/ Grays Harbor and Cape Flattery areas' chinook catch of the 1982 May troll fishery.

	Columbia River/Grays Harbor			Cape Flattery		
Management stock group	Percent	Number	s.d.	Percent	Number	s.d.
California fall	4.2	2,855	614	4.2	135	450
California spring	1.1	774	205	0.2	6	226
Oregon coastal spring/ fall	2.8	1,931	1,160	4.7	154	545
Lower Columbia River/ Bonnevile Pool fall	78.2	53,379	273	45.6	1,481	275
Lower Columbia River (Willamette) spring	2.3	1,554	136	0.1	4	123
Lower Columbia River (Cowlitz/Kalama) spring	3.2	2,170	511	2.2	71	364
Upper Columbia River fall/summer	4.0	2,753	498	8.8	286	308
Upper Columbia River/ Snake River spring	1.2	794	287	0.1	3	364
Washington coastal spring/fall/summer	1.0	712	1,187	5.0	162	433
Puget Sound summer/fall	0.5	370	450	7.2	232	139
British Columbia summer/fall	1.4	924	457	22.0	716	204
Total	100.0	68,216	-	100.0	3,250	-

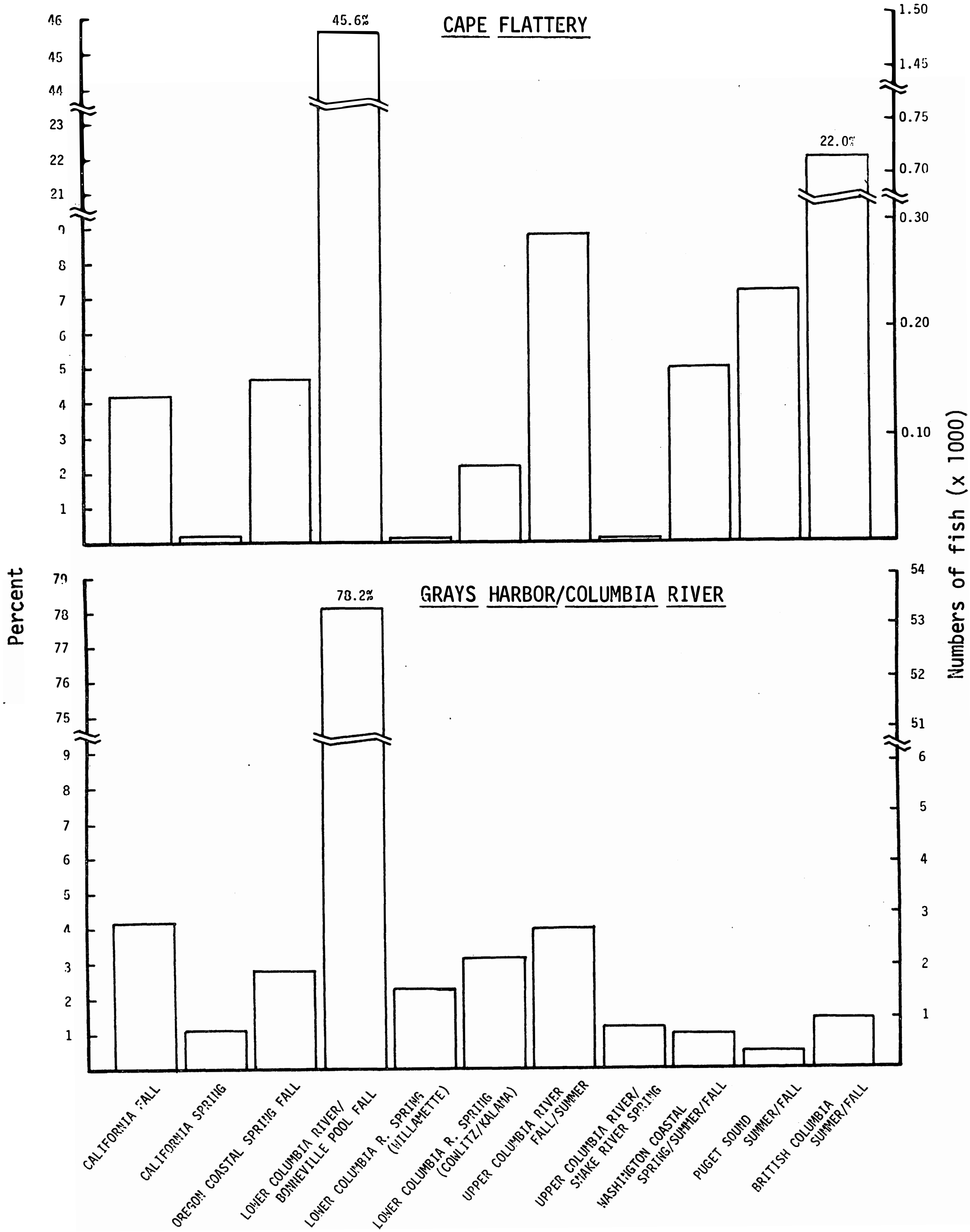

Figure 4. Estimated management stock group contribution to Grays Harbor/Columbia River and Cape Flattery area chinook catch in 1982 May commercial troll fishery north of Cape Falcon.

DISCUSSION

Evaluation of GSI Estimates

Evaluation of the GSI estimates is made from two perspectives, precision and accuracy. Precision is the expected degree of agreement among estimates that would be obtained by repeated sampling of the same population, while accuracy describes the closeness of an estimate to its true value.

Estimated standard deviations presented are generally conservative measures of precision of the GSI estimates of contribution. In previous Monte Carlo tests actual standard deviations were smaller than those calculated with the statistic used in these study results, particularly when associated with small sample sizes and/or very small contributions (Milner et al., 1981). Standard deviations for the estimated contributions to the total catch range from less than 1% of the estimate for the major contributing (76.5%) stock group to over 100% for groups contributing at very low levels (0.3%). The standard deviations of the three stock groups with 4% or more contribution range from 1 to 26 percent of their estimates.

Accuracy of stock contribution estimates is more difficult to evaluate than precision. While the true stock contribution of a fishery is never known absolutely, a perspective on the true value may be developed through comparison with independently derived estimates including subjective or qualitative information.

General conceptions of stock composition in the ocean troll catch prior to this study have been based upon various sources of stock-specific information including relative abundance in terminal areas, scale analysis, and ocean distribution information provided by juvenile and adult tagging experiments. For example, Columbia River fall chinook have been estimated to contribute on the average 70% of the total annual chinook harvest off the Washington coast (Wright, 1976). Coded wire tagging experiments with hatchery releases representing lower Columbia River and Bonneville Pool stocks have established that Washington coastal fisheries constitute a major component of the total ocean harvests and terminal abundance in 1982 was above average, particularly for the 1979 brood year (age 3 in 1982) component.

Coded wire tags recovered from the 1982 May troll fishery provide a qualitative though incomplete description of chinook stock group composition

(Table 7). For example, Sacramento River fall chinook of the 1978 and 1979 brood years from four hatchery origins and a diverse group of rearing and release histories definitely contributed to the May 1982 troll fishery, however extrapolation to the total population of Sacramento River system fall chinook requires the acceptance of a broad spectrum of assumptions about representation by tagged fish of untagged hatchery releases as well as a substantial natural population.

For the purpose of comparison with GSI method estimates, an independent contribution estimate was made for the Lower Columbia River/Bonneville Pool stock group using coded-wire tag recoveries. Catch of each production component of the stock group was estimated by combining (1) the ratio of total number of juveniles released from hatcheries to number of tagged releases, and (2) number of recoveries in the fishery expanded by total catch-sample fractions. Estimated contribution to the Columbia River and Grays Harbor areas' catch by the 1979 brood, 29,900 fish or 38%, compares to 52,000 fish or 81% estimated by the GSI method (Table 8). Complete representation of this stock group by coded-wire tagging is unquestionably lacking; although the stock group is principally hatchery produced, a portion of the production is from natural spawning sources, and a large part of the hatchery production is inadequately represented by tagging. A more appropriate expansion of coded-wire tag recoveries would be made by utilizing adult tag ratios from the terminal areas, however, these are unavailable at this time. In general, the result of coded-wire tag expansion appears to be an underestimate of the true contribution made by the stock group.

Just as representation is the critical factor in assessing validity of a coded-wire tagging contribution estimate so the comprehensive nature of the baseline data determines the validity of GSI method estimates. The baseline data set used for this study has been scrutinized for its adequacy in representing all potentially contributing stock groups, particularly key management stock groups. Potential deficiencies were remedied prior to the study. For example, the upper Columbia River fall group recently added representative samples from the Deschutes River and additional samples from the natural spawning population of the Hanford Reach area. Columbia River stock groups were the most comprehensively sampled of all groups included in the baseline data set, so deficiencies in the baseline regarding the estimated

Table 7. Coded-wire tag representation in the May 1982 troll fishery off Washington by management stock group, area, and brood year.

Stock	Columbia River		Grays Harbor		Quillayute/ Cape Flattery	
	Brood Year					
	1978	1979	1978	1979	1978	1979
Upper Columbia River summer						
Puget Sound summer						
Lower Columbia River (Cowlitz/Kalama) spring						
Lower Columbia River (Willamette) spring	X	X	X			X
Upper Columbia River spring						
Snake River spring						
California spring		X				
Oregon coast spring	X	X	X	X		X
Washington coast spring					X	
Fraser River spring						
Lower Columbia River/ Bonneville Pool fall	X	X	X	X	X	X
Upper Columbia River fall	X		X	X	X	X
California fall	X	X	X	X	X	X
Washington coast fall						
Puget Sound fall	X	X	X	X	X	X
British Columbia fall						X

Table 8. 1979 brood year lower Columbia River[1/] Hatchery fall chinook production and contribution to the May 1982 Washington ocean troll fishery in the Columbia River and Grays Harbor catch areas.

Production subunit	(1) Total production (in millions)	(2) Coded-wire tag production (in millions)	Expansion (1) - (2)	Estimated recoveries		Estimated catch	
				Columbia River	Grays Harbor	Columbia River	Grays Harbor
Washington							
Elokomin, Toutle, Cowlitz, Washougal, Grays	23.012	.800	28.766	23	16	662	460
Lower Kalama, Kalama Falls	8.571	.245	35.000	1	3	35	105
Lewis River (Wild + hatchery)	-	-	14.286	2	0	29	0
Klickitat	3.139	.156	20.122	5	12	101	241
Oregon							
Big Creek	6.433	.143	44.986	25	66	1,125	2,969
Klaskanine	3.555	.066	53.864	1	0	54	0
Willamette	6.349	.282	22.515	49	160	1,103	3,602
Bonneville/Oxbow	11.364	.222	51.189	4	8	205	410
Bonneville studies	.949	.197	4.817	5	14	24	67
U.S. Fish & Wildlife Service							
Little White Salmon/Spring Creek							
Fingerlings	23.221	.434	53.51	58	267	3,104	14,287
Fall release	1.089	.024	45.38	8	12	363	545
Experiments	.213	.206	1.04	84	311	87	323
Total						6,892	23,009

1/ Including Bonnevile Pool production but not including egg bank upriver bright production from Bonneville and Kalama hatcheries.

principle component of the May troll chinook harvest are difficult to criticize. Baseline data for stock groups outside the Columbia River drainage appeared adequate in representation for their apparently small contribution but additional sampling of management critical stocks, e.g., Washington coastal, would be desirable for future analysis.

Evaluation of Study Design and Future Study Development

Estimation of stock group contributions to the total catch of the May troll fishery was the principle objective of GSI method application. A sampling program for meeting this objective was designed to approximate the area distribution of the catch. In addition to the principle objective, estimates with comparable precision of stock contribution to individual catch areas were obtained.

Project design factors which critically influence or limit results can be categorized under four general headings:

(1) A priori estimate intentions -
Sampling design is dependent upon the level of identification of stocks (the extent of grouping), the extent to which catch estimates are to be stratified (e.g., area, age, time, etc.) and the acceptable level of precision of the estimates. For example, stock composition estimation by age was not a specific design intention for the 1982 study and sample size for age specific estimates was sufficient only for the age 3 category.

(2) Fishery dynamics -
The dynamic nature of the ocean troll salmon fishery defies application of a static design to achieve a representative distribution of samples. While total sample size requirements in 1982 were achieved, area specific sample size was less than desired. Difficulty of sample collection from different segments of the fishery varies with disposition of fish at time of landing and the ability to prearrange collection of samples.

(3) Budget constraints -
As stated in the introduction, the May troll fishery was chosen for this study because of the relative availability of sampling effort on the part of WDF's ocean salmon sampling program during that time.

Sampling during all-species troll seasons or when sport fishery is proceeding may be subject to significant budget constraints as would increased sampling efforts during chinook-only troll seasons. Future study design may need to incorporate greater efficiency in the gathering of samples (no more samples than necessary within each port) or modification in study intention.

(4) GSI sample requirements -

Computer simulations using 1982 information can be used to establish sample size requirement to achieve specific objectives for the 1983 season. The sample sizes that will be established using the simulation procedures will depend on the key stock or stock groups to be estimated, the level of breakdown of the estimates (area, age, etc.), and the desired precision of the estimates as determined during the planning stage.

The tissue or combination of tissues used in future seasons should be selected on the basis of both information contributed and ease of collection. Maximum genetic information is obtained by using all of the standard tissues/organs (eye, liver, heart and white muscle). Therefore, the level of precision obtained in 1982 can be increased or the sample size needed for the same level of precision can be reduced by collecting white muscle and eye tissues in addition to the tissues collected this year. The effect of substituting tissues that are available at dockside for those typically discarded at sea would reduce the need for sample collection by skippers and on-board technicians. Computer simulations could be used to evaluate the stock identification information provided by various tissue combinations in the context of sampling practicality.

On-board preservation and storage of tissues would be more effective in portable freezers. Dry ice cost $1567 in the 1982 study and was not always readily available. Permanent freezing facilities in each port would also reduce the possibility of sample loss and deterioration.

CONCLUSION

The objective of this study was twofold: (1) evaluating GSI method's application as a practical salmon management tool; and (2) increasing the collective information base with which the Oregon and Washington May troll chinook fisheries north of Cape Falcon is managed.

The GSI method has the potential to be an extremely valuable ocean fishery management tool. This new ability to monitor the contribution of specific stocks to a fishery would provide improved, direct estimates of a fishery's impact on critical, weak stocks, as well as provide allocation estimates (e.g., U.S./Canada interceptions) which are actual measures of "real" fish. The GSI method, then, would represent an inseason complement to other stock specific planning tools such as fishery models which rely on coded-wire tag recovery data as input data.

The 1982 study corroborated this application potential to chinook fishery management off the northern Oregon and Washington coast. The chinook baseline data is comprehensive and provides good resolution of stock differences. The only operational barrier for the GSI method as an annual stock monitoring technique is cost. The ultimate goal for fullscale implementation would be development of dockside sampling capabilities which currently exist for coded-wire tags and scales. The continued constraint of collecting samples at sea is unacceptable for an annual tool because of observer expense. A long term voluntary sampling program is not realistic for a fishery which may be actively managed by the information collected. In addition, a small subsample of boats at sea cannot provide reasonable assurance of unbiased results. Representative dockside sampling is a key to obtaining this objective.

Future work should concentrate on evaluating specific management applications which could be achieved within budget constraints. The question of sample collection logistics as well as sample size would be extremely pertinent.

Even if certain fullscale management constraints are identified, the GSI method still would have a valuable potential for gaining intermittent information on stock composition in ocean fisheries. The May 1982 study, for example, provided the first direct measure of chinook stock composition off the Washington coast. While results confirmed most expectations, the ability to quantify estimates provides new information of great management significance. Considering the existence of coastwide chinook conservation problems, application of the GSI tool to other areas and fisheries would be extremely valuable. In addition, the replication of the 1982 study off the Washington coast would provide valuable information on annual variability of stock composition.

In summary, the GSI method probably represents the most promising new technique for improved ocean management capabilities which managers will have tor many years to come. Future application evaluations and data collection studies should be given priority much ahead of refinements to existing tools which may provide only marginal benefits in management capability.

SUMMARY

1. A total of 73,196 chinook were caught during the 1982 May troll fishery adjacent to the Washington coast.
2. Heart and liver samples were collected from 2,508 chinook salmon provided by commercial trollers for the purpose of obtaining genetic stock identification method estimates of stock contribution to the 1982 May chinook fishery catch.
3. Scale analysis showed that age 3 chinook were the predominant age group, comprising 88 percent of the total catch.
4. Contribution to the total catch was estimated for 17 management stock groups. GSI method results showed the predominant stock group was lower Columbia/Bonneville Pool fall comprising an estimated 76.5% of the total catch. All other stock group contributions were less than 6.0%.
5. Contribution to catch within the Cape Flattery catch area and from the combined Columbia River/Grays Harbor catch area was estimated using 11 management stock groups. A significant difference in stock group composition exists between northern and southern areas.
6. Precision of the stock group contribution estimates, presented as standard deviation, ranges between 1% of the estimate for the Lower Columbia River/Bonneville Pool stock group to much greater than 100% for groups contributing at very low levels.
7. Accuracy of estimates is assessed by examining other indicators of stock contribution, but comparison with independent estimates is inconclusive.
8. Accuracy is assessed from perspective of representation of stock groups, i.e., comprehensive base line data. Representation is adequate, especially for Columbia River drainage stocks which comprise the major stock component.
9. Study results are evaluated from perspective of critical project design factors: (1) estimate intentions, (2) fishery dynamics, (3) ongoing WDF ocean sampling, and (4) GSI sample requirements. Results from the 1982 study provide guidelines for more efficient experiment design of future studies.

10. The GSI method provides significant new information for coastwide chinook salmon management in quantification of stock contribution. Benefits to management capability justify continued refinement in implementation of the method including application to other areas and fisheries. Valuable information would be obtained by replication of the 1982 study. Techniques will be modified to improve representative sampling and reduce costs associated with the need for on-board tissue collection.

ACKNOWLEDGEMENTS

The authors are indebted to a long list of individuals and organizations who contributed to the success of the project.

The 15 trollers listed at the beginning of the report sacrificed a great deal by volunteering services, including fishing time. The troller associations were very helpful in assuring a full complement of contributors.

John Linth and Randy McIntosh of the Washington Department of Fisheries coordinated sampler activity at dockside. John DeVore, Harold Lincoln, Rick McNicholas and Mark O'Toole were on-board observers for the month. Carol Ranck and Paul Aebersold of National Marine Fisheries Service performed the laboratory procedures that converted simple tissue samples into analyzable genetic data.

Finally, two individuals are credited with the insight that allowed merging of two independent research projects into this unified effort. The original work of Dr. Fred Utter evolved into the tools for applying genetic stock identification to an ocean mixed stock fishery. The recognition of potential, the decision for application, and the guidance which assured practical employment of this management tool can be attributed to Richard Lincoln.

LITERATURE CITED

May, B. P. 1975. Electrophoretic variation in the genus Oncorhynchus: the methodology, genetic basis, and practical application to fisheries research and management. University of Washington, M. S. thesis.

Milner, G. B., and D. J. Teel. 1979. Columbia River Stock Identification Study: Annual Report of Research (FY 78), NOAA, NWAFC, Seattle, WA 98112.

Milner, G. B., D. J. Teel, and F. M. Utter. 1980. Columbia River Stock Identification Study: Annual Report of Research (FY 79), NOAA, NWAFC, Seattle WA 98112.

Milner, G. B., D. J. Teel, F. M. Utter, and C. L. Burley. 1981. Columbia River Stock Identification Study: Validation of Genetic Method: Annual Report of Research (FY 80), NOAA, NWAFC, Seattle, WA 98112.

Wright, Samuel G. 1976. Status of Washington's Commercial Troll Fishery in the mid-1970's. Wash. Dept. Fish. Tech. Report No. 21. 50 pp.