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BIOCHEMICAL GENETIC STOCK IDENTIFICATION OF CHUM SALMON IN SOUTHERN BRITISH COLUMBIA 1991

by

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ABSTRACT

Hop Wo, L., S.C. Di Novo, A.P. Gould and W.H. Luedke. 1992. Biochemical Genetic Stock Identification of Chum Salmon in Southern British Columbia 1991. Can. Data. Rep. Fish. Aquat. Sci. No. 874: 22p.

Genetic stock identification (GSI) is used by the Department of Fisheries and Oceans in estimating chum stock composition. In 1991 approximately 6,200 fish samples were collected from four fishing areas (Johnstone Strait, Mid Vancouver Island, Nanaimo and Nitinat). Stock composition results are presented.

Key words: chum salmon, genetic stock identification, stock composition, fishery management, Southern British Columbia.

RÉSUMÉ

Hop Wo, L., S.C. Di Novo, A.P. Gould et W.H. Luedke. 1992. Biochemical Genetic Stock Identification of Chum Salmon in Southern British Columbia 1991. Can. Data. Rep. Fish. Aquat. Sci. No. 874: 22p.

L'identification génétique des stocks (GSI) est utilisée par le ministère des Pêches et des Océans dans l'estimation de la composition des stocks de saumon kéta. En 1991, environ 6 200 échantillons de poissons provenant de quatre secteurs de pêche (détroit de Johnstone, partie centrale de l'île de Vancouver, Nanaimo et Nitinat) ont été prélevés. Les résultats sur la composition des stocks sont présentés.

Mots-clés : saumon kéta, identification génétique des stocks, composition des stocks, gestion des pêches, sud de la Colombie-Britannique.

INTRODUCTION

Genetic stock identification (GSI) has occurred in Canadian chum fisheries since 1981 (Beacham et al. 1985). More recently (GSI) programs have established stock composition for every major chum fishery in Southern British Columbia. GSI results provide fisheries staff with stock identification information needed to effectively manage commercial fisheries. In addition, this information provides estimates of harvest by country, which are used in implementing the terms of the Pacific Salmon Treaty.

For Canadian commercial fisheries, GSI results have provided information on migration routes and timing as well as assisted in stock abundance estimates. This information is a vital component in the planning of expected fisheries. During the season, weekly results provide managers with an indication of chum run activity. After final analysis are complete, GSI results are used to estimate catch interceptions, which are required for stock assessment and Pacific Treaty obligations. This annual report (sixth of a series) includes a description of GSI sampling methods, analysis and results conducted in the 1991 fishing season.

METHOD

(1) Collection

In 1991, a total of 6,177 fish were sampled from four chum fishing areas in Southern British Columbia. Sampling occurred from early September to early November. The samples were collected from two commercial gear types (gillnet and seine), and sampled from either commercial fishing boats, fish processing plants, or Department of Fisheries and Oceans (DFO) chartered fishing vessels.

Briefly, samples collected consisted of heart, liver, and muscle tissues from freshly caught adult chum salmon. Muscle tissue was extracted using a coring technique described in Hop Wo et al. 1991. The individually packaged tissues were then frozen to help prevent protein degeneration. Protein analysis was provided by a consultant, using the horizontal starch gel technique described by Utter et al. (1974).

Chum salmon were sampled in 1991 from the following four fishing areas (Fig. 1): Johnstone Strait (Area 12 and 13); Mid Vancouver Island (Area 14); Nanaimo (Area 17) and Nitinat (Area 21). These samples were taken in order to determine the stock composition of commercial fisheries. In general, sample sizes of approximately 150-200 chum were obtained on a weekly or per fishing area basis. However some areas received additional sampling, such as the Johnstone Strait September 24 fishery where 899 chum were sampled.

The Johnstone Strait (Area 12) test fishery sampling program was conducted aboard two chartered seine vessels. Tissue samples

were collected each week in conjunction with stock abundance testing at predetermined sites as described in Vreeling et al. (1987). Sampling commenced early in September and continued until early November. A total of 2,547 samples were collected from both vessels over a 9 week period. Each vessel collected approximately 150 chum samples per week while on charter. Note, for the last week of October only one vessel was retained on charter, hence the total sample for that week was 150 chum.

In addition to the annual test fishery sampling program, 1991 was the second year of a funded program to compare Johnstone Strait commercial sampling with test fishery sampling. Each commercial fishery was sampled at three or more landing sites. At each landing site, approximately 200 fish were randomly sampled from selected seine vessels. Sampling was stratified by Statistical Areas, based on the proportion of total estimated catch from each area (Area 12 and 13).

During the chum fishing season, only one commercial fishery occurred in Johnstone Strait. The fishery transpired on September 23 where a total of 899 chum samples were collected from 5 different landing sites. Three sample groups of approximately 200 fish each were collected in Vancouver and contained a stratified sample mixture of Areas 12 and 13 caught fish (60% and 40% respectively). The fourth sample group of 100 was collected from Port Hardy and contained only Area 12 fish. The fifth sample of 200 was collected from Campbell River and consisted exclusively of Area 13 fish.

The Mid Vancouver Island (Area 14) sampling program occurred during or immediately after each of the four commercial fishery. Sampling for the first two gillnet fisheries was aboard packing vessels located on the fishing grounds. Three separate sub areas were sampled from both gillnet fishery. The sample target per sub area was 150 fish, however, some sampling was limited due to availability of catch. The gillnet fisheries occurred during October 15-16 and 21-22.

The remaining two fisheries were commercial seine fisheries which occurred on October 28 and November 5. Sample collection from these two fisheries totalled 299 and 199 respectively. Sub area separation for these fisheries was not possible, due to the mobility of the seine fleet.

For the Nitinat fisheries (Area 21) all samples were randomly collected from packers delivering to processing plants in Vancouver. Early commercial gillnet fisheries commenced on September 23; 30; October 7 and 19. Seine fishing commenced on October 15 and ended 11 days later. Sampling occurred in every week of the fishery except the first week where insufficient fish were caught to obtain a sample. A total of 1300 samples were obtained from these fisheries. Sample sizes ranged from 200 for

early gillnet fisheries to 300 and 600 for later seine fisheries. Note that the October 16 sample was 600, however only 150 were analyses due to a cold storage malfunction which spoiled 450 chum samples.

Chum fisheries frequently occur in discreet terminal areas such as Cowichan (Area 18). This year four commercial gillnet fisheries occurred in this area during November. No sampling was scheduled for this area as the vast majority of catches were anticipated close to the inner fishing boundary. In addition recent results (Hop Wo et al. 1991) have shown a small interception (0.01%) of non Canadian origin stocks in outside fishing areas.

Another terminal chum fishing area in Southern British Columbia which received no GSI sampling was the Fraser River. Two terminal fisheries occurred in this area, the first in late October and the second in early November.

Analysis

After collection, the frozen chum tissues were sent to a contract laboratory for protein analysis. The tissues were analyzed for protein variation. The seven loci analyzed and coded are listed using nomenclature described by Shaklee et al. 1991: IDH-1 (1.1.1.42); PGDH (1.1.1.44); ME (1.1.1.39); G3PDH (1.1.1.8); IDH-3 (1.1.1.42); MPI (5.3.1.8); and Pep (3.4.-.-,) leucyl glycyl glycine substrate. This information was coded and returned to DFO for comparison to appropriate baseline samples.

Information from each fishery is compared to a baseline grouping which includes all possible stock contributors to the fishery. For Johnstone Strait, Qualicum and Nanaimo fisheries the baseline group used includes stocks originating from Johnstone Strait, Georgia Strait and Washington (Table 1). For Nitinat fisheries the baseline used includes West Coast Vancouver Island, Georgia Strait and Washington stocks (Table 2). Stocks included in respective baseline are based upon chum migration routes and stock abundance. Information contained in the baseline are observed genotypic frequencies of each locus.

Stock compositions are derived from comparisons and analysis which employed the method described by Fournier et al. (1984). The results were estimated using the genotypic frequencies and allocation method outlined by Beacham et al. (1987). Method and procedures for analysis using a maximum likelihood computer model are outlined in McKinnell 1990. The standard deviations of the estimates were determined by boot strapping, where new samples were constructed by sampling the original mixture and baseline with replacement. Computer model parameters (convergence criteria) were set at 10 e^{-10} for point estimates and 10 e^{-7} for boot strapping. Standard deviation estimates were derived from a boot strapped learning sample.

In addition, processing checks were conducted by resubmission of a previous sample. Individual scores and results were then compared to original processed results.

RESULTS

The GSI (electrophoretic) stock composition results from four commercial fishery locations are presented in Tables 3 to 7.

The results of GSI analysis are expressed as percentages by major stock areas (Fraser River; Johnstone Strait/Strait of Georgia; United States; and West Coast Vancouver Island). Included with stock composition estimates are, week and area of collection, sample date and size, gear type sampled from, and estimates of standard deviation.

Results of the processing check sample (n=200) revealed 1.2% of the individual scores were different from the original scores (missing scores not included). Stock composition results from re-analysis are present in Table 7.

ACKNOWLEDGEMENTS

Senior management technicians D. Brouwer and J. Mitchell coordinated sampling and test fishing. Samples were collected by; S.C. Di Novo, A. Dunlop, L. Naylor, D. Ritchie and C. McConnell. Skippers of chartered vessels include S. Beans, and "Moon" Stauffer. A. Sewid coordinated the Mid Vancouver Island sampling. Protein analysis was by provided Aqua Life Diagnostics and commercial sampling was assisted by J.O. Thomas Ltd. B. Adkins prepared the tables.

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Table 1. Allelic Frequencies of Baseline Spawning Ground Samples for Johnstone and Georgia Strait Fisheries

Non– Fraser Population

Locus	Nanaimo	Goldstream	Sliammon	L. Qualicum	Puntledge	B. Qualicum	Cowichan	Rosewall C.	Chehalis	Butle Inlet	Orford	Homathko	Toba	Tzoonie	Mamquam R.	Squamish	Indian R.	Salter B.
IDH–1																		
(N)	199	192	191	250	386	263	200	92	70	104	100	106	103	105	99	100	48	67
A	0.91	0.89	0.94	0.94	0.94	0.96	0.94	0.95	0.94	0.93	0.92	0.94	0.96	0.93	0.96	0.93	0.92	0.94
B	0.09	0.11	0.06	0.06	0.06	0.04	0.07	0.05	0.06	0.07	0.08	0.06	0.04	0.07	0.04	0.07	0.08	0.06
6–PG																		
(N)	200	192	200	300	400	300	200	92	100	104	100	106	103	107	101	100	50	70
A	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
B	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ME–1																		
(N)	199	192	200	300	392	298	200	92	97	102	100	106	103	106	93	100	50	69
A	0.78	0.68	0.77	0.75	0.77	0.80	0.76	0.76	0.83	0.81	0.84	0.81	0.82	0.77	0.78	0.78	0.78	0.81
B	0.22	0.32	0.23	0.25	0.23	0.21	0.24	0.25	0.17	0.19	0.17	0.19	0.18	0.23	0.22	0.23	0.22	0.19
AGP–2																		
(N)	188	181	99	197	301	195	280	87	104	64	100	106	154	107	61	201	50	167
A	0.97	0.93	0.94	0.95	0.93	0.93	0.96	0.93	0.97	0.98	0.94	0.97	0.96	1.00	0.93	0.96	0.94	0.97
B	0.03	0.07	0.06	0.05	0.07	0.07	0.04	0.08	0.03	0.02	0.06	0.03	0.04	0.00	0.07	0.04	0.06	0.03
IDH–3																		
(N)	200	192	193	296	379	294	199	92	97	103	98	106	103	106	101	81	50	68
A	0.05	0.07	0.06	0.05	0.08	0.04	0.06	0.07	0.02	0.08	0.06	0.12	0.03	0.09	0.05	0.06	0.02	0.07
B	0.30	0.29	0.33	0.27	0.27	0.29	0.23	0.24	0.22	0.15	0.19	0.19	0.25	0.27	0.31	0.30	0.32	0.26
C	0.06	0.05	0.07	0.04	0.05	0.02	0.05	0.03	0.06	0.03	0.04	0.03	0.04	0.06	0.05	0.04	0.04	0.05
D	0.59	0.59	0.54	0.63	0.60	0.65	0.66	0.67	0.71	0.74	0.70	0.67	0.68	0.59	0.60	0.61	0.62	0.62
E	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PMI																		
(N)	207	192	100	198	302	200	284	90	105	104	100	106	154	107	101	201	50	167
A	0.89	0.88	0.92	0.90	0.92	0.91	0.87	0.88	0.90	0.93	0.99	0.98	0.98	0.94	0.88	0.88	0.88	0.88
B	0.11	0.12	0.09	0.10	0.08	0.09	0.13	0.12	0.10	0.07	0.02	0.02	0.02	0.07	0.12	0.12	0.12	0.12
C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LGG																		
(N)	97	188	96	60	200	99	199	91	99	75	100	106	102	107	100	100	50	70
A	0.89	0.84	0.88	0.89	0.78	0.79	0.81	0.78	0.84	0.91	0.88	0.90	0.88	0.86	0.84	0.83	0.81	0.81
B	0.11	0.16	0.12	0.11	0.22	0.21	0.19	0.22	0.16	0.09	0.13	0.10	0.12	0.14	0.16	0.18	0.19	0.19

Table 1. (cont'd) Allelic Frequencies of Baseline Spawning Ground Samples for Johnstone and Georgia Strait Fisheries

	Fraser Population											U. S. Population		
Locus	Weaver	Vedder	Harrison	Squakum	Inch C.	Blaney C.	Stave R.	Chehalis R.	Wallace S.	Fraser M.	Alouette	N. Puget	S. Puget	Hood Canal
IDH-1														
(N)	100	298	377	124	113	98	190	200	100	95	100	242	192	399
A	0.92	0.88	0.89	0.90	0.88	0.88	0.91	0.92	0.92	0.92	0.95	0.84	0.82	0.72
B	0.08	0.12	0.11	0.10	0.12	0.12	0.09	0.08	0.08	0.08	0.06	0.16	0.18	0.28
6-PG														
(N)	100	300	378	124	136	100	194	200	100	95	100	531	862	938
A	1.00	1.00	0.99	1.00	0.99	1.00	0.99	1.00	1.00	0.97	0.99	0.99	0.99	0.99
B	0.00	0.00	0.01	0.00	0.02	0.01	0.01	0.00	0.01	0.03	0.02	0.01	0.01	0.01
ME-1														
(N)	100	297	373	123	149	100	189	200	99	95	100	223	193	316
A	0.85	0.80	0.85	0.85	0.86	0.88	0.79	0.85	0.87	0.85	0.94	0.73	0.73	0.73
B	0.16	0.20	0.15	0.15	0.14	0.12	0.21	0.16	0.13	0.15	0.07	0.27	0.27	0.28
AGP-2														
(N)	95	253	272	196	259	151	197	401	180	94	198	225	192	400
A	0.97	0.94	0.95	0.95	0.95	0.92	0.96	0.95	0.91	0.93	0.92	0.87	0.92	0.84
B	0.03	0.06	0.05	0.05	0.05	0.08	0.04	0.05	0.09	0.07	0.08	0.13	0.08	0.16
IDH-3														
(N)	94	293	373	124	146	100	197	198	100	95	60	430	883	929
A	0.07	0.12	0.07	0.11	0.03	0.08	0.07	0.09	0.07	0.12	0.10	0.08	0.05	0.06
B	0.29	0.27	0.29	0.27	0.31	0.31	0.25	0.27	0.27	0.21	0.28	0.26	0.32	0.25
C	0.01	0.05	0.04	0.06	0.03	0.10	0.05	0.05	0.06	0.02	0.04	0.05	0.15	0.11
D	0.63	0.56	0.60	0.56	0.62	0.52	0.63	0.60	0.61	0.66	0.58	0.61	0.48	0.58
E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PMI														
(N)	96	296	280	197	260	153	199	404	200	93	200	531	1380	937
A	0.92	0.87	0.86	0.87	0.84	0.87	0.86	0.87	0.87	0.93	0.92	0.81	0.76	0.80
B	0.08	0.13	0.14	0.13	0.16	0.13	0.14	0.13	0.14	0.08	0.08	0.19	0.24	0.20
C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LGG														
(N)	98	97	179	98	53	97	196	200	100	92	99	242	193	400
A	0.90	0.84	0.84	0.90	0.78	0.86	0.84	0.82	0.80	0.80	0.86	0.81	0.84	0.69
B	0.10	0.16	0.16	0.10	0.22	0.14	0.16	0.18	0.20	0.20	0.14	0.19	0.16	0.31

Table 2. Allelic Frequencies of Baseline Spawning Ground Samples for Nitinat Fisheries

Non–Fraser Population

Locus	Nanaimo	Goldstream	Sliammon	L. Qualicum	Puntledge	B. Qualicum	Cowichan	Roswell C.	Chemainus	Tzoonie	Mamquam R.	Squamish	Indian R.	Salt B.
IDH–1														
(N)	199	192	191	250	386	263	200	92	70	105	99	100	48	67
A	0.91	0.89	0.94	0.94	0.94	0.96	0.94	0.95	0.94	0.93	0.96	0.93	0.92	0.94
B	0.09	0.11	0.06	0.06	0.06	0.04	0.07	0.05	0.06	0.07	0.04	0.07	0.08	0.06
6–PG														
(N)	200	192	200	300	400	300	200	92	100	107	101	100	50	70
A	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
B	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ME–1														
(N)	199	192	200	300	392	298	200	92	97	106	93	100	50	69
A	0.78	0.68	0.77	0.75	0.77	0.80	0.76	0.76	0.83	0.77	0.78	0.78	0.78	0.81
B	0.22	0.32	0.23	0.25	0.23	0.21	0.24	0.25	0.17	0.23	0.22	0.23	0.22	0.19
AGP–2														
(N)	188	181	99	197	301	195	280	87	104	107	61	201	50	167
A	0.97	0.93	0.94	0.95	0.93	0.93	0.96	0.93	0.97	1.00	0.93	0.96	0.94	0.97
B	0.03	0.07	0.06	0.05	0.07	0.07	0.04	0.08	0.03	0.00	0.07	0.04	0.06	0.03
IDH–3														
(N)	200	192	193	296	379	294	199	92	97	106	101	81	50	68
A	0.05	0.07	0.06	0.05	0.08	0.04	0.06	0.07	0.02	0.09	0.05	0.06	0.02	0.07
B	0.30	0.29	0.33	0.27	0.27	0.29	0.23	0.24	0.22	0.27	0.31	0.30	0.32	0.26
C	0.06	0.05	0.07	0.04	0.05	0.02	0.05	0.03	0.06	0.06	0.05	0.04	0.04	0.05
D	0.59	0.59	0.54	0.63	0.60	0.65	0.66	0.67	0.71	0.59	0.60	0.61	0.62	0.62
E	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PMI														
(N)	207	192	100	198	302	200	284	90	105	107	101	201	50	167
A	0.89	0.88	0.92	0.90	0.92	0.91	0.87	0.88	0.90	0.94	0.88	0.88	0.88	0.88
B	0.11	0.12	0.09	0.10	0.08	0.09	0.13	0.12	0.10	0.07	0.12	0.12	0.12	0.12
C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LGG														
(N)	97	188	96	60	200	99	199	91	99	107	100	100	50	70
A	0.89	0.84	0.88	0.89	0.78	0.79	0.81	0.78	0.84	0.86	0.84	0.83	0.81	0.81
B	0.11	0.16	0.12	0.11	0.22	0.21	0.19	0.22	0.16	0.14	0.16	0.18	0.19	0.19

Table 2. (cont'd) Allelic Frequencies of Baseline Spawning Ground Samples for Nitinat Fisheries

West Coast Population

Locus	Nitinat	Atleo	Sarita	Couma	Marble	Tahsish	Nahmint	Tahsis	Canton	Sucowa	Burman	Zeballos	Megin
IDH-1													
(N)	603	200	201	200	97	100	98	100	99	99	100	100	99
A	0.96	0.95	0.95	0.95	0.98	0.96	0.95	0.97	0.96	0.97	0.96	0.96	0.95
B	0.04	0.05	0.05	0.06	0.02	0.04	0.05	0.03	0.05	0.03	0.04	0.04	0.05
6-PG													
(N)	604	200	200	200	97	100	100	100	99	100	100	100	100
A	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00
B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00
ME-1													
(N)	604	200	201	199	97	100	98	98	99	100	100	100	99
A	0.79	0.84	0.78	0.80	0.84	0.82	0.85	0.81	0.81	0.79	0.84	0.82	0.87
B	0.21	0.17	0.22	0.20	0.17	0.19	0.15	0.19	0.19	0.21	0.16	0.18	0.13
AGP-2													
(N)	599	200	186	189	96	95	97	96	93	99	97	92	98
A	0.95	0.96	0.99	0.96	0.98	0.97	0.97	0.94	0.97	0.96	0.94	0.97	0.97
B	0.05	0.04	0.01	0.05	0.02	0.03	0.03	0.06	0.03	0.04	0.06	0.03	0.03
IDH-3													
(N)	615	200	201	199	97	99	98	100	100	100	100	100	100
A	0.16	0.18	0.18	0.14	0.12	0.19	0.19	0.17	0.13	0.22	0.14	0.13	0.20
B	0.31	0.30	0.28	0.28	0.37	0.31	0.26	0.29	0.22	0.26	0.27	0.29	0.27
C	0.10	0.07	0.09	0.10	0.04	0.06	0.09	0.12	0.10	0.10	0.06	0.08	0.12
D	0.42	0.46	0.46	0.48	0.47	0.45	0.47	0.43	0.56	0.43	0.54	0.51	0.42
E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PMI													
(N)	604	199	197	199	96	99	100	100	99	100	100	99	100
A	0.83	0.92	0.90	0.93	0.97	0.90	0.86	0.88	0.93	0.97	0.88	0.87	0.90
B	0.17	0.09	0.10	0.08	0.03	0.10	0.15	0.12	0.07	0.04	0.13	0.13	0.10
C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LGG													
(N)	599	200	200	199	96	90	98	100	99	100	100	100	99
A	0.72	0.71	0.72	0.74	0.73	0.72	0.71	0.73	0.69	0.71	0.67	0.70	0.70
B	0.29	0.29	0.28	0.26	0.27	0.28	0.29	0.27	0.31	0.29	0.33	0.30	0.30

Table 2. (cont'd) Allelic Frequencies of Baseline Spawning Ground Samples for Nitinat Fisheries

	Fraser Population											U. S. Population		
Locus	Weaver	Vedder	Harrison	Squakum	Inch C.	Blaney C.	Stave R.	Chehalis R.	Wallace S.	Fraser M.	Aloutte	N. Pugett	S. Pugett	Hood Canal
IDH-1														
(N)	100	298	377	124	113	98	190	200	100	95	100	242	192	399
A	0.92	0.88	0.89	0.90	0.88	0.88	0.91	0.92	0.92	0.92	0.95	0.84	0.82	0.72
B	0.08	0.12	0.11	0.10	0.12	0.12	0.09	0.08	0.08	0.08	0.06	0.16	0.18	0.28
6-PG														
(N)	100	300	378	124	136	100	194	200	100	95	100	531	862	938
A	1.00	1.00	0.99	1.00	0.99	1.00	0.99	1.00	1.00	0.97	0.99	0.99	0.99	0.99
B	0.00	0.00	0.01	0.00	0.02	0.01	0.01	0.00	0.01	0.03	0.02	0.01	0.01	0.01
ME-1														
(N)	100	297	373	123	149	100	189	200	99	95	100	223	193	316
A	0.85	0.80	0.85	0.85	0.86	0.88	0.79	0.85	0.87	0.85	0.94	0.73	0.73	0.73
B	0.16	0.20	0.15	0.15	0.14	0.12	0.21	0.16	0.13	0.15	0.07	0.27	0.27	0.28
AGP-2														
(N)	95	253	272	196	259	151	197	401	180	94	198	225	192	400
A	0.97	0.94	0.95	0.95	0.95	0.92	0.96	0.95	0.91	0.93	0.92	0.87	0.92	0.84
B	0.03	0.06	0.05	0.05	0.05	0.08	0.04	0.05	0.09	0.07	0.08	0.13	0.08	0.16
IDH-3														
(N)	94	293	373	124	146	100	197	198	100	95	60	430	883	929
A	0.07	0.12	0.07	0.11	0.03	0.08	0.07	0.09	0.07	0.12	0.10	0.08	0.05	0.06
B	0.29	0.27	0.29	0.27	0.31	0.31	0.25	0.27	0.27	0.21	0.28	0.26	0.32	0.25
C	0.01	0.05	0.04	0.06	0.03	0.10	0.05	0.05	0.06	0.02	0.04	0.05	0.15	0.11
D	0.63	0.56	0.60	0.56	0.62	0.52	0.63	0.60	0.61	0.66	0.58	0.61	0.48	0.58
E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PMI														
(N)	96	296	280	197	260	153	199	404	200	93	200	531	1380	937
A	0.92	0.87	0.86	0.87	0.84	0.87	0.86	0.87	0.87	0.93	0.92	0.81	0.76	0.80
B	0.08	0.13	0.14	0.13	0.16	0.13	0.14	0.13	0.14	0.08	0.08	0.19	0.24	0.20
C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LGG														
(N)	98	97	179	98	53	97	196	200	100	92	99	242	193	400
A	0.90	0.84	0.84	0.90	0.78	0.86	0.84	0.82	0.80	0.80	0.86	0.81	0.84	0.69
B	0.10	0.16	0.16	0.10	0.22	0.14	0.16	0.18	0.20	0.20	0.14	0.19	0.16	0.31

Table 3. Weekly chum stock composition in Johnstone Strait (Areas 12 & 13) seine test fishery, 1991 (1).

Week	Sample Date	Sample Size	Gear (3)	Stock Composition (2) FR %	FR (1SD)	JS,GS %	JS,GS (1SD)	U.S. %	U.S. (1SD)
9/1	No Sample								
9/2	Sep 11–13	300	TS	36.6	(12.7)	57.6	(11.1)	5.8	(4.8)
9/3	Sep 16–20	300	TS	35.5	(10.4)	60.8	(9.2)	3.7	(4.8)
9/4	Sep 25–28	297	TS	56.5	(13.9)	43.0	(13.8)	0.6	(3.8)
10/1	Sep 30–Oct 4	300	TS	37.4	(13.8)	55.5	(12.5)	7.2	(5.7)
10/2	Oct 7–11	300	TS	23.7	(13.7)	64.7	(13.9)	11.6	(7.1)
10/3	Oct 14–20	300	TS	28.1	(13.5)	57.4	(13.8)	14.5	(9.7)
10/4	Oct 21–25	300	TS	12.1	(7.7)	77.8	(8.3)	10.1	(6.6)
10/5	Oct 29–Nov 1	300	TS	41.3	(14.8)	51.8	(11.7)	6.9	(7.0)
11/1	Nov 4–5	150	TS	17.1	(14.1)	75.1	(14.7)	7.9	(6.0)

(1) Stock composition from electrophoretic samples taken in test fisheries. Point estimate (%) for week and standard deviation (1SD) from bootstrap simulation.

(2) Area: FR – Fraser River; JS,GS – Johnstone Strait, Strait of Georgia; US – Washington State.

(3) Gear: TS = test seine.

Table 4. Weekly chum stock composition in Johnstone Strait (Areas 12 & 13) commercial seine fisheries, 1991 (1).

					Stock Composition (2)					
					FR		JS,GS		U.S.	
Week	Sample Date	Sample Size	Area	Gear (3)	%	(1SD)	%	(1SD)	%	(1SD)
9/4	Sep 23–24	200	A12/13	SN	39.6	(13.7)	54.0	(13.0)	6.5	(4.6)
9/4	Sep 23–24	200	A12/13	SN	35.6	(13.4)	64.5	(13.4)	0.0	(0.5)
9/4	Sep 23–24	200	A12/13	SN	31.1	(15.1)	65.3	(15.2)	3.6	(5.2)
9/4	Sep 23–24	100	A12	SN	37.2	(18.6)	62.8	(17.9)	0.0	(3.6)
9/4	Sep 23–24	199	A13	SN	4.3	(12.8)	90.0	(12.5)	5.7	(4.7)

(1) Stock composition from electrophoretic samples taken in commercial fisheries. Point estimate (%) for week and standard deviation (1SD) from bootstrap simulation.

(2) Area: FR – Fraser River; JS,GS – Johnstone Strait, Strait of Georgia; US – Washington State.

(3) Gear: SN = seine.

Table 5. Weekly chum stock composition in Mid Vancouver Island (Area 14) commercial fisheries, 1991 (1).

Week	Sub–areas Sampled (3)	Sample Dates	Sample Size	Gear (4)	Stock Composition (2) FR %	FR (1SD)	JS,GS %	JS,GS (1SD)	U.S. %	U.S. (1SD)
10/3	14–4,5 (i)	Oct 15	150	GN	2.1	(7.6)	97.8	(9.2)	0.1	(5.4)
10/3	14–4,5 (o)	Oct 14–15	136	GN	19.0	(14.0)	59.9	(14.3)	21.2	(8.0)
10/3	14–9, 10(u)	Oct 14–15	120	GN	15.6	(12.2)	80.3	(13.3)	4.2	(4.5)
10/4	14–4,5 (i)	Oct 21–22	150	GN	10.9	(10.6)	89.0	(11.0)	0.1	(4.2)
10/4	14–4,5 (o)	Oct 22	148	GN	69.3	(21.2)	28.3	(20.1)	2.4	(5.2)
10/4	14–9, 10(u)	Oct 21–22	150	GN	1.8	(6.1)	97.5	(6.4)	0.7	(3.3)
10/5	14–4,5,9,10	Oct 28	299	SN	28.0	(9.9)	71.9	(9.7)	0.1	(2.3)
11/1	14–4,7,9,10	Nov 05	199	SN	11.1	(11.1)	88.8	(10.9)	0.0	(2.8)

(1) Stock composition from electrophoretic analysis of samples taken from the commercial gillnet and seine catch. Gillnet samples collected on fishing grounds, seine samples collected at landing site. Point estimate (%) for week and standard deviation (1SD) from bootstrap simulation.

(2) Area : FR – Fraser River; JS,GS – Johnstone Strait, Strait of Georgia; U.S. – Washington State.

(3) Sub areas : 14–4,5 (o) = outside, eastern boundary (most fishing occurs in 14–5); 14–4,5(i) = inside, western boundary; 14–9,10(u) = upper northern boundary.

(4) Gear : GN – gillnet; SN – seine.

Table 6. Weekly chum stock composition in the Nanaimo (Strait of Georgia, Area 17) commercial gillnet fishery, 1991 (1).

Week	Area Sampled	Sample Date	Sample Size	Stock Composition (2) FR %	FR (1SD)	JS,GS %	JS,GS (1SD)	U.S. %	U.S. (1SD)
10/5	A 17	Oct 31–Nov 1	79	31.2	(18.4)	68.1	(16.1)	0.7	(6.9)

(1) Stock composition from electrophoretic analysis of samples taken in the gillnet commercial fishery. Point estimate (%) for week and standard deviation (1SD) from bootstrap simulation.

(2) Area : FR – Fraser River; JS,GS – Johnstone Strait, Strait of Georgia; U.S. – Washington State.

Table 7. Weekly chum stock composition in Nitinat (Area 21) commercial fisheries, 1991 (1).

Week	Sample Date	Sample Size	Gear (3)	Stock Composition (2) FR %	FR (1SD)	JS,GS %	JS,GS (1SD)	U.S. %	U.S. (1SD)	WCVI %	WCVI (1SD)
10/1	Oct 03	200	GN	11.6	(7.1)	9.9	(8.7)	2.5	(3.6)	76.0	(10.0)
10/2	Oct 10	200	GN	18.8	(8.8)	12.8	(9.5)	2.1	(3.0)	66.4	(10.8)
10/3	Oct 16	150	SN	0.0	(0.5)	0.0	(5.2)	0.0	(0.1)	99.9	(5.3)
10/4	Oct 22	300	SN	0.0	(1.3)	0.1	(5.3)	0.0	(1.6)	99.8	(5.9)
10/2	Oct 10(4)	200	control	17.3	(8.7)	11.9	(9.4)	0.1	(2.1)	70.8	(11.0)

(1) Stock composition from electrophoretic analysis of samples taken from commercial fisheries in Area 21 and a portion of Area 121. Samples collected at landing site. Point estimate (%) for week and standard deviation (1SD) from bootstrap simulation.

(2) Area: FR – Fraser River; JS,GS – Johnstone Strait, Georgia Strait; U.S. – Washington State; WCVI – West Coast Vancouver Island.

(3) Gear: GN – gillnet; SN – seine.

(4) Control duplicated from wk 10/2 sample (samples with insufficent muscle tissue for re–processing retained original scores).

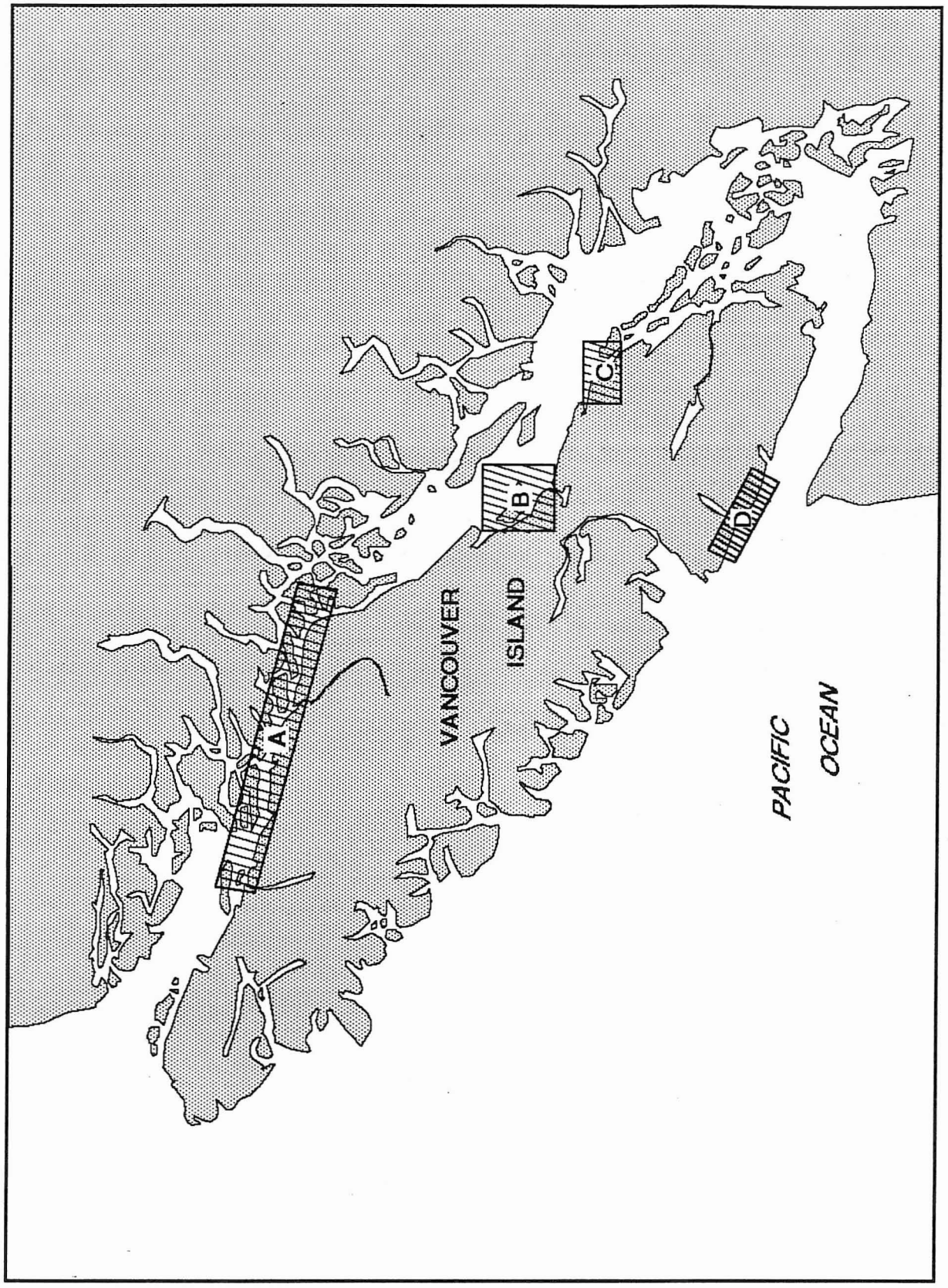

Figure 1. Regions of Chum Sampling in 1991.

(A) Johnstone Strait (B) Mid Vancouver Island (C) Nanaimo (D) Nitinat