Biochemical Genetic Stock Identification of Chum Salmon in Southern British Columbia, 1986

M.C. Vreeling, L. Hop Wo, A.P. Gould,
W. Luedke, S.R. Heizer and T.D. Beacham

Fisheries Branch
Department of Fisheries and Oceans
3225 Stephenson Point Road
Nanaimo, British Columbia V9T 1K3

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by

M.C. Vreeling, L. Hop Wo, A.P. Gould,

W. Luedke, S.R. Heizer and T.D. Beacham[1]

Department of Fisheries and Oceans

Fisheries Branch

3225 Stephenson Point Road

Nanaimo, British Columbia V9T 1K3

[1] Department of Fisheries and Oceans
Fisheries Research Branch
Pacific Biological Station
Nanaimo, British Columbia
V9R 5K6

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ABSTRACT

Vreeling, M.C., L. Hop Wo, A.P. Gould, W. Luedke, S.R. Heizer and T.D. Beacham. 1987. Biochemical Genetic Stock Identification of Chum Salmon in Southern B.C., 1986. Can. Data Rep. Fish. Aquat. Sci. No. 634: 19p.

Genetic variability among chum salmon stocks were used to estimate stock composition in both commercial and test fisheries in Southern British Columbia.

North and Central Coast and Queen Charlotte Island chum stocks comprised the main component in the northwest coast Vancouver Island troll fishery. The dominant stock in the Johnstone Strait fishery was the chum salmon of Johnstone and Georgia Strait origin. Georgia Strait chum salmon was the dominant run migrating through the Mid Vancouver fishery. Fraser River, Georgia Strait, West Coast Vancouver Island and U.S. stocks were mixed in the San Juan fishery. While West Coast Vancouver Island chum salmon the main component in the Nitinat fishery.

With the ability to identify these stocks, managers are able to structure new fisheries to minimize interception of non-target stocks as well as increase flexibility in fishery management.

Key words: chum salmon, genetic stock identification, fishery management.

RESUME

Vreeling, M.C., L. Hop Wo, A.P. Gould, W. Luedke, S.R. Heizer and T.D. Beacham. 1987. Biochemical Genetic Stock Identification of Chum Salmon in Southern B.C., 1986. Can. Data Rep. Fish. Aquat. Sci. No. 634: 19p.

Les auteurs ont utilisé les différences génétiques entre les stocks de saumon kéta pour estimer la composition des prises de pêches commercials et d'essai effectuées dans le sud de la Colombie-Britannique. Les stocks de saumon kéta des parties nord et centre de la côte ainsi que de l'île de la Reine-Charlotte constituent la majorité des prises de la pêche à la traîne effectuée au large de la côte nord-ouest de l'île Vancouver. Les prises de la pêche du détriot Johnstone étaient surtout composées de saumons kétas provenant de ce détroit et du détroit de Géorgie. Les saumons kétas du détroit de Géorgie constituaient le principal groupe en migration exploité par la pêche de la partie centrale de l'île Vancouver. Les prises de la pêche de San Juan étaient constituées de poissions des stocks du fleuve Fraser, du détroit de Géorgie, de la côte ouest de l'île Vancouver et des Etats-Unis. Les saumons kétas de la côte ouest de l'île Vancouver dominaient les prises de la pêche de Nitinat.

Disposant de moyens d'identifier ces stocks, les gestionnaires peuvent structurer les nouvelles pêches de facon à minimiser l'interception des stocks non visés et à accroître la souplesse de la gestion des pêches.

INTRODUCTION

Chum salmon returning to spawn in rivers tributary to Johnstone and Georgia Straits migrate primarily from the north through Johnstone Strait (Anderson and Beacham 1983), although in some years there can be a component of the run returning from the south through Juan de Fuca Strait (Beacham et al. 1987). The identification of the origins of chum salmon in these fisheries has become an increasing problem for management. In response to this problem a genetic method of stock identification (electrophoretics) has been employed since 1981 (Beacham et al. 1985). Domestically, this method has provided managers with the opportunities to assess the need to structure new fisheries to minimize interception of non-target stocks as well as to increase flexibility in fishery management. Internationally, stock identification results are used in identifying catch by country of origin and hence are used in implementing the terms of the Pacific Salmon Treaty between Canada and the U.S.

The largest mixed stock fishery in British Columbia occurs in Johnstone Strait. Different methods of stock identification have been examined for chum salmon. External tagging was an early method of stock identification which provided an understanding of general stock migration patterns (Pritchard 1929, 1931; Chatwin 1953; Manzer 1954; Anderson and Beacham 1983). It could not, however, provide timely in-season estimates of stock composition.

Variation in scale characters have been used in stock identification of chum salmon (Tanaka et al. 1969; Kovtun 1983; Nikolayeva and Semenets 1983). Meristic and morphometric studies were also conducted with only limited success (Beacham et al. 1983). None of these methods provides the ability to estimate stock composition during the fishery season.

Measuring genetically determined variations in protein structure in chum salmon stocks has shown promise for reliable estimates of stock composition (Wishard 1980; Okazaki 1981; Beacham et al 1985). In British Columbia initial surveys for biochemical genetic variation in chum salmon began in 1981 with the objective of providing managers with the ability to identify Fraser River chum salmon in a mixed stock fishery. Since 1981 additional baseline sampling has provided separation of other major chum stock areas.

Currently genetic stock identification (GSI) has provided managers of chum fisheries with the ability to discriminate between chum stocks from six major regions: (1) Queen Charlotte Islands; (2) North and Central coast; (3) West Coast of Vancouver Island; (4) Fraser River; (5) Johnstone and Georgia Strait area; (6) Washington State (U.S.A.) (Beacham et al. 1987). This report details the methods and results of stock identification for chum salmon in southern British Columbia fisheries using electrophoretic GSI for the 1986 season.

METHOD

(1) Collection

Collection of GSI samples occured in the following fishing areas: Northwest coast of Vancouver Island (Area 111 & 127); Johnstone Strait (Area 12); Mid Vancouver Island (Area 14); San Juan (Area 20); Nitinat (Area 21); (Fig. 1). Samples were taken in order to determine the stock composition in these mixed fisheries.

In general, 150 chum salmon were sampled per week or, in the case of commercial fisheries, per fishing period. Tissue samples of heart, liver and muscle were collected within 24 hours of catch, frozen, and sent, packed with dry ice for electrohporetic analysis. Processing was done by a consultant using the horizontal starch gel technique described by Utter et al. (1974).

Chum samples from the troll fishery off the northwest coast of Vancouver Island were randomly selected from day trollers returning to Winter Harbour. Variability in the number of chum salmon landed daily limited the consistency in sampling effort. A sample of insignificant size was obtained in Area 111 during July. Sampling commenced in Area 127 on June 2 and ended on August 4.

Samples from the Johnstone Strait fishery (Area 12) were collected by a chartered test fishing seine vessel at predetermined sites (Fig. 2). Each year test fishing vessels are chartered for stock assessment during which time electrophoretic samples are collected. Test fishing in the Hanson Island region commenced early September and a second test vessel commenced three weeks later in the Cracroft Point - Robson Bight region. Traditionally only the Hanson Island - Double Bay region was sampled. The second vessel was added to confirm existing stocks as well as provide an independent estimate of stock abundance. Test fishing continued in both regions till early November.

The sampling in the Mid Vancouver Island (Area 14) commercial fishery commenced on October 5 and continued for 5 weeks until November 3. Commercial fish packing vessels were boarded weekly in Comox Bay and Deep Bay to obtain randomly selected samples.

A D.F.O. test fishing vessel was chartered by D.F.O. to collect samples in the San Juan (Area 20) region. Sampling on a weekly basis began September 23 and was concluded on October 31. Sample sites were predetermined and chosen based on abundance (Fig. 3). Sampling was designed to avoid targeting on local stocks. Samples of approximately 150 fish were collected over a 3-5 day period stratified between the 6 different fishing sites each day.

In the Nitinat region (Area 21) samples were collected from fish plants in Ucluelet rather than on the fishing grounds as fish were more accessible in processing plants. Three samples from the commercial fishery were collected, one each week, beginning in September. Two additional samples were collected from the area test fishing vessel beginning the 4th week of September.

(2) Analysis

After the electrophoretic analysis had been completed by the consultant, stock composition in the test fisheries was estimated by the method of Fournier et al. (1984), using the genotypic frequencies for the baseline stocks as outlined by Beacham et al. (1987). The allocation method was similar to that outlined by Beacham et al. (1987). Standard deviations of the estimates were determined by bootstrap simulations where 50 new mixtures were constructed by sampling the original mixture with replacement. Stock composition was then estimated for each of these new mixtures and standard deviations derived from the 50 estimates.

RESULTS

Regional differentiation of allelic frequencies for chum salmon was observed and are presented in Tables 1 through 5. The most common allele at a locus was designated 100 and other alleles were assigned numbers according to the mobility of their homomeric protein products.

The results of biochemical genetic variants indicated that variation among regions is substantially greater than among stocks within regions. This enables managers to provide in-season and post-season estimates of stock composition for use in fisheries management.

North Coast, Central Coast and Queen Charlotte Island chum were the main component in the troll fishery off the northwest coast of Vancouver Island. Composition of Fraser River, Georgia Strait and U.S. chum were insignificant in the troll fishery (Table 6).

The results obtained from both test vessels (Hanson Island, Cracroft Point - Robson Bight) located in the Johnstone Strait were consistent with each other. An estimated peak of Fraser River chum salmon abundance in Johnstone Strait was during the week of September 27. Johnstone and Georgia Strait chum peaked in the fishery two weeks later during October 11 to October 18. An insignificant component of U.S. fish were recorded (Table 7).

Johnstone and Georgia Strait chum salmon were the main component in the Mid Vancouver Island fishery (Table 8). The U.S. return peaked in the Mid Vancouver Island fishery during the week of October 11 while the Fraser River run peaked during the week of October 25.

Sampling in the San Juan fishery indicated substantial mixing of Fraser River, Georgia Strait, West Coast Vancouver Island and U.S. chum salmon (Table 9). Georgia Strait chums were, however, the major stock component.

West Coast Vancouver Island chum salmon were the dominant stock in the Nitinat fishery. Fraser River, Georgia Strait, and U.S. chums comprised an insignificant component in the Nitinat area (Table 10).

The stock composition expressed as percentages by major areas of concern (Fraser River; Johnstone and Georgia Strait; United States; West Coast Vancouver Island; North and Central Coast and Queen Charlotte Islands)are depicted in Tables 6 through 10.

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TABLE 1

ALLELIC FEQUENCIES FOR WEST COAST TROLL - 1986

		LOCUS																							
		IDH-1			P-6-G			ME-1			AGP-2			IDH-3					PMI			LGG		
WEEK	SUB AREA	(N)	100	60	(N)	100	90	(N)	100	125	(N)	100	95	(N)	25	40	85	100	(N)	100	90	(N)	100	75
11-Oct-86		113	0.863	0.137	114	1.000	0.000	112	0.871	0.129	110	0.850	0.150	114	0.184	0.360	0.075	0.382	114	0.912	0.088	109	0.872	0.128
18-Oct-86		148	0.919	0.081	148	0.990	0.010	148	0.875	0.125	147	0.857	0.143	149	0.151	0.396	0.091	0.362	149	0.886	0.114	146	0.805	0.195
25-Oct-86		168	0.872	0.128	180	0.992	0.008	174	0.836	0.164	178	0.860	0.140	178	0.149	0.396	0.073	0.382	179	0.888	0.112	163	0.896	0.104

TABLE 2

ALLELIC FREQUENCIES FOR JOHNSTONE STRAIT - 1986

		LOCUS																						
		IDH-1			P-6-G			ME-1			AGP-2			IDH-3					PMI			LGG		
WEEK		(N)	100	60	(N)	100	90	(N)	100	125	(N)	100	95	(N)	25	40	85	100	(N)	100	90	(N)	100	75
06-Sep-86	Hanson Is.	138	0.924	0.076	141	0.996	0.004	140	0.350	0.150	140	0.929	0.071	140	0.061	0.221	0.152	0.586	139	0.903	0.097	137	0.836	0.164
13-Sep-86	Hanson Is.	150	0.927	0.073	150	0.990	0.010	149	0.339	0.161	152	0.957	0.043	150	0.053	0.237	0.073	0.637	151	0.881	0.119	148	0.875	0.125
20-Sep-86	Hanson Is.	149	0.940	0.060	150	1.000	0.000	150	0.320	0.180	150	0.950	0.050	150	0.077	0.233	0.053	0.637	148	0.889	0.111	149	0.926	0.074
27-Sep-86	Hanson Is.	149	0.909	0.091	150	1.000	0.000	149	0.856	0.144	149	0.956	0.044	150	0.090	0.300	0.033	0.577	146	0.921	0.079	147	0.959	0.041
04-Oct-86	Hanson Is.	148	0.936	0.064	148	0.997	0.003	148	0.787	0.213	147	0.912	0.088	148	0.084	0.284	0.037	0.595	146	0.914	0.086	145	0.817	0.183
11-Oct-86	Hanson Is.	144	0.944	0.056	149	0.997	0.003	149	0.782	0.218	147	0.956	0.044	149	0.057	0.248	0.054	0.641	150	0.880	0.120	133	0.816	0.184
18-Oct-86	Hanson Is.	147	0.918	0.082	150	0.997	0.003	147	0.820	0.180	142	0.961	0.039	149	0.081	0.295	0.034	0.591	147	0.908	0.092	148	0.851	0.149
25-Oct-86	Hanson Is.	150	0.923	0.077	149	0.990	0.010	149	0.802	0.198	149	0.936	0.064	149	0.084	0.252	0.040	0.624	150	0.907	0.093	149	0.799	0.201
01-Nov-86	Hanson Is.	149	0.923	0.077	149	1.000	0.000	149	0.809	0.191	147	0.959	0.041	147	0.058	0.269	0.048	0.626	148	0.885	0.115	146	0.753	0.247
08-Nov-86	Hanson Is.	145	0.931	0.069	146	0.997	0.003	149	0.755	0.245	148	0.936	0.064	149	0.087	0.255	0.044	0.614	149	0.886	0.114	146	0.791	0.209
27-Sep-86	Robson Bt.	149	0.936	0.064	149	0.997	0.003	148	0.848	0.152	144	0.920	0.080	150	0.077	0.323	0.043	0.557	144	0.910	0.090	145	0.862	0.138
04-Oct-86	Robson Bt.	145	0.910	0.090	144	0.990	0.010	144	0.799	0.201	148	0.936	0.064	147	0.082	0.245	0.065	0.609	146	0.928	0.072	149	0.869	0.131
11-Oct-86	Robson Bt.	147	0.949	0.051	150	0.997	0.003	148	0.811	0.189	150	0.950	0.050	149	0.077	0.295	0.037	0.591	149	0.913	0.087	150	0.843	0.157
18-Oct-86	Robson Bt.	150	0.927	0.073	150	1.000	0.000	150	0.787	0.213	149	0.970	0.030	150	0.043	0.277	0.600	0.620	150	0.897	0.103	147	0.881	0.119
25-Oct-86	Robson Bt.	150	0.927	0.073	150	0.997	0.003	150	0.850	0.150	150	0.953	0.047	148	0.054	0.348	0.071	0.527	150	0.877	0.120	144	0.840	0.160
01-Nov-86	Robson Bt.	148	0.919	0.081	149	0.997	0.003	148	0.791	0.209	147	0.946	0.054	149	0.067	0.305	0.047	0.581	149	0.909	0.091	148	0.824	0.176
08-Nov-86	Robson Bt.	148	0.922	0.078	148	0.993	0.007	148	0.791	0.209	146	0.959	0.041	148	0.084	0.324	0.044	0.547	147	0.901	0.099	143	0.769	0.231

TABLE 3

ALLELIC FREQUENCIES FOR GEORGIA STRAIT - 1986

		LOCUS																						
		IDH-1			P-6-G			ME-1			AGP-2			IDH-3					PMI			LGG		
WEEK		(N)	100	60	(N)	100	90	(N)	100	125	(N)	100	95	(N)	25	40	85	100	(N)	100	90	(N)	100	75
11-Oct-86	14-5, 7	108	0.917	0.083	108	1.000	0.000	105	0.757	0.243	105	0.933	0.067	106	0.057	0.316	0.052	0.575	109	0.881	0.119	107	0.780	0.220
18-Oct-86	14-5, 7	148	0.922	0.078	148	0.997	0.003	146	0.808	0.192	139	0.953	0.047	145	0.059	0.259	0.038	0.645	149	0.889	0.111	146	0.771	0.229
25-Oct-86	14-5, 7	143	0.909	0.091	144	0.993	0.007	144	0.806	0.194	142	0.940	0.060	141	0.071	0.294	0.035	0.599	143	0.909	0.087	144	0.771	0.229
25-Oct-86	14-9	149	0.956	0.044	149	0.993	0.007	149	0.765	0.235	144	0.958	0.042	145	0.062	0.238	0.072	0.628	148	0.899	0.101	144	0.823	0.177
01-Nov-86	14-5, 7	139	0.935	0.065	142	0.996	0.004	142	0.813	0.187	138	0.913	0.087	140	0.061	0.261	0.036	0.643	138	0.906	0.094	137	0.799	0.201
01-Nov-86	14-9	135	0.952	0.048	137	0.989	0.011	135	0.737	0.263	136	0.967	0.033	136	0.085	0.261	0.055	0.599	138	0.891	0.109	140	0.807	0.193
08-Nov-86	14-5, 7	149	0.940	0.060	148	0.997	0.003	147	0.823	0.177	142	0.951	0.049	147	0.051	0.255	0.085	0.609	148	0.912	0.088	149	0.815	0.185
08-Nov-86	14-9	149	0.936	0.064	148	0.993	0.007	149	0.792	0.208	140	0.946	0.054	142	0.042	0.243	0.042	0.673	145	0.910	0.090	146	0.791	0.209

TABLE 4

ALLELIC FREQUENCIES FOR THE WEST COAST - 1986

LOCUS

	IDH-1			P-6-G			ME-1			AGP-2			IDH-3					PMI			LDA		
WEEK	(N)	100	60	(N)	100	90	(N)	100	125	(N)	100	95	(N)	25	40	85	100	(N)	100	90	(N)	100	75
18-Oct-86	150	0.957	0.043	150	1.000	0.000	150	0.767	0.233	146	0.976	0.024	148	0.149	0.291	0.142	0.419	147	0.912	0.088	148	0.780	0.220
25-Oct-86	159	0.959	0.061	159	0.996	0.004	159	0.777	0.223	158	0.957	0.043	140	0.121	0.300	0.129	0.450	159	0.885	0.115	159	0.727	0.273
18-Oct-86	151	0.944	0.056	151	0.997	0.003	150	0.837	0.163	150	0.987	0.013	151	0.126	0.308	0.126	0.440	150	0.943	0.057	151	0.808	0.192
18-Oct-86	150	0.947	0.053	150	0.997	0.003	150	0.833	0.167	148	0.943	0.057	145	0.179	0.297	0.103	0.421	142	0.972	0.028	148	0.814	0.186
18-Oct-86	144	0.944	0.056	149	1.000	0.000	145	0.783	0.217	146	0.959	0.041	144	0.163	0.295	0.132	0.410	147	0.901	0.099	148	0.709	0.291

TABLE 5

ALLELIC FEQUENCIES FOR SAN JUAN - 1986

LOCUS

	IDH-1			P-6-G			ME-1			AGP-2			IDH-3					PMI			LDA		
WEEK	(N)	100	60	(N)	100	90	(N)	100	125	(N)	100	95	(N)	25	40	85	100	(N)	100	90	(N)	100	75
11-Oct-86	147	0.929	0.071	147	0.997	0.003	147	0.793	0.207	159	0.946	0.054	145	0.069	0.324	0.072	0.534	141	0.929	0.071	146	0.945	0.055
18-Oct-86	150	0.880	0.120	150	0.997	0.003	150	0.800	0.200	149	0.943	0.057	148	0.118	0.277	0.068	0.537	150	0.877	0.123	144	0.906	0.094
25-Oct-86	150	0.907	0.093	150	0.990	0.010	150	0.787	0.213	149	0.940	0.060	146	0.096	0.240	0.072	0.592	150	0.913	0.087	150	0.813	0.187
25-Oct-86	150	0.863	0.137	150	0.990	0.010	149	0.775	0.225	148	0.882	0.118	150	0.087	0.247	0.083	0.583	150	0.870	0.130	150	0.747	0.253
01-Nov-86	100	0.890	0.110	100	1.000	0.000	100	0.770	0.230	100	0.920	0.080	100	0.080	0.215	0.105	0.600	97	0.902	0.098	100	0.775	0.225
01-Nov-86	199	0.887	0.113	200	0.998	0.002	196	0.778	0.222	199	0.912	0.088	198	0.106	0.247	0.091	0.556	200	0.882	0.117	199	0.711	0.289

TABLE 6. Electrophoretic results from the west coast Vancouver Island troll fishery (Area 1-27), 1986.

1986 STOCK COMPOSITION - AREA 1-27

Area	Sample Date	Samp. Size	% FR	% JS/GS	% US	% WCVI	% NC,CC,QCI
127	JUN 29,JUL 7-13	114	12.1 (9.4)	0.6 (1.5)	3.2 (4.9)	0.1 (0.1)	84.0 (10.6)
127	JULY 14-18	149	14.9 (12.4)	0.8 (2.2)	2.6 (4.1)	8.4 (7.1)	73.4 (10.6)
127	JUL 24,28,AUG 1-4	182	8.4 (7.0)	12.2 (8.6)	1.3 (2.1)	3.4 (5.0)	74.7 (9.7)

( ) = Standard Deviation

(FR = Fraser River; JS/GS = Johnstone/Georgia Strait; U.S. = Washington State; WCVI = W.C. Vancouver Island; NC,CC,QCI = CDN. Areas N. Cape Caution)

TABLE 7. Electrophoretic results from Johnstone Strait (Area 12) test fishing, 1986.

1986 STOCK COMPOSITION - AREA 12

Area	Week Ending Date	Samp. Size	% FR	% JS/GS	% US
			Hanson Island (vessel 1)		
12	06-Sep-86	141	50.2 (14.4)	45.4 (13.4)	4.5 (6.1)
12	13-Sep-86	153	42.9 (16.1)	52.1 (13.8)	5.0 (6.5)
12	20-Sep-86	150	37.6 (12.1)	62.2 (11.9)	0.2 (0.7)
12	27-Sep-86	150	83.7 (11.1)	16.3 (11.1)	0.0 (0.0)
12	04-Oct-86	150	30.2 (12.1)	67.8 (11.9)	2.0 (3.5)
12	11-Oct-86	150	18.5 (12.0)	78.5 (12.9)	3.1 (5.5)
12	18-Oct-86	150	36.9 (15.3)	60.2 (14.3)	2.9 (3.6)
12	25-Oct-86	150	40.9 (12.8)	58.3 (13.1)	0.8 (1.8)
12	01-Nov-86	150	24.0 (13.8)	68.9 (12.4)	7.1 (6.6)
12	08-Nov-86	150	12.5 (12.1)	67.0 (11.9)	20.5 (10.5)
			Cracroft Pt.- Robson Bight (vessel 2)		
12	27-Sep-86	150	54.4 (14.1)	43.6 (13.7)	2.0 (3.9)
12	04-Oct-86	150	30.3 (15.9)	65.8 (15.8)	3.9 (4.6)
12	11-Oct-86	150	30.8 (17.4)	68.8 (17.6)	0.4 (1.6)
12	18-Oct-86	150	16.9 (13.2)	81.8 (13.3)	1.4 (3.4)
12	25-Oct-86	150	52.2 (16.3)	39.8 (16.5)	8.0 (6.7)
12	01-Nov-86	150	28.3 (15.0)	70.1 (15.9)	1.7 (4.1)
12	08-Nov-86	148	35.4 (19.4)	60.8 (18.5)	3.9 (4.3)

( ) = Standard Deviation

(FR = Fraser, JS, GS = Johnstone/Georgia Strait; U.S. = Washington State)

TABLE 8. Electrophoretic results from the Mid Vancouver Island Commercial fishery (Area 14), 1986.

1986 STOCK COMPOSITION - MID VANCOUVER ISLAND (AREA 14)

Area	Week Ending	Sample Size	% FR		% JS/GS		% US	
14-5,7	11-Oct-86	109	9.1	(12.4)	66.5	(11.8)	24.4	(9.4)
14-5,7	18-Oct-86	150	16.9	(12.5)	74.9	(12.6)	8.3	(6.3)
14-5,7	25-Oct-86	144	37.5	(15.0)	54.0	(14.7)	8.5	(7.7)
14-9	25-Oct-86	150	9.6	(7.9)	88.7	(9.4)	1.7	(3.6)
14-5,7	01-Nov-86	142	27.1	(12.5)	71.9	(12.6)	1.0	(2.5)
14-9	01-Nov-86	140	17.9	(11.7)	74.0	(12.6)	8.1	(7.5)
14-5,7	08-Nov-86	150	18.1	(13.4)	76.5	(13.9)	5.4	(5.2)
14-9	08-Nov-86	149	20.2	(9.8)	78.3	(10.2)	1.5	(3.9)

( ) = Standard Deviation

(FR = Fraser River; JS/GS = Johnstone/Georgia Strait; U.S. = Washington State)

TABLE 9. Electrophoretic results from San Juan (Area 20), 1986.

1986 STOCK COMPOSITION - SAN JUAN

Area	Week Ending	Sample Size	% FR		% JS/GS		% US		% WCVI	
20	27-Sep-86	151	44.5	(14.8)	54.7	(14.4)	0.7	(1.5)	0.1	(0.1)
20	04-Oct-86	150	67.2	(18.2)	20.0	(15.2)	9.5	(8.1)	3.4	(5.0)
20	11-Oct-86	150	27.7	(14.6)	49.0	(14.4)	10.1	(6.4)	13.2	(10.2)
20	18-Oct-86	150	19.0	(13.2)	13.9	(9.8)	43.7	(10.0)	23.3	(9.6)
20	25-Oct-86	100	6.4	(7.6)	49.6	(11.1)	26.0	(8.5)	18.0	(8.1)
20	01-Nov-86	200	4.7	(5.4)	15.5	(8.8)	26.7	(4.9)	53.2	(9.1)

( ) = Standard Deviation

(FR = Fraser River; JS/GS = Johnstone/Georgia Strait; U.S. = Washington State; WCVI = West Coast Vancouver Island).

TABLE 10. Electrophoretic results from Nitinat (Area 21), 1986.

1986 STOCK COMPOSITION - NITINAT

Area	Week Ending	Sample Size	% FR	% GS	% US	% WCVI
21	04-Oct-86	150	11.5 (8.1)	18.8 (12.3)	0.4 (1.1)	69.4 (12.4)
21	11-Oct-86	150	29.4 (10.1)	4.2 (7.2)	0.0 (0.0)	66.3 (10.3)
21	18-Oct-86	150	3.5 (6.0)	16.9 (8.5)	2.5 (4.5)	77.1 (9.6)
21	25-Oct-86	140	5.6 (6.5)	12.2 (10.9)	11.9 (9.0)	70.3 (11.5)
21	01-Nov-86	149	0.8 (2.3)	1.2 (3.2)	5.4 (4.5)	92.6 (5.4)

( ) = Standard Deviation

(FR = Fraser; JS/GS = Johnstone/Georgia Strait; U.S. = Washington State; WCVI = West Coast Vancouver Island).

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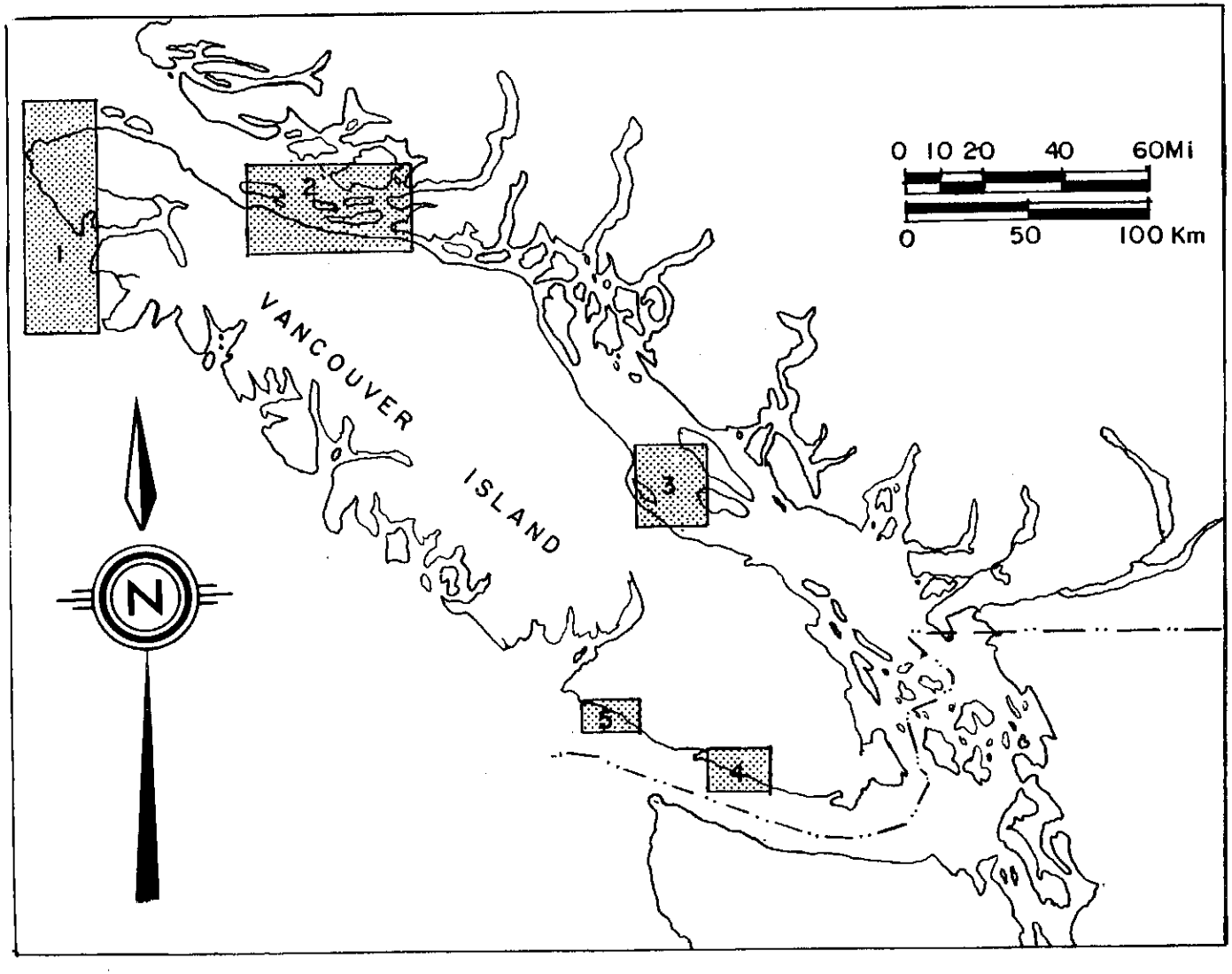

Figure I.

Fishing Areas for 1986 (1) Northwest Vancouver Island (2) Johnstone Strait

(3) Mid Vancouver Island (4) San Juan (5) Nitinat

UPPER JOHNSTONE STRAIT

1. Big Bay (Hanson Isle)
2. The Bluff
3. Blow Hole
4. Blue Line
5. Bold Point
6. China Town
7. Cracroft
8. Double Bay
9. Kelp Point
10. Merry Go Round
11. Parsons Bay
12. Siwash Rock
13. The Bank
14. White Rock
15. White Beach
16. Blinkhorn
17. Return Point
18. Freshwater Point
19. Izumi Rock
20. Bauza Cove
21. Robson Bight *
22. Beaver Cove
23. Nimpkish River
24. Blackfish Sound
25. Midsummer Island
26. Broken Island *
27. Beautiful Beach *
28. Pig Ranch
29. Glory Hole
30. Hot Spot
31. Boat Harbour
32. Hillier Point
33. Growler Cove
34. Sophia Island
35. Gravel Beach

* location not shown on map

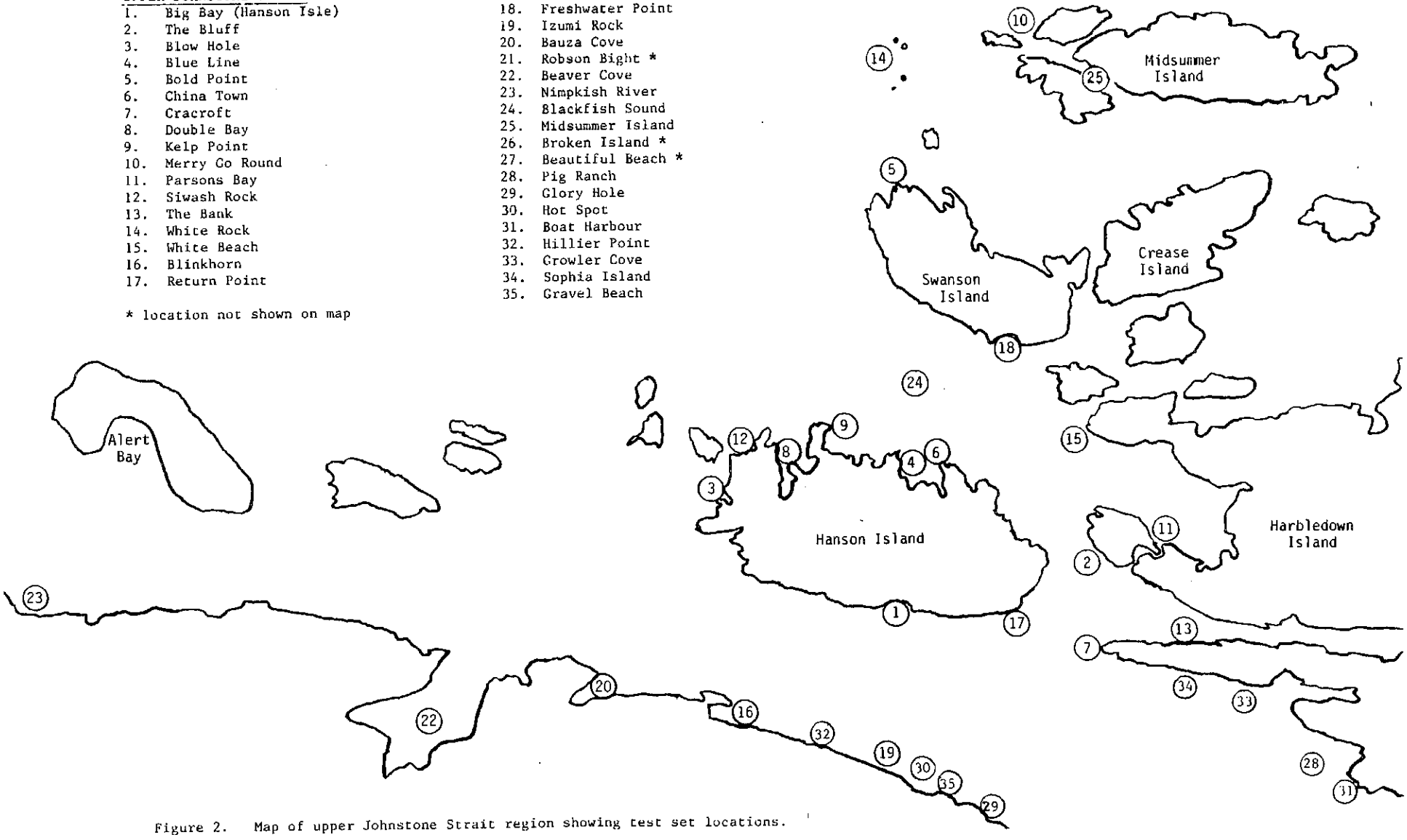

Figure 2. Map of upper Johnstone Strait region showing test set locations.

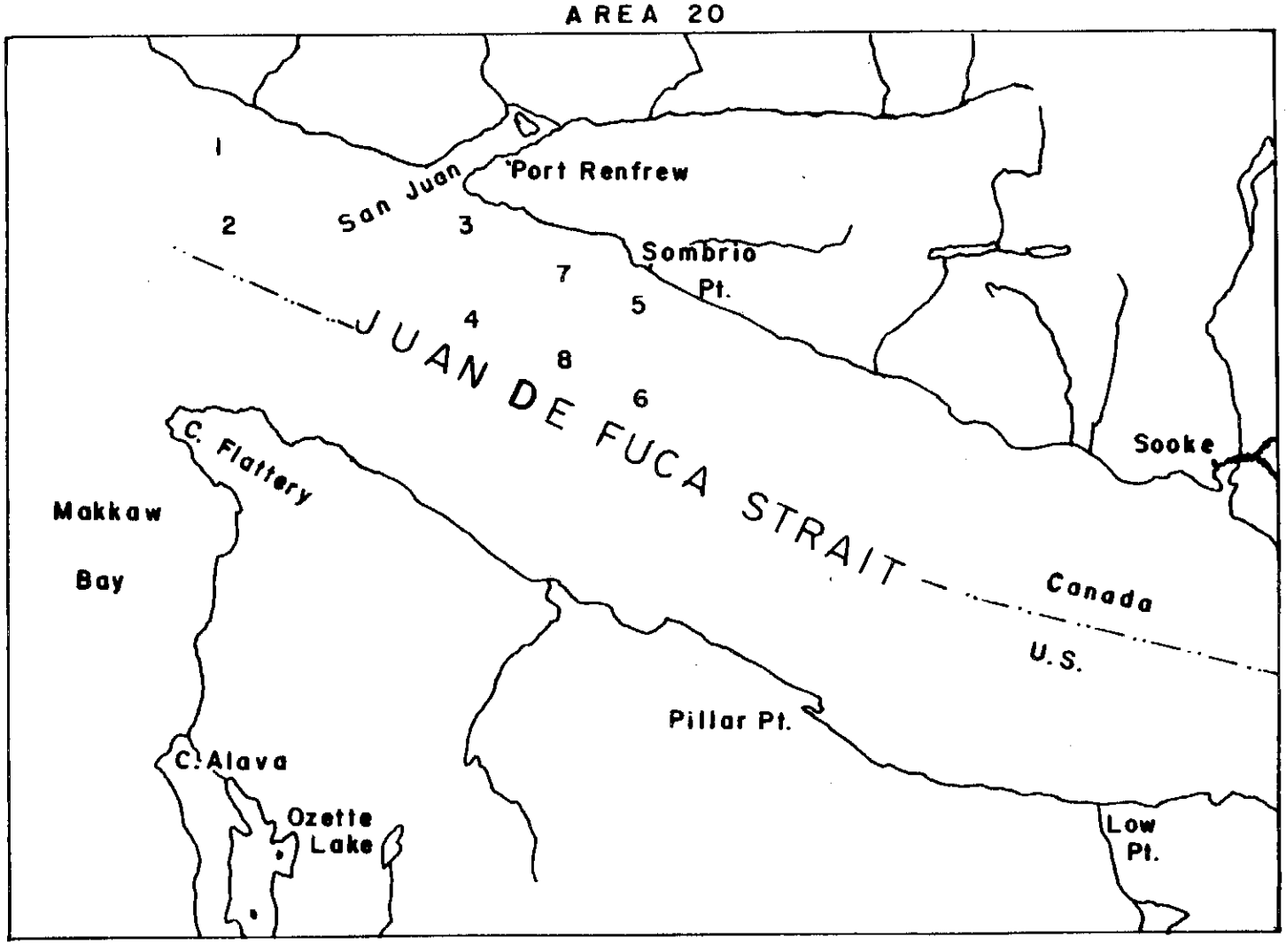

Figure 3. Chum test fishing sites for the San Juan region.

1. Camper Bay (inside)
2. Camper Bay (outside)
3. San Juan (inside)
4. San Juan (outside)
5. Sombrio Pt. (inside)
6. Sombrio Pt. (outside)
7. Mid Point (inside)
8. Mid Point (outside)