EFFECTS OF AMBIENT LIGHT CONDITIONS ON GILL NET CATCHES OF COHO AND CHUM SALMON IN A TEST FISHERY CONDUCTED IN UPPER CLARENCE STRAIT, ALASKA

By

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

A gill net test fishery was conducted in upper Clarence Strait in the Fall of 1988. The objective was to compare the catch per unit effort (CPUE) of coho and chum salmon between gill net sets made during three phases of ambient light. The results of analysis of variance tests showed that for this fishery no statistically significant differences between the CPUE for either species occurred among sets made during daylight, twilight, and hours of darkness.

KEY WORDS: Coho salmon, chum salmon, gill net, catch per unit effort, ambient light.

INTRODUCTION

An experimental fishery using drift gill net gear was conducted in upper Clarence Strait in Southeast Alaska to determine whether ambient light affected catch rates of coho (*Oncorhynchus kisutch*) and chum salmon (*O. keta*). The fishery occurred along the west coast of Etolin Island at Marsh Island (Figure 1) during a four week period between August 24 and September 16, 1988. Catch per unit effort (CPUE) of coho and chum salmon taken in drift gill net sets made during daylight, twilight and dark hours were compared to determine if light-specific gill net closures could be used as an effective management tool to minimize catches of coho while still maintaining fisheries for other species. This tool would be especially useful during periods of low coho abundance.

The majority of fall commercial drift gill net fishing in Southeast Alaska commercial fishing regulatory District 6 (Clarence and Sumner Straits) occurs near Macnamara Point, Point Colpoys, Kashevarof Passage, and Marsh Island (Figure 1). The bulk of the fishing takes place during daylight hours and the nets are set perpendicular to shore so that they are often "crowding" the beach on the onshore end throughout the drift. Daylight fishing predominates because fisherman generally are unable to visually observe their nets in the dark, and at this time of year when longer periods of darkness occur. Darkness, tidal action, weather, and debris can combine to make night fishing extremely hazardous. When night fishing does occur, it often takes place offshore, up to approximately one mile from shore, which minimizes the possibility of entangling the net on rocks, in debris or, tidal whirlpools. In the Marsh Island area coho salmon are often found in good abundance offshore where night fisheries can operate.

The test fishery was designed to emulate typical commercial fishing used by a gill net fisherman during the fall in District 6.

METHODS

Sampling Methods

The test fishing was done from the F/V *Fairhaven*, a 35-ft commercial Southeast Alaskan gill net vessel, using a standard fall commercial 300 fathom gill net made of 6.25-in stretched mesh "center core" webbing, 60 meshes deep. We attempted to keep the duration of each set near 2.0 h. The entire net was used on each set and the sets averaged 1.9 h. with a range from 0.48 to 3.16 h. The duration of each set depended upon its proximity to shore, drift speed and direction, debris, water and wind conditions. Fishing time was calculated using the standard formula employed in the Bristol Bay test fisheries (Van Alen 1981):

$$\text{Fishing Time (Hrs)} = (IN_s - OUT_f) + 1/2\ [(OUT_f - OUT_s) + (IN_f - IN_s)]$$

Where:

OUT_s = the time at the beginning of the set

OUT_f = the time at which the net was fully set

IN_s = the time at the beginning of net retrieval

IN_f = the time at which the net was fully onboard the vessel

The catch of each species was divided by the fishing time to obtain the CPUE for each set.

Offshore fishing initially was scheduled to comprise approximately 50% of the total test fishing time. This was done to ensure that the area normally fished at night would be sufficiently represented. However, high winds and rough seas occurred during much of the test fishing period and only 39.7% of the sets and 40.3% of the fishing time occurring in the offshore area. The offshore area was much more exposed to SE winds than the onshore area. Also, the period from midnight to 0300 hours was not normally sampled in order to provide a rest period for the skipper and crew.

Thirty-eight of the 63 sets made at Marsh Island were sets made onshore, while 25 of the sets were made in the offshore area. Three sets were made during the 1500-1700, period while eight sets were made in each of the 0700-0900, 0900-1100, and 1900-2100 periods (Figure 4). The number of onshore sets varied from two sets in the 0300-0400, 1100-1300, and 1700-1900 periods to six sets in the 1800-2100 time period (Figure 4). The number of offshore sets varied from zero sets in time periods 1500-1700 and 2300-0100, to four sets in the time period 0300-0500 (Figure 4).

Data recorded for each set included date, set number, location, fishing times, catch by species, weather conditions and tidal stage. Additionally, all fish were examined for coded wire tags (CWT) and measured from mid-eye to fork-of-tail. The sex was determined for the majority of coho captured. These data were ancillary to the study and were not included in the results.

Analysis Methods

The sets were grouped into 2-h periods according to the time when net retrieval within each set began. The periods were then arranged according to their occurrence during the three phases of ambient light (twilight, full daylight, and full darkness). The phases of light were determined as follows: (1) Twilight--the period between sunset and astronomical twilight, (2) Daylight--the period between sunrise and sunset, and (3) Darkness--the period between evening and morning astronomical twilight. The times for sunrise, sunset and twilight were obtained from standard nautical tables (USNO 1987).

To test for differences in CPUE between the three ambient light phases the Kruskall-Wallis Test, a non-parametric ANOVA based on ranking, was used (Zar 1984). The CPUE values during each light phase were ranked in ascending order, the sums obtained and the H statistic calculated and tested for significance with tabled X^2 values at the 90% level of confidence (Appendix A).

Tidal effects were not included in the analysis. Since both flood and ebb tides were fished randomly and were represented within each light phase, sets during all tidal stages within each light phase were combined. Weather and wave conditions were also not included in the analysis because of the difficulties in quantifying these affects.

RESULTS

A total of 412 coho and 598 chum salmon were caught in 63 sets during the test fishery (Table 1 and 2, Appendices A and B). In addition to the coho and chum, 112 pink salmon (*O. gorbuscha*), 16 sockeye salmon (*O. nerka*), and 10 chinook salmon (*O. tshawytscha*) were also caught during the course of the fishery.

Coho Salmon

The highest coho CPUE's in both fishing areas occurred during daylight hours near mid-day. Secondary peaks also occurred in the onshore area during the early morning twilight period and in the offshore area during the late evening twilight period (Figures 2 and 3).

The mean overall coho CPUE for all time periods combined was 3.4 fish/h. The overall CPUE peaks occurred during early morning and early afternoon time periods (Figure 3). The mean onshore catch rate for 38 sets was 4.1 fish/h with the peak (7.8 fish/h) occurring during the period 1100-1300 (Figure 2). The mean offshore coho catch rate for 25 sets was 2.6 fish/h with the peak (3.6 fish/h) occurring during the 1300-1500 period (Figure 2). A secondary offshore peak also occurred during the 1900-2100 period at 3.5 fish/h. The catch rates were not as high during periods of darkness as they were during full daylight hours. The periods from 1100 to 1500 hours produced the highest CPUE values for the onshore, offshore, and combined sets (Figure 2). The evening periods of darkness from 1900-0100 did not show significant peaks in CPUE for the onshore or offshore areas. Although the highest CPUE values for individual sets occurred in the onshore area during the late morning and early afternoon hours, the greatest variation in CPUE for individual sets also occurred during these same time periods with catch rates ranging from 0 fish/hr to 14.1 fish/h (Figure 2).

Sets made onshore appeared to have consistently higher catch rates than those made offshore (Figure 2). During those periods when both areas were sampled, 26.7% of the sets made onshore were greater than or equal to 6 fish/h, while only 6.9% of the sets made offshore during these same periods were greater than or equal to 6 fish/h. However, the Kruskal-Wallis est for combined fishing areas detected no significant differences in coho CPUE values between the three phases of ambient light at the 90% level of significance where H = 3.20 ($X^2_{.10,2}$ = 4.6). Coho CPUE values, ranks and resultant statistics are presented in Appendix C. Sets from both fishing areas were pooled because no significant differences between light phases were detected. Had significant differences been detected, a 3 X 2 model of light versus fishing area would have been applied to determine if fishing area was a significant factor influencing coho catches.

Chum Salmon

The highest chum CPUE's in both fishing areas occurred during daylight hours near mid-morning and early to mid-afternoon. Secondary peaks also occurred in the onshore area during the early morning twilight period and in the offshore area during the late evening twilight period (Figures 5 and 6).

The mean overall chum CPUE for all time periods combined was 4.86 fish/h. The overall CPUE peak (7.6 fish/h) occurred during mid-afternoon in the 1500-1700 period (Figure 6). The mean onshore catch rate over 38 sets was 5.55 fish/h, with the peak (7.8 fish/h) occurring during the 1100-1300 period (Figure 6). The mean offshore coho catch rate over 25 sets was 3.82 fish/h with the peak (6.5 fish/h) occurring during the 1300-1500 period (Figure 6). A secondary offshore peak (5.8 fish/h) also occurred during the 0700-0900 period. Unlike the coho catches, the chum catches did not show a peak during the early morning twilight period.

The chum CPUE's obtained in the onshore area were similar to coho catches in that they appeared to be consistently higher than those made in the offshore area (Figure 5). However, the Kruskal-Wallis test, when applied to chum CPUE values detected no significant differences at the 90% level between CPUE for the three different light levels where H = 2.55 ($X^2_{.10,2}$ = 4.6). Chum CPUE values, ranks and resultant statistics are presented in Appendix D. As with the coho analysis, no significant differences in chum catches between the three light phases were detected so the sets in both fishing areas were combined.

DISCUSSION

These results indicate that ambient light apparently does not appear to be a major influence upon coho gill net CPUE in the District 6 gill net areas. In the fall gill net fisheries targeting on chum salmon, the use of night fishing closures as a management option to reduce coho harvests during years of seriously reduced coho abundance, while targeting on chum salmon would not be effective. Furthermore, if night closures were implemented then total fishing time reductions might be necessary. Night closures would provide a defacto rest period for fishermen, and this could result in increased fishing effort during the open daylight periods.

Although no statistically significant differences existed between CPUE's during the three phases of ambient light, catch rates for coho between individual time periods did demonstrate distinct differences. The large variation in CPUE between individual sets combined with the small sample size for full darkness sets may have essentially masked any detectable differences in CPUE between the three ambient light phases. Different results than were seen in this study may have been obtained had the number of sets made during full darkness been greater. Increasing the number of night sets by including sets during the 0100-0300 period would have given us a more representative sample of catches during the full darkness period.

A more thorough project utilizing a greater number of sets in all three light phases is currently underway. It is hoped that by increasing the number of sets more conclusive information about the actual effects of light conditions on catches of coho, chum and other salmon species can be obtained.

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Table 1. Coho salmon catches, mean CPUE, hours fished, and number of sets by ambient light phase and fishing location for the 1988 Clarence Strait test fishery.

	Daylight	Twilight	Dark
		Onshore	
Catch	193	51	24
Mean CPUE	4.69	3.18	3.23
Sets	22	11	5
Hours Fished	39.72	21.04	7.44
		Onshore	
Catch	57	76	11
Mean CPUE	2.39	3.05	1.58
Sets	12	10	3
Hours Fished	24.22	23.89	5.23
		Locations Combined	
Catch	250	127	35
Mean CPUE	3.65	3.49	2.82
Sets	34	21	8
Hours Fished	63.94	44.93	12.67

Table 2. Chum salmon catches, mean CPUE, hours fished, and number of sets by ambient light phase and fishing location for the 1988 Clarence Strait test fishery.

	Daylight	Twilight	Dark
		Onshore	
Catch	266	83	35
Mean CPUE	6.57	3.62	5.30
Sets	22	11	5
Hours Fished	39.72	21.04	7.44
		Onshore	
Catch	99	100	15
Mean CPUE	3.88	4.01	2.93
Sets	12	10	3
Hours Fished	24.22	23.89	5.23
		Locations Combined	
Catch	365	183	50
Mean CPUE	5.62	3.62	4.41
Sets	34	21	8
Hours Fished	63.94	44.93	12.67

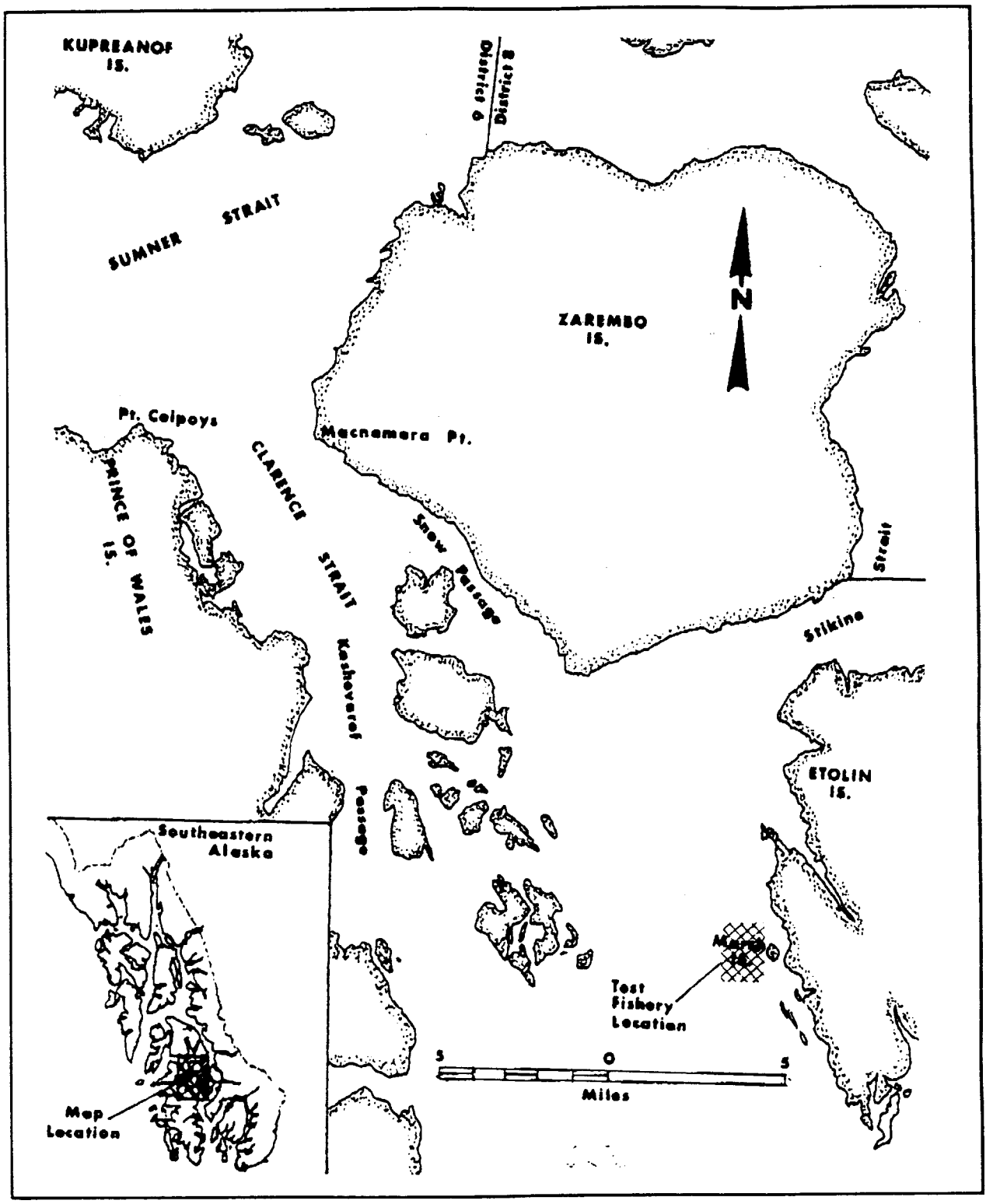

Figure 1. Map of Sumner and upper Clarence Strait showing the 1988 Clarence Strait gill net test fishery location.

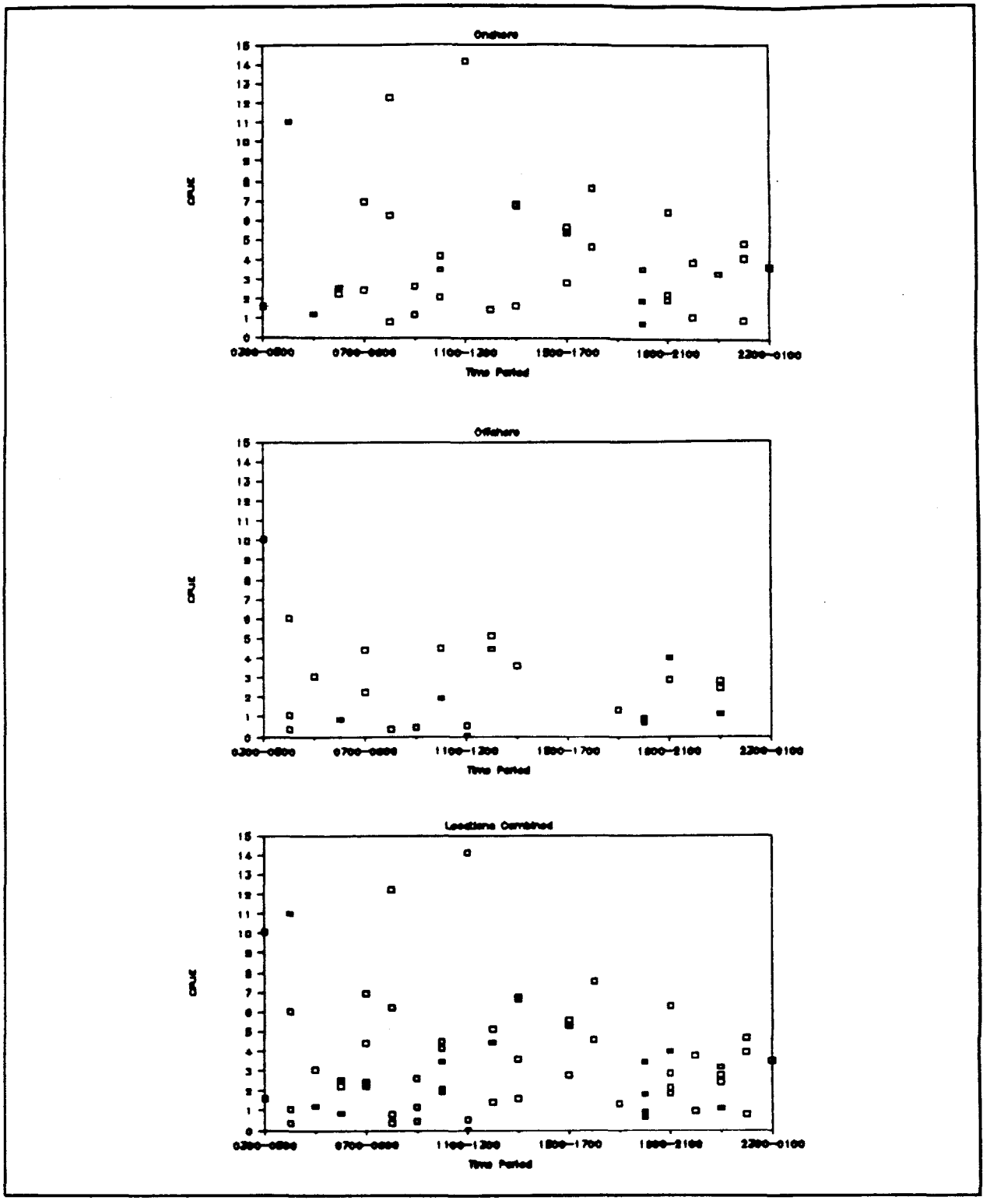

Figure 2. Distribution of coho salmon CPUE by time period for the onshore, offshore and combined fishing locations in the Clarence Strait gill net test fishery, 1988.

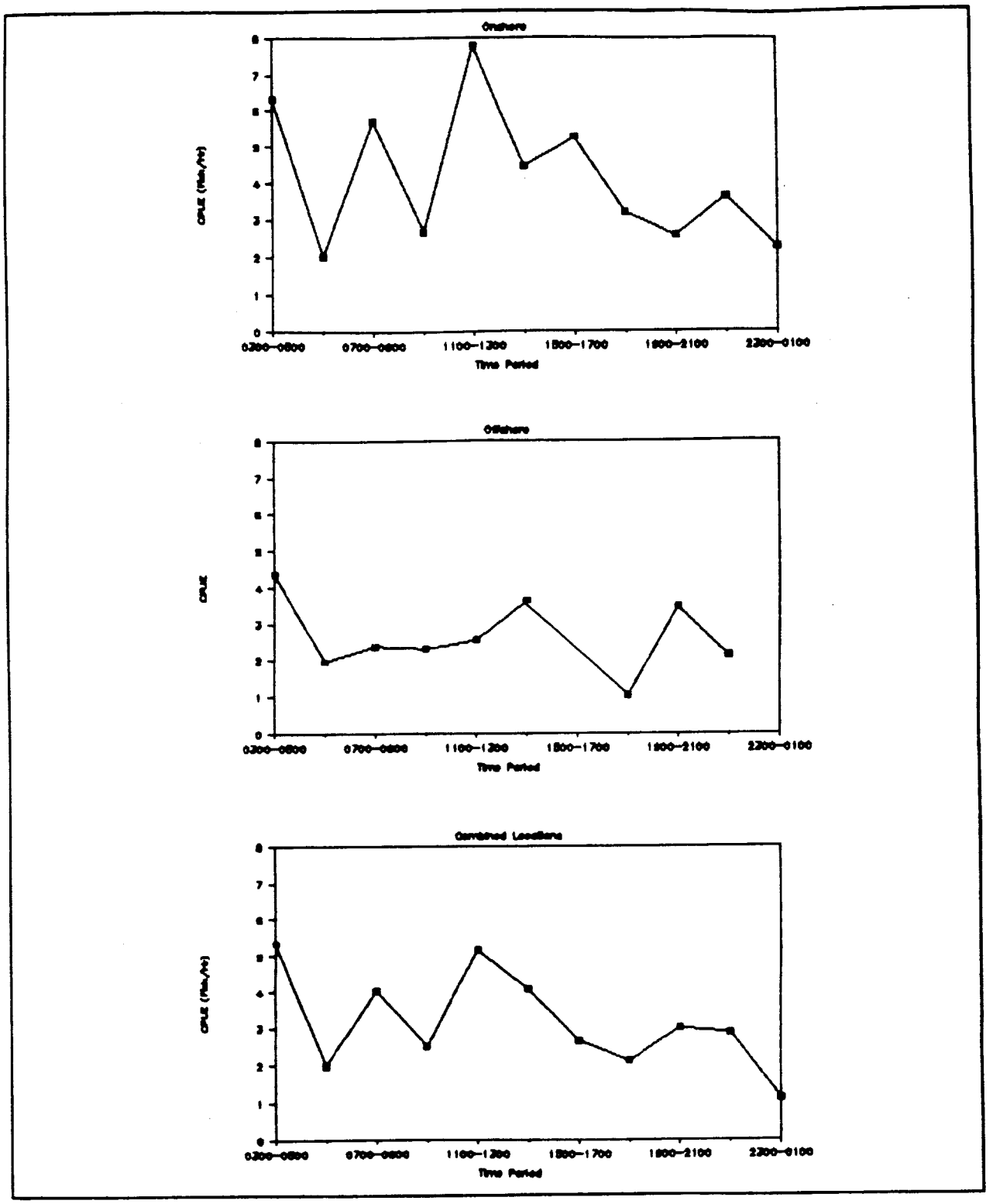

Figure 3. Mean coho salmon CPUE by time period for 5the onsore, offshore and combined fishing locations in the Clarence Strait gill net test fishery, 1988.

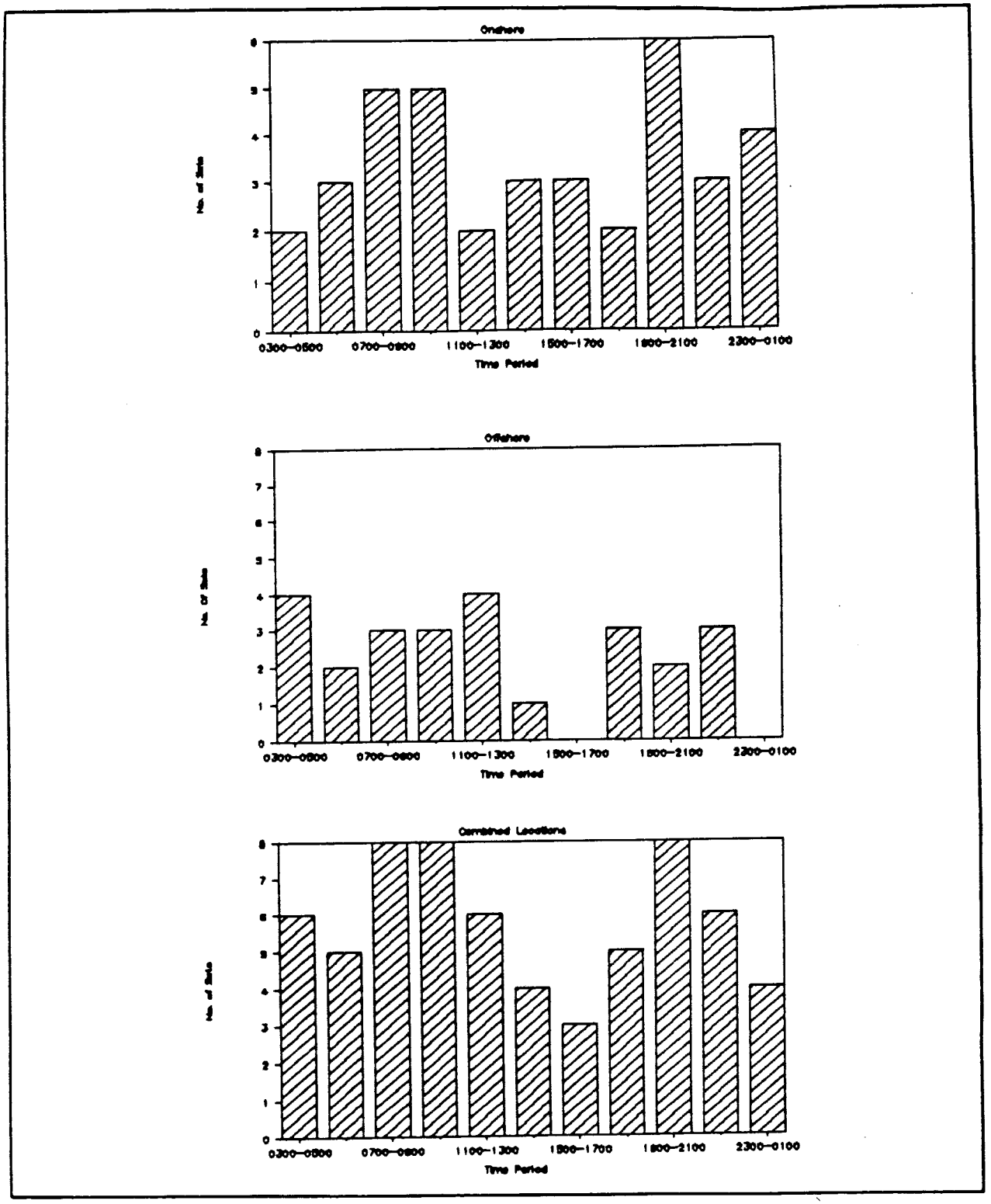

Figure 4. Number of gill net sets made in the onshore, offshore and combined fishing locations in the Clarence Strait gill net fishery, 1988.

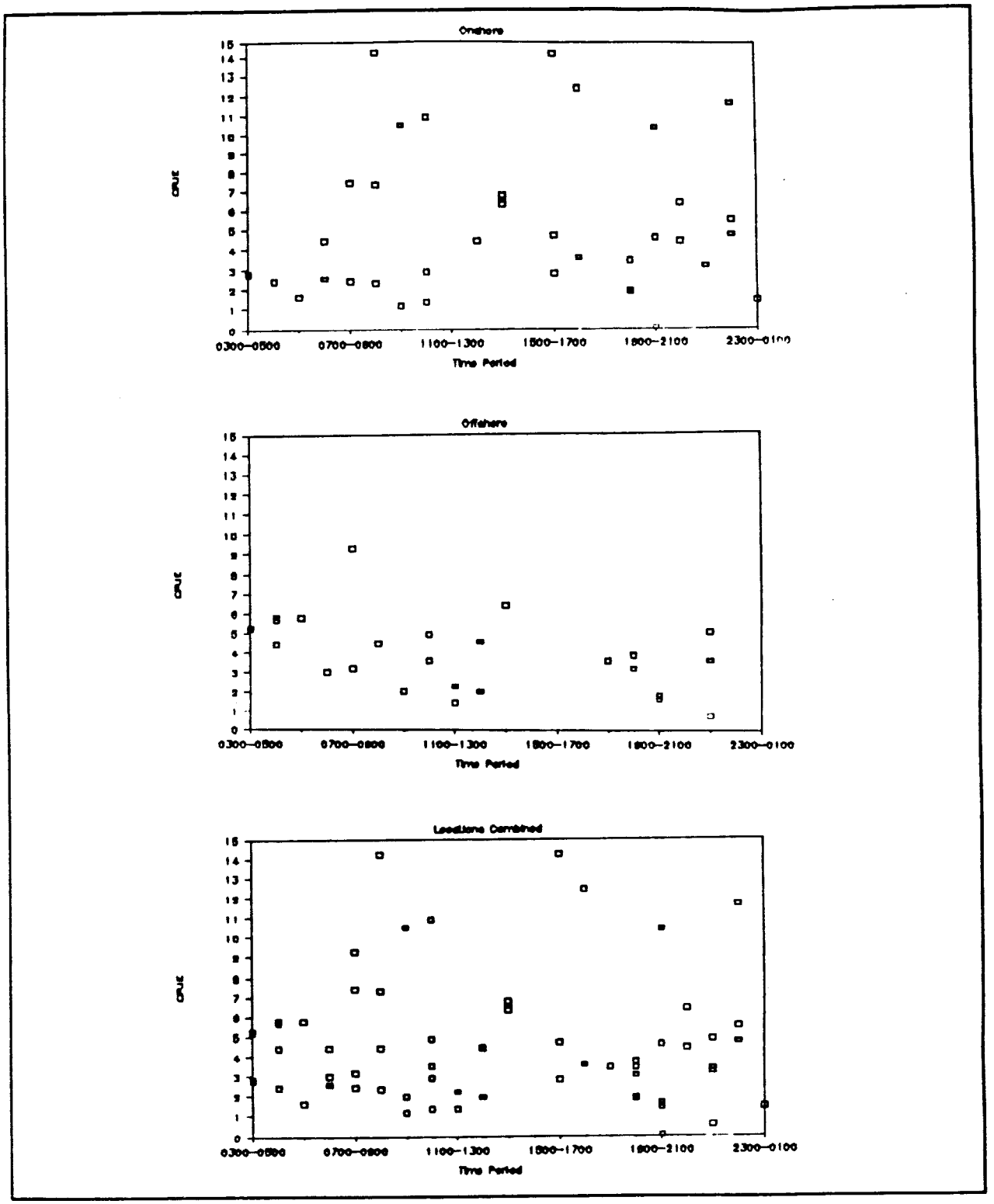

Figure 5. Distribution of chum salmon CPUE by time period for the onshore, offshore and combined fishing locations in the Clarence Strait gill net test fishery, 1988.

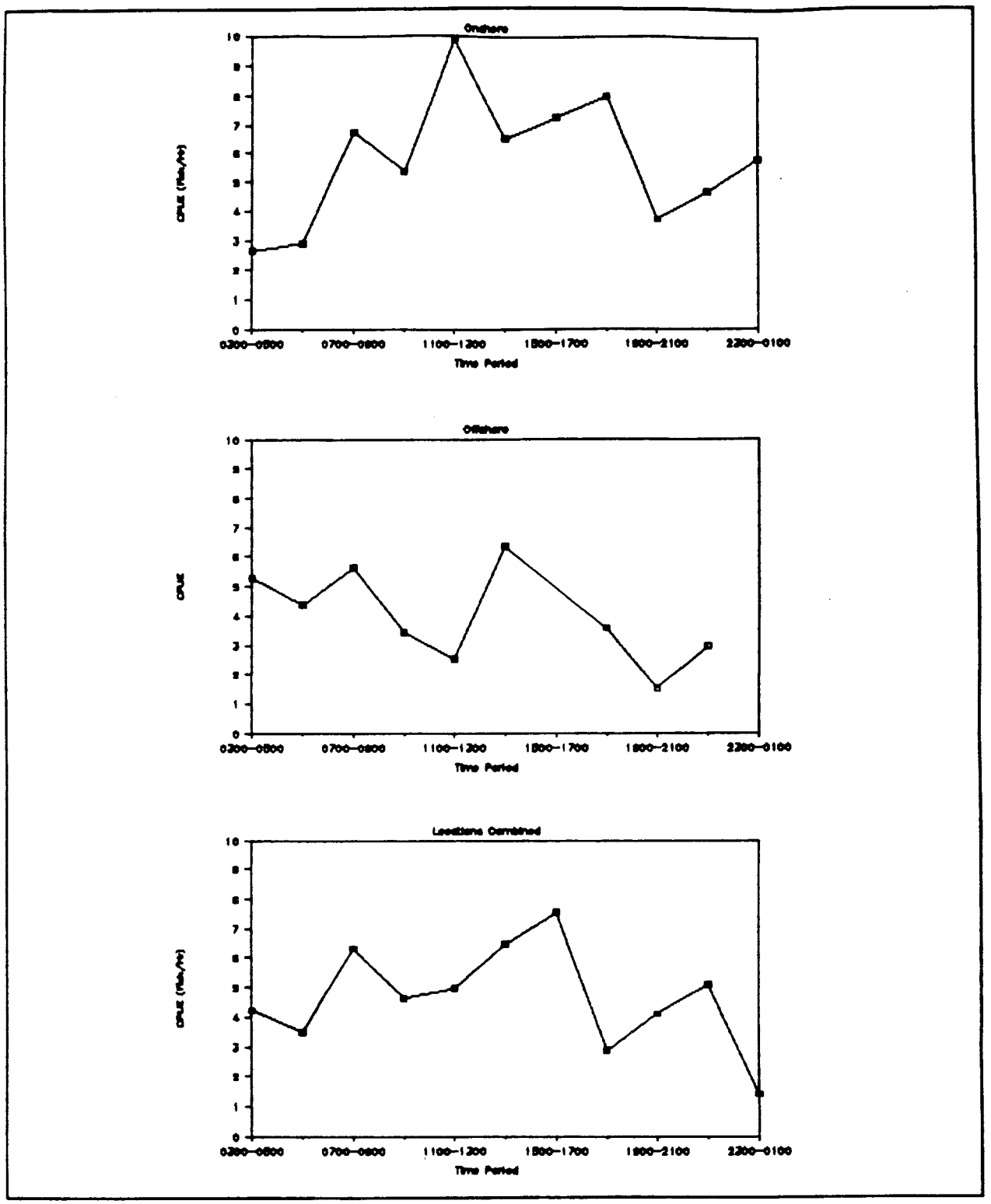

Figure 6. Mean chum salmon CPUE by time period for the onshore, offshore and combined fishing locations in the Clarence Strait gill net test fishery, 1988.

APPENDICES

Appendix A.1. Coho salmon catches, catch rates, fihing hours ambient light pahse and data of sets by fishing location and time for the 1988 Clarence Strait gill net test fishery.

Date	Coho Catch	Start Net Out	Net Full Out	Start Net In	Net Full In	Fishing Time Hour(s)	Catch Per Hour	Ambient Light Phase
				Onshore				
09/02	4	326	338	548	613	2.48	1.62	Twilight
08/26	9	455	503	536	600	0.82	11.02	Twilight
09/07	3	407	432	632	701	2.45	1.22	Twilight
09/02	3	623	632	745	752	1.35	2.22	Daylight
08/26	4	611	619	740	756	1.55	2.58	Daylight
09/07	2	705	732	800	815	0.82	2.45	Daylight
09/16	16	713	721	916	954	2.30	6.96	Daylight
08/26	1	813	819	924	940	1.27	0.79	Daylight
09/02	12	755	803	941	1008	1.93	6.23	Daylight
08/24	18	812	822	931	1000	1.48	12.20	Daylight
09/14	3	805	820	1033	1100	2.57	1.17	Daylight
09/07	6	825	840	1035	1105	2.29	2.62	Daylight
09/15	6	1008	1016	1142	1210	1.73	3.46	Daylight
09/02	3	1014	1022	1137	1152	1.44	2.08	Daylight
08/24	8	1003	1010	1150	1215	1.93	4.14	Daylight
09/07	22	1110	1118	1230	1305	1.56	14.12	Daylight
09/02	2	1201	1211	1319	1337	1.37	1.46	Daylight
09/16	16	1224	1233	1435	1508	2.38	6.71	Daylight
08/24	19	1217	1225	1457	1527	2.85	6.67	Daylight
09/02	2	1346	1354	1455	1512	1.23	1.63	Daylight
08/24	9	1530	1537	1705	1727	1.71	5.27	Daylight
09/16	6	1515	1520	1715	1737	2.14	2.80	Daylight
09/02	9	1525	1532	1652	1719	1.62	5.57	Daylight
09/14	17	1532	1540	1730	1813	2.26	7.53	Daylight
09/07	9	1617	1624	1805	1832	1.97	4.58	Daylight
09/06	4	1805	1825	2010	2040	2.17	1.85	Twilight
09/01	1	1836	1843	1958	2016	1.46	0.69	Twilight
08/24	9	1730	1734	1957	2019	2.60	3.46	Twilight
08/25	3	2029	2037	2052	2111	0.48	6.32	Twilight
09/15	5	1837	1850	2043	2121	2.31	2.17	Twilight
08/30	5	1825	1845	2055	2130	2.63	1.90	Twilight
09/01	2	2023	2032	2215	2245	2.04	0.98	Twilight
08/24	6	2025	2033	2152	2216	1.58	3.79	Twilight
09/06	6	2045	2110	2235	2305	1.88	3.20	Dark
08/30	8	2137	2152	2328	2402	2.01	3.98	Dark
08/24	1	2220	2228	2329	2351	1.27	0.79	Dark
09/01	4	2254	2303	2340	2400	0.86	4.66	Dark
09/06	5	2315	2330	2435	2500	1.42	3.53	Dark

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Appendix A.1. (page 2 of 2.)

Date	Coho Catch	Start Net Out	Net Full Out	Start Net In	Net Full In	Fishing Time Hour(s)	Catch Per Hour	Ambient Light Phase
					Offshore			
08/25	23	317	332	523	600	2.28	10.07	Twilight
09/15	3	350	407	630	657	2.75	1.09	Twilight
09/16	1	345	404	640	704	2.96	0.34	Twilight
09/08	19	342	405	644	722	3.16	6.02	Twilight
09/09	9	403	417	650	725	2.96	3.04	Twilight
08/25	2	606	613	807	852	2.33	0.86	Daylight
09/09	5	728	735	930	1000	2.23	2.25	Daylight
09/15	11	707	718	921	1001	2.48	4.44	Daylight
09/08	1	732	749	955	1023	2.48	0.40	Daylight
08/25	1	852	900	1050	1108	2.05	0.49	Daylight
09/16	9	1000	1009	1153	1217	2.01	4.48	Daylight
09/09	4	1008	1015	1201	1229	2.06	1.94	Daylight
08/25	1	1108	1117	1253	1309	1.81	0.55	Daylight
09/14	0	1110	1128	1237	1254	1.44	0.00	Daylight
09/15	8	1216	1223	1343	1402	1.55	5.16	Daylight
09/09	7	1230	1238	1353	1423	1.57	4.47	Daylight
09/14	8	1256	1304	1458	1527	2.21	3.62	Daylight
09/08	2	1729	1737	1850	1912	1.47	1.36	Twilight
08/25	1	1901	1908	2000	2018	1.08	0.93	Twilight
09/14	2	1824	1833	2052	2123	2.65	0.75	Twilight
09/07	6	1906	1914	2102	2127	2.08	2.89	Twilight
09/08	10	1918	1925	2139	2204	2.50	4.00	Twilight
09/15	5	2133	2147	2319	2338	1.81	2.76	Dark
09/14	4	2126	2137	2259	2321	1.64	2.44	Dark
09/07	2	2127	2138	2308	2330	1.78	1.13	Dark

Appendix A.2. Chum salmon catches, catch rates, fihing hours ambient light pahse and data of sets by fishing location and time for the 1988 Clarence Strait gill net test fishery.

Date	Coho Catch	Start Net Out	Net Full Out	Start Net In	Net Full In	Fishing Time Hour(s)	Catch Per Hour	Ambient Light Phase
				Onshore				
09/02	7	326	338	548	613	2.48	2.83	Twilight
08/26	2	455	503	536	600	0.82	2.45	Twilight
09/07	4	407	432	632	701	2.45	1.63	Twilight
09/02	4	611	619	740	756	1.55	2.58	Daylight
08/26	6	623	632	745	752	1.35	4.44	Daylight
09/07	2	705	732	800	815	0.82	2.45	Daylight
09/16	17	713	721	916	954	2.30	7.39	Daylight
08/26	14	755	803	941	1008	1.93	7.27	Daylight
09/02	21	812	822	931	1000	1.48	14.24	Daylight
08/24	3	813	819	924	940	1.27	2.37	Daylight
09/14	3	805	820	1033	1100	2.57	1.17	Daylight
09/07	24	825	840	1035	1105	2.29	10.47	Daylight
09/15	21	1003	1010	1150	1215	1.93	10.86	Daylight
09/02	5	1008	1016	1142	1210	1.73	2.88	Daylight
08/24	2	1014	1022	1137	1152	1.44	1.39	Daylight
09/07	24	1110	1118	1230	1305	1.56	15.40	Daylight
09/02	6	1201	1211	1319	1337	1.37	4.39	Daylight
09/16	18	1217	1225	1457	1527	2.85	6.32	Daylight
08/24	16	1224	1233	1435	1508	2.38	6.71	Daylight
09/02	8	1346	1354	1455	1512	1.23	6.53	Daylight
08/24	6	1515	1520	1715	1737	2.14	2.80	Daylight
09/16	23	1525	1532	1652	1719	1.62	14.23	Daylight
09/02	8	1530	1537	1705	1727	1.71	4.68	Daylight
09/14	28	1532	1540	1730	1813	2.26	12.40	Daylight
09/07	7	1617	1624	1805	1832	1.97	3.56	Daylight
09/06	5	1730	1734	1957	2019	2.60	1.92	Twilight
09/01	4	1805	1825	2010	2040	2.17	1.85	Twilight
08/24	5	1836	1843	1958	2016	1.46	3.43	Twilight
08/25	12	1825	1845	2055	2130	2.63	4.57	Twilight
09/15	24	1837	1850	2043	2121	2.31	10.40	Twilight
08/30	0	2029	2037	2052	2111	0.48	0.00	Twilight
09/01	13	2023	2032	2215	2245	2.04	6.37	Twilight
08/24	7	2025	2033	2152	2216	1.58	4.42	Twilight
09/06	6	2045	2110	2235	2305	1.88	3.20	Dark
08/30	11	2137	2152	2328	2402	2.01	5.48	Dark
08/24	6	2220	2228	2329	2351	1.27	4.74	Dark
09/01	10	2254	2303	2340	2400	0.86	11.65	Dark
09/06	2	2315	2330	2435	2500	1.42	1.41	Dark

--Continued--

Appendix A.2. (page 2 of 2.)

Date	Coho Catch	Start Net Out	Net Full Out	Start Net In	Net Full In	Fishing Time Hour(s)	Catch Per Hour	Ambient Light Phase
				Offshore				
08/25	12	317	332	523	600	2.28	5.26	Twilight
09/15	18	342	405	644	722	3.16	5.70	Twilight
09/16	13	345	404	640	704	2.96	4.39	Twilight
09/08	16	350	407	630	657	2.75	5.82	Twilight
09/09	17	403	417	650	725	2.96	5.75	Twilight
08/25	7	606	613	807	852	2.33	3.00	Daylight
09/09	23	707	718	921	1001	2.48	9.29	Daylight
09/15	7	728	735	930	1000	2.23	3.15	Daylight
09/08	11	732	749	955	1023	2.48	4.44	Daylight
08/25	4	852	900	1050	1108	2.05	1.95	Daylight
09/16	7	1000	1009	1153	1217	2.01	3.49	Daylight
09/09	10	1008	1015	1201	1229	2.06	4.86	Daylight
08/25	4	1108	1117	1253	1309	1.81	2.21	Daylight
09/14	2	1110	1128	1237	1254	1.44	1.39	Daylight
09/15	3	1216	1223	1343	1402	1.55	1.94	Daylight
09/09	7	1230	1238	1353	1423	1.57	4.47	Daylight
09/14	14	1256	1304	1458	1527	2.21	6.34	Daylight
09/08	5	1729	1737	1850	1912	1.47	3.41	Twilight
08/25	4	1901	1908	2000	2018	1.08	3.72	Twilight
09/14	8	1824	1833	2052	2123	2.65	3.02	Twilight
09/07	3	1906	1914	2102	2127	2.08	1.45	Twilight
09/08	4	1918	1925	2139	2204	2.50	1.60	Twilight
09/15	8	2126	2137	2259	2321	1.64	4.87	Dark
09/14	6	2127	2138	2308	2330	1.78	3.38	Dark
09/07	1	2133	2147	2319	2338	1.81	0.55	Dark

Appendix A.3. Coho CPUE values, ranks and resultant statistics from the Kruskal-Wallis test.

Daylight		Twilight		Dark	
CPUE	Rank	CPUE	Rank	CPUE	Rank
0.00	1	0.34	2	0.79	8.5
0.40	3	0.69	6	1.13	14
0.49	4	0.75	7	2.44	28
0.55	5	0.93	11	2.76	32
0.79	8.5	0.98	12	3.20	36
0.86	10	1.09	13	3.53	39
1.17	15	1.22	16	3.98	42
1.46	18	1.36	17	4.66	49
1.63	20	1.62	19		
1.94	23	1.85	21		
2.08	24	1.90	22		
2.22	26	2.17	25		
2.25	27	2.89	34		
2.45	29	3.04	35		
2.58	30	3.46	37.5		
2.62	31	3.79	41		
2.80	33	4.00	43		
3.46	37.5	6.02	53		
3.62	40	6.32	55		
4.14	44	10.07	60		
4.44	45	11.02	61		
4.47	46.5				
4.48	46.5				
4.58	48				
5.16	50				
5.27	51		$H_o = CPUE_{daylight} = CPUE_{twilight} = CPUE_{dark}$		
5.57	52				
6.23	54		$H_A = CPUE_{daylight} = CPUE_{twilight} = CPUE_{dark}$		
6.67	56				
6.71	57				
6.96	58				
7.53	59				
12.20	62				
14.12	63				
SUM(R_i)	1177		590.5		248.5
n_i	34		21		8
MEDIAN	3.13		1.90		2.98

$$H = \frac{12}{N(N+1)} \sum_{i=1}^{k} \frac{R_i}{n_i} - 3(N+1) = 3.20 \qquad N = \Sigma n_i = 63$$

$$C = 1 - \frac{\Sigma T}{N^3 - N} = .999 \qquad \Sigma T = \sum_{i=1}^{m} (t_i^3 - t_i) = 18$$

$H_C = H/C = 3.20$ Not significant @ $\alpha = .10$ ($X_{.10,2} = 4.6$)
Therefore, accept H_o

Where: t_i = number of ties in the i^{th} group of ties
m = number of groups of tied ranks = 2
C = correction factor for tied ranks
H_C = corrected H statistic

Appendix A.4. Chum values, ranks and resultant statistics from the Kruskal-Wallis test.

Daylight		Twilight		Dark	
CPUE	Rank	CPUE	Rank	CPUE	Rank
1.17	3	0.00	1	0.55	2
1.39	4.5	1.45	7	1.41	4.5
1.39	4.5	1.60	8.5	3.20	25
1.94	11.5	1.63	8.5	3.38	26
1.95	11.5	1.85	10	4.74	40
2.21	14	1.92	11.5	4.87	41.5
2.37	15	2.45	16.5	5.48	44
2.45	16.5	2.83	20	11.65	59
2.58	18	3.02	22.5		
2.80	19	3.43	27.5		
2.88	21	3.72	31		
3.00	22.5	4.39	32.5		
3.15	24	4.42	34.5		
3.41	27.5	4.57	38		
3.49	29	5.26	43		
3.56	30	5.70	45		
4.39	32.5	5.75	46		
4.44	34.5	5.82	47		
4.44	34.5	6.37	50		
4.47	37	10.40	56		
4.68	39				
4.86	41.5				
6.32	48.5				
6.34	48.5				
6.53	51		$H_o = CPUE_{daylight} = CPUE_{twilight} = CPUE_{dark}$		
6.71	52				
7.27	53		$H_A = CPUE_{daylight} = CPUE_{twilight} = CPUE_{dark}$		
7.39	54				
9.29	55				
10.47	57				
10.86	58				
12.40	60				
14.23	61.5				
14.24	61.5				
15.40	63				
SUM(R_i)	1213.5	590.5		242	
n_i	34	21		8	
MEDIAN	4.44	3.58		4.74	

$$H = \frac{12}{N(N+1)} \sum_{i=1}^{k} \frac{R_i}{n_i} - 3(N+1) = 2.55 \quad N = \Sigma n_i = 63$$

$$C = 1 - \frac{\Sigma T}{N^3 - N} = .999 \quad \Sigma T = \sum_{i=1}^{m} (t_i^3 - t_i) = 96$$

$H_C = H/C = 2.55$ Not significant @ $\alpha = .10$ ($X_{.10,2} = 4.6$)
Therefore, accept H_o

Where: t_i = number of ties in the i^{th} group of ties
m = number of groups of tied ranks = 2
C = correction factor for tied ranks
H_C = corrected H statistic