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Calculation of Partial Selection for Cod in Subdivision 3Ps

by

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INTRODUCTION

The fishing mortality vector in a given year can be thought of as being composed of two effects, an effect due to the amount of effort exerted and an effect reflecting the relative selection at age. The latter effect can be a result of factors such as mesh size, hook size, gear composition, or location of capture. In some instances, the fishing mortality at age may be estimated directly but often, due to constraints with the data, the estimation is done in two steps. First, partial selection is determined, then the fishing mortality for the fully recruited ages is obtained.

Various approaches have been used to estimate a partial selection, a common one being to use the average partial selection in recent years. This method assumes that the gear composition remains the same from year to year. Another approach involves the calculation of partial selection for each gear involved in the fishery. The overall partial selection can then be computed as the average partial selection, weighted by the catch of the component gears. This method could potentially take into account changes in the gear composition. Another advantage of the latter approach is that the partial selection for each gear, once established, would not need to be recalculated each year unless there was a change in some factor that might affect the individual partial selections, i.e. mesh size.

The partial selection factors for cod in Subdivision 3Ps have been calculated by the former method in past years. This paper examines the adequacy of available data for calculation of partial selection by the latter method.

METHOD

The partial fishing mortality for each of the gear components was calculated by multiplying the fishing mortality obtained from a cohort analysis by the ratio of the catch at age for that gear to the total catch at age. The partial selections were then computed by dividing the partial fishing mortality by the fishing mortality for the age or ages which appeared to be fully recruited to that gear. The age or ages at full recruitment were determined for each gear after examination of the partial fishing mortality.

Data were available to compute the partial selection for trap, line trawl, gill net, handline and otter trawl from 1977-83. An average partial selection was calculated for this time period, excluding the last two years, because of the influence of the input data, and any years which exhibited an anomalous pattern. The entire excercise was repeated for three values of fully recruited fishing mortalities, 0.15, 0.25, and 0.35, to examine the effect of this parameter on the results. The input partial selection for the cohort analysis was the vector used as input in the 1983 assessments (Bishop and Gavaris, 1983).

RESULTS

Using age length keys and length frequencies which had been sampled from the commercial catch, the catch at age by each of the gear components was constructed for the years 1977-83 (Table 1). The fishing mortalities from the three cohort analyses are shown in Table 2. The partial fishing mortalities and partial selections are contained in Tables 3-5. Fully recruited age or ages were determined to be 5 for trap, 8 for line trawl, 8-10 for gill net, 5-6 for handline, and 7-8 for otter trawl. For gears where more than one age was determined

to be fully recruited, the partial fishing mortalities were divided by the arithmetic mean of the fishing mortalities for these ages. The years used for averaging the partial selections of each gear are indicated with the results in Table 6. The effect of different fully recruited fishing mortalities in 1983 on the average was marginal. This suggests that the use of the rounded average partial selections shown in Table 7 may be adequate for calculation of partial selection for the fishery. As an example of such a calculation the 1983 catch for each gear was used to weight their respective partial selections to arrive at an estimate for the 1983 fishery (Table 7).

DISCUSSION

It is evident from Tables 3-5 that the results are quite variable and exhibit large fluctuations in particular years. This is especially so for gears where the catch is small such as otter trawl. Nevertheless, the averages obtained display relatively smooth patterns and appear reasonable. These results can therefore be tentatively accepted pending further evaluation as the cohort analyses is extended each year.

REFERENCES

Bishop, C. A., and S. Gavaris. 1983. Assessment of the cod stock in Subdivision 3Ps. CAFSAC Res. Doc. 83/32.

Table 1. Catch at age by gear for the Canadian cod fishery in Subdivision 3Ps from 1979 to 1983.

OTTER TRAWL

AGE	1977	1978	1979	1980	1981	1982	1983
3	274	1	39	68	5	1	8
4	1894	314	352	308	12	142	33
5	1880	1074	2718	1137	45	270	472
6	596	1707	1859	2234	258	243	180
7	146	576	754	2072	269	345	132
8	58	252	294	445	148	295	187
9	31	39	95	78	28	59	161
10	14	32	16	1	7	18	33
11	5	12	1	1	4	10	16
12	2	3	1	1	4	1	1
13	1	4	1	1	1	1	1
14	2	1	1	1	1	1	1

TRAP

AGE	1977	1978	1979	1980	1981	1982	1983
3	118	57	45	125	326	53	193
4	4454	1452	996	679	561	1679	951
5	2546	1034	1670	959	149	629	1621
6	733	165	96	369	73	80	284
7	39	23	11	49	40	44	64
8	8	5	3	5	9	22	21
9	0	0	0	0	1	4	23
10	0	0	0	0	1	1	2
11	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0

GILL NET

AGE	1977	1978	1979	1980	1981	1982	1983
3	0	0	0	0	1	0	1
4	10	36	12	5	13	113	32
5	424	165	247	219	132	382	554
6	913	313	649	988	406	400	662
7	210	265	532	565	845	676	379
8	90	110	132	243	304	857	234
9	39	47	46	68	145	182	280
10	15	40	14	31	50	66	79
11	4	15	11	20	22	23	28
12	3	4	1	13	10	6	14
13	4	2	1	7	8	3	5
14	0	2	1	8	1	1	2

LINE TRAWL

AGE	1977	1978	1979	1980	1981	1982	1983
3	391	98	31	68	404	29	430
4	1356	1750	624	357	1498	1378	920
5	2179	2146	3351	1946	1916	1454	2965
6	607	1432	2023	4076	2608	683	1185
7	387	681	1088	1576	3030	950	491
8	175	284	390	704	778	1015	389
9	147	149	125	199	275	225	353
10	65	109	48	73	90	97	92
11	37	43	35	34	34	30	35
12	29	19	18	29	15	14	18
13	20	13	10	12	7	5	12
14	8	8	9	17	1	3	5

HAND LINE

AGE	1977	1978	1979	1980	1981	1982	1983
3	99	57	34	37	132	2	1
4	942	684	368	295	312	665	142
5	840	880	1624	835	176	469	954
6	238	529	462	668	139	110	302
7	89	222	143	125	101	92	91
8	39	71	39	23	33	80	38
9	31	7	10	4	9	19	47
10	14	7	2	0	4	5	7
11	8	5	2	0	0	2	2
12	7	0	0	0	0	0	1
13	5	0	0	0	0	0	0
14	1	0	0	0	0	0	0

Table 2. Fishing mortalities from cohort analyses over a range of fully recruited F's for cod in Subdivision 3Ps.

FISHING MORTALITY

AGE	1977	1978	1979	1980	1981	1982	1983
3	0.012	0.005	0.005	0.004	0.005	0.001	0.003
4	0.237	0.068	0.066	0.063	0.051	0.034	0.026
5	0.418	0.214	0.215	0.196	0.149	0.100	0.071
6	0.435	0.385	0.333	0.288	0.248	0.146	0.107
7	0.334	0.464	0.436	0.518	0.292	0.259	0.150
8	0.366	0.486	0.440	0.456	0.352	0.285	0.150
9	0.395	0.403	0.353	0.310	0.334	0.272	0.150
10	0.451	0.549	0.229	0.210	0.300	0.290	0.150
11	0.291	0.601	0.257	0.232	0.279	0.240	0.150
12	0.505	0.209	0.290	0.376	0.247	0.163	0.150
13	0.682	0.437	0.128	0.528	0.384	0.149	0.150
14	0.370	0.480	0.430	0.470	0.310	0.270	0.150

FISHING MORTALITY

AGE	1977	1978	1979	1980	1981	1982	1983
3	0.013	0.006	0.006	0.006	0.009	0.001	0.005
4	0.253	0.077	0.080	0.086	0.076	0.055	0.043
5	0.438	0.232	0.250	0.246	0.212	0.156	0.118
6	0.459	0.413	0.370	0.351	0.332	0.223	0.178
7	0.360	0.505	0.486	0.613	0.386	0.386	0.250
8	0.432	0.544	0.505	0.543	0.463	0.421	0.250
9	0.421	0.521	0.421	0.381	0.438	0.403	0.250
10	0.491	0.608	0.331	0.267	0.401	0.429	0.250
11	0.308	0.674	0.301	0.380	0.386	0.359	0.250
12	0.523	0.225	0.347	0.469	0.489	0.248	0.250
13	0.712	0.463	0.140	0.708	0.541	0.374	0.250
14	0.386	0.519	0.470	0.530	0.500	0.450	0.250

FISHING MORTALITY

AGE	1977	1978	1979	1980	1981	1982	1983
3	0.014	0.006	0.007	0.008	0.012	0.002	0.007
4	0.260	0.082	0.088	0.102	0.097	0.074	0.060
5	0.447	0.240	0.269	0.277	0.260	0.206	0.165
6	0.470	0.426	0.389	0.388	0.389	0.288	0.249
7	0.372	0.525	0.511	0.666	0.447	0.488	0.350
8	0.366	0.574	0.539	0.592	0.536	0.531	0.350
9	0.395	0.403	0.460	0.422	0.505	0.509	0.350
10	0.451	0.549	0.229	0.303	0.470	0.540	0.350
11	0.291	0.601	0.257	0.232	0.461	0.456	0.350
12	0.505	0.209	0.290	0.376	0.247	0.320	0.350
13	0.682	0.437	0.128	0.528	0.384	0.149	0.350
14	0.370	0.480	0.430	0.470	0.310	0.270	0.350

Table 3. Fishing mortality and partial recruitment estimates by gear from a cohort analysis at F_t=0.15.

FISHING MORTALITY

	AGE	1977	1978	1979	1980	1981	1982	1983
TRAP	3	0.001	0.001	0.001	0.002	0.002	0.000	0.001
	4	0.115	0.023	0.028	0.026	0.010	0.011	0.009
	5	0.128	0.041	0.037	0.037	0.008	0.015	0.014
	6	0.099	0.015	0.006	0.013	0.004	0.006	0.009
	7	0.014	0.006	0.002	0.006	0.002	0.004	0.007
	8	0.007	0.003	0.001	0.002	0.002	0.002	0.003
	9	0.000	0.000	0.000	0.000	0.001	0.001	0.003
	10	0.000	0.000	0.000	0.000	0.001	0.001	0.001
	11	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	12	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	14	0.000	0.000	0.000	0.000	0.000	0.000	0.000

	AGE	1977	1978	1979	1980	1981	1982	1983
GILL NET	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	4	0.000	0.001	0.000	0.000	0.000	0.001	0.000
	5	0.021	0.007	0.005	0.008	0.007	0.009	0.005
	6	0.124	0.029	0.041	0.034	0.024	0.029	0.022
	7	0.076	0.069	0.090	0.067	0.048	0.062	0.039
	8	0.083	0.073	0.066	0.078	0.068	0.079	0.032
	9	0.058	0.078	0.057	0.060	0.085	0.068	0.039
	10	0.058	0.116	0.039	0.062	0.074	0.064	0.045
	11	0.020	0.119	0.059	0.086	0.069	0.054	0.042
	12	0.035	0.032	0.015	0.116	0.067	0.029	0.049
	13	0.088	0.046	0.012	0.195	0.128	0.030	0.034
	14	0.000	0.096	0.043	0.150	0.052	0.027	0.033

	AGE	1977	1978	1979	1980	1981	1982	1983
LINE TRAWL	3	0.005	0.002	0.001	0.001	0.002	0.000	0.002
	4	0.035	0.027	0.017	0.014	0.028	0.009	0.009
	5	0.109	0.085	0.074	0.075	0.100	0.035	0.026
	6	0.082	0.131	0.129	0.141	0.153	0.050	0.039
	7	0.141	0.176	0.183	0.186	0.171	0.088	0.051
	8	0.162	0.189	0.194	0.226	0.174	0.093	0.054
	9	0.219	0.247	0.155	0.177	0.161	0.084	0.049
	10	0.250	0.316	0.134	0.147	0.132	0.095	0.052
	11	0.189	0.340	0.188	0.146	0.107	0.071	0.052
	12	0.340	0.153	0.274	0.260	0.100	0.067	0.063
	13	0.440	0.299	0.116	0.334	0.112	0.050	0.082
	14	0.269	0.384	0.387	0.320	0.052	0.081	0.083

	AGE	1977	1978	1979	1980	1981	1982	1983
HAND LINE	3	0.001	0.001	0.001	0.001	0.001	0.000	0.000
	4	0.024	0.011	0.010	0.011	0.006	0.004	0.001
	5	0.042	0.035	0.036	0.032	0.009	0.011	0.008
	6	0.032	0.048	0.029	0.023	0.008	0.008	0.010
	7	0.032	0.057	0.024	0.015	0.008	0.008	0.009
	8	0.036	0.047	0.019	0.007	0.007	0.007	0.005
	9	0.046	0.012	0.012	0.004	0.005	0.007	0.007
	10	0.054	0.020	0.006	0.000	0.006	0.005	0.004
	11	0.041	0.040	0.011	0.000	0.000	0.005	0.003
	12	0.082	0.000	0.000	0.000	0.000	0.000	0.003
	13	0.110	0.000	0.000	0.000	0.000	0.000	0.000
	14	0.034	0.000	0.000	0.000	0.000	0.000	0.000

	AGE	1977	1978	1979	1980	1981	1982	1983
OTTER TRAWL	3	0.003	0.000	0.001	0.001	0.000	0.000	0.000
	4	0.049	0.005	0.010	0.012	0.000	0.001	0.000
	5	0.094	0.043	0.060	0.044	0.002	0.007	0.004
	6	0.081	0.156	0.118	0.077	0.015	0.018	0.006
	7	0.053	0.149	0.127	0.245	0.015	0.032	0.014
	8	0.054	0.168	0.146	0.143	0.033	0.027	0.026
	9	0.046	0.065	0.118	0.069	0.016	0.022	0.022
	10	0.054	0.093	0.045	0.002	0.010	0.018	0.019
	11	0.026	0.095	0.005	0.004	0.013	0.024	0.024
	12	0.023	0.024	0.015	0.009	0.027	0.005	0.003
	13	0.022	0.092	0.012	0.028	0.016	0.010	0.007
	14	0.067	0.048	0.043	0.019	0.052	0.027	0.017

PARTIAL RECRUITMENT

	AGE	1977	1978	1979	1980	1981	1982	1983
TRAP	3	0.011	0.030	0.037	0.050	0.226	0.028	0.053
	4	0.904	0.554	0.751	0.705	1.330	0.739	0.670
	5	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	6	0.777	0.368	0.166	0.345	0.553	0.387	0.665
	7	0.111	0.145	0.050	0.156	0.291	0.267	0.477
	8	0.058	0.081	0.041	0.043	0.260	0.133	0.208
	9	0.000	0.000	0.000	0.000	0.075	0.098	0.229
	10	0.000	0.000	0.000	0.000	0.190	0.064	0.081
	11	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	12	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	14	0.000	0.000	0.000	0.000	0.000	0.000	0.000

	AGE	1977	1978	1979	1980	1981	1982	1983
GILL NET	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	4	0.004	0.006	0.006	0.003	0.003	0.011	0.008
	5	0.320	0.074	0.101	0.126	0.091	0.131	0.123
	6	1.861	0.322	0.764	0.509	0.316	0.418	0.560
	7	1.149	0.770	1.661	0.996	0.631	0.886	1.020
	8	1.255	0.821	1.217	1.166	0.902	1.117	0.837
	9	0.876	0.876	1.058	0.901	1.124	0.968	1.009
	10	0.869	1.303	0.725	0.933	0.974	0.915	1.154
	11	0.308	1.330	1.092	1.284	0.915	0.769	1.077
	12	0.530	0.360	0.282	1.739	0.884	0.408	1.265
	13	1.324	0.516	0.215	2.906	1.695	0.424	0.883
	14	0.000	1.077	0.797	2.246	0.684	0.383	0.863

	AGE	1977	1978	1979	1980	1981	1982	1983
LINE TRAWL	3	0.030	0.011	0.005	0.004	0.012	0.002	0.030
	4	0.217	0.145	0.089	0.061	0.158	0.099	0.168
	5	0.674	0.451	0.380	0.332	0.572	0.378	0.475
	6	0.507	0.695	0.663	0.622	0.878	0.540	0.720
	7	0.867	0.933	0.945	0.822	0.979	0.942	0.949
	8	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	9	1.353	1.309	0.800	0.781	0.923	0.905	0.914
	10	1.544	1.675	0.692	0.650	0.759	1.017	0.966
	11	1.167	1.799	0.967	0.646	0.612	0.758	0.967
	12	2.099	0.808	1.414	1.148	0.574	0.720	1.169
	13	2.712	1.583	0.599	1.475	0.642	0.534	1.523
	14	1.660	2.032	1.995	1.413	0.296	0.869	1.551

	AGE	1977	1978	1979	1980	1981	1982	1983
HAND LINE	3	0.033	0.030	0.032	0.020	0.082	0.002	0.000
	4	0.657	0.257	0.313	0.410	0.662	0.458	0.155
	5	1.133	0.838	1.098	1.165	1.058	1.167	0.908
	6	0.867	1.162	0.902	0.835	0.942	0.833	1.092
	7	0.870	1.378	0.740	0.534	0.657	0.874	1.046
	8	0.971	1.133	0.596	0.268	0.854	0.755	0.581
	9	1.243	0.279	0.381	0.129	0.608	0.732	0.724
	10	1.450	0.487	0.172	0.000	0.679	0.502	0.437
	11	1.100	0.948	0.329	0.000	0.000	0.484	0.329
	12	2.209	0.000	0.000	0.000	0.000	0.000	0.386
	13	2.956	0.000	0.000	0.000	0.000	0.000	0.000
	14	0.904	0.000	0.000	0.000	0.000	0.000	0.000

	AGE	1977	1978	1979	1980	1981	1982	1983
OTTER TRAWL	3	0.063	0.000	0.009	0.005	0.001	0.000	0.002
	4	0.920	0.031	0.071	0.061	0.009	0.032	0.016
	5	1.767	0.269	0.438	0.226	0.097	0.222	0.205
	6	1.512	0.988	0.865	0.398	0.627	0.607	0.297
	7	0.994	0.942	0.930	1.262	0.627	1.081	0.694
	8	1.006	1.058	1.070	0.738	1.373	0.919	1.306
	9	0.866	0.409	0.863	0.357	0.678	0.750	1.133
	10	1.010	0.587	0.327	0.010	0.426	0.597	0.941
	11	0.479	0.599	0.039	0.022	0.520	0.799	1.202
	12	0.440	0.152	0.112	0.046	1.105	0.163	0.176
	13	0.412	0.581	0.085	0.143	0.662	0.337	0.345
	14	1.260	0.303	0.315	0.097	2.139	0.916	0.843

Table 4. Fishing mortality and partial recruitment estimates by gear from a cohort analysis at F_t=0.25.

FISHING MORTALITY

TRAP

AGE	1977	1978	1979	1980	1981	1982	1983
3	0.002	0.002	0.002	0.003	0.003	0.001	0.001
4	0.123	0.026	0.034	0.036	0.016	0.018	0.016
5	0.134	0.044	0.043	0.046	0.011	0.024	0.023
6	0.105	0.016	0.007	0.016	0.006	0.009	0.015
7	0.015	0.006	0.002	0.007	0.003	0.006	0.011
8	0.009	0.004	0.002	0.002	0.003	0.003	0.005
9	0.000	0.000	0.000	0.000	0.001	0.002	0.005
10	0.000	0.000	0.000	0.000	0.002	0.001	0.002
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000	0.000	0.000	0.000

GILL NET

AGE	1977	1978	1979	1980	1981	1982	1983
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.001	0.000	0.000	0.000	0.001	0.001
5	0.022	0.007	0.006	0.011	0.010	0.014	0.008
6	0.130	0.031	0.046	0.042	0.032	0.045	0.036
7	0.082	0.075	0.100	0.079	0.063	0.093	0.066
8	0.098	0.082	0.075	0.093	0.090	0.116	0.054
9	0.062	0.101	0.068	0.074	0.111	0.101	0.065
10	0.062	0.129	0.057	0.080	0.098	0.095	0.074
11	0.022	0.133	0.069	0.141	0.095	0.081	0.069
12	0.036	0.035	0.018	0.145	0.132	0.044	0.081
13	0.092	0.049	0.013	0.261	0.180	0.075	0.057
14	0.000	0.104	0.047	0.170	0.083	0.045	0.056

LINE TRAWL

AGE	1977	1978	1979	1980	1981	1982	1983
3	0.005	0.003	0.001	0.001	0.003	0.000	0.003
4	0.037	0.031	0.021	0.019	0.041	0.015	0.015
5	0.115	0.092	0.086	0.094	0.142	0.055	0.043
6	0.087	0.141	0.143	0.172	0.205	0.077	0.065
7	0.151	0.192	0.204	0.220	0.225	0.131	0.085
8	0.191	0.212	0.223	0.269	0.229	0.138	0.090
9	0.233	0.320	0.185	0.217	0.211	0.125	0.082
10	0.267	0.351	0.194	0.188	0.177	0.140	0.086
11	0.200	0.381	0.219	0.239	0.147	0.106	0.087
12	0.353	0.164	0.329	0.324	0.198	0.102	0.105
13	0.459	0.317	0.127	0.447	0.158	0.125	0.136
14	0.281	0.415	0.423	0.360	0.083	0.135	0.139

HAND LINE

AGE	1977	1978	1979	1980	1981	1982	1983
3	0.001	0.002	0.001	0.001	0.001	0.000	0.000
4	0.026	0.012	0.012	0.015	0.009	0.007	0.002
5	0.044	0.038	0.042	0.040	0.013	0.018	0.014
6	0.034	0.052	0.033	0.028	0.011	0.012	0.016
7	0.035	0.063	0.027	0.017	0.008	0.013	0.016
8	0.043	0.053	0.022	0.009	0.010	0.011	0.009
9	0.049	0.015	0.015	0.004	0.007	0.011	0.011
10	0.058	0.023	0.008	0.000	0.008	0.007	0.007
11	0.043	0.044	0.013	0.000	0.000	0.007	0.005
12	0.085	0.000	0.000	0.000	0.000	0.000	0.006
13	0.115	0.000	0.000	0.000	0.000	0.000	0.000
14	0.035	0.000	0.000	0.000	0.000	0.000	0.000

OTTER TRAWL

AGE	1977	1978	1979	1980	1981	1982	1983
3	0.004	0.000	0.002	0.001	0.000	0.000	0.000
4	0.052	0.006	0.012	0.016	0.000	0.002	0.001
5	0.099	0.046	0.070	0.055	0.003	0.010	0.007
6	0.085	0.168	0.131	0.094	0.020	0.027	0.010
7	0.057	0.162	0.142	0.290	0.020	0.047	0.023
8	0.063	0.188	0.168	0.170	0.044	0.040	0.043
9	0.049	0.084	0.141	0.085	0.021	0.033	0.037
10	0.058	0.103	0.065	0.003	0.014	0.026	0.031
11	0.027	0.106	0.006	0.007	0.017	0.035	0.040
12	0.024	0.026	0.018	0.011	0.053	0.007	0.006
13	0.023	0.097	0.013	0.037	0.023	0.025	0.011
14	0.070	0.052	0.047	0.021	0.083	0.045	0.028

PARTIAL RECRUITMENT

TRAP

AGE	1977	1978	1979	1980	1981	1982	1983
3	0.012	0.034	0.043	0.059	0.253	0.029	0.053
4	0.919	0.583	0.785	0.767	1.404	0.761	0.670
5	1.000	1.000	1.000	1.000	1.000	1.000	1.000
6	0.783	0.365	0.159	0.336	0.520	0.378	0.665
7	0.114	0.146	0.048	0.148	0.269	0.254	0.477
8	0.065	0.084	0.040	0.041	0.240	0.125	0.208
9	0.000	0.000	0.000	0.000	0.069	0.093	0.229
10	0.000	0.000	0.000	0.000	0.178	0.061	0.081
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000	0.000	0.000	0.000

GILL NET

AGE	1977	1978	1979	1980	1981	1982	1983
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.004	0.006	0.006	0.003	0.004	0.012	0.008
5	0.301	0.068	0.095	0.129	0.098	0.139	0.123
6	1.763	0.296	0.688	0.507	0.321	0.432	0.560
7	1.110	0.720	1.496	0.960	0.631	0.891	1.020
8	1.330	0.790	1.129	1.130	0.898	1.116	0.837
9	0.836	0.971	1.023	0.902	1.115	0.970	1.009
10	0.833	1.239	0.848	0.968	0.987	0.914	1.154
11	0.292	1.280	1.032	1.710	0.957	0.776	1.077
12	0.493	0.333	0.274	1.766	1.325	0.420	1.265
13	1.241	0.469	0.190	3.172	1.810	0.717	0.883
14	0.000	0.999	0.704	2.062	0.836	0.431	0.863

LINE TRAWL

AGE	1977	1978	1979	1980	1981	1982	1983
3	0.029	0.012	0.006	0.005	0.015	0.003	0.030
4	0.196	0.147	0.094	0.069	0.181	0.108	0.168
5	0.598	0.436	0.386	0.349	0.620	0.400	0.475
6	0.453	0.665	0.642	0.638	0.896	0.558	0.720
7	0.791	0.907	0.917	0.818	0.984	0.947	0.949
8	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9	1.219	1.509	0.833	0.806	0.920	0.907	0.914
10	1.396	1.655	0.871	0.696	0.773	1.016	0.966
11	1.046	1.799	0.984	0.888	0.643	0.766	0.967
12	1.841	0.775	1.478	1.203	0.865	0.741	1.169
13	2.399	1.496	0.570	1.661	0.689	0.904	1.523
14	1.466	1.960	1.900	1.338	0.364	0.979	1.551

HAND LINE

AGE	1977	1978	1979	1980	1981	1982	1983
3	0.035	0.034	0.038	0.023	0.094	0.002	0.000
4	0.666	0.272	0.334	0.451	0.719	0.477	0.155
5	1.130	0.842	1.120	1.178	1.088	1.179	0.908
6	0.870	1.158	0.880	0.822	0.912	0.821	1.092
7	0.891	1.394	0.723	0.510	0.626	0.838	1.046
8	1.092	1.179	0.600	0.257	0.810	0.721	0.581
9	1.259	0.334	0.400	0.127	0.575	0.700	0.724
10	1.473	0.501	0.218	0.000	0.656	0.479	0.437
11	1.108	0.987	0.337	0.000	0.000	0.467	0.329
12	2.178	0.000	0.000	0.000	0.000	0.000	0.386
13	2.939	0.000	0.000	0.000	0.000	0.000	0.000
14	0.898	0.000	0.000	0.000	0.000	0.000	0.000

OTTER TRAWL

AGE	1977	1978	1979	1980	1981	1982	1983
3	0.064	0.000	0.010	0.006	0.001	0.000	0.002
4	0.867	0.032	0.077	0.070	0.010	0.035	0.016
5	1.639	0.264	0.450	0.239	0.105	0.234	0.205
6	1.413	0.958	0.850	0.410	0.639	0.625	0.297
7	0.947	0.927	0.915	1.260	0.629	1.084	0.694
8	1.053	1.073	1.085	0.740	1.371	0.916	1.306
9	0.816	0.478	0.911	0.370	0.675	0.750	1.133
10	0.955	0.587	0.418	0.011	0.433	0.594	0.941
11	0.449	0.607	0.040	0.031	0.545	0.805	1.202
12	0.403	0.148	0.118	0.049	1.661	0.167	0.176
13	0.381	0.556	0.082	0.162	0.709	0.570	0.345
14	1.164	0.296	0.304	0.092	2.620	1.028	0.843

Table 5. Fishing mortality and partial recruitment estimates by gear from a cohort at F_t=0.35.

FISHING MORTALITY

	AGE	1977	1978	1979	1980	1981	1982	1983
TRAP	3	0.002	0.002	0.002	0.003	0.004	0.001	0.002
	4	0.127	0.028	0.037	0.042	0.020	0.025	0.022
	5	0.137	0.046	0.046	0.052	0.014	0.031	0.033
	6	0.107	0.017	0.007	0.017	0.007	0.012	0.022
	7	0.016	0.007	0.002	0.007	0.003	0.008	0.016
	8	0.007	0.004	0.002	0.002	0.003	0.004	0.007
	9	0.000	0.000	0.000	0.000	0.001	0.003	0.007
	10	0.000	0.000	0.000	0.000	0.002	0.002	0.003
	11	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	12	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	14	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GILL NET	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	4	0.000	0.001	0.000	0.000	0.000	0.002	0.001
	5	0.023	0.007	0.007	0.012	0.012	0.019	0.011
	6	0.134	0.032	0.048	0.046	0.037	0.058	0.050
	7	0.085	0.078	0.105	0.086	0.073	0.118	0.092
	8	0.083	0.087	0.080	0.101	0.104	0.147	0.075
	9	0.058	0.078	0.074	0.082	0.128	0.128	0.091
	10	0.058	0.116	0.039	0.090	0.115	0.120	0.104
	11	0.020	0.119	0.059	0.086	0.114	0.103	0.097
	12	0.035	0.032	0.015	0.116	0.067	0.056	0.114
	13	0.088	0.046	0.012	0.195	0.128	0.030	0.080
	14	0.000	0.096	0.043	0.150	0.052	0.027	0.078
LINE TRAWL	3	0.006	0.003	0.001	0.002	0.005	0.001	0.004
	4	0.039	0.033	0.023	0.022	0.053	0.020	0.021
	5	0.117	0.096	0.092	0.106	0.174	0.073	0.060
	6	0.089	0.145	0.150	0.190	0.240	0.099	0.090
	7	0.157	0.200	0.215	0.239	0.261	0.165	0.119
	8	0.162	0.223	0.238	0.293	0.265	0.174	0.125
	9	0.219	0.247	0.202	0.241	0.243	0.158	0.115
	10	0.250	0.316	0.134	0.212	0.207	0.176	0.121
	11	0.189	0.340	0.188	0.146	0.176	0.134	0.121
	12	0.340	0.153	0.274	0.260	0.100	0.132	0.147
	13	0.440	0.299	0.116	0.334	0.112	0.050	0.191
	14	0.269	0.384	0.387	0.320	0.052	0.081	0.194
HAND LINE	3	0.001	0.002	0.002	0.001	0.002	0.000	0.000
	4	0.027	0.013	0.014	0.018	0.011	0.010	0.003
	5	0.045	0.039	0.045	0.045	0.016	0.023	0.019
	6	0.035	0.054	0.034	0.031	0.013	0.016	0.023
	7	0.036	0.065	0.028	0.019	0.009	0.016	0.022
	8	0.036	0.056	0.024	0.010	0.011	0.014	0.012
	9	0.046	0.012	0.016	0.005	0.008	0.013	0.015
	10	0.054	0.020	0.006	0.000	0.009	0.009	0.009
	11	0.041	0.040	0.011	0.000	0.000	0.009	0.007
	12	0.082	0.000	0.000	0.000	0.000	0.000	0.008
	13	0.110	0.000	0.000	0.000	0.000	0.000	0.000
	14	0.034	0.000	0.000	0.000	0.000	0.000	0.000
OTTER TRAWL	3	0.004	0.000	0.002	0.002	0.000	0.000	0.000
	4	0.054	0.006	0.013	0.019	0.000	0.002	0.001
	5	0.101	0.048	0.075	0.062	0.004	0.014	0.009
	6	0.087	0.173	0.138	0.104	0.024	0.035	0.014
	7	0.059	0.169	0.149	0.315	0.023	0.060	0.032
	8	0.054	0.198	0.179	0.185	0.050	0.051	0.060
	9	0.046	0.065	0.154	0.094	0.025	0.041	0.052
	10	0.054	0.093	0.045	0.003	0.016	0.033	0.043
	11	0.026	0.095	0.005	0.004	0.021	0.045	0.055
	12	0.023	0.024	0.015	0.009	0.027	0.009	0.008
	13	0.022	0.092	0.012	0.028	0.016	0.010	0.016
	14	0.067	0.048	0.043	0.019	0.052	0.027	0.039

PARTIAL RECRUITMENT

	AGE	1977	1978	1979	1980	1981	1982	1983
TRAP	3	0.013	0.036	0.047	0.066	0.277	0.031	0.053
	4	0.926	0.598	0.804	0.810	1.464	0.782	0.670
	5	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	6	0.785	0.363	0.155	0.330	0.498	0.370	0.665
	7	0.115	0.146	0.047	0.143	0.255	0.243	0.477
	8	0.054	0.085	0.040	0.040	0.227	0.120	0.208
	9	0.000	0.000	0.000	0.000	0.065	0.089	0.229
	10	0.000	0.000	0.000	0.000	0.170	0.058	0.081
	11	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	12	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	14	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GILL NET	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	4	0.004	0.007	0.007	0.003	0.004	0.013	0.008
	5	0.342	0.079	0.105	0.130	0.104	0.145	0.123
	6	2.011	0.339	0.745	0.505	0.324	0.443	0.560
	7	1.278	0.831	1.623	0.941	0.630	0.894	1.020
	8	1.255	0.925	1.244	1.110	0.895	1.116	0.837
	9	0.876	0.834	1.151	0.901	1.109	0.972	1.009
	10	0.869	1.241	0.605	0.989	0.996	0.913	1.154
	11	0.308	1.267	0.911	0.942	0.986	0.782	1.077
	12	0.530	0.343	0.236	1.276	0.577	0.429	1.265
	13	1.324	0.492	0.180	2.132	1.106	0.227	0.883
	14	0.000	1.026	0.665	1.648	0.447	0.205	0.863
LINE TRAWL	3	0.036	0.013	0.006	0.006	0.018	0.003	0.030
	4	0.238	0.149	0.097	0.076	0.199	0.116	0.168
	5	0.721	0.428	0.388	0.360	0.656	0.419	0.475
	6	0.548	0.650	0.632	0.647	0.907	0.572	0.720
	7	0.966	0.894	0.903	0.816	0.986	0.951	0.949
	8	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	9	1.353	1.107	0.852	0.820	0.918	0.909	0.914
	10	1.544	1.417	0.564	0.724	0.782	1.015	0.966
	11	1.167	1.521	0.789	0.498	0.665	0.772	0.967
	12	2.099	0.683	1.154	0.885	0.378	0.757	1.169
	13	2.712	1.339	0.489	1.137	0.422	0.286	1.523
	14	1.660	1.719	1.628	1.089	0.195	0.466	1.551
HAND LINE	3	0.037	0.036	0.041	0.027	0.106	0.002	0.000
	4	0.670	0.279	0.346	0.479	0.764	0.494	0.155
	5	1.128	0.844	1.132	1.186	1.109	1.189	0.908
	6	0.872	1.156	0.868	0.814	0.891	0.811	1.092
	7	0.901	1.402	0.714	0.497	0.605	0.811	1.046
	8	0.904	1.203	0.601	0.251	0.781	0.694	0.581
	9	1.158	0.250	0.410	0.127	0.553	0.676	0.724
	10	1.350	0.438	0.141	0.000	0.640	0.461	0.437
	11	1.024	0.851	0.271	0.000	0.000	0.453	0.329
	12	2.056	0.000	0.000	0.000	0.000	0.000	0.386
	13	2.752	0.000	0.000	0.000	0.000	0.000	0.000
	14	0.842	0.000	0.000	0.000	0.000	0.000	0.000
OTTER TRAWL	3	0.072	0.000	0.011	0.007	0.002	0.000	0.002
	4	0.954	0.032	0.080	0.076	0.011	0.038	0.016
	5	1.788	0.261	0.457	0.247	0.111	0.244	0.205
	6	1.547	0.943	0.842	0.416	0.646	0.640	0.297
	7	1.047	0.920	0.907	1.258	0.630	1.086	0.694
	8	0.953	1.080	1.093	0.742	1.370	0.914	1.306
	9	0.820	0.353	0.938	0.377	0.673	0.750	1.133
	10	0.956	0.506	0.273	0.012	0.438	0.592	0.941
	11	0.453	0.517	0.033	0.017	0.563	0.809	1.202
	12	0.416	0.131	0.093	0.036	0.725	0.170	0.176
	13	0.390	0.501	0.071	0.111	0.434	0.180	0.345
	14	1.193	0.261	0.262	0.075	1.404	0.488	0.843

Table 6. Average partial selection for each year based on partial fishing mortalities from cohort analyses with fully recruited fishing mortality of 0.15, 0.25, and 0.35 in 1983.

	Trap (1977-80)			Gill net (1978-81)			Line trawl (1977-80)			Hand line (1978-81)			Otter trawl (1978-81)		
Age	0.15	0.25	0.35	0.15	0.25	0.35	0.15	0.25	0.35	0.15	0.25	0.35	0.15	0.25	0.35
3	.03	.04	.04	0	0	0	.013	.013	.015	.04	.04	.05	.004	.005	.005
4	.73	.76	.78	.005	.005	.005	.13	.13	.14	.39	.42	.44	.04	.05	.05
5	1.00	1.00	1.00	.10	.10	.10	.46	.44	.47	1.00	1.00	1.00	.26	.26	.27
6	.41	.41	.41	.48	.45	.49	.62	.60	.62	.92	.89	.87	.72	.71	.71
7	.12	.11	.11	1.01	.95	1.01	.89	.86	.89	.80	.77	.75	.94	.93	.93
8	.06	.06	.05	1.03	.99	1.04	.100	1.00	1.00	.69	.67	.66	1.06	1.07	1.07
9	0	0	0	.99	1.00	1.00	1.06	1.10	1.03	.34	.34	.31	.58	.61	.59
10	0	0	0	.98	1.01	.96	1.14	1.15	1.06	.32	.33	.29	.34	.36	.31
11	0	0	0	1.16	1.24	1.03	1.14	1.18	.99	.31	.31	.26	.29	.31	.28
12	0	0	0	.82	.92	.61	1.37	1.32	1.21	0	0	0	.35	.49	.25
13	0	0	0	1.33	1.41	.98	1.60	1.53	1.42	0	0	0	.37	.38	.28
14	0	0	0	1.20	1.15	.95	1.77	1.67	1.52	0	0	0	.71	.83	.50

Table 7. Rounded average partial selections for each gear and the calculated partial selection for the fishery in 1983.

Trap	Gill net	Line trawl	Hand line	Otter trawl	1983
0.050	0.000	0.015	0.050	0.005	0.023
0.750	0.005	0.130	0.400	0.050	0.252
1.000	0.100	0.450	1.000	0.250	0.601
0.400	0.450	0.600	0.900	0.700	0.743
0.100	0.950	0.850	0.750	1.000	1.000
0.050	1.000	1.000	0.650	1.000	1.079
0.000	1.000	1.000	0.350	0.600	0.971
0.000	1.000	1.000	0.350	0.500	1.684
0.000	1.000	1.000	0.300	0.500	1.679
0.000	1.000	1.000	0.300	0.500	1.679
0.000	1.000	1.000	0.300	0.500	1.679
0.000	1.000	1.000	0.300	0.500	1.679