International Commission for the Northwest Atlantic Fisheries

ANNUAL MEETING - JUNE 1979

Assessment of the Redfish (*Sebastes marinus*) Stock at West Greenland (ICNAF Subarea 1)[1]

by

A. Schumacher
Bundesforschungsanstalt für Fischerei
Hamburg, Federal Republic of Germany

1. **Biological Information**

   Two species of redfish occur in West Greenland waters in exploitable
   quantities, *Sebastes mentella* (Travin) and *Sebastes marinus* (L.). However,
   the commercial fishery has, to the present time, been concentrated on *S.
   marinus* due to the fact that this species is of higher value on the market.
   Although the areal distribution of the two species is almost identical, the
   fishery can be directed to only one species, since the distribution according
   to depth is clearly distinct. *S. marinus* lives in a depth zone from 150 to
   about 300 m, whereas *S. mentella* is found at greater depths.

   The redfish population at West Greenland cannot be considered as a stock
   in the sense that larvae produced by the spawning stock are recruiting as
   young fish to the same stock. In fact, only little spawning (extrusion of
   larvae) and very few small larvae have been observed in West Greenland
   waters. The main component of the larval and 0-group supply to the West
   Greenland population arrives in that area from the main redfish spawning
   areas in the Irminger Sea by drift with the Irminger Current.

   The distribution of the population according to size is not uniform, young
   redfish being more concentrated in the northern part and the older fish in
   the more southern divisions of Subarea 1, as a result of a southward migration
   which may continue around Cape Farewell to East Greenland as shown by Danish
   tagging experiments. It is, however, difficult to evaluate the tagging
   results in quantitative terms for assessment purposes. Therefore, in the
   present assessment the likely emigration to East Greenland has not been
   considered.

2. **Fishery Trends**

   Exploitation of the redfish population at West Greenland began in the mid-
   1950's by vessels from Iceland and the Federal Republic of Germany. A
   maximum catch of 60,352 tons was taken in 1962. Subsequently, catches
   decreased continuously to about 2,800 tons in 1971 and increased again to
   31,000 tons reported for 1977 (Table 1, Fig. 1). Up to 1973, German (F.R.)
   vessels took the main part of the total catch (82% of the average for 1962-
   73). Up to 1967, the fishery was distributed more or less evenly over
   ICNAF Div. 1C to 1F, with a smaller proportion in Div. 1B. In the period
   1970 to 1974, the fishery was concentrated i n the southern divisions (1E
   and 1F) but it changed back in 1975 to a pattern similar to that of the
   previous period (Table 2).

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[1] The Appendix to this paper was added after discussion at the April 1979 Meeting of the Assessments
Subcommittee.

[2] The term "redfish" in this paper refers to *S. marinus*.

Fishing effort followed the trend of the catches and catch per unit effort followed a slight downward trend over the period 1962 to 1976 with large fluctuations (Table 3, Fig. 1).

The fishery was in part directed towards redfish concentrations and, in part, a mixed fishery for cod and redfish. Also, at least in the German (F.R.) fishery, the by-catch of redfish in the directed fishery for cod was retained on board of the vessels. However, the by-catch of redfish in the cod fishery of other countries was likely to have been discarded, but the amount cannot be quantified at present. The by-catch of redfish in the newly-developed shrimp fishery is high enough to have a very significant effect on redfish abundance (ICNAF *Redbook* 1978, page 13). Since the by-catch in the shrimp fishery consists mainly of small redfish below marketable size, the quantities discarded do not affect the present assessment, but it will, however, affect recruitment to the redfish fishery in future years.

3. Assessments

    (a) Basic material

        i)   Fishing effort. Data used in the calculation of total effort in the redfish fishery were derived from the ICNAF *Statistical Bulletin*. The effort was calculated in fishing days of German (F.R.) trawlers of tonnage class 5 (500-999 GRT). This category was selected because vessels of this size participated in the directed redfish fishery from its beginning in the mid-1950's to the present. To estimate the catch per unit effort (CPUE) of this vessel category per month and division, only those entries were used in which the proportion of redfish of the total catch was highest. On this basis, total international effort was estimated for each month by division and summed up to the annual total effort (Table 3). In the years 1977 and 1978, total effort was derived from a regression of days fished on total catch (Fig. 2).

        ii) Length composition. Data from redfish landings on the German (F.R.) market and from catches measured on board of commercial vessels at sea were available, covering almost the entire period from 1962 to 1978, except for the years 1970 and 1974. The length composition of the total international catch in numbers per cm-group was calculated, considering the distribution of the catch by division and season. For the years 1970 and 1974, a length composition was constructed using the length data from the second half of the preceding year and the first half of the following year to be applied to the catch of the first half and the second half of the year in question, respectively.

        iii) Age composition. An age-length key for West Greenland was available only for 1975, but keys were available for East Greenland for the years 1975, 1977, and 1978. Since the mean length per age in 1975 for East Greenland and West Greenland was almost identical, the four age-length keys were combined to form a standard age-length key. This procedure implies that there was no change in growth during the whole period under consideration. In view of the slow growth of redfish, this assumption seems to be justified. The total catch in numbers per cm-group was then converted to numbers per age-group (Table 4).

        iv) Mean weight per age-group. Only limited data on weight per age were available. A preliminary VPA (virtual population analysis) using these data showed that in years when younger fish were dominant in the catches the sum of products (catch in number x $\overline{W}$) was considerably higher than the reported catch, whereas in years when older fish were dominant the sum of products was lower than the reported catch. A second run using weight at age data for the Irminger Sea stock complex (from the ICES Working Group on Redfish) gave satisfactory results. The mean deviation of the sum of products

from the reported catch was 0.14% (standard deviation 6.24) range
from 9.1%-13.0%, a systematic bias could not be detected and, there-
fore, these data were used in the further analysis (Table 7).

(b) Parameters used

i) Natural mortality (M). No attempt has been made to estimate M from
the data available for West Greenland redfish since the basic
requirement of such an estimate that there was no substantial
change in the fishing pattern is not met. The value of M = 0.1
used in the present assessment was taken from the ICES Working
Group on Redfish and was based on an estimate for S. mentella and
and on estimates for S. marinus found in the literature (Mayo and
Miller, 1977; Sandeman, 1973).

ii) Initial fishing mortality for the oldest age-group. Cohort analysis
based on average length composition data for three groups of years
was carried out to estimate F for the cm-groups which represent the
fish of age 30 and older. The average F's for the largest fish
were 0.29, 0.29, and 0.32 and, consequently, an F of 0.3 was taken
as the starting value.

iii) Exploitation pattern (partial recruitment). Average fishing
mortalities for each cm-group for the period 1975-78 were obtained
from the cohort analysis on length data, and by using the age-length
key average F's for each age-group were estimated, which served as
the basis for the construction of a preliminary array of propor-
tional F's to be applied to the average F in 1978. The final
array of proportional F's was derived from a computer run using
the preliminary array by averaging the F's for each age-group
over the years 1962 to 1975 (Table 7).

iv) Fishing mortality in 1978. The parameters estimated so far were
used to run several VPA's with different starting F's for 1978.
The weighted average F's for the years 1962 to 1974 which were
almost identical in all runs were plotted against the fishing
effort in the respective years and a linear regression was calcu-
lated. The average F of the run in which the sum of the differences
between the values of the weighted average F for the years 1975 to
1978. and the corresponding point on the regression line was mini-
mized was taken as starting F (0.35) for 1978 (Fig. 3).

4. Results of VPA

(a) Stock size (Table 5, Fig. 1)

The size of the recruited stock, both in terms of numbers and weight,
decreased sharply during the period 1962 to 1968 from 222,000 tons to
62,000 tons at the beginning of 1969, representing only 28% of the
previous level. This decline is due to the high level of exploitation
and due to five recruiting year-classes well below the 1962-1975 average.
As a result of reduced exploitation in the period 1969 to 1975 and an
increasing trend in recruitment, the size of the stock increased slowly
to 110,000 tons by 1978, but is still about 50% below the 1962 level.

The proportion of redfish age 19 and older in the stock generally shows
a declining trend since 1966 as a result of concentration of the fishery
in the southern part of Subarea 1, where larger fish are predominant
(Fig. 4), and as a result of the increasing trend in recruitment. The
decline from 1976 to 1978 is influenced by the high recruitment figures
from the VPA's and might, therefore, be less than indicated in Fig. 4A.

(b) Fishing mortality

Following the trend in fishing effort, fishing mortality (weighted
average) decreased from the 1962-1964 level of about 0.3 to 0.06 by
1969 and remained at that low level up to 1975. Due to increasing
effort and higher catches, F increased again approaching the previous
high level of 1977.

5.   Catch Projection for 1979 and 1980

The basic data and parameters used to calculate catches for 1979 and 1980
and the resulting stock biomass for 1980 and 1981 are given in Table 7.
The results for the 1979 fishery are given in Fig. 5A and for the fishery
in 1980 in Fig. 6A and 7A. Depending on the management objective, all
options can be evaluated on the basis of the graphs.

Since the possibility cannot be excluded that recruitment in 1978 might
be overestimated in the VPA, an alternative catch projection was calculated
assuming recruitment in 1978 to be 20 million fish corresponding to the
average over the years 1973 to 1975. Information derived from this alter-
native assessment is given in square brackets [] in the following section
and in Fig. 5B, 6B, and 7B.

6.   Management Options

Since the redfish population at West Greenland is not a self-sustaining
stock, it would not be very meaningful to consider the maintenance of a
certain spawning stock level as the main management objective. Therefore,
consideration should be given to the best possible use of the growth
potential of redfish and to the maintenance of a fishable biomass which can
support a viable fishery in the long term. Since the yield-per-recruit
curve (Fig. 8) calculated on the basis of the parameters given in Table 7
has no well defined maximum, the best use of the growth potential would be
obtained by fishing at that level of F at which the yield-per-recruit curve
starts to level off, i.e., a level around $F = 0.25$. This approach would
result in a catch of 7,000 [6,500] tons in 1979 and, if this approach is
to be continued, a catch of 8,000 [6,500] tons in 1980. The resulting
recruited biomass would then remain stable at the 1978 level, i.e., about
110,000 [85,000] tons.

Fishing at the level of $F_{0.1} = 0.13$ would allow a catch of 4,000 [3,500] tons
in 1979 and of approximately 4,500 [4,000] tons in 1980. Under this option,
the recruited biomass is expected to increase by the beginning of 1981 by
about 7% [10%] compared to 1978.

Maintaining the 1978 level of exploitation ($F = 0.35$) into 1979 and 1980
would give a catch of 9,500 [8,500] and 10,000 [8,500] tons, respectively.
The biomass would be reduced by about 3% [2%] below the 1978 level.

7.   Concluding Remarks

In this paper, a first attempt has been made to work out an analytical
assessment for the redfish stock at West Greenland. There are several
weaknesses in this paper due to the limited data on which the assessment
has to be based and to which reference has been made in the description
of the material used. Therefore, one cannot expect that the results have
the same degree of precision as compared to assessments based on more
sufficient data. However, the results indicate the order of magnitude
of stock biomasses and total allowable catches to be expected in the near
future.

Table 1. Redfish (*Sebastes marinus*) at West Greenland: Nominal catches (metric tons) by country, 1962-78.

	DENMARK FAROER	GREEN	FRANCE	GDR	GERMANY F.R.	ICEL.	NORW.	POL.	PORT.	USSR	U.K.	USA	TOTAL
1962	204	134	-	-	54972	4495	-	164	-	-	383	-	60352
1963	211	168	-	-	42804	2226	-	60	-	868	320	-	46657
1964	12	222	-	2835	24346	1956	116	3	-	-	521	-	30011
1965	60	265	-	1224	15821	1254	56	3	-	130	239	-	19052
1966	47	291	-	753	14450	969	25	46	-	-	177	-	16758
1967	-	174	2	1221	11288	176	10	6	-	260	73	-	13210
1968	-	136	3	469	8782	-	35	68	-	90	23	-	9606
1969	-	138	6	573	3962	-	103	5	-	33	-	5	4825
1970	65	171	-	1415	3592	-	-	-	-	231	42	-	5516
1971	114	324	-	116	2023	-	56	-	-	13	110	-	2756
1972	18	244	-	20	2614	-	47	-	-	24	21	-	2988
1973	8	1112	-	6	2078	-	56	-	-	43	16	-	3319
1974	-	2405	-	4	568	-	81	-	-	192	74	-	3324
1975	-	1406	-	-	3120	-	45	-	33	3982	43	-	8629
1976	-	2696	-	-	5074	-	38	-	62	5825	3	-	13698
1977	-	1077	-	-	29569	-	44	-	-	390	-	-	31080
1978*	-	-	-	-	(7000)	-	-	-	-	-	-	-	(10000)

* Estimated

Table 2. Redfish (*Sebastes marinus*) at West Greenland: Nominal catches (metric tons) and % distribution by Division, 1962-77.

	DIV. 1A tons	%	DIV. 1B tons	%	DIV. 1C tons	%	DIV. 1D tons	%	DIV. 1E tons	%	DIV. 1F tons	%
1962	82	0.1	2259	3.8	12248	20.4	15850	26.4	20490	34.0	9219	15.3
1963	-	-	2770	6.0	8323	17.9	12561	27.0	15389	33.2	7403	15.9
1964	10	20.1	3370	12.4	5466	20.2	7083	26.2	6657	24.6	4500	16.6
1965	-	-	1310	7.4	2778	15.7	3851	21.7	4604	26.0	5185	29.2
1966	-	-	281	1.7	3158	18.9	3819	22.9	3137	18.8	6316	37.8
1967	-	-	346	2.7	1588	12.3	5384	41.6	2699	20.9	2923	22.6
1968	-	-	3	<0.1	1641	17.1	2204	23.0	2011	21.0	3712	38.8
1969	5	0.1	2	<0.1	724	15.6	1295	27.9	1056	22.8	1553	33.6
1970	-	-	-	-	363	6.8	832	15.6	1826	34.3	2298	43.2
1971	-	-	-	-	141	6.0	223	9.4	317	13.4	1687	71.2
1972	-	-	-	-	99	3.6	223	8.0	1610	57.9	848	30.5
1973	-	-	15	0.5	315	9.5	611	18.5	1385	41.9	977	29.6
1974	-	-	78	2.3	511	15.4	791	23.8	1283	38.6	661	19.9
1975	-	-	3609	41.8	637	7.4	787	9.1	1613	18.7	1981	23.0
1976	-	-	2873	21.0	443	3.2	1706	12.5	3488	25.5	5188	37.9
1977	3	<0.1	5	<0.1	1835	5.9	11119	35.8	3868	12.4	14250	45.8

Table 3. Redfish (*Sebastes marinus*) at West Greenland:
         Fishing effort (tons per day) of German (F.R.)
         vessels (500-999 GRT) and catch per unit
         effort, 1962-78.

YEAR	DAYS FISHED	t/DAY
1962	2291	26.3
1963	1587	29.4
1964	1326	22.6
1965	830	23.0
1966	841	19.9
1967	638	20.7
1968	522	18.4
1969	202	23.9
1970	314	17.6
1971	124	22.2
1972	269	11.1
1973	187	17.7
1974	222	15.0
1975	607	14.2
1976	675	20.3
1977	(1265)[1]	(24.6)
1978	(498)[1]	(20.1)

[1] Estimated from Regression (Fig. 2)

Table 4. Redfish (*Sebastes marinus*) at West Greenland: Catch in numbers (10^{-3}) by age group, 1962-78.

AGE (YEARS)	1962	1963	1964	1965	1966	1967	1968	1969
12	772	848	413	317	105	200	262	9
13	1 319	1 264	815	681	232	320	326	31
14	2 584	2 486	1 837	1 595	508	613	547	75
15	2 936	3 046	2 506	1 885	608	703	531	95
16	3 732	4 018	3 304	2 339	796	945	611	146
17	2 808	2 926	2 384	1 556	605	856	494	124
18	4 461	4 606	3 506	2 296	1 001	1 569	793	238
19	4 457	4.316	3 145	2 050	981	1 528	763	261
20	2 666	2 434	1 620	965	564	857	450	179
21	5 530	4 383	2 803	1 722	1 128	1 627	873	387
22	5 428	3.627	2 163	1 383	1.083	1 253	843	433
23	4 400	2 642	1 615	956	940	873	651	392
24	4 691	2.460	1 672	798	1.312	764	684	549
25	1 594	834	595	246	531	253	241	229
26	1 349	793	286	97	555	117	142	178
27	238	160	59	8	95	29	39	34
28	396	278	81	39	169	35	52	37
29	60	46	1	4	35	7	7	5
30+	41	33	1	5	14	9	6	5
Total	49 462	41 200	28 806	18 942	11 262	12 558	8 315	3 407

AGE (YEARS)	1970	1971	1972	1973	1974	1975	1976	1977	1978
12	4	1	28	286	189	244	811	2 164	954
13	27	1	47	271	198	322	942	2 428	831
14	75	5	80	368	284	526	1 401	3 456	946
15	90	8	84	326	283	636	1 376	3 033	792
16	137	17	103	328	321	818	1 616	3 200	768
17	125	28	87	211	244	717	1 086	1 743	448
18	281	99	148	267	346	1 099	1 642	2 204	648
19	326	134	149	217	306	1 026	1 478	1 830	614
20	251	112	94	107	164	569	809	881	360
21	572	300	198	168	265	933	1 268	1 230	713
22	683	368	210	143	198	647	876	664	594
23	592	322	195	112	.146	464	569	407	455
24	642	384	337	152	137	309	452	297	530
25	211	118	170	74	51	77	.158	93	219
26	120	58	165	87	49	20	72	728	124
27	19	11	45	25	12	1	5	258	39
28	6	7	55	38	20	1	7	769	32
29	3	2	2	9	6	1	1	392	1
30+	1	1	1	6	3	1	1	525	1
Total	4 165	1 976	2 198	3 195	3 222	8 411	14 570	26 302	9 069

Table 5. Redfish (*Sebastes marinus*) at West Greenland: Stock in numbers (10^{-3}), 1962-78.

AGE (YEARS)	1962	1963	1964	1965	1966	1967	1968	1969
12	17 334	14 941	10 208	10 395	12 073	12 256	13 704	14 819
13	23 418	14 951	12 713	8 844	9 105	10 824	10 900	12 151
14	24 182	19 936	12 327	10 729	7 356	8 018	9 490	9 553
15	25 967	19 426	15 678	9 410	8 193	6 173	6 672	8 067
16	23 241	20 707	14 686	11 807	6 726	6 836	4 918	5 533
17	20 904	17 486	14 923	10 154	8 463	5 330	5 288	3 869
18	19 668	16 248	13 044	11 240	7 710	7 083	4 010	4 316
19	16 733	13 564	10 335	8 478	7 991	6 026	4 921	2 876
20	14 814	10 915	8 184	6 371	5 727	6 299	4 003	3 728
21	14 350	10 874	7 567	5 867	4 848	4 646	4 886	3 195
22	12 224	7 749	5 690	4 192	3 677	3 317	2 663	3 592
23	8 551	5 926	3 582	3 101	2 483	2 300	1 815	1 611
24	6 499	3 580	2 863	1 714	1 900	1 357	1 255	1 026
25	2 776	1 470	924	1 013	796	484	506	489
26	1 720	1 007	543	275	683	220	199	230
27	574	290	167	221	157	98	89	47
28	463	294	112	96	192	53	61	43
29	111	49	8	25	50	16	15	7
30+	55	44	1	7	19	12	8	7
Total	233 584	179 457	133 556	103 938	88 148	81 348	75 402	75 157

AGE (YEARS)	1970	1971	1972	1973	1974	1975	1976	1977	1978
12	15 969	15 864	15 834	17 781	19 548	22 159	(25 953)	(39 868)	*(67 327)*
13	13 400	14 446	14 353	14 300	15 817	17 508	19 818	*(22 712)*	*(34 017)*
14	10 965	12 099	13 070	12 943	12 682	14 124	15 536	17 037	18 245
15	8 572	9 850	10 943	11 750	11 361	11 205	12 280	12 726	12 136
16	7 209	7 671	8 905	9 822	10 322	10 011	9 534	9 804	8 638
17	4 867	6 393	6 925	7 960	8 576	9 035	8 281	7 093	5 839
18	3 383	4 285	5 758	6 183	7 002	7 528	7 494	6 462	4 765
19	3 679	2 794	3 783	5 069	5 341	6 007	5 768	5 223	3 759
20	2 354	3 019	2 401	3 282	4 380	4 542	4 461	3 817	2 992
21	3 203	1 892	2 625	2 083	2 868	3 808	3 569	3 269	2 618
22	2 523	2 355	1 427	2 187	1 725	2 343	2 560	2 029	1 793
23	2 839	1 635	1 782	1 092	1 843	1 373	1 507	1 487	1 206
24	1 086	2 007	1 174	1 427	881	1 529	803	825	959
25	410	377	1 452	743	1 147	667	1 090	300	465
26	226	171	229	1 152	602	989	531	837	183
27	41	91	100	52	960	498	876	412	77
28	10	19	72	48	23	857	450	788	129
29	5	4	11	14	8	3	775	400	4
30+	1	1	1	8	4	1	1	700	1
Total	80 744	84 975	90 846	97 896	105 090	114 186	121 286	135 787	165 155

Table 6. Redfish (*Sebastes marinus*) at West Greenland: Fishing mortality, 1962-78.

AGE (YEARS)	1962	1963	1964	1965	1966	1967	1968	1969
12	0.048	0.061	0.043	0.033	0.009	0.017	0.020	0.001
13	0.061	0.093	0.070	0.084	0.027	0.032	0.032	0.003
14	0.119	0.140	0.170	0.170	0.075	0.084	0.062	0.008
15	0.126	0.180	0.184	0.236	0.081	0.127	0.087	0.012
16	0.185	0.228	0.269	0.233	0.133	0.157	0.140	0.028
17	0.152	0.193	0.183	0.175	0.078	0.185	0.103	0.034
18	0.272	0.352	0.331	0.241	0.146	0.264	0.232	0.060
19	0.327	0.405	0.384	0.292	0.138	0.309	0.178	0.100
20	0.209	0.266	0.233	0.173	0.109	0.154	0.126	0.052
21	0.516	0.548	0.491	0.367	0.280	0.457	0.208	0.136
22	0.624	0.672	0.507	0.424	0.369	0.503	0.403	0.135
23	0.771	0.628	0.637	0.390	0.504	0.506	0.471	0.295
24	1.387	1.255	0.939	0.667	1.267	0.886	0.841	0.818
25	0.914	0.896	1.111	0.294	1.185	0.789	0.688	0.671
26	1.679	1.694	0.799	0.460	1.842	0.809	1.352	1.618
27	0.568	0.856	0.460	0.039	0.994	0.371	0.616	1.420
28	2.153	3.455	1.403	0.556	2.376	1.177	2.116	2.143
29	0.828	3.497	0.133	0.185	1.320	0.603	0.689	1.509
30+	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
W.MEAN F	0.288	0.305	0.273	0.219	0.173	0.192	0.135	0.058

AGE (YEARS)	1970	1971	1972	1973	1974	1975	1976	1977	1978
12	0.000	0.000	0.002	0.017	0.010	0.012	0.033	0.059	0.015
13	0.002	0.000	0.003	0.020	0.013	0.020	0.051	0.119	0.026
14	0.007	0.000	0.006	0.030	0.024	0.040	0.099	0.239	0.056
15	0.011	0.001	0.008	0.030	0.027	0.061	0.125	0.287	0.071
16	0.020	0.002	0.012	0.036	0.033	0.090	0.196	0.418	0.098
17	0.027	0.005	0.013	0.028	0.030	0.087	0.148	0.298	0.084
18	0.091	0.025	0.027	0.046	0.053	0.166	0.261	0.442	0.154
19	0.098	0.052	0.042	0.046	0.062	0.197	0.313	0.457	0.188
20	0.119	0.040	0.042	0.035	0.040	0.141	0.211	0.277	0.135
21	0.207	0.182	0.083	0.088	0.102	0.297	0.465	0.500	0.336
22	0.334	0.179	0.168	0.071	0.128	0.342	0.444	0.420	0.426
23	0.247	0.231	0.122	0.114	0.087	0.437	0.503	0.338	0.502
24	0.959	0.224	0.358	0.119	0.178	0.238	0.885	0.473	0.859
25	0.772	0.398	0.131	0.110	0.048	0.129	0.165	0.393	0.678
26	0.806	0.438	1.382	0.083	0.089	0.021	0.154	2.289	1.219
27	0.655	0.135	0.636	0.697	0.013	0.002	0.006	1.058	0.757
28	0.952	0.474	1.557	1.728	2.131	0.001	0.016	5.172	0.300
29	1.138	0.882	0.213	1.138	1.653	0.536	0.001	5.605	0.300
30+	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
W.MEAN F	0.065	0.027	0.029	0.036	0.033	0.084	0.143	0.277	0.065

Table 7. Redfish (*Sebastes marinus*) at West Greenland: Parameters used for catch prediction.

AGE	1978 STOCK	1978 CATCH NUMBERS x 10^{-3}	1979 STOCK	PROPORTION OF MEAN F	AVERAGE WEIGHT PER AGE GROUP (kg)
12	67327	954	(15200)	.041	.536
13	34017	831	(60013)	.074	.591
14	18245	946	29990	.160	.652
15	12136	792	15609	.202	.720
16	8638	768	10228	.281	.794
17	5839	448	7086	.241	.876
18	4765	648	4858	.441	.966
19	3759	614	3696	.537	1.066
20	2992	360	2818	.385	1.176
21	2618	713	2366	.959	1.297
22	1793	594	1693	1.216	1.431
23	1206	455	1060	1.435	1.579
24	959	530	661	2.455	1.742
25	465	219	368	1.937	1.924
26	183	124	213	3.483	2.120
27	77	39	49	2.162	2.339
28	129	32	33	. 86	2.580
29	4	1	87	. 86	2.846
30+	1	1	6	. 86	3.200
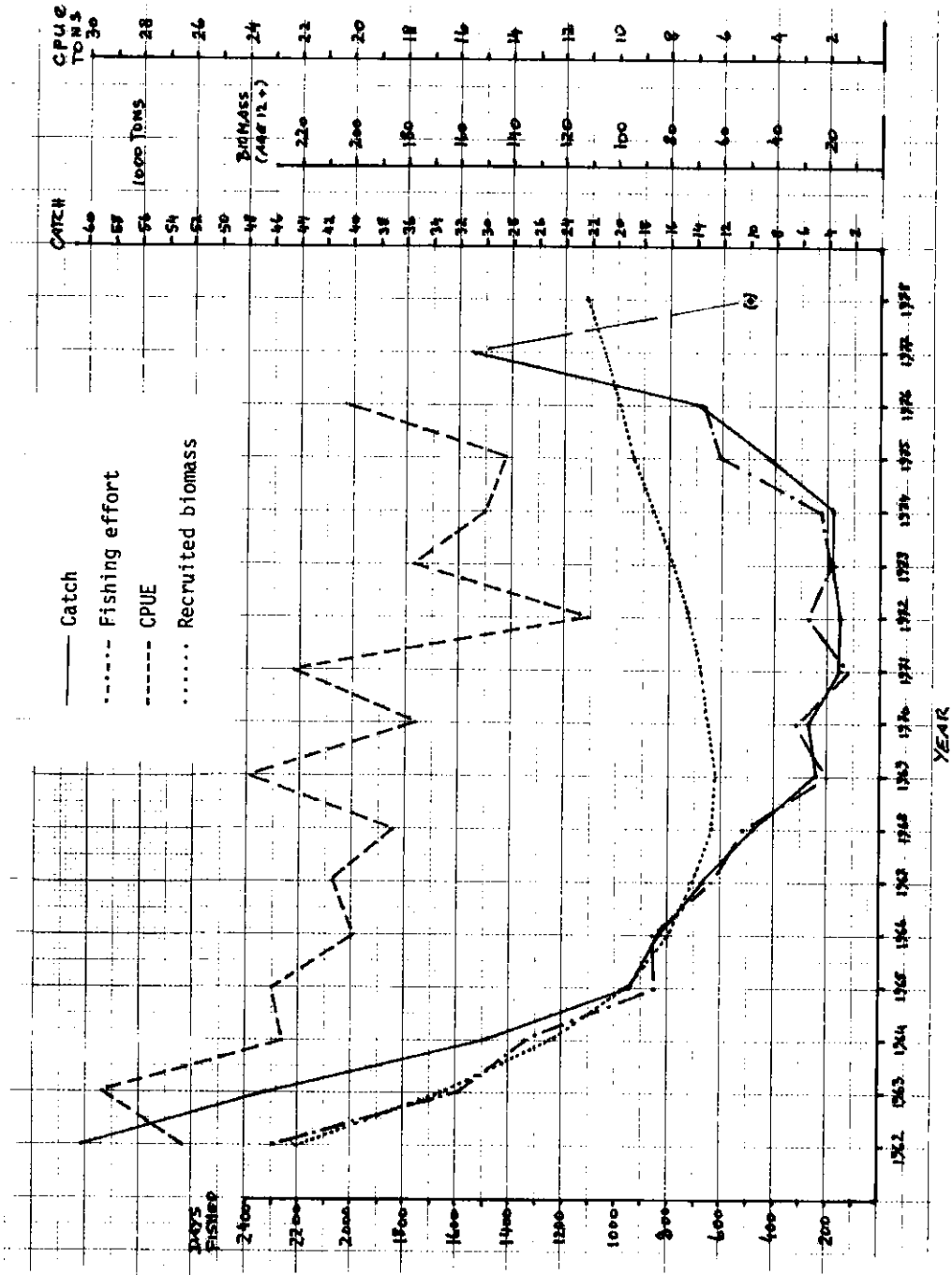
Fig. 1. Redfish at West Greenland: trends in catch, fishing effort, CPUE, and recruited biomass.
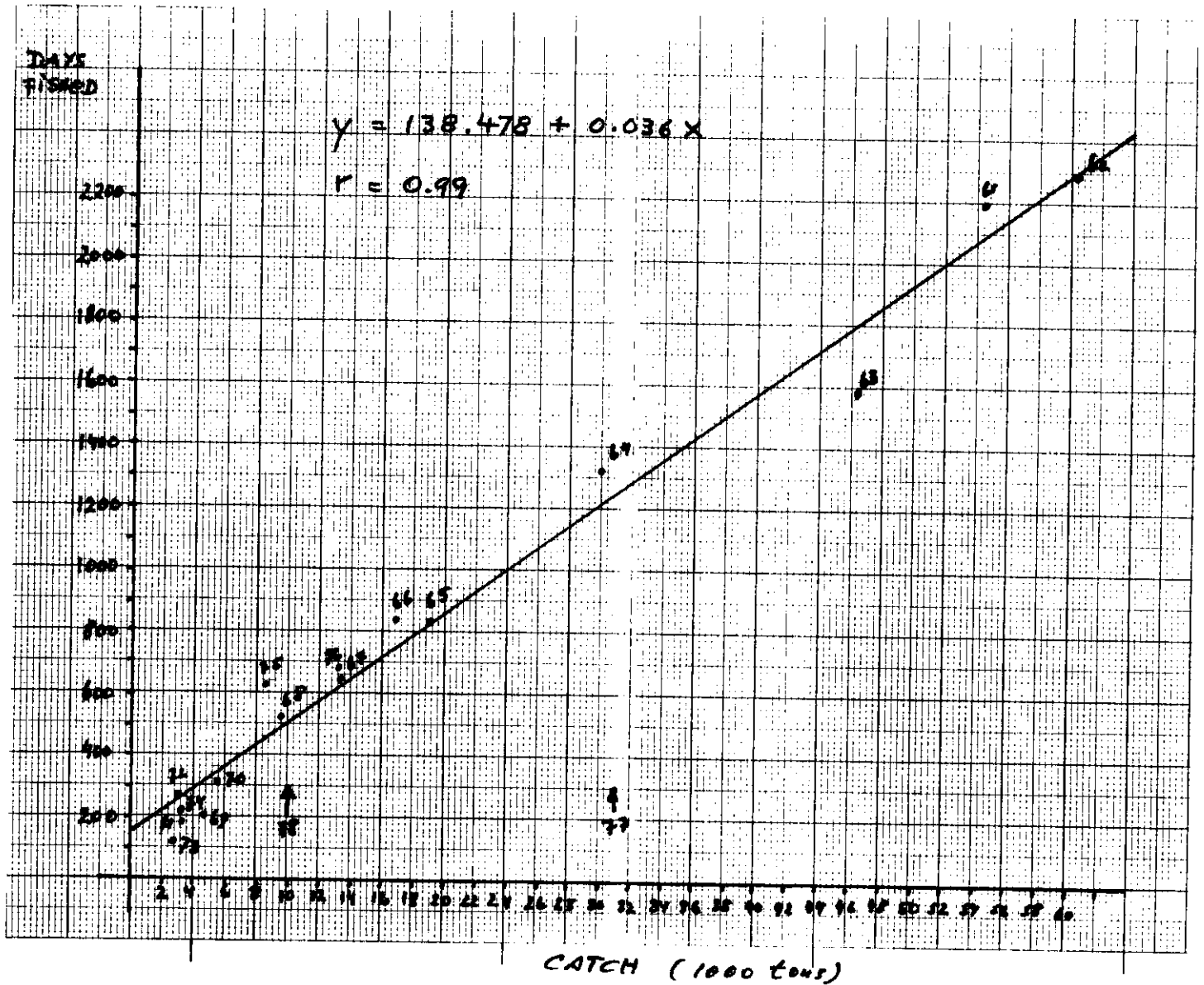
Fig. 2. Redfish at West Greenland: regression of fishing effort on catch.
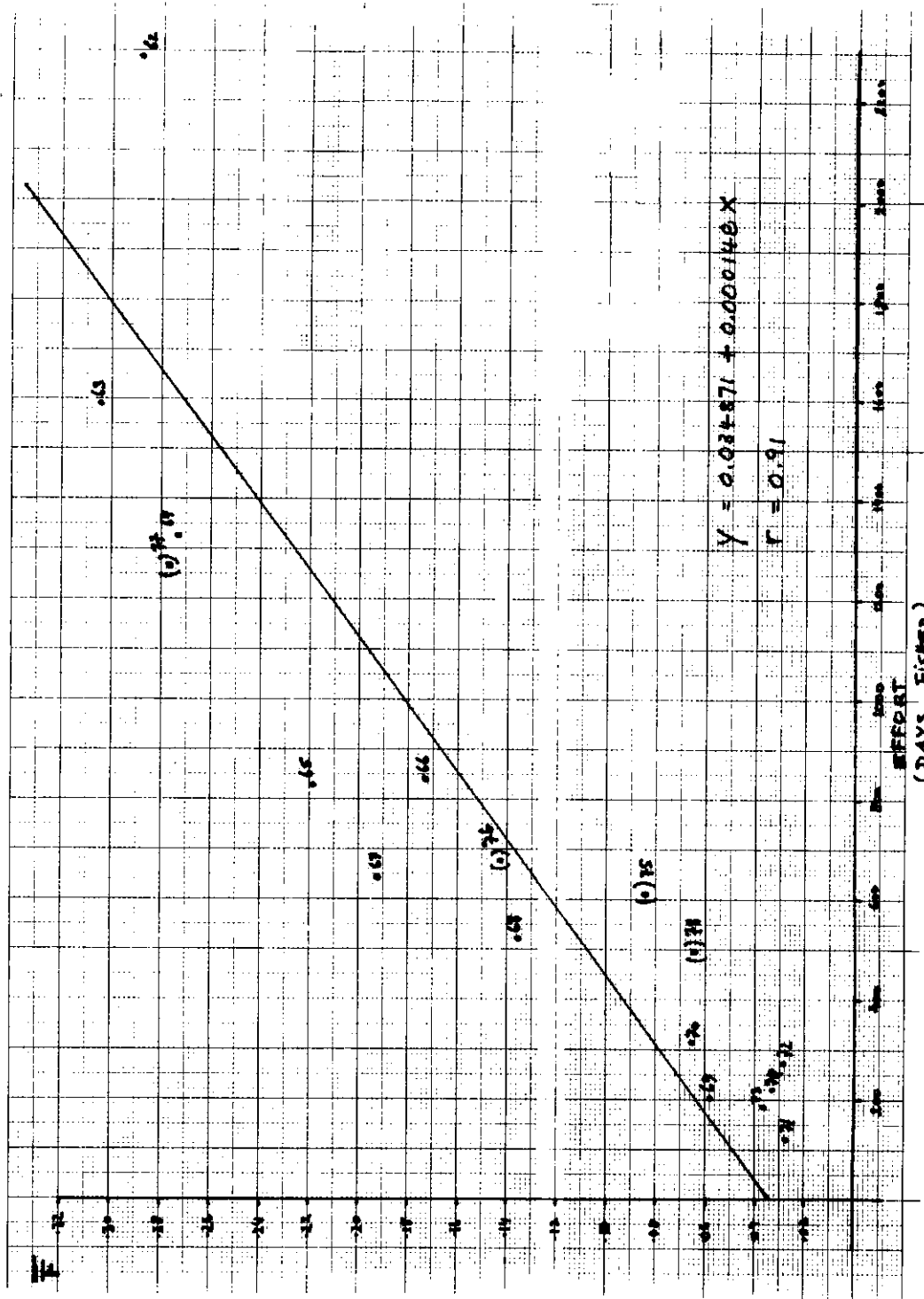
Fig. 3. Redfish at West Greenland: regression of F on fishing effort.
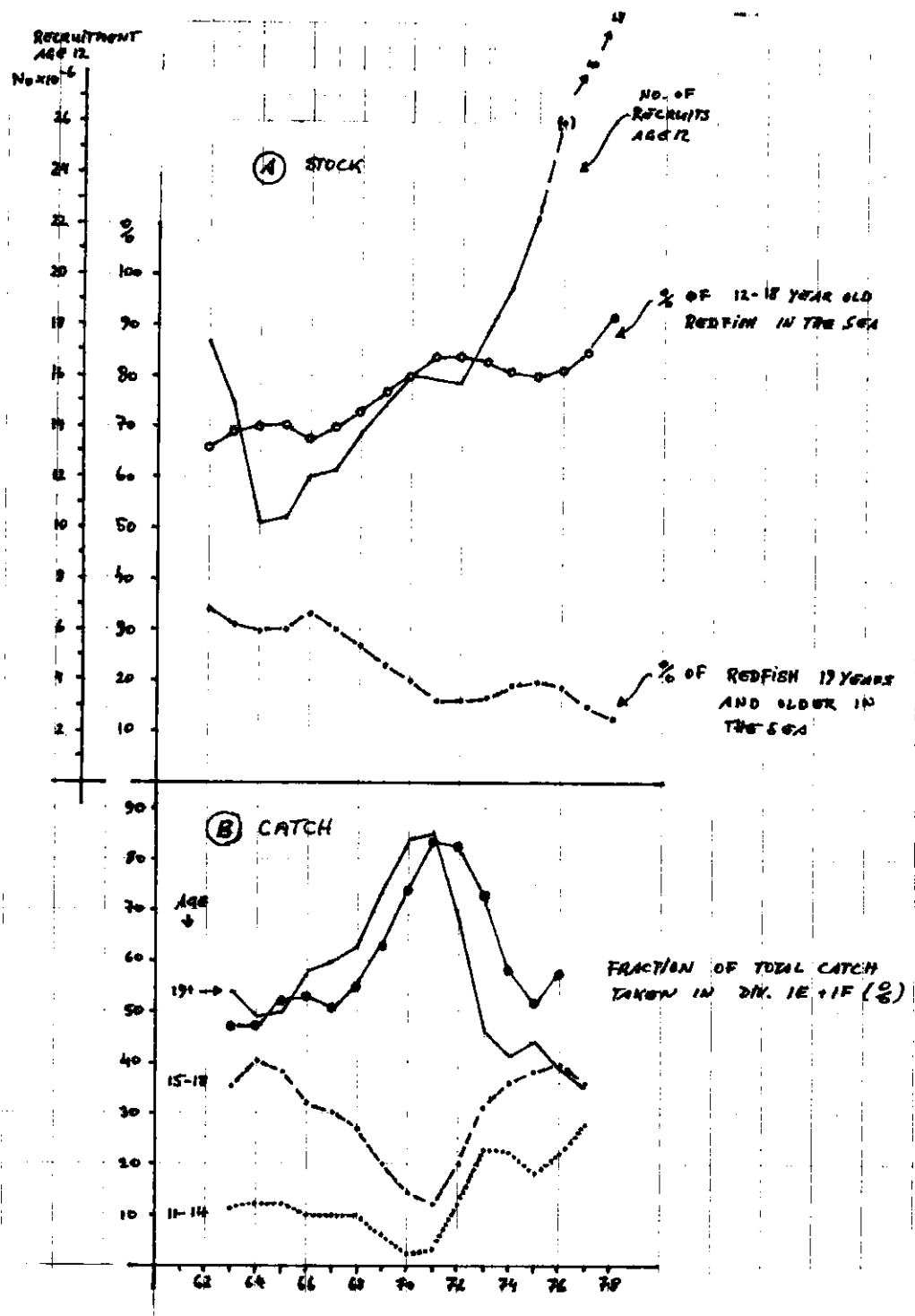
Fig. 4. Redfish at West Greenland: trends in age composition of stock (A) and
catch (B).
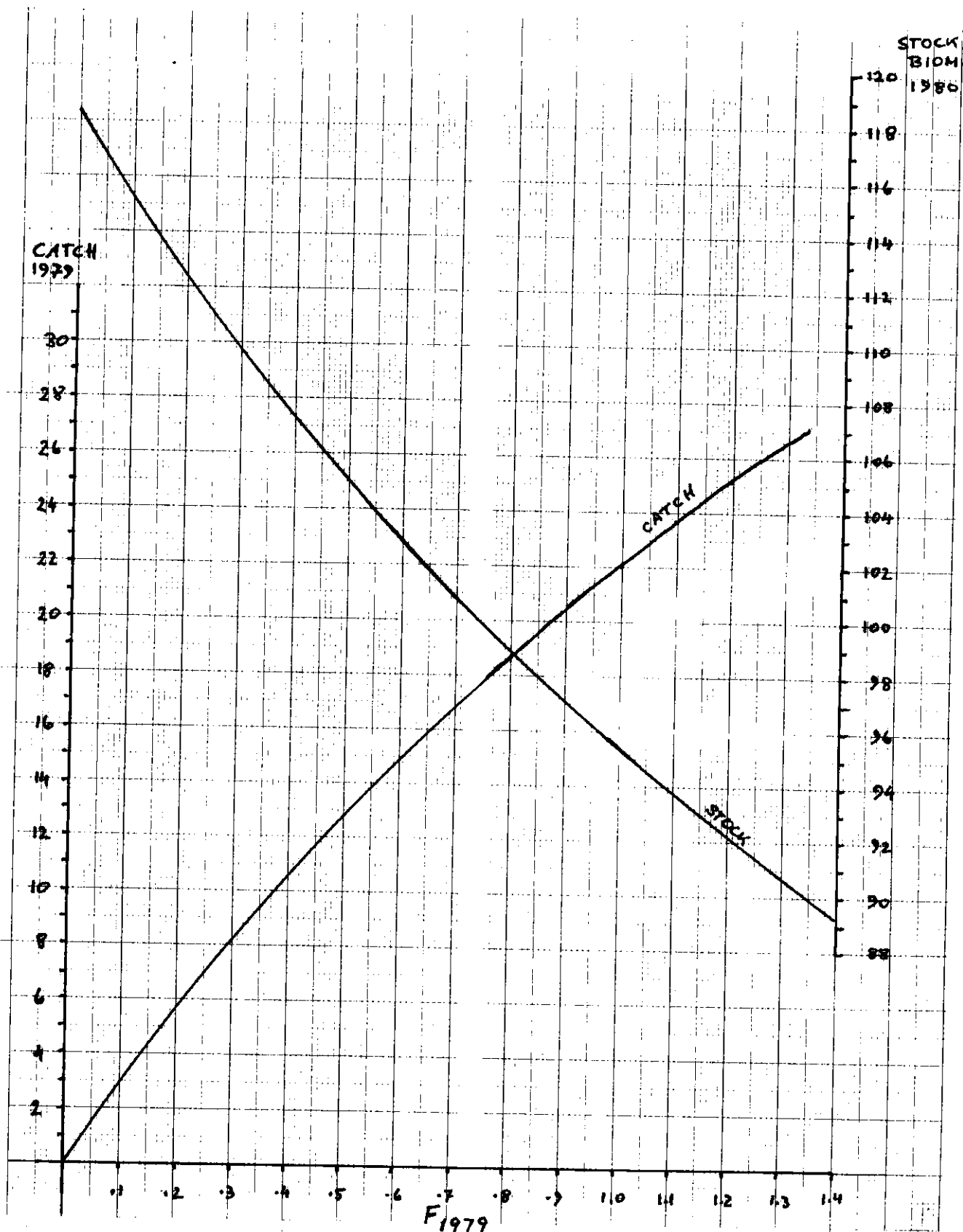
Fig. 5A. Redfish at West Greenland: catch in 1979 and stock biomass in 1980 (000 tons) at different levels of F in 1979.
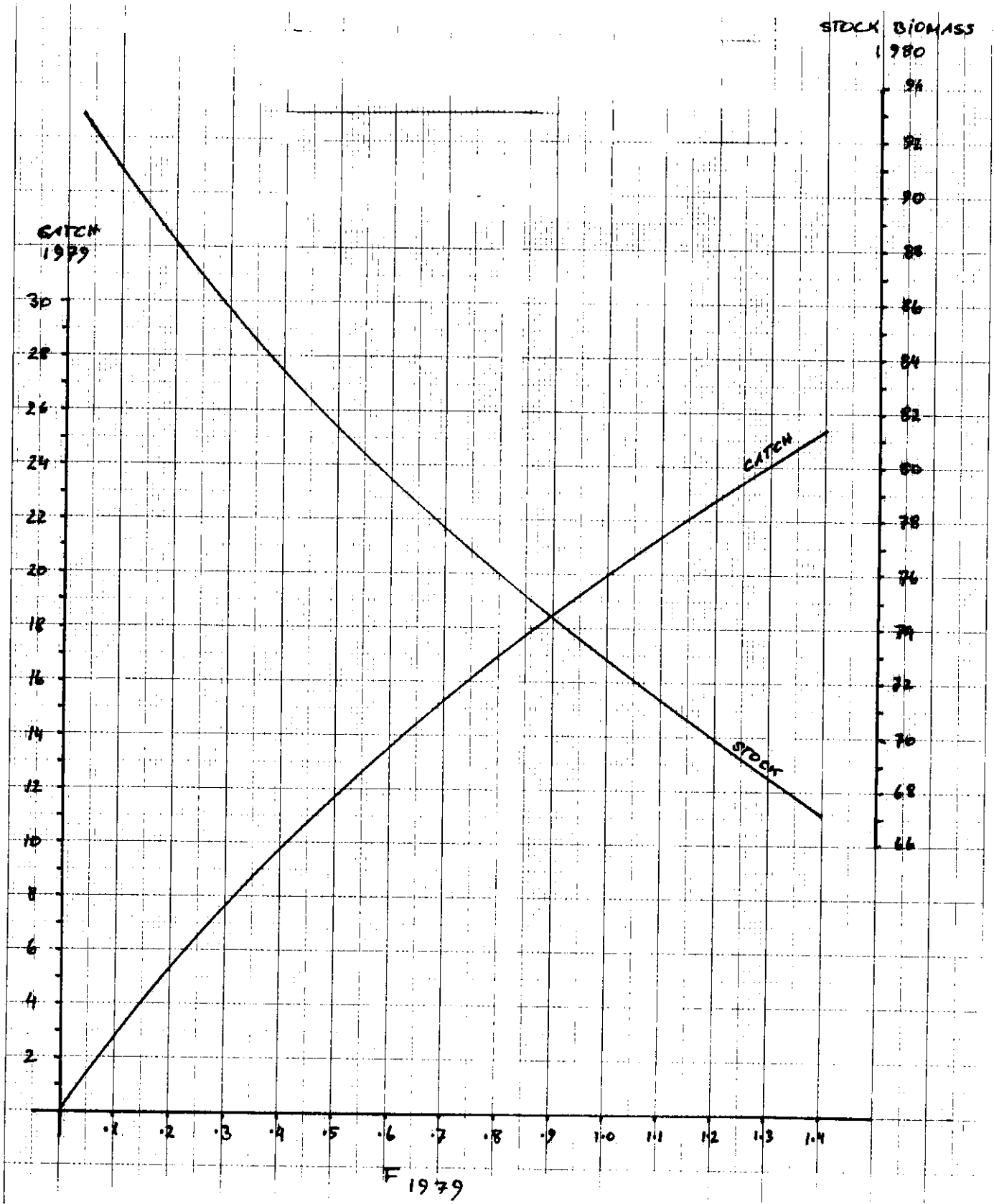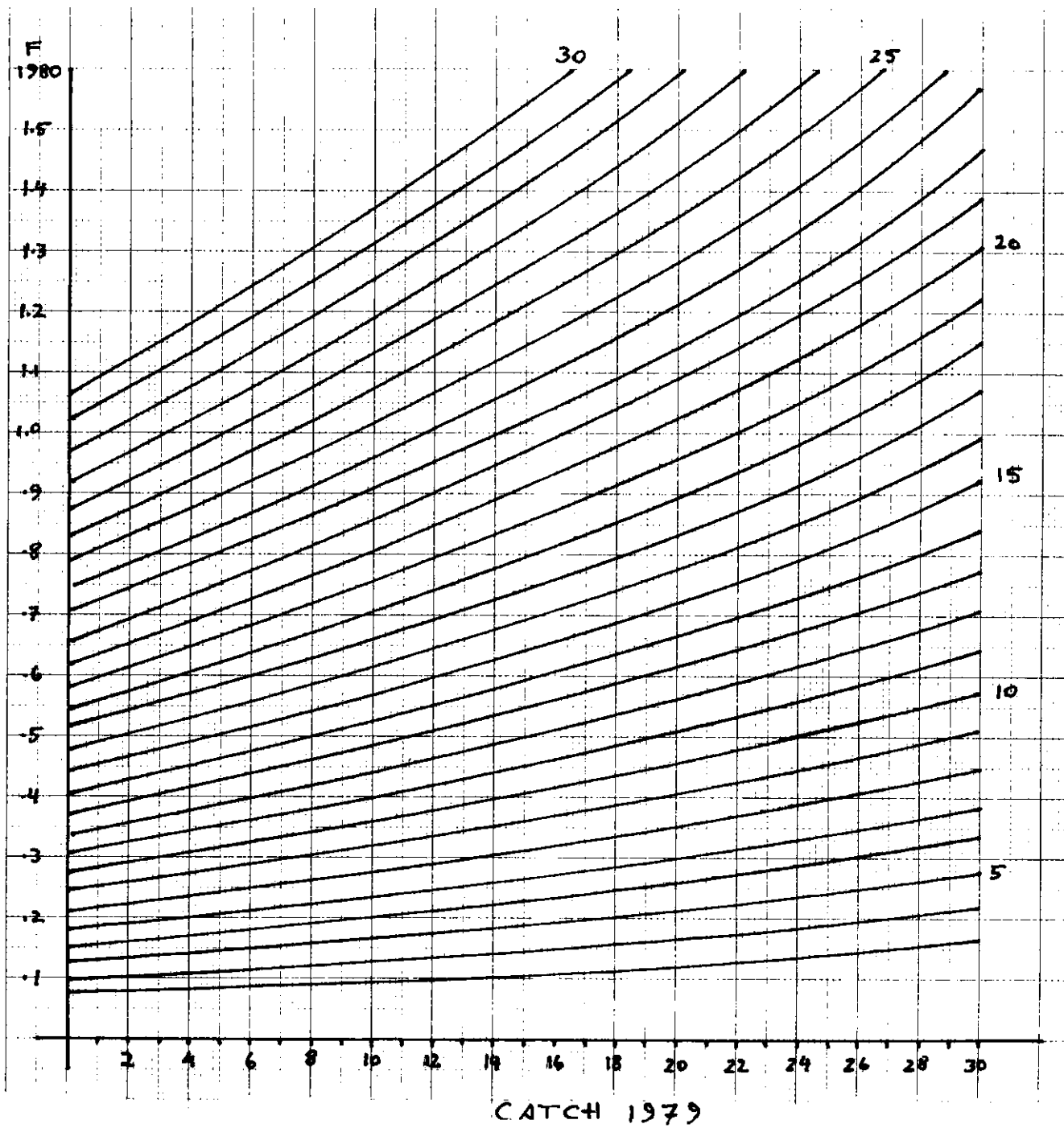
Fig. 5B. Redfish at West Greenland: catch in 1979 and stock biomass in
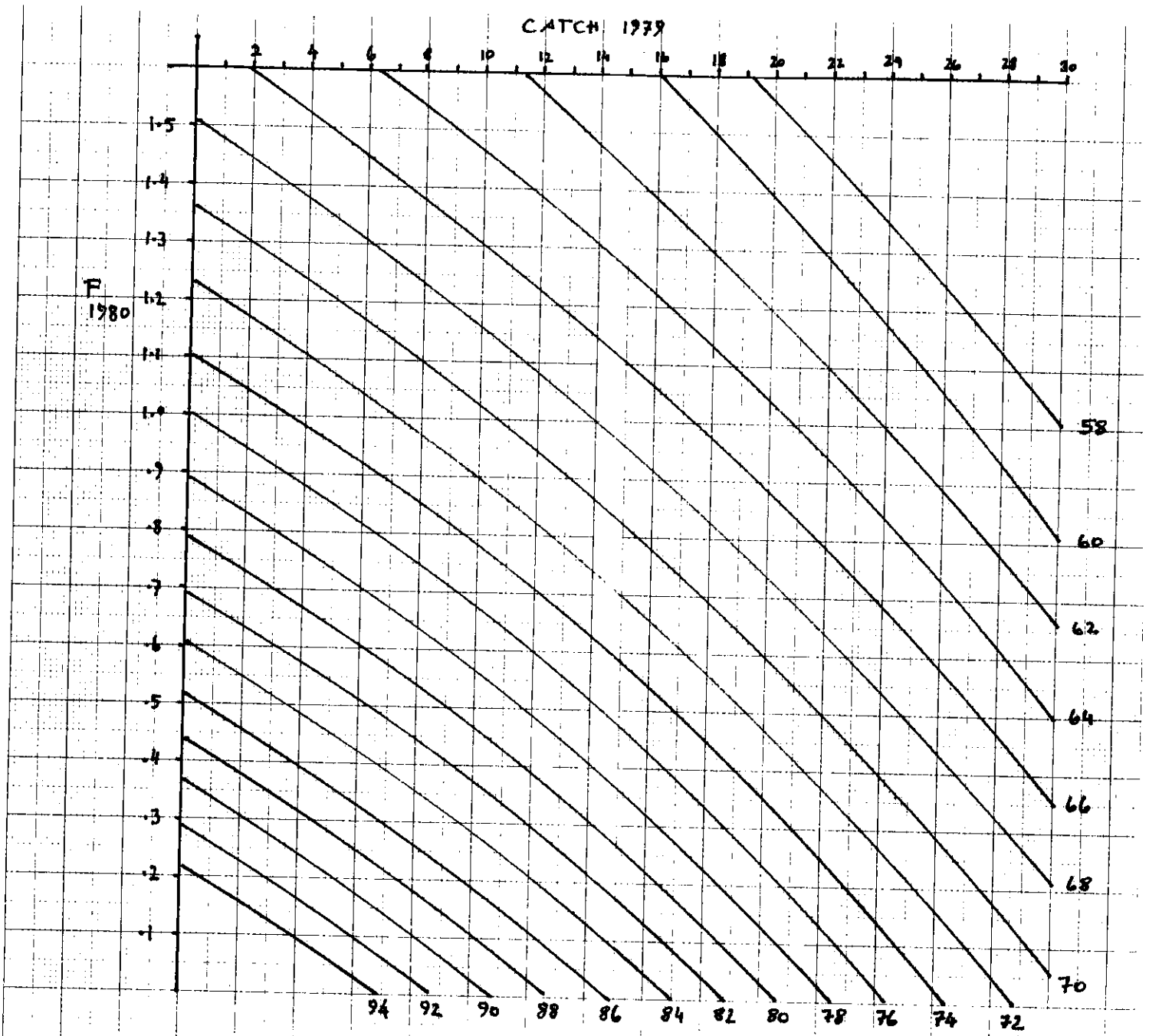1980 (000 tons) at different levels of F in 1979.

Fig. 6 A. Redfish (*Sebastes marinus*) at West Greenland (SA 1): Catch in 1980 at different level of fishing mortality in 1980 and different catch level in 1979. (In 1000 metric tons.)
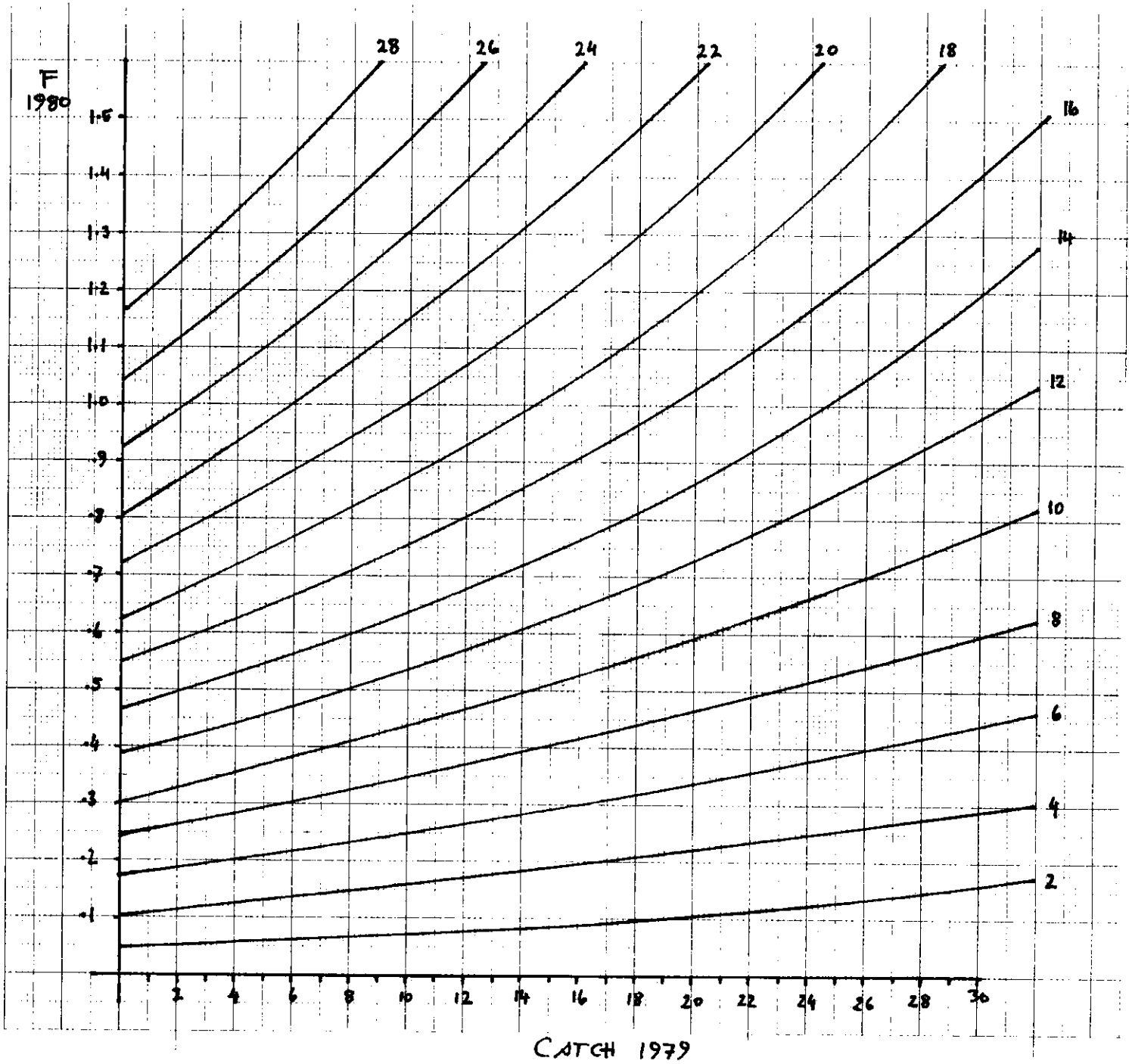
Fig. 6B. Redfish (*Sebastes marinus*) at West Greenland (SA 1): Catch in 1980
at different level of fishing mortality in 1980 and different catch
level in 1979. (In 1000 metric tons). Alternative Assessment.
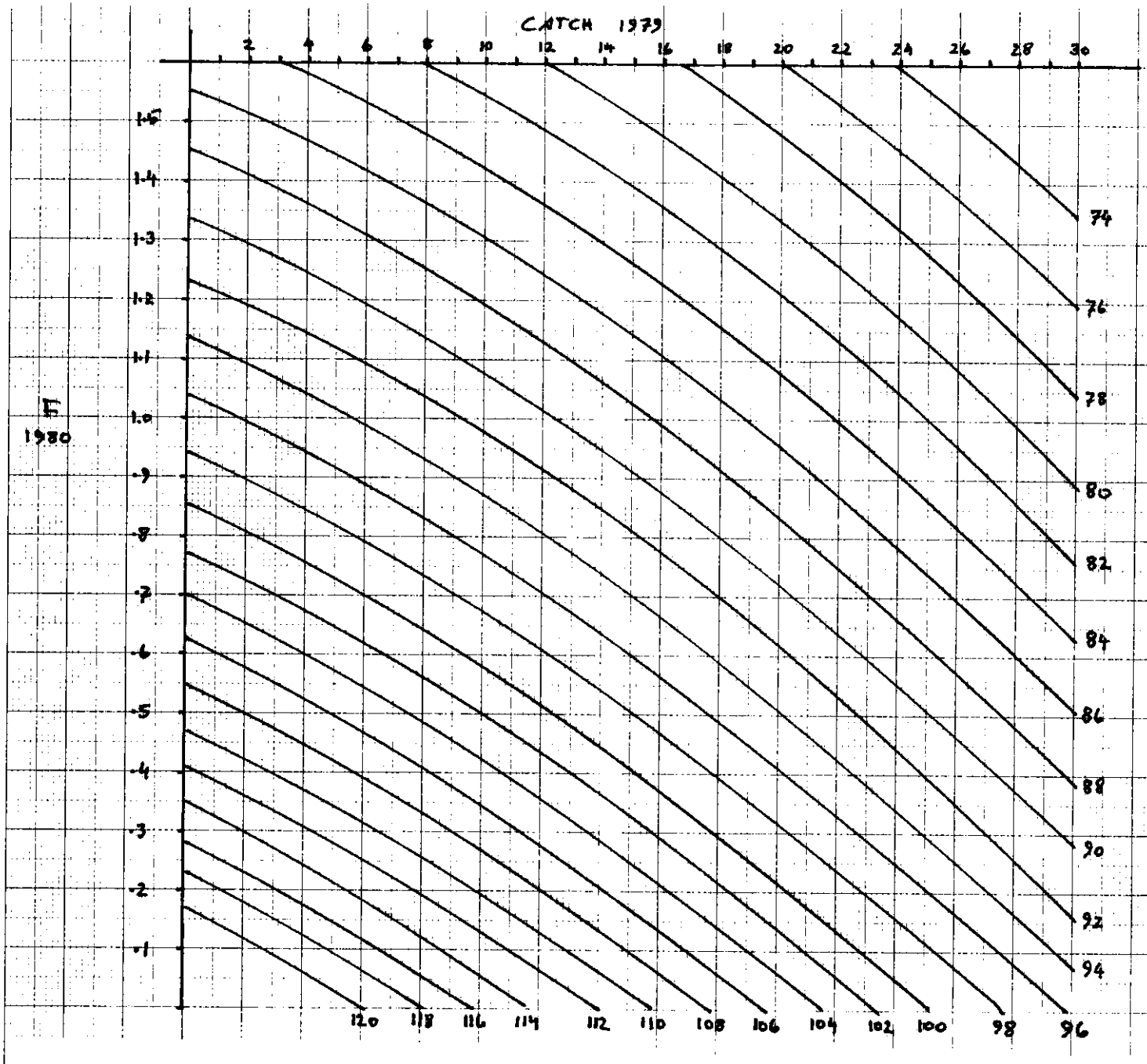
Fig. 7A. Redfish (*Sebastes marinus*) at West Greenland (SA 1): Stock biomass
in 1981 at different level of fishing mortality in 1980 and different
catch level in 1979 (in metric tons).

Fig. 7B. Redfish (*Sebastes marinus*) at West Greenland (SA 1): Stock biomass
in 1981 at different level of fishing mortality in 1980 and different
catch level in 1979 (in 1000 metric tons). Alternative assessment.
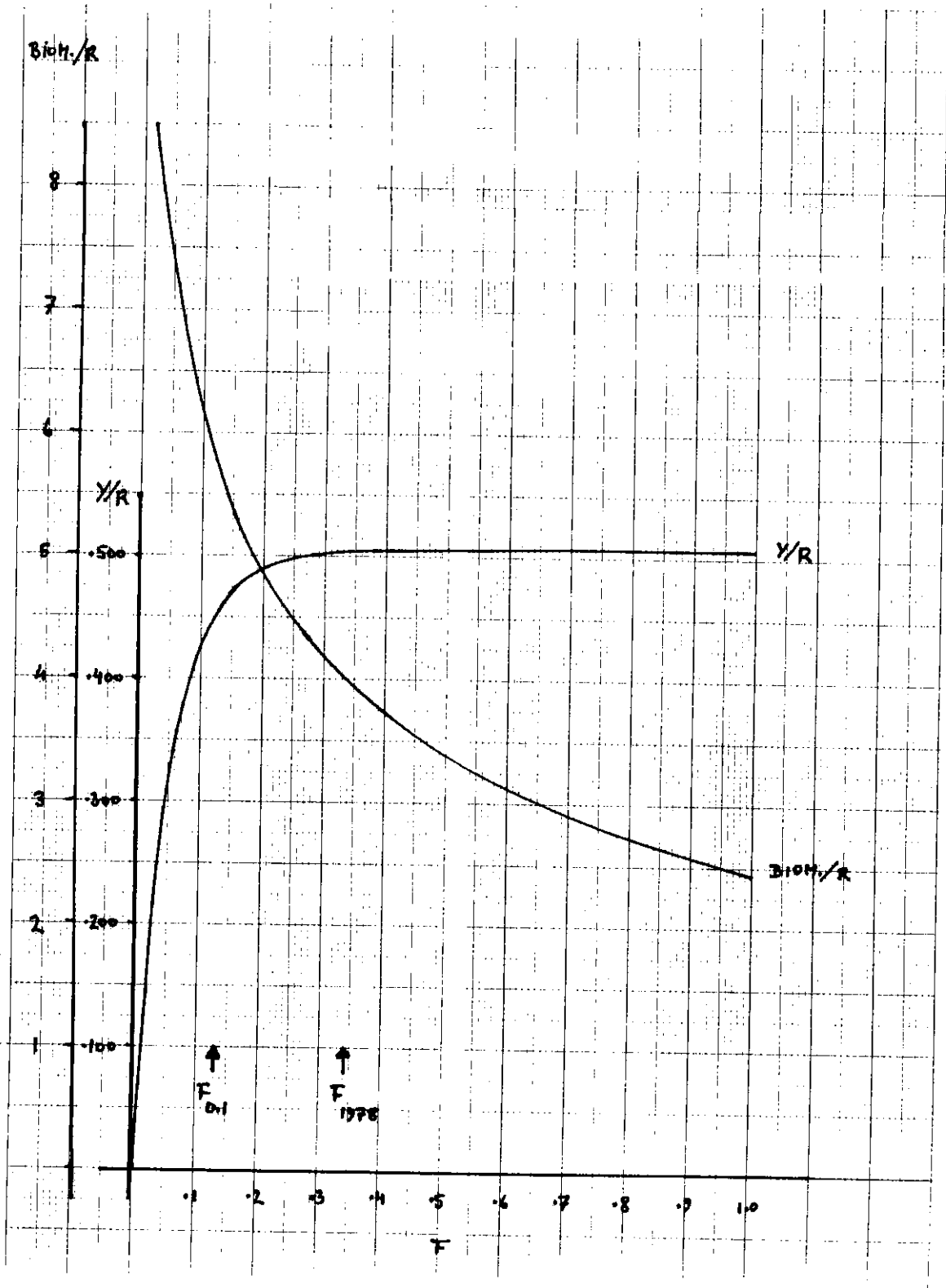
Fig. 8. Redfish at West Greenland: yield per recruit
and biomass per recruit (kg).

Further Consideration of the Assessment of Redfish in Subarea 1

During the discussion of the assessments prescribed for the redfish stock (*S. marinus*) at West Greenland it was pointed out that the analytical assessment presented in this research document does not reflect the trends in recruited biomass, in the age structure of the catch and recruitment to the fishery since a standard age-length key had to be used due to lack of age determinations.

In the assessment of this stock based on a generalized productive model (Res. Doc. 79/VI/54) substantial data from a period in which the fishery exploited an accumulated stock was also not considered as being a sound basis for advice on management for this stock.

In both research documents for two different vessel categories a series of standardized fishing effort and catch per unit effort figures derived from it is given, a generalized production model (Schaefer model modified by Gulland) was calculated. These calculations are based on an 11-year running average for a period in which the exploitation of a previously unfished stock was changing to a more normal situation. Only for an 11-year running average the slope of the regression of CPUE on effort was negative. All other periods showed a positive slope or an extremely low correlation coefficient.

The results (Fig. 1 and 2) from both series of data indicate a MSY level of about 10,000 tons and an equilibrium catch at 2/3 MSY of about 9,000 tons. These figures are of the same level as the result from the analytical assessment (this document) for the maintenance of the present level of exploitation.
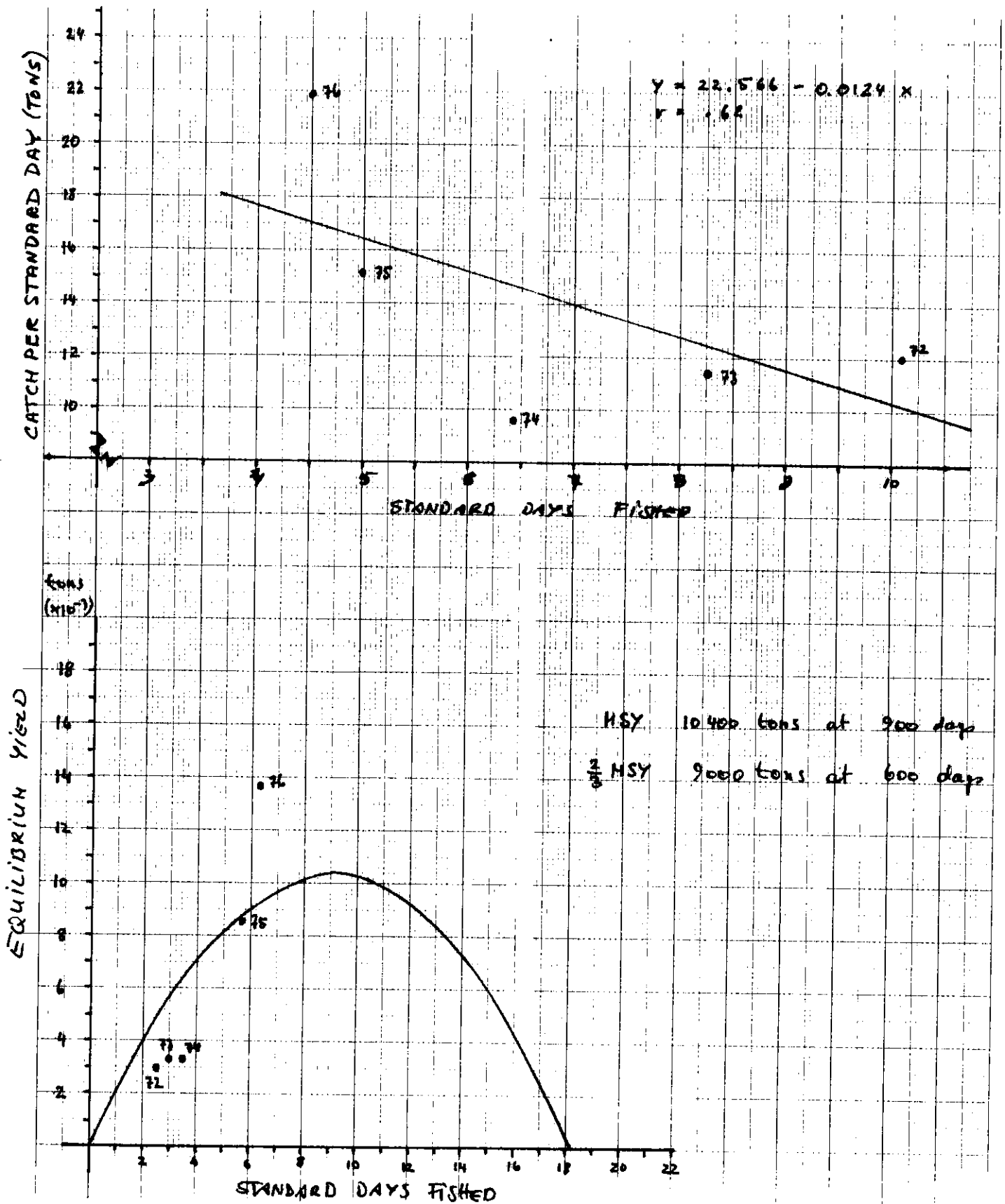
App. Fig. 1.   Redfish at West Greenland: yield curve using Fed. Rep. Germany vessel
class 6 as the effort standard and a 11-year running average.
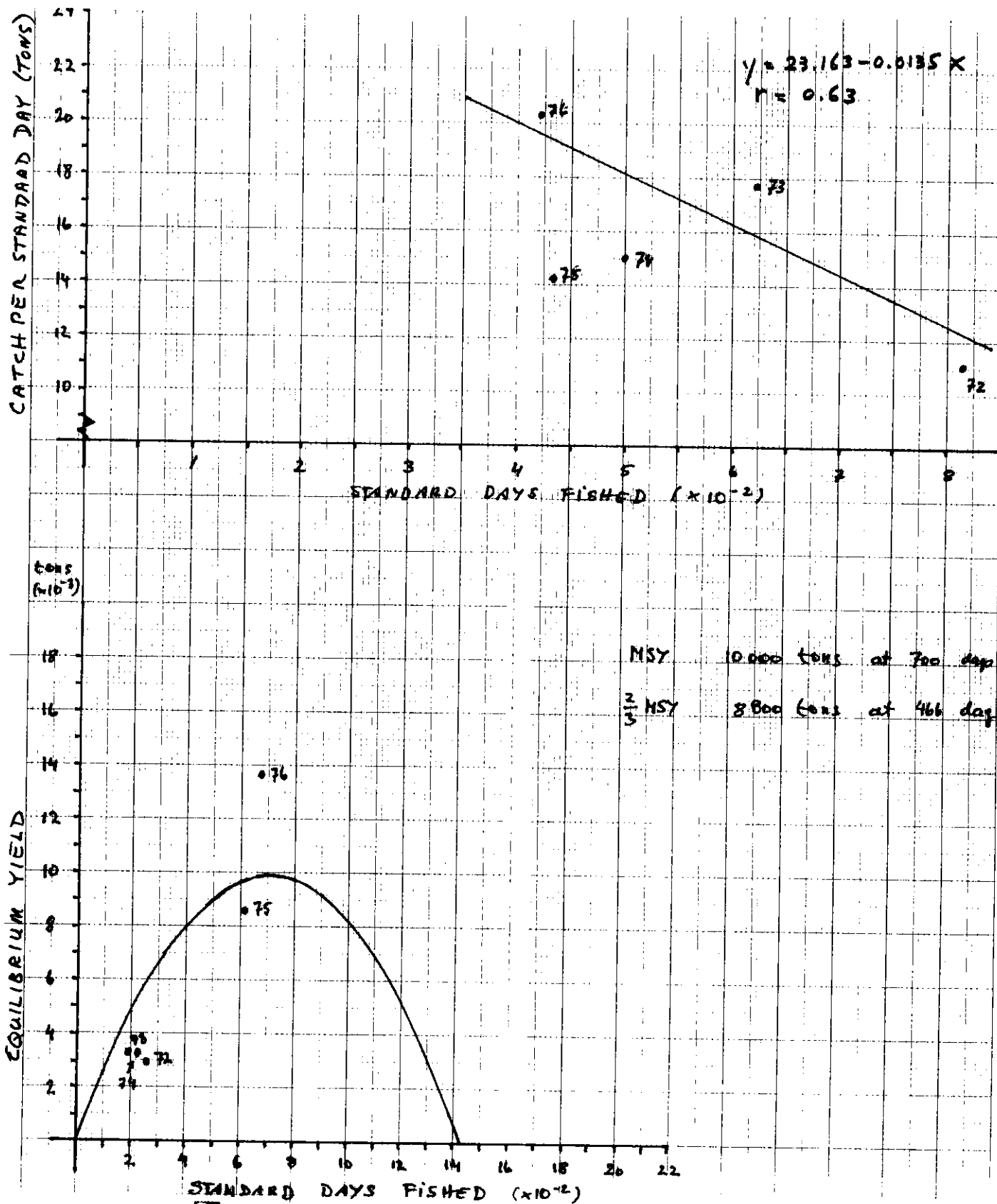
App. Fig. 2. Redfish at West Greenland: yield curve using Fed. Rep. Germany vessel
class 5 as the effort standard and a 11-year running average.