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An Examination of the Witch By-catch Fishery
in NAFO Divisions 2J and 3KL

by

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Abstract

Nominal catches in the 1960's increased from less than 5,000 t to a high of 24,000 t in 1973 and subsequently declined to a low of 3,000 t in 1980. The 1981 catch increased slightly to 4,000 t. Research vessel surveys indicate that about 85% of the exploitable biomass is located in Div. 3K and the stock has been stable over the last several years at 30,000-35,000 t. Fishing at $F_{0.1}$ would, therefore, give catches near the present TAC of 8,000 t.

Résumé

La quantité nominale des prises est passée de moins de 5 000 t dans les années 1960, à un maximum de 24 000 t en 1973; elle a ensuite diminué et atteint son plus bas niveau en 1980, soit 3 000 t. En 1981, les prises se sont élevées légèrement, passant à 4 000 t. Des recensements effectués à bord de navires de recherche révèlent que 85 % de la biomasse exploitable est concentrée dans la division 3K et que la taille du stock est relativement constante depuis plusieurs années à environ 30-35 000 t. Par conséquent, la pêche à $F_{0.1}$ permettrait des prises se rapprochant des PTA fixées actuellement à 8 000 t.

The Fishery

The fishery for witch flounder in stock area 2J3KL has been conducted traditionally by Newfoundland inshore gillnet fishermen and Canadian and foreign otter trawlers in the offshore region. While the stock area is considered to be NAFO Divs. 2J3KL, for practical purposes, the witch fishery is generally concentrated in Div. 3K.

Nominal catches from this area increased from less than 5,000 t in the mid-1960's to a high of 24,000 t in 1973 and declined sharply to less than 3,000 t in 1980 (Fig. 1). During 1981 the landings showed an increase to near 4,000 t, the first since 1972 (Fig. 1). This increase in landings in 1981 was a direct result of an early closure of the northern (2J3KL) cod and American plaice (2+3K) fisheries to the Canadian offshore fleet requiring effort be diverted to other species such as Greenland halibut and redfish where witch provides a significant by-catch. With the introduction of "boat quotas" by industry in the Canadian northern cod fishery during 1982, effort towards other species in this area has been very reduced. The landings of witch, for example, from Div. 2J3KL by the Canadian offshore sector at the end of April 1982 is less than 250 t compared to over 1600 t during the same period last year and is likely to be close to the total annual witch landings from this area for the Canadian offshore fleet for 1982.

Commercial Data

Age composition

As pointed out in Bowering (1981), the low landings and by-catch nature of this species has made it extremely difficult to obtain adequate sampling data, however, some data are available since 1976. On the other hand, with the increase in Canadian otter trawl landings in 1981, some of the better sampling data are available for this year. Since Bowering (1981) reviewed the changes in commercial age composition of this stock from 1976 to 1980, the 1981 data are only compared to the more recent 1980 data (Fig. 2 and 3).

The commercial age composition of males (Fig. 2) in 1981 ranged from 4 to 13 years old with most of the catch in the 7-9 year-old range. This is similar to 1980 except that none were caught less than 6 years old or beyond 11 years old in 1980. This may be a result of distribution differences between years or more likely due to inadequate sampling in 1980. In the youngest ages, the effect of discarding may be apparent. Females ranged from 4 to 17 years old in 1981, however, those less than 5 years old and greater than 15 years old were negligible, leaving the age composition relatively similar to that of 1980. There was also a slight shift to the younger ages in 1981 compared to 1980 which is part of a general trend from 1976 onwards, discussed in Bowering (1981).

Catch and effort

Since the witch fishery is primarily by-catch, catch per unit effort statistics were difficult to ascertain. An attempt was made to calculate CPUE from the Canada(N) OT fleet in Div. 3K by using main species landed as a criterion. The results were as follows:

Year	CPUE (t/hr)	MS Catch (t)	% Of total catch
1978	0.257	211	3%
1979	0.138	113	3%
1980	0.269	93	3%
1981	0.323	409	10%

For obvious reasons these CPUE values were not considered very reliable. Also, the fact that main species was the criterion for the calculation does mean that the fishing effort was directed towards witch and clearly, for this area this is very unlikely to be the case.

Mortality estimates

Due to the lack of adequate data such as catch/effort statistics, it was not possible to obtain real time mortality estimates from commercial data. Catch curves were, therefore, constructed for males and females for the combined commercial data from 1976 to 1981 in order to get some idea of long-term average mortality (Fig. 4). For the males the average mortality over the 15-20 year olds has been very high, $Z_{15-20} = 1.052$ with more than 99% of the

variation explained by the regression (Table 1). Little exploitation on the 8-15 year olds appears to have occurred in earlier years giving a flat-topped appearance to the catch curve. A regression on the 8-15 year olds yielded a Z of 0.11, however, much of the data goes unexplained ($r^2 = 0.66$) by the regression and is subject to much variation from other sources. For the females the average mortality over the 18-25-year-old range has been quite high, $Z_{18-25} = 0.67$ with $r^2 = 0.91$. The age groups of 9-18 on the other hand were lightly exploited in earlier years giving a $Z_{9-18} = 0.16$ and an $r^2 = 0.93$. This value with most of the variation in the data explained by the regression may somewhat approximate natural mortality.

Since the more recent commercial fishery has now been directed towards younger age groups, catch curves were also constructed for the combined 1980 and 1981 data for males and females (Fig. 5). Calculations of Z for ages 8-13 for males and 11-17 for females yielded values of 0.98 and 0.95 with r^2 of 0.98 and 0.95 respectively (Table 1). All these values are beyond the $F_{0.1}$ levels of 0.43 and 0.27 for males and females respectively (Fig. 6). However, with the poor data base and difficulty in interpreting catch curves due to year-class strength influence, these actual mortality values must be treated with caution.

Survey Data

Biomass and age composition

Research vessel surveys were continued for 1981 similar to those reported in Bowering (1981) for each of Divs. 2J, 3K, and 3L. The average numbers and weights per set are presented in Tables 2 and 3 for Div. 2J; 4 and 5 for Div. 3K; and 6 and 7 for Div. 3L.

In Div. 2J the estimate of biomass in 1981 was down approximately 900 t
from the 1980 estimate with similar coverage (Table 3). For Div. 3K the 1981
estimate of biomass was 31,200 t compared with 34,800 t during a similar
survey in 1980. All surveys from 1979 would suggest a biomass averaging about
30,000 t for this division (Table 5). The estimates of biomass for Div. 3L
are generally dependent on a few key strata (Table 7) which may vary with
adjacent strata from year to year according to distribution patterns. Two
surveys conducted during 1981 yielded estimates of 3700 t and 7500 t compared
to 7500 t and 3500 t in 1980. The differences in the estimates were almost
entirely dependent on catches in strata 345 and 346.

Age compositions from the surveys in autumn 1980 and 1981 for males and
females are generally similar for both years (Fig. 7 and 8), however, as with
the 1980 and 1981 commercial data there is a shift towards the younger age
groups.

Mortality estimates from survey data

Catch curves were constructed from the biomass at age estimates for the
Div. 3K surveys from 1978 to 1981 combined (Fig. 9). Estimates of Z for males
age 8-12 was 0.92 and for females age 12-15, $Z = 1.06$. The Z value for females
when age 16 was included was 1.16 (see Table 1). All values were high and
very similar to those of the commercial data (Table 1). These estimates
probably reflect removals when at a peak during the early 1970's. These
estimates should be treated with some skepticism, however, since there is an
obvious change in the mortality pattern between ages 8 and 10 in the males and
ages 12 and 14 in the females. These patterns may be caused by such things as
changes in fishing effort, recruitment, or natural mortality, however, the
true culprit is difficult to determine.

In order to get some real time estimates of mortality, survival rates
were calculated between years for the autumn surveys in Div. 3K since this is
where the main biomass occurs (Table 8). The most recent estimates, i.e.
between 1980 and 1981 suggest F levels for males at 0.46 and females at 0.31
compared to $F_{0.1}$ levels of 0.43 and 0.27 respectively. It would seem that,
based upon these figures, the $F_{0.1}$ removal levels should be near 3500 t.

General

With the lack of adequate commercial data and such a short time series of
research data, it is difficult to properly assess witch in this stock area.
It should be pointed out that for this stock area, there has been identified
at least three separate breeding stocks by two independent stock identification
studies (Fairbairn 1981; Bowering and Misra 1982). As a result, fishing
intensity on an individual stock may not be easily detected and it is, therefore,
possible to overfish one stock while underfishing another in the same NAFO
stock area. Furthermore, it is unlikely that good statistical data will be
obtained from this area in the near future since interest in this species from
this area is usually only generated when the TAC for cod is taken and then
only as a mixed catch with Greenland halibut, redfish, and possibly, American
plaice. With the introduction of company quotas, boat quotas, and the subsequent
increases in TAC for 2J3KL cod, further interest in witch, in fact, will

likely be minimal. Another point in this regard, is that the fisheries for witch are generally directed on spawning concentrations in winter and early spring when CPUE might be profitable. It is also the time when industry exploits the 2J3KL cod. I would suggest that the probability of industry directing effort from 2J3KL cod to 2J3KL witch would be highly insignificant. Furthermore, the probability of the 1982 catch of 2J3KL witch exceeding 3000 t has about the same level of significance.

References

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Table 1. Results of catch curve regressions on both commercial and survey data for the 2J3KL witch stock.

Type	Years	Sex	Age range	$\bar{Z}$	r^2
Commercial	1976-81	M	8-15	0.106	0.663
	1976-81	M	15-20	1.052	0.997
	1980-81	M	8-13	0.977	0.975
	1976-81	F	9-18	0.160	0.932
	1976-81	F	18-25	0.667	0.910
	1980-81	F	11-17	0.946	0.947
Research	1978-81	M	8-12	0.919	0.772
	1978-81	F	12-15	1.061	0.984
	1978-81	F	12-16	1.162	0.986

Table 2. Gadus 2J - Witch average number per set (numbers in parentheses in this and subsequent tables are numbers of sets).

Stratum	Gadus 3 1977	12 1978	15 1978	27 1979	29 1979	42 1980	44 1980	58 1981
201	0.00(2)		0.00(3)		0.00(2)		0.00(3)	0.00(5)
202	0.00(2)	0.00(2)	0.00(2)	0.00(2)	0.00(2)	0.00(2)	0.00(2)	0.00(2)
203	0.00(2)	0.00(2)		0.00(2)		0.00(2)	0.00(2)	0.00(2)
204	1.50(2)	0.00(2)		1.50(2)				2.00(2)
205	0.00(4)		0.00(4)		0.00(2)		0.00(4)	0.00(8)
206	0.36(11)		0.00(7)		0.00(8)		0.00(7)	0.00(11)
207	0.00(5)		0.00(4)		0.00(5)		0.00(5)	0.00(9)
208	5.25(4)	1.00(2)	1.00(3)	3.50(2)	1.00(2)	17.00(2)	0.50(2)	2.50(2)
209	0.71(7)	0.50(2)	0.00(4)	0.50(2)	0.00(5)	1.50(2)	0.25(4)	0.00(6)
210	1.36(6)	0.67(3)	0.25(4)	0.50(2)	1.50(2)	0.50(2)	6.00(3)	0.33(3)
211	12.00(2)	3.00(2)	10.50(2)	6.50(2)	0.00(2)	23.50(2)	1.07(3)	2.25(2)
212	27.97(4)	1.50(2)		12.50(2)		3.00(2)		11.00(2)
213	1.62(8)	0.00(3)	2.25(4)	0.33(3)	1.25(4)	3.00(3)	0.40(5)	2.00(6)
214	1.67(6)	0.00(3)	0.75(4)	0.00(2)	0.00(4)	1.50(2)	0.00(3)	0.40(5)
215	1.25(4)	0.00(3)	0.20(5)	0.00(2)	0.25(4)	0.00(2)	0.00(2)	0.20(5)
216	0.00(2)	0.00(2)		0.00(2)	1.50(2)	0.00(2)	1.50(2)	2.00(2)
217	0.00(3)	0.00(2)		0.50(2)		0.00(2)		0.00(2)
218	0.00(2)	0.00(2)				0.00(2)		0.00(2)
219								0.00(2)
220		0.00(2)						
221								
222	5.50(4)	0.00(2)	5.00(3)	0.00(2)	1.50(2)	3.00(2)	2.00(2)	4.50(2)
223	0.50(2)	0.00(2)		0.00(2)		0.00(2)		1.50(2)
224	0.00(2)	0.00(2)		0.00(2)		0.00(2)		0.00(2)
225	0.00(2)							
226		0.00(2)						
227	2.50(4)	2.00(2)		0.75(2)		6.50(2)		2.00(2)
228	2.87(8)	1.33(3)		1.00(2)	3.00(4)	1.50(2)	5.67(3)	1.00(6)
229	3.67(4)	0.00(2)	8.50(2)	1.00(2)	3.50(2)	2.50(2)	5.50(2)	1.50(2)
230	0.00(3)	0.00(2)				0.50(2)		0.00(2)
231	0.00(2)	0.00(2)				0.00(2)		
232	0.00(2)	0.00(2)						
233								
234	0.00(2)	1.00(3)	0.00(2)	1.00(2)	0.00(2)	0.00(2)	0.00(2)	0.00(2)
235	24.25(4)	0.00(2)		11.00(2)		11.50(2)		12.50(2)
236	0.00(2)							1.50(2)
Total Number ('000)	4,166	566	1,212	1,658	870	3,106	1,425	1,983

Table 3. Gadus 2J - Witch average weight per set

	Gadus							
Stratum	3 1977	12 1978	15 1978	27 1979	29 1979	42 1980	44 1980	58 1981
201	0.00(2)		0.00(3)		0.00(2)		0.00(3)	0.00(5)
202	0.00(2)	0.00(2)	0.00(2)	0.00(2)	0.00(2)	0.00(2)	0.00(2)	0.00(2)
203	0.00(2)	0.00(2)		0.00(2)		0.00(2)	0.00(2)	0.00(2)
204	1.59(2)	0.00(2)		1.02(2)				2.65(2)
205	0.00(4)		0.00(4)		0.00(2)		0.00(4)	0.00(8)
206	0.43(11)		0.00(7)		0.00(8)		0.00(7)	0.00(11)
207	0.00(5)		0.00(4)		0.00(5)		0.00(5)	0.00(9)
208	3.46(4)	0.67(2)	0.61(3)	2.49(2)	0.91(2)	15.00(2)	0.50(2)	2.50(2)
209	0.52(7)	0.44(2)	0.00(4)	1.02(2)	0.00(5)	1.00(2)	0.50(4)	0.00(6)
210	1.58(6)	0.30(3)	0.34(4)	0.68(2)	2.84(2)	0.50(2)	4.67(3)	0.25(3)
211	12.26(2)	1.81(2)	9.53(2)	4.76(2)	0.00(2)	20.50(2)	0.85(3)	1.75(2)
212	26.06(4)	1.36(2)		13.15(2)		2.75(2)		11.25(2)
213	1.48(8)	0.00(3)	2.50(4)	0.30(3)	1.59(4)	3.77(3)	0.40(5)	1.50(6)
214	1.55(6)	0.00(3)	0.69(4)	0.00(2)	0.00(4)	1.30(2)	0.00(3)	0.50(5)
215	1.59(4)	0.00(3)	0.27(5)	0.00(2)	0.11(4)	0.00(2)	0.00(2)	0.64(5)
216	0.00(2)	0.00(2)		0.00(2)	1.24(2)	0.00(2)	1.25(2)	1.25(2)
217	0.00(3)	0.00(2)		0.57(2)		0.00(2)		0.00(2)
218	0.00(2)	0.00(2)				0.00(2)		0.00(2)
219								0.00(2)
220		0.00(2)						
221								
222	4.82(4)	0.00(2)	2.86(3)	0.00(2)	1.02(2)	2.25(2)	1.25(2)	4.00(2)
223	0.68(2)	0.00(2)		0.00(2)		0.00(2)		2.00(2)
224	0.00(2)	0.00(2)		0.00(2)		0.00(2)		0.00(2)
225	0.00(2)							
226		0.00(2)						
227	2.72(4)	1.59(2)		0.86(2)		6.75(2)		2.50(2)
228	3.43(8)	0.74(3)		0.68(2)	3.63(4)	1.50(2)	4.50(3)	1.08(6)
229	2.67(4)	0.00(2)	4.99(2)	0.68(2)	4.43(2)	2.00(2)	3.00(2)	2.00(2)
230	0.00(3)	0.00(2)				0.50(2)		0.00(2)
231	0.00(2)	0.00(2)				0.00(2)		
232	0.00(2)	0.00(2)						
233								
234	0.00(2)	0.76(3)	0.00(2)	1.59(2)	0.00(2)	0.00(2)	0.00(2)	0.00(2)
235	17.76(4)	0.00(2)		9.30(2)		10.00(2)		11.50(2)
236	0.00(2)							0.85(2)
Total Weight (tons)	3,829	397	993	1,598	1,058	2,893	1,109	1,968

Table 4. Gadus 3K - Witch average number per set

Stratum	Gadus						
	12 1978	15 1978	27 1979	29 1979	42 1980	44 1980	58&59 1981
620	0.00(5)	4.86(7)	10.67(3)	2.86(7)	1.00(3)	2.11(9)	0.40(10)
621	0.80(5)	7.14(7)	24.33(3)	9.75(8)	5.67(3)	1.80(10)	0.91(11)
622	15.00(2)		21.33(3)		38.50(2)		18.00(2)
623	2.00(3)	9.67(3)		5.67(3)	11.00(2)	3.75(4)	6.06(4)
624	3.50(4)	7.00(3)	2.50(2)	2.50(2)	1.00(2)	2.50(2)	6.50(2)
625	5.67(3)	17.33(3)	17.50(2)	43.00(3)	16.00(2)	13.75(4)	23.00(4)
626	15.00(3)	81.50(4)	92.50(2)	77.67(3)	193.00(2)	11.00(3)	12.20(5)
627	30.00(2)		47.33(3)		78.50(2)		127.33(6)
628	15.50(2)	28.60(5)	68.33(3)	54.00(2)	52.50(2)	32.38(4)	12.00(6)
629	18.67(3)	64.33(3)		45.00(2)	85.50(2)	54.50(3)	53.00(3)
630	27.00(2)		12.50(2)	21.50(2)	28.50(2)	7.16(2)	17.50(2)
631	29.50(2)		24.67(3)		29.00(3)		80.60(5)
632	3.50(4)	16.67(3)	4.50(2)	23.50(2)	3.00(2)	6.77(2)	11.00(2)
633	0.50(4)	20.06(5)	12.50(4)	15.06(6)	16.33(3)	18.00(7)	7.67(8)
634	4.50(4)	3.20(5)	1.50(2)	5.33(6)	5.50(2)	6.00(5)	3.05(7)
635	4.00(4)	17.60(5)	8.67(3)	15.40(5)	7.00(2)	13.50(4)	9.80(5)
636	6.75(4)	14.33(3)	8.00(2)	10.00(5)	13.00(2)	10.20(5)	6.33(6)
637	6.00(5)	17.00(4)	7.00(3)	34.00(4)	5.50(2)	16.75(4)	17.67(6)
638	8.33(3)	27.60(5)	38.00(2)	59.14(7)	6.00(3)	39.67(6)	34.50(8)
639	2.50(4)	16.00(5)	4.50(2)	9.50(2)	11.50(2)	16.50(4)	11.70(6)
640	9.50(2)				9.00(2)		3.50(2)
641	0.00(2)		0.00(2)		1.00(2)		2.00(2)
642	0.00(2)				0.50(2)		0.00(3)
643	0.00(2)		0.00(2)				
644	0.00(2)		0.00(2)				
645	0.50(2)				0.00(2)		0.50(2)
646	0.00(2)		0.00(2)		1.00(2)		0.50(2)
647	0.00(2)		0.00(2)		0.00(2)		0.00(2)
648	0.00(2)						
649	0.00(2)						
Total Number ('000)	15,105	30,010	39,612	37,822	45,139	23,508	38,400
					33,481[a]		
					40,920[b]		

[a]Gadus 42 compared 44

[b]Gadus 42 compared 27

Table 5. Gadus 3K - Witch average weight per set

	Gadus						
Stratum	12 1978	15 1978	27 1979	29 1979	42 1980	44 1980	58&59 1981
620	0.00(5)	4.54(7)	8.39(3)	3.30(7)	1.17(3)	2.00(9)	0.45(10)
621	0.36(5)	3.97(7)	22.83(3)	9.41(8)	6.33(3)	1.25(10)	1.64(11)
622	3.39(2)		16.48(3)		25.25(2)		14.75(2)
623	1.34(3)	5.94(3)		6.57(3)	7.75(2)	2.88(4)	5.41(4)
624	2.27(4)	6.51(3)	1.81(2)	2.15(2)	0.55(2)	1.75(2)	5.25(2)
625	3.25(3)	12.71(3)	10.55(2)	32.51(3)	13.50(2)	10.63(4)	16.88(4)
626	5.14(3)	47.79(4)	51.25(2)	53.83(3)	124.50(2)	9.33(3)	11.30(5)
627	18.14(2)		23.59(3)		66.25(2)		94.75(6)
628	12.02(2)	23.88(5)	56.85(3)	52.65(2)	46.00(2)	26.50(4)	10.83(6)
629	10.58(3)	48.73(3)		28.58(2)	51.50(2)	34.67(3)	42.33(3)
630	14.52(2)		6.92(2)	16.55(2)	26.00(2)	6.03(2)	15.75(2)
631	8.18(2)		12.26(3)		15.17(3)		60.90(5)
632	2.67(4)	13.77(3)	4.43(2)	22.22(2)	2.75(2)	5.77(2)	10.00(2)
633	0.29(4)	19.28(5)	9.90(4)	14.02(6)	14.50(3)	17.93(7)	6.32(8)
634	5.79(4)	2.72(5)	1.81(2)	6.16(6)	6.50(2)	5.50(5)	2.94(7)
635	4.59(4)	20.61(5)	13.46(3)	16.87(5)	8.75(2)	13.50(4)	10.80(5)
636	4.99(4)	17.25(3)	9.98(2)	11.25(5)	12.25(2)	12.20(5)	7.50(6)
637	3.76(5)	18.04(4)	8.78(3)	28.02(4)	6.00(2)	16.00(4)	17.00(6)
638	6.43(3)	17.43(5)	29.95(2)	41.12(7)	3.95(3)	26.42(6)	26.75(8)
639	1.76(4)	14.08(5)	6.01(2)	10.44(2)	11.00(2)	15.00(4)	11.23(6)
640	5.45(2)				8.00(2)		3.25(2)
641	0.00(2)		0.00(2)		0.50(2)		1.15(2)
642	0.00(2)				0.50(2)		0.00(3)
643	0.00(2)		0.00(2)				
644	0.00(2)		0.00(2)				
645	0.34(2)				0.00(2)		0.50(2)
646	0.00(2)		0.00(2)		1.75(2)		0.25(2)
647	0.00(2)		0.00(2)		0.00(2)		0.00(2)
648	0.00(2)						
649	0.00(2)						
Total Weight (tons)	8,763	23,996	30,223	31,632	34,839	19,517	31,210
					26,165[a]		
					32,159[b]		

[a]Gadus 42 compared 44

[b]Gadus 42 compared 27

Table 6. A. T. Cameron 3L - Witch average number per set

	ATC						
Stratum	246 1976	262 1977	276 1979	290 1980	305 1980	317&318 1981	323&325 1981
328			0.00(3)		0.00(5)	0.00(2)	
341		0.00(4)	0.00(4)	0.17(6)		0.00(2)	0.00(3)
342		0.00(2)	0.00(2)	0.00(4)			0.00(3)
343		0.00(2)	0.00(3)	0.25(4)		0.00(2)	0.00(4)
344	0.26(4)	0.75(4)	0.25(4)	1.00(2)	0.40(3)	0.00(5)	1.25(4)
345	6.71(4)	41.96(4)	5.00(2)	21.75(4)	9.60(5)	1.25(4)	26.00(4)
346	40.50(2)	51.51(3)		65.00(4)	6.67(3)	27.33(3)	56.00(3)
347	2.47(3)	0.00(3)	0.25(4)	1.50(4)	2.60(5)	0.00(4)	2.33(3)
348	0.00(6)	0.00(6)	0.00(6)	0.00(6)	0.00(3)	0.00(7)	0.17(6)
349	0.00(3)	0.00(6)	0.00(6)	0.43(7)		0.00(4)	0.00(7)
350	0.00(4)	0.00(4)	0.00(6)	0.22(9)		0.00(3)	0.00(6)
363	0.00(4)	0.00(5)	0.00(5)	0.25(8)	0.33(3)	0.00(3)	0.00(4)
364	0.00(3)	0.00(7)	0.00(6)	0.00(8)	0.00(5)	0.00(2)	0.78(9)
365	0.00(3)	0.00(3)	0.00(2)	0.75(4)	0.50(4)		0.25(4)
366	0.25(4)	0.25(4)		1.00(4)	1.50(4)	1.00(3)	1.33(3)
368	2.00(3)	3.10(3)		3.00(4)	0.00(2)	4.00(2)	0.50(2)
369	0.78(4)	2.60(3)	2.00(2)	2.25(4)	7.33(3)	0.50(2)	4.50(2)
370	0.00(3)	0.00(3)	0.00(3)	0.00(4)	0.00(3)	0.00(2)	0.25(4)
371		0.00(3)	0.00(3)	0.00(3)	0.00(3)	0.00(2)	0.00(4)
372	0.00(3)	0.00(6)	0.00(7)	0.33(9)	0.00(4)	0.00(4)	0.00(5)
384		0.00(2)	0.00(3)	0.00(4)	0.00(2)	0.00(2)	
385	0.00(2)	0.17(6)	0.17(6)	0.00(7)	1.00(4)	0.33(3)	0.00(8)
386	1.03(2)	13.67(3)	8.67(3)	9.75(4)	1.00(2)	5.00(2)	10.67(3)
387	24.75(3)	10.50(2)	3.33(3)	3.00(4)	6.50(2)	13.50(2)	5.50(2)
388	49.15(2)	12.00(2)	24.50(2)	3.67(3)	1.50(2)	4.00(2)	
389	1.06(2)	1.67(3)	1.00(3)	0.25(4)	0.33(3)	2.00(2)	
390		0.00(2)	0.50(4)	0.00(5)	0.00(3)	0.50(2)	0.00(3)
391		1.00(2)	0.00(2)	1.00(4)	1.50(2)	1.00(2)	
392		2.50(2)	0.67(3)	0.33(3)	1.00(2)	1.50(2)	
Total number ('000)	6,502	10,311	2,365	8,430	3,176	3,681	8,539

Table 7. A. T. Cameron 3L - Witch average weight per set

	ATC						
Stratum	246 1976	262 1977	276 1979	290 1980	305 1980	317&318 1981	323&325 1981
328		0.00(3)		0.00(5)		0.00(2)	
341		0.00(4)	0.00(4)	0.15(6)		0.00(2)	0.00(3)
342		0.00(2)	0.00(2)	0.00(4)			0.00(3)
343		0.00(2)	0.00(3)	0.29(4)		0.00(2)	0.00(4)
344	0.18(4)	0.91(4)	0.05(4)	0.91(2)	0.80(3)	0.00(5)	1.75(4)
345	7.70(4)	36.06(4)	4.31(2)	19.97(4)	8.80(5)	0.38(4)	19.88(4)
346	28.15(2)	45.58(3)		53.85(4)	7.33(3)	24.50(3)	46.50(3)
347	4.81(3)	0.00(3)	0.45(4)	1.42(4)	2.70(5)	0.00(4)	2.83(3)
348	0.00(6)	0.00(6)	0.00(6)	0.00(6)	0.00(3)	0.00(7)	0.17(6)
349	0.00(3)	0.00(6)	0.00(6)	0.39(7)		0.00(4)	0.00(7)
350	0.00(4)	0.00(4)	0.00(6)	0.08(9)		0.00(3)	0.00(6)
363	0.00(4)	0.00(5)	0.00(5)	0.14(8)	0.50(3)	0.00(3)	0.00(4)
364	0.00(3)	0.00(7)	0.00(6)	0.00(8)	0.00(5)	0.00(2)	1.06(9)
365	0.00(3)	0.00(3)	0.00(2)	0.79(4)	1.00(4)		0.25(4)
366	0.23(4)	0.57(4)		0.74(4)	1.25(4)	0.63(3)	1.67(3)
368	1.51(3)	3.74(3)		2.10(4)	0.00(2)	5.00(2)	0.50(2)
369	0.71(4)	2.23(3)	2.27(2)	2.10(4)	10.50(3)	0.75(2)	5.75(2)
370	0.00(3)	0.00(3)	0.00(3)	0.00(4)	0.00(3)	0.00(2)	0.25(4)
371		0.00(3)	0.00(3)	0.00(3)	0.00(3)	0.00(2)	0.00(4)
372	0.00(3)	0.00(6)	0.00(7)	0.27(9)	0.00(4)	0.00(4)	0.00(5)
384		0.00(2)	0.00(3)	0.00(4)	0.00(2)	0.00(2)	
385	0.00(2)	0.19(6)	0.26(6)	0.00(7)	1.31(4)	0.67(3)	0.00(8)
386	1.04(2)	20.13(3)	12.26(3)	12.60(4)	0.88(2)	6.25(2)	10.50(3)
387	29.14(3)	11.58(2)	5.15(3)	2.21(4)	6.00(2)	13.00(2)	4.25(2)
388	99.30(2)	9.99(2)	22.70(2)	2.98(3)	1.75(2)	5.00(2)	
389	0.48(2)	2.57(3)	1.29(3)	0.11(4)	0.17(3)	3.00(2)	
390		0.00(2)	0.45(4)	0.00(5)	0.00(3)	1.00(2)	0.00(3)
391		0.91(2)	0.00(2)	0.96(4)	1.25(2)	1.00(2)	
392		2.50(2)	0.45(3)	0.61(3)	0.50(2)	1.25(2)	
Total Weight (tons)	7,512	9,869	2,644	7,529	3,454	3,669	7,461

Table 8. Population numbers at age for witch flounder in Division 3K with between year mortality estimates.

	GADUS 15 1978	GADUS 29 1979	GADUS 44 1980	GADUS 58-59 1981
Age		Males		
3	48		89	15
4	62	104	40	348
5	1056	1013	50	510
6	1134	3090	244	807
7	2800	7390	1956	5679
8	3340	5103	2253	7564
9	2055	2004	1461	2464
10	1647	1105	1625	1459
11	884	126	443	132
12	213	22	43	
	$\bar{Z}_{8_+} = 0.89$	$\bar{Z}_{8_+} = 0.85$	$\bar{Z}_{9_+} = 0.66$	
Age		Females		
3			92	
4	108	80	46	239
5	1235	841	67	516
6	1183	1339	275	921
7	1892	3258	1650	3055
8	3111	4178	2031	4445
9	2463	2310	2117	4257
10	1796	2599	2096	2776
11	1626	1490	1235	1739
12	1677	638	926	831
13	1083	196	685	109
14	403		95	
15	173		18	
16	40			
	$\bar{Z}_{8_+} = 0.39$	$\bar{Z}_{8_+} = 0.47$	$\bar{Z}_{10_+} = 0.46$	
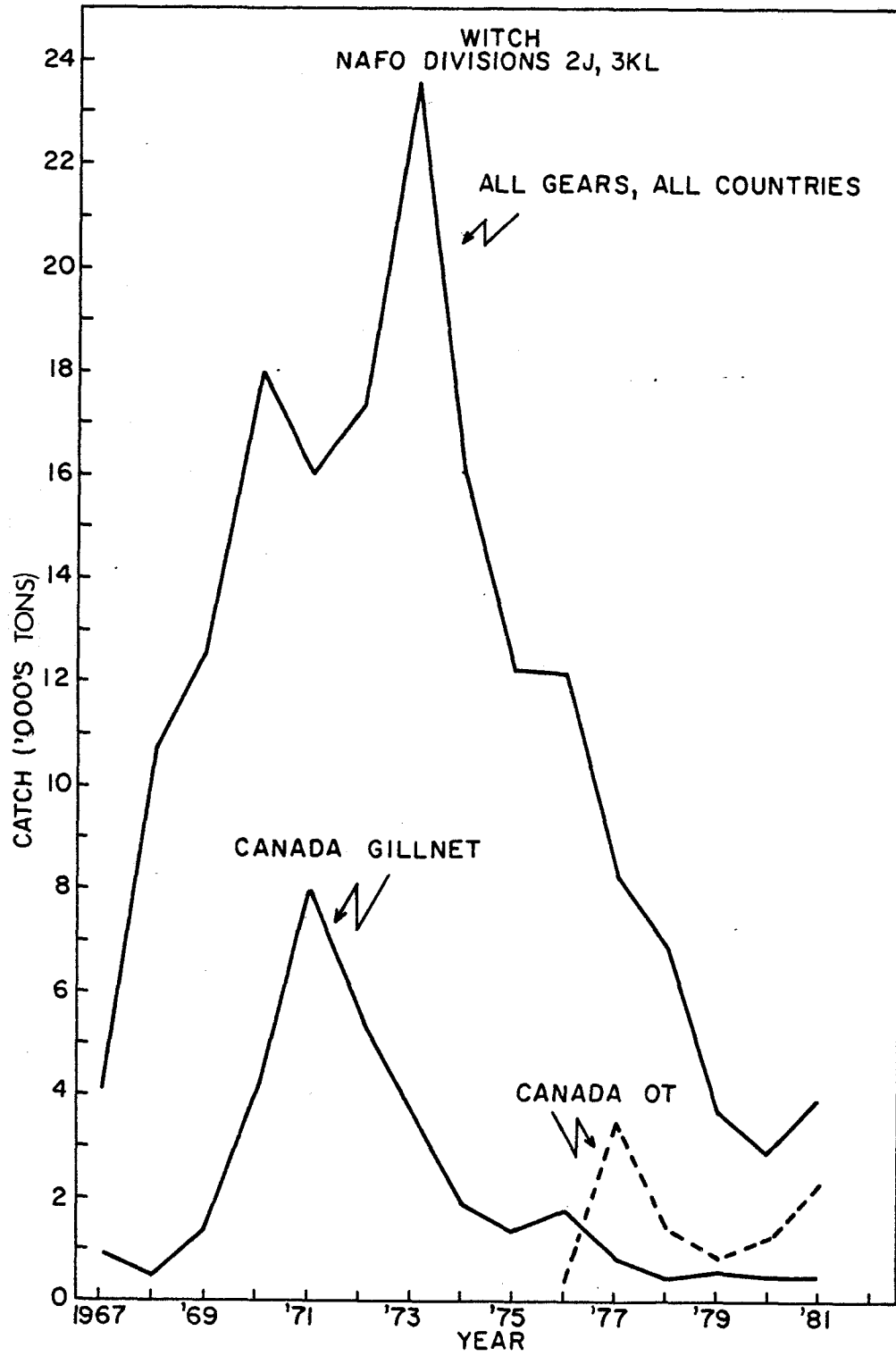
Figure 1. Commercial witch landings in NAFO Divisions 2J3KL.
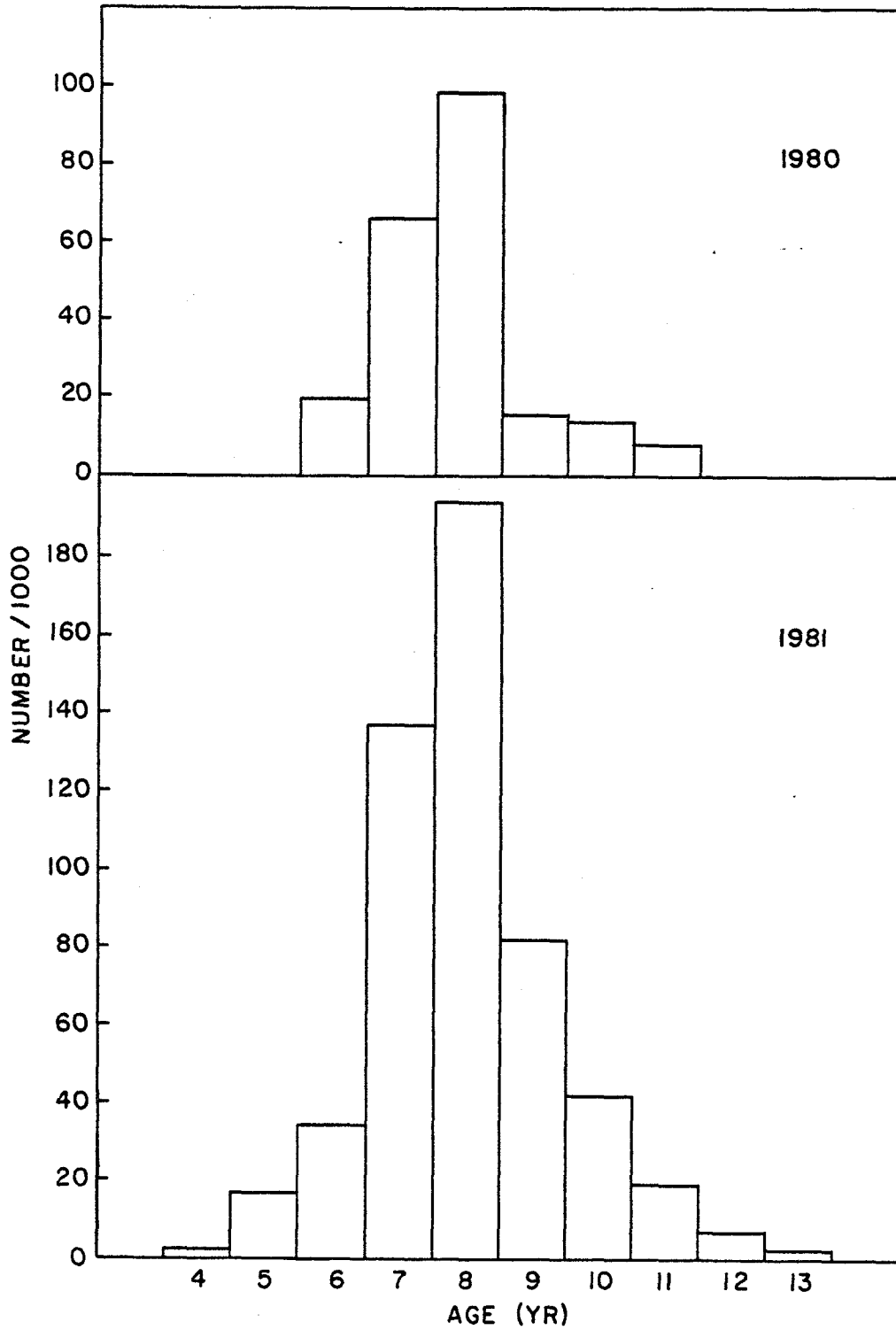
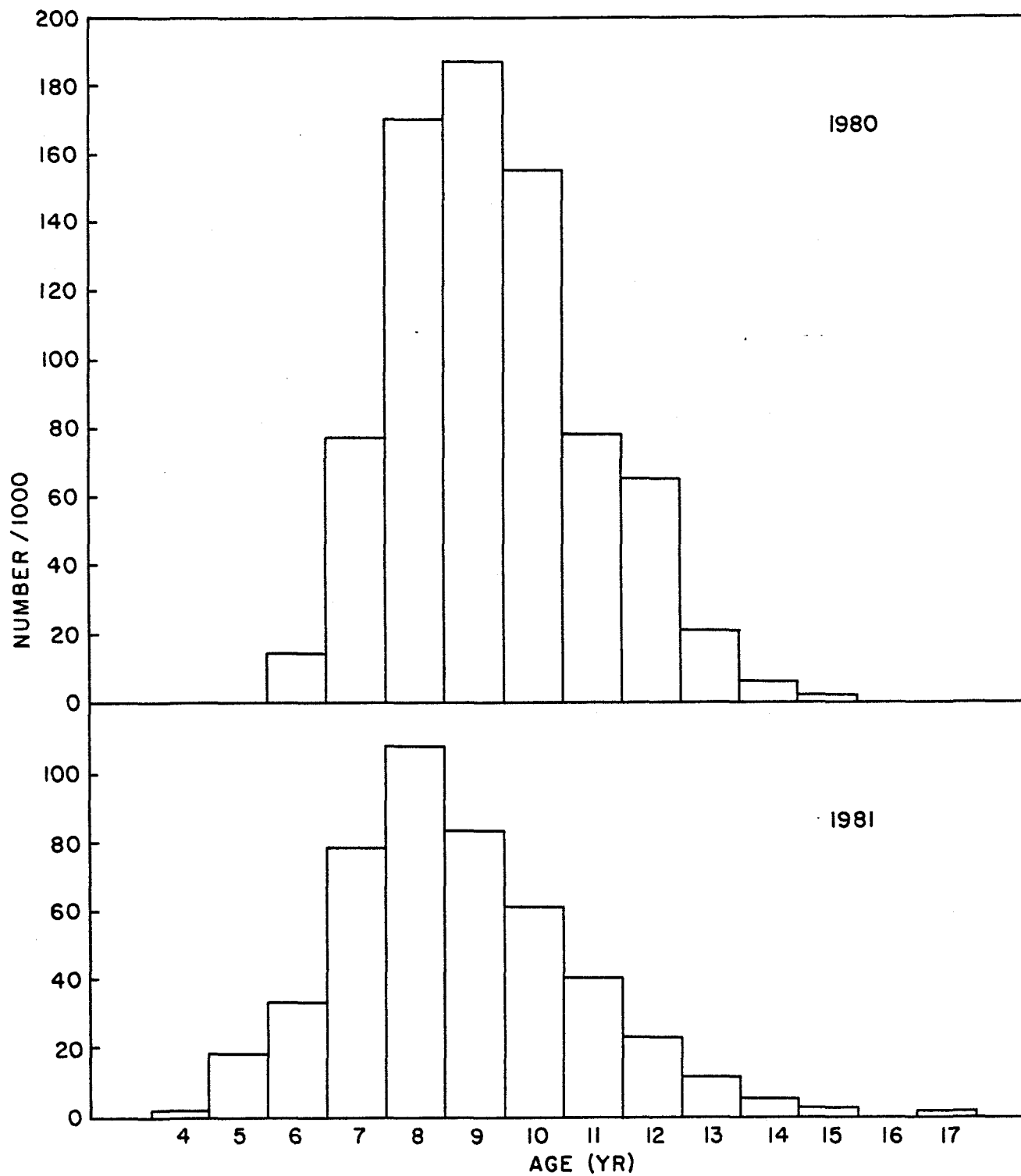Fig. 2. Commercial age composition for male witch in Div. 2J3KL in 1980 and 1981.

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COMMERCIAL FEMALE WITCH
DIV· 2J 3KL

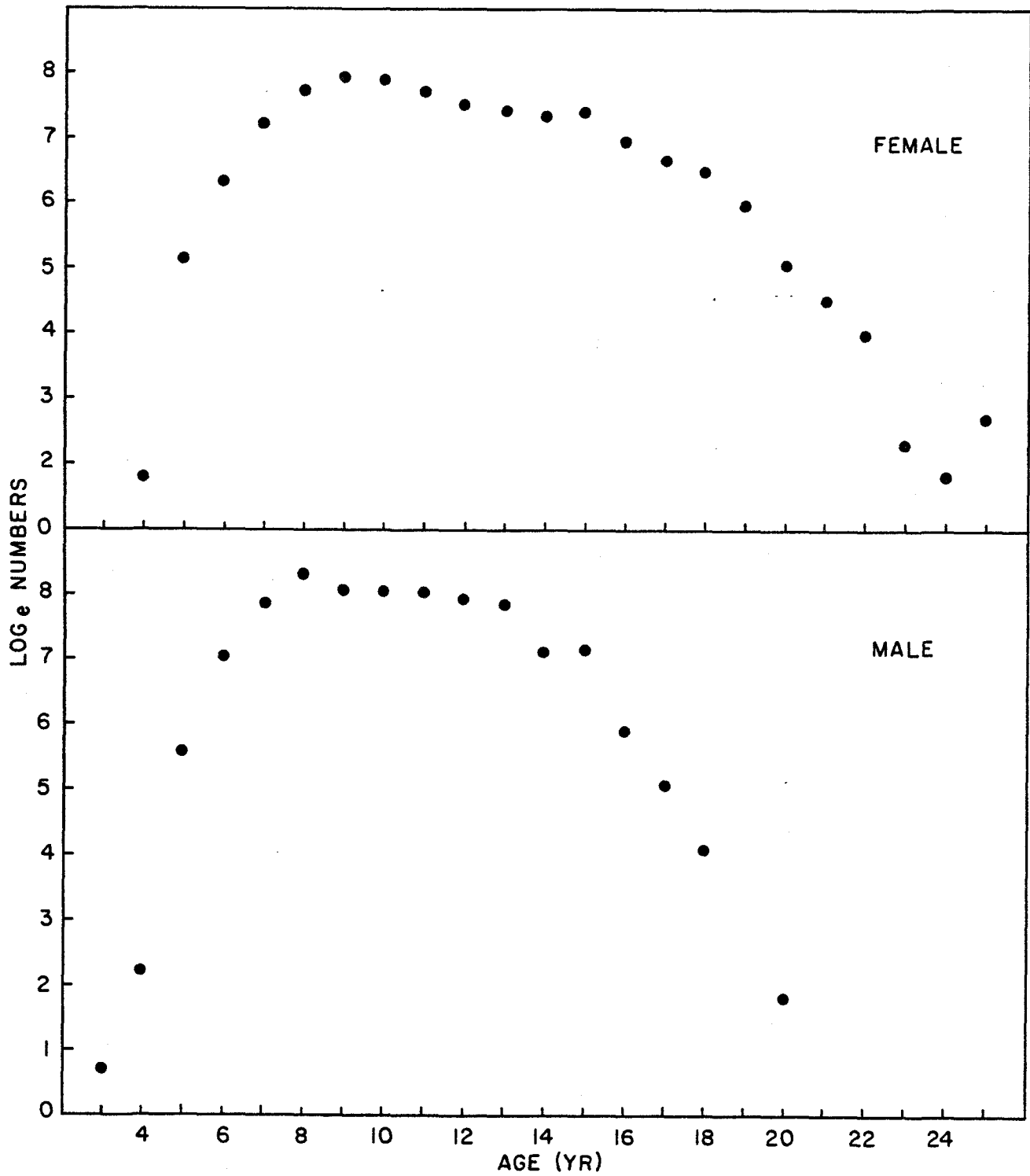Fig. 3. Commercial age composition for female witch in Div. 2J3KL for 1980 and 1981.

COMMERCIAL WITCH (2J3KL)
1976-81

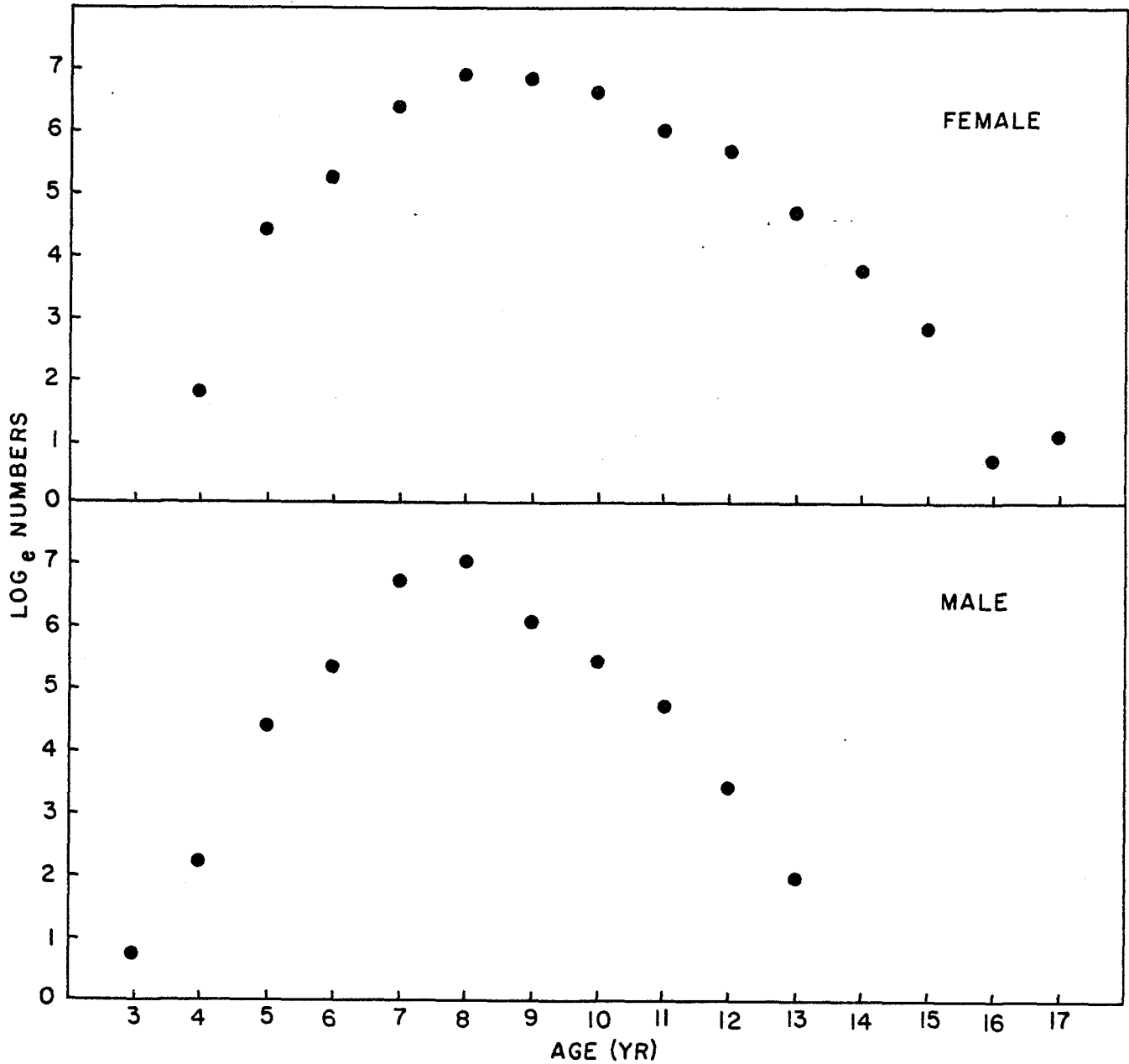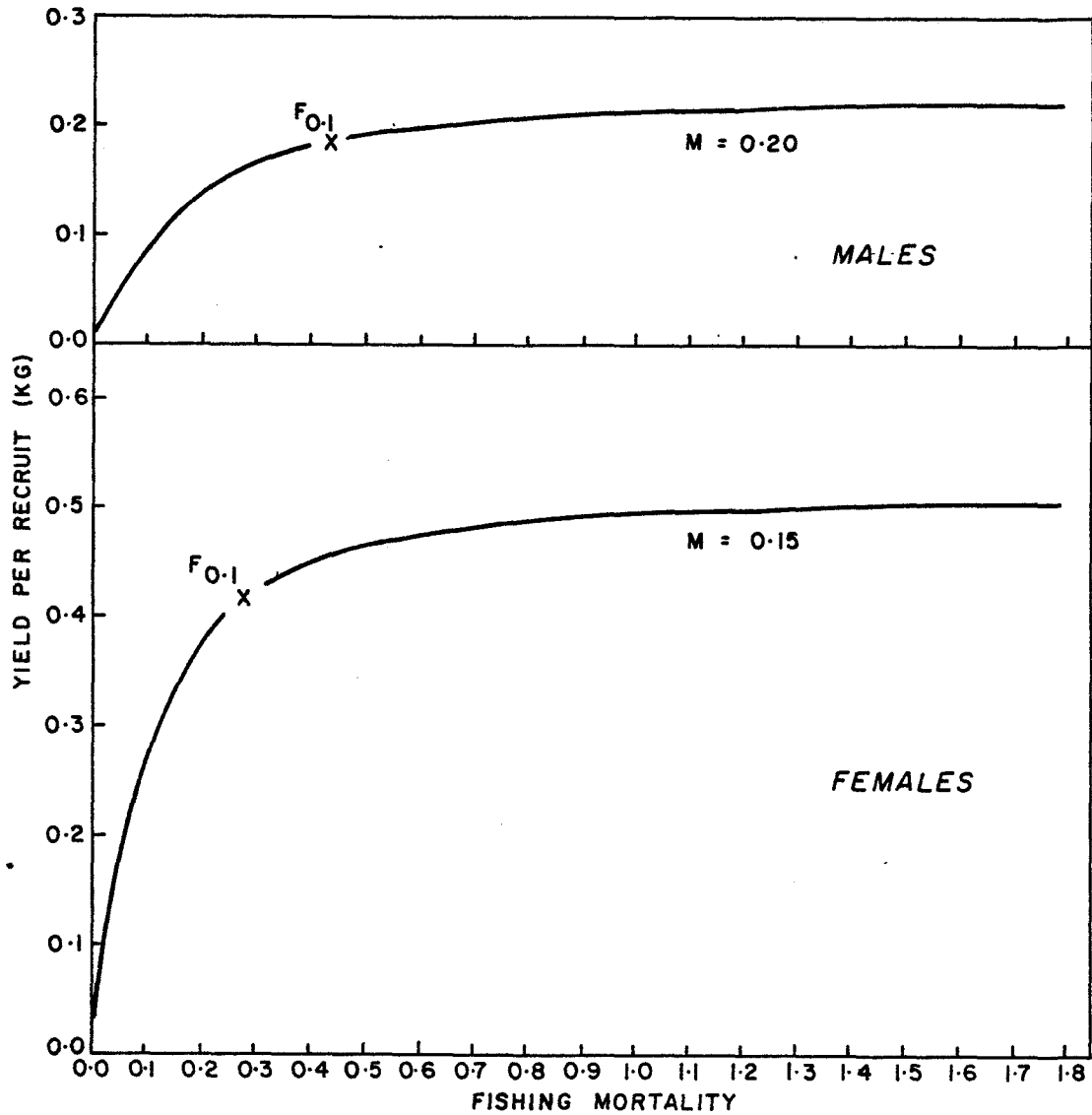Fig. 4. Catch curves for male and female witch in Div. 2J3KL for 1976-81 combined.

Fig. 5. Catch curves for male and female witch from Div. 2J3KL for 1980-81 combined.

WITCH
DIVISIONS 2J, 3KL

Figure 6. Yield per recruit curves from Bowering and Baird, 1980.
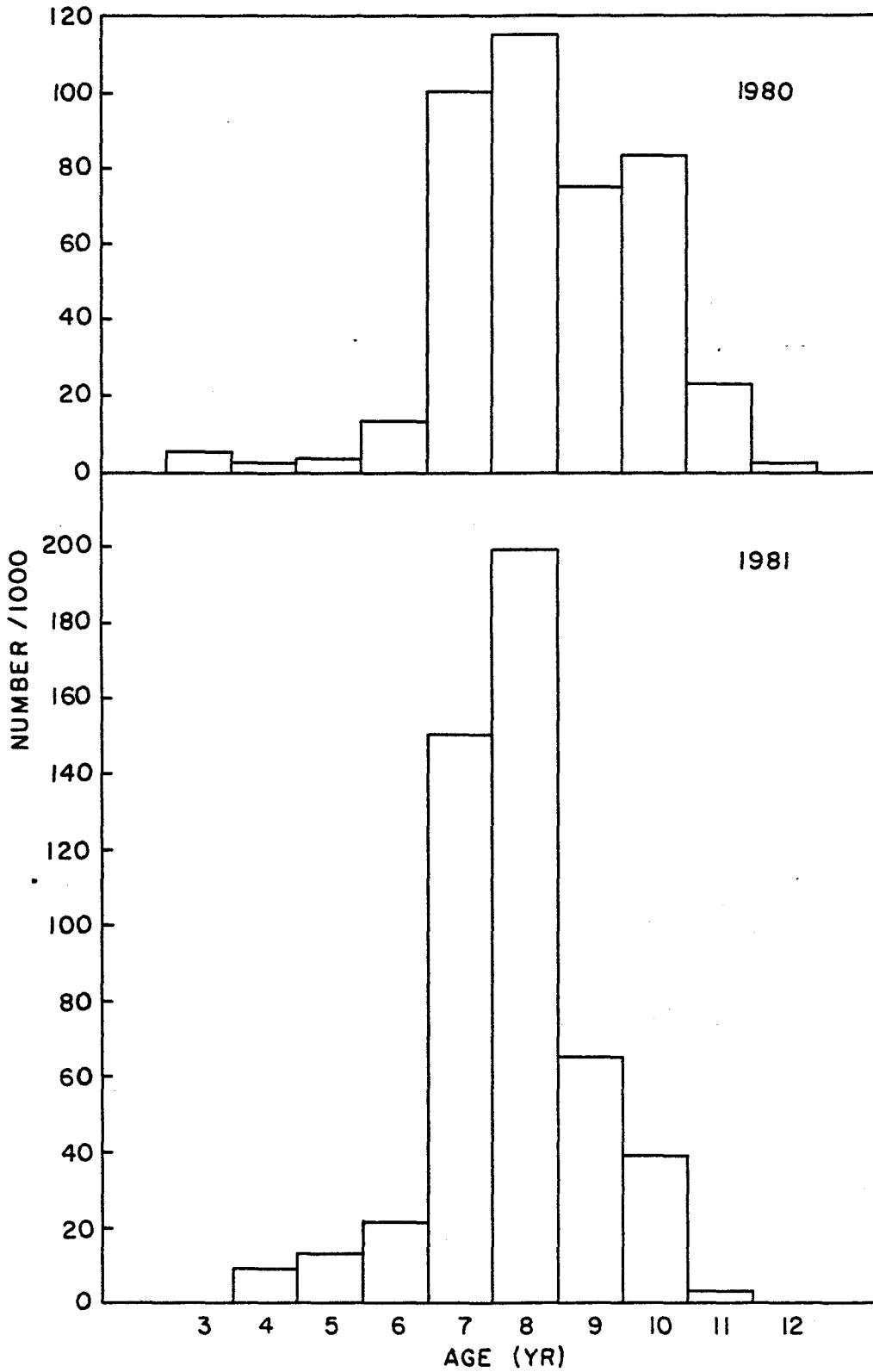
RESEARCH MALE WITCH

DIV· (2J 3KL)

Fig. 7. Research age composition for male witch in Div. 2J3KL for 1980 and 1981.
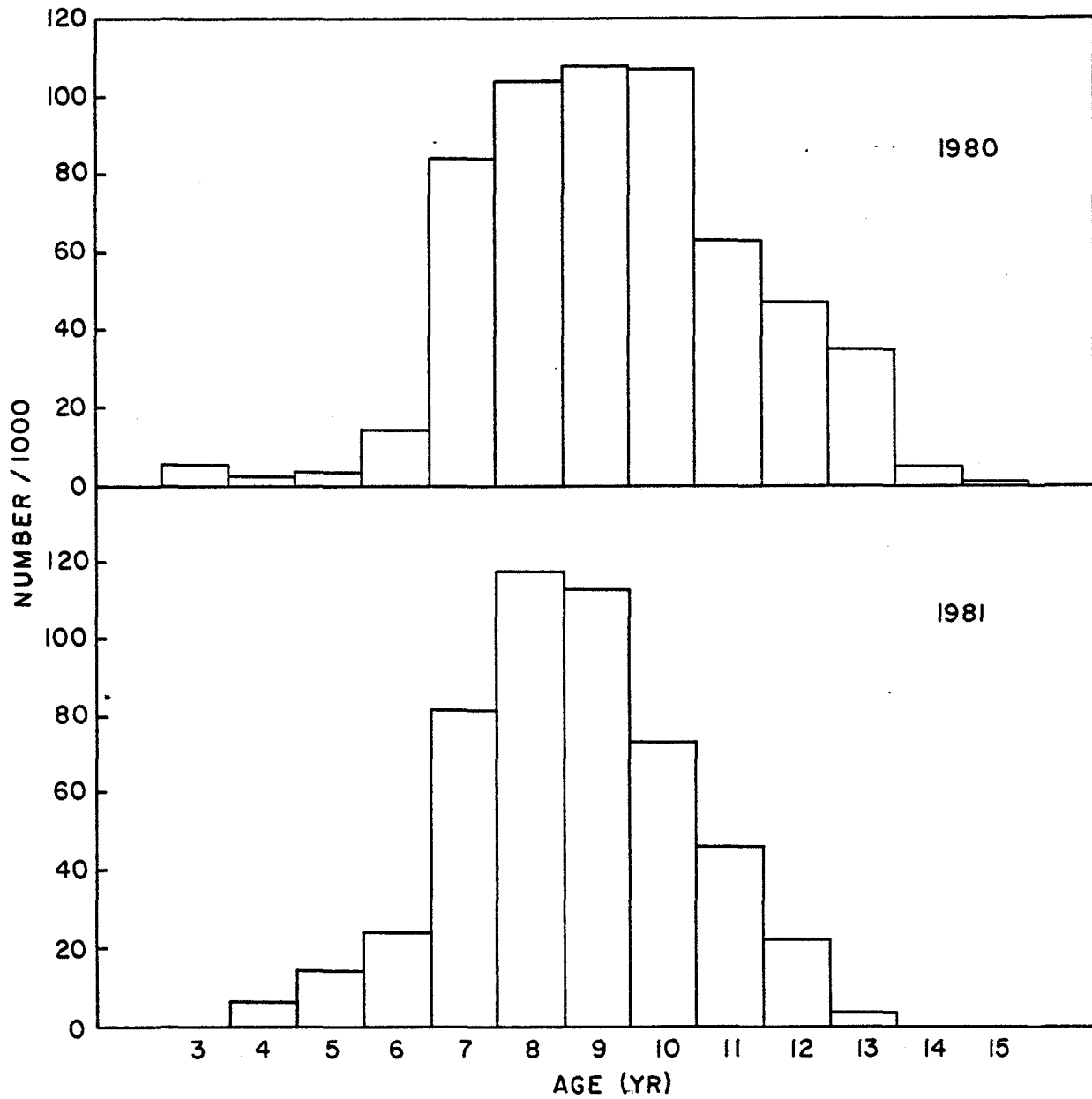
RESEARCH FEMALE WITCH
DIV· (2J3KL)

Fig. 8. Research age composition for female witch in Div. 2J3KL for 1980 and 1981.
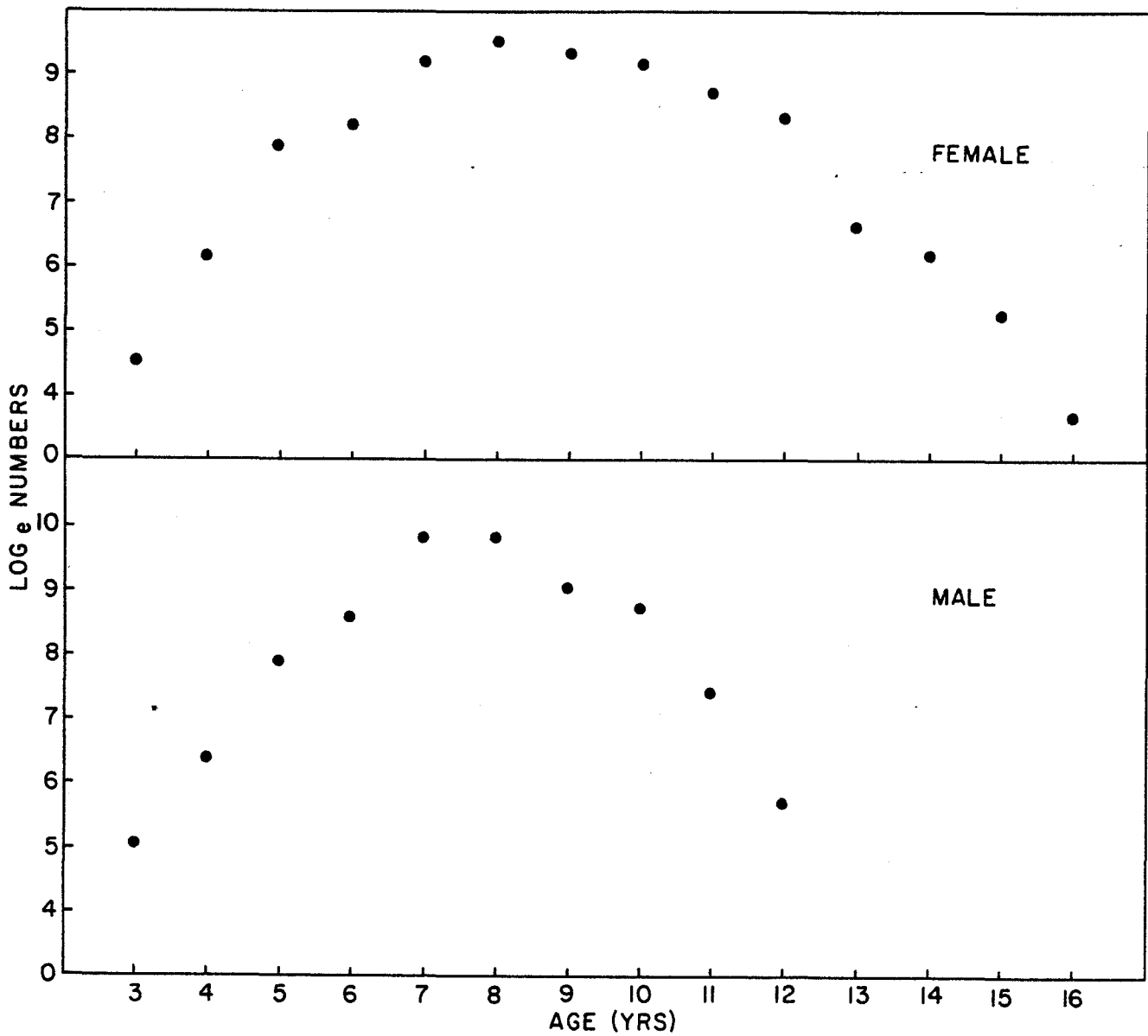
RESEARCH WITCH (3K)
1978-81

Fig. 9. Catch curves for male and female research witch from Div. 3K   for 1978-81 combined.