

INTERNATIONAL PACIFIC HALIBUT COMMISSION

Relationship of Halibut Stocks in Bering Sea as  
Indicated by Age and Size Composition\*

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Tagging experiments by the International Pacific Halibut Commission throughout southeastern Bering Sea have shown that a considerable proportion of tagged halibut emigrate from Bering Sea to grounds in the Gulf of Alaska and some are recovered as distant as the coasts of Oregon and California. However, although there is no evidence of any barrier to free movement of halibut from ground to ground along the 750-mile continental edge in Bering Sea from Unimak Pass to Siberia, the great majority of recoveries within Bering Sea are taken in the vicinity of tagging (Dunlop, et al, 1964). Early recoveries from more recent experiments in western Bering Sea provide similar results (International Pacific Halibut Commission, Mss.). Thus interchange between grounds within Bering Sea appears to be limited.

Age and size composition data have been examined for information which may provide supporting evidence of the relationships of Bering Sea halibut.

Such data can only be indicative of stock relationships, and must be interpreted with a view to changes in composition which may have resulted from removal of larger and older fish due to fishing or which are known to be due to the variable seasonal or bathymetric movements of components of the population (Dunlop, et al, 1964).

Investigations by the Halibut Commission in the northeastern Pacific Ocean have shown that while similarities in composition exist between the halibut from widely separated grounds, differences may appear to exist between closely adjacent fishing grounds apart from those caused by fishing. Such differences were also observed between adjacent grounds in Bering Sea at the time of their initial exploitation.

In addition there are seasonal changes in composition during the year as components of the population participate in movements from deeper water in the spring to shoal grounds in the summer. Movements of this nature were

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also observable at the outset of fishing in Bering Sea (IPHC, No. 27, 1959) and account for much of the seasonal change in composition throughout the region. Consequently, with stock composition data subject to such variation, caution must be exercised in drawing conclusions upon the degree of intermingling or upon the separability of the stocks from one region to another.

Most of the material for size and age composition studies on Bering Sea halibut has been collected by the Halibut Commission since 1956 when the recent fishery began. One of the most extensive data series for a single year is that collected by a Commission chartered vessel in 1967. In the summer of that year exploratory halibut setline fishing and associated tagging and collection of size and age composition data was conducted over the range of known concentrations of halibut along the Bering Sea edge from Unimak Pass to Cape Navarin on the Asiatic coast, on the flats of southeastern Bering Sea and along the Aleutian Islands to Bowers Bank (Figure 1).

The percentage age compositions of the foregoing exploratory setline fishing in 1967 are given in Table 1. In addition the percentage age compositions of North American commercial setline fishing in April of 1967 on some grounds in eastern Bering Sea are given in Table 2. Although the differences between grounds in age composition, particularly in the relative availability of older fish, can be attributed to a considerable degree to the length of time and magnitude of North American setline fishing to which the respective grounds have been exposed, some grounds show a lack of such older fish even when initially exploited by North American vessels.

While the grounds on the edge between 170° W. and 175° W. longitude, commonly known as the Corridor, have been fished by North American setline vessels relatively intensively since about 1962, only an occasional North American vessel has proceeded as far as the grounds between 175° W. and 180° longitude, and no North American setline vessels have fished commercially for halibut further westward along the edge. Similarly little commercial setline fishing has been conducted as far as the Andreanof Islands or on Bowers Bank. Thus despite the great difference observed between the composition of catches from these grounds, it cannot be attributed to any differences in the amount of commercial setline fishing upon them.

Longer-fished grounds in the so-called Triangle Area (see Area 4A, Pacific Halibut Fishery Regulations, 1969) consisting of the Polaris, Clipper and Misty Moon grounds, and which, except for the Clipper ground, initially contained noteworthy accumulations of older fish, now display a lack of older fish. This has been shown to be largely the result of removals by the fishery particularly during the past ten years (Dunlop, et al, 1964) (IPHC Annual Reports, 1957-1969 incl.).

Table 1. Percentage age compositions of setline halibut catches by the International Pacific Halibut Commission tagging vessel on Bering Sea grounds in 1967

Age	Grounds						
	Cape Navarin	175°W.- 180° Edge	Corridor	Pribilof Islands	Bowers Bank	Atka Island	St. Matthew Island
	June	June	June	June	July	July	Aug.
5	-	-	-	-	0.6	1.2	0.1
6	0.4	1.2	-	0.9	0.2	8.7	1.0
7	0.5	1.7	3.4	2.3	0.4	7.2	0.5
8	4.1	3.6	1.7	10.2	2.8	11.2	3.0
9	4.6	8.9	19.5	27.2	9.8	22.0	6.2
10	10.2	9.1	15.3	17.6	4.6	16.7	10.1
11	10.2	7.7	7.6	7.5	4.2	9.1	7.2
12	7.5	6.9	10.2	17.7	7.7	14.6	10.3
13	9.2	2.2	11.0	3.7	4.2	2.7	6.0
14	5.7	8.1	5.1	8.0	10.9	2.3	5.2
15	8.2	6.0	5.1	1.6	2.2	0.6	8.0
16	6.5	8.1	4.2	1.0	3.4	2.2	10.4
17	5.8	3.8	2.5	0.6	1.2	0.3	7.2
18	4.2	3.4	0.9	0.7	4.8	0.6	6.8
19	3.7	4.8	0.0	0.2	6.9	0.1	5.5
20	3.9	7.9	6.8	0.4	5.4	0.3	3.1
21	2.8	3.8	2.5	0.2	1.6	0.0	1.4
22	2.8	3.1	0.0	0.2	3.4	0.1	1.3
23	3.5	1.4	0.0	0.1	3.4	0.2	1.2
24	1.8	1.9	0.0	-	5.0	-	1.2
25	1.1	2.6	1.7	-	4.8	-	0.4
26	1.7	2.6	2.5	-	4.0	-	0.9
27	1.0	0.5	-	-	2.6	-	0.7
28	0.3	0.7	-	-	1.6	-	0.1
29	0.1	-	-	-	2.2	-	0.1
30	0.2	-	-	-	1.2	-	0.0
31	-	-	-	-	0.4	-	0.0
32	-	-	-	-	0.6	-	0.1
33	-	-	-	-	-	-	0.1
(16+	39.4	44.6	21.1	3.4	52.5	3.8	40.5)
Total	100.0	100.0	100.0	100.1	100.1	100.1	100.1

The effects of fishing by other nations on the age composition on some of the foregoing grounds are difficult to appraise due to the different selection properties of the gear used, both setline and trawl net. Nevertheless, the trawl fishery on some grounds does appear to be having a significant effect upon the age structure (IPHC, No. 49, 1969).

Obviously with the complication of fishery-induced differences, the condition of the virgin or non-fished accumulations prior to exploitation would be more indicative of inherent composition differences.

Table 2. Percentage age composition of United States and Canadian commercial setline halibut catches on Bering Sea grounds in 1967

Age	Grounds				
	Polaris April	Clipper April	Misty Moon April	Corridor April	St. Matthew Island Oct.
5	0.1	-	-	-	-
6	6.6	1.5	0.4	0.1	-
7	5.6	3.6	1.5	0.2	-
8	10.3	11.4	3.3	3.4	0.7
9	32.6	36.6	25.5	24.3	6.4
10	15.2	23.4	22.7	14.5	9.3
11	7.0	6.3	9.4	7.8	2.9
12	12.3	10.1	17.3	11.3	10.0
13	4.0	2.8	5.3	1.5	6.4
14	2.0	2.3	4.3	4.8	6.4
15	1.4	0.4	3.1	4.6	8.6
16	0.7	1.6	2.3	4.9	11.4
17	0.5	-	1.1	6.5	7.9
18	0.3	-	0.7	5.9	8.6
19	0.2	-	1.0	2.2	7.1
20	0.5	-	0.8	2.0	3.6
21	0.2	-	0.1	1.1	3.6
22	0.1	-	0.1	0.6	2.1
23	0.1	-	0.0	0.6	0.0
24	0.0	-	0.2	1.7	1.4
25	0.1	-	0.0	0.3	1.4
26	0.0	-	0.3	0.8	1.4
27	0.1	-	0.1	0.4	0.7
28	0.0	-	-	0.1	-
29	0.0	-	-	0.3	-
30	0.0	-	-	0.0	-
31	0.1	-	-	0.1	-
(16+	2.9	1.6	6.7	27.5	49.2)
Total	100.0	100.0	100.0	100.0	99.9

Percentage compositions by groups of ages in samples of initial North American catches by setline gear from most known Bering Sea grounds are shown in Table 3.

Though some grounds such as the Fox Islands grounds in 1930, Slime Bank in 1952, Clipper in 1959, Nunivak in 1965, and Atka Island in the Andreanof group in 1967, were conspicuous by a relatively large proportion of young fish at their initial stage of fishing by North American setline gear, other grounds, namely Polaris, Corridor, portions of the edge between 175° W. and 180°, the flats in the vicinity of St. Matthew Island, Cape Navarin and Bowers Bank displayed a considerable proportion of older fish.

Table 3. Percentage composition by groups of ages (under age 11, age 11-15, and age 16 and older) at the initial stage of North American setline fishing on various grounds in Bering Sea

Grounds	Date of Initial Catches	Percentage of Catch		
		Under Age 11	Age 11-15	Age 16 & Older
Fox Islands Grounds	6/30	47.1	36.4	16.5
Slime Bank	8/52	65.5	33.5	1.0
Polaris Ground	6/56	13.0	53.8	33.2
Clipper Ground	5/59	69.0	22.7	8.3
Misty Moon Ground	4/63	34.3	52.5	13.2
Corridor Grounds	4/63	31.2	51.7	17.1
175° W. - 180° Edge	4/64	18.2	52.0	29.8
Pribilof Islands	7/64	35.8	60.0	4.2
Bowers Bank	4/65	5.7	22.5	71.8
Nunivak Island	8/65	91.4	7.9	0.7
St. Matthew Island	8/65	10.5	50.0	39.5
Cape Navarin	6/67	19.8	40.8	39.4
Atka Island	7/67	67.0	29.3	3.7

The observed similarities obviously were not related to the proximity of any of these grounds one to another, while the differences between other quite adjacent grounds suggest their relative independence. It would seem unlikely that such differences would be apparent between adjacent grounds when initially exploited if mixing occurred to any significant degree. Furthermore, if mixing were even relatively rapid, it would tend to obscure the differences due to effects of the fishery. That such mixing does not occur rapidly between grounds along the edge is evidenced further by the lack of recovery of heavily-fished grounds in regulatory Area 4A, particularly the Polaris ground, from their decimated condition since 1963 (IPHC, No. 46, 1968) despite the fact that adjacent but less heavily-exploited grounds to the westward continue to contain relatively high proportions of older and larger halibut.

On the other hand the same prominent as well as the same relatively weak year classes show up simultaneously throughout the above wide range of samples. Such similarities in year-class strength, while not proof of any close relationships of the stock components, at least suggest that the recruitment to the several sections of the region had been exposed to not dissimilar survival conditions.

Age-weight relationships of female halibut in the June 1967 catches by the Halibut Commission tagging vessel at various locations from the Corridor grounds to Cape Navarin and for commercial catches from Polaris ground in April 1967 shown in Figure 2 indicate a progressive decrease in average weight at each age from southeast to northwest and suggest that

little intermingling occurs along the Bering Sea edge. The catches off Cape Navarin contained the smallest halibut for their age found to date in North American setline catches in Bering Sea.

Similarly, average weight by age data from unsexed samples of commercial landings from grounds in southeastern Bering Sea in 1969 display a progressive reduction in size from east to west (Figure 3). Although the sex composition of these samples was not available, catches from this region over a period of years have consistently been of predominately female fish at the time of the commercial setline fishing season in early spring (Dunlop, H. A., et al, 1964, and IPHC, 1964 to 1969 inclusive).

Differences in size and age composition comparable to those above have also been shown by Novikov (1964) for Soviet trawl catches of halibut in various Bering Sea and Asiatic coastal locations. The largest halibut reported in the Soviet catches were found in southeastern Bering Sea in the vicinity of the Polaris ground. Halibut reported by Novikov from northwest and central Bering Sea (probably from about the same region along the edge as Commission samples from between 175° W. and 180°) and from far-western Cape Olyutorski were progressively smaller than those from southeastern Bering Sea. The smallest trawl-caught halibut reported were from the westerly Sea of Okhotsk. The age-length relationship of these latter small young fish extrapolates moderately well into that of the relatively small but older fish in the setline catch by the Halibut Commission off Cape Navarin.

While differences in average weight of similar magnitude have been observed for adjacent grounds elsewhere on the Pacific Coast, the consistency of the progressive reduction in average size of halibut from east to west tends to confirm other indications from tagging and age composition that mixing of stock between grounds along the edge remains incomplete.

#### Summary

In support of direct evidence from tagging, comparison of data upon size and age composition of the halibut from different grounds in Bering Sea provides indications that little intermingling occurs between grounds in the region, or at least that such interchange is slow and incomplete except for the expected seasonal movements between deep and shoal waters.

Though such data must be interpreted with caution due to observed effects of fishing and seasonal changes in composition, differences are observed between adjacent grounds which might be expected to have been obscured if free interchange existed. Furthermore, the existence of notable differences in composition between proximate grounds in their virgin unfished state supports this conclusion.

On the other hand, similarities in composition between other grounds and in year-class strength throughout the wide range of halibut in Bering Sea suggest that common conditions for survival of recruitment may prevail.

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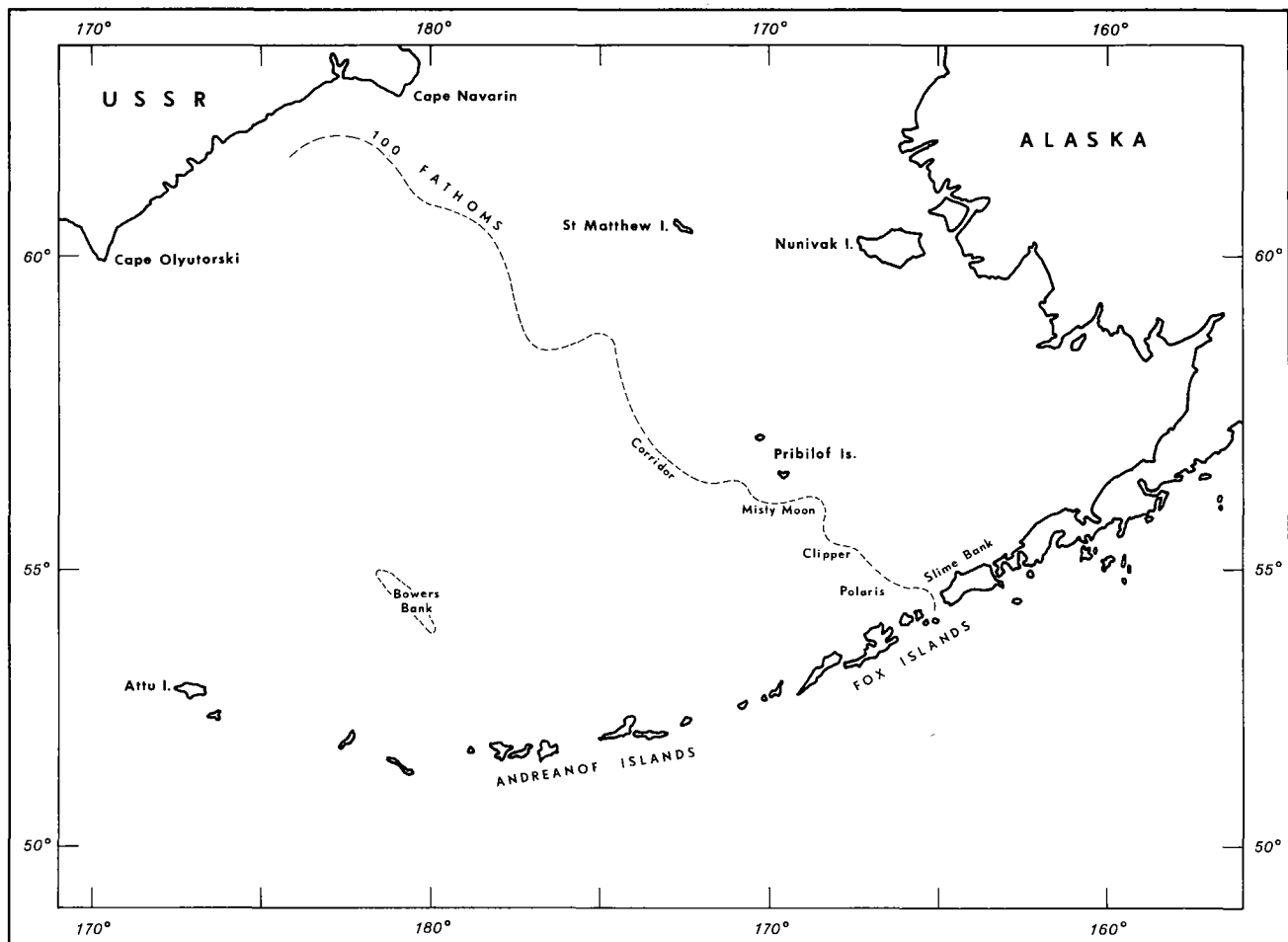


Figure 1. Fishing grounds and locations in Bering Sea referred to in this report.

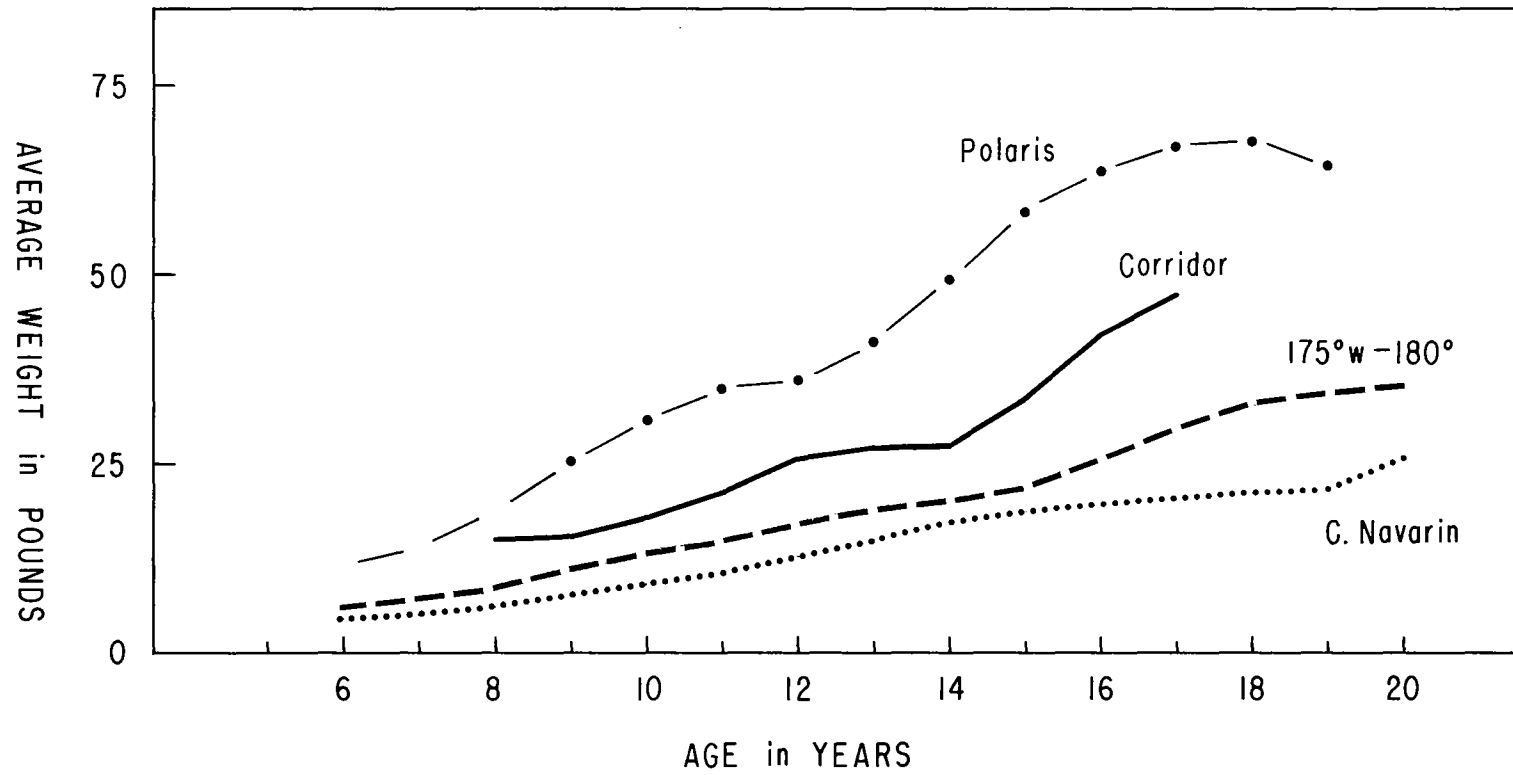


Figure 2. Average weight at each age for setline-caught female halibut on edge grounds in Bering Sea in 1967. Polaris ground data are from "observed" North American commercial catches; data from other grounds are from Commission charter vessel catches

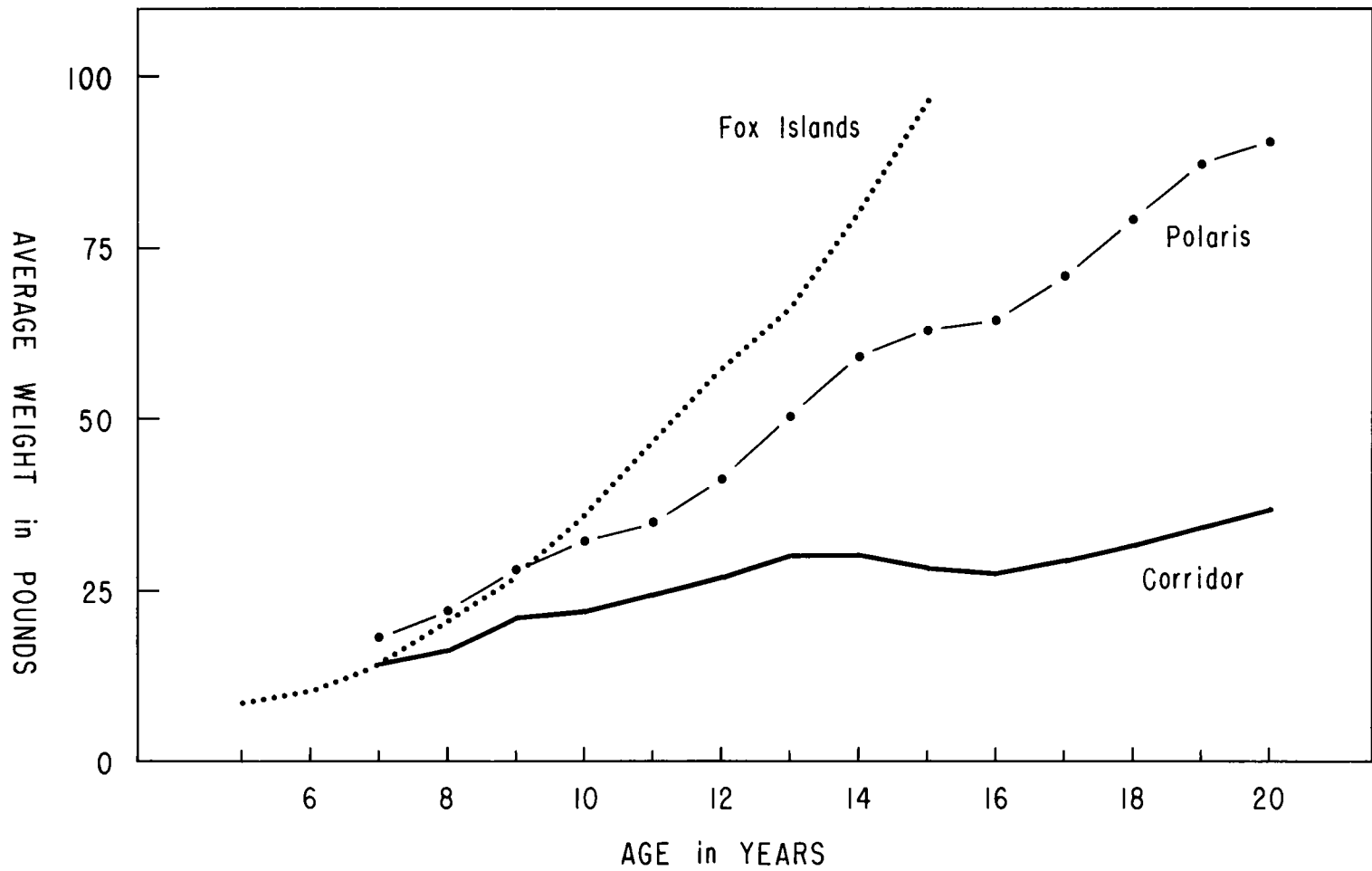


Figure 3. Average weight at each age of unsexed halibut taken by North American commercial setline vessels from grounds in southeastern Bering Sea in April 1969