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Progress Report on the Cooperative study of Ageing Silver Hake

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Scientific advisors to Panel Five recommended at the 1964 annual meeting a cooperative study of methods of ageing silver hake (Proceedings No. 5, Appendix I, 1964 Annual Meeting). The initial effort was to be an exchange of otoliths, and the U.S.A. agreed to coordinate the exchange.

An exchange of otoliths has been completed among Canada, U.S.S.R. and U.S.A. The U.S.A. sent samples of aged otoliths of male and female silver hake from Subarea 5 to Canada and the U.S.S.R., and received similar samples of otoliths from Subarea 4 from both countries in return (Table 1).

The authors have made age estimates of the otolith samples received, and have examined age estimates of the U.S.A. otoliths by U.S.S.R. and Canadian biologists. Age estimates are summarized in tables 2 through 7. The results are provisional and serve primarily to show the degree of agreement, and to emphasize specific ageing problems.

Otoliths from the three areas (5Z, 4X, 4W) appeared to be about equally readable. Aside from the differences in size composition of the fish, the samples differed mainly in that the opaque centers of the Sable Island otoliths were uniformly larger than those in the samples from Subareas 4X and 5Z.

Despite a comparatively low percentage of agreement (38%), it is encouraging to find that the majority of disagreements are within one year. There was no tendency to double or triple the estimates through reading split hyaline zones as additional year zones. This is relatively good agreement in the absence of preliminary studies defining time of spawning, growth rate of juveniles, and seasonal variation in opaque and hyaline zone formation.

Year Zone Interpretation

Disagreement in zone interpretation appears to be concentrated in two portions of the otolith. More than half of the differences are related to the interpretation of the first hyaline zone near the otolith center. A lesser amount of disagreement is caused by differences in interpreting the nature of the otolith edge during late summer and fall, particularly in large fish.

Two readily identifiable patterns of center zone formation occur in silver hake otoliths from the Georges Bank area. Otoliths with very small opaque centers surrounded by a clearly defined hyaline zone comprise the first group and include about one third of the samples. The second pattern is found in about half the fish and consists of a large, obscure opaque center surrounded by an indistinct hyaline zone. The remainder consist of a variety of patterns intermediate between the two. In correspondence last year, Emery, the Canadian cooperator, noted the two types of opaque center and attributed the large centers to fish spawned in early summer and the small centers to fish spawned in the fall. We feel that this is a logical deduction, but we do not have spawning data to substantiate this point at the present time.

Frequently two well defined hyaline zones are visible near the opaque center of the otolith, but the inner zone is often discounted as an accessory ring by some age readers. Back calculations of age from scales and otoliths indicate that some silver hake in the Georges Bank area are less than 5 cm long at the time of the inner hyaline zone formation, and this zone near the center of some otoliths may represent the first winter zone of the smaller members of a year class. It is this portion of the otolith that frequently is interpreted differently by different age readers. A detailed study of the seasonal growth of young fish will be necessary to clarify the formation of the inner hyaline zones in scales and otoliths.

Interpretation of the otolith edge is particularly difficult in the fall when it is not clear whether summer growth has ceased. In many larger otoliths, much of the edge is hyaline throughout the year, and the opaque zones are apparent primarily at the elongated tips of the otolith. Opaque zones near the edge of larger otoliths tend to be very narrow in comparison to earlier year zones. These narrow zones, similar to "spawning zones" in cod, might be construed as split hyaline zones by the age reader and be grouped together as a year zone. Split zones do occur but can often be detected by the recurrence of a similar pattern of spacing in the earlier year zones.

Time of spawning and young-of-the-year silver hake occurrence

A considerable body of data on occurrence and length frequency of silver hake have been collected in the Georges Bank region during the past 15 years on research cruises of the ALBATROSS III, DELAWARE and ALBATROSS IV. Hardy Plankton Recorder samplings in 1953, 1955 and 1956 (Marak and Colton, 1961; Marak, Colton and Foster, 1962; Marak, Colton, Foster and Miller, 1962) provided excellent coverage of the surface waters of the Gulf of Maine and vicinity from early March till June of each year. In each year, no silver hake eggs or larvae were collected until the latter half of May, and the larvae/eggs ratio was increasing steadily when sampling was discontinued in mid-June (Table 8). The first eggs were encountered each year in the waters south of Nantucket Shoals and western Georges Bank. Spawning probably begins regularly about mid-May in this area. Unfortunately, we have little planktonic data to indicate how long spawning continues or whether there is more than one seasonal peak in silver hake spawning activity in this region.

Seasonal samplings of silver hake smaller than 25 cm collected on U.S. research cruises in otter trawls or midwater trawls are summarized in Table 9. Midwater sampling from July through September yielded considerable numbers of silver hake ranging from 1 to 7 cm that had apparently been spawned between June and September. Bottom trawling in September-October showed a mode in the length-frequency at about 5-6 cm that was not present during the January to June sampling. The young-of-the-year fish mode was at 6 cm in November, 9 cm in January, 10 cm in February, and at 14 cm in June. At that time a few 1-2 cm fish had begun to appear again in the catch. This progression of modes serves as some measure of the average growth of silver hake in the Georges Bank region during their first year. Most of the fish are probably less than 11 cm long on January 1st, and this point will be a useful guide in establishing the rate of tissue accretion in scales and otoliths during the first winter.

Studies are in progress comparing the seasonal changes in growth pattern in scales and otoliths of small silver hake during the first year of life. Midwater sampling for small hake will be done in late summer, fall and winter to add to our present knowledge of the early life history of this species. Age back calculations on scales and otoliths of large silver hake will be made to relate the calculated length at first year zone to the size composition of small fish observed during the first winter.

Based on the experience of this otolith exchange, the authors feel that further comparisons of ageing techniques for silver hake will be better accomplished through the exchange of duplicate sets of enlarged photographs of otoliths and scales. These could be examined, marked and returned to a central coordinator who could determine precisely where the various readers agreed or disagreed in their age estimates.

Table 1.

Silver hake otolith collections used in ICNAF otolith exchange.

Country of origin	ICNAF Subarea	Date Collected	Number of fish			Size range	Preservative
			Juv.	Male	Female		
Canada	4X(Nova Scot.Bk)	Sept.22 1964		21	29	25-43 cm.	50% Glycerin-water
U.S.A.	5Z(Georges Bank)	July-Aug.1964	5	16	19	10-43 cm.	95% Ethyl alcohol
U.S.S.R.	4W(Sable Island)	August 1964	1	22	17	19-34 cm.	95% Alcohol

Table 2.

Canadian and U.S.A. age estimates of Silver Hake otoliths from Subarea 4X. (Canadian sample collected Sept. 22, 1964)

Sex	Length cm.	Age estimates: Emery Canada	Nichy U.S.A.	Kelly U.S.A.
Males	27	2	3	2
	29	4	3	4
	31	6	7	6
	31	6	5	7
	26	3	3	4
	29	4	5	5
	25	5	7	7
	30	4	3	5
	34	7	6	9
	28	6	4	6
	34	6	5	5
	35	9	6	7
	32	5	6	6
	28	5	5	5
	25	-	3	3
	35	10	5	11
	32	8	7	8
	27	6	6	6
	25	4	5	5
	33	7	7	8
	30	6	4	6
Females	41	9	8	8
	39	7	6	7
	38	9	8	10
	39	8	6	8
	26	3	4	2
	34	6	5	6
	32	5	5	7
	37	7	7	9
	37	11	8	9
	28	3	3	4
	36	7	5	6
	43	10	8	10
	30	5	5	4
	31	6	4	5
	33	4	4	5
	32	5	6	8
	35	7	6	9
	36	7	7.	7
	27	2	3	4
	33	5	5	5
	34	6	5	7
	38	9	7	9
	30	5	5	5
	29	5	4	5
	35	7	6	7
	40	9	9	9
	28	4	5	5
	43	7	7	7

Table 3.

U.S.S.R and U.S.A. age estimates of Silver Hake otoliths from the Sable Island area, ICNAF Subarea 4W.

(U.S.S.R. sample collected August 1964)

Sample Number	Length cm.	Sex		Age Estimates U.S.S.R.	U.S.A. NICHY	U.S.A. KELLY				
1	34	♀		4	5	6				
2	29	♂		3	4	4 (5)				
3	26	♂		2-3 ?	3	3				
4	27	♂		3	4	4				
5	26	♀		3	3	4				
6	24	♂		2	3	3				
7	23	♂		2	3	3				
8	24	♂		2	3	3				
9	26	♂		2	3	4 (3)				
10	24	♂		2	3	3				
11	25	♂		3	3 (2)	4				
12	26	♂		3-4 ?	3 ?	5				
13	27	♀		3	3	5				
14	30	♀		4	4	5				
15	26	♀		3	2 (3)	4				
16	24	♂		2	2 (3)	3				
17	25	♂		3	2	4				
18	24	♂		2	2	3				
19	27	♂		2-3 ?	3	3				
20	25	♂		2	3	4				
21	29	♂		3	3 (4) ?	4				
22	26	♂		3	4 (3)	6				
23	27	♀		3	3 (2)	5				
24	25	♂		2	3	4				
25	26	♂		2	3 (2)	3				
26	25	♂		2	2	4				
27	31	♀		3	4	4				
28	29	♀		3	4	4				
29	31	♂		4-3 ?	5	5				
30	30	♀		3	3	3				
31	28	♀		3	4	5				
32	26	♀		2	3	3				
33	30	♀		4	4	4				
34	19	Juv.		1	1	1				
35	32	♀		4-3 ?	4 (5)	5				
36	25	♂		2	3	2				
37	26	♀		3	3	2				
38	29	♀		4	4	4				
39	29	♀		3	4	4				
40	27	♀		3	5 (4)	5				

Table 4.

U.S.S.R. and U.S.A. age estimates of Silver Hake otoliths from Georges Bank, Subarea 5Z.

(U.S.A. sample collected July-August, 1964)

Sample Number	Length cm.	Sex		Age Estimates U.S.S.R.		U.S.A.				
82 - 1	17	Juv.		1		1				
" - 2	32	♂		5		4(5)				
" - 3	31	♀		3		4				
" - 4	31	♀		4		4				
" - 5	28	♂		3		3				
" - 6	27	♂		3		3				
" - 7	21	♂		-		2				
" - 8	26	♂		3		3				
" - 9	19	Juv.		1		2?				
" - 10	25	♂		2		3				
81 - 11	22	♂		2		2				
" - 12	28	♀		3		3				
85 - 13	10	Juv.		1?		1?				
" - 14	30	♀		3		4				
" - 15	11	Juv.		1		1				
" - 16	26	♀		3		3?				
67 - 17	33	♀		4		3				
" - 18	35	♀		4		4				
" - 19	34	♀		4		3				
" - 20	34	♀		4		4				
91 - 1	43	♀		7		7				
" - 2	36	♀		4		4				
" - 3	32	♂		4		6				
" - 4	31	♂		4		4				
" - 5	29	♂		3		4				
" - 6	31	♀		3		2				
" - 7	25	♂		2		3				
" - 8	19	♀		1		1				
" - 9	26	♂		3		2				
" - 10	22	♀		2		2				
" - 11	20	♀		1		1				
" - 12	19	♂		1		1				
" - 13	15	♂		1		1				
82 - 14	42	♀		4		4				
" - 15	30	♀		3		3				
" - 16	27	♀		3		3				
" - 17	27	♂		3		3				
" - 18	26	♂		3		2				
" - 19	28	♀		3		3				
" - 20	15	Juv.		1		1				

Table 5.

Summary of Canadian and U.S.A. age estimates of Silver Hake from Subarea 4X (Canadian sample). Percentage of agreement and deviation of Reader No. 1 estimates compared with Reader No. 2 data.

Reader No. 1 --	Reader No. 2	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	Percentage Agreement
Emery (Can.)	- Nichy (U.S.A.)					1	9	14	14	7	2	-	1		- 29.1
Kelly (U.S.A.)	- Emery (Can.)					2	6	20	13	6	1				- 41.7
Kelly (U.S.A.)	- Nichy (U.S.A.)					1	3	15	15	12	-	-	-	1	- 31.2

Table 6.

Summary of U.S.S.R. and U.S.A. age estimates of Silver Hake from Sable Island area, Subarea 4W (U.S.S.R. sample). Percentage of agreement and deviation of Reader No. 1 estimates compared with Reader No. 2 data.

Reader No. 1 -	Reader No. 2	-3	-2	-1	0	+1	+2	+3	Percentage Agreement
U.S.S.R.	- Nichy (U.S.A.)		1	21	16	2			- 40.0
U.S.S.R.	- Kelly (U.S.A.)	1	10	23	5	1			- 12.5
Nichy (U.S.A.)	- Kelly (U.S.A.)		7	12	19	2			- 47.5

Table 7.

Summary of U.S.A. and U.S.S.R. age estimates of Silver Hake from Georges Bank, Subarea 5Z (U.S.A. sample). Percentage of agreement and deviation of Reader No. 1 estimates compared with Reader No. 2 data.

Reader No. 1 -	Reader No. 2	-3	-2	-1	0	+1	+2	+3	Percentage Agreement
U.S.S.R.	- Nichy (U.S.A.)		1	6	26	6			66.7

Table 8.

Summary of Hardy Plankton Recorder collections of Silver Hake eggs and larvae from Gulf of Maine and Georges Bank, Spring 1953-55. (Albatross III Cruises)

Year	Cruise Number		Dates	Number Days		Silver Hake Eggs	Silver Hake Larvae		
1953	Alb-III-	46	Mar.19-Apr.2	15		0	0		
	" "	48	Apr.24-May 8	15		0	0		
	" "	50	May 25-June 3	10		64	71		
1955	Alb-III-	57	Feb.21-Mar.2	10		0	0		
	" "	58	Mar.19-Apr.1	14		0	0		
	" "	60	Apr.19-May 2	14		0	0		
	" "	61	May 16-May 28	13		114	109		
1956	Alb-III-	71	Feb. 20-Mar.2	12		0	0		
	" "	72	Mar. 21-Mar.31	11		0	0		
	" "	73	Apr. 17-Apr.28	12		0	0		
	" "	75	May.16-May 29	14		94	27		
	" "	76	June 11-June 24	14		81	507		

Table 9.

Length frequencies of Silver Hake smaller than 25 cm. collected in United States research vessel otter trawl and midwater trawl samples from the Georges Bank region. Modes in length frequencies are enclosed in blocks.

Length cm.	Jan. 1959	Feb. 1955	June 1955	June 1961	July Aug. 1957	July Aug. 1958	Sept. 1957	Sept. 1958	Sept. 1953	Sept. Oct. 1958	Nov. 1956
1			1		3			521	6		
2			1		69		25	1958	20	1	3
3					61	2	96	659	28	18	44
4					1	1	521	115	7	81	113
5		1					243	34	13	192	219
6					1		59		40	188	567
7	12	3					4		31	66	326
8	13	30	1						1	31	64
9	18	123	2		1				1	9	28
10	12	165	3	1						1	12
11	6	129	25	9							3
12	1	71	80	72							3
13	8	34	145	178							5
14	6	10	160	228	3					5	8
15	1	2	96	157	5	1				13	19
16	8	1	71	63	3	1				27	37
17	3	2	26	23	1	2				33	47
18	2	3	17	9		1				46	51
19	3	3	19	5		2				44	68
20	11	7	23	3		1				48	92
21	37	6	24	15		1				40	99
22	112	14	43	12						44	98
23	137	19	50	45						45	126
24	139	11	38	47						67	133
25	67	24	60	64		1				102	144
Type of Fishing Gear	1/ O.T.	O.T.	O.T.	O.T.	2/ M.W.T.	M.W.T.	M.W.T.	M.W.T.	O.T.	O.T.	O.T.

1/ O.T. represents 1/ 36 otter trawl with $\frac{1}{2}$ inch liner.

2/ M.W.T. represents 10 foot Isaacs-Kidd midwater trawl with 3/8 inch liner.