Report From The Workshop On Ageing Methodology Of Walleye Pollock (Theragra chalcogramma)

Held at the Sea Fisheries Institute
Gdynia, Poland
September 10-14, 1990

At the Khabarovsk Symposium, held April 2-5, 1990, a research plan for Donut Hole pollock in the Bering Sea was adopted. The first item in this plan was that a workshop on ageing methodology be convened in Poland during 1990 to standardize age determination techniques for walleye pollock. Such a meeting was held from Sept. 10-14, 1990, at the Sea Fisheries Institute, Gdynia, Poland. The participants were:

1. Canada, Dr. Richard J. Beamish, Pacific Biological Station.

2. Japan, Dr. Akira Nishimura, Mr. Taku Yoshimura, Institute For Far Seas Fisheries, Shimizu.

3. Peoples Republic of China, Mr. Ren Shengmin, Yellow Sea Fisheries Institute, Qingdao.

4. Poland, Dr. Tomasz B. Linkowski, Dr. Jerzy Janusz, Ms. Magdalena Kowalewska-Pahlke, Ms. Barbara Szostakiewicz, Sea Fisheries Institute, Gdynia.

5. United States, Dr. Daniel K. Kimura, Ms. Julie Lyons, Alaska Fisheries Science Center, Seattle.

Dr. R.J. Beamish presented preliminary data to show that accurate estimates of strong year classes are important in the understanding of the effects of climate changes on recruitment. Mr. R. Shengmin presented a paper titled: Age determinations of walleye pollock based on otoliths in the eastern Bering Sea. The Japanese participants gave a presentation titled: Scanning electron microscope observations of the polished surface of the otolith of adult walleye pollock in the Aleutian Basin. And the U.S. participants presented three working papers (Appendix 1). In addition, ageing criteria for walleye pollock were discussed using photographic prints and slides provided by the Sea Fisheries Institute.

Two otolith reference samples were prepared for this meeting:

1. The Alaska Fisheries Science Center (AFSC) prepared a sample of 125 otolith pairs collected from 4 areas of the Bering Sea and the Gulf of Alaska. These were either whole otoliths or break and burn otoliths.

2. The Sea Fisheries Institute (SFI) prepared a sample of 144 otolith thin sections, collected from areas of the Bering Sea, and the north Pacific.

The AFSC reference sample was aged prior to the meeting by age readers from Canada, Poland, and the U.S. prior to the meeting. This sample was aged during the meeting by the P.R.C. reader during the meeting. The SFI reference sample was aged prior to the meeting by three Polish age readers, and were aged during the meeting by age readers from the other participating countries. In addition, the Donut Hole subsample from the SFI reference sample was also aged using the break and burn method.

The results from the AFSC reference samples were very encouraging (Table 1). These results were judged to be very good considering that age readers came from distant countries and generally have not had opportunities to work together.

The results from ageing the SFI reference sample was also thought to be good (Table 2). Again, considering that readers were from distant countries and did not have the opportunity to work together, reader agreement was thought to be quite good. The Donut Hole subsample of the SFI reference sample was also aged using the break and burn method (Table 3). The comparison of thin section and break and burn ages from this sample showed that ages compared quite well, but with the thin section method, on average, providing ages slightly older than the break and burn method.

Considering both the time preparing structures, and the quality of resulting age data, the participants at this workshop unanimously agreed that under our present knowledge that the break and burn method provides the best method for ageing walleye pollock. The participants also unanimously agreed that scale ageing seriously underage walleye pollock.

It was noted that pollock ageing methodology in the participating countries could be made more similar by exchanging reference samples on an annual basis. Canada, Poland, P.R.C., and the U.S. agreed to begin this exchange during the first half of 1991, with an exchange of 125 otolith pairs that would be aged using the break and burn method. It was agreed that Poland would initiate the sample, with the sample being subsequently passed to the U.S., Canada, and P.R.C., in that order. Japan declined to be involved in the exchange at this time because no production ageing of walleye pollock is currently being planned.

Several research issues surfaced during the workshop:

1. It was felt that identification of the first annulus in walleye pollock should be investigated. Identification of the first annulus might be a major factor causing uncertainty in the exact timing of two dominant year classes (1972 or 1973, and 1977 or 1978). Exact timing of year classes is critical when attempts are being made to correlate year class strength with environmental events.

2. The break and burn method for ageing walleye pollock has never been properly validated. Validation is a difficult problem, but without validation, pollock age data will depend on our working hypotheses concerning what annuli are in this species, and may in fact be incorrect.

3. Participants at this workshop agreed that an interchange of scientific information and manuscripts concerning the age determination for walleye pollock would be mutually beneficial. The AFSC agreed to be the clearing house for passing information on to workshop participants.

Table 1. Results from ageing the Alaska Fisheries Science Center reference sample using the break and burn method. Reader 1=Julie Lyons, 2=Betty Goetz, 3=Shayne MacLellan, 4=Barbara Szostakiewicz, 5=Magdalena Kowalewska-Pahlke, 6=Jerzy Janusz, 7=Ren Shengmin.

specimen	sex 1=m 2=f	length mm	U.S. 1	U.S. 2	Can 1	Poland 1	Poland 2	Poland 3	P.R.C. 1
SHELIKOF AREA									
1	2	410	4	5	4	5	5	4	5
2	1	390	5	5	4	5	4	4	5
3	2	430	5	5	5	6	6	4	5
4	2	260	2	2	2	2	2	2	3
5	1	510	11	12	10	11	12	9	11
6	1	470	5	5	5	6	9	5	6
7	2	470	6	6	6	6	8	5	6
8	2	440	6	6	7	6	6	5	6
9	1	530	13	11	12	13	13	9	10
10	2	410	5	5	4	5	5	4	5
11	2	620	11	11	10	11	11	10	13
12	1	440	5	5	4	5	6	4	5
13	2	460	11	9	5	8	7	7	6
14	2	380	4	5	4	4	4	4	5
15	1	380	4	4	4	4	4	4	5
16	2	370	5	5	4	4	4	4	5
17	2	530	11	12	13	13	13	12	11
18	2	410	5	5	5	5	5	5	5
19	2	340	3	4	3	3	3	3	4
20	1	230	2	2	2	2	2	2	3
21	2	420	4	5	4	5	4	4	5
22	1	470	9	7	6	6	6	6	6
23	2	540	9	9	9	10	10	8	10
24	2	640	17	16	11	13	12	12	14
25	2	230	2	2	2	2	2	2	3

CONTINUED

SOUTHEAST SHELF AREA

26	1	470	8	9	8	7	8	7	6
27	1	460	7	7	7	8	7	7	6
28	2	530	11	15	13	15	15	14	11
29	1	510	11	9	8	9	9	8	9
30	1	460	7	10	8	8	8	8	6
31	2	560	10	9	9	9	9	9	9
32	1	440	5	5	5	6	6	5	6
33	1	530	9	9	9	9	9	9	9
34	1	560	9	8	6	7	7	7	9
35	2	400	6	5	5	5	5	5	5
36	1	430	11	11	9	10	10	8	8
37	2	550	7	7	8	8	7	7	8
38	1	590	14	12	11	11	12	11	14
39	1	460	8	7	7	8	7	7	8
40	2	460	5	5	5	6	5	6	6
41	2	480	5	5	5	5	6	5	5
42	1	450	7	7	7	8	7	7	8
43	1	430	6	6	6	7	6	6	6
44	2	430	7	7	8	8	7	7	8
45	1	460	6	7	7	7	6	6	7
46	1	400	6	7	8	8	7	6	6
47	1	470	7	7	7	7	9	7	7
48	1	440	7	7	7	8	8	7	7
49	1	380	8	9	8	8	8	8	5
50	1	460	7	7	7	8	8	7	8

NORTHWEST SHELF AREA

51	1	370	5	5	5	6	5	5	6
52	2	400	6	6	5	6	5	5	6
53	1	460	7	7	7	8	7	7	7
54	2	440	5	6	5	5	5	6	6
55	2	390	5	5	5	6	5	5	6
56	2	420	7	7	7	7	7	6	6
57	2	380	5	5	5	6	5	5	6
58	2	370	6	5	5	6	5	5	5
59	1	420	5	5	5	6	6	6	6
60	1	440	7	7	7	8	7	6	7
61	2	430	5	5	5	5	6	5	5
62	1	450	7	7	7	8	7	7	6
63	2	470	7	7	8	7	8	6	6
64	1	450	7	7	7	8	8	7	7
65	2	390	5	5	5	6	5	5	6
66	2	370	5	5	5	6	5	4	5
67	1	360	5	5	5	6	5	5	5
68	2	410	5	5	5	6	6	5	6
69	2	450	7	7	7	8	7	7	8
70	2	430	6	6	5	6	6	6	6
71	1	380	5	5	5	6	5	5	6
72	1	350	4	4	4	5	4	5	5
73	1	390	6	5	5	6	5	5	6
74	1	400	5	5	5	6	5	5	6
75	2	400	5	5	5	5	5	5	6

CONTINUED

DONUT HOLE AREA

76	1	480	10	11	10	10	10	11	8
77	1	470	10	10	10	12	11	11	9
78	1	490	10	10	11	10	11	10	8
79	1	470	10	9	9	10	10	9	10
80	1	500	24	23	23	21	21	21	10
81	2	460	5	5	5	6	6	6	5
82	2	480	8	8	8	7	9	9	9
83	2	450	10	9	9	9	9	9	6
84	2	490	10	10	10	10	11	11	8
85	2	460	7	7	7	8	8	6	7
86	2	510	10	12	10	12	12	11	11
87	2	470	10	10	11	10	12	9	10
88	2	470	10	10	8	10	10	11	9
89	2	550	16	16	13	16	16	16	18
90	1	460	10	10	10	11	11	11	5
91	1	500	16	14	14	14	15	13	10
92	1	500	13	12	11	13	12	12	10
93	1	490	16	10	10	10	10	12	10
94	2	520	12	12	11	10	12	11	13
95	2	520	16	15	15	15	15	13	14
96	1	480	7	7	5	6	7	6	5
97	1	450	10	10	9	10	11	10	8
98	2	490	10	10	9	10	10	10	9
99	2	480	6	6	5	7	7	7	7
100	2	470	9	9	9	9	9	8	7

BOGOSLOF AREA

101	2	430	6	6	5	7	7	6	6
102	2	530	11	11	11	11	11	10	11
103	2	520	11	11	11	11	12	10	11
104	2	480	11	11	11	11	11	12	11
105	1	490	8	8	8	9	8	7	9
106	1	470	7	7	8	8	7	7	9
107	1	490	11	10	10	11	11	10	10
108	2	490	8	7	7	8	8	7	9
109	1	490	17	12	11	12	12	9	11
110	1	470	11	11	11	11	12	10	10
111	1	460	17	16	14	17	16	15	9
112	2	510	11	11	11	11	11	10	11
113	2	470	7	7	7	8	7	7	8
114	1	470	11	12	11	11	12	11	10
115	2	530	8	9	8	8	8	9	9
116	1	480	11	12	10	10	12	12	9
117	1	440	9	9	9	10	9	9	9
118	2	440	4	5	4	5	7	5	6
119	2	440	4	5	4	5	7	5	5
120	2	520	11	12	10	12	11	11	11
121	1	470	13	13	11	13	12	13	14
122	1	460	11	10	9	10	9	9	10
123	1	460	11	11	9	10	9	11	19
124	1	500	17	16	15	17	16	13	16
125	1	460	17	16	16	15	15	15	10

Table 2. Results from ageing the Sea Fisheries Institute reference sample using thin sections. Reader 1-Barbara Szostakiewicz, 2-Magdalena Kowalewska-Pahlke, 3-Jerzy Janusz, 4-Richard Beamish, 5-Julie Lyons, 6-Akira Nishimura, 7-Taku Yoshimura, 8-Ren Shengmin.

No.	Length cm	1	2	3	4	5	6	7	8
	Sample No. 1		DONUT HOLE						
1	40.0	7	7	7	6	6	5	6	7
2	43.0	8	8	9	8	6	6	6	8
3	45.0	12	12	13	--	11	9	9	8
4	47.0	13	13	13	12	12	11	12	9
5	49.0	13	13	13	--	13	11	10	12
6	51.0	13	13	13	12	13	11	13	12
7	52.0	19	20	19	13	19	19	21	--
8	54.0	19	19	18	--	17	18	17	10
9	38.0	6	6	6	6	4	4	5	5
10	41.0	8	8	8	6	8	6	6	7
11	42.0	7	8	7	--	5	5	6	5
12	44.0	8	9	9	--	7	6	6	8
13	46.0	9	9	10	6	8	7	7	7
14	48.0	11	11	11	11	11	10	10	7
15	49.0	13	13	14	--	12	11	13	7
16	50.0	12	12	13	11	11	11	9	9
17	51.0	13	13	13	11	11	11	10	9
18	52.0	12	12	14	12	11	11	11	8
19	53.0	13	13	13	12	11	12	10	11
20	54.0	22	21	21	22	21	21	20	11
21	55.0	15	14	15	--	13	13	11	13
22	56.0	12	11	12	11	10	10	12	11
23	57.0	18	17	18	16	18	16	16	--
24	58.0	14	14	13	11	11	14	10	14

CONTINUED

Sample No. 2 EASTERN BERING SEA

1	36.0	5	5	4	5	4	4	4	5
2	37.0	5	5	4	--	4	4	4	5
3	38.0	6	6	6	4	5	5	4	6
4	39.0	6	6	6	4	5	5	4	6
5	40.0	5	5	5	4	4	5	4	5
6	49.0	19	18	18	--	17	--	--	6
7	41.0	5	5	4	4	4	4	4	5
8	42.0	6	5	5	4	5	4	5	6
9	43.0	5	5	4	4	4	4	4	5
10	44.0	6	6	6	--	5	5	6	6
11	45.0	7	7	7	--	7	6	7	8
12	46.0	7	7	7	6	7	5	6	7
13	47.0	7	7	7	5	6	6	6	7
14	48.0	8	7	8	5	7	8	6	7
15	49.0	7	7	8	6	6	6	7	7
16	50.0	7	8	7	7	7	8	7	8
17	50.0	9	9	9	5	7	7	7	8
18	51.0	7	7	7	6	6	6	6	8
19	51.0	7	7	6	6	7	6	6	7
20	52.0	7	8	7	6	7	6	6	7
21	53.0	19	19	18	17	14	15	17	--
22	56.0	9	9	8	8	10	10	11	9
23	57.0	12	12	12	10	10	12	11	12
24	58.0	13	14	12	12	12	12	12	12

Sample No. 3 ALEUTIAN

1	37.0	4	4	4	--	4	4	4	4
2	40.0	4	4	4	4	4	3	3	4
3	42.0	6	6	5	--	5	5	5	6
4	44.0	7	6	6	--	6	4	6	6
5	46.0	8	8	7	--	--	5	6	7
6	48.0	7	7	6	3	6	4	6	7
7	50.0	7	7	6	--	7	6	6	8
8	51.0	13	13	13	--	12	12	10	12
9	52.0	9	10	9	--	8	10	8	10
10	43.0	6	6	5	--	6	5	7	6
11	45.0	8	8	7	--	8	7	7	8
12	47.0	6	6	6	4	7	5	6	6
13	49.0	9	9	9	--	9	11	11	12
14	53.0	12	12	11	11	11	12	11	12
15	54.0	7	7	6	4	7	6	9	10
16	55.0	13	13	12	--	13	12	13	13
17	56.0	13	13	12	11	11	12	12	13
18	57.0	7	7	6	6	8	5	--	12
19	58.0	17	17	17	15	18	17	18	14
20	59.0	10	11	10	8	9	--	13	13
21	61.0	12	12	12	12	13	12	12	13
22	62.0	11	11	11	12	11	11	12	13
23	64.0	12	12	12	--	12	12	13	13
24	65.0	12	13	13	12	12	12	13	14

CONTINUED

Sample No. 4 CHIRIKOF

1	35.0	3	2	2	2	2	2	3	3
2	36.0	3	3	3	--	3	3	3	4
3	37.0	3	3	3	3	3	3	4	4
4	40.0	3	3	3	3	3	3	4	4
5	42.0	3	3	3	3	3	3	3	4
6	44.0	3	3	3	--	5	3	4	4
7	45.0	5	5	5	--	6	3	6	6
8	47.0	7	7	7	7	7	6	6	8
9	48.0	6	6	6	5	6	5	6	8
10	49.0	7	7	7	--	9	8	7	10
11	50.0	6	6	6	5	5	5	6	8
12	52.0	9	10	10	8	10	8	10	10
13	53.0	8	8	8	7	8	8	8	10
14	53.0	9	8	8	--	9	8	10	10
15	54.0	9	10	9	7	9	9	14	11
16	50.0	5	5	4	--	6	5	6	--
17	51.0	7	7	7	6	6	9	8	--
18	51.0	9	9	8	8	7	8	8	9
19	52.0	7	7	8	6	6	6	9	9
20	52.0	7	7	7	6	6	5	7	--
21	52.0	6	6	6	--	6	5	5	9
22	53.0	10	10	10	8	9	9	10	11
23	54.0	9	8	8	7	8	8	8	10
24	54.0	5	5	5	4	--	4	5	10

Sample No. 5 KODIAK

1	43.0	4	4	3	3	3	3	3	4
2	44.0	5	5	5	4	4	4	4	4
3	46.0	4	4	3	--	3	3	3	5
4	47.0	7	5	5	--	5	6	5	6
5	48.0	8	8	7	--	6	5	7	8
6	49.0	5	5	5	--	--	4	5	9
7	50.0	7	6	6	--	--	6	7	10
8	51.0	6	6	6	--	6	6	5	8
9	52.0	9	8	7	--	6	8	6	9
10	57.0	7	7	7	5	9	6	7	10
11	43.0	4	4	3	--	3	3	4	4
12	44.0	5	5	5	--	5	4	4	5
13	45.0	5	5	5	4	3	4	4	5
14	47.0	7	7	7	--	6	6	6	7
15	49.0	7	7	7	--	--	8	6	9
16	50.0	6	6	6	5	6	5	10	9
17	51.0	7	7	7	--	6	5	6	--
18	52.0	9	9	8	7	8	7	8	9
19	53.0	7	6	5	--	--	4	7	10
20	54.0	7	7	7	--	7	9	10	11
21	54.0	7	7	6	--	7	9	10	--
22	56.0	8	9	8	--	8	6	7	12
23	54.0	8	9	9	--	8	8	7	10
24	59.0	10	10	9	9	9	9	9	13

CONTINUED

Sample No. 6 VANCOUVER

1	36.0	2	2	2	2	2	2	3	3
2	37.0	2	2	2	2	2	2	4	3
3	38.0	2	2	2	--	2	2	3	3
4	40.0	2	2	2	2	2	2	3	3
5	43.0	4	4	4	3	4	3	4	5
6	44.0	5	5	5	3	4	4	6	5
7	45.0	6	4	4	--	7	3	6	5
8	46.0	7	7	7	6	11	7	7	7
9	47.0	4	4	4	4	4	4	4	--
10	42.0	2	2	2	2	2	4	3	3
11	45.0	5	5	4	--	4	4	5	5
12	46.0	4	4	4	4	4	4	4	4
13	47.0	5	4	4	4	--	4	4	5
14	48.0	5	5	5	--	6	4	6	5
15	49.0	8	8	8	7	9	8	9	8
16	50.0	8	8	8	6	8	5	8	9
17	50.0	5	5	5	--	5	7	7	--
18	51.0	7	8	9	--	11	8	7	10
19	52.0	6	5	5	--	5	5	6	6
20	52.0	7	6	6	6	8	6	7	9
21	53.0	7	8	7	6	9	9	10	10
22	53.0	7	7	7	7	10	12	12	10
23	54.0	7	7	7	7	8	--	8	9
24	58.0	9	9	9	8	--	13	11	--

Table 3. Results from ageing the Donut Hole subsample of the Sea Fisheries Institute reference sample using the break and burn method. These results can be compared with the results using thin sections in Table 2.

No.	Length cm	1	2	3	4	5	6	7	8
1	40.0	6	6	6	6	6	6	5	
2	43.0	6	6	6	6	8	6	6	
3	45.0	11	11	11	11	12	12	12	
4	47.0	12	12	14	12	14	11	12	
5	49.0	12	12	11	11	14	11	11	
6	51.0	12	12	12	12	13	12	11	
7	52.0	19	18	17	19	18	17	20	
8	54.0	17	18	18	17	19	20	16	
9	38.0	4	4	3	3	4	5	5	
10	41.0	7	6	7	7	7	7	8	
11	42.0	7	6	7	5	5	5	7	
12	44.0	7	7	7	7	6	7	10	
13	46.0	9	9	9	7	7	11	8	
14	48.0	10	10	10	12	11	10	8	
15	49.0	12	13	12	12	12	11	10	
16	50.0	11	11	11	12	10	11	11	
17	51.0	11	11	11	11	12	11	11	
18	52.0	11	12	11	--	10	11	11	
19	53.0	12	12	11	11	10	11	11	
20	54.0	21	22	22	22	21	21	21	
21	55.0	14	14	13	12	13	15	14	
22	56.0	12	12	12	13	12	13	14	
23	57.0	18	17	19	17	16	16	16	
24	58.0	13	13	15	11	13	16	12	

Appendix 1

Information Concerning the Reference Sample of Walleye Pollock Provided by the Alaska Fisheries Science Center and Some Additional Donut Hole Data

by

Daniel K. Kimura
and
Julaine J. Lyons

Prepared for the
Workshop on Ageing Methodology of Walleye Pollock
Held at the Sea Fisheries Institute
Gdynia, Poland
September 10-14, 1990

In accordance with agreements reached at the Khabarovsk Symposium (April 2-5, 1990), the Alaska Fisheries Science Center has prepared a reference sample of 125 specimens sampled from various areas of the Bering Sea and the Gulf of Alaska. Twenty-five otolith pairs are provided from each of five areas (Fig.1):

1. Shelikof, specimen 1-25, collected 3/15/89
2. Southeast Shelf, specimens 26-50, collected 2/28/89
3. Northwest Shelf, specimens 51-75, collected 2/17/89
4. Donut Hole, specimens 76-100, collected 12/22/88
5. Bogoslof, specimens 101-125, collected 2/23/89

An effort was made to provide samples from surveys made during nearly the same time period so that the structures and data would be most comparable. The samples from the Northwest Shelf, Southeast Shelf, Bogoslof, and Shelikof were collect by the R.V. Miller Freeman during the first quarter of 1989. And the Donut Hole samples were collected by the Japanese vessel Kaiyo Maru during December 1988 and sent to us for ageing.

Since the larger survey of which the reference collection is a part has been aged at the Alaska Fisheries Science Center, we provide age distributions and size at age distributions based on these broader samples (Table 1). For the Donut Hole samples, which were collected late in 1988, one year was added to the ages so that these ages would be directly comparable with ages from the other areas. Also, we did not plot the broader sample from the Northwest Shelf because only one haul was made in that area.

Fig. 2 (Table 1) shows the age distributions collected from four areas. This figure shows that age compositions were much younger in the Southeast Shelf Area of the Bering Sea compared with the deeper Bogoslof and Donut Hole areas. It is interesting to note that although the age ranges found in the Southeast Shelf area is similar to that found in the Shelikof area, the dominant year-class appeared to be different in the two areas.

Fig. 3 (Table 1) shows the average length at age distributions calculated from these samples. Evidently, the Shelikof length at age is greater than in the Bering Sea samples. In the Bering Sea, the greater length at age seen in the older fish collected from the Southeast Shelf compared to the Bogoslof and Donut Hole areas, may be partially due to the relatively small samples for fish 7yr-old and older.

Because only a very small sample was available from the survey of the Donut Hole, additional samples collected from 1985 through 1989 by U.S. Observers aboard fishing vessels were examined. Although sample sizes were small (Table 2), the 1978 year-class was clearly visible in these data. The length at age data from all of the years combined (Table 3) indicate the length at age in the Donut Hole is not dramatically different from other areas in the Central and Eastern Bering Sea.

Table 1. Length at age (cm) and sample size for walleye pollock sampled from four different areas.

Southeast Shelf

Age	Males		Females		Sexes Combined	
4	41.5	11	41.5	8	41.5	19
5	41.0	106	41.9	71	41.4	177
6	42.6	31	43.2	33	42.9	64
7	44.8	122	45.9	128	45.3	250
8	45.4	18	46.1	27	45.8	45
9	50.3	8	49.8	21	49.9	29
10	53.0	2	53.5	2	53.3	4
11	52.6	5	53.3	12	53.1	17
13	.0	0	57.0	1	57.0	1

Bogosloff

Age	Males		Females		Sexes Combined	
4	42.0	1	.0	0	42.0	1
5	40.7	3	44.0	2	42.0	5
6	45.3	6	46.8	10	46.3	16
7	44.8	32	46.6	65	46.0	97
8	47.0	14	48.4	21	47.9	35
9	47.6	27	49.0	20	48.1	47
10	47.0	10	48.8	12	48.0	22
11	47.6	104	49.7	157	48.9	261
12	47.8	19	50.3	33	49.4	52
13	49.9	16	50.0	32	50.0	48
14	49.1	7	50.8	12	50.2	19
15	48.6	9	51.8	11	50.3	20
16	48.8	5	50.0	2	49.1	7
17	47.6	5	51.1	8	49.8	13

Donut Hole

Age	Males		Females		Sexes Combined	
5	39.0	1	.0	0	39.0	1
6	.0	0	43.0	2	43.0	2
7	44.6	8	46.8	8	45.7	16
8	46.5	2	47.0	5	46.9	7
9	45.0	3	47.2	5	46.4	8
10	47.8	9	48.8	5	48.1	14
11	47.3	20	49.9	22	48.6	42
12	49.5	4	50.0	2	49.7	6
13	48.8	4	52.7	3	50.4	7
14	48.0	1	.0	0	48.0	1
15	48.2	5	53.2	6	50.9	11
16	.0	0	54.0	2	54.0	2

Shelikof

Age	Males		Females		Sexes Combined	
2	23.5	31	23.8	35	23.7	66
3	31.5	60	32.2	50	31.8	110
4	38.3	194	39.1	171	38.7	365
5	39.3	231	41.4	232	40.4	463
6	44.8	68	47.0	70	45.9	138
7	48.4	35	50.6	55	49.7	90
8	51.6	19	52.8	16	52.1	35
9	50.2	9	54.7	11	52.7	20
10	53.3	3	54.8	6	54.3	9
11	51.7	29	55.8	56	54.4	85
12	52.5	2	54.5	6	54.0	8
13	.0	0	55.0	1	55.0	1

Table 2. Age distributions from commercial catches of fish caught in the Donut Hole and sampled by U.S. Observers.

Age	Years 85	86	87	88	89
4	4	0	4	0	6
5	9	4	17	1	23
6	35	2	11	12	17
7	126	4	6	24	45
8	64	4	7	23	36
9	65	11	44	33	23
10	62	3	7	130	20
11	55	2	8	25	157
12	47	1	6	30	9
13	25	1	14	10	6
14	17	2	5	16	3
15	15	0	2	9	6
16	4	0	0	1	0
17	4	0	1	0	2
18	2	0	0	2	0
19	1	0	0	0	0
20	0	0	0	0	0
21	0	0	0	0	0
22	0	0	0	1	0

Table 3. Length at age (cm) and sample size for walleye pollock sampled from the Donut Hole during 1985-1989.

	Donut Hole					
Age	Males		Females		Sexes Combined	
4	40.2	5	41.1	9	40.8	14
5	40.5	28	42.7	26	41.6	54
6	42.0	32	43.2	45	42.7	77
7	43.8	100	44.7	105	44.2	205
8	45.5	57	46.5	77	46.1	134
9	47.0	87	48.3	89	47.6	176
10	47.4	101	49.3	121	48.4	222
11	48.8	107	50.2	140	49.6	247
12	50.2	43	52.1	50	51.2	93
13	50.4	25	52.3	31	51.5	56
14	51.5	16	52.9	27	52.4	43
15	51.3	10	52.5	22	52.2	32
16	50.7	3	53.5	2	51.8	5
17	51.8	4	55.0	3	53.1	7
18	54.0	1	52.7	3	53.0	4
19	.0	0	53.0	1	53.0	1
22	.0	0	51.0	1	51.0	1

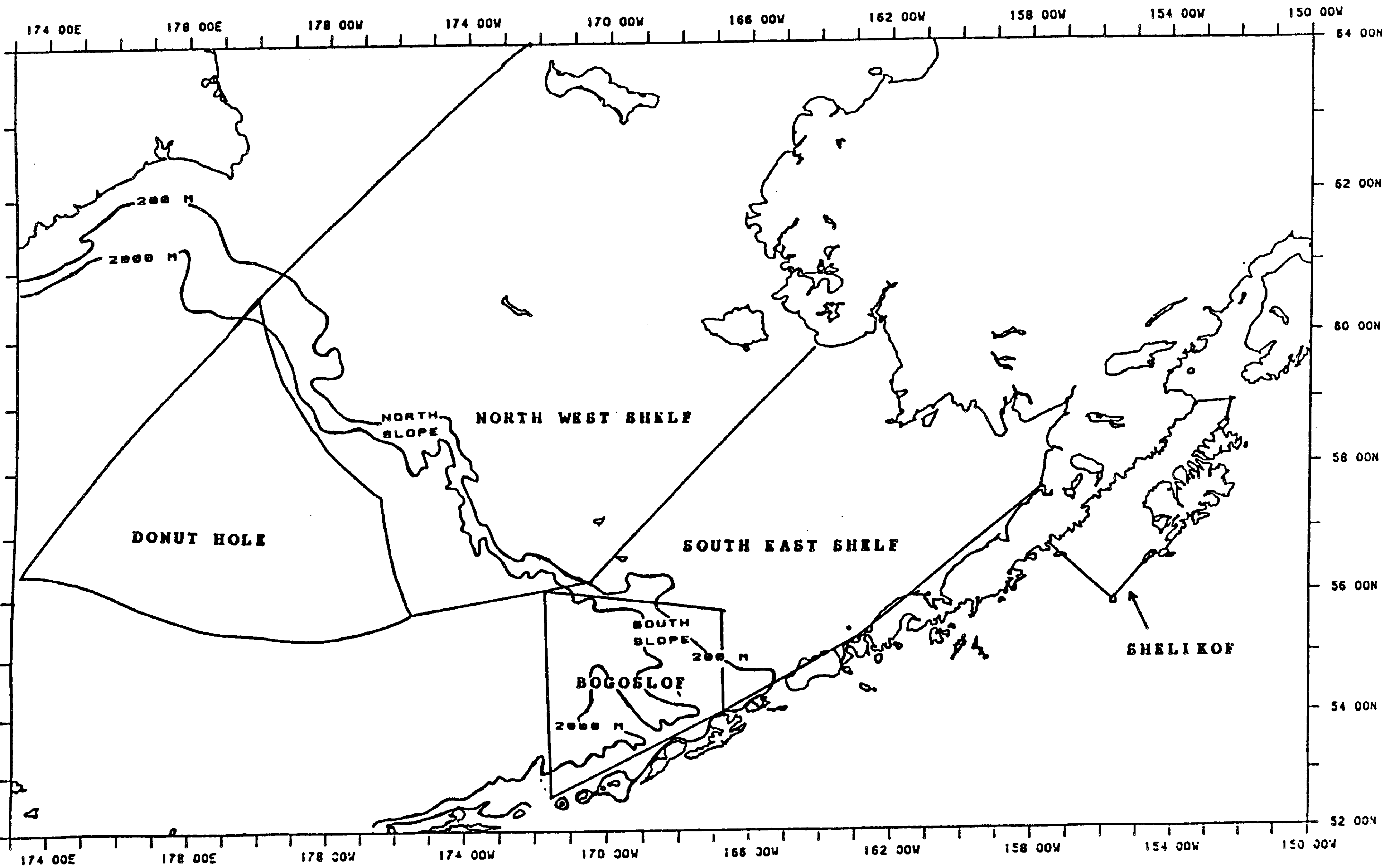


Figure 1. Map showing the five areas of the Bering Sea and the Gulf of Alaska from which reference samples were collected.

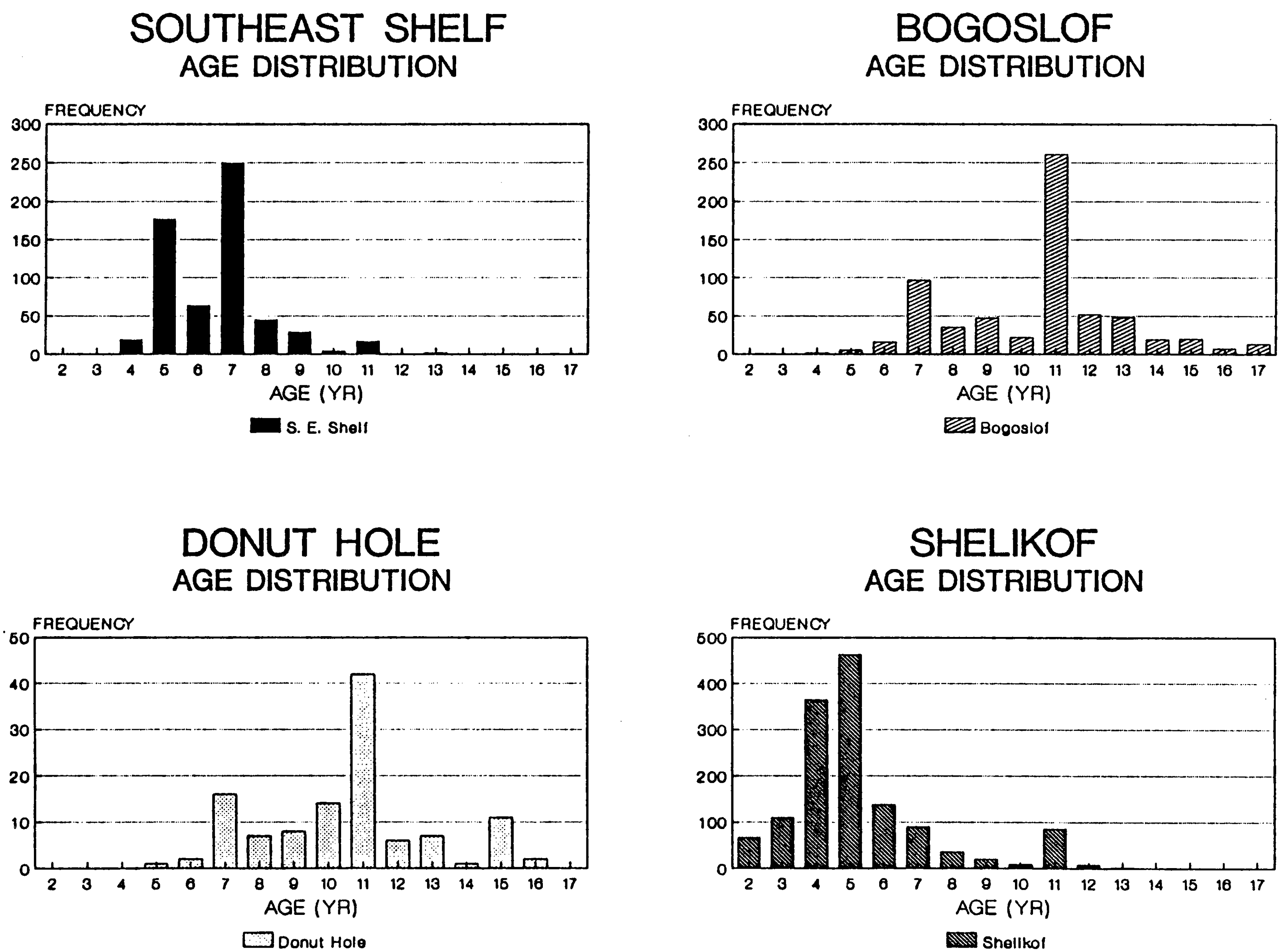


Figure 2. Age distributions calculated from the broader surveys from which reference samples were collected.

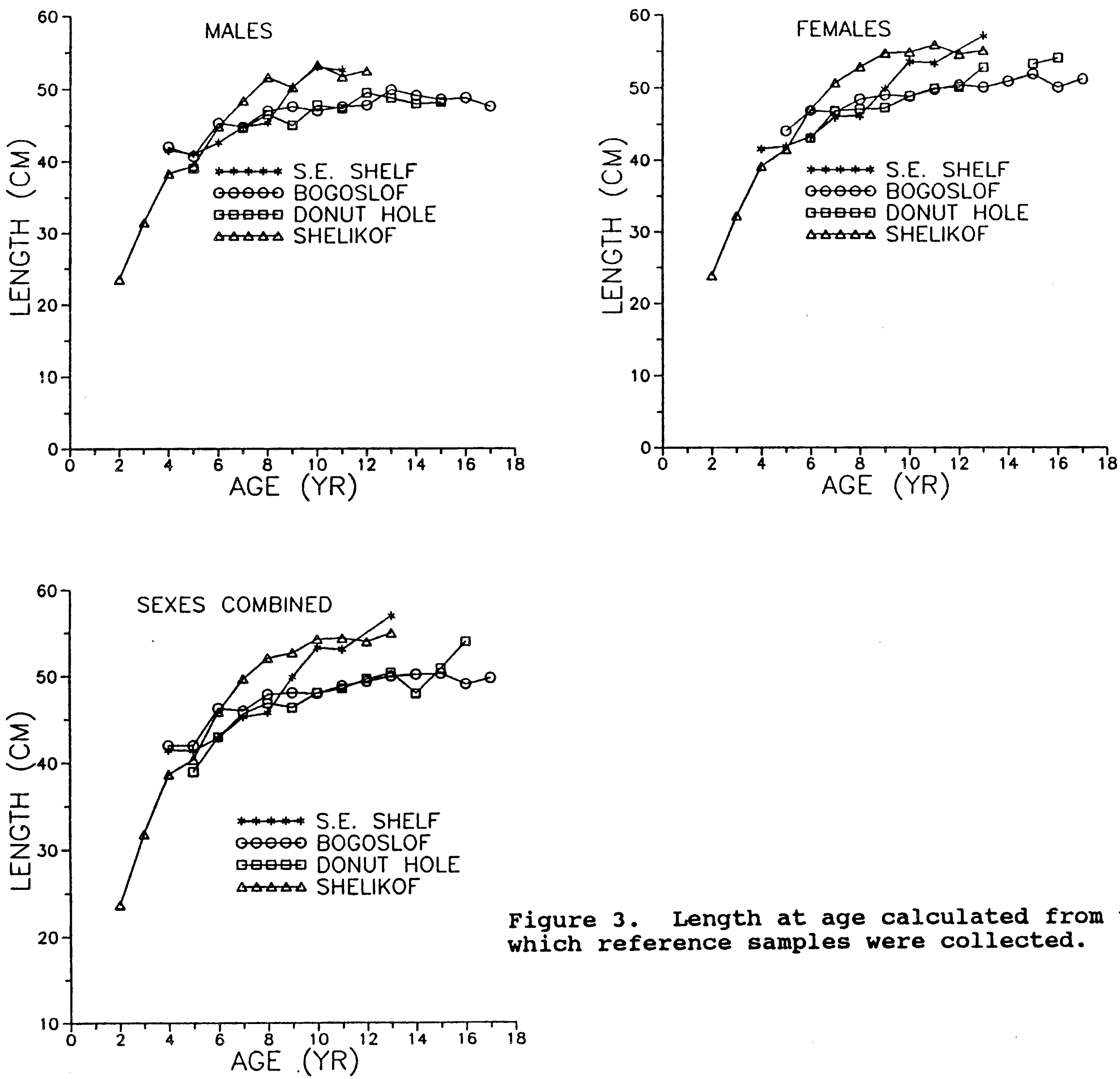


Figure 3. Length at age calculated from the broader surveys from which reference samples were collected.

Comparisons of Scale and Otolith Ages For Walleye Pollock

by

Daniel K. Kimura
and
Julaine J. Lyons

Prepared for the
Workshop on Ageing Methodology of Walleye Pollock
Held at the Sea Fisheries Institute
Gdynia, Poland
September 10-14, 1990

Scales and otoliths have long been the favorite structures for the ageing of fishes. Walleye pollock (Theragra chalcogramma) from the North Pacific appear to have been first aged using scales (Ogata 1956). Sometime later (LaLanne 1975, 1977), proposed using otoliths. For some unknown reason pollock otoliths collected from Alaskan waters during the 1970's appeared clearer than those collected today, so LaLanne proposed surface readings. LaLanne examined transverse cuts of the otolith for the purpose of validating the surface readings. Beamish (1981) and McFarlane and Beamish (1990) found pectoral and dorsal fin-ray sections useful in the ageing of slow growing pollock from the Strait of Georgia.

The discrepancy between scale ages and otolith ages has long been a concern at Alaska Fisheries Science Center. In 1977 a study was performed comparing scale ages read at the Japanese Far Seas Fisheries Research Laboratory, with otolith surface ages read at the U.S. Alaska Fisheries Science Center on the same fish. The results of this study (Bakkala et al. 1985) are summarized in Fig. 1. Clearly scale ages differed greatly from otolith surface ages at ages 6yr and older.

During June and July, 1990, we had the good fortune of having Ms. Marina Raklistova and Dr. Valery Paschenko of the Pacific Scientific Research Institute of Fisheries and Oceanography (TINRO) visit the Alaska Fisheries Science Center. They were particularly interested in comparing their scale ages with the otolith ageing method we currently use. Their sample consisted of fish for which both scales and otoliths had been collected. Since 1981, the Alaska Fisheries Science Center's method of ageing walleye pollock has been to read a surface age if the fish is young and the otolith relatively clear, and use the break and burn method (Beamish and Chilton 1982) if the otolith is unclear and/or old. As the sampled otoliths became more difficult to age (i.e. more unclear and older), we have progressively used the break and burn method (generally using an isomet saw for the transverse cut) on a greater percentage of otoliths. A comparison of the age distribution of ages read by Marina Raklistova and Julie Lyons is presented in Fig. 2.

It is apparent that by age 7yr there were serious discrepancies between scale and otolith ages. In addition, a plot was prepared showing the deviation of the average scale age for all fish of a given otolith age (Fig. 3). It is apparent from this figure that the deviation between scale and otolith ages increase with otolith age.

Because of studies such as these there is little doubt that scale and otolith ages can differ significantly for walleye pollock. However, to say that one is wrong and one is right is more difficult. From 1980-1989 we have aged over 173,000 pollock otoliths, so it should be apparent which structure we favor.

Other researchers (Janusz 1986, Lai and Yeh 1986, McFarlane and Beamish, 1990) appear also to favor otoliths. They appear to do so on the basis of precision and the probable correctness of the older ages than on actual validation data. McFarlane and

Beamish (1990) concluded that the geographic location and age structure of a population will affect the choice of ageing structure and preferred method of ageing walleye pollock. This would imply that the older population structure which has been observed in the international Donut Hole should be aged using the break and burn method.

From our point of view, we favor otolith ages because they allow us to follow strong year-classes to older ages. Fig. 4 shows how the strong 1978 year-class appeared in catch at age data from 1980 through 1987. From Fig. 4, it can be seen that at every age, compared with other year-classes, the 1978 year-class made up the largest percentage of the annual catch of that age. Also, by generalization, the older ages attributed to some rockfish species using the otolith break and burn method (Beamish 1979), appear to have been validated using radioisotopes (Bennett et al. 1987, Campana 1990). Therefore, we expect the older break and burn otolith ages for pollock to prove to be correct.

References

Bakkala, R.G., K. Wakabayashi, and T.M. Sample. 1985. Results of demersal trawl surveys. I.N.P.F.C. Bulletin 44:39-191.

Beamish, R.J. 1979. New information on longevity of Pacific Ocean perch (Sebastes alutus). J. Fish. Res. Board Can. 36:1395-1400.

Beamish, R.J. 1981. Use of fin-ray sections to age walleye pollock, Pacific cod, and albacore, and the importance of this method. Trans. Am. Fish. Soc. 110:287-299.

Bennett, J.T., G.W. Boehlert, and K.K. Turekian. 1982. Confirmation of longevity in Sebastes diploproa (Pisces: Scorpaenidae) from Pb-210/Ra-226 measurements in otoliths. Mar. Biol. 71:209-215.

Campana, S.E., K.C.T. Zwanenburg, and J.N. Smith. 1990. Pb-210/Ra-226 determination of longevity in redfish. Can. J. Fish Aquat. Sci. 47:163-165.

Chilton, D.E., and R.J. Beamish. 1982. Age determination methods for fishes studied by the groundfish program at the Pacific Biological Station. Can. Spec. Publ. Fish. Aquat. Sci. 60, 102p.

Janusz, J. 1986. Biology of walleye pollock (*Theragra chalcogramma*) from the Gulf of Alaska. I.N.P.F.C. Bulletin Number 45: 247-261.

Lai, H.L., and S.Y. Yeh. 1986. Age Determinations of walleye pollock (*Theragra chalcogramma*) from four age structures. I.N.P.F.C. Bulletin Number 45: 66-89.

LaLanne, J.J. 1975. Age determination of walleye pollock (*Theragra chalcogramma*) from otoliths. NMFS, NWAFC Processed Rep., 19p.

LaLanne, J.J. 1977. The validity and consistency of age determinations from otoliths of Pacific pollock (*Theragra chalcogramma*). I.N.P.F.C. Annual Report 1977: 99-107.

McFarlane, G.A., and R.J. Beamish. 1990. An examination of age determination structures of walleye pollock (*Theragra chalcogramma*) from five stocks in the Northeast Pacific Ocean. I.N.P.F.C. Bulletin Number 50.

Ogata, T. 1956. Studies on fisheries and biology of important fish: Alaska pollock. Bull. Jpn. Sea Reg. Res. Lab. 4:93-140.

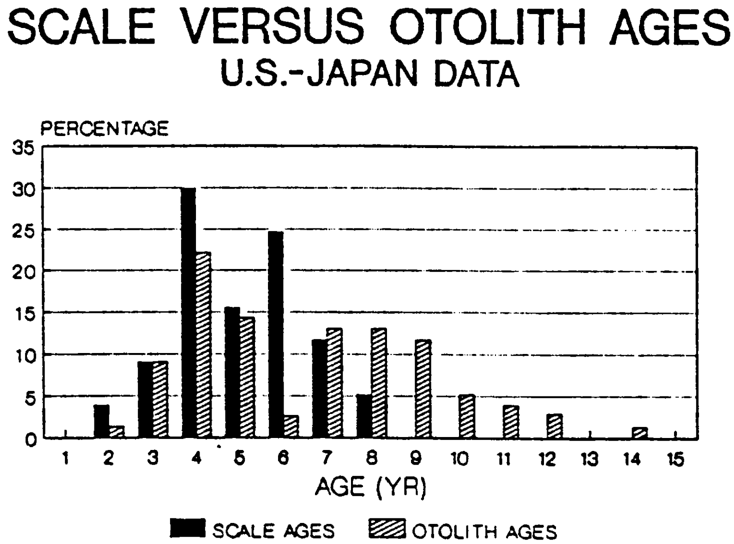


Figure 1. A comparison of age distributions when the same fish are aged using scales and otoliths. Scale ages were read by the Japanese Far Seas Fisheries Research Laboratory and surface otolith ages were read by the U.S. Alaska Fisheries Science Center.

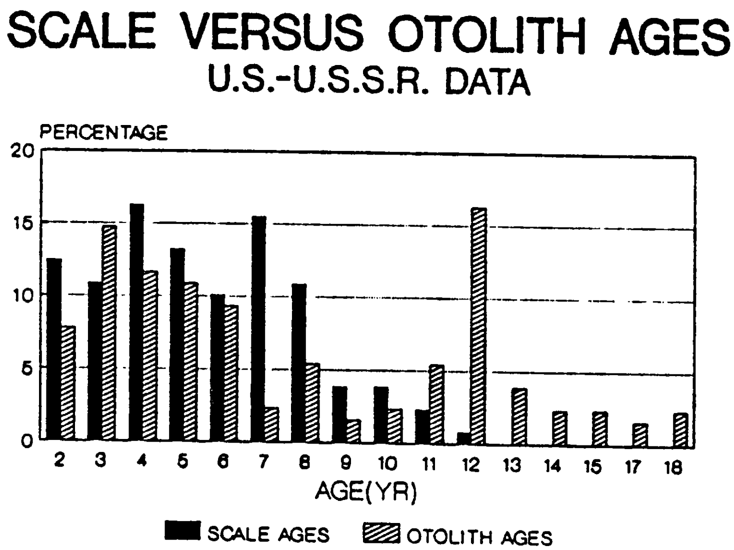


Figure 2. A comparison of age distributions when the same fish are aged using scales and otoliths. Scale ages were read by the Soviet Pacific Scientific Research Institute of Fisheries (TINRO) and otolith ages were read by the U.S. Alaska Fisheries Science Center using surface or break and burn methods as required.

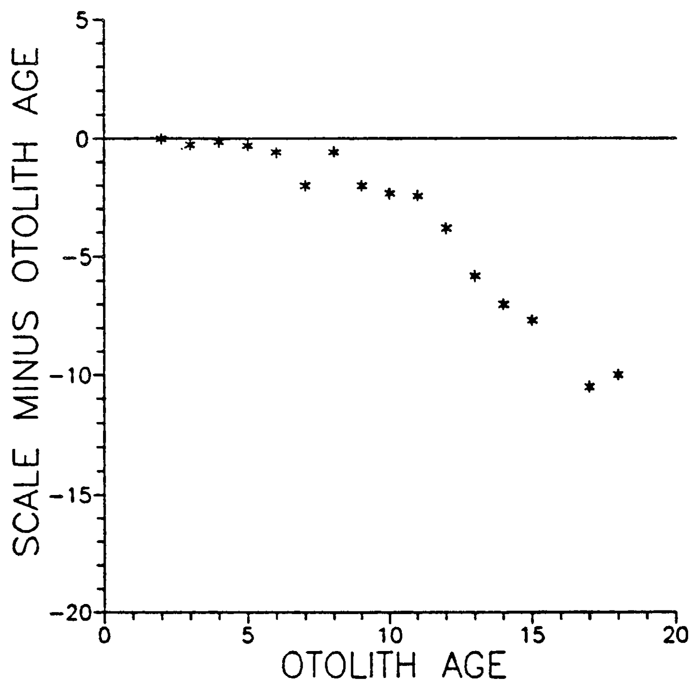


Figure 3. A graph of deviations between scale and otolith ages at nominal otolith ages. The deviation shown is the difference between the average scale age and the nominal otolith age using U.S.-U.S.S.R. data.

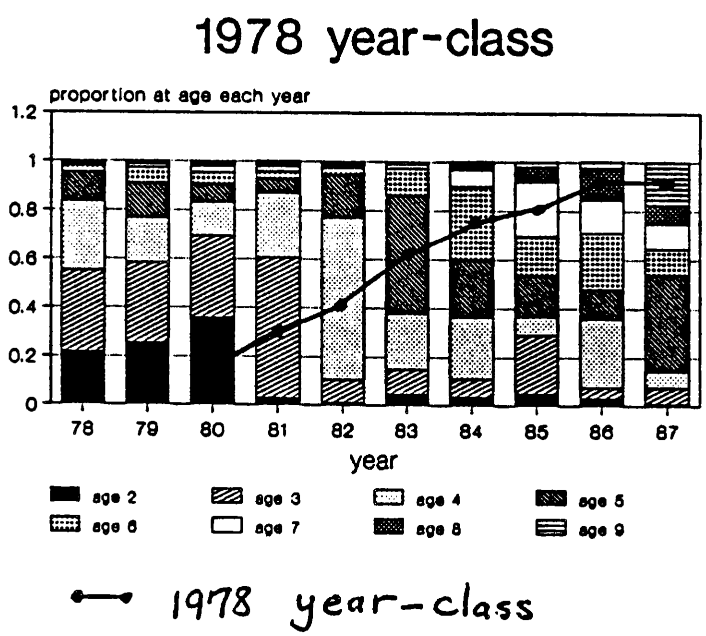


Figure 4. Graph of the age composition of catches taken from the Eastern Bering Sea during 1978-1987, using otolith ages, showing the dominance of the 1978 year-class.

Comparison of Break and Burn and Otolith Thin section Ages From Walleye Pollock

by

Daniel K. Kimura
and
Julaine J. Lyons

Prepared for the
Workshop on Ageing Methodology of Walleye Pollock
Held at the Sea Fisheries Institute
Gdynia, Poland
September 10-14, 1990

Following the I.N.P.F.C. Meeting held in Seattle during 1989, Dr. Jerzy Janusz of the Sea Fisheries Institute visited the Alaska Fisheries Science Center. During this visit he met with Ms. Julie Lyons and discussed the ageing of Walleye Pollock through the use of otolith thin sections. During this meeting Dr. Janusz and Ms. Lyons examined a sample of several thin sectioned otoliths that Dr. Janusz had prepared. The clarity of these thin sections were impressive to us, and we felt that we should further examine thin sections, particularly to see whether ages obtained from thin sections compared well with ages obtained using our standard break and burn or whole otolith methods.

For this study, we prepared 42 otoliths collected by U.S. Observers aboard commercial fishing vessels. The otoliths that were selected were from previously aged samples for which we already had production ages. The selected otoliths were collected from the Donut Hole and the Southeast Shelf areas in the first quarter of 1989:

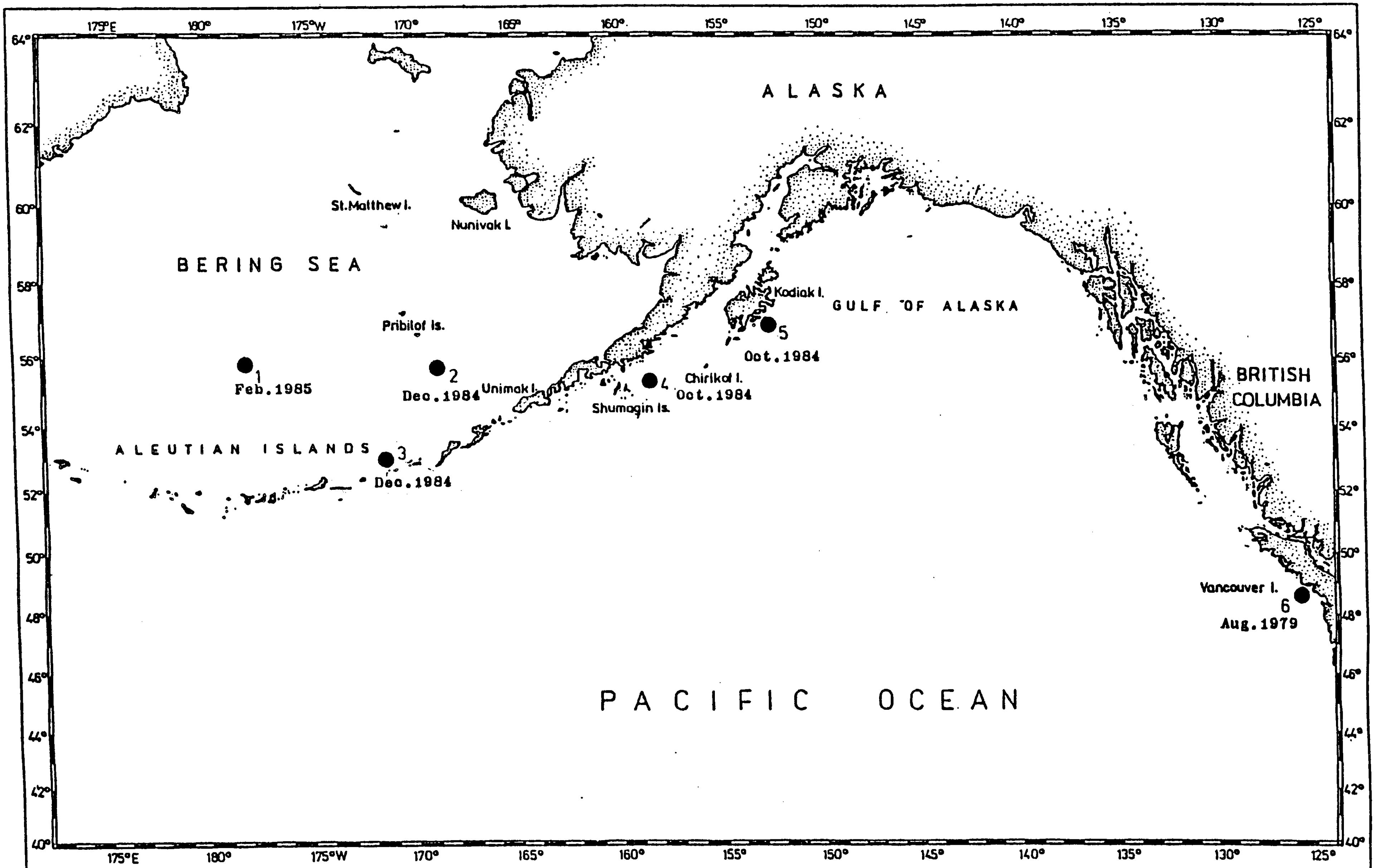
Break & burn Age	Donut Hole (number)	S. E. Shelf (number)	
6	0	2	
7	8	6	1982 year-class
8	0	1	
9	3	0	
11	11	8	1978 year-class
13	0	1	
14	1	0	
17	1	0	

Results from ageing these specimens using thin sections are shown below.

break & burn age	Section Ages (yr) 5	6	7	8	9	10	11	12	13	14
6	1	.	.	.	.	.	1	.	.	.
7	1	1	3	8	.	.	1	.	.	.
8	.	.	.	1	.	.	.	.	.	.
9	.	.	.	1	1	.	1	.	.	.
10	.	.	.	.	.	.	.	.	.	.
11	.	.	.	.	1	.	13	1	1	3
12	.	.	.	.	.	.	.	.	.	.
13	.	.	.	.	.	.	1	.	.	.
14	.	.	.	.	.	.	1	.	.	.
15	.	.	.	.	.	.	.	.	.	.
16	.	.	.	.	.	.	.	.	.	.
17	.	.	.	.	.	.	.	.	.	1

Results comparing the thin section ages with break and burn ages were disappointing. Otoliths sections were overaged compared to break and burn ages. Also, the 1982 year-class (i.e. 7 yr-olds), which was thought to be strong from break and burn ages, was entirely missed by the otolith thin sections. Therefore, based on this very limited study, we have some doubts concerning the usefulness of otolith thin sections.

Appendix 2



LOCATION OF WALLEYE POLLOCK REFERENCE SAMPLES

Appendix 3

WORKSHOP ON AGEING METHODOLOGY OF WALLEYE POLLOCK
GDYNIA, 10-14 SEPTEMBER 1990

LIST OF PARTICIPANTS

1. CANADA

Dr. Richard J. Beamish

-Pacific Biological Station,
Nanaimo B.C. Canada
V9R 5K6 Fax: 604-75f6-7053
Telex: 044-6128
Tel.: 604-756-7041

2. JAPAN

Dr. Akira Nishimura
Mr. Taku Yoshimura

-National Research Institute of Far Seas Fisheries,
5-7-1, ORIDO, SHIMIZU, 424
Japan
Tel.: 0543-34-0715
Fax : 0543-35-9642

3. P. R. of CHINA

Mr. Shengmin Ren

-Yellow Sea Fisheries Research Institute,
19, LAIYANG Road
Qingdao 266003
P. R. China
Tel.: /0532/286650
Fax: /0532/270702
Telex: 32151 BOOTH CN

4. U.S.A.

Ms. Julie Lyons
Dr. Daniel K. Kimura

-Alaska Fisheries Science Center
Bldg. 4, BIN C15700
7600 Sand Point Way N.E.
Seattle, WA 98115-0070
Fax: 206-526-6723

5. POLAND

Dr. Tomasz B. Linkowski
Dr. Jerzy F. Janusz
Ms. Magdalena Kowalewska-Pahlke
Ms. Barbara Szostakiewicz

-Sea Fisheries Institute,
Al. Zjednoczenia 1
81-345 Gdynia
Poland
Tel.: /58/21-70-21
Telex: 054348 miryb
Fax: 58-20-28-31

END OF SUPPLEMENT D.1 AND MODULE D