1st Meeting of SIOFA SAWG (Stock Assessments Working Group)
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Age Composition of Sleeping Beauty Spawning Aggregation 2017

Relates to agenda item: 4 Working paper

Delegation of Cook Islands

Abstract

Otoliths of orange roughy (*Hoplostethus atlanticus*) were prepared and aged from the Sleeping Beauty seamount in the Southern Indian Ocean. Otoliths were prepared and read by one reader following the accepted ageing protocol. The aim was to develop an age composition for potential use in an assessment of this stock. A sample of 400 otoliths collected in 2017 was analysed. The age sample had a broad range from 21 to 140 years, with a mode from around 32 to 45 years.

Recommendation

That the Stock Assessment Working Group

1. Accept the results of the ageing work carried out under agreed protocols as valid inputs to the Orange Roughy Stock Asessment
2. Accept the age composition data as inputs to assessment of biological parameters for the assessment of Orange Roughy Stocks in SIOFA

NIWA
Taihoro Nukurangi

Age distribution of orange roughy on the Sleeping Beauty seamount, Southern Indian Ocean.

Prepared for Sealord Group

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Executive summary

Otoliths of orange roughy (Hoplosteuthus atlanticus) were prepared and aged from the Sleeping Beauty seamount in the Southern Indian Ocean. Otoliths were prepared and read by one reader following the accepted ageing protocol. The aim was to develop an age composition for potential use in an assessment of this stock. A sample of 400 otoliths collected in 2017 was analysed. The age sample had a broad range from 21 to 140 years, with a mode from around 32 to 45 years.

1 Introduction

The objective of this work was the otolith preparation and ageing of a sample of orange roughy from the Sleeping Beauty feature in the Indian Ocean. Sleeping Beauty is a rocky bank covering over 100 square miles on Walter's Shoal (c. 32°30'S, 44°E) in the Southern Indian Ocean. The area was mapped with sidescan sonar in 2000. It is a common type of habitat in this region, with a very small proportion that can be fished with bottom trawls, having only three trawl paths.

The area has had many acoustic surveys since 2004, including multi-frequency AOS acoustic surveys (G. Patchell, Sealord Group, pers. comm.). Orange roughy otoliths have been collected from this area since 2006, and in 2017 the Scientific Committee of the Southern Indian Ocean Fisheries Agreement (SIOFA) recommended an assessment of this stock be carried out, because of the extensive data series (SIOFA 2017). In recent years the orange roughy stock assessments in New Zealand and Australia have highlighted the need for good age distributions as assessment inputs, and for this reason a large otolith sample was collected in July 2017 during commercial fishing operations by F.V. Will Watch.

A protocol for age interpretation of orange roughy was developed during an international workshop held at NIWA, Wellington, in 2007. In 2009, the new protocol was tested by two NIWA and two FAS (Fish Ageing Services Pty. Ltd., Victoria, Australia) readers by ageing the otolith pairs from 160 fish, i.e., potentially 8 age estimates per fish. The new protocol provided a consistent and documented method for the interpretation of growth zones in orange roughy otoliths (Horn et al. 2016).

Early growth of orange roughy was validated by examining the otolith marginal increment type and by length frequency analysis (Mace et al. 1990). Later, Andrews et al. (2009) applied an improved lead-radium dating technique to otolith cores, grouped by growth-zone counts from thin sections. Results showed a high degree of correlation of the growth-zone counts to the expected lead-radium growth curve, and provided support for both a centenarian life span for orange roughy and for the age estimation procedures using thin otolith sectioning.

2 Methods

2.1 Ageing of orange roughy

Otoliths were prepared using the NIWA preparation method (Horn et al. 2016). One otolith from each of the pairs was individually embedded in resin and cured in an oven. A thin section was cut along a line from the primordium through the most uniform posterior-dorsal axis using a sectioning saw with dual diamond-impregnated wafering blades separated by a 380 µm spacer. The section was mounted on a glass microscope slide under a glass cover slip.

All otoliths were read once by one reader. Otolith interpretation and reading protocols followed those described in the Ageing Workshop Report (Horn et al. 2016). The data produced included counts of zones from the primordium to the transition zone (TZ), and from the TZ to the otolith margin, and readability codes for those readings (on a 5-stage scale). Data with a readability code of 5 (i.e., unreadable) for either the pre- or post-TZ readings were excluded. The presence of a TZ was identified using the following three criteria: a clear reduction in zone width, a marked change in the optical density of the otolith from dark to light, and a change in curvature of the posterior arm of the otolith (Horn et al. 2016).

Transition zones were classified using a 4-stage scale, i.e.:

- 0, not formed (observed),
- 1, clear and unambiguous with all three criteria met,
- 2, a gradual transition with at least two criteria met,
- 3, a gradual transition with none or one of the criteria met.

For TZ classification 3, only a total age was recorded.

2.2 Analytical methods

It was initially intended (and preferable) that the method of otolith selection and analysis would follow that of Doonan et al. (2013) for ORH 7A orange roughy from New Zealand. [That method assigned a probability to each otolith collected which represented the contribution that the sampled orange roughy catch (in the tow the otolith came from) made to the total abundance (in numbers).] However, owing to the method of collection and storage of the available otoliths, about one-third were found to be broken or incomplete. Incomplete otoliths were generally missing the tip of the posterior-dorsal axis — that section contains the growth zones formed after the transition zone. Consequently, otoliths for preparation were chosen roughly randomly in proportion to the size of the orange roughy catch from each tow. The intention was to more intensively sample larger catches. This process was continued until there were 400 otoliths believed to be suitable for preparation. All usable otoliths from six of the seven largest tows were prepared. Details of the stations and otoliths used in the analysis are listed in Table 1.

Table 1: Stations (sorted by orange roughy catch weight), catch, number of otoliths collected, number of otoliths prepared, and remaining number of otoliths that appear to be complete and so would be usable (Residual). Tow dates are also listed.

Tow	ORH	Number of otoliths			Date
number	catch (t)	Collected	Prepared	Residual	
102	55	40	33	0	2017-07-05
92	30	40	34	0	2017-07-03
114	30	40	32	0	2017-07-08
86	25	98	58	15	2017-07-01
82	18	40	26	0	2017-07-01
94	11	40	28	0	2017-07-03
96	10	40	28	0	2017-07-03
110	7	40	26	2	2017-07-07
127	7	40	20	2	2017-07-10
85	6	102	30	44	2017-07-01
91	6	40	31	2	2017-07-02
84	4	100	25	38	2017-07-01
107	4	40	19	0	2017-07-06
118	1	40	10	13	2017-07-08
Totals		740	400	116	

For each tow, an age frequency was formed. The combined age frequency was the weighted mean age frequency over the tow age frequencies, where the weight was the square-root of the tow's catch. The CV was estimated by bootstrapping the tows 500 times.

Kernel smoothing was used to show the plotted results. It used one parameter, width, which is approximately the moving window width over which the average age was calculated. This procedure used the 'density' function from the R statistical package (R Core Team 2014). Width was set to 10.

3 Results

Details of the aged otolith sample from the Sleeping Beauty feature are listed in Table 2, and the age-frequency is presented in Figure 1. Age-frequency data are listed in Table 3.

Table 2: Details of 2017 Sleeping Beauty orange roughy otolith sample. N, intial number of otoliths selected; Rejects (i.e., preparations unable to be aged); numbers of aged otoliths by transition zone classification (see Section 2.1).

		Transition zone classification code			
N	Rejects	0	1	2	3
400	1	54	55	259	31

Table 3: Estimated age frequencies for Sleeping Beauty orange roughy from the 2017 commercial fishery.

Age	Frequency	% CV	Age	Frequency	% CV	Age	Frequency	% CV
21	0.002	97.1	61	0.008	51.6	101	0.011	45.2
22	0.002	95.8	62	0.007	59.7	102	0	0
23	0.005	63.8	63	0.019	35.9	103	0.006	68.3
24	0.002	95.4	64	0.002	97.1	104	0	0
25	0.018	37.2	65	0.014	48.3	105	0	0
26	0.013	45.6	66	0.011	47.0	106	0.005	75.8
27	0.023	33.5	67	0.010	47.2	107	0	0
28	0.018	28.2	68	0.006	52.2	108	0	0
29	0.017	26.5	69	0.015	35.0	109	0	0
30	0.013	39.9	70	0.011	43.1	110	0	0
31	0.018	55.3	71	0.014	32.8	111	0.005	68.0
32	0.028	24.3	72	0.010	47.5	112	0.002	97.1
33	0.009	45.0	73	0.008	48.2	113	0	0
34	0.042	23.0	74	0.010	48.1	114	0	0
35	0.017	29.3	75	0	0	115	0.003	106.7
36	0.036	40.2	76	0.004	65.6	116	0.002	108.9
37	0.025	45.3	77	0.005	67.7	117	0	0
38	0.022	34.5	78	0.007	53.8	118	0	0
39	0.024	19.6	79	0.005	75.8	119	0	0
40	0.040	23.7	80	0.009	70.7	120	0	0
41	0.011	60.9	81	0.007	54.0	121	0	0
42	0.029	33.8	82	0.005	89.2	122	0	0
43	0.038	21.8	83	0.009	51.6	123	0	0
44	0.013	46.1	84	0.006	68.3	124	0	0
45	0.014	39.8	85	0.007	54.3	125	0	0
46	0.012	58.4	86	0.014	49.9	126	0.002	95.1
47	0.013	36.5	87	0	0	127	0	0
48	0.017	43.7	88	0.006	66.4	128	0	0
49	0.019	39.6	89	0.002	97.5	129	0	0
50	0.009	47.0	90	0.002	108.1	130	0	0
51	0.016	48.7	91	0.012	60.0	131	0	0
52	0.014	32.8	92	0.002	97.5	132	0	0
53	0.018	33.8	93	0	0	133	0	0
54	0.018	40.4	94	0.002	108.1	134	0	0
55	0.010	57.3	95	0	0	135	0	0
56	0.009	47.9	96	0.009	50.7	136	0	0
57	0.022	42.1	97	0.002	95.8	137	0	0
58	0.016	35.2	98	0	0	138	0	0
59	0.015	32.5	99	0.003	97.2	139	0	0
60	0.011	40.6	100	0	0	140	0.003	106.7

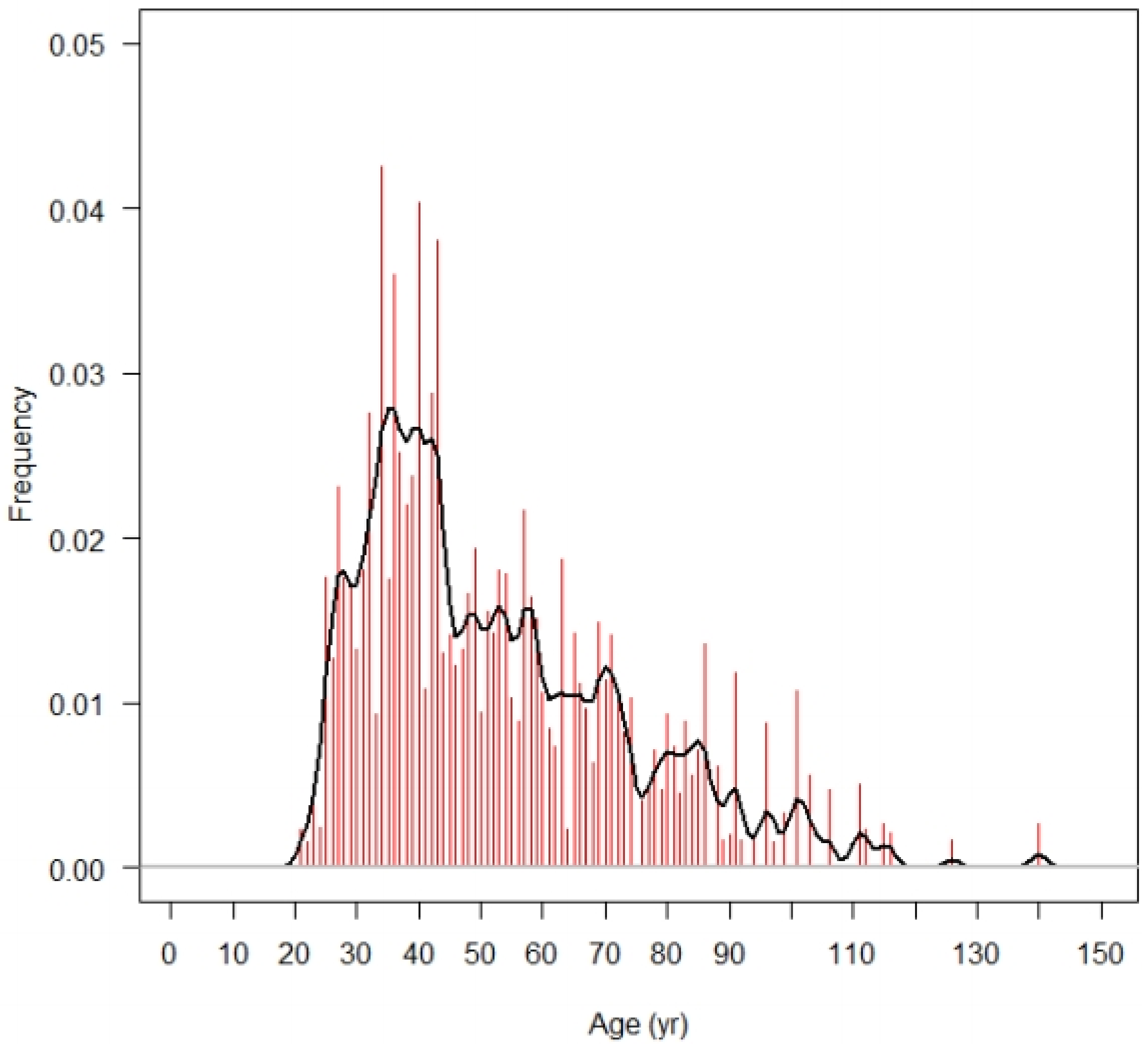

Figure 1: 2017 Sleeping Beauty estimated age frequency (red bars) with a smoothed density through the age estimates (black curve).

4 Conclusions

The structure of the Sleeping Beauty otoliths exhibited some general differences relative to otoliths from New Zealand stocks. The otoliths from the Indian Ocean appeared to be generally longer, indicative either of a longer period of pre-transition zone growth or a faster growth rate of the otolith. Also, one criterion used to define the location of the transition zone (i.e., a change in curvature of the posterior arm of the otolith) was often not met, resulting in a relatively high proportion (65%) of transition zone classifications of 2 (see Table 2). New Zealand samples generally have about 20–45% of transition zone classifications of 2 (e.g., Doonan et al. 2014). This is indicative of post-transition zone fish growth rate being generally faster than that for New Zealand orange roughy. These characteristics were not investigated using any mathematical analyses.

Sleeping Beauty had an age frequency comprised of more older fish than generally seen in New Zealand fisheries; the range of ages was from 21 to 140 years, with a broad mode from around 32 to 45 years. The proportion of fish older than 90 years was estimated to be 7%; in New Zealand fisheries it is rare for more than 3% of fish to be estimated as being older than 90 (e.g., Doonan et al. 2014).

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