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Catch-at-age and Abundance-at-age Using New Criteria of Age Assignment

Chile

Catch-at-age and abundance-at-age for jack mackerel in Chile by using new criteria of age assignment.

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Abstract

This report shows the progress status of age structure data series of the Chilean jack mackerel, based on validated age-length keys, that was changed accord at the new ageing criteria. The results include 1) the commercial catch age structure from 1980 to 2020 by quarter and fleet; 2) the abundance by age group of acoustic surveys in fleet 1 area for 2006, 2007, 2009, from 2013 to 2020 and fleet 2 from 2001 to 2012, 2017, 2020. These age structure include the mean length and weight fish by age group.

Introduction

The joint-stock assessment model for Jack Mackerel (JJM) used for the South Pacific Regional Fisheries Management Organization (SPRFMO) integrates two age-structured fishery-dependent and one age-structured fishery-independent time series, both annually provided by Chile for fitting purposes. Those data series help for interpreting the age-vulnerability pattern of fishing fleets operating along the central-south and north, as the age-acoustic surveyed abundance at southern Chile, respectively.

Two studies were carried out to validate the age of jack mackerel and provide more exact age structures (Cerna et al. 2016; Araya et al. 2019). Analyzing the microstructure of the otoliths and other methods such as monitoring a strong annual class and radiocarbon bomb, they concluded that jack mackerel shows high somatic growth in the first and second year of life. These results suggest that the first and third growth rings, identified in the historical ageing criteria, are false. Based on these findings, it was necessary to modify the age structure of the jack mackerel catches and the abundances of the acoustic cruises, based on new age-length keys that included these changes. For more details of these results consult the paper SC8-JM07.

This report describes the details about the ageing structure series of commercial and acoustic survey of Chilean jack mackerel using new age-length key that were changed according to the new ageing criteria.

Results

Reconstruction of commercial catches by age-group

The reconstruction of the catch age structure considered first the changes of otolith ageing data and second time were checking and validating of the lengths and biological's data for each of the quarters. This was possible to do for the period 1980-2020. This series was reconstituted with all the data: original, catch, length distribution and biological data for each year, quarter and fleet (Table 1 y 2).

Table 1. Catch by age group of the series 1980-2020 for the fleet 1, based in age-length key modified according new ageing criteria validated.

Arica - Antofagasta (Fleet 1)														
	Age group													
	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
1980		459	5982	21939	50622	81771	62964	11476	13					235226
1981		1106	17058	39342	76752	143649	97690	28500	6903					410999
1982	2	1555	65574	81331	151875	216755	155563	63948	13443	251				750295
1983		968	12595	31619	65088	80167	50717	11772	652	19				253596
1984		7304	126775	64101	98913	151317	150477	48508	2274					649671
1985		3790	55384	102762	148266	109156	37434	8325	957					466074
1986	78	633	1795	2439	6535	13653	9222	2513	148					37017
1987	164	35630	171055	41393	13871	12118	6472	781	400					281884
1988		259	9471	35972	20733	1799	344	21						68599
1989		372	14441	89422	96227	23087	5657	1930	505	98				231738
1990	325	8940	7057	69113	140187	33369	4513	711	261	4				264481
1991		16316	53718	22223	60419	91344	25807	7043	2338	478				279686
1992	166	15268	56225	63635	69420	49531	21194	4085	686					280212
1993	59	46522	210831	44804	27278	10618	3241	1188	310	96	73	1		345022
1994	30	27617	41616	70659	42023	8351	2313	1140	156					193904
1995		3482	105810	52183	22364	7437	242	92						191610
1996	9869	51279	130417	33042	10773	1938	68	94						237482
1997		31903	49590	4251	401	23								86167
1998	4	2501	17725	4706	1391	155	2							26483
1999	21	4113	32218	5630	2245	278	20							44524
2000	1161	16481	60055	27381	2221	49								107348
2001	346	122422	116432	3839	333	100								243472
2002		14139	53847	27944	7815	1745	210							105699
2003	48	21630	87736	11460	6646	3717	925	56						132217
2004	1	14984	92463	37238	2117	118								146921
2005	207	42236	73509	30669	13164	1941	88	28						161841
2006	94	7023	119057	14688	9856	3910	642	32						155303
2007	258	15267	103497	29879	10050	7793	2879	962						170585
2008	3987	44820	41751	31823	30837	5063	450	120	31					158880
2009	49	15451	75443	8006	20618	1091	46							120706
2010		5913	85527	33460	10643	3652	176	340						139711
2011	12	17812	7966	1580	709	131								28210
2012	0	1258	8093	1449	27	2								10830
2013	0	3919	8329	593	856	995	23	17						14731
2014		6884	9321	749	264	14	3							17235
2015	2	859	18713	7215	3940	3167	719	163						34778
2016		843	1765	1576	2820	3532	1727	3671	620	127				16682
2017		3400	21389	2626	764	458	52	83	36					28807
2018		5070	67	21	13	3								5175
2019	3	153	1053	786	2034	1970	1051	1512	1064	749	1024	325	930	12654
2020				951	32236	29768	28618	18448	10182	1968	570	217	19	122977

Table 2. Catch by age group of the series 1980-2020 for the fleet 2, based in age-length key modified according new ageing criteria validated.

Caldera - Guaitecas (Fleet 2)														
Age group													Total	
0	1	2	3	4	5	6	7	8	9	10	11	12		
1980		308	4477	8941	6781	2583	441	84					23615	
1981	2	553	5156	10547	11707	5154	1384	183	16				34702	
1982	5	583	11295	17816	13395	4628	980	163	9				48874	
1983	7	2322	5729	7344	7109	4434	1147	268	34				28395	
1984	2	2532	16696	4650	9118	9254	5883	2010	127				50273	
1985		1127	11832	12970	13021	13570	6417	1875	68	2			60881	
1986	66	791	3460	9969	13109	13352	8718	1340	66	2			50872	
1987	5	2011	12071	2805	6489	13695	8916	1652	166	1			47811	
1988	0	1608	5539	4601	1614	2443	2029	432	55	14			18334	
1989		1134	19608	80355	69028	27656	18839	8704	1425	43			226792	
1990		523	12983	153241	769778	1165435	813871	619792	184590	15474	71		3735760	
1991		9992	34283	6721	205626	970879	1217384	926322	617583	242596	78725	7105	1943	4319159
1992		12554	93290	110668	125411	266605	866054	992366	861545	583042	265129	15798		4192463
1993		12884	186475	283426	294933	303557	353895	618563	660850	259930	49996	3161		3027671
1994		687	96374	340350	432930	417937	492609	912418	788571	297439	50955	1444		3831713
1995		16027	610459	752185	1271434	1456400	719890	974018	700668	281235	94949	2133		6879398
1996	164	87332	446514	576334	672359	833445	781151	631289	400954	202721	56206	14553		4703022
1997	185	161711	996583	667348	451607	378358	430927	489010	318528	212176	100677	32083	8283	4247476
1998	603	143787	1001142	362847	230467	160068	269287	396180	239605	117941	37486	11436	640	2971490
1999	817	292361	804459	369616	201584	81487	59909	125163	122838	64384	47417	21386	8887	2200307
2000	12	143360	746028	480195	267592	97613	66146	79377	98603	59390	35064	23428	15577	2112384
2001		80600	605074	555054	290943	130372	95927	121860	137372	145444	100659	83056	30771	2377132
2002	197	77309	426873	380383	325814	175139	147224	161627	168019	148260	160520	79584	55347	2306296
2003	35	26349	217222	257436	228789	116212	58451	55822	59419	43770	34810	20540	5631	1124486
2004		9839	142798	239876	256428	137757	83367	69371	49625	25374	15783	16080	15800	1062099
2005		3435	49607	149668	284379	208010	116425	88657	46521	25120	16446	11837	12062	1012166
2006	17	3007	21136	49843	132225	196029	137391	123566	95169	57725	35342	16986	23261	891696
2007		131	48310	75646	71124	128471	149528	153840	133937	80236	43233	29945	22856	937256
2008	38	1008	1862	20955	82182	97261	93795	75630	73744	51147	38437	24845	33414	594317
2009		3929	23900	7267	77812	101553	98092	71442	60775	41194	19381	15033	14598	534976
2010		338	36179	29343	20009	27520	21172	37893	31519	13044	5842	6491	2578	231927
2011		1674	7477	14494	44619	17691	18262	37286	6741	5765	1553	1372	302	157236
2012		53	9074	39484	50338	75103	23968	13325	3148	163	203	378	101	215338
2013		1959	26508	57822	74669	37230	7042	1847	530	295	26	195	286	208410
2014	0	651	15224	44618	62581	61847	40933	12092	4167	2472	515	275	379	245753
2015	36	14821	68821	28526	34813	44331	34972	16325	7756	2221	2930	835	349	256735
2016		707	39470	53582	54351	44735	30825	19333	12927	5359	2252	3295	1454	268290
2017		3481	30539	30028	38815	46444	39100	29953	26074	21463	12125	5639	10589	294250
2018		1478	37511	64144	66026	75018	46599	35293	23790	17660	9610	9196	4523	390847
2019	0	14	22688	49576	79771	107290	76471	53938	31011	9618	2225	890	702	434191
2020				1226	56387	61283	95689	138446	125771	86042	48955	16155	7815	637768

Reconstruction of acoustic surveys abundance by age-group

The same way that the catch age structure, the reconstruction of the abundances to the age considered first, the changes of otolith ageing data, and second, the checking and validating of the lengths and biological data of acoustic surveys. This was possible to do for the northern zone the years 2006, 2007, 2009, from 2013 to 2020 and southern zone from 2001 to 2012, 2017, 2020 (Table 3). This series did not have all ageing data, lacked original reading data from 2001 to 2004 in the southern zone and 2007 in the northern and southern zones. As the diagram indicates (Figure 1), in these cases a sample of 300 readings was taken from the ageing's total data of acoustic surveys, which was selected in proportion to the length frequency distribution of the year and zone without readings.

Table 3 Abundance by age group of acoustic survey's series for northern and southern zone, based on age-length key modified according new ageing criteria validated.

Northern zone (Arica - Antofagasta)													
	Age group												Total
	0	1	2	3	4	5	6	7	8	9	10	11	
2006	13346	98362	2813										114521
2007	14506	157154	72237	22835	5957								272689
2009	11399	6654	313	42	44								18453
2013	9360	18512	42854	49504	19557	4319	449						144555
2014	62529	5291	1785	12218	7752								89575
2015	91405	196182	78930	62629	23175	1773	1263						455358
2016	193137	218435	73995	38237	23253	17602	10362		2710				577732
2017	140370	218445	131722	25578	16318		8442	3305	1482	539	549		546750
2018	197785	71907	21571	6375	3874	1817	2566	949					306844
2019	42593	864731	424553	87221	44008	13735	4837						1481678
2020	69685	129263	529748	677668	254034	57584							1717982

Southern zone (Caldera - Guaitecas)														
	Age group												Total	
	0	1	2	3	4	5	6	7	8	9	10	11		12
2001		7410	571630	233333	421274	181543	163118	84118	97608	46685	76915	19843	33415	1936891
2002		25153	578674	460111	276781	150950	217727	83310	57218	13321		5346	2360	1870951
2003		24117	533583	696464	606105	264033	177182	113609	82781	39739	55804	7429	39144	2639990
2004		12936	267006	499722	820676	741707	529989	556838	338795	109996	34686	876	18357	3931584
2005		26635	326879	643903	1511927	773600	301138	179608	133236	108237	76038	29490	1480	4112170
2006			2793	183485	545815	608226	192609	166905	137495	75261	43104	15816	10480	1981989
2007				43481	290404	463860	595946	616827	524358	348199	104172	95166	58087	3140501
2008					45071	137419	119674	72104	58654	29940	20484	15838	20654	519838
2009						3132	125881	112565	89620	104107	42483	27684	29171	534643
2010			68	64	193	849	2408	5730	8704	2540	1957	962	549	24024
2011						13851	18653	54469	28649	6038	2673	1610	1264	127206
2012			82	200	1911	3538	6932	12488	1861	1121	124			28256
2017			102542	70932	74213	69378	71736	32471	5806	782	2103	958		430921
2020					10862	149761	247989	334237	333594	277433	103862	66714	18313	1542764

Discussion

Modification of the historic series from the new allocation criteria is supported by the evidence derived from the results of the validation of jack mackerel age with a multidisciplinary approach that included methods of daily micro increase, progression of strong year classes and radiocarbon bomb (Cerna et al. 2016, Araya et al. 2019, SC5-JM02, SC-04-JM-05, SC8-JM07, SC8-JM09).

The catch age structure was constituted by quarter for the series 1980 to 2020, using the age-length keys modified according to the new validated ageing criteria. The period before to 1980 could not be made due to the lack of information at a quarterly level, which would allow to made structures that are reliable.

The reconstruction of abundance age structure of the acoustic surveys has a preliminary character, since some data are missing and had to be replaced. However, this can be improved when the missing data becomes available.

The construction of catch age structure of the international fleet is still pending work. Although, these structure uses the age-length keys of Chile, in order to carry out this work we need to have the length frequency distribution of each year of this series that allows us to expand the catch by age group, data we understand could be available in the countries that contribute with these catches.

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