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ANNUAL ESTIMATES OF PURSE SEINE CATCHES BY SPECIES BASED ON ALTERNATIVE DATA SOURCES

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ABSTRACT

The current paper responds to the request originally from SC11 to update the table of purse seine catch by species estimates using several approaches. This paper has now become a regular SC Statistics and Data Theme Information paper.

Purse seine catches by species were estimated using the same four methods as reported to SC11 – uncorrected logsheets (Method 1), preserving the logsheet estimate of skipjack catch and using observer grab sampling data to determine the catches of yellowfin and bigeye tuna (Method 2), the current method based on estimation of the three species using observer grab sampling data corrected for selectivity bias (Method 3) and the current method but using uncorrected grab sampling data (Method 4).

1. INTRODUCTION

The Scientific Committee at its 11th session (SC11) requested that (paragraph 11a, SC11 Report):

> *The WCPFC science/data service provider produce an update to Table 1 in ST-WP-02 annually (until an agreement on methodology can be reached) as it provides a very useful summary of the purse-seine catch estimates derived using the four different methods to ascertain catch composition.*

Table 1 of WCPFC-SC11-ST-WP-02 referred to in the request reported annual estimates of purse-seine catch based on four different methods:

Method 1: Unadjusted logsheet data. Total catches are disaggregated by species according to the species catch proportions in logsheet data, stratified by year, month, flag, one-degree square and set type (the so-called 'S_BEST' stratification). This method has never been used by SPC for any analytical purpose.

Method 2: YFT-BET adjusted: Total catches are disaggregated into skipjack and yellowfin+bigeye according to the unadjusted logsheet data with the same S_BEST stratification as above. The yellowfin+bigeye component is then split into separate yellowfin and bigeye tuna components using uncorrected observer grab sampling data in an analysis of variance (ANOVA) or General Additive Model (GAM) procedure (Lawson 2007). Versions of this method were used by SPC to estimate purse seine species composition prior to 2008. These estimates were used in stock assessments and other analytical work conducted prior to 2008.

Method 3: Full species adjustment using observer sampling data corrected for grab sample selection bias: Total catches are disaggregated into skipjack, yellowfin and bigeye using the method described as "Case D" in Lawson (2013). The features of this method are:

- Proportions of skipjack, yellowfin and bigeye tuna are estimated directly from pooled observer data (that has been corrected for grab sample bias using estimates obtained from paired spill sampling and grab sampling experiments), stratified by year, quarter, five-degree square and school association, where the coverage of observer data (total catch compared to observed catch) in individual strata is >20%. The percentage of total strata meeting this criteria is close to 100% since 2010, when observer coverage increased dramatically (Lawson 2013, Table 6). These observer data are then applied to produce catch estimates in the S_BEST stratification.

- For strata not meeting the 20% observer coverage criteria, the species composition is estimated using a series of General Linear Models (GLMs).The GLMs estimate species composition from observer data that are corrected for grab sample bias using correction factors estimated from paired spill sampling and grab sampling experiments. The models have the following features:
    - For the period **1967-1995**, covariates of *quarter*, a two-dimensional spline of latitude and longitude, *lat_lon* and vessel *flag* are used in models fit separately to data for associated and unassociated sets. The model for associated sets additionally includes a categorical variable for *associated set sub-type* (anchored FADs, drifting FADs, logs, other). The unadjusted proportions of skipjack tuna obtained from logsheet data are used as a covariate in the model. Note that this model has no year effect, due to the paucity of observer data during this period.
    - For the period **1996-2001**, a *year* effect is added as a categorical variable.

- For the period **2002-present**, the model also includes interaction terms for *year* and *quarter*, and *year* and *geographical areas* defined to be east and west of 170°E.

The series of GLMs therefore consist of 18 discrete models defined by three time periods, two types of data (associated and unassociated sets) and three species. The models are then used to produce catch estimates in the S_BEST stratification for strata not covered by the direct estimates from observer data as described above.

For the estimates compiled in this report, we have not updated the GLM results for the historical estimates, to avoid making changes to these historical estimates based on new sampling data received during the last year. Such changes could occur through the updating of model coefficients when all data, including the recently received data, are re-analysed. Only the stratified estimates (where observer coverage is >20%) have been updated using the recently received sampling data.

Method 4: Full species adjustment using uncorrected observer data: This method is identical to method 3, except that we use observer grab sampling data that have not been corrected for grab sample selection bias. This method is not used for any analytical purpose, but has been included here to isolate the effects of full (SKJ/YFT/BET) species adjustment using the observer data and grab sample bias correction.

2. PURSE SEINE CATCH ESTIMATES

Purse seine catch estimates for 1967 – 2016 for the tropical purse seine fishery (20°N – 20°S) in the WCPFC Convention Area, excluding the domestic purse seine fisheries of Indonesia, Philippines and Vietnam, have been derived according to the methods noted above and are shown in Figure 1 and in Table 1.

We note that Method 3 continues to be the current method of choice for purse seine catch estimation for the purposes of stock assessment and catch reporting.

In April 2017, Japan resubmitted aggregate purse seine data for the period 1995–2016 with a revision to their species composition based on unloadings and port sampling data (see Peatman et al., 2017a). These new estimates are now incorporated into the WCPFC aggregate databases and reflected in the Tables and Figures presented below.

3. FUTURE WORK

Over the past year, progress has been made on re-writing the software for purse seine species composition estimation, to make it more efficient and consistent with new database structures now in use within the SPC-OFP (see Peatman et al., 2017b).

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Table 1. Purse seine catch estimates derived using the four different methods. See text for details.

	METHOD 1: UNADJUSTED LOGSHEET			METHOD 2: YFT-BET CORRECTION			METHOD 3: SKJ-YFT-BET CORRECTION, ADJ GRAB SAMPLING			METHOD 4: SKJ-YFT-BET CORRECTION, UNADJ GRAB SAMPLING		
Year	BET	SKJ	YFT	BET	SKJ	YFT	BET	SKJ	YFT	BET	SKJ	YFT
1967	-	34	33	-	34	33	1	40	26	1	38	28
1968	-	140	218	-	140	218	10	189	159	12	173	172
1969	-	77	3	-	77	3	2	63	15	5	58	17
1970	-	333	123	-	333	123	12	318	126	22	292	142
1971	35	667	192	35	667	192	32	602	260	50	558	286
1972	47	539	188	47	539	188	25	514	235	46	470	258
1973	166	1,602	504	166	1,602	504	54	1,537	682	68	1,466	738
1974	194	2,437	743	194	2,437	743	158	2,314	901	226	2,152	995
1975	141	4,583	1,664	141	4,583	1,664	334	4,494	1,560	458	4,162	1,769
1976	241	10,353	3,305	241	10,353	3,305	788	9,588	3,522	931	9,069	3,899
1977	153	13,434	4,956	153	13,434	4,956	818	12,448	5,277	997	11,720	5,825
1978	307	23,249	7,654	307	23,249	7,654	1,401	21,391	8,419	1,986	19,837	9,387
1979	403	24,875	10,671	403	24,875	10,671	1,458	24,104	10,387	2,132	22,246	11,571
1980	397	31,794	9,696	397	31,794	9,696	1,977	29,047	10,863	2,444	27,485	11,958
1981	1,037	55,069	40,856	1,037	55,069	40,856	7,533	60,625	28,804	8,402	56,273	32,287
1982	1,050	129,893	64,209	1,050	129,893	64,209	13,483	126,387	55,281	14,116	119,445	61,591
1983	1,425	250,073	92,451	1,425	250,073	92,451	18,424	233,072	92,452	20,236	221,384	102,327
1984	653	263,766	101,257	653	263,766	101,257	19,945	253,733	91,998	22,665	239,916	103,096
1985	2,003	231,858	74,101	2,003	231,858	74,101	15,138	213,195	79,629	17,511	201,949	88,503
1986	2,575	258,215	95,046	2,575	258,215	95,046	22,556	249,278	84,001	25,008	237,517	94,408
1987	1,629	255,347	147,712	1,629	255,347	147,712	25,489	257,164	122,036	29,969	248,382	139,275
1988	488	372,656	85,643	488	372,656	85,643	24,338	339,325	95,124	29,381	330,877	110,810
1989	1,538	373,471	152,581	1,538	373,471	152,581	25,491	355,932	146,168	30,473	342,429	167,099
1990	3,958	491,765	162,839	3,958	491,765	162,839	32,066	448,235	178,262	34,781	425,349	198,640
1991	2,756	617,208	213,692	2,756	617,208	213,692	33,028	591,206	209,423	36,546	564,201	232,630
1992	3,960	588,243	255,757	3,960	588,243	255,757	42,237	566,774	238,949	44,883	537,530	265,031
1993	2,139	481,233	240,158	6,739	481,233	235,558	33,010	488,738	201,782	34,991	466,343	222,079
1994	1,681	608,494	210,054	6,413	608,494	205,323	32,547	580,901	206,782	34,918	557,471	227,840
1995	3,196	585,377	172,211	7,469	585,377	167,938	23,092	548,851	188,841	31,326	528,495	198,155
1996	5,448	615,114	107,689	20,753	615,114	92,385	40,123	528,482	159,647	42,596	506,298	174,507
1997	17,713	476,014	248,020	58,094	476,014	207,638	75,496	398,223	268,028	74,198	377,662	287,093
1998	7,550	739,149	250,377	27,275	739,149	230,651	66,803	564,853	365,419	69,686	535,542	385,697
1999	11,005	663,183	196,168	27,186	663,183	179,987	65,188	519,151	286,017	69,787	485,712	308,332
2000	15,040	725,734	173,924	21,544	725,734	167,420	43,597	581,276	289,825	39,599	557,491	309,618
2001	13,659	687,279	207,496	25,537	687,279	195,618	49,641	584,890	273,904	46,863	564,170	290,289
2002	9,622	887,307	156,997	26,705	887,307	139,914	57,103	765,051	231,773	59,232	737,493	249,482
2003	10,155	792,272	192,521	19,828	792,272	182,848	36,747	685,945	272,255	37,590	662,223	289,104
2004	11,891	910,361	141,764	23,067	910,361	130,588	64,263	729,491	270,262	66,805	695,833	295,230
2005	16,082	953,570	222,271	32,860	953,570	205,494	50,342	834,181	307,401	49,354	805,487	330,440
2006	13,171	1,033,216	178,734	23,852	1,033,216	168,053	49,512	932,130	243,480	52,062	907,216	259,602

	METHOD 1: UNADJUSTED LOGSHEET			METHOD 2: YFT-BET CORRECTION			METHOD 3: SKJ-YFT-BET CORRECTION, ADJ GRAB SAMPLING			METHOD 4: SKJ-YFT-BET CORRECTION, UNADJ GRAB SAMPLING		
Year	BET	SKJ	YFT	BET	SKJ	YFT	BET	SKJ	YFT	BET	SKJ	YFT
2007	16,951	1,142,275	198,106	24,878	1,142,275	190,179	43,614	1,039,283	274,434	45,667	1,014,840	290,895
2008	28,478	1,065,507	306,714	34,020	1,065,507	301,171	51,724	982,535	366,440	51,861	963,768	379,261
2009	23,423	1,306,046	197,613	31,123	1,306,046	189,912	53,797	1,194,924	278,361	53,649	1,174,995	293,005
2010	25,025	1,183,433	278,255	33,809	1,183,433	269,471	52,041	1,114,430	320,241	52,464	1,112,499	321,750
2011	34,023	1,154,386	220,848	41,029	1,154,386	213,842	70,615	1,055,808	282,834	71,139	1,054,033	284,085
2012	28,357	1,316,777	304,033	46,068	1,316,777	286,322	61,763	1,247,234	340,170	61,384	1,245,834	341,948
2013	34,573	1,317,289	231,669	43,736	1,317,289	222,506	69,936	1,215,032	298,563	70,174	1,214,404	298,952
2014	32,080	1,473,075	271,376	42,779	1,473,075	260,677	63,970	1,393,647	318,916	63,867	1,392,935	319,731
2015	23,893	1,316,976	248,683	28,792	1,316,976	243,784	47,681	1,268,145	273,725	47,774	1,267,520	274,257
2016	29,058	1,289,684	289,716	36,850	1,289,684	281,924	57,752	1,218,848	331,858	59,385	1,211,316	337,758

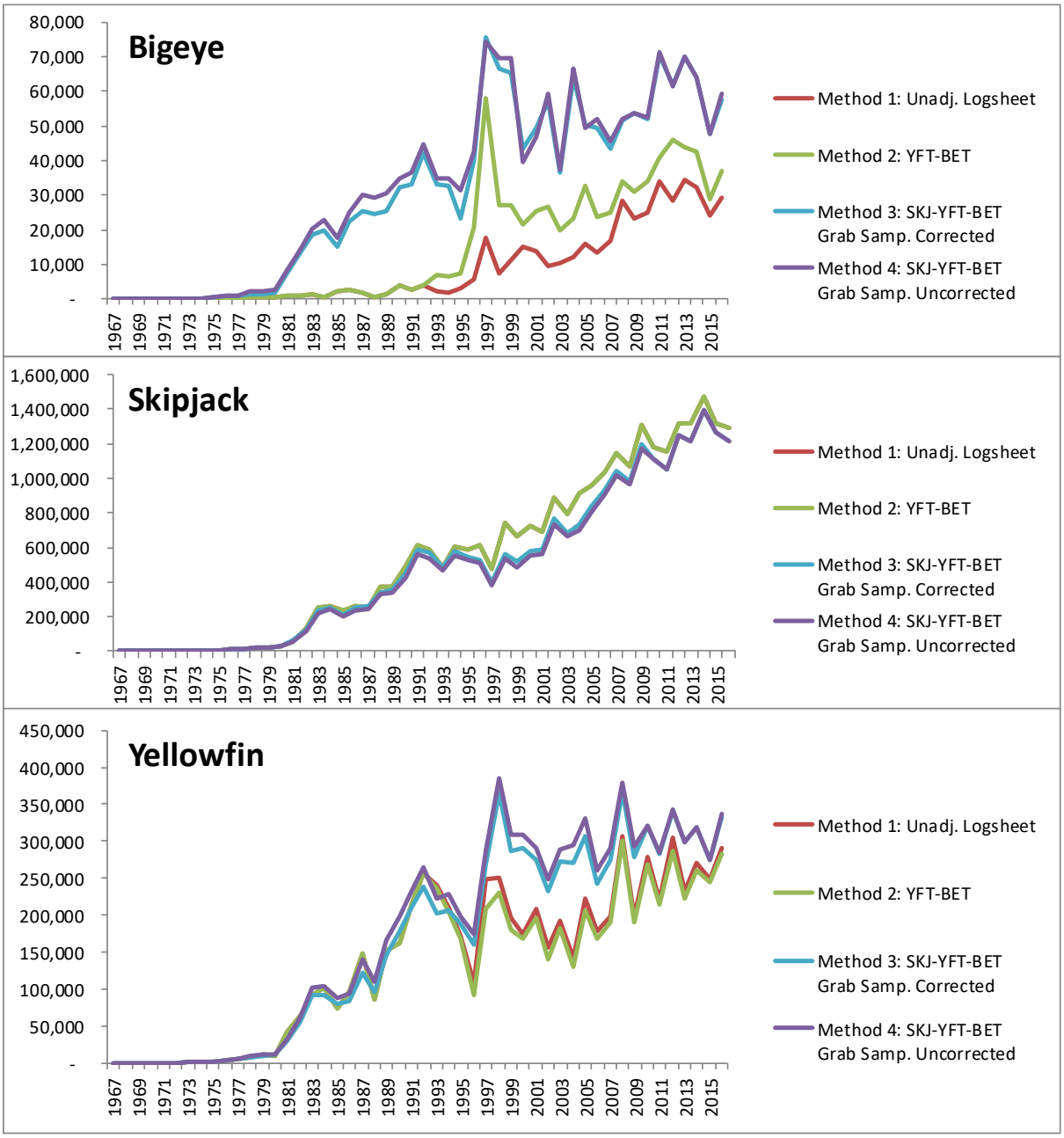

Figure 1. Purse seine catch estimates for bigeye, skipjack and yellowfin tuna, derived using the four methods described in the text. Note that for skipjack, the Method 1 and Method 2 catches are identical.