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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 from SC11 to update the table of purse seine catch by species estimates using several approaches.

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 use 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 – 2015 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.

3. FUTURE WORK

Over the coming year, we plan to re-write 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.

REFERENCES

Lawson, T. 2007. Further analysis of the proportion of bigeye in 'yellowfin plus bigeye' caught by purse seiners in the WCPFC statistical area. WCPFC-SC3-2007-ST-SWG-IP-05. http://www.wcpfc.int/system/files/ST%20IP-5.pdf

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Lawson, T. 2014. Comparison of the species composition of purse-seine catches determined from logsheets, observer data, market data, cannery receipts and port sampling data. WCPFC-SC10-2014-ST-WP-02. http://www.wcpfc.int/system/files/SC10-ST-WP-2%20PS%20spp%20catch%20comp.pdf

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	11	185	162	12	173	172
1969	-	77	3	-	77	3	4	61	15	5	58	17
1970	-	333	123	-	333	123	20	307	130	22	292	142
1971	35	667	192	35	667	192	44	593	257	50	558	286
1972	47	539	188	47	539	188	41	501	232	46	470	258
1973	166	1,602	504	166	1,602	504	60	1,545	668	68	1,466	738
1974	194	2,437	743	194	2,437	743	203	2,278	892	226	2,152	995
1975	141	4,583	1,664	141	4,583	1,664	411	4,402	1,575	458	4,162	1,769
1976	241	10,353	3,305	241	10,353	3,305	832	9,599	3,467	931	9,069	3,899
1977	153	13,434	4,956	153	13,434	4,956	895	12,434	5,214	997	11,720	5,825
1978	307	23,249	7,654	307	23,249	7,654	1,782	21,028	8,400	1,986	19,837	9,387
1979	403	24,875	10,671	403	24,875	10,671	1,937	23,587	10,426	2,132	22,246	11,571
1980	397	31,794	9,696	397	31,794	9,696	2,188	28,974	10,725	2,444	27,485	11,958
1981	1,037	55,069	40,856	1,037	55,069	40,856	7,793	60,218	28,951	8,402	56,273	32,287
1982	1,050	129,893	64,209	1,050	129,893	64,209	13,041	127,020	55,091	14,116	119,445	61,591
1983	1,425	250,073	92,451	1,425	250,073	92,451	18,754	233,200	91,994	20,236	221,384	102,327
1984	653	263,766	101,257	653	263,766	101,257	20,992	252,567	92,118	22,665	239,916	103,096
1985	2,003	231,858	74,101	2,003	231,858	74,101	15,923	212,675	79,364	17,511	201,949	88,503
1986	2,575	258,215	95,046	2,575	258,215	95,046	22,768	249,129	83,939	25,008	237,517	94,408
1987	1,629	255,347	147,712	1,629	255,347	147,712	25,748	256,105	122,835	29,969	248,382	139,275
1988	488	372,656	85,643	488	372,656	85,643	25,312	338,091	95,384	29,381	330,877	110,810
1989	1,538	373,471	152,581	1,538	373,471	152,581	26,436	354,193	146,962	30,473	342,429	167,099
1990	3,958	491,765	162,839	3,958	491,765	162,839	31,527	447,763	179,272	34,781	425,349	198,640
1991	2,756	617,208	213,692	2,756	617,208	213,692	33,346	589,729	210,581	36,546	564,201	232,630
1992	3,960	588,243	255,757	3,960	588,243	255,757	41,444	566,315	240,200	44,883	537,530	265,031
1993	2,139	481,233	240,158	6,789	481,233	235,508	32,295	488,298	202,936	34,991	466,343	222,079
1994	1,681	608,494	210,054	6,421	608,494	205,315	31,926	580,582	207,721	34,918	557,471	227,840
1995	952	585,891	171,132	5,954	585,891	166,130	28,441	550,481	179,054	31,326	528,495	198,155
1996	3,241	616,133	104,038	18,546	616,133	88,733	37,916	529,501	155,995	42,596	506,298	174,507
1997	12,042	477,400	249,528	52,423	477,400	209,147	69,824	399,609	269,536	74,198	377,662	287,093

	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
1998	4,988	738,720	247,228	24,713	738,720	227,503	64,241	564,424	362,271	69,686	535,542	385,697
1999	7,543	664,455	191,834	23,724	664,455	175,653	61,726	520,423	281,682	69,787	485,712	308,332
2000	9,531	727,968	169,209	16,035	727,968	162,705	38,088	583,510	285,110	39,599	557,491	309,618
2001	9,110	691,178	201,033	20,988	691,178	189,155	45,092	588,789	267,441	46,863	564,170	290,289
2002	7,181	886,993	152,059	24,264	886,993	134,976	54,662	764,737	226,835	59,232	737,493	249,482
2003	8,758	794,495	185,805	18,431	794,495	176,132	35,350	688,168	265,539	37,590	662,223	289,104
2004	9,347	913,902	134,619	20,523	913,902	123,443	61,719	733,032	263,117	66,805	695,833	295,230
2005	13,325	955,504	217,133	30,103	955,504	200,355	47,585	836,115	302,262	49,354	805,487	330,440
2006	11,990	1,036,405	170,484	22,671	1,036,405	159,803	48,331	935,318	235,230	52,062	907,216	259,602
2007	15,196	1,144,212	191,994	23,123	1,144,212	184,067	41,859	1,041,219	268,322	45,667	1,014,840	290,895
2008	25,858	1,069,513	299,518	31,401	1,069,513	293,975	49,105	986,541	359,244	51,861	963,768	379,261
2009	20,922	1,310,105	190,622	28,622	1,310,105	182,921	51,296	1,198,984	271,370	53,649	1,174,995	293,005
2010	23,234	1,187,713	273,232	31,904	1,187,713	264,561	49,757	1,119,010	315,412	50,073	1,117,231	316,876
2011	32,475	1,141,304	215,802	38,880	1,141,304	209,397	68,089	1,044,533	276,959	68,580	1,042,714	278,287
2012	25,985	1,328,428	295,362	42,502	1,328,428	278,846	59,862	1,252,733	337,180	59,186	1,251,677	338,911
2013	32,656	1,325,370	226,053	41,449	1,325,370	217,260	66,816	1,222,070	295,194	67,716	1,220,312	296,052
2014	29,905	1,491,090	266,781	40,110	1,491,090	256,577	62,702	1,409,082	315,993	62,671	1,407,660	317,446
2015	21,761	1,326,491	244,561	28,426	1,326,491	237,896	44,774	1,278,734	269,306	45,079	1,276,694	271,040

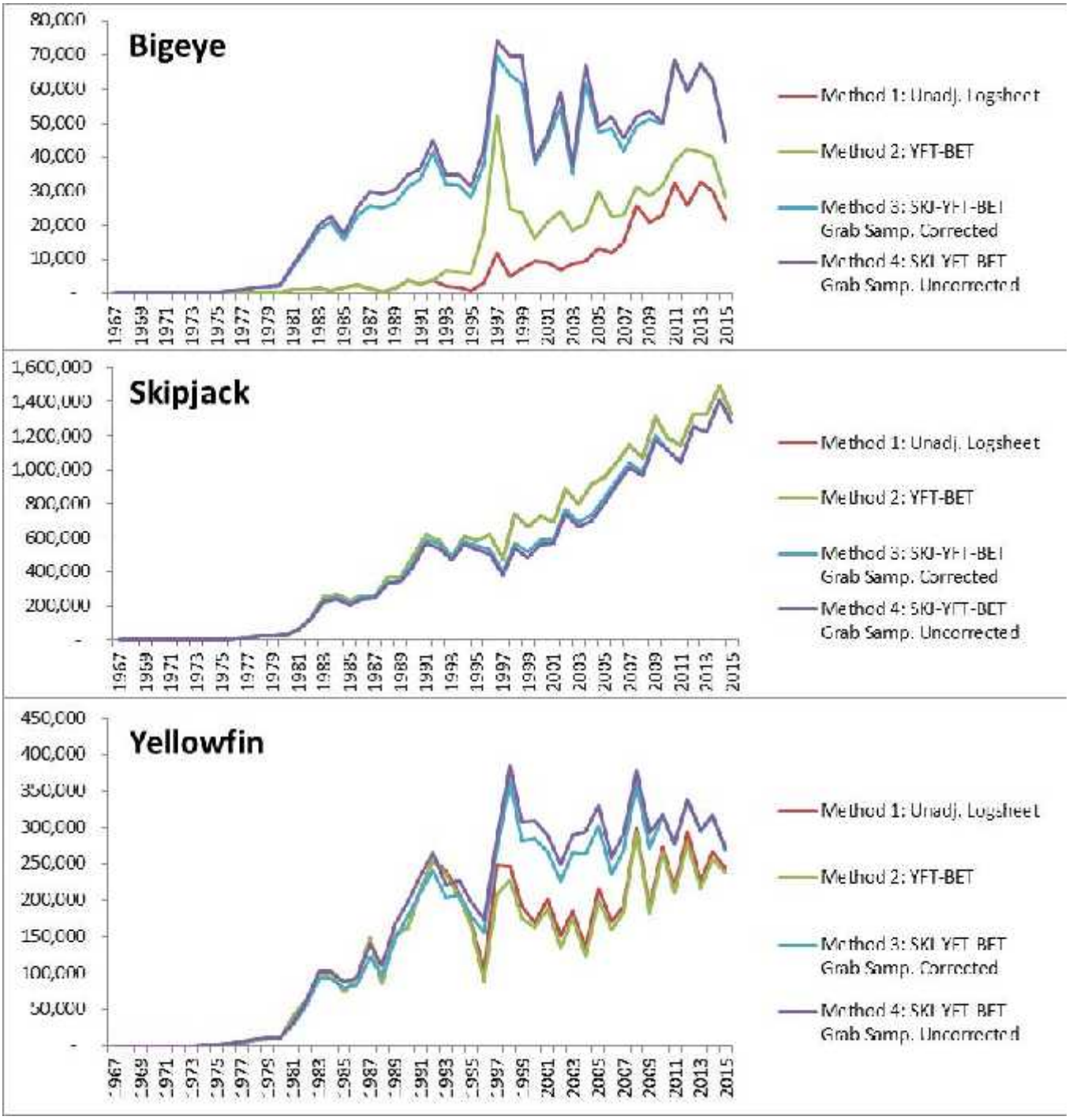

Figure 1. Purse seine catch estimates for bigeye, skipjack and yellowfin tuna, derived using the four methods described in the text. Note that for skipjack, the Method 1 and Method 2 catches are identical.