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Update on the estimation of selectivity bias based on paired spill and grab samples collected by observers on purse seiners in the Western and Central Pacific Ocean

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UPDATE ON THE ESTIMATION OF SELECTIVITY BIAS BASED ON PAIRED SPILL AND GRAB SAMPLES COLLECTED BY OBSERVERS ON PURSE SEINERS IN THE WESTERN AND CENTRAL PACIFIC OCEAN

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1. Introduction

Lawson (2009) estimated the selectivity bias of observers in species composition data by comparing paired grab and spill samples collected during four purse-seine trips taken in 2008. Since that paper was published, paired samples for an additional thirteen trips have become available for analysis. Table 1 summarises information about each trip. Trips #1 to #15 took place on vessels of Papua New Guinea fishing in their home waters, while Trips #16 and #17 took place on a United States vessel fishing in the waters of Papua New Guinea, Federated States of Micronesia and Nauru.

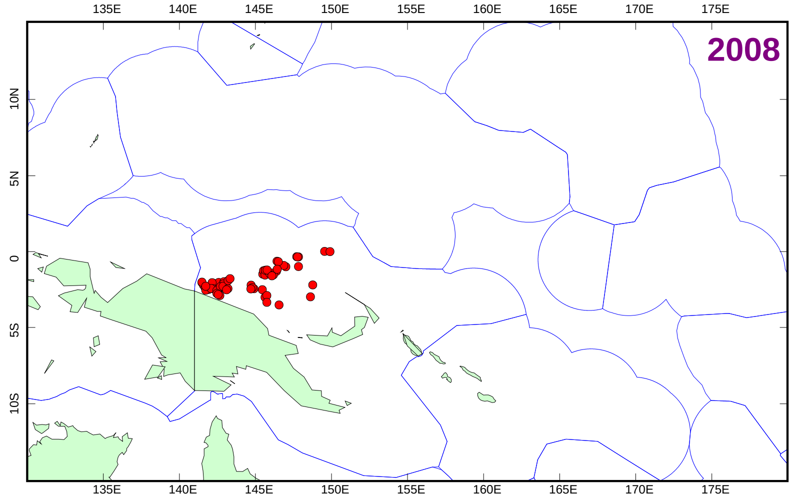
Table 1. Date, location, catch and number of sets sampled for trips during which paired grab and spill samples were collected

Trip #	Date		Latitude		Longitude		Catch (Tonnes)			Number of Sets Pair Sampled					
	Min	Max	Min	Max	Min	Max	Total	Pair Sampled	Not Pair Sampled	Total	Anchored FADs	Drifting FADs	Logs	Unassoc	Other
1	23-Mar-08	27-Mar-08	03S	01S	143E	146E	452	452	0	7	7	0	0	0	0
2	18-May-08	08-Aug-08	04S	00N	141E	150E	2,108	1,172	935	31	30	0	1	0	0
3	07-Jun-08	30-Jun-08	04S	00N	143E	149E	649	580	69	13	10	1	0	0	2
4	14-Jul-08	09-Aug-08	03S	02S	141E	146E	698	615	83	15	9	4	1	0	1
5	03-May-09	05-Jun-09	04S	02S	148E	151E	508	469	39	15	13	0	1	1	0
6	04-May-09	04-Jun-09	03S	01S	143E	146E	408	256	152	9	8	0	0	0	1
7	04-Jun-09	04-Aug-09	05S	02S	142E	151E	789	613	175	23	20	1	2	0	0
8	14-Jun-09	28-Jul-09	05S	01S	142E	148E	498	335	163	13	9	0	4	0	0
9	16-Jun-09	26-Jul-09	05S	02S	142E	150E	359	352	7	22	17	0	5	0	0
10	22-Aug-09	10-Sep-09	05S	04S	150E	151E	317	317	0	16	10	1	4	0	1
11	10-Sep-09	10-Oct-09	05S	02S	143E	150E	605	518	87	10	7	0	3	0	0
12	09-Oct-09	21-Oct-09	02S	02S	143E	144E	565	541	25	8	4	0	4	0	0
13	03-Nov-09	01-Dec-09	03S	01S	142E	146E	534	514	20	15	12	0	3	0	0
14	11-Nov-09	04-Dec-09	03S	02S	143E	146E	411	388	23	14	13	0	0	0	1
15	13-Nov-09	07-Dec-09	03S	02S	142E	143E	589	460	129	15	15	0	0	0	0
16	19-Mar-10	18-Apr-10	04S	01N	146E	165E	821	749	71	20	0	10	0	9	1
17	29-Apr-10	11-May-10	06S	01N	152E	156E	383	343	40	8	0	7	0	1	0
						Total	10,693	8,675	2,019	254	184	24	28	11	7

Paired samples were collected from 254 sets, including 184 (72.4%) sets on schools associated with anchored FADs, 24 (9.4%) on drifting FADs, 28 (11%) on logs and 11 (4.3%) sets on unassociated schools. [1, 2]

The locations of the sets from which the paired samples were collected are shown in Figure 1.

Figure 1. Location of sets from which paired spill and grab samples were collected



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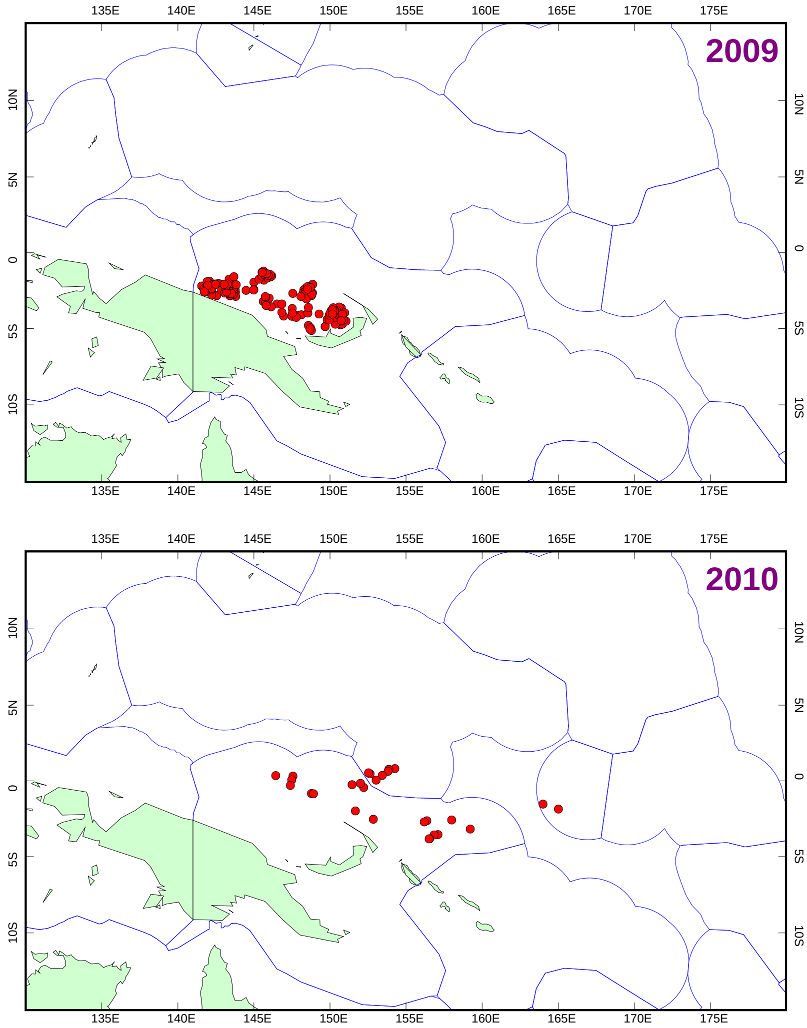
[1] Note in Table 1 that for Trips #2 to #4, schools associated with anchored FADs were not fished exclusively, in contrast to what was reported in Lawson (2009). The database system for entering paired samples collected by observers was not fully developed when the analyses presented in that study were conducted. When the data were re-entered using the fully developed system, it was determined that for Trips #2 to #4, (i) a small number of non-target fish had been included in the catches of bigeye, (ii) one page of data containing the species and lengths for 120 fish from one set had not been entered, (iii) there were minor errors in the set weights, (iv) not all sets had been sampled and (v) schools associated with anchored FADs had not been fished exclusively. It was noted in that study that the species composition for these three trips were similar; the species compositions for Trips #2 to #4 determined from the re-entered data indicate that they are slightly more similar than reported in Lawson (2009). The effect of the data-entry errors was thus minor.

[2] Paired samples were also collected during four trips taken onboard a New Zealand purse seiner fishing out of Pago Pago, American Samoa during 2009. However, the observers' daily logs revealed that the sampling protocol for spill samples was not followed due to lack of cooperation of the captain and crew, which took three forms. First, the initial brail sampled should have been selected by the observer and rotated among the first ten brails in the following sets; instead, the captain or navigator usually determined the first brail to sample, which was usually one of the first few brails. Second, every tenth brail after the initial brail should also have been selected for a spill sample; instead, for those sets for which more than one brail should have been sampled, the observer was not usually allowed to sample the additional brails. Third, all fish in the spill sample should have been measured; instead, the observer was required to stop measuring as soon as brailing had been completed, such that not all fish were measured. Since one or more of these problems affected almost all of the spill samples, the data for these four trips have not been included in the current analysis.

Figure 1 (continued)



2. Species Compositions by School Type

Figure 2 presents the species compositions determined from paired spill and grab samples collected by observers during the seventeen trips, for all school associations combined and for schools associated with anchored FADs, drifting FADs, logs and unassociated schools. The species compositions are in terms of weight; the weights of the sampled fish were determined from lengths using length-weight curves and the total weights in each sample were raised by the set weight.

Figure 2. Estimates of purse-seine species composition determined from paired spill and grab samples collected by observers during seven trips in 2008–2009

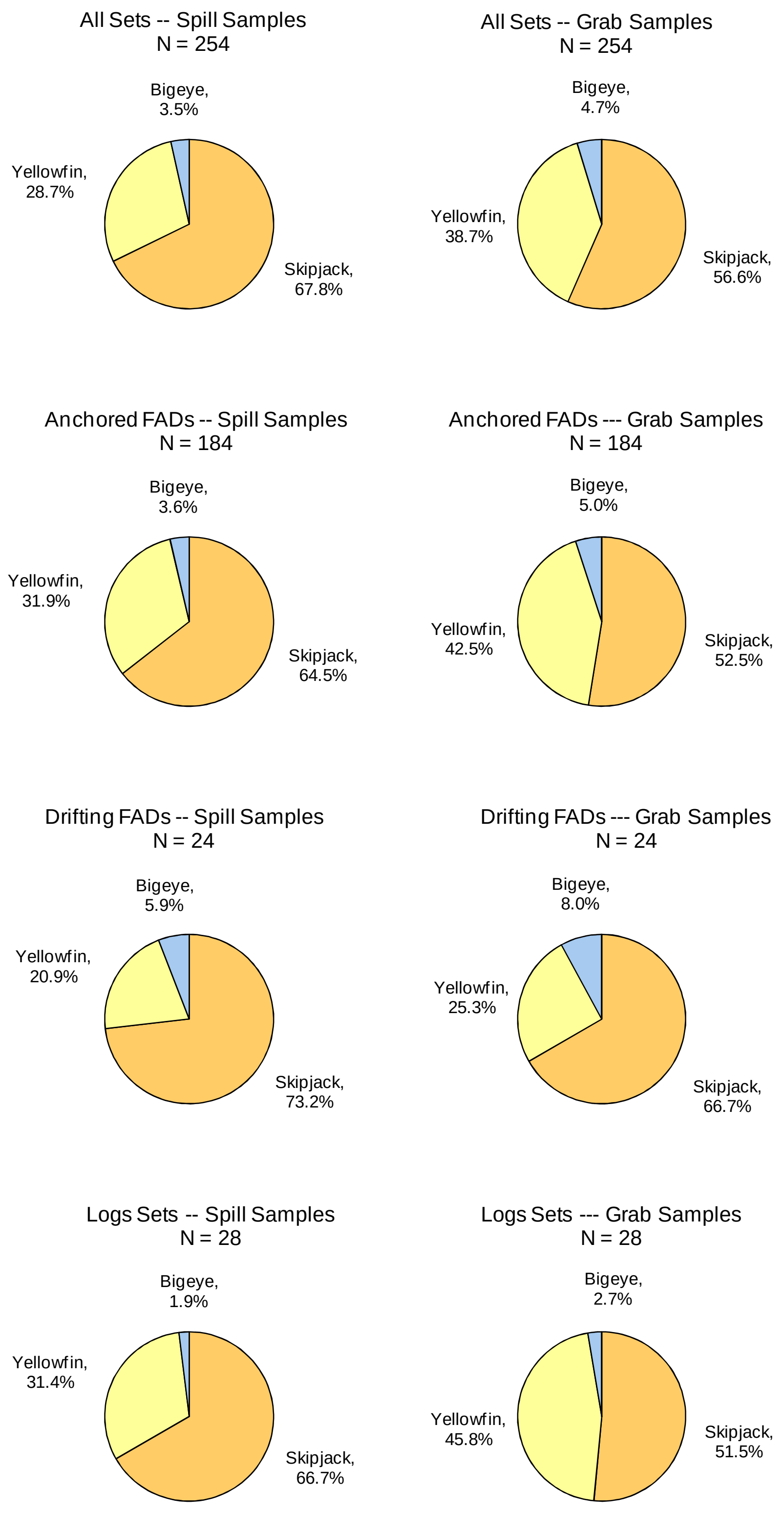
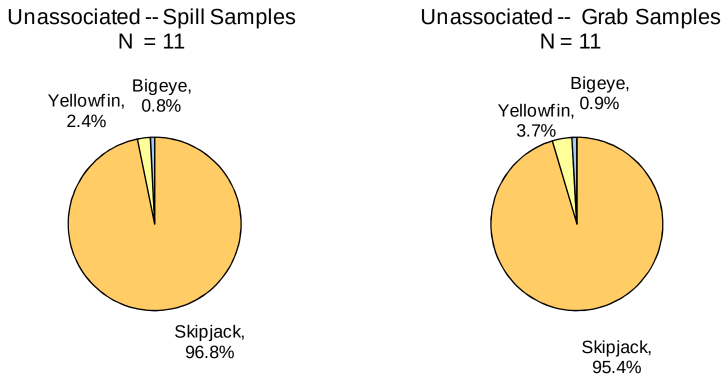


Figure 2 (continued)



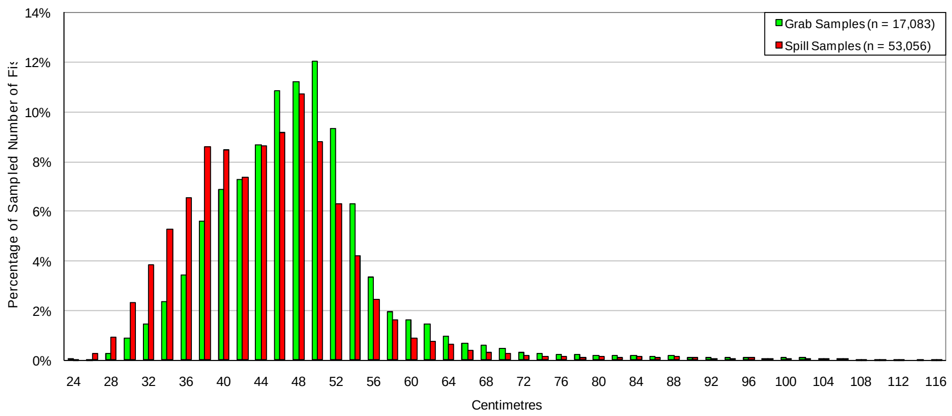
For all sets combined and for each of the school associations, the species compositions show a greater proportion of skipjack and a smaller proportion of yellowfin and bigeye in those determined from spill samples, compared to grab samples. For all sets combined, the increase in the proportion of skipjack is 11.2% and the decreases in the proportions of yellowfin and bigeye are 10.0% and 1.2% respectively. The magnitude of the difference in the species compositions depends, obviously, on the species composition; thus, for the eleven sets on unassociated schools, which consisted of over 95% skipjack, the difference is minor, while for the associated schools, the differences are considerable.

3. Selectivity bias in grab samples

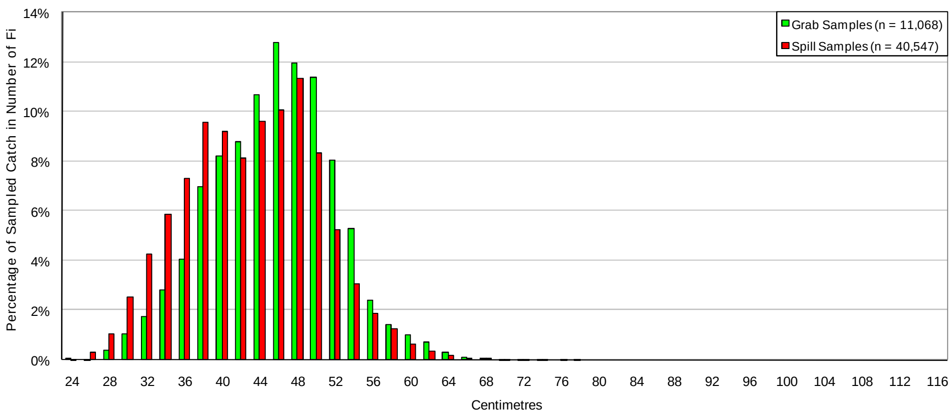
Figure 3 presents length frequencies (in terms of numbers of fish, rather than weight) determined from all (254) sets. The length frequency at the top of Figure 3 is for skipjack, yellowfin and bigeye combined, and shows that for lengths less than 44 cm, there are greater proportions of fish in the spill samples than in the grab samples and vice versa for fish greater than or equal to 44 cm. This is a clear indication of a size selection bias on the part of the grab samplers (assuming that length frequencies determined from spill samples are unbiased). The same pattern is observed in the length frequencies for each species separately, although the length at which the change occurs differs slightly, which suggests that the size of fish is of greater importance in the selectivity bias than the species. For bigeye, the pattern is somewhat less distinct because of the smaller number of fish in the samples. For all fish greater than about 70 cm, the pattern is indistinct for the same reason.

Figure 3. Length frequencies in terms of number of fish determined from grab samples and spill samples

All Species



Skipjack



Yellowfin

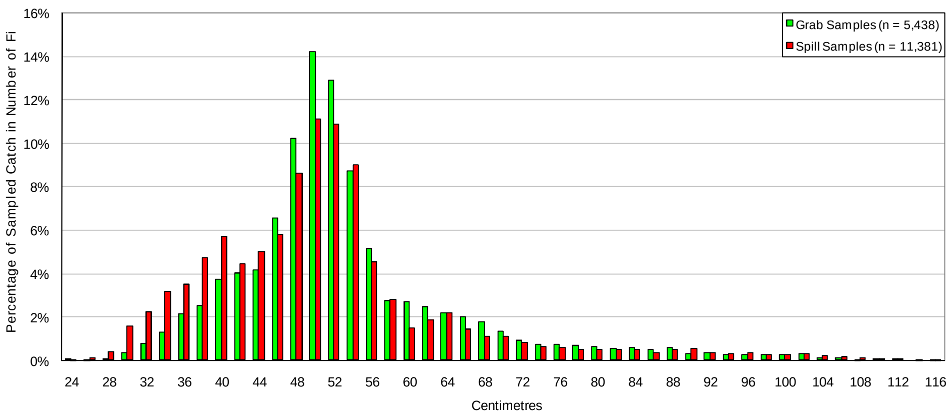
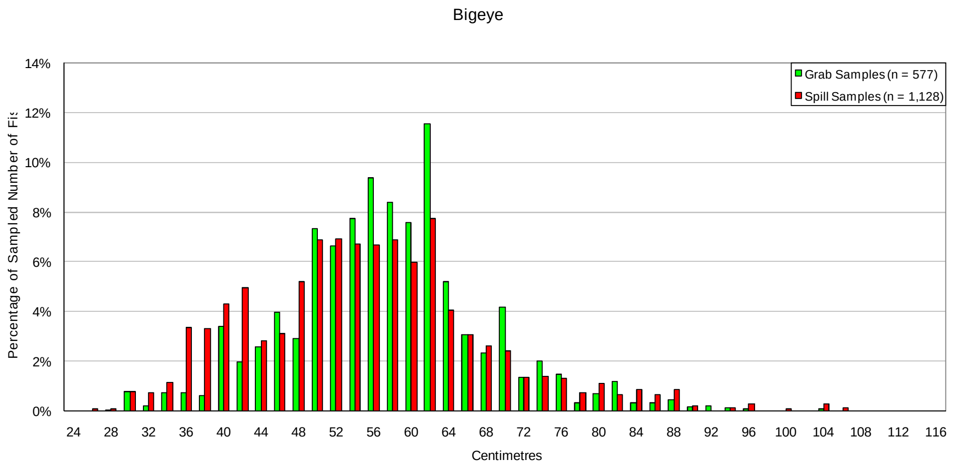


Figure 3 (continued)



The selectivity bias in grab samples was estimated using the model developed in Lawson (2009):

$$n_{jk} = \frac{W_k \cdot T_{jk}}{\overline{w}_j} \cdot A_j + \varepsilon \tag{1}$$

where n_{ijk} is the number of fish of length interval *j* selected by a grab sampler from set k ; W_k is the total weight of set k ; T_{ijk} is the “true” proportion of fish of length interval *j* in set *k*, in terms of weight, determined from the spill sample taken from set k ; $\overline{w}_j$ is the average weight of fish of length interval j ; A_j is the probability that a grab sampler will select a fish of length interval j , which can also be considered as the *availability* of a fish to be selected; and ε is a random variable of mean zero.

The availability parameters, A_j in equation (1), were, in the first instance, estimated for 13 intervals of 10 cm. The model was fit using the Normal distribution and untransformed n_{jk}. Table 2 shows the length interval, the estimate of availability for each interval and the standard error, t value and statistical significance of the estimate.

Table 2. Estimates of availability for a model with 10 cm length intervals

Interval	Estimate	Std Error	t value	Pr(>|t|)
20-29	0.000646	0.001074	**0.601153**	**0.54783899**
30-39	0.001778	0.000156	11.369904	0.00000000
40-49	0.003532	0.000114	30.954678	0.00000000
50-59	0.004891	0.000213	22.975776	0.00000000
60-69	0.006505	0.001125	5.783014	0.00000001
70-79	0.008042	0.003578	2.247507	0.02476891
80-89	0.008101	0.005629	**1.439106**	**0.15035288**
90-99	0.011751	0.008798	**1.335693**	**0.18187537**
100-109	0.007269	0.013615	**0.533909**	**0.59349251**
110-119	0.004345	0.042858	**0.101375**	**0.91926792**
120-129	0.011320	0.097295	**0.116352**	**0.90739081**
130-139	0.000000	0.254564	**0.000000**	**1.00000000**
140-149	0.000000	0.187920	**0.000000**	**1.00000000**

Unfortunately, the estimates for the 20–29 cm interval and the intervals of 80–89 cm and above (in bold) are not significant, almost certainly because of the small number of fish in these intervals in the spill and grab samples. Therefore, a model with a smaller number of intervals, in which the smallest and largest intervals in the table above were grouped, was fit; the results are shown in Table 3.

Table 3. Estimates of availability for a model with 10 cm length intervals, with small fish and large fish grouped

Interval	Estimate	Std Error	t value	Pr(>|t|)
≤ 39	0.001745	0.000169	10.313902	0.00000000
40-49	0.003532	0.000130	27.202819	0.00000000
50-59	0.004891	0.000242	20.191000	0.00000000
60-69	0.006505	0.001280	5.082084	0.00000044
≥ 70	0.011163	0.002388	4.675594	0.00000330

Grouping the smaller and larger fish into single length intervals results in statistically significant estimates of their availability, as expected, but at the expense of lower resolution.

Figure 4 shows the estimates of availability, with bars of plus or minus two standard errors. The estimates of availability increase in an almost linear manner from fish ≤ 39 cm to 60–69 cm fish, then jump up to a higher availability for fish ≥ 70 cm; however, the estimate of availability for fish ≥ 60 cm is less reliable, as shown by the wider error bars.

Figure 4. Estimates of availability for a model with 10 cm length intervals, with small fish and large fish grouped

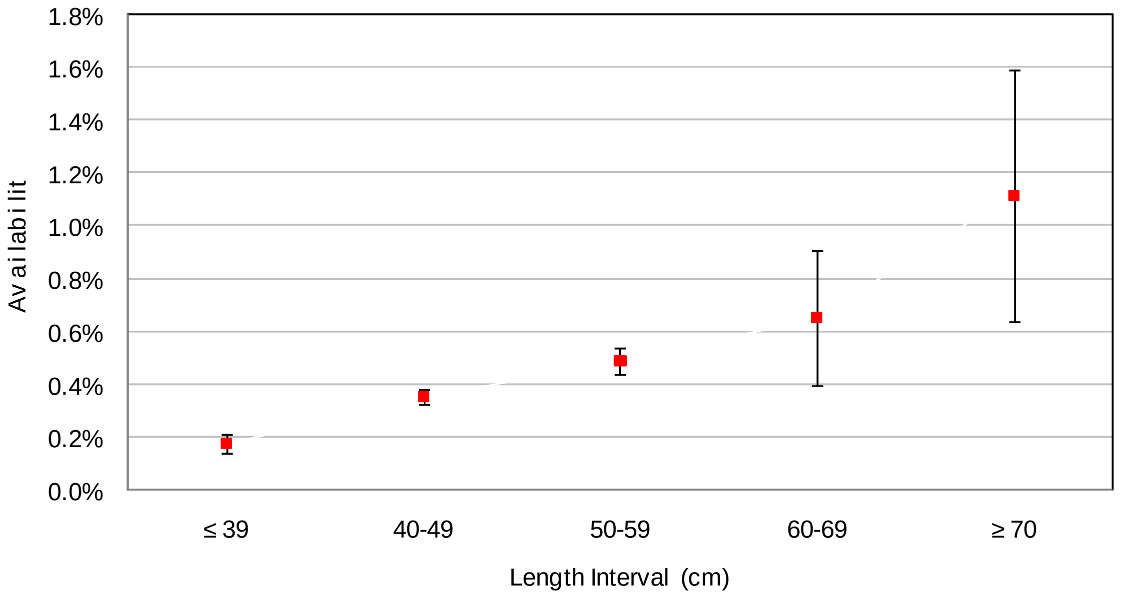


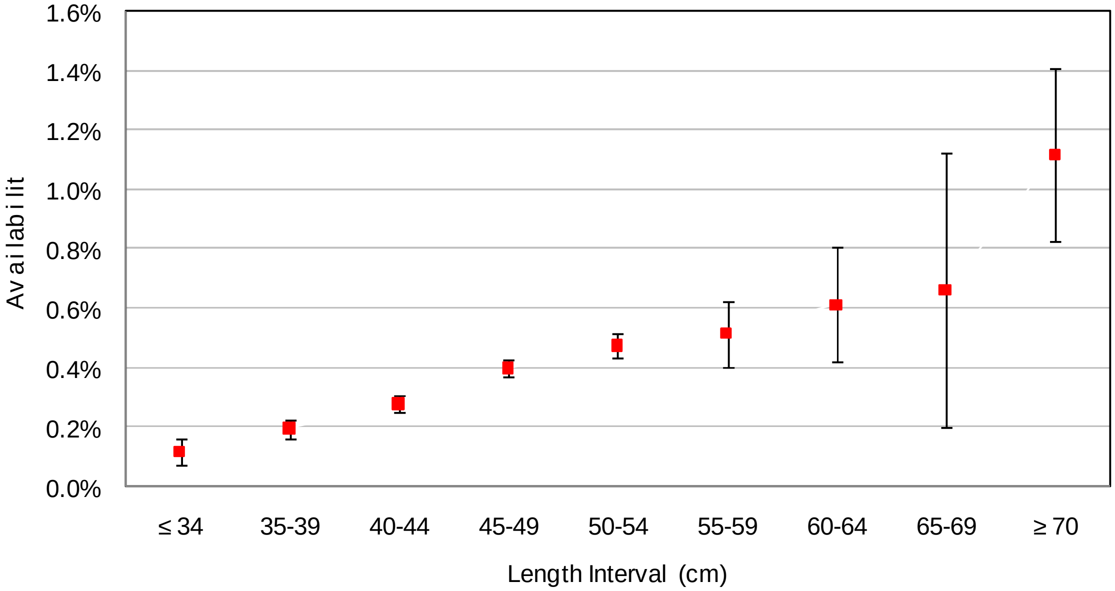
Figure 4 suggests that the size selectivity is a relatively simple function of length, wherein the probability of a fish being selected by a grab sampler increases almost linearly with the length of a fish. This was examined in greater detail using a model with 5 cm intervals. The same procedure as for the models with 10 cm intervals was followed, with the grouping of length intervals for which the estimates of availability were not significant. The results are shown in Table 4 and Figure 5.

In contrast to the estimate of availability for 30–39 cm fish in the 10 cm model, the estimate for 35–39 cm fish in the 5 cm model was significant; all fish ≤ 34 cm and ≥ 70 cm were grouped in the final 5 cm model. Figure 5 shows that the estimates of availability increase with size; however, the relationship is obscured by the wide error bars for fish ≥ 55 cm.

Table 4. **Estimates of availability for a model with 5 cm length intervals, with small fish and large fish grouped**

Interval	Estimate	Std Error	t value	Pr(>|t|)
≤ 34	0.001186	0.000224	5.286590	0.00000014
35-39	0.001962	0.000156	12.536774	0.00000000
40-44	0.002794	0.000143	19.557551	0.00000000
45-49	0.003991	0.000142	28.155110	0.00000000
50-54	0.004752	0.000190	25.013712	0.00000000
55-59	0.005145	0.000562	9.159454	0.00000000
60-64	0.006121	0.000967	6.329040	0.00000000
65-69	0.006621	0.002301	2.877551	0.00405405
≥ 70	0.011163	0.001461	7.639209	0.00000000

Figure 5. **Estimates of availability for a model with 5 cm length intervals, with small fish and large fish grouped**



The selectivity bias for sizes greater than 54 cm is uncertain because of the lack of sufficient data. Another approach to estimating availability, which may shed some light on what the relationship looks like at larger sizes even though data are lacking, is to model it as a polynomial function of length. Instead of estimating availability for each length interval, the parameters of a complex function, which describes the relationship between availability and length, are estimated.

Estimates of the parameters of a polynomial spline were obtained using the following relationship for data grouped by set and length interval, which is derived from equation (1):

$$\frac{\dfrac{n_{jk}}{W_k \cdot T_{jk}}}{\overline{w}_j} = A_j + \varepsilon \tag{2}$$

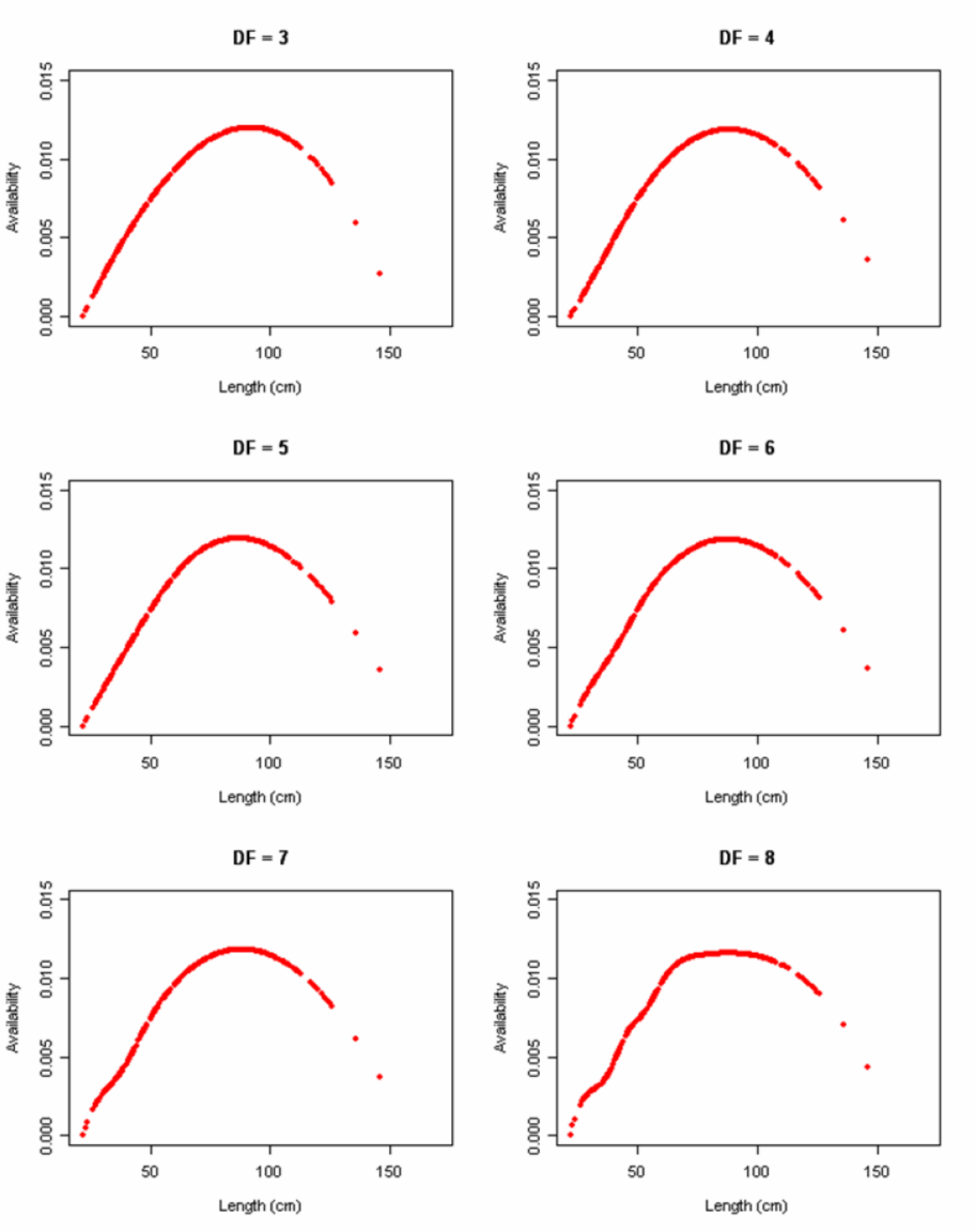
$$A_j = f\left(\overline{L}_{jk}, \beta\right) \tag{3}$$

where the lefthand side of equation (2) is determined for each stratum from the data, the function *f* is a polynomial spline, $\overline{L}_{jk}$ is the average length in the stratum, and β is the vector of parameters to be estimated. The length of the vector β is equal to the degrees of freedom, which, in turn, determines the complexity of the relationship between availability and length; an increase in the degrees of freedom increases the complexity.

Figure 6 shows the relationship between availability and length using from three to eight degrees of freedom in the splines. The paired spill and grab samples were grouped by set and length intervals of 5 cm; intervals for fish less than 35 cm or greater than 69 cm were not combined. The plots show the fitted values of availability. For lengths less than about 75 cm and degrees of freedom of six or less, availability increases almost linearly with length, as when availability is estimated for each length interval individually using equation (1). For lengths greater than about 80 to 90 cm, availability decreases. This suggests that grab samplers under-select very large fish as well as very small fish; however, it should be noted that these results are based on a relatively small sample of large fish. Fish in the paired spill and grab samples greater than 80 cm represent only 1.8% of the total. All strata with lengths greater than 105 cm in Figure 6 are supported by no more than two fish in the spill sample. Our confidence in the results of this analysis should increase as more data from paired samples containing larger fish become available.

Figure 6 indicates that the relationship between availability and length does not depend greatly on the degrees of freedom, although with six or more degrees of freedom, the relationship for fish less than about 75 cm is less linear than with fewer degrees of freedom.

Figure 6. Relationship between availability and length estimated using polynomial functions with various degrees of freedom (DF)



4. Correction of grab samples for size selectivity bias and application of the corrected grab samples to catch data used in the MULTIFAN-CL analyses

The estimates of availability can be used to correct the species composition for an individual set determined from the grab samples as follows:

$$\widehat{P}_{ik} = \frac{\sum_j \frac{W_{ijk}}{A_j}}{\sum_i \sum_j \frac{W_{ijk}}{A_j}} \tag{4}$$

$$W_{ijk} = W_k \cdot \frac{\sum_l a_i \cdot L_{ijkl}^{b_i}}{\sum_i \sum_j \sum_l a_i \cdot L_{ijkl}^{b_i}} \tag{5}$$

where $\widehat{P}_{ik}$ is the estimated proportion of species *i* in set k ; W_{ijk} is the weight of fish of species *i* and length interval *j*, raised by the set weight W_k , that were selected by the grab sampler from set k ; L_{ijkl} is the length of fish *l* in the category of species *i* and length interval *j* in the sample taken from set k ; and a_i and b_i are the weight-length parameters for species *i* (Lawson 2009).

Equations (4) and (5), and the estimates of availability using the 10 cm model (Tables 3), were used to correct the species compositions for each set for which a grab sample was collected by an observer; the SPC Oceanic Fisheries Programme (OFP) holds grab sample data for 27,999 sets sampled from 1995 to 2009.

The corrected grab samples were then used to adjust the species compositions in the catch data used by the MULTIFAN-CL (MFCL) analyses, in a five-step procedure as follows.

First, the catch data from the "*s_best*" database of purse-seine catch and effort data that is maintained by the OFP were grouped by year (1972–2009), quarter, two MFCL areas (20°N–20°S / 120°E–170°E and 20°N–20°S / 170°E–150°W) and school association (unassociated and associated). (The areas are those used in the MFCL assessment of skipjack; similar areas are used in the MFCL analyses of yellowfin and bigeye, except the southern and western boundaries are 10°S and 110°E.) The catch data in *s_best* that were the basis for the adjustment are determined from logsheet data, with a modification of the proportions of bigeye and yellowfin in the combined catch of yellowfin plus bigeye reported on the logsheets, using uncorrected grab samples (Lawson 2007) [3]. The estimates of skipjack catches in *s_best* are not modified and, since they are often over-

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[3] Except for data covering the Japanese fleet since 1996, the domestic fleets of Indonesia and the Philippines, the Spanish fleet and other fleets operating from the Eastern Pacific Ocean, for which unadjusted logsheets or aggregated data provided by the flag state are used.

reported on logsheets, are therefore biased upwards, while the estimates of catches of yellowfin and bigeye are biased downwards.

Second, the corrected grab samples were also grouped by year, quarter, MFCL area and school association, and the species composition was determined for each stratum from the grouped samples.

Third, for each stratum for which there were at least 20 sets sampled, the species composition from the corrected grab samples was applied directly to the catch data for that stratum that were grouped from *s_best*. The catches by species for each stratum thus reflect the total catch prior to the adjustment and the species composition determined from the corrected grab samples; the unadjusted species composition in *s_best* for particular fleets (such as the Japanese fleet and others mentioned in the footnote above) were ignored for this study.

Fourth, for those strata for 1996–2009 for which there were less than 20 sets sampled, the species composition was predicted with the linear categorical model below (Lawson 2009)[4]:

$$p_{ijkl}^{SKJ} = \beta_{Intercept}^{SKJ} + \beta_i^{SKJ} \cdot YY_i + \beta_j^{SKJ} \cdot QQ_j + \beta_k^{SKJ} \cdot AR_k + \beta_l^{SKJ} \cdot AS_l \qquad (6)$$

$$p_{ijkl}^{YFT} = \beta_{Intercept}^{YFT} + \beta_i^{YFT} \cdot YY_i + \beta_j^{YFT} \cdot QQ_j + \beta_k^{YFT} \cdot AR_k + \beta_l^{YFT} \cdot AS_l \qquad (7)$$

$$p_{ijkl}^{BET} = \beta_{Intercept}^{BET} + \beta_i^{BET} \cdot YY_i + \beta_j^{BET} \cdot QQ_j + \beta_k^{BET} \cdot AR_k + \beta_l^{BET} \cdot AS_l \qquad (8)$$

where the proportion of each species — e.g., p_{ijkl}^{SKJ}, the proportion of skipjack in year *i*, quarter *j*, area *k* and school association *l* — is predicted as a function year (YY_i), quarter (QQ_j), MFCL area (AR_k) and school association (AS_l). All first-order interactions, except year–area, were also included in the model. The model parameters — the β's — were fitted to the species compositions determined from the corrected grab samples. The model explained 48.0%, 46.3% and 51.4% of the deviance in the proportions of skipjack, yellowfin and bigeye respectively. As in the third step, the predicted species composition for each stratum was applied to the catch data for that stratum that were grouped from *s_best*.

Fifth, for strata for 1972–1995 (for which there were no grab samples, except for a small number of samples in 1995), the species composition was predicted with a linear categorical model similar to equations (6)–(8), but without a year effect (since there were no grab sample data for those years) and with all first-order interaction terms among the remaining variables. The model parameters were fitted to the same species compositions determined from the corrected grab samples as in the

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[4] Linear categorical models of the species composition have the useful property that the predicted proportions of each species in a stratum always sums to unity. Such models are more statistically rigorous than the usual practice of substituting the species compositions from neighbouring strata into strata with insufficient sampling data; substituting from neighbouring strata can be considered as a less than rigorous use of the interaction terms.

fourth step. The predicted species composition for each stratum was applied to the catch data for that stratum that were grouped from *s_best*. The model explained 8.8%, 5.9% and 28.2% of the deviance in the proportions of skipjack, yellowfin and bigeye respectively. While the deviance explained by the model without the year effect was much less than the model with the year effect, it was considered that the predictions of the species compositions for 1972–1995 were still better than those determined from the unadjusted data grouped from *s_best*.

The five-step procedure was then repeated using grab samples corrected with estimates of availability using the 5 cm model (Table 4). The deviances explained by the models fitted in the fourth and fifth steps were almost identical to those using grab samples corrected with estimates of availability using the 10 cm model.

Figure 7 shows the species compositions for associated schools, unassociated schools and all schools combined determined from (i) the unadjusted data grouped from *s_best*, (ii) the data from *s_best* that were adjusted with grab samples corrected with estimates of availability using the 10 cm model (Table 3) and (iii) the data from *s_best* that were adjusted with grab samples corrected with estimates of availability using the 5 cm model (Table 4). The species compositions are for all strata of year, quarter, area and school association combined.

Figure 7. Species compositions for unadjusted and adjusted catch data used in MFCL analyses, 1972–2009, 20°S to 20°N and 120°E to 150°W

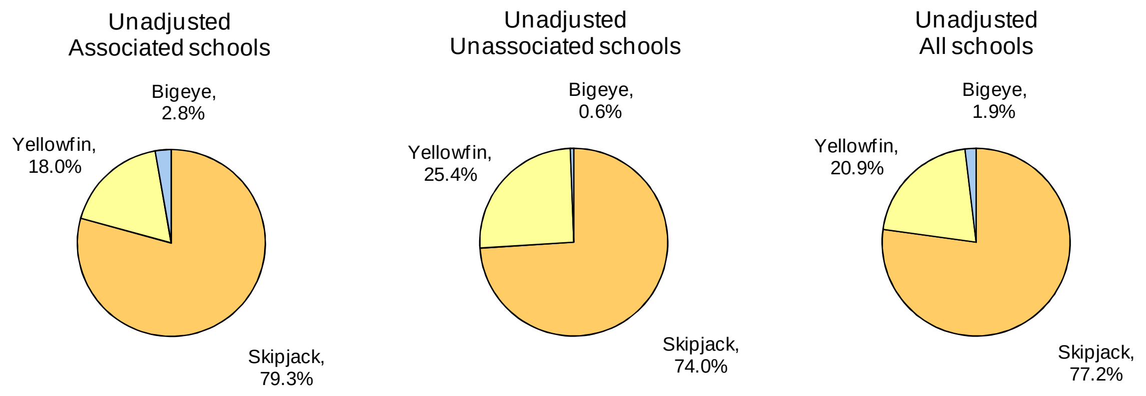
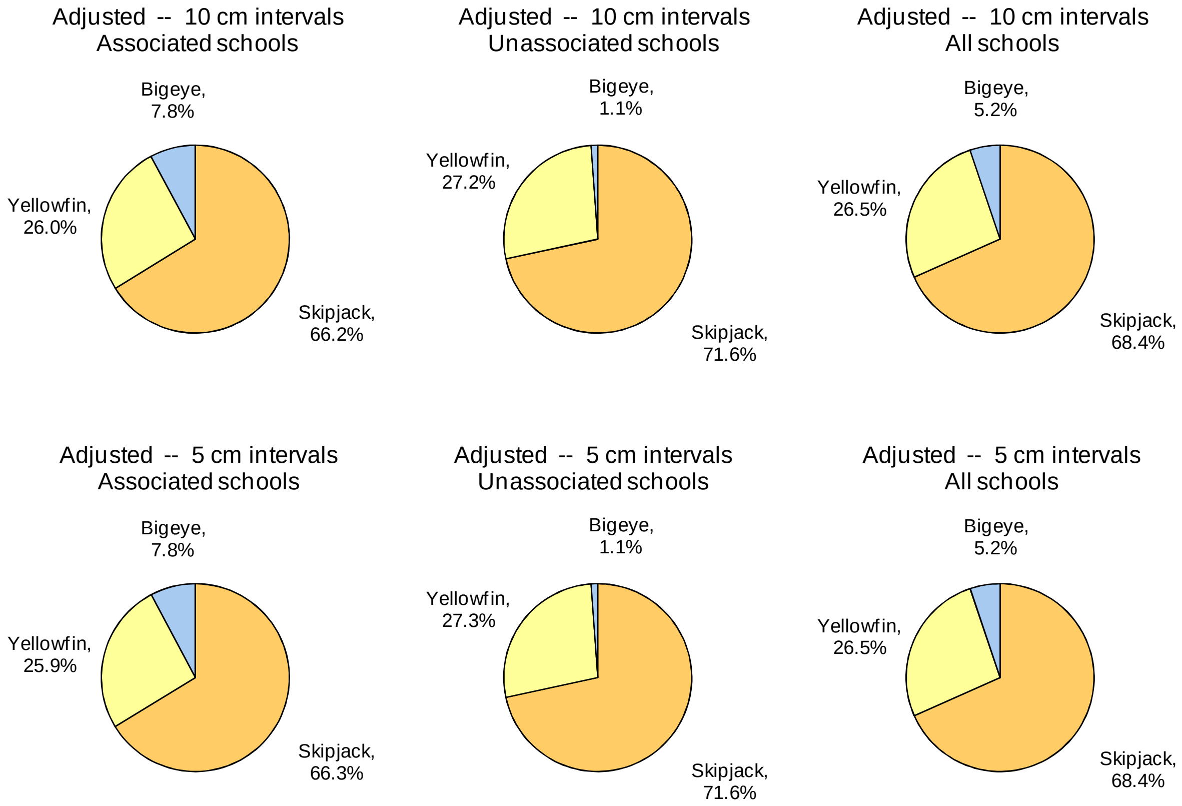


Figure 7 (continued)



The species compositions determined from the unadjusted and adjusted data for unassociated schools are similar, although the proportion of skipjack is smaller and the proportions of yellowfin and bigeye somewhat larger in the adjusted data than in the unadjusted data.

For associated schools, the differences in the species compositions are considerable, with the proportion of skipjack 13% smaller and the proportions of yellowfin and bigeye 8% and 5% larger, respectively, in the adjusted data. That the differences for associated schools are so much greater than for unassociated schools may be related to the fact that associated schools tend to contain smaller fish and almost always contain a mix of species, both of which increase the potential for mis-reporting of the catches on logsheets.

The species compositions determined from the data adjusted with estimates of availability using the 10 cm model and those using the 5 cm model are almost identical; thus, at the level of aggregation of all strata combined, the more highly resolved estimates of availability using the 5 cm model do not have an impact. It remains to be seen whether this is the case when the species compositions for more disaggregated strata are compared.

5. Discussion

An increase in the number of purse-seine trips during which paired spill and grab samples were collected, from four examined in Lawson (2009) to 17, has allowed the size selectivity bias in grab samples to be estimated at a higher resolution and with increased reliability. However, an important assumption in the analysis is that the species compositions determined from spill samples are unbiased. In this regard, the species compositions determined from spill samples should be compared to the best alternative estimates of species composition, which are those determined from cannery receipts together with port samples of landing categories of species and size, for trips during which both spill samples and port samples of landing categories took place. The protocol for sampling landing categories is to select fish by grabbing them and so the port samples may therefore be subject to size selection bias, but the comparison should nonetheless be informative, if not definitive. Fleets for which landing categories are sampled in port include those of Japan and the United States, while sampling of landing categories may soon be implemented at Noro, Solomon Islands. Extensive port sampling has been done recently in Papua New Guinea, although not of landing categories; these data may be useful for comparison with spill samples. All other fleets operating in the Western and Central Pacific Ocean, except for some smaller vessels in Indonesia and the Philippines, tranship their catches. [5]

At present, there are no trips for which both types of sampling data are available. Instead, Lawson (2009) used port samples of landing categories collected by the National Marine Fisheries Service (NMFS) from the United States fleet landing in Pago Pago, American Samoa during 1996–2007 to adjust the catch data in *s_best*. The data in *s_best* and the port samples were grouped by year and school association, and the species composition in each stratum of the grouped port samples was applied to the respective stratum of the catch data. The average annual species compositions are shown in Figure 8. While the species composition for all schools combined is remarkably similar to those determined from the data adjusted with grab samples corrected for availability (Figure 7), there are differences when associated and unassociated schools are considered separately. This may be due to differences in the time periods, geographic areas and school associations covered by the two types of samples. A more valid approach would be to limit the data for comparison to more highly resolved strata of time, area and school association that are covered by samples collected by both observers and port samples. However, an even better approach would be to compare the species compositions at the level of trip, as suggested above.

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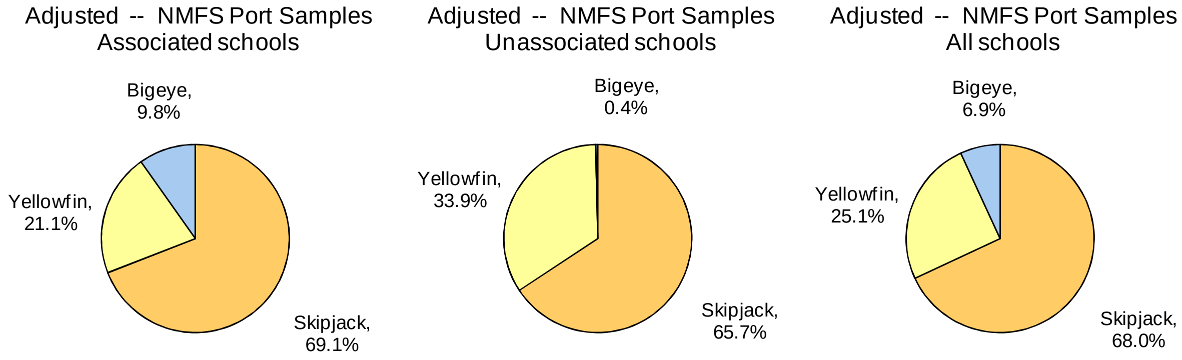
[5] Port sampling of catches that are transshipped are subject to several problems: (i) very small fish (≤ 40 cm) discarded at sea are not sampled; (ii) fish are taken from wells, which may contain only part of one large set or several smaller sets together; (iii) samples are subject to errors in the date, location and school association of the set or sets sampled due to well mixing; and (iv) the samples are not representative of the sizes of schools fished (Lawson 2008). Port sampling of catches that are transshipped is therefore impractical.

Figure 8. Species compositions for catch data in *s_best* adjusted with NMFS port sampling data



The grab samples collected during the 17 trips listed in Table 1 were taken by 14 different observers. While this is an improvement over the three observers that collected the grab samples analysed in Lawson (2009), it is still a somewhat small number. Additional paired samples with different grab samplers are required to obtain estimates of size selectivity bias that are representive of the population of observers.

Reliable estimates of availability have been obtained for fish from 35 cm to 54 cm in length, while less reliable, but still statistically significant, estimates have been obtained for fish from 55 cm to 69 cm. Additional paired samples are required to obtain reliable estimates of availability of fish less than 35 cm and greater than 54 cm; paired samples of large fish in unassociated schools would be particularly useful.

The use of polynomial splines to estimate availablility shows promise, particularly if additional data covering large fish become available. Time constraints did not permit the application of the results of the analysis using splines to the correction of grab samples and the adjustment of MFCL catch data, and this should be addressed.

The analyses presented above have assumed that selectivity bias depends only on the size of fish; other variables — such as species, school association and the observer — should also be examined as the data permit.

References

Lawson, T.A. 2007. Analysis of the proportion of bigeye in 'yellowfin plus bigeye' caught by purse seiners in the WCPFC Statistical Area. Information Paper SC3–ST–IP5. Third Regular Session of the Scientific Committee of the Western and Central Pacific Fisheries Commission, 13–24 August 2007, Honolulu, Hawaii, United States of America. Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia http://www.wcpfc.int/sc3/pdf/ST%20IP-5.pdf

Lawson, T.A. 2008. Factors affecting the use of species composition data collected by observers and port samplers from purse seiners in the Western and Central Pacific Ocean. Working Paper SC4–ST–WP3. Fourth Regular Session of the Scientific Committee of the Western and Central Pacific Fisheries Commission, 11–22 August 2008, Port Moresby, Papua New Guinea. Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia
http://www.wcpfc.int/sc4/pdf/sc4-st-wp3%20lawson.pdf

Lawson, T.A. 2009. Selectivity bias in grab samples and other factors affecting the analysis of species composition data collected by observers on purse seiners in the Western and Central Pacific Ocean. Working Paper SC5–ST–WP3. Fifth Regular Session of the Scientific Committee of the Western and Central Pacific Fisheries Commission, 10–21 August 2009, Port Vila, Vanuatu. Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia
http://www.wcpfc.int/system/files/documents/meetings/scientific-committee/5th-regular-session/statistics-swg/working-papers/SC5-ST-WP-03%20%5BSensitivity%20analysis%20-%20species%20coposition%5D.pdf