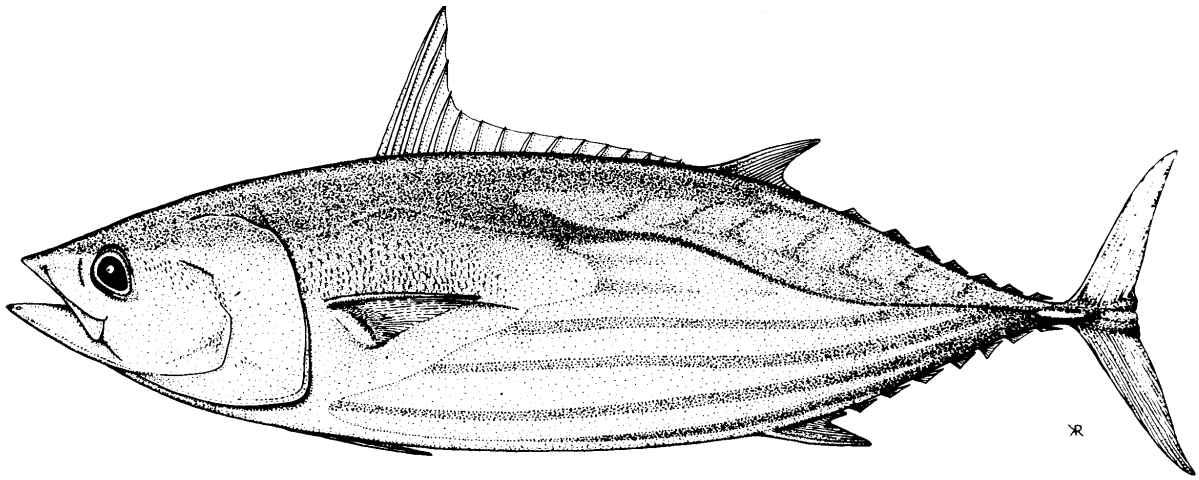
SCTB15 Working Paper

SWG–5

SAMPLING THE PROPORTION OF BIGEYE IN THE CATCH BY PURSE SEINERS IN THE WESTERN AND CENTRAL PACIFIC OCEAN

Tim Lawson



Oceanic Fisheries Programme
Secretariat of the Pacific Community
Noumea, New Caledonia

July 2002

INTRODUCTION

At the fourteenth meeting of the Standing Committee on Tuna and Billfish (SCTB), 9–16 August 2001, Bigelow (2001) reported differences in the sampling by port samplers and observers of the species composition of the catch taken by purse seiners in the western and central Pacific Ocean, determined from data held by the Oceanic Fisheries Programme (OFP) of the Secretariat of the Pacific Community. He found that for sets on schools associated with logs or drifting fish aggregation devices (FADs), the proportion of bigeye tuna determined from port sampling data was consistently higher than the proportion determined from observer data. The SCTB Statistics Working Group was therefore directed to examine these discrepancies by considering the accuracy of species identification and sampling protocols (Anon., 2002). This report examines these two aspects of the species composition sampling of purse-seine catches by port samplers and observers.

PORT SAMPLING DATA

Distribution of samples by year and port sampling programme

Table 1 presents the number of species composition samples taken from purse seiners by port samplers, by year and nationality of the sampling programme. In July 2002, the OFP held data for 10,592 port samples of species composition. The samples were taken from 1987 to 2002 by seven national programmes (Federated States of Micronesia, Japan, Kiribati, Marshall Islands, Papua New Guinea, Solomon Islands and the United States of America). About three-quarters of the samples (71.9 percent) were taken by the United States National Marine Fisheries Service (NMFS) in Pago Pago, American Samoa; these samples are all from United States purse seiners. The port sampling programme in the Marshall Islands, which began in 1998, accounts for 18.6 percent of the samples. The remaining 9.5 percent of the samples were taken in Papua New Guinea (3.7 percent), the Federated States of Micronesia (2.5 percent), Solomon Islands (1.4 percent), Japan (1.3 percent) and Kiribati (0.7 percent).

Percentage of samples containing yellowfin, but not bigeye, for port sampling programmes

In order to evaluate the quality of the species composition samples from the various sources, the percentage of samples containing yellowfin tuna, but not containing bigeye, were examined. Only sets on schools associated with logs or drifting FADs were considered, since these schools usually contain bigeye in association with juvenile yellowfin. The NMFS species composition samples are usually taken only when both bigeye and yellowfin are encountered while taking length samples; therefore, both length samples and species composition samples taken from the same well were examined to determine the presence of yellowfin and bigeye.

Table 2 presents the number of samples on log and drifting FAD schools that contain yellowfin, while Table 3 presents the percentage of samples that contain yellowfin, but that do not contain bigeye. Of the 2,812 wells sampled for lengths and species composition by NMFS, 14.5 percent contain yellowfin, but not bigeye. In contrast, the percentage of samples that contain yellowfin, but that do not contain bigeye, is lower for Japan, 4.1 percent (98 samples), and higher for the other programmes: 39.1 (23 samples) for the Federated States of Micronesia; 61.5 percent (13 samples) for Solomon Islands; and 75.3 percent (336 samples) for the Marshall Islands. (Sample sizes for Kiribati and Papua New Guinea are too small to obtain meaningful results.)

While a percentage of log and drifting FAD schools that contain yellowfin either do not contain bigeye or contain such small amounts of bigeye that they may not be detected by the port samplers,

the magnitude of the percentage probably depends on the area and time period fished and possibly vessel and gear attributes. Nevertheless, the percentages for the Solomon Islands and the Marshall Islands are sufficiently high as to suggest that bigeye identification in those programmes may be less reliable than for the programmes of the United States and Japan.

Number of log schools and drifting FAD schools sampled by individual port samplers

The quality of the species composition samples was further examined by considering the number of log and drifting FAD sets sampled by individual samplers from programmes other than NMFS and Japan, and the percentages of samples that contain yellowfin, but not bigeye. Table 4 presents the distribution of the number of samplers by the number of log and drifting FAD sets sampled. Of the 129 non-NMFS/Japan port samplers, 79 samplers (61.2 percent) have not sampled log or drifting FAD sets. Of the 50 samplers that have sampled log or drifting FAD sets, 25 samplers (50 percent) have sampled less than five sets. Only a small number of non-NMFS/Japan port samplers, 25 out of a total of 129 (19.4 percent), have had more than a small amount of experience sampling log and drifting FAD sets.

Percentage of samples containing yellowfin, but not bigeye, for individual port samplers

Table 5 shows that only five of the 25 non-NMFS/Japan samplers (20 percent) that have sampled five or more log or drifting FAD sets have percentages of sets that contain yellowfin, but not bigeye, that appear to be reasonable, i.e. less than 50 percent. The other 20 samplers have percentages that are much higher. Eight of these samplers (32 percent) have never recorded bigeye in species composition samples from log or drifting FAD sets.

Subjective evaluation of port samplers

The port samplers were subjectively evaluated by the OFP Fisheries Monitoring Supervisor, who is responsible for providing technical support for the port sampling programmes and observer programmes of SPC member countries and territories and who is thus familiar with the work of most port samplers in the region. Out of the total 129 port samplers, excluding the NMFS and Japanese samplers, only 19 (15 percent) were judged to be reliable samplers. Table 6 presents the number of reliable samplers by port sampling programme.

Five of the 19 port samplers judged to be reliable are included in the list of samplers (Table 5) that have sampled five or more log or drifting FAD sets. They correpond to the five samplers on the list with the lowest percentages of sets that contain yellowfin, but not bigeye, which indicates that the subjective evaluation is in accordance with the objective evaluation.

Training courses for port samplers in the Federated States of Micronesia, Marshall Islands and Papua New Guinea were held after the data analysed in this report were collected; hence, the reliability of the port samplers is expected to improve.

Heterogeneity of trips with regard to school association

The examination of species composition samples from log and drifting FAD sets may be complicated by well mixing, which occurs frequently on Korean and Taiwanese purse seiners. If extensive well mixing has taken place, then the well numbers that are recorded on the catch and effort logsheet for each set may not be appropriate and, hence, the school association assigned to each sampled well may be in error. One possible way of evaluating the extent of this problem is to examine the heterogeneity of school associations during a trip. If trips usually consist of a high percentage of sets of the same school association, then the problem may not be significant.

Information regarding the school associations during the trip was available for 3,397 out of a total of 10,455 non-Japanese port samples. (No information on the identity of the vessel was provided with the Japanese data, so the port samples could not be linked to logsheets.) The samples were screened to include only those from trips with five or more sets, which resulting in 2,234 trips. The percentage of sets during each trip was then determined for six school associations (unassociated, feeding on bait, log, drifting FAD, anchored FAD and marine mammal).

The proportion of trips for which a single school association represented 70, 80 or 90 percent or more of all sets was 74, 62 and 47 percent respectively. This suggests that well mixing is an important problem, but perhaps not as important as may have been expected, since almost half of all trips have the same school association for 90 percent or more of sets. For those trips, well mixing would not usually be expected to introduce errors in the school association attributed to a sample.

For United States vessels, the proportion of trips (n = 1,448 or 65 percent) for which a single school association represented 70, 80 or 90 percent or more of all sets was 73, 60 and 45 percent respectively. For Korean vessels, the proportion of trips (n = 376 or 17 percent) was 77, 64 and 49 percent respectively. For Taiwanese vessels, the proportion of trips (n = 266 or 12 percent) was 73, 63 and 46 percent respectively. Hence, the proportion of trips for which a single school association represented 70, 80 or 90 percent or more of all sets is consistent among the three fleets.

NMFS species composition and samples

The sampling protocol for NMFS species composition sampling is as follows (Coan & Yamasaki, 1990):

> *Skipjack are usually unloaded separately since the price paid for this species by the canneries is different from that paid for yellowfin or bigeye. The prices paid for yellowfin and bigeye is the same, and consequently, the two species are often landed together and called yellowfin. In order to separate the reported unloading weight, when different species are being unloaded and reported together, species composition samples must be taken.*
>
> *When taking a length-frequency sample, if more than one species is encountered, a species composition sample of 100 fish must be drawn. For example, when drawing yellowfin for a yellowfin length-frequency sample, the fifth fish drawn is a bigeye. Continue drawing 95 more fish noting the size and species. If the species cannot be determined from external characters, then the fish should be put aside and later identified by examination of the liver. If at the end of drawing 100 fish, there are 60 yellowfin, 10 black skipjack and 30 bigeye, a Length-Frequency Sampling Form is completed for the yellowfin and bigeye that were measured, and the sizes of the 10 black skipjack are noted on the Species Composition Form. If there are more bigeye still being unloaded, 20 more bigeye are drawn at random and recorded on the same Length-Frequency Sampling Form used to record the first 30 drawn. The bigeye drawn for the species composition sample are separated from those drawn to complete a fifty fish sample. If fish are unloaded by size groups and each size group contains mixed species, a 100 fish composition sample must be drawn from each size group.*

The above sampling protocol indicates that sampling for species composition is primarily directed towards bigeye and yellowfin. Table 7 presents several statistics for the NMFS species composition and length samples provided to SPC. The number of length samples with more than one species is 4,109, whereas the number of species composition samples is 2,645; hence, species composition samples have been taken for only 64 percent of length samples with more than one species. Species composition samples containing bigeye and yellowfin have been taken in 96 percent of instances

when bigeye and yellowfin are encountered in a length sample. However, species composition samples containing skipjack have been taken in only 14 percent of instances when skipjack and bigeye are encountered in a length sample and only 10 percent of instances when skipjack and yellowfin are encountered.

There are many length samples for wells containing yellowfin, but no bigeye. Species composition samples containing yellowfin were taken in only 28 percent of these instances, confirming that the species composition samples are usually taken only when yellowfin and bigeye are encountered together in length samples.

The data provided by NMFS appear to be inconsistent insofar as there are 769 instances in which bigeye are present in the species composition sample, but not in the length sample. This may be because NMFS has not provided most of the bigeye length samples to SPC for which the sample size is small. Table 8 shows that only 3 percent of bigeye length samples have sample sizes of less than 5 fish, while 80 percent have 50 fish or more. Ignoring the small sample sizes is appropriate if the objective is to estimate the length frequency for individual sets, but the primary objective of the NMFS program is to estimate the length frequency for time-area strata.

Number of reliable species composition samples by port sampling programme

Table 9 presents the number of species composition samples taken by the reliable port samplers identified by the OFP Fisheries Monitoring Supervisor (see Table 6). Excluding unreliable samples, the total number of samples declines from 10,592 to 8,206 (77 percent). The number of non-NMFS/Japan samples declines from 2,839 to 453 (16 percent).

Number of reliable species composition samples by vessel flag

Table 10 presents the number of reliable species composition samples by vessel flag. The United States fleet accounts for 93 percent of all samples and has been covered consistently since 1988. A small number of samples are available for the Japanese fleet each year during 1995–2001. For the Korean and Taiwanese fleets, a relatively large number of samples are available for 1998 and 1999, but none or only a small number for other years. The fleets of Australia, the Federated States of Micronesia, Papua New Guinea, Solomon Islands and Vanuatu account for less than one percent of all samples. No reliable samples are available for the fleets of Kiribati, the Marshall Islands, Mexico, the Philippines, Russia and Spain.

Number of reliable species composition samples by school association

Table 11 presents the number of reliable species composition samples by school association. The samples primarily cover the United States fleet; hence changes in the distribution of the samples by school assocation closely follow changes in the fishing practices of the United States fleet. From 1988 to 1995, samples of unassociated schools are predominant, with a smaller number of samples taken from log schools. From 1996 to 2001, samples of schools associated with drifting fish aggregating devices (FADs) are predominant, especially in 1999 and 2000.

Percentage of bigeye in yellowfin plus bigeye, in port samples, by school association

Table 12 presents the percentage of bigeye in samples containing yellowfin plus bigeye, by school association. The percentage is low in unassociated schools and schools feeding on bait, 2.6 and 4.6 respectively. The percentage increases to 20.3 percent for log schools and increases further to 37.7 percent for schools associated with drifting FADs. The percentages for other and unknown

associations are intermediate, 11.3 and 24.4 respectively. The sample sizes for the remaining types of association are too small to obtain meaningful results.

The standard deviations for unassociated schools and schools feeding on bait are relatively small, whereas for log and drifting FAD schools, they are relatively large, which indicates that the percentage varies to a much greater degree in log and drifting FAD schools.

Percentage of bigeye in yellowfin plus bigeye, in port samples, by school association, vessel flag and year

The percentages of bigeye in samples containing yellowfin plus bigeye that are presented in Table 12 are dominated by samples covering the United States fleet. Variation in the percentage by vessel flag are examined in Tables 13–15 for unassociated, log and drifting FAD schools respectively.

In almost all instances, the numbers of samples for the Japanese, Korean and Taiwanese fleets are too small to draw comparisons between fleets for individual years. However, if only those percentages for all years combined that are based on 20 or more samples are considered, then the following comparisons can be made.

For unassociated schools, the percentage for all years combined is low for the United States fleet (2.5 percent), somewhat higher for the Korean and Taiwanese fleets (6.6 and 5.9) and much higher for the Japanese fleet (17.4).

For log schools, the percentage for all years combined is similar for the Japanese (21.9), Taiwanese (19.0) and United States (20.4) fleets.

For drifting FAD schools, the percentages for all years combined for the Japanese (29.8), Taiwanese (18.3) and United States (38.3) fleets are considerably different.

The sample sizes are low for the Japanese, Korean and Taiwanese fleets; however, these comparisons suggest that there may not be much variation among fleets for unassociated schools, except perhaps for the Japanese fleet, and log schools. For drifting FAD schools, however, there may be considerable differences, which may be related to the area and time period fished and possibly vessel and gear attributes.

Percentage of bigeye in yellowfin plus bigeye, in port samples, by size of fish

Table 16 presents the percentage of bigeye in samples containing yellowfin and/or bigeye, for small and large fish in unassociated schools (including schools feeding on bait), log schools and drifting FAD schools. The statistics in Table 16 are based on samples collected by NMFS for the United States fleet. Well tonnages corresponding to each sample were stratified by species and by size class. Small and large bigeye were defined to be fish smaller or larger than 72 cm and small and large yellowfin were defined to be fish smaller or larger than 78 cm. The average percentage of bigeye in yellowfin plus bigeye, for each size class, was determined by weighting the percentage for the species and size class in each sample by the well tonnage for the species and size class.

For unassociated schools, the percentage of bigeye in yellowfin plus bigeye for large fish is neglible (0.4), while for small fish, it is low (13.3). For log schools, the percentage is low (10.4) for large fish and moderate (25.3) for small fish. For drifting FAD schools, the percentage is moderate (30.4) for large fish and high (49.4) for small fish.

The percentage varies considerably among years, except for large fish in unassociated schools, for which the percentage is consistently low.

OBSERVER DATA

Distribution of samples by year and observer programme

Table 17 presents the number of sets sampled for species composition by observers onboard purse seiners, by year and observer programme. A total of 8,914 sets have been sampled by observers from 1993 to 2001, compared to 10,592 wells sampled by port samplers from 1987 to 2002 (Table 1). More than half of the observer samples (57.1 percent) were taken under the US Treaty observer programme. The observer programme in the Federated States of Micronesia accounts for 18.3 percent of the sets sampled. The remaining 24.6 percent of the samples were collected through the observer programmes of the Solomon Islands (7.7 percent), Papua New Guinea (7.5 percent), SPC/OFP (7.0 percent), the FSM Arrangement (2.4 percent) and Nauru (0.0 percent). The observer programmes of the US Treaty and the FSM Arrangement are managed by the Forum Fisheries Agency and utilise observers from FFA member countries.

Percentage of samples containing yellowfin, but not bigeye, for observer programmes

The quality of the species composition samples were examined by considering the percentage of samples from log and drifting FAD schools that contain yellowfin, but not bigeye. Table 18 presents the number of samples on log and drifting FAD schools that contain yellowfin, while Table 19 presents the percentage of samples that contain yellowfin, but not bigeye.

The SPC/OFP observers are the most experienced; hence, the percentage for the SPC/OFP observers, 32.6 (291 sets), should be considered the most reliable. In contrast, the percentage for observers of Solomon Islands is 54.5 (178 sets); for the US Treaty, 62.0 (2,863 sets); for the Federated States of Micronesia, 65.5 percent (704 sets); and for Papua New Guinea, 77.4 percent (257 sets). This suggests that the identification of bigeye by observers in the other programmes may be less reliable than for SPC/OFP observers.

Number of log schools and drifting FAD schools sampled by individual observers

Table 20 presents the number of log and drifting FAD sets sampled by individual observers. In contrast to the port samplers, of whom only 19 percent have sampled five or more log or drifting FAD sets, 81 percent of observers (122 out of a total of 151) have sampled five or more log or drifting FAD sets.

Percentage of samples containing yellowfin, but not bigeye, for individual observers

Of the 122 observers that have sampled five or more log schools or drifting FAD sets, only 45 (39 percent) have percentages of sets that contain yellowfin, but not bigeye, that appear to be reasonable, i.e. less than 50 percent. The other 77 observers (63 percent) have percentages that are higher than expected. Sixteen (13 percent) have never recorded bigeye in species composition samples from log or drifting FAD sets.

It would therefore appear that, in general, observers have had considerably more experience sampling log sets and drifting FAD sets than non-NMFS/Japan port samplers, and hence the quality of the species composition sampling by observers is somewhat better than the quality of the species

composition sampling by non-NMFS/Japan port samplers, although the quality of sampling varies considerably among observers.

Subjective evaluation of observers

The ability of observers to identify bigeye was subjectively evaluated by the OFP Fisheries Monitoring Supervisor, the FFA Observer Programme Manager and the Tuna Biologist at the National Oceanic Resource Management Authority of the Federated States of Micronesia. Table 21 presents the number of reliable observers and sets sampled, by country of residence of the observer. (Many observers have worked for both the US Treaty observer programme and their national programme; hence the statistics are not presented by observer programme.) The statistics are preliminary since information concerning the reliability of several observers is not yet available; observers whose reliability is unknown were considered to be 'unreliable' for the present analysis. There are a total of 151 observers, of which 83 (55 percent) were judged to be reliable. The total number of sets sampled is 8,914, of which 6,264 (70 percent) were judged to be reliably sampled for bigeye.

There are 121 observers that have sampled five or more log or drifting FAD sets; among them are 74 of the observers that were judged to be reliable. However, in contrast to port samplers, the observers that were judged to be reliable have percentages of sets that contain yellowfin, but not bigeye, that are evenly spread from zero to 100. Ten had percentages from 0 to 25; 21 from 25 to 50; 20 from 50 to 75; and 23 from 75 to 100.

The fact that (a) six of the observers that were judged to be reliable have not recorded any bigeye for log or drifting FAD sets, even though the number of sets that they sampled averages 23 and ranges from 10 to 46, and (b) ten of the observers that had percentages of less than 30 percent, but were not judged to be reliable, suggests that the subjective evaluation of observers may not be as accurate as the subjective evaluation of port samplers. If the subjective evaluation is incorrect and data from observers with low percentages but that were not judged to be reliable are excluded from analysis (and data from observers with high percentages but that were judged to be reliable are included), then the observer data remaining for analysis will under-estimate the catch of bigeye.

Number of reliable species composition samples by vessel flag

Table 22 presents the number of reliable species composition samples by vessel flag, according to the subjective evaluation of observers. The United States fleet accounts for 64 percent of all samples and has been covered consistently since 1994. The Taiwanese and Korean fleets account for 15 and 7 percent respectively; sampling for these fleets has been consistent over time, although the number of sets sampled in some years is small. The Japanese and Papua New Guinea fleets account for 4 and 3 percent, respectively, of sets sampled; sampling has been consistent over time, but the number of sets sampled each year has been small. Sampling of the fleets of the Federated States of Micronesia, Kiribati, the Philippines, Solomon Islands and Vanuatu has been sporadic. No sets have been sampled for the fleets of Australia, the Marshall Islands, Mexico, Russia and Spain.

Number of reliable species composition samples by school association

Table 23 presents the number of reliable species composition samples by school association (assuming that the subjective evaluation is correct and exluding samples from observers that were not judged to be reliable). As for the port samples, the observer samples primarily cover the United States fleet; hence changes in the distribution of the samples by school assocation closely follow changes in the fishing practices of the United States fleet. For 1994 and 1995, samples of

unassociated schools (including schools feeding on bait) are predominant, with a smaller number of samples taken from log schools. From 1996 to 1998, samples of schools associated with drifting fish aggregating devices (FADs) become increasingly important. From 1999 to 2001, samples of schools associated with drifting FADs represent 69 percent of all samples, whereas samples of unassociated schools and log schools represent 21 and 2 percent respectively.

Percentage of bigeye in observer samples containing yellowfin plus bigeye, by school association

Table 24 presents the percentage of bigeye in yellowfin plus bigeye, by school association, determined from data collected by observers that were subjectively evaluated as reliable. The percentage is low in unassociated schools and schools feeding on bait, 2.6 and 1.4 respectively (compared to 2.6 and 4.6 percent, respectively, for port samples). The percentage increases to 13.7 percent for log schools (compared to 20.3 percent for port samples) and increases further to 19.1 percent for schools associated with drifting FADs (compared to 37.7 percent for port samples). The percentage for anchored FADs, 18.0, is similar to the percentage for drifting FADs. The percentages for other and unknown associations are intermediate, 15.3 and 13.0 respectively (compared to 11.3 and 24.4 for port samples).

As for port samples, the standard deviations for unassociated schools and schools feeding on bait are relatively small, whereas for log, drifting FAD and anchored FAD schools, they are relatively large, which indicates that the percentage varies to a much greater degree in log, drifting FAD and anchored FAD schools.

The percentages of bigeye in yellowfin plus bigeye determined from data collected by observers that were subjectively evaluated to be reliable are considerably less than the percentages determined from data collected by port samplers for log schools and drifting FAD schools. However, it was suggested above that the subjective evaluation of observers may not be as accurate as the subjective evaluation of port samplers and that the result of excluding data collected by observers that were not judged to be reliable will be to under-estimate the amount of bigeye caught. The analysis was therefore repeated on the basis of an objective evaluation of observers. In this analysis, only data from observers who have sampled at least five log or drifting FAD sets and for whom the percentage of log or drifting FAD sets containing yellowfin, but not bigeye, was less than or equal to 50 were considered.

Table 25 presents the number of objectively-evaluated reliable observers and sets sampled, by country of residence of the observer. The number of objectively-evaluated reliable observers is considerably less than for the subjective evaluation, 47 (31 percent) compared to 83 (55 percent). There are 29 observers that have not sampled five or more log or drifting FAD samples, including one SPC observer, and so could not be evaluated. The number of sets that were reliably sampled, based on the objective evaluation, is 3,222 (36 percent), compared to 6,262 (70 percent) for the subjective evaluation.

Table 26 presents the percentage of bigeye in yellowfin plus bigeye, by school association, determined from data collected by observers that were objectively evaluated as reliable. Since data collected by observers that recorded bigeye in less than 50 percent of log or drifting FAD sets were excluded from the analysis, it is expected that the estimate of the percentage of bigeye in yellowfin plus bigeye in log or drifting FAD sets will be greater than for the subjective evaluation of reliability. The percentage for log schools for the objective evaluation is 30.1, compared to 13.7 for the subjective evaluation. For drifting FAD schools for the objective evaluation, it is 29.8, compared to 19.1 for the subjective evaluation.

The percentages for the objective evaluation are greater than for the subjective evaluation, as expected, although the difference between the percentages for log and drifting FAD schools is minor for the objective evaluation, whereas for the subjective evaluation (and for port samples), it is considerable. Compared to the percentages determined from port samples, the percentage of bigeye in yellowfin plus bigeye for log sets, determined from objectively-evaluated observers, is greater, 30.1 compared to 20.3, while for drifting FAD sets, it is less, 29.8 compared to 37.7.

SAMPLING PROTOCOLS AND SAMPLE SIZES

The NMFS port sampling protocol for species composition is to sample 100 fish if more than one species is encountered during a length sample. In practise, however, skipjack are usually ignored and only bigeye and yellowfin are included in the 100 fish sample (see *NMFS species composition and samples* above).

The protocol for non-NMFS port sampling programmes is to randomly select approximately five fish from every net that is unloaded from the well, regardless of the species. The protocol for observer programmes is to randomly select approximately five fish from every brail from the set, regardless of the species.

Figures 1 and 2 show the distributions of the number of bigeye plus yellowfin sampled in port samples and observer samples respectively. The distributions are noticeably different. Most (70 percent) of the NMFS port samples contain between 91 and 110 yellowfin plus bigeye, with only 11 percent of samples containing 50 yellowfin plus bigeye or less. In contrast, the size of the non-NMFS port samples is more evenly spread out, with a peak at 41–50 yellowfin plus bigeye and with 54 percent of samples containing 50 yellowfin plus bigeye or less.

The distribution for the observer samples is different from either of the distributions for port samples. The observer samples peak at 1–10 yellowfin plus bigeye (56 percent) and then decline continuously; 93 percent of the observer samples contain 50 yellowfin plus bigeye or less. The distribution for observer samples is the same as the distribution of the amount of yellowfin and bigeye caught per set and reported on logsheets.

DISCUSSION

Table 27 compares estimates of the percentage of bigeye in yellowfin plus bigeye determined from port sampling data and observer data. The differences between the percentages determined from the port samplers and the subjectively and objectively evaluated observers are considerable, particularly for log and drifting FAD sets. The differences may be due, in part, to the areas and time periods covered by the samples or to vessel and gear attributes. However, before the relationship between the percentage of bigeye in yellowfin plus bigeye and area, time period or vessel and gear attributes can be examined, the port sampling and observer data must be further evaluated for their reliability, using both objective and subjective criteria. This is now a high priority of the Statistics and Monitoring Section of the OFP, which will evaluate the data in collaboration with the port sampler and observer supervisors in the region.

The sampling protocols for the NMFS port samples, the non-NMFS port samples and the observer samples are different, such that the size of the observer samples is proportional to the amount of catch from the set, whereas the size of the NMFS port samples is constant. The size of the non-NMFS port samples is proportional to the amount of fish in the well, which may or may not be

proportional to the amount of catch from the set (or sets). However, if the sampling is truly random, then each of the protocols will result in unbiased samples. At present, there is no indication that the samples are not taken randomly, although this should be examined closely by the port sampler and observer supervisors.

REFERENCES

Anonymous. 2002. Report of the Fourteenth Meeting of the Standing Committee on Tuna and Billfish, 9–16 August 2001, Noumea, New Caledonia. Secretariat of the Pacific Community, Noumea, New Caledonia.

Bigelow, K. 2001. Estimation of bigeye catches by purse seiners. Working Paper SWG–8. Fourteenth Meeting of the Standing Committee on Tuna and Billfish, 9–16 August 2001, Noumea, New Caledonia. Secretariat of the Pacific Community, Noumea, New Caledonia.

Coan, A.L. & G. Yamasaki. 1990. Sampling manual for collection of biological data from U.S. purse seiners fishing in the South Pacific. Administrative Report LJ–90–02. National Marine Fisheries Service, La Jolla, California, United States of America.

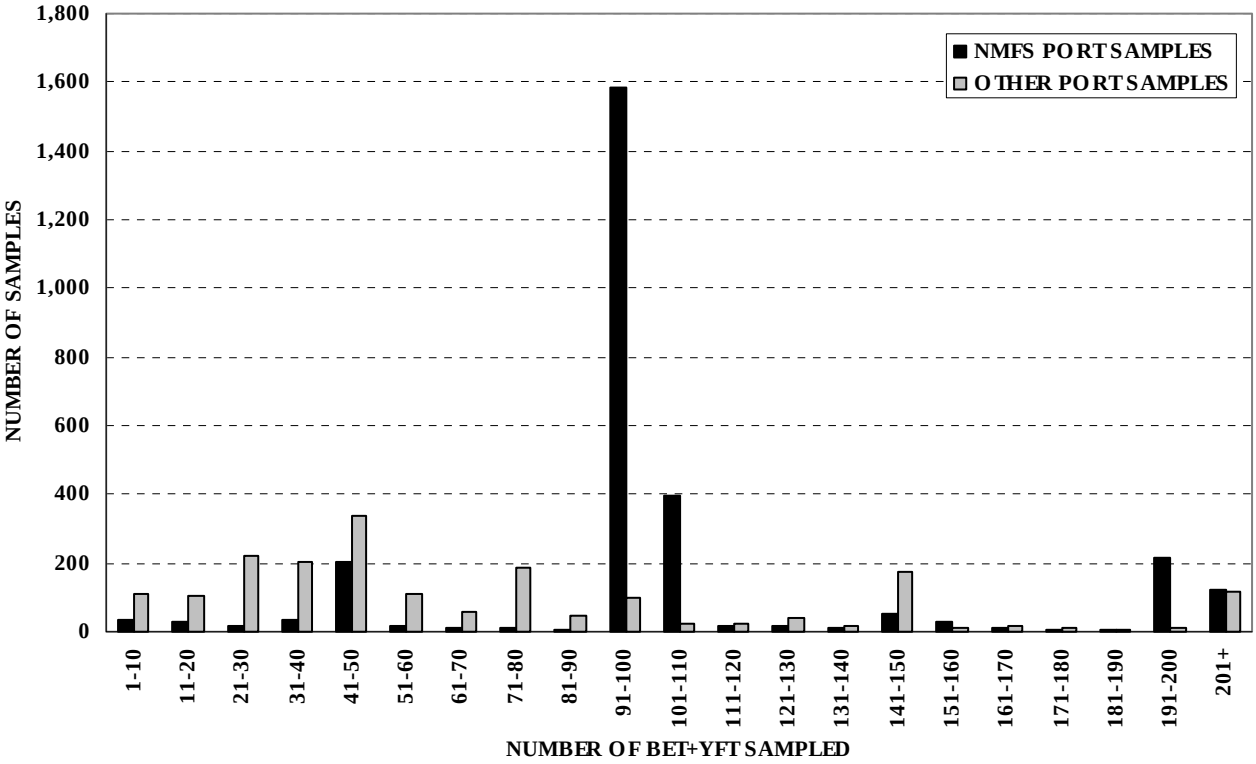


Figure 1. **Distribution of number of bigeye and yellowfin sampled in port samples**

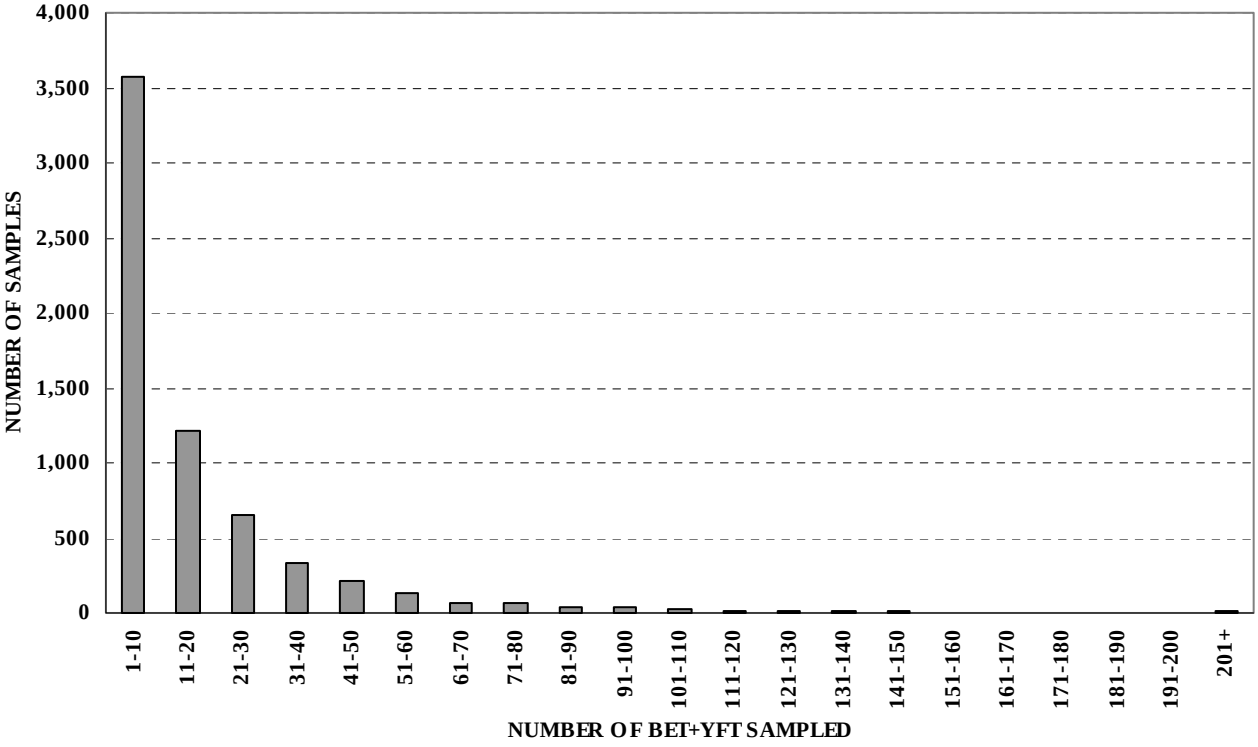


Figure 2. **Distribution of number of bigeye and yellowfin sampled in observer samples**

Table 1. Number of species composition samples taken from purse seiners by port samplers, by year and sampling programme. Key: FM = Federated States of Micronesia; KI = Kiribati; MH = Marshall Islands; PG = Papua New Guinea; SB = Solomon Islands; US = United States.

YEAR	FM	JP	KI	MH	PG	SB	US	TOTAL
1987	-	-	-	-	-	-	5	5
1988	-	-	-	-	-	-	280	280
1989	-	-	-	-	-	-	624	624
1990	-	-	-	-	-	-	726	726
1991	-	-	-	-	-	-	928	928
1992	-	-	-	-	-	-	664	664
1993	26	-	-	-	-	-	621	647
1994	72	-	5	-	-	45	674	796
1995	29	22	-	-	6	10	483	550
1996	32	23	-	-	64	1	486	606
1997	21	20	34	-	10	19	484	588
1998	22	24	36	439	297	54	376	1,248
1999	56	23	-	1,496	10	17	429	2,031
2000	3	21	-	27	1	1	437	490
2001	-	4	-	6	-	-	395	405
2002	-	-	-	-	-	-	4	4
TOTAL	261	137	75	1,968	388	147	7,616	10,592
%	2.5	1.3	0.7	18.6	3.7	1.4	71.9	100.0

Table 2. Number of port samples of species composition from sets on logs and drifting FADs that contain yellowfin. Key: FM = Federated States of Micronesia; KI = Kiribati; MH = Marshall Islands; PG = Papua New Guinea; SB = Solomon Islands; US = United States.

YEAR	FM	JP	KI	MH	PG	SB	US	TOTAL
1987	-	-	-	-	-	-	-	-
1988	-	-	-	-	-	-	74	74
1989	-	-	-	-	-	-	163	163
1990	-	-	-	-	-	-	143	143
1991	-	-	-	-	-	-	139	139
1992	-	-	-	-	-	-	271	271
1993	-	-	-	-	-	-	233	233
1994	-	-	1	-	-	2	126	129
1995	-	15	-	-	-	3	138	156
1996	-	17	-	-	-	-	241	258
1997	2	14	1	-	1	3	276	297
1998	2	15	-	24	1	4	173	219
1999	19	16	-	312	-	1	379	727
2000	-	18	-	-	-	-	285	303
2001	-	3	-	-	-	-	170	173
2002	-	-	-	-	-	-	1	1
TOTAL	23	98	2	336	2	13	2,812	3,286
%	0.7	3.0	0.1	10.2	0.1	0.4	85.6	100.0

Table 3. Percentage of port samples of species composition from sets on logs and drifting FADs that contain yellowfin, but that do not contain bigeye. Key: FM = Federated States of Micronesia; KI = Kiribati; MH = Marshall Islands; PG = Papua New Guinea; SB = Solomon Islands; US = United States.

YEAR	FM	JP	KI	MH	PG	SB	US	TOTAL
1987	-	-	-	-	-	-	-	-
1988	-	-	-	-	-	-	32.4	32.4
1989	-	-	-	-	-	-	16.0	16.0
1990	-	-	-	-	-	-	7.7	7.7
1991	-	-	-	-	-	-	20.9	20.9
1992	-	-	-	-	-	-	10.3	10.3
1993	-	-	-	-	-	-	20.6	20.6
1994	-	-	100.0	-	-	100.0	5.6	7.8
1995	-	0.0	-	-	-	33.3	10.9	10.3
1996	-	5.9	-	-	-	-	9.5	9.3
1997	50.0	7.1	0.0	-	0.0	33.3	20.7	20.2
1998	100.0	0.0	-	45.8	0.0	75.0	11.6	16.4
1999	31.6	6.3	-	77.6	-	100.0	23.5	46.6
2000	-	5.6	-	-	-	-	8.1	7.9
2001	-	0.0	-	-	-	-	-	4.6
2002	-	-	-	-	-	-	0.0	0.0
TOTAL	39.1	4.1	50.0	75.3	0.0	61.5	14.5	20.8

Table 4. Distribution of the number of non-NMFS samplers by the number of log and drifting FAD sets sampled

CATEGORY OF SAMPLERS	NO	%
0 LOG OR DRIFTING FAD SAMPLES	79	61.2
1 LOG OR DRIFTING FAD SAMPLE	14	10.9
2 LOG OR DRIFTING FAD SAMPLES	5	3.9
3 LOG OR DRIFTING FAD SAMPLES	3	2.3
4 LOG OR DRIFTING FAD SAMPLES	3	2.3
5+ LOG OR DRIFTING FAD SAMPLES	25	19.4
TOTAL	129	100.0

Table 5. Percentage of log or drifting FAD sets with yellowfin, but no bigeye, by individual non-NMFS/Japan port samplers that have sampled at least five log or drifting FAD sets

SAMPLER	COUNTRY	LOG & FAD SAMPLES	W/O BET	%
A	MH	7	1	14.3
B	MH	9	2	22.2
C	MH	27	6	22.2
D	MH	7	2	28.6
E	FM	17	7	41.2
F	MH	12	6	50.0
G	MH	16	10	62.5
H	MH	14	9	64.3
I	MH	16	12	75.0
J	MH	25	19	76.0
K	MH	9	7	77.8
L	MH	14	11	78.6
M	MH	6	5	83.3
N	MH	9	8	88.9
O	MH	15	14	93.3
P	MH	20	19	95.0
Q	MH	27	26	96.3
R	MH	10	10	100.0
S	MH	11	11	100.0
T	MH	8	8	100.0
U	MH	8	8	100.0
V	MH	7	7	100.0
W	MH	12	12	100.0
X	MH	6	6	100.0
Y	MH	16	16	100.0

Table 6. Number of reliable port samplers and species composition samples, excluding the NMFS and Japanese port sampling programmes

PORT SAMPLING PROGRAMME	ALL SAMPLERS		RELIABLE SAMPLERS	
	SAMPLERS	SAMPLES	SAMPLERS	SAMPLES
Federated States of Micronesia	10	260	4	75
Kiribati	16	74	0	0
Marshall Islands	46	2,103	6	343
Papua New Guinea	22	259	0	0
Solomon Islands	35	143	9	35
Total	129	2,839	19	453

Table 7. Statistics for NMFS species composition and port samples provided to SPC

DESCRIPTION	WELLS SAMPLED
Total number of wells sampled	7,167
Number of length samples	7,166
Length samples with more than one species	4,109
Species composition samples	2,645
Length samples with BET and SKJ	1,843
Above and species composition samples with BET	1,759
Above and species composition samples with SKJ	261
Length samples with BET and YFT	1,843
Above and species composition samples with BET	1,771
Above and species composition samples with YFT	1,771
Length samples with SKJ and YFT	4,001
Above and species composition samples with SKJ	383
Above and species composition samples with YFT	2,495
Length samples with BET and no YFT	59
Above and species composition samples with BET	43
Length samples with YFT and no BET	2,885
Above and species composition samples with YFT	801
BET in spec comp sample, but not in length sample	769
SKJ in spec comp sample, but not in length sample	0
YFT in spec comp sample, but not in length sample	59

Table 8. Distribution of the number of wells sampled by the size of NMFS bigeye length samples

BET LENGTH FREQUENCY SAMPLE SIZE	WELLS SAMPLED	%
1	11	0.6
2	21	1.1
3	16	0.8
4	15	0.8
5 TO 9	100	5.3
10 TO 19	134	7.0
20 TO 29	33	1.7
30 TO 39	18	0.9
40 TO 49	17	0.9
>= 50	1,537	80.8
TOTAL	1,902	100.0

Table 9. Number of reliable species composition samples taken from purse seiners by port samplers, by year and sampling programme. Key: FM = Federated States of Micronesia; KI = Kiribati; MH = Marshall Islands; PG = Papua New Guinea; SB = Solomon Islands; US = United States.

YEAR	FM	JP	KI	MH	PG	SB	US	TOTAL
1987	-	-	-	-	-	-	5	5
1988	-	-	-	-	-	-	280	280
1989	-	-	-	-	-	-	624	624
1990	-	-	-	-	-	-	726	726
1991	-	-	-	-	-	-	928	928
1992	-	-	-	-	-	-	664	664
1993	-	-	-	-	-	-	621	621
1994	1	-	-	-	-	8	674	683
1995	-	22	-	-	-	2	483	507
1996	-	23	-	-	-	1	486	510
1997	2	20	-	-	-	6	484	512
1998	20	24	-	163	-	16	376	599
1999	49	23	-	179	-	1	429	681
2000	3	21	-	1	-	1	437	463
2001	-	4	-	-	-	-	395	399
2002	-	-	-	-	-	-	4	4
TOTAL	75	137	0	343	0	35	7,616	8,206
%	0.9	1.7	0.0	4.2	0.0	0.4	92.8	100.0

Table 10. Number of reliable species composition samples taken from purse seiners by port samplers, by year and fishing nation. Key: AU = Australia; FM = Federated States of Micronesia; JP = Japan; KR = Korea; PG = Papua New Guinea; SB = Solomon Islands; TW = Taiwan; US = United States; VU = Vanuatu. No reliable samples are available for the fleets of Kiribati, the Marshall Islands, Mexico, the Philippines, Russia and Spain.

YEAR	AU	FM	JP	KR	PG	SB	TW	US	VU	TOTAL
1987	-	-	-	-	-	-	-	3	-	3
1988	-	-	-	-	-	-	-	272	-	272
1989	-	-	-	-	-	-	-	606	-	606
1990	-	-	-	-	-	-	-	707	-	707
1991	-	-	-	-	-	-	-	930	-	930
1992	-	-	-	-	-	-	-	658	-	658
1993	-	-	-	-	-	-	-	621	-	621
1994	-	1	-	8	-	-	-	676	-	685
1995	-	-	22	2	-	-	-	483	-	507
1996	-	-	23	-	-	1	-	486	-	510
1997	-	-	20	2	-	-	6	484	-	512
1998	4	14	24	74	8	6	79	377	14	600
1999	3	2	23	40	13	-	149	429	22	681
2000	-	-	21	3	-	1	1	437	-	463
2001	-	-	4	-	-	-	-	423	-	427
2002	-	-	-	-	-	-	-	4	-	4
TOTAL	7	17	137	129	21	8	235	7,596	36	8,186
%	0.1	0.2	1.7	1.6	0.3	0.1	2.9	92.8	0.4	100.0

Table 11. Number of reliable species composition samples by school association

YEAR	UNKNOWN	UNASS	FEEDING ON BAIT	LOG	DRIFTING FAD	ANCHORED FAD	LIVE WHALE	MARINE MAMMAL	OTHER	TOTAL
1987	-	-	-	-	-	-	-	-	3	3
1988	18	124	-	76	2	-	-	-	52	272
1989	28	312	-	170	2	-	-	-	94	606
1990	2	544	-	149	2	-	-	-	10	707
1991	-	757	-	142	1	-	-	-	30	930
1992	-	367	-	276	-	-	-	-	15	658
1993	-	349	-	243	-	-	-	-	29	621
1994	-	523	4	138	-	-	-	-	20	685
1995	-	322	1	157	6	-	-	-	21	507
1996	1	138	69	102	175	-	1	1	23	510
1997	-	41	140	163	141	-	-	-	27	512
1998	89	82	130	126	146	11	-	9	7	600
1999	40	61	30	74	463	-	-	11	2	681
2000	10	32	99	21	300	-	-	-	1	463
2001	127	67	74	4	151	-	-	-	4	427
2002	4	-	-	-	-	-	-	-	-	4
TOTAL	319	3,719	547	1,841	1,389	11	1	21	338	8,186
%	3.9	45.4	6.7	22.5	17.0	0.1	0.0	0.3	4.1	100.0

Table 12. Mean and standard deviation of the percentage of bigeye in yellowfin plus bigeye in port samples, by school association

SCHOOL ASSOCIATION	N	MEAN	STANDARD DEVIATION
UNKNOWN	179	24.4	25.4
UNASSOCIATED	1,644	2.6	10.2
FEEDING ON BAIT	249	4.6	13.4
LOG	1,696	20.3	20.6
DRIFTING FAD	1,221	37.7	25.0
ANCHORED FAD	2	0.0	0.0
LIVE WHALE	1	85.0	0.0
MARINE MAMMAL	7	7.9	18.1
OTHER	294	11.3	16.3
ALL	5,293	17.7	23.1

Table 13. Percentage of bigeye in yellowfin plus bigeye in samples of unassociated schools

YEAR	JAPAN		KOREA		TAIWAN		UNITED STATES	
	N	P	N	P	N	P	N	P
1988	-	-	-	-	-	-	50	4.3
1989	-	-	-	-	-	-	206	1.2
1990	-	-	-	-	-	-	252	1.2
1991	-	-	-	-	-	-	256	2.8
1992	-	-	-	-	-	-	157	2.1
1993	-	-	-	-	-	-	152	2.4
1994	-	-	8	1.3	-	-	247	1.9
1995	6	2.9	2	0.0	-	-	144	2.6
1996	5	23.3	-	-	-	-	55	2.7
1997	4	0.9	2	10.9	2	11.1	127	2.0
1998	4	46.0	17	6.5	17	7.4	69	1.8
1999	4	15.4	15	8.6	14	3.9	5	15.1
2000	1	34.0	1	23.7	1	0.0	56	10.3
2001	-	-	-	-	-	-	10	30.9
2002	-	-	-	-	-	-	-	-
TOTAL	24	17.4	45	6.6	34	5.9	1,786	2.5

Table 14. Percentage of bigeye in yellowfin plus bigeye in samples of log schools

YEAR	JAPAN		KOREA		TAIWAN		UNITED STATES	
	N	P	N	P	N	P	N	P
1988	-	-	-	-	-	-	72	18.6
1989	-	-	-	-	-	-	156	16.0
1990	-	-	-	-	-	-	134	19.9
1991	-	-	-	-	-	-	136	14.3
1992	-	-	-	-	-	-	266	17.8
1993	-	-	-	-	-	-	230	15.2
1994	-	-	-	-	-	-	125	23.0
1995	13	12.7	-	-	-	-	134	25.1
1996	16	17.4	-	-	-	-	80	32.1
1997	13	32.7	-	-	2	3.8	142	22.4
1998	15	26.5	-	-	2	0.0	82	33.3
1999	5	13.8	6	8.7	24	21.9	17	14.9
2000	3	25.7	-	-	-	-	15	44.0
2001	1	37.1	-	-	-	-	3	46.9
2002	-	-	-	-	-	-	-	-
TOTAL	66	21.9	6	8.7	28	19.0	1,592	20.4

Table 15. Percentage of bigeye in yellowfin plus bigeye in samples of drifting FAD schools

YEAR	JAPAN		KOREA		TAIWAN		UNITED STATES	
	N	P	N	P	N	P	N	P
1988	-	-	-	-	-	-	2	23.3
1989	-	-	-	-	-	-	2	62.0
1990	-	-	-	-	-	-	2	34.0
1991	-	-	-	-	-	-	1	83.0
1992	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-
1995	2	30.3	-	-	-	-	4	49.9
1996	1	22.9	-	-	-	-	160	42.6
1997	1	69.5	-	-	1	49.8	133	40.3
1998	-	-	-	-	4	22.5	91	41.2
1999	11	23.1	1	66.1	24	16.2	357	26.9
2000	15	30.3	-	-	-	-	272	43.6
2001	2	45.7	-	-	-	-	125	48.1
2002	-	-	-	-	-	-	-	-
TOTAL	32	29.8	1	66.1	29	18.3	1,149	38.3

Table 16. Number of samples and percentage of bigeye in yellowfin plus bigeye, by size of fish, in unassociated, log and drifting FAD schools, determined from NMFS samples for United States purse seiners

YEAR	UNASSOCIATED				LOG				DRIFTING FAD			
	SMALL		LARGE		SMALL		LARGE		SMALL		LARGE	
	N	%	N	%	N	%	N	%	N	%	N	%
1987	0	-	0	-	0	-	0	-	0	-	0	-
1988	32	10.98	45	0.00	64	29.44	59	0.71	1	46.46	2	2.30
1989	82	4.95	203	0.06	158	16.10	119	18.62	2	59.10	2	66.05
1990	40	4.92	244	0.15	135	22.66	98	6.75	2	32.54	0	-
1991	158	4.02	246	0.14	137	16.41	117	5.67	1	86.73	1	63.16
1992	48	6.26	160	0.30	261	22.46	210	10.60	0	-	0	-
1993	78	8.29	152	0.56	226	19.38	193	9.02	0	-	0	-
1994	36	52.04	243	0.09	123	26.24	89	4.13	0	-	0	-
1995	58	3.87	141	1.00	134	25.84	90	8.68	4	51.77	4	10.57
1996	15	9.19	56	0.54	77	39.57	57	26.87	154	47.13	121	47.51
1997	28	50.69	128	0.31	119	37.57	117	11.39	127	45.10	100	35.15
1998	4	24.61	66	0.00	69	47.78	44	9.30	85	44.64	51	22.68
1999	3	40.32	5	0.00	17	33.06	18	6.94	306	38.21	333	30.96
2000	17	39.56	53	2.99	14	48.17	13	46.66	239	70.47	241	24.22
2001	27	45.05	77	1.62	3	48.92	1	24.00	152	47.43	87	21.63
2002	0	-	0	-	0	46.00	0	-	1	46.00	1	38.93
TOTAL	626	13.26	1,819	0.40	1,537	25.29	1,225	10.39	1,074	49.43	943	30.47

Table 17. Number of species composition samples taken from purse seiners by observers, by year and sampling programme. Key: FAOB = FSM Arrangement; FMOB = Federated States of Micronesia; NROB = Nauru; PGOB = Papua New Guinea; SBOB = Solomon Islands; SPOB = SPC; TTOB = US Treaty.

YEAR	FAOB	FMOB	NROB	PGOB	SBOB	SPOB	TTOB	TOTAL
1993	-	131	-	-	-	-	-	131
1994	-	291	-	-	-	-	405	696
1995	-	182	-	1	-	47	407	637
1996	-	103	4	351	-	154	704	1,316
1997	-	195	-	258	-	91	828	1,372
1998	42	132	-	11	664	159	787	1,795
1999	22	297	-	48	20	72	593	1,052
2000	66	296	-	-	2	85	631	1,080
2001	85	0	-	-	-	16	734	835
TOTAL	215	1,627	4	669	686	624	5,089	8,914
%	2.4	18.3	0.0	7.5	7.7	7.0	57.1	100.0

Table 18. Number of observer samples of species composition from sets on logs and drifting FADs that contain yellowfin. Key: FAOB = FSM Arrangement; FMOB = Federated States of Micronesia; NROB = Nauru; PGOB = Papua New Guinea; SBOB = Solomon Islands; SPOB = SPC; TTOB = US Treaty.

YEAR	FAOB	FMOB	NROB	PGOB	SBOB	SPOB	TTOB	TOTAL
1993	-	47	-	-	-	-	-	47
1994	-	146	-	-	-	-	54	200
1995	-	91	-	-	-	32	91	214
1996	-	45	3	100	-	74	304	526
1997	-	101	-	126	-	46	509	782
1998	22	56	-	0	176	68	406	728
1999	11	100	-	31	2	41	552	737
2000	53	118	-	-	-	27	494	692
2001	55	0	-	-	-	3	453	511
TOTAL	141	704	3	257	178	291	2,863	4,437
%	3.2	15.9	0.1	5.8	4.0	6.6	64.5	100.0

Table 19. Percentage of observer samples of species composition from sets on logs and drifting FADs that contain yellowfin, but that do not contain bigeye. Key: FAOB = FSM Arrangement; FMOB = Federated States of Micronesia; NROB = Nauru; PGOB = Papua New Guinea; SBOB = Solomon Islands; SPOB = SPC; TTOB = US Treaty.

YEAR	FAOB	FMOB	NROB	PGOB	SBOB	SPOB	TTOB	TOTAL
1993	-	63.8	-	-	-	-	-	63.8
1994	-	56.8	-	-	-	-	92.6	66.5
1995	-	67.0	-	-	-	65.6	70.3	68.2
1996	-	73.3	100.0	79.0	-	55.4	62.2	65.6
1997	-	53.5	-	73.0	-	19.6	66.8	63.3
1998	40.9	58.9	-	-	55.1	11.8	61.3	54.4
1999	54.5	85.0	-	90.3	0.0	24.4	58.7	61.5
2000	24.5	69.5	-	-	-	14.8	66.8	62.0
2001	12.7	-	-	-	-	66.7	50.8	46.8
TOTAL	24.8	65.5	100.0	77.4	54.5	32.6	62.0	60.1

Table 20. Distribution of the number of observers by the number of log and drifting FAD sets sampled

CATEGORY OF OBSERVERS	NO	%
0 LOG OR DRIFTING FAD SAMPLES	9	6.0
1 LOG OR DRIFTING FAD SAMPLE	7	4.6
2 LOG OR DRIFTING FAD SAMPLES	8	5.3
3 LOG OR DRIFTING FAD SAMPLES	2	1.3
4 LOG OR DRIFTING FAD SAMPLES	3	2.0
5+ LOG OR DRIFTING FAD SAMPLES	122	80.8
TOTAL	151	100.0

Table 21. Number of reliable observers, based on a subjective evaluation, and species composition samples, by country

COUNTRY	ALL OBSERVERS		RELIABLE OBSERVERS	
	OBSERVERS	SAMPLES	OBSERVERS	SAMPLES
Australia	3	71	3	71
Cook Islands	2	90	2	90
Federated States of Micronesia	23	2,077	12	1,540
Fiji	11	511	3	296
Kiribati	14	443	6	129
Marshall Islands	3	48	0	0
Nauru	5	262	1	198
New Caledonia	1	16	1	16
Niue	2	243	2	243
Papua New Guinea	24	998	9	534
Secretariat of the Pacific Community	5	551	5	551
Solomon Islands	35	2,351	24	1,713
Tokelau	3	147	2	119
Tonga	6	210	3	110
Tuvalu	6	499	3	285
United States of America	6	209	5	181
Vanuatu	2	188	2	188
Total	151	8,914	83	6,264

Table 22. Number of reliable species composition samples taken from purse seiners, by year and fishing nation, according to a subjective evaluation of observers. Key: FM = Federated States of Micronesia; JP = Japan; KI = Kiribati; KR = Korea; PG = Papua New Guinea; PH = Philippines; SB = Solomon Islands; TW = Taiwan; US = United States; VU = Vanuatu. No reliable samples are available for the fleets of Australia, the Marshall Islands, Mexico, Russia and Spain.

YEAR	FM	JP	KI	KR	PG	PH	SB	TW	US	VU	TOTAL
1993	-	29	-	23	-	-	-	10	-	-	62
1994	23	21	-	38	-	-	-	30	153	-	265
1995	-	31	25	12	17	-	-	70	272	7	434
1996	8	46	-	87	14	22	-	168	350	13	708
1997	-	38	-	50	16	32	-	103	557	17	813
1998	33	29	-	71	41	49	29	226	764	-	1,242
1999	11	29	7	65	22	-	15	158	580	13	900
2000	50	23	8	84	38	13	35	171	646	-	1,068
2001	25	-	-	16	43	-	-	-	688	-	772
TOTAL	150	246	40	446	191	116	79	936	4,010	50	6,264
%	2.4	3.9	0.6	7.1	3.0	1.9	1.3	14.9	64.0	0.8	100.0

Table 23. Number of reliable species composition samples taken from purse seiners, by year and school association, according to a subjective evaluation of observers

YEAR	UNKNOWN	UNASS	FEEDING ON BAIT	LOG	DRIFTING FAD	ANCHORED FAD	LIVE WHALE	WHALE SHARK	OTHER	TOTAL
1993	29	16	-	2	15	-	-	-	-	62
1994	21	81	45	69	42	3	2	-	2	265
1995	19	58	171	149	10	1	23	2	1	434
1996	18	93	139	242	188	13	8	4	3	708
1997	37	66	147	231	290	30	7	3	2	813
1998	37	199	227	312	351	75	30	6	5	1,242
1999	14	47	86	23	683	27	14	4	2	900
2000	29	56	161	38	712	51	18	1	2	1,068
2001	12	97	142	5	508	3	1	1	3	772
TOTAL	216	713	1,118	1,071	2,799	203	103	21	20	6,264
%	3.4	11.4	17.8	17.1	44.7	3.2	1.6	0.3	0.3	100.0

Table 24. Mean and standard deviation of the percentage of bigeye in bigeye plus yellowfin in samples taken by subjectively-evaluated reliable observers, by school association

SCHOOL ASSOCIATION	N	MEAN	STANDARD DEVIATION
UNKNOWN	157	13.0	25.8
UNASSOCIATED	240	2.6	11.6
FEEDING ON BAIT	423	1.4	8.7
LOG	972	13.7	23.6
DRIFTING FAD	2,620	19.1	27.2
ANCHORED FAD	194	18.0	20.5
LIVE WHALE	84	4.2	16.6
LIVE WHALE SHARK	19	12.1	23.9
OTHER	19	15.3	17.6
ALL	4,728	15.0	24.9

Table 25. Number of objectively-evaluated reliable observers, by country

COUNTRY	ALL OBSERVERS		RELIABLE OBSERVERS	
	OBSERVERS	SAMPLES	OBSERVERS	SAMPLES
Australia	3	71	0	0
Cook Islands	2	90	1	67
Federated States of Micronesia	23	2,077	6	662
Fiji	11	511	3	137
Kiribati	14	443	5	138
Marshall Islands	3	48	0	0
Nauru	5	262	1	24
New Caledonia	1	16	0	0
Niue	2	243	0	0
Papua New Guinea	24	998	5	262
Secretariat of the Pacific Community	5	551	4	544
Solomon Islands	35	2,351	11	877
Tokelau	3	147	1	84
Tonga	6	210	1	43
Tuvalu	6	499	3	214
United States of America	6	209	5	162
Vanuatu	2	188	1	8
Total	151	8,914	47	3,222

Table 26. Mean and standard deviation of the percentage of bigeye in yellowfin plus bigeye in samples taken by objectively-evaluated reliable observers, by school association

SCHOOL ASSOCIATION	N	MEAN	STANDARD DEVIATION
UNKNOWN	71	11.1	21.0
UNASSOCIATED	171	3.2	13.5
FEEDING ON BAIT	242	4.7	17.4
LOG	555	30.1	32.9
DRIFTING FAD	1,210	29.8	28.0
ANCHORED FAD	193	23.3	24.0
LIVE WHALE	52	3.8	16.2
LIVE WHALE SHARK	12	19.2	27.7
OTHER	11	17.0	17.6
ALL	2,517	24.0	28.8

Table 27. Percentage of bigeye in yellowfin plus bigeye, by school association, for port sampling data and subjectively and objectively evaluated observer data

SCHOOL ASSOCIATION	PORT SAMPLING DATA		OBSERVER DATA			
			SUBJECTIVE EVALUATION		OBJECTIVE EVALUATION	
	N	MEAN	N	MEAN	N	MEAN
UNKNOWN	179	24.4	157	13.0	71	11.1
UNASSOCIATED	1,644	2.6	240	2.6	171	3.2
FEEDING ON BAIT	249	4.6	423	1.4	242	4.7
LOG	1,696	20.3	972	13.7	555	30.1
DRIFTING FAD	1,221	37.7	2,620	19.1	1,210	29.8
ANCHORED FAD	2	0.0	194	18.0	193	23.3
LIVE WHALE	1	85.0	84	4.2	52	3.8
LIVE WHALE SHARK			19	12.1	12	19.2
MARINE MAMMAL	7	7.9				
OTHER	294	11.3	19	15.3	11	17.0
ALL	5,293	17.7	4,728	15.0	2,517	24.0