SCIENTIFIC COMMITTEE
SECOND REGULAR SESSION

7-18 August 2006
Manila, Philippines

SCIENTIFIC ASPECTS OF OBSERVER PROGRAMMES FOR TUNA FISHERIES IN THE WESTERN AND CENTRAL PACIFC OCEAN

WCPFC-SC2-2006/ST WP-1

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July 2006

INTRODUCTION

At its inaugural meeting in August 2005, the Statistics Specialist Working Group of the WCPFC Scientific Committee identified a need to "review scientific aspects of observer programmes, such as objectives, coverage rates, sampling protocols, standards for data collection forms, and the relationship between national and regional observer programmes" (Anon. 2005, Annex VII). Further aspects that were identified as needing review included the types of scientific data that should be collected by observers, best practices in tuna fishery observer programmes, the performance of existing sub-regional and national observer programmes, and the relationship between regional, sub-regional and national observer programmes.

The current study attempts to review some, but not all, of these aspects of observer programmes. Those that are considered include the scientific objectives of tuna fishery observer programmes, the types of data collected, sampling protocols, sampling designs, coverage rates, and the recruitment, training and debriefing of observers. The relationship between regional, sub-regional and national observer programmes was considered beyond the scope of the current study; this aspect should be considered following the establishment of priorities and objectives of the regional observer programme, and in conjunction with the development of an integrated sampling design for sampling programmes and data collection standards.

This review of scientific aspects of observer programmes is based on information provided by national and international agencies, both within the Western and Central Pacific region and beyond. Agencies within the region that were asked to provide information include the Bureau of Rural Sciences of Australia, the Ministry of Fisheries of New Zealand, the National Fisheries Research and Development Institute of the Republic of Korea, the Fisheries Agency of Chinese Taipei and the National Marine Fisheries Service of the United States of America. Information on the observer programmes of Pacific islands countries and territories (PICTs) that are supported by SPC and the Forum Fisheries Agency, including the observer programmes of the US Treaty and the FSM Arrangement, was provided by SPC. Agencies beyond the region that were contacted include the Inter-American Tropical Tuna Commission (IATTC) in regard to the purse-seine observer programme in the Eastern Pacific Ocean conducted under the Agreement on the International Dolphin Conservation Program (AIDCP), and the *Institut de recherche pour le développement* (IRD) of France and the *Instituto Español de Oceanografia* (IEO) of Spain in regard to purse-seine observer programmes in the Atlantic Ocean and the Indian Ocean. The responses that were subsequently provided are presented in Appendices I and II, for longline and purse-seine observer programmes respectively.

Following a summary of the information provided by the respondents regarding longline and purse-seine observer programmes, two issues are examined further: (1) the relationship between observer

coverage rates and the reliability of estimates of catch rates, and (2) the sampling of species composition by observers onboard purse seiners.

A REVIEW OF SCIENTIFIC ASPECTS OF LONGLINE OBSERVER PROGRAMMES

Scientific objectives

The objectives of longline observer programmes provided by the respondents are listed below, ranked in the order of the number of programmes having the objective. The objectives are:

(5) to record the species, fate (retained or discarded) and life status of the catch of target and non-target species, including species of special interest (i.e., marine reptiles, marine mammals and sea birds) (PICTs, Australia, New Zealand, Korea, Chinese Taipei);

(4) to sample the length of target and non-target species (PICTs, Australia, New Zealand, Korea);

(4) to collect data to standardise fishing effort, such as gear and vessel attributes, and other factors affecting fishing power (PICTs, Australia, New Zealand, Korea);

(4) to sample other biological parameters, such as gender, stomach contents, hard parts (e.g., otoliths, first dorsal bone), tissue samples (PICTs, Australia, New Zealand, Chinese Taipei);

(3) to collect data to determine relationships between length and weight, and processed weight and whole weight (PICTs, Australia, Chinese Taipei);

(2) to record information on mitigation measures utilised and their effectiveness (Australia, New Zealand).

The first four objectives listed above represent the most common objectives of longline observer programmes and could be considered as the primary objectives for the Western and Central Pacific region. The objective of collecting data to determine relationships between length and weight, and processed weight and whole weight, could be considered as a secondary objective.

The objective of recording information on mitigation measures was included in responses from only two respondents; however, the programmes of the two respondents are the only programmes covering vessels that currently utilise mitigation measures. Therefore, this objective could be considered as a primary objective for observers onboard vessels that utilise mitigation measures.

Australia has also conducted observer programmes with more specific objectives, such as the monitoring of the bycatch of southern bluefin tuna in closed areas, a study on the use of wire leaders, a study on the use of circle hooks, and a study on effective effort utilising time-depth recorders.

Sampling protocols

For the PICTs, Australia, New Zealand and Korea, the sampling protocol is to collect data for all fish caught for all sets, except for distant-water vessels covered by PICT observers, for which the sampling protocol is to collect data from all fish caught on two out of every three sets.

For Chinese Taipei, the sampling protocol is to collect data for up to 60 tuna and up to 30 billfish or sharks.

Sampling design and coverage rates

For the PICTs, observer placements have been made on an opportunistic basis, except for the programme in Papua New Guinea, for which target and actual coverage rates have been 5% of trips in national waters.

For Australia, observer placements have been determined on the basis of random sampling, stratified in regard to time period and geographic area. Target coverage rates are to be increased from 5.1% to 8.5% of hooks deployed by domestic vessels. The coverage for the observer programmes with specific objectives have been 100% for the monitoring of southern bluefin tuna in closed areas, 25% of all hooks deployed off North Queensland in 2006 for the study on wire leaders, and limited numbers of trips or sets for the studies on circle hooks and effective effort.

For New Zealand, observer coverage during 2005 was stratified by target species, geographic area and season. Target coverage was determined in number of days for domestic and chartered longliners separately, although the percentage of the total number of days represented by the target was not mentioned in the response; actual coverage was 48% and 78% of the target number of days for domestic and chartered vessels respectively.

For Korea, observer coverage has not been stratified by time period or geographic area, and a target coverage rate has not been established.

For Chinese Taipei, the coverage rate in terms of the number of unique vessels active that were covered during the year was about 3% in 2004 and increased to about 5% in 2005; however, coverage in terms of the number of trips or fishing effort (hooks deployed) was much lower.

Recruitment and training of observers

For the PICTS, candidates are recruited on the basis of a pre-selection test, with a minimum grade of 70%. Candidates that have passed the pre-selection test then attend a three-week training course. They are tested throughout the course, take a final exam, and must achieve an overall grade of at least 70% to become qualified observers.

For Chinese Taipei, candidates must be graduates of senior high school or college. With at least five years experience at sea. Training courses are four weeks long, including one week at sea. Candidates must pass exams in all subjects to become qualified observers.

For Korea, candidates are recruited on the basis of a pre-selection test, with a minimum grade of 80%. Candidates that have passed the pre-selection test then attend a three-week training course. They are tested throughout the course, take a final exam, and must achieve an overall grade of at least 80% to become qualified observers.

For Australia, observer candidates are recruited from a variety of sources and training courses of two to three days are held on an annual basis.

For New Zealand, observer candidates are recruited on the basis of eight core competencies and an assessment based on three role plays and psychometric tests. Training courses are three weeks long and candidates must pass a final exam to become qualified observers.

Data collection forms and debriefing

The agencies responsible for the development of data collection forms are listed in Appendix I.

Debriefing forms and procedures have been developed and are being implemented by the programmes supported by SPC and FFA, and the programme of Korea.

There are no debriefing forms for the programme of Chinese Taipei, however, there is a debriefing meeting at the end of each calendar year.

For Australia, informal debriefings are conducted by telephone after each trip, and formal debriefings lasting a couple of days take place on an annual basis.

For New Zealand, debriefing forms and procedures have been developed and are currently under review.

A REVIEW OF SCIENTIFIC ASPECTS OF PURSE SEINE OBSERVER PROGRAMMES

Scientific objectives

The objectives of purse-seine observer programmes provided by the respondents are listed below, ranked in the order of the number of programmes having the objective. The programmes of the PICTS, the US Treaty and the FSM Arrangement are essentially identical and have therefore been treated as one programme, as have the programmes of France and Spain. The objectives are:

(5) to collect data on interactions with species of special interest (i.e., marine reptiles, marine mammals and sea birds), including sightings, species identification, length and condition on capture (PICTs & US Treaty & FSM Arrangement, Chinese Taipei, Korea, France & Spain, AIDCP);

(4) to estimate the catch and discards of non-target species (PICTs & US Treaty & FSM Arrangement, Korea, France & Spain, AIDCP);

(4) to collect data to standardise fishing effort, such as gear and vessel attributes, and data on daily activities and setting (PICTs & US Treaty & FSM Arrangement, Korea, France & Spain, AIDCP);

(4) to sample other biological parameters, such as stomach contents, hard parts (e.g., otoliths, first dorsal bone) and tissue samples (PICTs & US Treaty & FSM Arrangement, Chinese Taipei, France & Spain, AIDCP);

(4) to sample the length composition of target tunas (PICTs & US Treaty & FSM Arrangement, Chinese Taipei, Korea, France & Spain);

(3) to sample of the species composition of target tunas (PICTs & US Treaty & FSM Arrangement, Korea, France & Spain);

(3) to estimate the discards of target tunas (PICTs & US Treaty & FSM Arrangement, Chinese Taipei, France & Spain);

(3) to estimate catches of target tunas (PICTs & US Treaty & FSM Arrangement, Chinese Taipei, AIDCP); and

(1) to monitor dolphin mortality and to collect data to assist in reducing dolphin mortality (AIDCP).

The most common objectives are (i) to collect data on interactions with species of species interest, (ii) to estimate the catch and discards of non-target species, (iii) to collect data to standardise fishing effort, and (iv) to sample biological data.

While the sampling of the species composition of target tunas and the sampling of the length composition of target tunas are also a common objectives, it should be noted that the programmes of France and Spain assign lower priority to these objectives, since the random sampling of tunas by observers is considered to be very difficult.

The objective of estimating discards of target tunas was only reported three times; however, it could be that this objective was not specified explicitly in the response from IATTC since it may be covered implicitly under the objective "to collect data on catch and bycatch of all marine animals". In any case, information on discards is not available from any other source, so this objective should be considered more important than would appear from the information provided by the respondents.

Estimates of the retained catches of target tunas are available from catch and effort logsheets or logbooks, and reports of unloadings, each of which can be used to verify the other, and this is probably why the estimation of the catches of target tunas is a less common scientific objective. (On the other hand, it might be considered an important compliance objective in regard to the monitoring of catches within restricted areas.)

The monitoring of dolphin mortality and the collection of data to reduce dolphin mortality are objectives specific to the AIDCP, since dolphin interactions are common in the Eastern Pacific. Interactions with dolphins are much less common in the Western and Central Pacific and so this objective should be adequately covered under the collection of data on interactions with species of special interest in general.

Given the information provided by the respondents and the discussion above, one possible ranking of the scientific objectives for purse-seine observer progammes for the Western and Central Pacific region is as follows:

(1) to collect data on interactions with species of special interest (i.e., marine reptiles, marine mammals and sea birds), including sightings, species identification, length, and condition on capture and release;

(2) to estimate the catch and discards of non-target species;

(3) to estimate the discards of target tunas;

(4) to collect data to standardise fishing effort, such as gear and vessel attributes, and data on daily activities and setting;

(5) to sample other biological data, such as stomach contents, hard parts (e.g., otoliths, first dorsal bone) and tissue samples;

(6) to sample the length composition of target tunas;

(7) to sample of the species composition of target tunas; and

(8) to estimate catches of target tunas.

Sampling protocols

Sampling protocols for length and species composition include:

- randomly selecting five fish from each brail (PICTS & US Treaty & FSM Arrangement);
- randomly selecting 100–150 tuna discards per set (France & Spain); and
- randomly selecting fish on an opportunistic basis (Korea, AIDCP).

For the Chinese Taipei programme, fifty skipjack per set are randomly selected for length samples; species composition samples are not taken.

Sampling design and coverage rates

The target coverage rates for the US Treaty and FSM Arrangement programmes have been 20% and this coverage rate has been consistently achieved. The programme of the FSM Arrangement covers the purse-seine fleets of the Federated States of Micronesia, Kiribati, Marshall Islands, Papua New Guinea, Solomon Islands and Vanuatu; while the coverage for the individual fleets vary, the average coverage has been about 20% in recent years.

The target coverage rate for the programme of Papua New Guinea, which covers vessels fishing in national waters, has been 20%, whereas the actual coverage rate has been 5%. The coverage of purse seiners in the national waters of other PICTs, other than vessels operating under the US Treaty and the FSM Arrangement, has been opportunistic (i.e., depending on the availability of trained observers and vessels willing to accept observers), with actual coverage rates of a few percent or less.

Observer placements in the programmes of the US Treaty, the FSM Arrangement and the national programmes of the PICTS has not been conducted under a sampling design whereby coverage is stratified by geographic area, time period and type of school association. Rather, placements have been made on an opportunistic basis.

Coverage of the Chinese Taipei programme is based on scientific need, although there were only four trips in 2004 and two trips in 2005.

A target coverage rate for the Korean programme has not been established; there was one trip in 2004 and one trip in 2005.

For the programme of France and Spain, the target coverage is 10%. Observer coverage is attempted throughout the year; however, this is not always possible.

The AIDCP programme requires 100% coverage by purse seiners with carrying capacity of greater than 363 tonnes. Actual levels of coverage have been 100% during 1993–2000 and 2004–2005; coverage during 2001–2003 was 98%, 99% and 99% respectively.

Recruitment and training of observers

For the PICTS, Chinese Taipei and Korea, the criteria for recruiting candidates and training for their purse-seine observer programmes are similar to their longline observer programmes.

For the French and Spanish programmes, either a university degree or fishing experience is required. A training course is attended before boarding.

For the AIDCP programme, candidates must have at least a bachelor’s degree (four years of university) in biology or related life-sciences fields. Training courses are three weeks long, during which they are tested and graded, and there is a final exam.

From the responses discussed above and those for the longline observer programmes, it appears that the criteria for recruiting candidates for observer training ranges considerably, from no minimum education criteria to high school graduates to a university degree, and no fishing or seagoing experience to at least five years experience. The implication is that the criteria for recruiting

candidates depends on local circumstances, primarily the general level of education of the pool from which potential candidates are drawn. In countries where the level of education is limited, then aptitude as determined through pre-selection tests is the most important criteria.

Data collection forms and debriefing

The agencies responsible for the development of data collection forms are listed in Appendix II.

Debriefing forms and procedures have been developed and are being implemented by the programmes supported by SPC and FFA, and the programme of Korea.

There are no debriefing forms for the programme of Chinese Taipei, however, there is a debriefing meeting at the end of each calendar year.

Observers in the AIDCP programme are debriefed in one of IATTC's six field offices in Mexico, Panama, Ecuador and Venezuela.

ACTUAL OBSERVER COVERAGE RATES IN THE WCPFC STATISTICAL AREA

The coverage by observer data held by the SPC Oceanic Fisheries Programme (OFP) for longliners and purse seiners in the WCPFC Statistical Area are presented in Table 1.

Table 1. Observer coverage rates for longliners (percentage of hooks observed) and purse seiners (percentage of days fished and searched observed) in the WCPFC Statistical Area

YEAR	LONGLINE	PURSE SEINE
1994	0.56	2.01
1995	0.49	2.98
1996	0.49	2.56
1997	0.63	3.03
1998	0.51	1.82
1999	0.41	2.25
2000	0.52	2.93
2001	0.55	5.07
2002	0.87	5.44
2003	1.01	6.75
Total	0.77	3.59

OBSERVER COVERAGE RATES AND THE RELIABILITY OF CPUE ESTIMATES

The relationship between observer coverage rates and the reliability of estimates of the catch per unit of effort (CPUE) has been examined for offshore longline fleets targeting albacore (Lawson 2003), offshore longliners fishing in tropical waters (Lawson 2004) and purse seiners (Lawson

2006). In each case, the relationship can be described by an equation based on an approximation of the variance of a ratio estimator (Cochran 1977):

$$CV = \frac{\sqrt{V(\hat{U})}}{U} \cong \sqrt{\frac{1}{n} - \frac{1}{N}} \cdot \frac{\sqrt{\frac{\sum_{i}^{N} (c_i - Ue_i)^2}{N-1}}}{\overline{C}}, \qquad (1)$$

where CV is the coefficient of variation of the estimate of CPUE; U and $\hat{U}$ are the true CPUE and estimated CPUE; $V(\hat{U})$ is the variance of $\hat{U}$; N and n are the total number of trips and the number of observed trips; c_i and e_i are the catch and effort for the ith observed trip; and $\overline{C}$ is the true average catch per trip. The coefficient of variation thus depends on the number of trips observed and the total number of trips (i.e., the left-hand part of the formula) and a constant related to the ratio of the variation in the catch per trip to the average catch per trip (i.e., the right-hand part of the formula).

For unstratified sampling, the coefficients of variation of CPUE based on Equation (1) have been shown to be identical to those determined empirically (i.e., by sub-sampling of the observer data), indicating that the coefficients of variation based on sampling theory are unbiased (Lawson 2004).

Figure 1 illustrates how the coefficient of variation depends on the coverage rate in a general case, with the constant on the right-hand side of equation (1) assumed equal to 1 and the total number of trips scaled to 100. The coefficient of variation in Figure 1 decreases rapidly as the coverage rate increases to about 20%, then it decreases slowly until reaching zero at a coverage rate of 100%. While the actual magnitude of the coefficients of variation will depend on the CPUE — such that the coefficients of variation for rare species are much greater than for common species — the shape of the relationship is always the same.

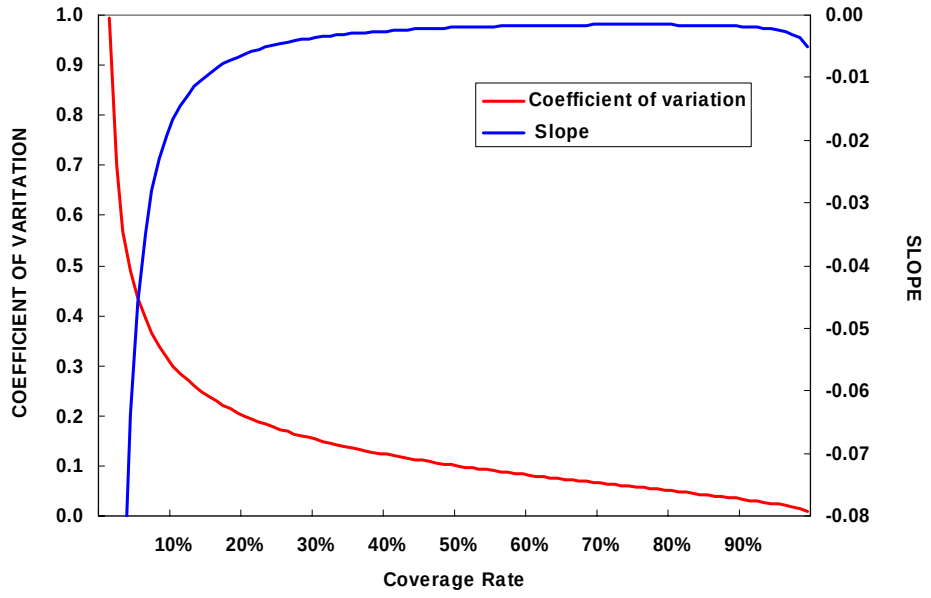

Figure 1. Relationship between the coefficient of variation of estimates of CPUE and the observer coverage rate, based on Equation (1) in the text

While reliable estimates of CPUE for species with extremely low catch rates, such as certain species of special interest (i.e., marine reptiles, marine mammals and sea birds), will require almost complete observer coverage, Figure 1 suggests that increases in the coverage rate beyond 20% result in smaller incremental improvements in the coefficient of variation of estimates of CPUE. If financial or other constraints limit the level of observer coverage, then the fact that the reliability of estimates of CPUE improves less rapidly with increasing coverage, once coverage rates of 20% percent are achieved, will be an important consideration in determining target coverage rates.

SAMPLING OF SPECIES COMPOSITION ONBOARD PURSE SEINERS

We have seen in the review of purse-seine observer programmes that the programmes of the PICTs, the US Treaty and the FSM Arrangement have as an important objective to sample the species composition of the catch of target tunas. In contrast, the French and Spanish programmes consider that random sampling by observers is difficult to achieve; therefore, the species composition is usually sampled in port during unloading, rather than by observers. The response concerning the AIDCP programme also indicates that observers do not sample the species composition. This section examines species composition data collected by observers from the programmes of the PICTs, the US Treaty and the FSM Arrangement.

Comparison of the species composition determined from observer data and other types of data

Lawson & Williams (2005) compared the species compositions determined from 4,428 samples collected by observers during 1995–2003 to four other types of data, i.e., operational (logsheet) catch and effort data, reports of unloadings, port sampling data and Final Out-Turn reports. The percentage of skipjack determined from observer data was 55%, whereas the percentage determined from the other types of data was 78% for logsheet data, 77% for unloadings data and 72% for port sampling data. From the port sampling data and the Final Out-Turn reports, it was further determined that the discrepancy was due primarily to greater amounts of large (>80 cm) yellowfin and bigeye in the samples collected by observers.

It could not be determined whether the discrepancy between the species compositions based on observer data and other sources of data is the result of bias in the observer data or in the other sources of data. However, it was considered of interest to determine the level of bias in observer sampling that would be required to explain the discrepancy. By varying the probability of sampling large yellowfin and bigeye in a range from the random probability up to four times the random probability, it was found that the proportion of skipjack determined from actual observer data for associated and unassociated sets corresponds to a bias of 3.0 and 2.6 times the random probability respectively.

While the bias expressed as a multiple of the random probability appears high, 3.0 and 2.6 for associated and unassociated sets, the bias expressed in terms of the absolute number of fish is small. For the associated set, the average number of large yellowfin and bigeye in simulations of sampling from an averaged size set is 2.0 fish for random sampling and 5.7 fish for bias of 3.0 times the random probability. For the unassociated set, the numbers of large yellowfin and bigeye corresponding to random sampling and bias of 2.6 times the random probability are 1.0 fish and 2.4 fish respectively.

Comparison of port samples for trips with and without observers

Anecdotal evidence from industry suggests that the discrepancy in the species compositions determined from observer data and other types of data may be due to large yellowfin and bigeye being transshipped at sea. Transshipment at sea is not allowed under the minimum terms and conditions of licensing of the FFA member countries, and so would only occur if observers were not onboard. This would explain why more large yellowfin and bigeye appear in the observer samples. Under this scenario, if they were transshipped at sea when observers were not onboard, large yellowfin and bigeye would not be available for sampling in port.

To examine this possibility, the species composition determined from port sampling for trips without observers was compared to the species composition determined from port sampling for trips with observers. If large yellowfin and bigeye are being transshipped at sea, the port samples for trips without observers should indicate fewer large yellowfin and bigeye than for trips with observers.

While there are 835 port samples for trips without observers, covering 11 flags from 1993 to 2005, there are only 45 port samples for trips with observers. For sets on associated and unassociated schools for trips without observers, the average percentages of skipjack (unweighted by the total catch per set) are 68.1% and 71.6% respectively, whereas for trips with observers, the percentages are 49.2% and 71.9% respectively. While the number of samples is relatively small, the percentages determined from port sampling data for trips with observers would appear to be consistent with those determined from observer data, i.e., 47.8% and 70.7% for associated and unassociated schools respectively (Lawson & Williams 2005, Table 11).

The variability in the percentages of skipjack among port samples was examined by analysis of variance, with first order effects of school association, year, flag and the presence of observer. An arcsine–square root transformation was applied to the percentages of skipjack in the samples to improve normality and homoscedasticity (Snedecor & Cochran 1989). Since the variables were unbalanced (i.e., the number of replicates was unequally distributed among categories of each variable), the residual sum of squares was determined after dropping each term from the model and the analysis of variance was then conducted with the results listed for variables in the order of their effect on the residual sum of squares.

The results from the analysis of variance, with variables listed in order of their effect on the residual sum of squares, is given below. If variables with $p<0.001$ are considered strongly related to the percentage of skipjack in the sample and if variables with $0.001<p<0.01$ are considered weakly related, then flag is strongly related, year is weakly related, and the presence of an observer and school association are not related.

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Flag	10	6.042	0.604	6.1744	4.023e-09
Year	12	3.219	0.268	2.7415	0.001184
Observer	1	0.394	0.394	4.0302	0.045032
School	1	0.023	0.023	0.2402	0.624226
Residuals	795	77.791	0.098		

When the analysis of variance was repeated with the presence of an observer as the first variable, followed by flag, year and school association, flag and year were strongly related, while the presence of an observer and school association were not related.

The results from the analysis of variance suggest that the presence of observers is not related to the percentage of skipjack in port samples. However, port samples for trips with observers are few in

number and unequally distributed among the variables examined in the analysis of variance, so these results should not be considered as conclusive. It may be that the presence of observers is indeed related to the percentage of skipjack in port samples, but that the effect is confounded with flag and year.

Accuracy and reliability of estimates of species composition

The accuracy and reliability of estimates of the species composition determined from sampling data was examined by simulating the sampling of the purse seine catch. The input data to MULTIFAN-CL assessments are stratified by quarter and area; hence, quarterly catches in bigeye and yellowfin area 3 (10°S–20°N, 110°E–170°E), and the sampling of those catches, were examined in the study reported below. The obsrver data were insufficient to examine the sampling in bigeye and yellowfin area 4.

The average catches and number of sets in area 3 (Table 2), by school association, were determined from aggregated catch and effort data for all flags combined. A 'virtual population' of sets was modelled by randomly applying the species and size compositions of the 108 samples of associated sets and 107 samples of unassociated sets collected by port samplers during 2000–2003 to the average number of sets per quarter in area 3 during this period, ie., to 6,036 associated sets and to 4,025 unassociated sets (Table 2). The port samples were smoothed to account for rounding to the nearest 5 cm or 10 cm. The catches per set, and hence the number of fish caught in each set, were normalised such that the total quarterly catches for each school association and area corresponded to those given in Table 2. The variation in the species and size composition among sets in the virtual population therefore reflects the variation among the port samples collected during 2000–2003. The variation in the virtual population may be somewhat greater than in the real world, since the virtual population was not stratified by year and quarter.

Table 2. Average quarterly number of sets, catch (tonnes) and catch per set (tonnes) in the purse-seine fishery in area 3 during 2000–2003

Area	School Association	Sets	Total	
			Catch	Catch Per Set
3	Associated	6,036	105,118	17.416
	Unassociated	4,025	90,047	22.370
	Total	10,061	195,164	19.398

Sampling of the virtual population was simulated by applying the actual average quarterly coverage rate of sets sampled by observers in area 3 during 2000–2003 (i.e., 5.16%) and the average proportion of fish sampled during each set (i.e., 0.39%). Sets were randomly selected for sampling from the virtual population of sets, and fish were randomly selected and sampled, at the appropriate coverage rates. The species composition in terms of weight was then determined from all the fish sampled in each stratum of school association.

Table 3 presents the bias and coefficients of variation for estimates of the species composition determined from 20 replicates of the simulation procedure discussed in the previous paragraph.

Table 3. Bias and coefficients of variation in estimates of the purse-seine species composition in terms of weight. All values are percentages.

Species	Variable	Area 3	
		Associated	Unassociated
Skipjack	True value	69.607	79.465
	Average estimated value	69.638	79.824
	Bias	0.032	0.359
	Bias as % of true value	0.046	0.452
	Coefficient of variation	2.202	2.749
Yellowfin	True value	23.598	17.548
	Average estimated value	23.638	17.122
	Bias	0.039	-0.425
	Bias as % of true value	0.166	-2.424
	Coefficient of variation	5.899	10.993
Bigeye	True value	6.795	2.987
	Average estimated value	6.724	3.053
	Bias	-0.071	0.065
	Bias as % of true value	-1.046	2.192
	Coefficient of variation	8.153	20.238

Table 3 suggests that, at the average level of observer coverage rates for purse-seine during 2000–2003, random sampling results in estimates of the species composition that are unbiased and that have acceptable coefficients of variation, except for those species and strata for which the catches are small, i.e., bigeye in unassociated schools, for which the coefficient of variation is large.

The levels of coverage that are required to reduce all coefficients of variation to less than 10% were determined by conducting binary searches. When the proportion of fish sampled per set is held at the 2000–2003 average value, the coverage of sets sampled in area 3 must be increased to 16%, which is over three times the actual average value of 5.16%.

When the coverage of the number of sets sampled is held at the 2000–2003 average value, the proportion of fish sampled per set must be increased to 7.4% in area 3, which is 19 times the actual average value of 0.39%.

The bias and coefficients of variation of estimates of the proportion of bigeye in ‘yellowfin plus bigeye’ was also examined (Table 4). At the average level of observer coverage rates for purse seine during 2000–2003, random sampling results in estimates of the proportion of bigeye in ‘yellowfin plus bigeye’ with biases and coefficients of variation that are similar to those for the percentage of bigeye in the total catch (Table 3).

Table 4. Bias and coefficients of variation in estimates of the proportion of bigeye in 'yellowfin plus bigeye'. All values are percentages.

Variable	Area 3	
	Associated	Unassociated
True value	22.357	14.548
Average estimated value	22.819	14.643
Bias	0.462	0.095
Bias as % of true value	2.067	0.654
Coefficient of variation	6.914	19.287

Tables 3 and 4 suggest that the level of observer coverage in area 3 during 2000–2003 (i.e., 5.16% of sets) results in reliable estimates of the species composition, except for bigeye in unassociated schools. Increasing the observer coverage to 16% of sets would result in reliable estimates for all species and school associations, with coefficients of variation of less than 10%. However, these conclusions depend on the assumptions that (a) the 215 species composition samples collected by observers in area 3 during 2000–2003 are representative of the variation in species composition, which is perhaps reasonable, and (b) that the actual sampling by observers is random, which is open to question.

REFERENCES

Anonymous. 2005. Report of the First Regular Session of the Scientific Committee of the Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean, Noumea, New Caledonia, 8–19 August 2005 Western and central Pacific Fisheries Commission, Pohnpei, Federated States of Micronesia.

Cochran, W.G. 1977. Sampling Techniques, Third Edition. John Wiley & Sons, New York, New York.

Lawson, T. 2003. Observer coverage rates and the accuracy and reliability of estimates of CPUE for offshore longline fleets targeting South Pacific albacore. Working Paper SWG–4. Sixteenth Meeting of the Standing Committee on Tuna and Billifsh, 9–16 July 2003, Mooloolaba, Queensland, Australia. Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

Lawson, T. 2004. Observer coverage rates and reliability of CPUE estimates for offshore longliners in tropical waters of the Western and Central Pacific Ocean. Working Paper SWG–4. Seventeenth Meeting of the Standing Committee on Tuna and Billifsh, 9–18 August 2004, Majuro, Marshall Islands. Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

Lawson, T. 2006. Observer coverage rates and reliability of CPUE estimates for purse seiners in the Western and Central Pacific Ocean. Information Paper ST IP–3. Second Meeting of the Scientific Committee of the Western and Central Pacific Fisheries Commission, 7–18 August 2006, Manila, Philippines. Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia. 12 pp.

Lawson, T. & P. Williams. 2005. Comparison of the species composition of catches by purse seiners in the Western and Central Pacific Ocean determined from observer and other types of data. Working Paper WCPFC–SC1 ST WP-4. First Meeting of the Scientific Committee of the Western and Central Pacific Fisheries Commission, 8–19 August 2005, Noumea, New Caledonia. Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia. 20 pp.

Snedecor, G.W. & W.G. Cochran. 1989. Statistical Methods (8th Edition). Iowa State University Press, Ames, Iowa.

APPENDIX I. CHARACTERISTICS OF LONGLINE OBSERVER PROGRAMMES

Characteristic	Longline Observer Programmes in the WCPO Supported by SPC and FFA
Annual number of observer trips	2004: Cook Islands = 4, Federated States of Micronesia = 6, Fiji = 11, French Polynesia = 20, Marshall Islands = 23, New Caledonia = 12, Palau = 5, Papua New Guinea = 19, Solomon Islands = 21, Tonga = 11, Total = 132
Scientific objectives	Sample the species, length and fate (retained or discarded) of the catch of target and non-target species; collect data to standardise effort, such as vessel and gear attributes; collect data on interactions with species of special interest (marine turtles, sea birds and marine mammals); collect data to determine relationships between length and weight, and processed weight and whole weight; sample other biological parameters and collect other data as required.
Vessel and gear attributes collected	Vessel name, flag, registration number, owner, call sign. Make and model of various electronics. Crew details. Presence of mainline hauler, branchline hauler, line shooter, bait thrower, branchline attacher. Mainline material, branchline material, presence of wire trace. Refrigeration method.
Set details collected	Date, time, position, wind speed and direction, sea condition and cloud cover of start of set, end of set, start of haul, end of haul, and at hourly intervals during setting and hauling. Number of hooks, number of hooks per basket, number of baskets, length of floatline, length of branchlines. Vessel speed, line setting speed, branchline set interval, distance between branchlines. Bait species. Target species. Soak time. Hook number, species, length, gender, fate, condition at capture and release, and, if tagged, tag number, of all species caught.
Sampling protocols	For offshore longliners, data (see above) are collected for all fish caught during all sets. For distant-water longliners, data are collected for all fish caught during the first and second of every three sets.
Sampling protocols for other types of sampling	Stomach contents, otoliths and tissue samples have been sampled opportunistically by designated observers. Species that cannot be identified are photographed or frozen and retained for identification in the lab.
Other data collected	Vessel and aircraft sightings, info on interactions with species of special interest (marine turtles, sea birds and marine mammals).
Priority of observer activities	Observers are expected to collect all data with equal priority.
Sampling design and target and actual coverage rates	Target and actual coverage rates for Papua New Guinea have been 5%. Coverage of other national programmes has been opportunistic. None of the programmes attempt to stratify observer coverage by time period, geographic area or flag.

Observer recruitment criteria, training of observers, and criteria for evaluation of training results	Candidates must achieve 70% on a pre-selection test. Training courses are three weeks in duration. Trainees are tested throughout the course, take a final exam and must achieve an overall grade of at least 70% to pass the course.
Data collection forms and debriefing	Data collection forms have been developed and are maintained by the SPC/FFA Tuna Fishery Data Collection Committee, which meets biennially. Debriefing forms and procedures have been developed and are currently being implemented.

Characteristic	**Australian East Coast Tuna and Billfish Longline Observer Programme**
Annual number of observer trips	2004/05: 140 trips (402 sets)
Scientific objectives	Collect information pertaining to fishing effort and total catch of all species caught. Obtain estimates of catch at size of target and non-target species for stock assessments, including life status and discarding rates. Determine the effectiveness of bycatch mitigation measures. Collect information on factors affecting fishing power to assist effort standardisation. Collect information on length-weight and processed weight conversion factors, and biological samples as required.
Vessel and gear attributes collected	Vessel name, flag, registration number, owner, call sign. Make and model of various electronics. Crew details. Presence of mainline hauler, branchline hauler, line shooter, bait thrower, branchline attacher. Mainline material, branchline material, hook types, lightsticks. Refrigeration method.
Set details collected	Date, time, position, wind speed and direction, sea condition and cloud cover of start of set, end of set, start of haul, end of haul, and at hourly intervals during setting and hauling. Number of hooks, number of hooks per basket, number of baskets, length of floatline, length of branchlines. Vessel speed, line setting speed, branchline set interval, distance between branchlines. Bait species and status (live vs. dead). Target species. Species, length, gender, fate, condition at capture and release, and, if tagged, tag number, of all species caught. Beginning to record hook number.
Sampling protocols	Usually monitor entire haul, identifying and measuring every animal caught, reporting the fate of animals discarded or released. Regularly monitor longline deployment, including seabird abundance counts and attempts at stealing baits.
Sampling protocols for other types of sampling	Wire leader and circle hook study: Regularly monitor the pattern of leader- or hook-types and bait-type during the set. Identify and measure all animals hooked and report leader- and hook-type. Effective effort study: Deployment of temperature-depth recorders (TDRs) and hook-timers (HTs) to determine depths and habitats fished by longline hooks. Monitors to be deployed by two observers at any one time and over time across the spatial range of the fishery.

Other data collected	Hard part samples for age and growth studies, stomachs for ecological studies, tissue samples for genetics studies.
Priority of observer activities	Priority given to reporting interactions with threatened or endangered species; then identifying and reporting fate of all animals; measuring animals landed; seabird abundance counts; other samples collected as time permits.
Sampling design and target and actual coverage rates	Random stratified sampling. The Commonwealth Scientific and Industrial Research Organisation (CSIRO) has identified problems in low levels of coverage in certain areas (e.g., off North Queensland) and allowing observers to select vessels, which has resulted in low levels of coverage of small, inshore longliners off New South Wales. Target coverage rate to be increased from 5.1% to 8.5% of all hooks deployed. Coverage rate of 4.3% achieved in 2004/05. SBT bycatch monitoring: 100% observer coverage in closed area. Wire leader study: 25% of all hooks deployed off North Queensland in 2006. Circle hook study: 12 trips on 4 longliners in 2006/07. Effective effort study: 81 sets (697 hooks) monitored with TDRs during 2004/05 and, to date, 95 sets (685 hooks) monitored with TDRs in 2005/06. A total of 450 hook-timers triggered.
Observer recruitment criteria, training of observers, and criteria for evaluation of training results	Observers recruited from a variety of sources. The Australian Fisheries Management Authority (AFMA) usually holds an annual training course of 2-3 days at CSIRO in Hobart, Tasmania. Every three years they have a one-week sea-safety and first aid course at the Australian Maritime College in Launceston, Tasmania.
Data collection forms and debriefing	Data collection forms developed by AFMA in consultation with the Bureau of Rural Sciences (BRS) and CSIRO. Standard reporting and debriefing procedures have been implemented. Observers are not formally debriefed after each trip; however, informal briefings and debriefings are usually done by phone before and after each trip. There is an annual debriefing, and observers are also be expected to spend a couple of days in Canberra at least once per year.

Characteristic	New Zealand Longline Observer Programme
Annual number of observer trips	2005: 24 trips
Scientific objectives	Characterising catch composition, providing size and sex composition data for stock assessment, confirming commercial catch and effort statistics, identifying changes in operational methods of fishing, determine effects of fishing so that fisheries management measures can be determined, collecting data to allow estimation of rates of non-fish (seabirds, marine mammals, marine reptiles) mortalities in tuna longline fisheries.
Vessel and gear attributes collected	Vessel name, nationality, registration number. Make and model of various electronics. Senior crew details. Cruising speed. Other vessel attributes can also be accessed through a database containing information provided by the permit holder. Length of mainline, length of float line. Number of hooks, number of baskets. Hook colour, hook type, hook size, swivel type, snood length.
Set details collected	Target species. Date, time, position of start of set and end of set. Hourly times and positions during hauling. Cloud coverage, barometric pressure, wind direction and force, sea surface temperature. Bait species and condition (frozen or thawed). Presence of bait thrower, snood signal time, line feeder rate. Species, condition, fate, fork length, whole weight, processed state, processed weight and gender of all species caught. Weights are measured with balanced beam scales on large (usually charter) vessels and by eye on smaller vessels. In 2007, the following will also be collected: Type of mitigation. Bait landing inside vessel wake? Offal discharge? Bait discharge?
Sampling protocols	Where possible, data are collected for all fish caught during all sets.
Sampling protocols for other types of sampling	Stomach contents, otoliths and tissue samples have been sampled as required, by designated observers. Species that cannot be identified are photographed or frozen and retained for identification. Observers are also involved in tagging programmes, as required.
Other data collected	Information (and specimens) from interactions with seabirds, marine mammals and marine reptiles. Mitigation details: CCAMLR-type tori pole?, number of branch streamers, length of tori line, height of attachment above water, Is this configuration over the bait entry point?, distance from bait entry point and tori line. In 2007, mitigation details will be recorded for all types of mitigation used, and not just tori lines.

Priority of observer activities	These are solo observer trips and observers are not allowed to work for more than 12 hours in a shift. Therefore observers are briefed to watch the beginning of the set only and to concentrate on observing the haul.
Sampling design and target and actual coverage rates	Tuna domestic long-line fleet (22 trips in 2005): target coverage was 650 days and 312 days were achieved. Tuna charter long-line fleet (2 trips in 2005): target coverage was 287 days and 225 days were achieved. Stratification plan for 2005 was: Tuna domestic a) Southern bluefin, East Coast North Island: 30% of coverage – Autumn / Winter b) Southern bluefin, West Coast South Island: 8% – Winter c) Bigeye & Pacific bluefin: 47% – Spring / Summer / Autumn d) Tuna general, other areas: 15% Tuna charter a) Southern bluefin: 69% – Autumn / Winter b) Albacore: 31% – Spring
Observer recruitment criteria, training of observers, and criteria for evaluation of training results	Observers are not recruited specifically for tuna coverage. The general recruitment process is: (a) Initial selection made against eight core competencies. (b) Assessment centre selection based on three role plays and psychometric tests. (c) Acceptance onto three-week training course, with final exam requiring a 70% or better. Tuna trips are specifically briefed, and there is a full day training course on tuna tagging.
Data collection forms and debriefing	Data collection forms were developed by the Ministry of Fisheries (MFish) and the National Institute of Water and Atmospheric Research (NIWA). These forms are currently under review and will be redesigned over the next twelve months. Once the new forms are implemented, they will be regularly reviewed. Debriefing forms and procedures were developed with the forms, and are also under review at present.

Characteristic	**Republic of Korea Longline Observer Programme**
Annual number of observer trips	2004 : 0 in WCPFC area, 2 in other areas 2005 : 1 in WCPFC area, 3 in other areas
Scientific objectives	Length and fate (retained or discarded) of the catch of target and non-target species; collect data to standardise effort, such as vessel and gear attributes; collect data on interactions with species of special interest (marine turtles, sea birds and marine mammals).
Vessel and gear attributes collected	Vessel name, flag, registration number, owner, call sign. Presence of mainline hauler, branchline hauler, line shooter, bait thrower, branchline attacher. Mainline material, branchline material, presence of wire trace. Refrigeration method.

Set details collected	Date, time, position, wind speed and direction, sea condition and cloud cover of start of set, end of set, start of haul, end of haul, and at hourly intervals during setting and hauling. Number of hooks, number of hooks per basket, number of baskets, length of floatline, length of branchlines. Vessel speed, line setting speed, branchline set interval, distance between branchlines. Bait species. Target species. Soak time. Hook number, species, length, gender, fate, condition at capture and release, and, if tagged, tag number, of all species caught.
Sampling protocols	Data (see above) are collected for all fish caught during all sets.
Sampling protocols for other types of sampling	Species that cannot be identified are photographed for identification in the lab.
Other data collected	Vessel sightings, information on interactions with species of special interest (marine turtles, sea birds and marine mammals).
Priority of observer activities	Observers are expected to collect all data with equal priority.
Sampling design and target and actual coverage rates	None of the programmes attempt to stratify observer coverage by time period and geographic area. A target coverage rate has not been established.
Observer recruitment criteria, training of observers, and criteria for evaluation of training results	Candidates must achieve 80% on a pre-selection test. Training courses are three weeks in duration. Trainees are tested throughout the course, take a final exam and must achieve an overall grade of at least 80% to pass the course.
Data collection forms and debriefing	Data collection forms have been developed and are maintained by the Distant Water Fisheries Resources Team of the National Fisheries Research and Development Institute (NFRDI). Debriefing forms and procedures have been developed.

Characteristic	**Chinese Taipei Longline Observer Programme**
Annual number of observer trips	2004: 2 observers and 4 trips in the Pacific Ocean. 2005: 4 observers and 6 trips in the Pacific Ocean.
Scientific objectives	Collect operational information on catch and effort, for all major species, and information on non-target species (including incidental take of sea turtles and marine mammals), and collect biological samples for specific research projects.

Vessel and gear attributes collected	Vessel name, company, registration number, call sign. Ocean area. Crew number. Gross registered tonnage, overall length, engine horse power, fuel well capacity, hold capacity. Number and model of radio buoys. Model of hauler, line-shooter, global positioning system, radio navigator, direction detector, navigation radar, fish detector, sonar, satellite fax receiver, cruise grapher, NOAA satellite receiver, Doppler current recorder, sea surface temperature recorder, time-depth recorder, vessel monitoring system and computer equipment.
Set details collected	Date, sea condition, wind direction, sea surface temperature, moon phase, weather condition. Position, direction and time of setting and hauling. Floating line length, distance between floats, branch line length, hooks per basket, total number of baskets, total hooks. Material of main line, branch line and float line. Use of autobaiting machine, baiting underwater, tori line, weighting of branch line, tighting buoy. Bait type, live/dead, colouring, defrosting. Number of fish, whole weight, processing type and processing weight, number discarded or released, number predated by marine mammal or shark, for all species of fish caught. Number and condition of all species of marine mammals, turtles and sea birds caught.
Sampling protocols	For up to 60 tuna, the length and weight, the basket number and hook number, and the condition (live or dead) are recorded. For up to 30 billfish or sharks, the length and weight, gender and condition are recorded.
Sampling protocols for other types of sampling	As many otoliths, muscle tissues and gonads as possible are sampled. Species that cannot be identified are photographed.
Other data collected	For sightings, record the species and amount of marine mammals, sea turtles and sea birds. For encounters, photograph and record the species, number and condition of marine mammals, sea turtles and sea birds, and collect the bill of dead sea birds.
Priority of observer activities	Observers are expected to collect all data with equal priority.
Sampling design and target and actual coverage rates	The coverage rate in terms of the number of unique vessels active that were covered during the year was about 3% in 2004 and increased to about 5% in 2005; however, coverage in terms of the number of trips or fishing effort (hooks) was much lower.
Observer recruitment criteria, training of observers, and criteria for evaluation of training results	Candidates must be senior high school or college graduates with at least five years experience at sea. Training courses are four weeks, including one week of training at sea. Candidates must pass exams in all subjects to obtain their qualification.
Data collection forms and debriefing	Data collection forms have been developed by the panel organised by staff from the Fisheries Administration (FA), the Overseas Fisheries Development Council (OFDC) and researchers, and maintained by FA. There is no specific debriefing forms, but there is a debriefing meeting at the end of calendar year.

APPENDIX II. CHARACTERISTICS OF PURSE-SEINE OBSERVER PROGRAMMES

Characteristic	Purse-Seine Observer Programmes in the WCPO Supported by SPC and FFA
Annual number of observer trips	2004: US Treaty = 22, FSM Arrangement = 44, Federated States of Micronesia = 7, Kiribati = 3, Marshall Islands = 3, Papua New Guinea = 74, Total = 153
Scientific objectives	Sample the lengths and species composition of the catch of tuna; estimate the discards of tuna; estimate the catches of non-target species; collect data to standardise effort, such as vessel and gear attributes, data on daily activities and setting; collect data on interactions with species of special interest (marine turtles, sea birds and marine mammals); sample other biological parameters and collect other data as required.
Vessel and gear attributes collected	Vessel name, flag, registration number, owner, call sign. Number of ancillary boats. Cruising speed. Helicopter make, model and range. Make and model of various electronics. Well capacity. Crew details. Make and model of power block and winch. Maximum net depth and length, number of strips, mesh size. Brail capacity.
Information on daily activities collected	Time spent in transit, searching, investigating schools or floating objects, setting, in port, etc. Association and method of detection are recorded for each school investigated.
Set details collected	Date, time and position of start of set, pursing, brailing and end of set. Catch estimates and fate of all species. Information on tag recoveries.
Length and/or species composition sampling protocols	Five fish from each brail are randomly selected and the species and length recorded.
Sampling protocols for other types of sampling	Stomach contents, otoliths and tissue samples have been sampled opportunistically by designated observers. Species that cannot be identified are photographed or frozen and retained for identification in the lab.
Other data collected	Vessel and aircraft sightings, info on interactions with species of special interest (marine turtles, sea birds and marine mammals).
Priority of observer activities	Observers are expected to collect all data with equal priority.
Sampling design and target and actual coverage rates	Target and actual coverage rates for the US Treaty and FSM Arrangement have been 20%. Target and actual coverage for Papua New Guinea have been 20% and 5% respectively. Coverage of other national programmes has been opportunistic. None of the programmes attempt to stratify observer coverage by time period, geographic area or flag.

Observer recruitment criteria, training of observers, and criteria for evaluation of training results	Candidates must achieve 70% on a pre-selection test. Training courses are three weeks in duration. Trainees are tested throughout the course, take a final exam and must achieve an overall grade of at least 70% to pass the course.
Data collection forms and debriefing	Data collection forms have been developed and are maintained by the SPC/FFA Tuna Fishery Data Collection Committee, which meets biennially. Debriefing forms and procedures have been developed and are currently being implemented.

Characteristic	**Republic of Korea Purse-Seine Observer Programme**
Annual number of observer trips	2004 : 1 in WCPFC area 2005 : 1 in WCPFC area, 2 in other areas
Scientific objectives	Sample the lengths and species composition of the catch of tuna; estimate the catches of non-target species; collect data to standardise effort, such as vessel and gear attributes, data on daily activities and setting; collect data on interactions with species of special interest (marine turtles, sea birds and marine mammals);
Vessel and gear attributes collected	Vessel name, flag, registration number, owner, call sign. Number of ancillary boats. Cruising speed. Helicopter make, model and range. Make and model of various electronics. Well capacity. Make and model of power block and winch. Maximum net depth and length, mesh size.
Information on daily activities collected	Time spent in transit, searching, investigating schools or floating objects, setting.
Set details collected	Date, time and position of start of set, pursing, brailing and end of set. Catch estimates and fate of all species.
Length and/or species composition sampling protocols	Fish are randomly selected on an opportunistic basis (i.e., without a sampling protocol) and their length recorded.
Sampling protocols for other types of sampling	Species that cannot be identified are photographed for identification in the lab.
Other data collected	Information on interactions with species of special interest (marine turtles, sea birds and marine mammals).
Priority of observer activities	Observers are expected to collect all data with equal priority.
Sampling design and target and actual coverage rates	None of the programmes attempt to stratify observer coverage by time period and geographic area. A target coverage rate has not been established.

Observer recruitment criteria, training of observers, and criteria for evaluation of training results	Candidates must achieve 80% on a pre-selection test. Training courses are three weeks in duration. Trainees are tested throughout the course, take a final exam and must achieve an overall grade of at least 80% to pass the course.
Data collection forms and debriefing	Data collection forms have been developed and are maintained by the Distant Water Fisheries Resources Team of the National Fisheries Research and Development Institute (NFRDI). Debriefing forms and procedures have been developed and are currently being implemented.

Characteristic	**Chinese Taipei Purse-Seine Observer Programme**
Annual number of observer trips	2004: 1 observer and 4 trips. 2005: 1 observer and 2 trips.
Scientific objectives	Collect operational information on catch and effort, for all major species, and information on non-target species (including incidental take of sea turtles and marine mammals); estimate the proportion of bigeye in the catch.
Vessel and gear attributes collected	Vessel name, registration number, FFA Regional register number, company, owner, gross registered tonnage, call sign, net size.
Information on daily activities collected	Position of each set or, if no was made, the noon position and main activity (searching, transiting, in port, etc.). School type when investigating schools or floating objects.
Set details collected	Date, time and position of start of set, pursing, brailing and end of set. School type. Catch estimates and fate of all species.
Length and/or species composition sampling protocols	Sample the fork length of fifty skipjack per set, selected randomly. Lengths and conditions of non-target species are also recorded.
Sampling protocols for other types of sampling	Prior to 2004, five skipjack of different sizes were selected randomly from each set for head, muscle tissue and gonads. No other sampling occurred in 2004 and 2005.
Other data collected	Marine mammals sightings. Species, length and condition of the sea turtles and marine mammals. Unloading operation and the unloading amounts by species.
Priority of observer activities	Observers are expected to collect all data with equal priority.

Sampling design and target and actual coverage rates	The scientific observer deployment strategy is designed upon the scientific need.
Observer recruitment criteria, training of observers, and criteria for evaluation of training results	Candidates must be senior high school or college graduates with at least five years experience at sea. Training courses are four weeks, including one week of training at sea. Candidates must pass exams in all subjects to obtain their qualification.
Data collection forms and debriefing	Data collection forms have been developed by the panel organised by staff from the Fisheries Administration (FA), the Overseas Fisheries Development Council (OFDC) and researchers, and maintained by FA. There is no specific debriefing forms, but there is a debriefing meeting at the end of calendar year.

Characteristic	**French and Spanish Purse-Seine Observer Programme in the Atlantic and Indian Oceans**
Annual number of observer trips	France: 8 Atlantic Ocean (moratorium) + 0 Indian Ocean = 8 trips in 2004; 8 Atlantic Ocean (moratorium) + 1 Atlantic Ocean + 1 Indian Ocean = 10 trips in 2005, carried out by the *Institut de Recherche pour le Développement* (IRD). Spain: 20 (14 Indian Ocean, 6 Atlantic Ocean), carried out by the *Instituto Español de Oceanografia* (IEO) and *Arrantzuarekiko Zientzia eta Teknika Iraskundea* (AZTI) *Instituto Tecnológico Pesquero y Alimentario.*
Scientific objectives	Estimate the discards of tuna; estimate the catches and discards of non-target species; sample the lengths and species composition of the catch of tuna (if there is enough time and possibilities); collect data to standardise effort, such as vessel and gear attributes, data on daily activities and setting; collect data on interactions with species of special interest (marine turtles, sea birds and marine mammals); sample other biological parameters and collect other data as required.
Vessel and gear attributes collected	Name, country, gear, category (size of the vessel), flag, year of construction, capacity (M^3), power (HP).
Information on daily activities collected	Date, daily distance run, time (every hour or event's change), quadrant, latitude, longitude, activity of the vessel, fleet activity near the vessel, speed, surface temperature, wind speed. School detection method (binoculars, bird radar, etc.), school association and aspect (unassociated, birds, floating object, etc.), distance to the school. If set not made, reason for not making a set.

Set details collected	Date and time of start a set, time of pursing the net, time of end a set, depth of the set (only if depth sensor available), reason for null set, size of school and mean weight estimates, is school visible to the naked eye?, sonar data (thickness and depth of the school), school association and aspect, name of auxiliary vessel if used. **Tuna catch:** catch estimates (provided by the crew), by species and size category, and well number. **Tuna discards:** observer estimates of discards by species and size category. **Other species:** catch estimates in numbers or weight, by species (including sailfish, sharks, other fish, turtles, marine mammals).
Length and/or species composition sampling protocols	Random size sample of tuna discards of 100–150 fish. Other species: random sample of every species. Sampling of the retained catch of tuna is not a priority and is only conducted if it is possible to do random sampling and if time permits. Length are truncated to the lower centimetre.
Sampling protocols for other types of sampling	Stomach contents, mainly from small tunas. The first dorsal bone of albacore tuna is collected for growth studies. All species are photographed.
Other data collected	Depth sensor data (i.e., temperature, depth of the gear, etc.). Forms are used to collect data about logs, FADs, buoys, etc.
Priority of observer activities	Estimates of discards and catches of other species are the priorities. Random sampling of tuna by observers is considered to be very difficult; sampling of retained tuna catches is conducted primarily in port during unloading.
Programme target and actual coverage rates, and sampling design	Observer coverage is attempted throughout the year; however, this is not always possible due to issues with vessel owners. The target coverage rate is 10% of the fleet's activities.
Observer recruitment criteria, training of observers, and criteria for evaluation of training results	Either a university degree or fishing experience is required. A training course is attended before boarding. Each observers' data are verified together with programme staff.
Data collection forms and debriefing	Data collection forms have been developed by the IEO and IRD.

Characteristic	Agreement on the International Dolphin Conservation Program (AIDCP)
Annual number of observer trips	2005: 818 trips aboard Class-6 vessels (IATTC: 549 trips; National Programs: 269 trips by Ecuador, Mexico, Colombia and Venezuela). The Program covered vessels operating under the jurisdictions of, Colombia, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Spain, the United States, Vanuatu, and Venezuela. 2004: 834 trips aboard Class-6 vessels (IATTC: 583 trips; National Programs: 251 trips by Ecuador, Mexico, Spain, USA, and Venezuela). The Program covered vessels operating under the jurisdictions of Bolivia, Colombia, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Spain, the United States, Vanuatu, and Venezuela.
Scientific objectives	The observer program was initiated in 1978 to monitor dolphin mortality and estimate dolphin abundance, and to collect data that would assist in reducing dolphin mortality and study tuna-dolphin interactions. This also entailed recording data on tuna catch and effort, daily activities and sets, and cetacean sightings. The duties have expanded to collect data on catch and bycatch of all marine animals, sightings of seabirds, and sea turtles, collecting biological samples for basic and applied research, evaluating gear modifications, and monitoring compliance with national laws and the Agreement on the International Dolphin Conservation Program.
Vessel and gear attributes collected	Vessel name, fishing captain, flag, registration number, owner, call sign, number of various ancillary boats, well capacity, diameter of power block, presence of ring-stripper, high-intensity flood lamp, bird radar, sonar, bowthrusters, and helicopter, maximum depth and length of net and dolphin safety panel (DSP), number of strips of net and DSP, mesh size of net and DSP, number of divers.
Information on daily activities collected	Location, time spent in transit, searching, investigating schools or floating objects, setting, in port, etc. Association and method of detection are recorded for each school investigated, environmental data.
Set details collected	Date and time of start of chase, let go, rings up, start and end of backdown (sets on dolphins), and end of set. Species composition, herd size, behaviour, and number and causes of dolphin mortalities. Catch and bycatch estimates. Information on associated seabirds, sharks, rays, billfishes, and sea turtles. Net behaviour and malfunctions. Tag recoveries.
Length and or species composition sampling protocols	Opportunistic length measurements of dolphins, tunas and other bycatch species.
Sampling protocols for other types of sampling	Tuna stomach contents, otoliths and tissue samples have been sampled opportunistically by observers. Dolphin stomach contents, teeth, and reproductive and organs have been collected. Stomach contents of other bycatch species have been collected.

Other data collected	Vessel and helicopter sightings, sightings, interactions with species of special interest (sea turtles, seabirds, sharks, and marine mammals).
Priority of observer activities	Observers are expected to give highest priority to recording and reporting weekly dolphin mortality data and to monitoring AIDCP compliance.
Programme target and actual coverage rates, and sampling design	The AIDCP requires 100% coverage by observers of fishing trips by purse seiners with carrying capacities greater than 363 metric tons (IATTC Class 6) in the Agreement Area. 100% coverage has been achieved from 1993 through 2005, except for 2001, 2002 and 2003 (98%, 99% and 99% respectively).
Observer recruitment criteria, training of observers, and criteria for evaluation of training results	Candidates must have at least a bachelor's degree in biology or related life-sciences fields. They are recruited by personnel at the IATTC's field office stations and evaluated based on academic achievements and communications skills. Those selected engage in a three-week training course in which they are tested and graded with the help of a final exam.
Data collection forms and debriefing	Observers collect data in over ten paper data-set forms. At their return to port, observers are debriefed in one of the IATTC's six field office stations located in Mexico, Panama, Ecuador and Venezuela. After the data have been edited, they are sent to the IATTC's headquarters in La Jolla, California, and stored in a computer. Every year, the national programs and the IATTC exchange electronic data sets to complete their databases. Throughout the process, observer programs exchange preliminary information to obtain close to real-time observance of the fishery.