Col.Vol.Sci.Pap. ICCAT, 25 : 357-376 (1986)

REVIEW OF LEVELS OF SAMPLING IN ATLANTIC FISHERIES FOR TUNAS AND TUNA-LIKE FISHES

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SUMMARY

The levels of coverage in the ICCAT sampling program overall are remarkably good, considering the diversity of species, gears, countries, etc., that must be covered. There is, however, room for improvement. Substantial gaps exist in the coverage, especially for billfishes and small tunas. A survey of current levels of sampling shows several relatively low levels of coverage in sampling for size. A considerable amount of sampling for catch and effort is below recommended levels. The results of a literature search are presented as a bibliography.

RESUME

Le niveau de couverture du programme ICCAT d'échantillonnage est remarquablement satisfaisant dans l'ensemble, vu la diversité des espèces, engins, pays, etc. à couvrir. Il est néanmoins susceptible d'amélioration. La couverture montre quelques lacunes non négligeables, en particulier en ce qui concerne les poissons porte-épée et les petits thonidés. Un examen du taux actuel d'échantillonnage permet de déceler plusieurs niveaux de couverture relativement faibles dans l'échantillonnage de taille. Un volume considérable d'échantillonnage de prise et effort est d'une qualité inférieure au niveau recommandé. La bibliographie ci-joint est le résultat d'une étude des travaux publiés sur ce sujet.

RESUMEN

Los niveles de cobertura en el programa de muestreo ICCAT son, en general, singularmente buenos, teniendo en cuenta la diversidad de especies, artes, países, etc., que es necesario abarcar. Sin embargo, cabe la posibilidad de mejora. Existen importantes lagunas, en especial respecto a los marlines y pequeños túnidos. Un estudio de los actuales niveles de muestreo, señala que algunos de los muestreos de talla son bastante escasos. Una gran parte del muestreo de captura y esfuerzo está por debajo de los niveles recomendados. Como bibliografía, se presentan los resultados de una investigación entre los documentos publicados.

INTRODUCTION

The potential number of samples required to describe adequately Atlantic tuna fisheries is awesome. ICCAT reports catches of nearly 30 species of tunas and tuna-like fishes by more than 30 kinds of gear for over 80 countries. If catch and effort plus size data for all of these categories were to be reported quarterly for four areas, the number of reports annually would be well over 2,000,000. Fortunately not all countries take all species with all gears in all areas. Nonetheless, the number of species, area, etc., categories in the ICCAT Task II data base is now on the order of 500 and increasing.

The matter of appropriate sampling in Atlantic tuna fisheries was an early concern of ICCAT. The first guidelines were established very early in the Commission's history with the publication in 1972 of the first edition of the Field Manual (Miyake and Hayasi). Fonteneau and Soisson (1975) called for theoretical studies on problems of size sampling, such as what lengths should be measured, precision required, stratification, biases, etc., and suggested coordination of work in various organizations and for various species by a central body. They proposed an overall sampling plan to be developed in two phases, first theoretical, then operational.

As Schaaf (1977) pointed out:

> All fishery biologists and... laboratories recognize the need for adequately sampling the catch for size composition. Fishery administrators at the national level also recognize this need and support national programs for size frequency sampling. In spite of this recognized need, there is an extreme paucity of studies of the overall adequacy of sampling designs and programs. The problem becomes glaring and serious at the international level, when scientific committees of international fisheries commissions are... often faced with a potpourri of sampling data collected in various ways...

Hennemuth (1974) stated the problem and its ramifications in a different way:

> Sampling activities and problems pervade the field of fishery research. Hardly any statistics come from complete enumeration or counting. Samples of data form the basis of most population dynamics studies. The statistical literature is replete with the theoretical basis and methods of application. Hardly any statistical subject is better known. It is safe to say, sampling studies are the rarest in fisheries literature. For example, one sampling study, related to estimation of length composition, was done in years of IATTC research on tunas; only in the last year have some sampling studies been reported to ICNAF.
>
> The general neglect of this vital work may be related to a more general problem-- the lack of dedication to routine work for the common good, as opposed to special work of particular interest...

It is evident that ways must constantly be sought to improve, standardize and manage the ICCAT sampling data base.

LITERATURE SEARCH

The Sub-Committee on Statistics recommended during the 1984 SCRS meeting that:

> ...The Secretariat (biostatistician) should study recognized literature in order to find appropriate sample sizes and stratification procedures for each fishery.
>
> (Biennial Report for 1984-85, Part I)

An automated bibliographic search was carried out through the ASFA database maintained by the Aquatic Sciences and Fisheries Information System. Indices cover biology, oceanography and fisheries, among other subjects. Over 150 subject categories are maintained, of which approximately 30 are in fisheries. The earliest material in the Database is from 1975, but complete entries, including bibliographic citations, full content description, and abstracts are available from 1978. Centers in Canada, the Federal Republic of Germany, France, Japan, Mexico, Portugal, United Kingdom, USSR, USA and FAO monitor national and international literature and create input to the Database. Detailed information on the system and a user's guide has been published (NOAA, 1980).

This base was searched for information on sampling in fisheries with the assistance of the Fisheries Information, Data and Statistics Service of FAO, and yielded 95 bibliographic references. (Curiously enough, nearly 60 percent of them were published in Canada.) Copies of the printout of the search are available from the Secretariat.

The few references turned up to sampling in tuna fisheries were all ICCAT papers. It is apparent that ICCAT cannot expect much assistance from outside its own resources in solving tuna sampling problems.

A conventional search yielded over 40 papers related to Atlantic tuna sampling, only two of them published outside ICCAT-- see BIBLIOGRAPHY.

ICCAT-PUBLISHED RECOMMENDATIONS FOR SAMPLING

The second edition of the ICCAT Field Manual (Miyake and Havasi, 1978) sets out as general requirements that size sampling should be stratified:

- By major species
- By fishing gear
- For surface fisheries:
  - 1°x1° (at least 5°x10°)
  - Monthly
- For longline fisheries:
  - 5°x5° (at least 10°x20°)
  - Monthly (at least quarterly)

The Manual points out that the ideal location for measuring fish is aboard the fishing vessel at sea, but that the most common and economical method is to measure fish in port while they are being unloaded. In either case, the selection of individuals to be measured should be random. It recommends measuring about 500 fish for each ICCAT sampling area, quarterly period, and country-gear category, but notes that when variances are small, as in surface fisheries, 200 fish may be adequate.

For longline fisheries, the recommended level is 10 groups of 50 fish each for each time-area stratum, preferably one sample each from 10 vessels.

For surface fisheries, it is recommended that samples of 20-30 fish be taken from a single school, and that each vessel be sampled two or three times from different wells known to contain catches from different schools. About 10 boats should be sampled for each time-area stratum. However, if fish of a wide size range are caught in a single set, the sample size should be increased, e.g., to 50 fish.

The Annex to the Manual makes specific suggestions for size sampling at certain landing points:

Abidjan and Dakar -

Surface - generally 20-30 fish and 2-3 samples per species from each trip. If the length range in the sample is more than 50 cm, a sample of 50 fish is indicated. Recommended minimum level is 15-20 trips per quarter.

Longline - fifty fish per sample. If more than 10 boats are covered, one sample per species and boat. If less than 10 boats, two samples per species per boat.

Buenos Aires, Montevideo, Trinidad, etc. -

Recommended sample for longline fisheries is 100 fish per species per boat for as many boats as possible.

Capetown -

Fifty fish per sample, more than 10 samples/month (multiple samples per boat if less than 10 boats land).

Las Palmas and Tenerife-

Fifty fish per sample; one sample per boat from as many boats as possible.

Tema -

Twenty-thirty fish per sample, 2 to 3 samples per species from minimum 3 to 4 boats per month for each flag.

Sint Maarten-

Fifty fish per sample; one sample per boat from as many boats as possible.

Puerto Rico (transshipped fish) -

If school identification is possible, 3 samples of 20-30 fish for each species for each discharge, from different holds or different schools. For mixed catches, two samples of 50 fish per species at the beginning and end of each discharge.

For sampling of catch and effort, in homogenous fisheries a level of 40-50% is recommended. For heterogenous fisheries, such as many longline fisheries, 60-80% is recommended unless separate rates can be calculated for homogenous segments of the fleet.

The Port Sampler's Manual for the International Skipjack Year (ICCAT, 1981a) advises random sampling for size of a total of 50 fish from as many schools as possible. If the catch is made up of fish of unusually wide differences in size, 70-80 should be sampled. The recommended level of coverage for catch and effort sampling is indicated in the Introduction as 100%.

The Shipboard Sampler's Manual for the International Skipjack Year (ICCAT, 1981b) also advises random sampling for size of of 50 fish unless the catch is made up of fish of unusually wide differences in size and weight. In that case, the sample should be 80 fish. If the catch from a specific school is less than 50, all fish should be measured. The Manual also provides forms for detailed reporting of catch and effort.

RECENT REVIEWS OF NATIONAL SAMPLING PROGRAMS

A "Day to Review Statistics" was held during the 1984 meeting of the Standing Committee on Research and Statistics. A dozen papers describing national sampling methods were presented.

Brazil

Lima and Jablonski (1985) report on data collection systems in Brazil. Information on catch and effort in the baitboat fishery is collected by surveys, since most fishermen do not submit logbooks. Size frequencies for skipjack are collected at the main landing ports, taking as many samples as possible. Size sampling for yellowfin tuna has been initiated.

Catch and effort data are collected from logbooks for the leased/licensed longline fleet. Size frequency data are taken both at sea and at landing points, principally of bigeye and yellowfin tunas, albacore and swordfish. Collection of size frequencies for billfishes other than swordfish is recognized to be insufficient.

Cuba

Garcia Moreno (1985) says that catch and effort data for the Cuban longline fleet and a purse seiner are assembled from daily radio reports. Some adjustments are made after landing. Catch and effort data for the live bait fleet is collected on landing. Trolling vessels and vessels using trammel nets are covered in the same manner.

Size sampling is done on board and at discharge, principally for the live bait fleet. Sport fisheries for billfishes are sometimes sampled as are commercial fisheries in the Cuban EEZ. Trollers and trammel net fisheries are sampled for size only occasionally.

FISM

Diouf (1985) describes the methods used for yellowfin and bigeye tunas and skipjack in the eastern Atlantic for the FISM fleet and for the Spanish purse seine fleet landing at Dakar (16-20 vessels per year in 1982-83). Logbooks collected on a voluntary basis from nearly all vessels, and landing records collected from processing plants are used for basic catch and effort information.

For baitboats, which land mixed yellowfin and bigeye plus skipjack, 50-100 fish are measured for the mixed catch, if possible from a single school.

Sampling for size in the purse seine fisheries is done either at discharge or in the processing plants. A number of fish proportional to the size of the catch is taken, so that the species composition of the sample is representative of the species composition of the catch. Samples are taken from a well which contains fish from a single school or a single set whose position is known. See Cayré (1984) and Pallarés (1984) for discussions of problems and methods for mixed-species landings from French and Spanish purse seiners.

When the fish are frozen in brine, the samples are taken directly from the wells. When the fish are frozen dry, there is sorting by species before landing; this sorting presents a special sampling problem.

Sampling coverage for FISM and Senegalese baitboats in 1982-84 was 40-85 percent, for seiners from 60 to over 90 percent, and for Spanish seiners in 1982-83 over 100 percent.

France

Liorzou (1985) explains the methods used to collect catch and effort and size data in the French fisheries for bluefin tuna and albacore. The fishing effort for bluefin is expressed as the number of trollers and baitboats (cf. Cort, 1985). Size data are collected for the Mediterranean fisheries, but not for the Atlantic fisheries. Size data taken from the comparable Spanish fishery may be an acceptable substitute in the French Atlantic fisheries.

There is close to 100 percent coverage of catch and effort in terms of the number of trips, the length of each trip, and their catches for albacore, fished almost entirely in the Atlantic. Size information is collected by sampling at discharge of the vessels, although the amount of sampling is considered low and should be increased, as well as being expanded to the Basque country.

Japan

Kume (1985) notes that log sheets from which catch and effort data are derived for the Japanese longline fishery are still not submitted by all fishermen. For this reason, some adjustment of the data is necessary. The major change in the fishery has been the use of deep longlines since the late 1970s. The FSFRL started to differentiate these data after 1976. Studies to evaluate the change in efficiency of the longliners using this method are in progress. Most recent size data have been collected by fishermen, and the coverage in recent years has been more intense. The regulation of fishing for bluefin tuna in the western Atlantic has led to a reduction in the number of size samples taken from this area.

Kume points out that the catch and effort data from the Japanese Tema-based baitboat fishery for yellowfin and bigeye tunas must be treated with caution, since there is some inaccuracy in the separation of the species. In the early years, most size data were collected by the Ghanaian sampling program, but starting in 1975 the Japanese fishermen have been required to do at least some size sampling. In many instances, the amount of fish measured has been insufficient and the program not continuous. Intensified on-board size sampling was carried out in 1979-80, and there was also sampling by research personnel in connection with the International Skipjack Year.

Catch and effort data have been collected from the Tema-based Japanese purse seine fishery, which has begun to operate again in recent years. Size sampling was originally conducted by fishermen aboard the vessels, but at present the fishermen are not taking measurements. Some size sampling has been carried out by personnel of the Centre de Recherches Océanographiques at Abidjan.

Korea

Lee, Yang and Lee (1985) review sampling procedures for the Korean fisheries. They note that catch and effort coverage for the longline fishery has improved from a little less than 20 percent in 1975 to on the order of 60 percent in 1981-83. Size sampling is done by fishermen at sea, with about 30 fishes of each species measured on each vessel per month. Sailfish, blue marlin and swordfish have recently begun to be covered. Coverage of catch and effort for the baitboat fishery has been about 60-70 percent in 1980-83.

Portugal

Pereira (1985) describes the procedures used in the Azores. Catch and effort statistics for the industrial baitboat fleet were not satisfactory until 1983, when a logbook system was introduced, with about 30 percent effective coverage. Catch and effort data are not collected for the artisanal fleet.

Size sampling for the industrial baitboat fleet is done in canneries and at cold storage facilities. Measurements are taken two or three times a week at Faial (about 30 percent of the total Azores catch) from one or two boats, at Pico (about 40 percent) once a week, and at São Miguel in the bigeye season, principally April-May, twice a week from one or two boats. Size data for the artisanal fleet are collected during certain seasons at two ports out of more than 50.

Each size sample is of about 50 randomly-selected fish for each species present, or the total catch if the number is less than 50 fish. The size data submitted to the Secretariat group all measurements, wherever taken, by month of capture.

Sampling of the seiners that have been fishing from the Azores since 1982 is done by observers on board. Catch and effort data are collected from each set, and size sampling of all species is done wherever possible also from each set.

Senegal

Cayré (1985) describes the fisheries for sailfish in Senegal, which are prosecuted between June and October by several types of vessels, including sport fishermen. Fishing effort is estimated from the number of trips as described in Limouzy and Cayré (1981). The size distribution for the sport fisheries may be estimated from the size sampling in the artisanal fishery.

Spain

Fernández (1985) reports on the methods used by Spain for its tropical purse seine fisheries. Collection of catch and catch and effort statistics is complicated by the fact that commercial categories are recorded as species. For example, commercially designated "yellowfin" contains bigeye tuna, and commercial small "skipjack" contains variable quantities of small yellowfin and bigeye tunas. Thus it is necessary to correct commercial statistics on the basis of sampling of the catch for species composition (see Pallarés, 1984).

The basic source of data on catches and effort is logbooks. Coverage has been about 80 percent in recent years. Corrections for the amounts of yellowfin, bigeye and skipjack tunas actually caught are made. A new logbook, and insistence that the fishermen record the actual species caught are expected to improve data collection. Effort data as days fishing and days at sea by one-degree square and month are adjusted for the fishing power of individual vessels.

Size data for yellowfin, bigeye and skipjack tunas and for Auxis and Euthynnus have been collected since 1980, both to estimate the species composition of the catch and the size distribution of the species caught. Weighting methods are described.

See under FISM above for collection of data on Spanish purse seine landings at Dakar.

Cort (1985) describes the methods used for collection of data in the Spanish continental fisheries for bluefin tuna by baitboats and handliners, and by traps. Days at sea or man/days at sea are used as the effort unit for the Spanish and French live bait fleets, as recommended by Rodriguez-Roda (1980).

Size data are collected weekly from baitboats in two samples stratified by size at Fuenterrabia for about six percent of the fish caught. Size data as weights are collected in other Atlantic ports. Some size samples are collected at Mediterranean ports.

Santos Guerra (1985) reviews the methods used by Spain in the baitboat fisheries of the Canary Islands for yellowfin, bigeye and skipjack tunas and albacore, as well as bluefin tuna. Catch and effort data are collected at landing points. Sizes are sampled at the processing plants, and a sample of 100-200 individuals is taken whenever possible.

USA

Coan and Bartoo (1985) review the USA sampling. Catch and effort samples have been collected since 1967 for the USA distant-water fleet, usually at Puerto Rico. Coverage is normally 100 percent. To preserve confidentiality, these

catch and effort data are summarized by one-degree square and month before submission to the Secretariat.

Catch and effort data are not collected for commercial coastal fisheries. The recreational (sport) fisheries are expected to increase, and catch and effort data are being collected at tournaments and through intercept surveys. Coverage varies by area, but is generally less than 80 percent.

Size frequencies for the USA distant-water fisheries are collected in a two-stage process as described in Hennemuth (1957) and Sakagawa, Coan and Holzapfel (1976). Samples are taken from random wells in each vessel, and then random samples are taken from each species in the contents of the selected wells. Samples of 10-300 fish were taken opportunistically during 1967-71. A goal was established in 1972-80 of 6 skipjack and 12 yellowfin samples of 50 fish each from each NMFS area, but it was not always achieved. Since 1980 the method has been to take at least one sample of 50 fish for each area and month for each vessel.

Size samples are taken from coastal fisheries for as many fish as possible. Most samples are of bluefin tuna, blue and white marlins and sailfish, with occasional samples of yellowfin and skipjack tunas and swordfish.

Size samples are also taken from imported fish in Puerto Rico. Priority is given to sampling of imports from Tema-based fleets. Attempts are made to sample catch from a single fishing vessel. Sample sizes are 100 fish for yellowfin and bigeye tunas and 50 fish for skipjack and other tunas. Because of sorting at the port of origin, these samples cannot be considered representative of the actual length frequency or species composition of the catch.

The sampling procedures and methods described are considered generally adequate. Some improvements could be made for coastal fisheries.

GAPS BETWEEN SAMPLING AND REPORTING

Wise (1985a, 1985b) mentions the probability that Atlantic tuna sampling data that are collected are not always reported in the ICCAT Task II data base. The systematic transmission as appropriate of sampling data from the point of collection to a researcher's files, to general laboratory files, to national files, and to international files is basically a bureaucratic procedure in which many researchers understandably take not much interest. Nonetheless, the bureaucratic steps are essential if a multi-species, multi-gear, etc., base such as the ICCAT Task II base is to attain maximum usefulness.

It is discouraging in this respect to see that some of the national sampling mentioned in the preceding section is not in the ICCAT base. Examples are catch and effort data for Cuban baitboats, Spanish size sampling of purse seine catches of small tunas, and USA catch and effort data for sport fisheries. Researchers and administrators are urged to see that the necessary bureaucratic procedures are established and followed to eliminate such omissions wherever possible.

COMPARISONS OF RECENT SAMPLING RATES

Details of sampling for size and for catch and effort by species-fishery, country and sampling program for several years are given in Wise (1985a, 1985b). It is difficult to draw general conclusions about the present status of sampling from these reports. Size sampling is detailed for more than 120 species-fishery, country and sampling programs for eight years. Catch and effort sampling is detailed for more than 180 species-fishery, country and sampling programs for eight years. Much of the information, however, is historical documentation of minor species and of lack of sampling.

Tables 1-9 of this paper summarize size and catch and effort sampling for selected countries and sampling programs for recent years (1981-83), for nine major species-fishery combinations. The tables include information published as of ICCAT Data Record 25. Species-fishery combinations for which there has been little or no sampling are not included. Bluefin tuna is not included. Countries selected have an appreciable current catch in the species-fishery in question, and have operated programs for sampling of size and/or of catch and effort.

To reduce the effects of year-to-year variation, mean catch and mean sampling were calculated for the three years. Weighted means for size sampling, and for catch and effort sampling expressed either in weight or in number of fish, for the selected fisheries and countries were calculated and are shown in Tables 1-9. The weighting was done by summing mean sampling and dividing it by total mean catch. The weighted means are:

	Size (fish per ton)	C & E - weight (part sampled/ total catch)	C & E - no. (fish per ton)
YFT (Surf)	.40	.27	-
BET (Surf)	.48	.58	-
SKJ (East)	.53	.33	-
SKJ (West)	.32	.31	-
ALB	2.06	.40	61
YET (LL)	.97	.60	26
BET (LL)	.97	.59	25
SWO	.88	.81	17
BUM	.53	.81	11

Weighted means for size sampling in surface fisheries run from .32 fish/ton (skipjack, west) to .53 fish/ton (skipjack, east). Weighted means for size sampling in longline fisheries run from .53 fish/ton (blue marlin) to 2.06 fish/ton (albacore), but are clustered between .88 (swordfish) and .97 (yellowfin and bigeye tunas). The unusually high weighted mean for albacore is a function of large Chinese catches and the very high sampling rate in the Chinese national program (Table 5). If Chinese catches and sampling are not included, the weighted mean for albacore decreases to .55.

The difference between the overall levels of sampling for size in surface and longline fisheries appears appropriate, since longline fisheries usually capture individuals over a wider range of sizes than do surface fisheries.

Weighted means for catch and effort sampling expressed in weight for surface fisheries are clustered near .30 (30%), with bigeye tuna the exception at .58 (58%). The weighted means for yellowfin and skipjack tunas are below the 40-50% level recommended in the ICCAT Field Manual.

Weighted means for catch and effort sampling expressed in weight for longline fisheries (including all albacore) run from .40 (40%) (albacore) to .81 (81%) (swordfish and blue marlin). Weighted means for longline fisheries for yellowfin and bigeye tunas are close to the lower limit of the 60-80% recommended in the ICCAT Field Manual. Several individual means for albacore are below 60% (Table 5).

Weighted means for catch and effort sampling expressed in number of fish, all for longline fisheries, range widely, from 11 fish/ton (blue marlin) to 61 fish/ton (albacore), although most of them cluster in the range 17-26 fish/ton. The high mean for albacore reflects large Chinese catches plus the very high sampling rates in the Chinese national program, and the even higher sampling rates in the Japanese national program (Table 5).

When the mean size sampling rates for the selected countries in Tables 1-9 are compared to the overall weighted means, certain patterns emerge. The country means compared to the weighted means of sampling for size of individuals are:

	YFT Surf	YFT LL	BET Surf	BET LL	ALB	SKJ east	SKJ west	SWO	BUM
Angola	**	-	-	-	-	-	-	-	-
Brazil	**	*	-	*	-	-	**	0	-
C. Verde	0	-	**	-	-	0	-	-	-
China (Nat)	-	**	-	**	**	-	-	**	**
China (Sec)	-	**	-	0	0	-	-	-	-
FIS	**	-	**	-	0	**	-	-	-
Ghana	*	-	0	-	-	0	-	-	-
Japan (Nat)	**	**	**	**	**	*	-	*	0
Korea (Nat)	0	0	-	0	0	0	-	*	0
Korea (Gha)	**	0	-	-	-	0	-	-	-
Korea (Sec)	-	-	-	0	0	-	-	-	-
Portugal	-	-	**	-	0	**	-	-	-
S. Africa	-	-	-	-	0	-	-	-	-
Spain	0	-	0	-	0	0	-	-	-
USSR	**	-	-	*	-	0	-	-	-
USA	**	-	**	-	-	-	-	-	-
Venezuela	0	-	-	-	-	-	0	-	-

* Within plus or minus 20% of weighted mean
** More than 120% of weighted mean
0 Less than 80% of weighted mean

Japanese national sampling for size is usually above the weighted means, as is FIS sampling. Korean national sampling and other sampling of Korean catches is usually below the weighted means, as are Ghanaian, Spanish and Venezuelan sampling. (The distributions of levels in the columns are not normal because they are comparisons with weighted means.)

Low absolute values (below .3 fish/ton) are:

Yellowfin tuna (surface, Table 1) -
- Korea (national)
- Spain
- Venezuela

Bigeye tuna (Tables 3, 4) -
- Ghana (surface)
- Korea (longline, Secretariat)

Albacore (Table 5) -
- FIS
- South Africa

Skipjack (Tables 6, 7) -
- Ghana
- Korea (national)
- Venezuela

The country means compared to the weighted means of sampling for catch and effort reported in weight are:

	YFT Surf	YFT LL	BET Surf	BET LL	ALB	SKJ east	SKJ west	SWO	BUM
Angola	**	-	-	-	-	-	-	-	-
Brazil	**	**	-	**	-	-	*	*	0
C. Verde	**	-	**	-	-	**	-	-	-
China (Sec)	-	0	-	-	0	-	-	-	-
FIS	-	-	-	-	**	-	-	-	-
Ghana	0	-	0	-	-	0	-	-	-
Japan (Nat)	**	-	0	-	-	**	-	-	-
Japan (Gha)	0	-	0	-	-	0	-	-	-
Korea (Nat)	**	*	-	*	**	**	-	*	*
Korea (Gha)	0	-	-	-	-	0	-	-	-
Korea (Sec)	-	*	-	*	**	-	-	-	-
Portugal	-	-	**	-	**	**	-	-	-
S. Africa	-	-	-	-	**	-	-	-	-
Spain	-	-	-	-	*	-	-	*	-
USSR	**	-	-	**	-	**	-	-	-
USA	-	-	*	-	-	-	-	-	-
Uruguay	-	-	-	-	-	-	-	0	-
Venezuela	0	**	-	-	-	-	0	-	-

* Within plus or minus 20% of weighted mean
** Above 120% of weighted mean
0 Below 80% of weighted mean

Here also there are patterns. Cape Verde sampling is above the weighted means, as are Portuguese and USSR sampling. Sampling of Chinese, Ghanaian (including Ghanaian sampling of Japanese and Korean fisheries), Uruguayan and Venezuelan catches are frequently below the weighted means. (The distributions of levels in the columns are not normal because they are comparisons with weighted means.)

The ICCAT Field Manual recommends a level of 40-50% for homogenous fisheries and 60-80% for heterogenous fisheries, such as many longline fisheries. In these terms, very low absolute values for country means occur for Ghanaian sampling of Ghanaian, Japanese and Korean fisheries, and Japanese national sampling of bigeye, all presently at 10% or lower (Tables 1, 3, 6). Sampling of western Atlantic skipjack fisheries by Brazil and Venezuela is at levels of 20-30% (Table 7).

Other low absolute values for country means are for Secretariat sampling of the Chinese yellowfin and albacore fisheries, at 30%. Sampling of Korean albacore longline fisheries, both national and by the Secretariat, is at 50%. Sampling of Korean bigeye longline fisheries by the Secretariat, Brazilian blue marlin fisheries, and Uruguayan swordfish fishery are at rates of 40-50% (Tables 2, 4, 5, 8, 9).

The relatively few cases in which rates of sampling for catch and effort are expressed in number of fish are:

	YFT LL	BET LL	ALB	SWO	BUM
China (Nat)	*	*	*	*	*
Cuba	0	0	-	0	0
Japan (Nat)	*	*	*	*	*

* Within plus or minus 20% of weighted mean
0 Below 80% of weighted mean

Cuban sampling is clearly below the level of the Chinese and Japanese fisheries, but probably not alarmingly so (Tables 2, 4, 8, 9).

CONCLUSIONS

The ICCAT sampling program is remarkably good overall, especially considering the diversity of species, countries, gears, etc., that must be covered. There is, however, considerable room for improvement. Wise (1985a, 1985b) has called attention to gaps in coverage, many of which are gradually being filled:

1. Four countries whose catches are on the order of 10,000 tons a year or more have little or no coverage-- Italy, Mexico, Panama and Turkey.

2. Sampling of the French-Spanish Bay of Biscay albacore fisheries has not been adequate (but is improving).

3. Coverage of white marlin and sailfish and spearfish leaves much to be desired.

4. Coverage of small tunas is generally poor. These species, although of low commercial value, make up at least 20 percent of the total Atlantic catch of tunas and tuna-like fishes. They are especially important in developing countries as a source of food. Several countries with relatively large catches do little or no sampling: Brazil, Ghana, Mexico, Spain, Turkey, USSR, USA, and Venezuela.

This paper reviews a considerable number of species, fisheries and sampling programs, and compares them with each other and with standards established in the ICCAT Field Manual. Relatively low levels of coverage in size sampling are noted for some species fished by FIS (France, Ivory Coast, Senegal), Ghana, Korea, South Africa, Spain and Venezuela. Weighted mean levels of catch and effort sampling for longline-caught yellowfin and bigeye tunas are close to the lower limit of the recommended range. Several catch and effort sampling programs are operating below the recommended range. Ghanaian sampling of Ghanaian, Japanese and Korean fisheries is presently at very low levels, as is Japanese national sampling of surface bigeye catches.

Greater effort is needed to assure that sampling data that are collected are eventually submitted to the ICCAT Task II data base.

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Table 1 - Yellowfin tuna, surface fishing, sampling for size and catch and effort, and sampling rates, selected countries, 1981-83

	1981	1982	1983	Mean	Sampling rate Size	Sampling rate C & E
Angola						
Catch (tons)	959	1,467	788	1,071		
Size (no. fish)	555	852	50	486	.5	
C & E (weight)	748	1,362	706	939		.9
Brazil*						
Catch (tons)	936	1,004	1,957	1,299		
Size (no. fish)	-	-	757	757	.6	
C & E (weight)	136	453	1,273	621		.5
Cape Verde						
Catch (tons)	877	789	950	872		
Size (no. fish)	359	78	-	219	.3	
C & E (weight)	93	841	950	628		.7
FIS**						
Catch (tons)	51,874	42,537	37,567	43,993		
Size (no. fish)	26,221	28,728	-	27,475	.6	
C & E (weight)	- - - under revision - -			-		-
Ghana						
Catch (tons)	5,510	9,797	7,689	7,665		
Size (no. fish)	1,728	2,916	3,429	2,691	.4	
C & E (weight)	-	631	119	375		.1
Japan						
Catch (tons)	1,701	2,041	2,211	1,984		
Size (no. fish-1)	2,509	-	-	2,509	1.3	
Size (no. fish-2)	2,012	1,295	927	1,411	.7	
C & E (weight-1)	2,301	2,482	2,258	2,347		1.0
C & E (weight-2)	-	313	86	199		.1
Korea						
Catch (tons)	963	387	144	498		
Size (no. fish-1)	178	60	50	96	.2	
Size (no. fish-2)	1,026	1,197	380	560	1.1	
C & E (weight-1)	563	14	104	267		.5
C & E (weight-2)	-	93	19	56		.1
Spain						
Catch (tons)	51,428	54,164	47,290	50,961		
Size (no. fish)	8,419	7,300	-	7,859	.2	
C & E (weight)	- - - under revision - -			-		-
USSR						
Catch (tons)	327	903	1,247	826		
Size (no. fish)	642	852	224	573	.7	
C & E (weight)	92	903	1,247	747		.9
USA						
Catch (tons)	1,866	883	150	966		
Size (no. fish)	859	50	1,069	659	.7	
C & E (weight)	1,636	-	-	1,636		-
Venezuela						
Catch (tons)	3,500	13,942	14,919	10,787		
Size (no. fish)	-	-	-	501	.0	
C & E (weight)	692	1,726	-	1,209		.1
Mean sampling rates weighted by mean catch:						
All sampling except Venezuela					.40	
All sampling except FIS, Spain, USA						.27

*Includes leased/licensed vessels
**France, Ivory Coast, Senegal

Notes:
1. "Size (no. fish)" is number of fish in size samples. For Japan and Korea, "no. fish-1" is national sampling and "no. fish-2 is Ghanaian sampling.
2. "C & E (weight)" is weight of catch that was sampled. For Japan and Korea, "weight-1" is national sampling and "weight-2" is Ghanaian sampling.

Sources:
1. Catches from ICCAT Statistical Bulletin, Volume 14.
2. Weight or number of fish from ICCAT Data Record and ICCAT Statistical Series, various numbers. All FIS, plus Spanish purse seine, size sampling data from Cayré (ICCAT Coll. Vol. Sci. Pap. XXI(2): 102-107).

Table 2 - Yellowfin tuna, longline fishing, sampling for size and catch and effort, and sampling rates, selected countries, 1981-83

	1981	1982	1983	Mean	Sampling rate Size	Sampling rate C & E
Brazil*						
Catch (tons)	1,257	1,034	842	1,044		
Size (no. fish)	1,198	-	757	977	.9	
C & E (weight)	1,052	805	745	867		.8
China-Taiwan						
Catch (tons)	767	540	477	595		
Size (no. fish-1)	1,263	799	3,184	1,749	2.9	
Size (no. fish-2)	185	346	2,031	854	1.4	
C & E (K fish)	16	16	11	14		24**
C & E (weight)	97	95	333	175		.3
Cuba						
Catch (tons)	4,500	3,623	2,360	3,494		
Size (no. fish)	-	-	-	-	-	
C & E (K fish)	98	72	39	70		18**
Japan						
Catch (tons)	4,145	6,062	2,069	4,092		
Size (no. fish)	9,349	7,694	-	8,521	2.1	
C & E (K fish)	112	137	-	125		31**
Korea						
Catch (tons)	6,650	5,872	3,405	5,309		
Size (no. fish-1)	2,185	3,324	1,637	2,382	.4	
Size (no. fish-2)	2,214	1,960	1,811	1,995	.4	
C & E (weight-1)	4,655	2,897	2,132	3,228		.6
C & E (weight-2)	3,948	2,403	2,425	2,925		.6
Venezuela						
Catch (tons)	1,000	484	341	608		
Size (no. fish)	-	-	-	-	-	
C & E (weight)	406	762	-	584		.9
Mean sampling rates weighted by mean catch:						
All sampling except Cuba, Venezuela					.97	
All sampling by weight						.60
All sampling by number of fish						26**

*Includes leased/licensed vessels
**Fish per ton

Notes:
1. "Size (no. fish)" is number of fish in size samples. For China and Korea, "no. fish-1" is national sampling and "no. fish-2" is Secretariat sampling.
2. "C & E (weight)" is weight of catch that was sampled. For China, "K fish" is national sampling in thousands of fish, "weight" is Secretariat sampling. For Korea, "weight-1" is national sampling and "weight-2" is Secretariat sampling.

Sources:
1. Catches from ICCAT Statistical Bulletin, Volume 14.
2. Weight or number of fish from ICCAT Data Record and ICCAT Statistical Series, various numbers.

Table 3 - Bigeye tuna, surface fishing, sampling for size and catch and effort, and sampling rates, selected countries, 1981-83

	1981	1982	1983	Mean	Sampling rate Size	Sampling rate C & E
Cape Verde						
Catch (tons)	13	138	291	147		
Size (no. fish)	48	737	227	337	2.3	
C & E (weight)	1	124	291	139		.9
FIS*						
Catch (tons)	7,588	6,592	7,294	7,158		
Size (no. fish)	3,286	5,522	-	4,404	.6	
C & E (weight)	- - under revision - -			-		-
Ghana						
Catch (tons)	780	791	491	687		
Size (no. fish)	100	85	185	123	.2	
C & E (weight)	-	54	3	29		.0
Japan						
Catch (tons)	1,047	616	49	571		
Size (no. fish-1)	706	-	-	706	1.2	
Size (no. fish-2)	-	-	200	200	.4	
C & E (weight-1)	165	34	23	74		.1
C & E (weight-2)	-	5	1	3		.0
Portugal						
Catch (tons)	3,086	1,861	4,075	3,007		
Size (no. fish)	2,423	1,604	2,119	2,075	.7	
C & E (weight)	2,671	1,765	3,554	2,663		.9
Spain						
Catch (tons)	10,010	9,332	9,332	9,558		
Size (no. fish)	2,475	-	-	2,475	.3	
C & E (weight)	- - - under revision - -			-		-
USA						
Catch (tons)	152	337	224	251		
Size (no. fish)	203	-	-	203	.8	
C & E (weight)	118	-	-	118		.5
Mean sampling rates weighted by mean catch:						
All sampling					.48	
All sampling except FIS, Spain						.58

*France, Ivory Coast, Senegal

Notes:

1. "Size (no. fish)" is number of fish in size samples. For Japan, "no. fish-1" is national sampling and "no. fish-2 is Ghanaian sampling.
2. "C & E (weight)" is weight of catch that was sampled. For Japan, "weight-1" is national sampling and "weight-2" is Ghanaian sampling.

Sources:

1. Catches from ICCAT Statistical Bulletin, Volume 14.
2. Weight or number of fish from ICCAT Data Record and ICCAT Statistical Series, various numbers. All FIS, plus Spanish purse seine, size sampling data from Cayré (ICCAT Coll. Vol. Sci. Pap. XXI(2): 102-107).

Table 4 - Bigeye tuna, longline fishing, sampling for size and catch and effort, and sampling rates, selected countries, 1981-83

	1981	1982	1983	Mean	Sampling rate Size	Sampling rate C & E
Brazil*						
Catch (tons)	463	646	505	538		
Size (no. fish)	360	-	482	421	.8	
C & E (weight)	393	577	448	473		.9
China-Taiwan						
Catch (tons)	1,670	1,900	1,436	1,669		
Size (no. fish-1)	3,565	4,048	9,384	5,666	3.4	
Size (no. fish-2)	50	320	2,225	865	.5	
C & E (K fish)	49	43	28	40		24**
C & E (weight)	1,462	2,296	1,985	1,914		-
Cuba						
Catch (tons)	700	521	385	535		
Size (no. fish)	-	-	-	-	-	
C & E (K fish)	13	10	7	10		19**
Japan						
Catch (tons)	21,044	32,867	15,163	23,025		
Size (no. fish)	28,932	40,126	-	34,529	1.5	
C & E (K fish)	471	702	-	587		25**
Korea						
Catch (tons)	11,682	10,615	9,893	10,730		
Size (no. fish-1)	3,087	2,646	4,506	3,413	.3	
Size (no. fish-2)	2,343	2,250	1,602	2,065	.2	
C & E (weight-1)	7,268	6,603	5,979	6,617		.6
C & E (weight-2)	9,230	4,264	3,017	5,504		.5
USSR						
Catch (tons)	1,681	635	352	889		
Size (no. fish)	651	-	1,012	831	.9	
C & E (weight)	1,681	635	352	889		1.0
Mean sampling rates weighted by mean catch:						
All sampling except Cuba					.97	
All sampling by weight						.59
All sampling by number of fish						25**

*Includes leased/licensed vessels
**Fish per ton

Notes:

1. "Size (no. fish)" is number of fish in size samples. For China and Korea, "no. fish-1" is national sampling and "no. fish-2" is Secretariat sampling.
2. "C & E (weight)" is weight of catch that was sampled. For China, "K fish" is national sampling in thousands of fish, "weight" is Secretariat sampling. For Korea, "weight-1" is national sampling and "weight-2" is Secretariat sampling.

Sources:

1. Catches from ICCAT Statistical Bulletin, Volume 14.
2. Weight or number of fish from ICCAT Data Record and ICCAT Statistical Series, various numbers.

Table 5 - Albacore, sampling for size and catch and effort, and sampling rates, selected countries, 1981-83

	1981	1982	1983	Mean	Sampling rate Size	Sampling rate C & E
China-Taiwan						
Catch (tons)	24,771	33,300	23,756	27,276		
Size (no. fish-1)	53,662	133,768	274,429	153,953	5.6	
Size (no. fish-2)	3,614	12,216	9,197	8,342	.3	
C & E (K fish)	1,488	2,025	1,445	1,653		61**
C & E (weight)	3,214	10,780	11,792	8,595		.3
FIS*						
Catch (tons)	3,841	3,802	2,763	3,469		
Size (no. fish)	1,195	252	-	723	.2	
C & E (weight)	-	-	2,389	2,389		.7
Japan						
Catch (tons)	2,298	1,350	1,344	1,664		
Size (no. fish)	8,227	4,440	-	6,333	3.8	
C & E (K fish)	153	90	-	121		73**
Korea						
Catch (tons)	1,620	1,889	1,077	1,529		
Size (no. fish-1)	292	466	410	389	.3	
Size (no. fish-2)	1,084	2,400	1,118	1,534	1.0	
C & E (weight-1)	671	974	667	771		.5
C & E (weight-2)	909	848	674	810		.5
Portugal						
Catch (tons)	442	321	1,788	850		
Size (no. fish)	1,197	208	1,302	902	1.1	
C & E (weight)	441	117	1,659	739		.9
South Africa						
Catch (tons)	1,856	2,547	2,210	2,204		
Size (no. fish)	-	200	-	200	.1	
C & E (weight)	-	2,546	2,210	2,378		1.0
Spain						
Catch (tons)	22,631	26,156	30,387	26,391		
Size (no. fish)	-	17,298	-	17,298	.7	
C & E (weight)	1,009	10,648	18,725	10,127		.4
Mean sampling rates weighted by mean catch:						
All sampling					2.06	
All sampling by weight						.40
All sampling by number of fish						61**

*France, Ivory Coast, Senegal
**Fish per ton

Notes:
1. "Size (no. fish)" is number of fish in size samples. For China and Korea, "no. fish-1" is national sampling and "no. fish-2" is Secretariat sampling.
2. "C & E (weight)" is weight of catch that was sampled. For China, "K fish" is national sampling in thousands of fish, "weight" is Secretariat sampling. For Korea, "weight-1" is national sampling and "weight-2" is Secretariat sampling.

Sources:
1. Catches from ICCAT Statistical Bulletin, Volume 14.
2. Weight or number of fish from ICCAT Data Record and ICCAT Statistical Series, various numbers.

Table 6 - Skipjack tuna, eastern Atlantic, sampling for size and catch and effort, and sampling rates, selected countries, 1981-83

	1981	1982	1983	Mean	Sampling rate Size	Sampling rate C & E
Cape Verde						
Catch (tons)	1,584	1,564	1,337	1,495		
Size (no. fish)	586	751	-	669	.4	
C & E (weight)	260	1,557	1,337	1,051		.7
FIS*						
Catch (tons)	25,023	28,638	25,715	26,459		
Size (no. fish)	25,530	35,180	-	30,355	1.1	
C & E (weight)	- - - under revision - -			-		-
Ghana						
Catch (tons)	7,858	18,272	24,376	16,835		
Size (no. fish)	1,873	3,738	4,507	3,373	.2	
C & E (weight)	-	2,041	471	1,256		.1
Japan						
Catch (tons)	12,935	9,330	6,002	9,422		
Size (no. fish-1)	5,730	-	-	5,730	.6	
Size (no. fish-2)	5,024	1,600	2,596	3,073	.3	
C & E (weight-1)	11,611	1,368	6,001	6,327		.7
C & E (weight-2)	-	1,026	152	589		.1
Korea						
Catch (tons)	7,538	2,827	1,553	3,973		
Size (no. fish-1)	337	455	149	314	.1	
Size (no. fish-2)	1,448	1,205	345	999	.3	
C & E (weight-1)	5,430	2,139	1,115	2,895		.7
C & E (weight-2)	-	443	132	287		.1
Portugal						
Catch (tons)	2,825	5,530	1,113	3,156		
Size (no. fish)	6,649	2,094	1,132	3,292	1.0	
C & E (weight)	2,369	4,164	891	2,475		.8
Spain						
Catch (tons)	35,458	38,016	33,311	35,595		
Size (no. fish)	10,812	-	-	10,812	.3	
C & E (weight)	- - - under revision - -			-		-
USSR						
Catch (tons)	1,750	3,957	1,223	2,310		
Size (no. fish)	1,574	1,095	105	925	.4	
C & E (weight)	1,750	3,462	563	1,925		.8
Mean sampling rates weighted by mean catch:						
All sampling					.53	
All sampling except FIS, Spain						.33

*France, Ivory Coast, Senegal

Notes:

1. "Size (no. fish)" is number of fish in size samples. For Japan and Korea, "no. fish-1" is national sampling and "no. fish-2 is Ghanaian sampling.
2. "C & E (weight)" is weight of catch that was sampled. For Japan and Korea, "weight-1" is national sampling and "weight-2" is Ghanaian sampling.

Sources:

1. Catches from ICCAT Statistical Bulletin, Volume 14.
2. Weight or number of fish from ICCAT Data Record and ICCAT Statistical Series, various numbers. All FIS, plus Spanish purse seine, size sampling data from Cayre (ICCAT Coll. Vol. Sci. Pap. XXI(2): 102-107).

Table 7 - Skipjack tuna, western Atlantic, sampling for size and catch and effort, and sampling rates, selected countries, 1981-83

	1981	1982	1983	Mean	Sampling rate Size	Sampling rate C & E
Brazil*						
Catch (tons)	13,964	17,922	15,930	15,939		
Size (no. fish)	3,511	4,643	16,305	8,153	.5	
C & E (weight)	2,707	5,117	8,745	5,523		.3
Venezuela						
Catch (tons)	4,900	12,645	13,031	10,192		
Size (no. fish)	-	-	200	453	.0	
C & E (weight)	-	2,517	-	2,517		.2
Mean sampling rates weighted by mean catch:						
All sampling					.32	.31

*Includes leased/licensed vessels

Notes:
1. "Size (no. fish)" is number of fish in size samples.
2. "C & E (weight)" is weight of catch that was sampled.

Sources:
1. Catches from ICCAT Statistical Bulletin, Volume 14.
2. Weight or number of fish from ICCAT Data Record, various numbers.

Table 8 - Swordfish, sampling for size and catch and effort, and sampling rates, selected countries, 1981-83

	1981	1982	1983	Mean	Sampling rate Size	Sampling rate C & E
Brazil*						
Catch (tons)	619	979	754	784		
Size (no. fish)	176	-	506	341	.4	
C & E (weight)	497	790	594	627		.8
China-Taiwan						
Catch (tons)	546	600	410	519		
Size (no. fish)	615	523	1,368	835	1.6	
C & E (K fish)	9	8	5	7		17**
Cuba						
Catch (tons)	400	686	1,228	771		
Size (no. fish)	-	-	-	-	-	
C & E (K fish)	3	10	15	9		12**
Japan						
Catch (tons)	2,233	3,728	1,899	2,620		
Size (no. fish)	1,414	3,334	-	2,374	.9	
C & E (K fish)	39	65	-	52		20**
Korea						
Catch (tons)	447	684	462	531		
Size (no. fish)	-	116	625	371	.7	
C & E (weight)	392	371	296	353		.7
Spain						
Catch (tons)	5,134	5,454	8,422	6,337		
Size (no. fish)	-	-	-	-	-	
C & E (weight)	-	5,453	-	5,453		.9
Uruguay						
Catch (tons)	115	663	1,460	746		
Size (no. fish)	-	-	-	-	-	
C & E (weight)	115	607	-	361		.5
Mean sampling rates weighted by mean catch:						
All sampling except Cuba, Spain, Uruguay					.88	
All sampling by weight						.81
All sampling by number of fish						17**

*Includes leased/licensed vessels
**Fish per ton

Notes:
1. "Size (no. fish)" is number of fish in size samples.
2. "C & E (weight)" is weight of catch that was sampled. "K fish" is sampling in thousands of fish.

Sources:
1. Catches from ICCAT Statistical Bulletin, Volume 14.
2. Weight or number of fish from ICCAT Data Record and ICCAT Statistical Series, various numbers.

Table 9 - Blue marlin, sampling for size and catch and effort, and sampling rates, selected countries, 1981-83

	1981	1982	1983	Mean	Sampling rate Size	Sampling rate C & E
Brazil*						
Catch (tons)	25	36	19	27		
Size (no. fish)	-	-	-	-	-	
C & E (weight)	6	11	12	10		.4
China-Taiwan						
Catch (tons)	202	250	145	199		
Size (no. fish)	223	88	457	256	1.3	
C & E (K fish)	3	3	1	2		10**
Cuba						
Catch (tons)	300	436	396	377		
Size (no. fish)	-	-	-	-	-	
C & E (K fish)	-	3	2	3		8**
Japan						
Catch (tons)	468	1,132	440	680		
Size (no. fish)	132	315	-	223	.3	
C & E (K fish)	5	12	-	9		13**
Korea						
Catch (tons)	126	51	92	90		
Size (no. fish)	-	-	35	35	.4	
C & E (weight)	199	11	44	85		.9
Mean sampling rates weighted by mean catch:						
All sampling except Brazil, Cuba					.53	
All sampling by weight						.81
All sampling by number of fish						11**

*Includes leased/licensed vessels
**Fish per ton

Notes:
1. "Size (no. fish)" is number of fish in size samples.
2. "C & E (weight)" is weight of catch that was sampled. "K fish" is sampling in thousands of fish.

Sources:
1. Catches from ICCAT Statistical Bulletin, Volume 14.
2. Weight or number of fish from ICCAT Data Record and ICCAT Statistical Series, various numbers.