Notice on SEDAR Working Papers

Sampling Procedures Used in the Trip Interview Program (TIP)

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1. INTRODUCTION

The Trip Interview Program (TIP), previously the Creel Survey and Biological Sampling Program (CSBSP), for collecting interview and other fishery-dependent biological and socio-economic data required for fishery management is one of the major components of the region-wide State-Federal Cooperative Statistics Program in the Southeastern United States. The goal of TIP is to obtain representative samples from targeted fisheries. A representative TIP sample is a sample that meets sound statistical criteria for (at minimum) describing removals from a population. The populations are defined by fishery-time-area strata. For practical reasons area is defined here by area of landing, not the fishing area. Agents are assigned target numbers of measurements needed for stock assessment. Sampling targets will be assigned according to the historical landings within the fisheries. Data collected by the TIP program include trip data, landings data, sample data, measurement data, and sex and age data.

Trip data describes the location, fishing mode, fishery type, etc. for each fishing trip. Landings data consist of landings and associated price or value information. Sample data consists either of information for a composite sample (weight and/or number in a box of fish) or describes the kinds and numbers of individual measurements taken. Measurement data are the individual length and weight measurements. Age data consists of measurements required to determine age of a fish and sex determinations.

Trip data is obtained either by the samplers own knowledge or through conversation (interview) with a fisherman or dealer. Landings data is usually obtained from a written sales transaction (logbook, weigh-out or trip ticket) available from a fisherman or dealer. Sample data requires direct interaction with the fisherman (or dealer for composite samples) and observation of the catch. Measurement data requires actual handling of the catch in order to take measurements of individual fish. Finally, sex and age data requires taking fish organs or parts for immediate or subsequent observation or analysis.

An initial step in the data collection procedures is to identify fisheries which regularly land species that are the subject of current assessments or for which assessments are planned. These will be known as ‘Priority Fisheries’ for the purpose of this documentation. Of course, it is desirable to obtain data on all fisheries, but fisheries for assessment species must be prioritized until sampling targets are met. Priority species and associated targets are developed in conjunction with ACCSP and GULFFIN.

In general, sampling is the preferred method of data collection for most kinds of fishery data (including complete sampling or census as an option). Census type collection is sometimes required because the number of respondents is so limited that it is impossible to select a random sample. Levels of sampling are determined by 1) the variability or precision inherent in the data and 2) resources available for data collection. Methods of data collection are determined by 1) cost and 2) reporting burden.

2. PROTOCOLS FOR COLLECTING TIP SAMPLES

The purpose of any sampling plan is to obtain information that is representative of all of the information which could be collected. The sample(s) must be representative in kind (e.g species and size), in quantity (numbers and weight) and of fishery conditions. In many, if not most, instances, fishermen and/or fishing vessels participate in more than one fishery and the choice of fishery or target species and thus the time, location and number of fishing trips may be determined by a complex interaction of factors including:

1) seasonal availability
2) economic conditions
3) management regulations and
4) environmental conditions

Obviously it is not possible to develop a formal protocol which would optimize sampling for all of these dynamic factors simultaneously. In TIP, the goal is to sample fishing trips at random within specified areal-temporal strata so that each vessel or fisherman will occur in the sample in proportion to the fishing activity. Reports will be provided listing landings of the NOAA Fisheries, SEFSC priority species by quarter and gear for the most recent available data. These reports will be on the TIP web site and are also available from the TIP Coordinator. Samplers can refer to these reports when making decisions concerning which areas to focus on. Any considerations which may bias or limit areas of coverage should be documented.

A. Catch, effort and cpue

1. Purpose

Effort and catch per unit effort are quantities that may be used to obtain indices of fishing mortality and stock abundance. These parameters are used to determine fishing effort(f) and is related to fishing mortality (F). For economic analyses, these quantities are translated into operational costs and returns.

2. Methods

Selected trips should be commercial in nature. This means trips which are undertaken solely for the purpose of selling the catch. On occasion samplers will be asked to fill quotas for biological samples. In these cases recreational or fishery independent data may be entered into the TIP database, but it must be properly recorded as such. Trips should be primarily from the priority fisheries. Any time a sampler has left can be directed towards other fisheries.

Information on the landings from a trip may be obtained from the dealer records (trip ticket) or from logbooks filled out by the boat captain or by interviewing the boat captain. Catch (i.e. including area of fishing) and effort information will almost always only be available from the boat captain or representative. Trips sampled for catch, effort and cpue data must be representative of all trips within the reporting period and area.

Trips to be interviewed for catch and effort information (at least 10% for each gear type) should be selected to be representative of the fishing activity occurring within the time period and area. To the extent possible, random selection of trips by size of vessel, fishing area(s), time of landing, etc. should be attempted. Because of the large variability inherent in this data, sampling levels for CPUE should exceed the minimal levels whenever and wherever possible.

Multi-gear and multi-species fishing is becoming more and more common so that real fishing activity is increasingly difficult to define or estimate. In order that the data collected under the TIP program is as unbiased and as informative as is possible, it is important to allocate sampling effort in a scientific or statistical manner. To do so, estimates of the number of fishing trips by gear type should be obtained.

B. Dealer data

1. Purpose

In order to select sampling sites, it is necessary to project landings in that fishery/area/time frame by vessel or dealer. This usually will be done on the basis of historical landings. At the start of the fishing season, the landings from the prior season will be used as a starting point. The rest of the time, the most recent available data will be used. NOAA Fisheries Logbook Data and state 'trip ticket' data are valuable sources of historical landings. Timely knowledge of the sampler will often supersede historical data. The samplers are generally aware of changes in the fishery long before they are reflected in the database. In these instances, samplers should prioritize sampling as best they can. In the TIP, landings, price, size frequency, species identification, age and sex data are obtained for a representative sample of individual trips. In addition, trip data is collected in order:

1) to insure that samples will be representative in both kind and quantity and

2) to provide a method for extrapolating sample numbers and weights to the total fishery(ies).

2. Methods

There are three primary methods of obtaining information on landings and numbers of fishing trips:

a) dealer trip tickets or sales receipts
b) interviews (fishermen or dealer)
c) fisherman logbooks

Except for logbooks and automated sales receipt systems (trip tickets), port agents will be the primary method of data collection for both sampling and dealer information in the TIP.

Fishing trips are classified by the major gear type. This information may be obtained directly from reports (i.e trip tickets) already required by state agencies or fishery management plans, obtained indirectly from dealer records or personal communication or by observations at the landing site. If the fish are listed on the landings records by size or other market category, samplers should include this information here. Samplers should not attempt to assign a market category on their own just because the fish are a certain size. Landings information (lbs. and numbers if possible) are collected on a trip basis by species and market category.

C. Price and value data

1. Purpose

Size and species price information is becoming increasingly important for management, monitoring and analysis. Differential pricing can determine 1) the target species, 2) the fishing strategy, area and depth, 3) return on investment, etc. and is a critical factor in the development of economically based management methods. Prices are dynamic and depend upon a variety of biological, environmental and economic factors whose causes and/or impacts range from local to worldwide. Thus the understanding as well as the anticipation of changes in operations and strategies brought about by management actions or inactions requires broad scale, accurate and up-to-date information concerning the value of fish and fish products in the marketplace.

2. Methods

Price and value by market category and species will be obtained on a per trip basis from a sample of trips within each time-area stratum. In general, price and value information will be obtained at the same time as catch and effort data, i.e. during the trip interview or from the dealer transaction records. Variations in size categories used in commercial fishing transactions exist between and within states.

D. Species composition data

1. Purpose

The commercial landings for most species are obtained from the landings data collected by the port sampler or by voluntary or mandatory trip ticket systems. For certain species groups, the fish house does not break down the landings to individual species. Species groups in which this occurs are snappers, groupers, jacks and porgies. In order to identify the landings of these groups to species, actual sampling of the landings is required. The species composition of these samples may then be applied to the total landings obtained for the species group.

2. Methods

Species composition information may be obtained concurrently with size frequency sampling or separately. In the latter instance, size measurements will usually not be taken for individual fish but the number and/or weight of the sample will be required. All fish in the sample will be keyed to species. Numbers of fish by species and the combined weight will be recorded in TIP. The market category data, i.e. the fish house species group, must be obtained and this information recorded in the landings section of TIP.

E. Size frequency data

1. Purpose

Length frequency distributions are a tool used in the examination or estimation of the detailed structure of the fish population, in particular for estimating its age composition and growth and mortality rates. The length frequency distribution of the landings is estimated by sampling, since it is generally impossible and unnecessary to measure all fish landed. Length frequency distributions are mainly important as the first step in obtaining age frequency distributions, i.e. the numbers and sizes of fish of different ages in the "landings" or in the "gross catch". A series of age frequency distributions for a number of years forms the basis of most analytical assessment models. They are used to establish the growth of the various species of fish, the age structure of the population, the age at which young fish become liable to capture and how quickly the fish die off due to fishing and natural causes.

This kind of information, collected over a long period, is vital to an understanding of fish stocks, including the competitive relationships between different species, the relationship between the size of the adult stock of a species and the number of young produced (year-class strength) and the influence of climatic or other factors on year-class strength. These are the most important long term biological problems in rational exploitation of the sea, but the age and size characteristics are also needed by fisheries managers in order to make decisions on mesh size regulation and the closure of a fishery at certain times of year or in particular areas.

2. Methods and procedures

The location where sampling takes place will vary trip by trip. In the TIP, there are typically two locations involved; the landing dock and the dealer site. Vessels will not always land at the same dock or sell to the same dealer. Dealers may handle landings differently from day to day. The preferred method is to sample the catch at the initial point of off-loading. This is really the only way the samplers can be sure at the time of sampling that they are seeing the entire catch. Sometimes the dealer is this initial point. In other cases, dealer sites can be used as back-up locations only if the sampler has access to the entire catch of a particular species/market category from the trip.

The first step in the sampling procedure is to ensure that the samples taken are not biased. Bias can be introduced by not dispersing the samples taken by time, fishing location, landing location, etc. and by being selective in the individuals chosen for measurement, e.g. the tendency to pick out larger fish. Completely random sampling is often neither feasible nor efficient and more complex procedures such as stratified, systematic and two-stage sampling may be used. In order to effectively utilize other kinds of sampling plans, however, it is necessary to know something about the distribution of the sampling elements (e.g. fishing trips, fish onboard the vessel, fish being offloaded, etc.). When and where the distributions of fishing trips by time and area are generally unknown, numbers of trips will be assumed to be proportional to landings and numbers of trips to be sampled within areas should be determined on this basis.

Although it is preferred that the entire catch of all species from a trip be available for sampling, this is not always possible. Sampling may take place if the agent can be sure he/she is seeing the entire catch of the sampled species/market category for a particular trip. Samplers should not take size-frequency samples of any given species/market category unless the entire catch of that species/market category is available.

Because trip selections are made on a priority basis from the Priority Species List, the emphasis for selecting fish to measure is also related to the Priority Species List. As with trip selection, the fish should be measured to provide data that are as representative as possible of the catch. If fish from a trip are measured to meet biological sampling quotas such as for hard-parts, etc. and are not randomly selected, samplers make sure the data from these trips are clearly labeled in the TIP database as ‘Quota Samples’.

It is possible to introduce bias into the data by not selecting the fish randomly. Samplers attempt to avoid selecting fish in a manner that will introduce biases, e.g., always selecting large or small fish. If the catch is sorted, the potential for size bias is reduced. If possible, the total number and/or weight of the sorted group should be recorded. It is best not to begin taking individual measurements until the sample(s) have been separated from the catch. Having the sample(s) already set aside and under the sampler’s control will facilitate taking the individual measurements. It is not usually necessary to measure all of the fish of the same species from a trip. Measure 30 fish per species or as many as possible up to 30. It is best to follow some simple process like selecting every third or fifth fish to measure in order to avoid non-representative selection. Estimate the number of fish in the catch or sorted portion of the catch, divide by 30 and round down to obtain the order of selection. In the case of large catches, it may be desirable to measure more than 30, but it should not be necessary to measure more than 50 as long as the selection is random (Zweifel, 1988) (see Appendix 1). The emphasis in the TIP is on sampling more individual trips rather than taking a large number of measurements from a few trips; of course, the number of trips available within a set of strata will depend on the fishery. Rare or semi-rare species must however be sampled as the opportunity arises.

In order to extrapolate sample information and to construct size frequency distributions from sorted catches, it is *essential* to obtain both sample and category weights (and numbers if possible). This may be accomplished by 1) weighing the samples) or 2) observing all of the fish within the market category(ies). Since weighing is both difficult and time consuming, observing all of the catch for individual fishermen (for the species of interest) is recommended.

3. Measurements

a. Lengths

For reef fish, samplers will usually measure the total length (TL) of each fish. This is the greatest possible length of the fish with mouth closed and caudal rays squeezed together to give the maximum over-all measurement (see Figure 1). For pelagic species, the fork length (FL) will be the measurement of choice. Fork length is measured from the tip of a fish snout to the "fork" of the caudal fin (see Figure 1). For some reef fish, e.g. those with streamer tails, the fork length will be used. In some cases, standard length (SL) may also be used.

Lengths can be measured (a) by using a measuring board and then recording the data directly on the data form (or a similar form), (b) using an electronic measuring board or indirectly through use of a tape recorder or (c) by punching holes in plastic attached to a measuring board.

4. Other measurements and observations

a. Sex determination

Sex can be easily determined if samplers are allowed to cut open the body cavity. Sex should be recorded along with length *only* if sex can be correctly determined.

b. Stomach and gonad collections

Remove the digestive tract (including the stomach) and gonads by placing the fish on its side or back and by making a shallow cut from the anus to the throat area. Open the body cavity and cut the digestive tract at anus and esophagus. Remove viscera making sure that stomach and gonads are intact and place in a plastic bag with a label. Always include food items that are lodged in the fish's mouth. Store the samples on ice until they can be wrapped in cheesecloth, labeled, and preserved in 10% formalin (1 part commercial formalin, 9 parts water). Labels to be filled out are illustrated in Figure 2.

c. Aging structure collections

Information and materials that must be recorded for an aging sample include all of that stated for stomach and gonad samples. Aging structures include scales, otoliths, spines, and/or vertebrae (special instructions will be given for collecting vertebrae). Aging samples are to be maintained separately because, with most fish species, more time is required to remove, label, and store aging structures than to meet requirements of other types of sampling. For each species, port samplers will be told which structure and how many per size group are to be taken. Unless samplers are instructed otherwise, all scales will be taken beneath the tip of the posteriorly extended pectoral fin (Figure 1); at least 6-10 scales should be taken and stored in a scale envelope (Figure 2). Spines, when required, should be cut at the base (Figure 3) and stored in a scale envelope. Locations of otoliths are shown in Figure 4. There are several ways to remove otoliths. The method will depend on the size of the fish and whether one needs to preserve the appearance of the fish. The following three methods have been used: (1) horizontal cut, (2) vertical cut, and (3) hidden cut.

Horizontal cut: this method is useful for large fish; otolith exposure is accomplished by making a horizontal cut with a sharp knife from the top of the eye posteriorly to the trunk (Figure 4). This can be done more easily by removing the head with a hacksaw or large knife, placing the head on a solid object so that the snout is pointing upward, cut to expose the top of the cranial cavity. Use forceps to remove the two otoliths which are located posteriorly in the otic vesicles on both sides of the cranial cavity (Figure 4).

Vertical cut: otoliths in smaller fish can be removed by making a vertical cut behind the eye near the edge of the preopercle (Figure 4). The otic vesicles should appear as two small cavities on either side of the midline (Figure 4). If they are not visible, shave anteriorly until they appear. Use forceps to remove otoliths.

Hidden cut: this method is used when the external appearance of the fish must be preserved for marketing. The dorsal insertion of the gill arch is cut. The operculum is then lifted and the tissue is scraped away from the otic vesicle (Figure 4). In most fish a slight "bump" will appear in the cranial bone at the outside (distal) surface of the otic capsule. With a chisel gently remove the thin layer of bone. When the capsule is open, a cavity will appear with the white otolith in it. Remove the otoliths with forceps.

5. Preservation of samples

At the end of each day, all samples in plastic bags must be taken out and wrapped in gauze. Permanent labels must be then *securely* attached to the gauze bags. The viscera should be stored in a solution of 10% formalin. Sampling summary sheets should be completed. Labels must also be inserted in vials if otoliths were collected (Figure 2). Before storing each sample, labels for the viscera and aging structures should be checked against the data sheets.

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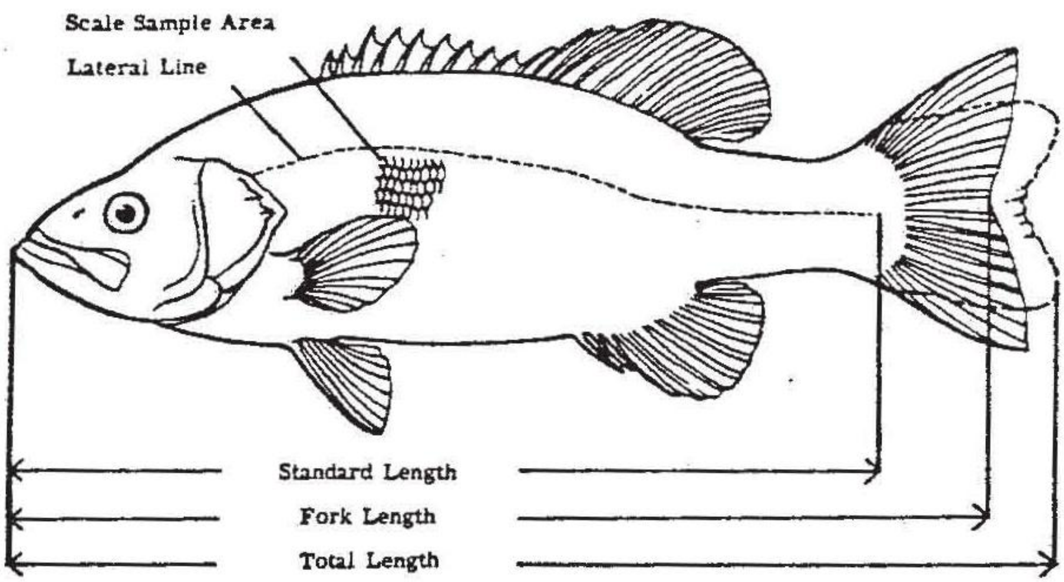

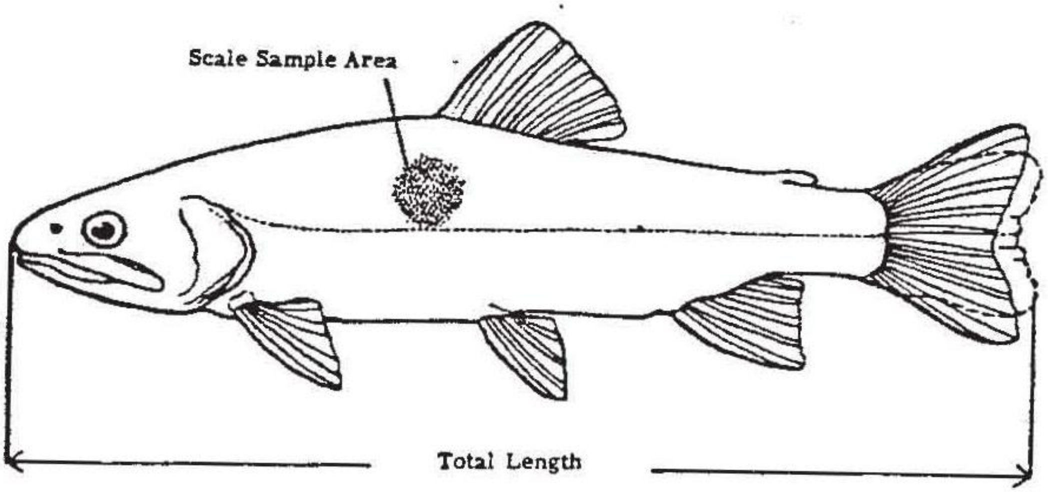

Figure 1. Length types and scale sampling areas.

ENVELOPE LABELS

STATE/ENVELOPE NUMBER	_____ /_________
DATE (MO/DAY/YR)	____ /____/_____
SPECIES CODE	_______________
COUNTY/PORT/LOC.	____/_____/_____
AGE STRUCTURE(S)	SC SP OT
LENGTH INTERVAL/MT	_____-____/_____
WEIGHT/MT	___________/___

OTOLITH AND VISCERA LABELS

STATE/ENVELOPE NUMBER	____/__________
DATE (MO/DAY/YR)	____/____/______
SPECIES CODE	_______________
COUNTY/PORT/LOC.	_____/____/_____

Figure 2. Format for age structure envelopes and sample labels.

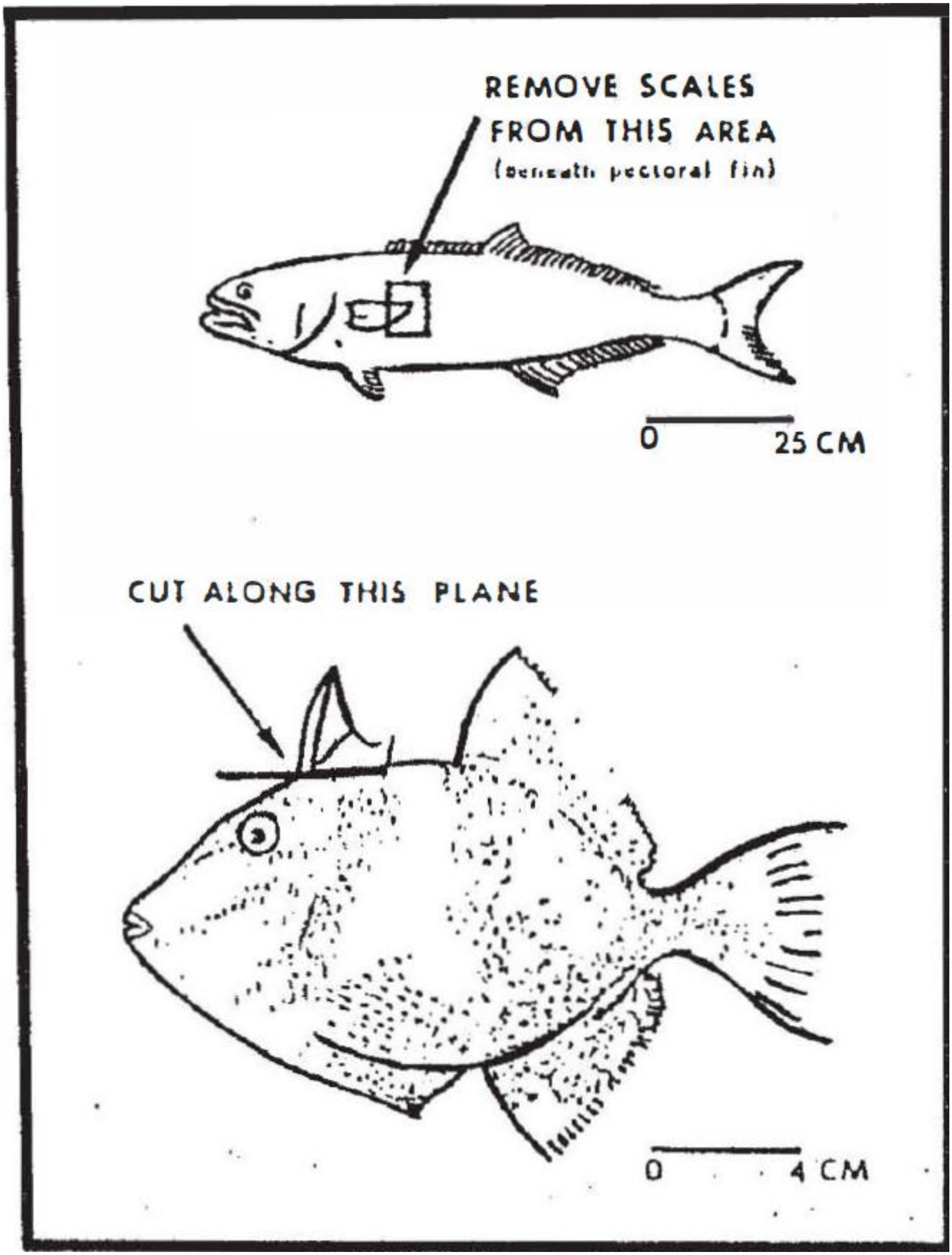

Figure 3. Scale removal area and spine removal method.

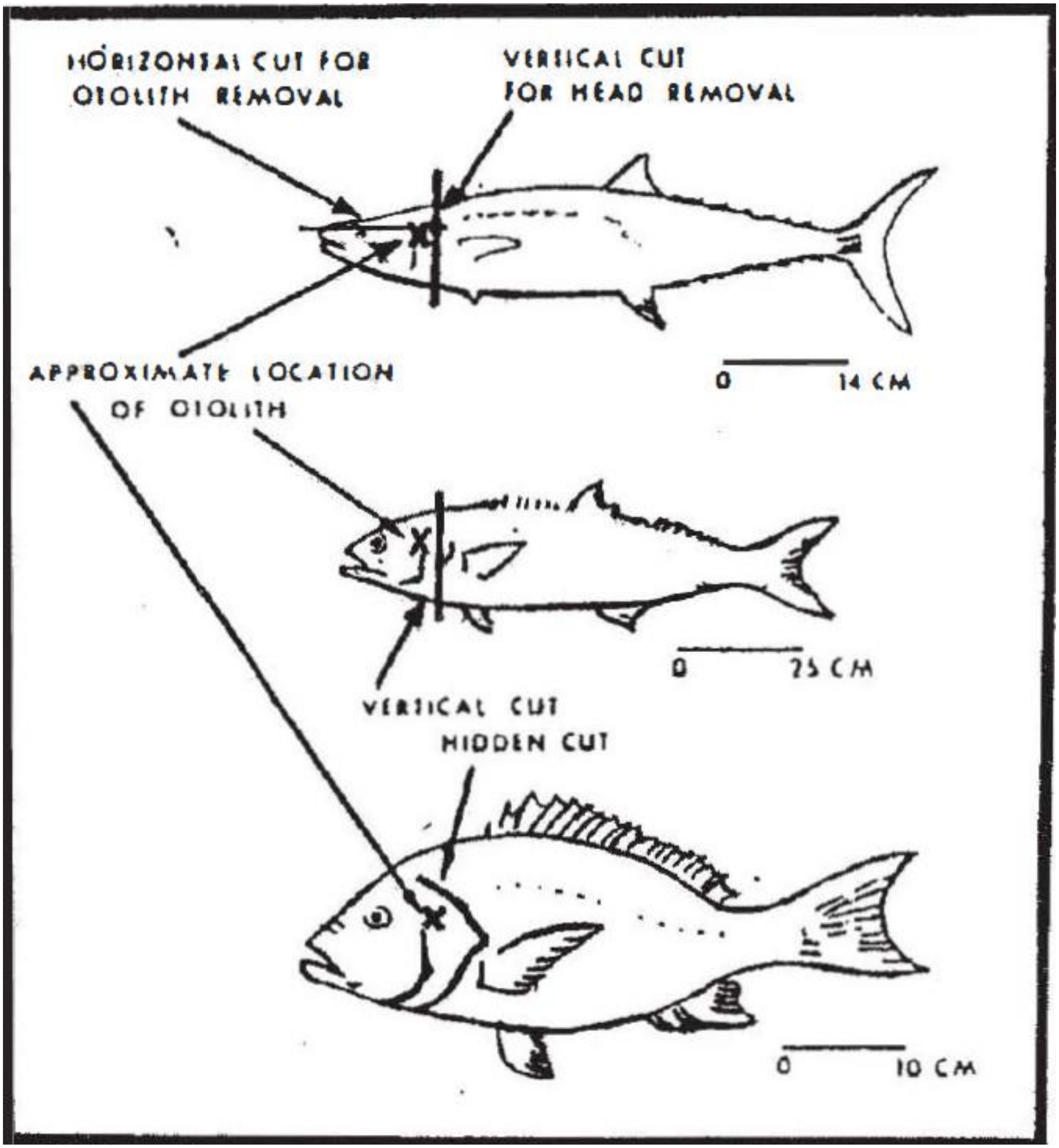

Figure 4. Otolith locations for horizontal, vertical and hidden cut methods of otolith removal.

Appendix 1. SAMPLING ALLOCATIONS (Zwiefel, 1988)

The many uses of size frequency distributions make it difficult to develop or prescribe generally efficient or sufficient sampling numbers, especially when the distributions of interest are composites obtained from samples taken in several time-area strata. Further, in fishery analyses changes in mean size are usually of relatively little interest, i.e. one needs to know if there are fewer large fish, more smaller fish, etc. Also, much of the important or critical stratification e.g. by depth of fishing cannot be done a priori but depends upon angler behavior. Although little evaluation has been done concerning the best sampling strategies, Coan and Bartoo (1983) conclude what is intuitively obvious, i.e. that both accuracy and precision are increased by sampling more vessels or trips but they also found that both accuracy and precision remain nearly constant when the number of fish observed per trip is increased beyond 50. Whatever the variable of interest, simple description of that variable or parameter with a population will be the least demanding on resources. Comparisons of resident populations or stock structure analysis will require at least twice the number of samples as for simple description. The numbers of samples required for age and mortality estimates depend both on the techniques used (e. g. hard parts or modal frequencies) and the assumptions made concerning the stability of the rates of growth and mortality with area and time or age.

Simplistically, required sample size depends on:

1) whether the purpose of the sampling effort is to define populations or monitor or measure changes or differences between populations and
2) whether precision of estimation is required on an absolute or relative scale.

For fisheries, particularly for species which are subject to regulation and management, changes in distributions from year to year or area to area are important especially if the effect of a regulation is to alter or improve the size distribution in relation to maximum or optimum yield.

In fishery work, relative precision is generally acceptable for monitoring management measures such as size regulations and time-area closures because the changes in average size are relatively small over time and area. However, for age and mortality analyses, absolute precision becomes important because change in size with age is sometimes as great as two to three orders of magnitude, i.e. limits of 8 -12 for a 10 cm fish are much more useful than limits of 80-120 for a 100 cm fish.

Also there are some practical or operational conditions which must be considered in addition to the statistical characteristics or inherent variability. For example, given a protocol which requires 20% of the fish landed, it would be difficult to choose a "representative" sample of 2 from 10 fish landed but relatively easy to choose 20 from 100.

Finally, while the management of many fisheries must be a regional rather than a local or state effort, the effects of management measures may be quite localized. Thus it is often necessary or desirable to describe local components as well as the composite whole. This is particularly true for either mobile stocks or stocks whose availability or catchability changes with time or season.

Nevertheless, there are some general phenomena and statistical relationships which can be of help. For many species and fisheries, samples of fish lengths (and weights as well) closely approximate the lognormal distribution in most instances so that inherent variability can be described in terms of the mean and variance of that distribution.

In fact, since the parameters of the lognormal distributions are related to untransformed mean (XBAR) and variance (S**2) by the relationships

$$var(logX) = log[1+(S/XBAR)**2]$$
$$= log[1+CV**2]$$

and $$logxbar = log(XBAR) - var(logX)/2,$$

inherent variability can be described in terms of the mean and variance of the measured lengths. Size frequency data from a variety of sources demonstrates that coefficients of variation (S/XBAR) for fish lengths are almost always in the range 15-25%. Coefficients of variation for fish weight are generally about 4 times as large, i.e. 60-100% and both are remarkably stable over time and area for the same species.

One usual or common method for determining sample size is to prescribe a tolerable coefficient of variation for the sample mean and use the relationship

$$cv(xbar) = S/XBAR/sqrt(n)$$

i.e. $$n = [S/XBAR/cv(xbar)]**2.$$

Since length frequency distributions are skewed, and tail or extreme frequencies of special importance, a more conservative approach is to prescribe a tolerance level for the estimated variance or standard deviation.

Hansen, et. Al (1953 p: 134) give the equation for the relative precision of the estimated standard deviation CV(s) in terms of the Pearson measure of kurtosis or peakedness B i.e.

$$CV(s) = sqrt[(B-l)/4n]$$

from which $$n = (B-l)/4/CV(s)**2 \qquad 1)$$

Patel et . al (1976) provide the formulae for moments of the lognormal distribution from which

$$B = [(W**3-4)*W**3 +3*(2*W-l)]/(W-l)**2 \qquad 2a)$$

where $$W = 1+CV**2 \qquad 2b)$$

Thus for any known coefficient of variation CV = S/XBAR and any prescribed relative precision for the estimated standard deviation CV(s) , equations 1 and 2 can be used to estimated the required sample size.

In Table 1, sample sizes are calculated for CV = .05, .10, .15, .20 and .25 and CV(s) = .05, .10, .15 and .20. For each n, the relative standard error CV/sqrt (n) is calculated and the absolute standard errors SE for the mean and SES for the standard deviation are calculated for XBAR = 10,30,50,70 and 90 cm and 1,3,5,7,9 kg.

Within the ranges for length CV and CV(s), peakedness is only slightly greater than for the normal distribution (B=3), sample sizes vary from approximately 10-300 and the relative standard error varies from 2 to 10% . As noted above, the average CV for most species is about .15 and at this level, 237 fish would be required in order that the coefficient of variation for the standard deviation would be about 5% and the relative standard error would be about 3%. 59 fish would be required for a CV(s) of .10 and a RSE of .05 etc . As shown in Table 1, the sample requirements for weight information are from 2 to 10 times as large as for length, increasing directly with the CV or the kurtosis coefficient B and indirectly with the CV(s).

Since variation due to changes in fishing behavior e.g. fishing different areas and/or depths cannot be predicted and since the primary goal of the sampling program is to obtain representative samples of fish taken in all areas, meaningful quota allocations are difficult. In addition, unusual sampling conditions may require alterations in the sampling protocol. For example, if the catch consists of a very large number of fish, the sampler may find it difficult to obtain a representative sample of 30-50 fish and may want to "over-sample" the catch. The samplers must use their best judgment in these situations but must recognize that a large but biased sample may be more misleading than a smaller one.

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