UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northeast Fisheries Science Center
166 Water Street
Woods Hole, MA 02543-1026

June 14, 2006

MEMORANDUM FOR: AIS Observers

FROM: David Potter
Branch Chief, FSB

SUBJECT: New Sub-Sampling Guidelines and Catch Estimation Worksheet

All observers are being asked to start using the provided guidelines for catch estimation and species composition whenever catches are too large to obtain actual weights. These guidelines were solely developed for trawl fisheries, with the exception of the pair trawl and mid-water trawl fisheries that use the Catch Composition Log to document sub-sampling.

Although these procedures have been improved and simplified, recording how estimations are made is not a new requirement. Observers have always been asked to show how they made catch estimations. The need to provide this documentation has increased over time. Fishermen, Fishery Management Councils and NGO's are all asking how observers make their estimations. Bycatch of non-targeted species is being scrutinized by many conservation organizations. Even though experienced observers are very skilled at estimating catches, it is no longer acceptable to make these estimations without complete documentation.

The worksheet was developed to help organize not only how an observer approaches sub-sample/catch estimation, but how they organize the recorded information. The intent is to make this as easy as possible for both the observer and the data editor. One worksheet should be included with each haul (regardless if the observer sub-sampled or not). Reflected on each of these worksheets is the catch estimation method the observer used on each haul. Certain measurements will not change within a trip (ex; container length and width). These measurements only need to be filled out once with a checkmark included next to the note that reads: "Check here if measurements are same as previous haul except as noted." Any measurements that change (ex; container depth) should be noted on a haul by haul basis.

The present version of the worksheet has gone through many iterations based on comments received during a workshop and three training sessions. Making the process as simple as possible for observers, while still capturing the needed information, was always one of the main goals.

Observers are asked to start using these guidelines and this worksheet immediately, but for the next two months errors will not be a factor when determining bonus eligibility. This does not mean that you should not employ these procedures right away. If you do not provide documentation on how estimations are made, that **will** affect your bonus. The grace period is being given so that all observers have ample time to use these procedures and receive feedback from their data editors if they are having problems. The grace period will be from now until September 1, 2006. At that time sampling/estimating errors will affect your bonus. Once we have had the opportunity to get the worksheet into the field for additional testing, FSB staff will inform observers of the specifics on how this will affect the bonus.

At times there may be legitimate reasons for not sampling/estimating catches. Safety is certainly one of those reasons. There may be others, and for those situations please provide comments. Data editors along with various FSB staff will consider the comments in determining whether or not bonus eligibility will be affected. Tow times, time between tows, catch sizes, weather, etc. will be considered when making that determination. If abusing this becomes a problem by an individual observer, it will be apparent. The idea is that for some isolated situations, no data are better than bad data. Forcing an observer to record something that they are not confident with, just to increase the possibility of obtaining a bonus, was never the intent of that program.

After the "trial period" FSB staff will evaluate how well the worksheet is working. If there are problems that need to be addressed then we will do so at that time. Observers will be asked for their feedback. Please keep in mind that it would be most useful to provide suggestions for changes along with any criticism. You are the people using this new worksheet and these procedures, so you would know best what the problems are and how to correct them.

In this packet you will find the following:
1) General Protocols
2) Catch Estimation Log Protocols
3) Practical Knowledge for Fisheries Observers (Calculation & Catch Estimation Guidelines)
4) Sub-sampling cheat sheet
5) Otter Trawl Haul log with Catch Estimation Log on back (100 copies).

Any questions regarding sub-sampling or the sub-sampling worksheet should to be directed toward Buck Denton at 508-495-2005 or by e-mail at Buck.Denton@noaa.gov.

Thank you.

General Notes for the Catch Estimation Worksheet

- Fill out for each Otter Trawl Haul Log, whether or not the volume to volume method was used. For example, if you have a catch that you can estimate by weighing totes and tote counts, you would still need to check off basket or tote count in the specified field.

- Fill out measurements for the fish bin at least once a trip. If the measurements do not change you do not have to fill this out for each haul.

- The listed species on the Catch Estimation Worksheet and their corresponding extrapolated weights (sub-sample weight multiplied by sample weight multiplier) should be recorded on the Otter Trawl Haul Log (these are all estimated weights).

- Many observers have questioned how to prioritize their sub-sampling, while continuing to do other required work. Sub-sampling and obtaining a more accurate estimate of the catch should be a priority. If you are faced with a haul and you think you can get 20% of the catch, but will not have time to do the required amount of length frequencies (according to Table 2 in the Biological Sampling Manual), it would be more important to obtain accurate weights. Likely in many cases, obtaining 20% of the catch will be difficult if not impossible. In these cases if you can prioritize your method of sub-sampling (i.e. try to get 10% or a reasonable amount of catch depending on volume) and continue to try to obtain lengths and age structures, that would be great. We want to be realistic, but also don’t want to discount the continued importance of obtaining age structures and length frequencies as these are also an integral part of your data collection.

CATCH ESTIMATION WORKSHEET

This worksheet contains detailed information about obtaining and recording catch weight information for sea life and/or debris taken by a trawl vessel. The worksheet also aids in the organization and illustration of the observer's catch estimation methodology and work. The log should be used for **every** haul to illustrate observer work or catch estimation methods. Actual weights are the observer's priority but may not always be possible to obtain. Critically important and managed species of Closed Areas and Special Area Programs have the highest priorities and the observer must take actual weights of these when possible. Therefore, if actual weights cannot be obtained this worksheet is used to organize catch estimation methods.

Sub-sampling coupled with the volume to volume method are tools to help the observer estimate large catches onboard trawl vessels that dump catch on deck. Use frequency of sub-sampling and the volume to volume method will depend on trip type and circumstances. If the catch is pumped the observer should use the Catch Composition Log to estimate total catch weights. The Catch Composition Log is used to estimate total catch weights from catch that occur in very large quantities thus must be pumped.

As part of required work observers must first develop an action plan and must share this action plan with the captain and crew. For example, before fishing operations begin the observer should take aft deck, fish bin and container measurements. Standard measurements for some containers are given (1.47 ft^3 for orange baskets and 2.65 ft^3 for fish totes).

Once the catch is dumped on deck the observer should gauge the size of kept versus discards within the pile. Then if possible to facilitate catch management, the observer should first allow fishers to remove the kept catch. Working with the fishers to separate the catch by catch disposition will make catch estimation work easier. Next, the observer should judge the volume of discards. For example, if discard volume is large and many estimations are expected the observer should estimate total catch weights through a sub-sample. If not, the observer should obtain as many actual weights as time allows according to priority of a species. Before sub-sampling the observer should try to remove few or manageable large and/or small sea life and debris and obtain actual weights. Taking as many actual weights as possible, before sub-sampling, will address priorities (actual weights), make sub-sampling easier (especially when removing larger species first) and reduce inflating weight estimations from choosing fish that occur at low frequencies too often. Consider Figure 1.

The most effective method of obtaining a representative and random sub-sample is to first mix the pile to be sub-sampled to reduce stratification of sea life and debris. The sub-sample volume obtained must be ≥ 20% of the total catch volume. Dividing the catch into a mental grid will facilitate random removal of sub-sample material. The sub-sample portions taken should come from the top, middle and bottom layers of the pile. To aid randomness, a shovel can be used to sort sub-sample material into containers. The goal is to take many small portions from numerous areas of the catch instead of large portions from few areas. Taking catch material from few areas will skew weight estimates. If total weight estimates are too large or small compared to the catch, then the observer introduced bias when obtaining the sub-sample (*i.e.*, sub-sample is too small or not randomly picked) or produced math errors within calculations.

If the volume to volume method is recorded as a catch estimation method then complete fields 4 – 9. Multiply the sub-sample weight by the sample weight multiplier to obtain the total estimated catch weight for the Trawl Haul Log. The weight recorded on the Trawl Haul Log is always an estimate.

Keep calculated and measured figures for shapes, number of sub-sampling containers used, container and sub-sample volumes in addition to the sample weight multiplier to the hundredths place. Do not round these figures. The actual sub-sample weight is recorded to the tenths if necessary as are weights on the haul log. For consistency, round only the final total estimated weight for the haul log because estimated haul log weights must be a whole number unless the estimated weight is > 1 pound (*i.e.*, 0.5 lbs). If the number at the tenths place is five or more round up. If the number is four or less do not round.

If there are insufficient lines on one form for all species sub-sampled in this haul, continue listing species on an additional catch estimation worksheet, making sure to complete all of the Header Information (A-B and 1).

DEFINITIONS

Area (ft^2): The amount of space in a flat surface measured in square units. Recorded in square feet.

Basket or Tote Count (A x B + C): Estimates of kept catch can be calculated by basket or tote counts when the kept is separated by species into containers. [Note: Do not forget to tare or subtract the weight of container used to hold the catch.] To perform this method, take an <u>average weight per container</u> (**A**), multiply this average weight by the <u>total number of containers</u> filled to the same level (**B**) and <u>add any container weight</u> that may be different, *i.e.*, ½ filled container (**C**).

Captain's Estimates: Sometimes due to safety concerns, weather conditions or large catch volumes, the total catch weights can be obtained from the captain. This method should **rarely** be used. Comments must be made as to why this method was chosen.

Catch Depth (D): The actual depth of the catch from which the observer intends to calculate a volume. If catch is first sorted by catch disposition and/or if species and/or debris are removed in order to take actual weights before sub-sampling, the catch depth should be taken afterwards to obtain the actual depth in order to calculate an accurate volume. Record in feet.

Diameter: A straight line that passes from side to side thorough the center of a circular object. Record in feet.

Fish Tote: Commonly known as the 70 liter or 100 lb. fish tote which is the standard for seafood handling in the North Atlantic. Equivalent to fish totes commonly seen in the gillnet fishery. NEFOP standard flush volume of 2.65 ft^3.

Length: Distance from one end to another.

Long Radius (r_2): Long radius is measured when a circular shape is irregular (*i.e.*, ellipse) to obtain an average radius. The long radius is defined as the distance from the center of a circle to the furthest point on the perimeter. Record in feet.

Long Width (W_2): Long width is measured when an angular shape is irregular (*i.e.*, trapezoid) to obtain an average width. Record in feet.
Orange Basket: Equivalent to orange bushel basket commonly seen on scallop and trawl trips. NEFOP standard flush volume of 1.47 ft^3.
Partial haul sampling: A large portion of the haul is sampled or actual weights are taken for a large portion of the haul. The rest of the haul is represented by estimated weights. See Figure1.
Pi (π): The ratio of the circumference of a circle to its diameter. The value of π is 3.14.
Radius (r): The distance between the center of a circle and any point on the circle's circumference. Record in feet.
Sample: A small part of something intended to represent the whole. The fishing vessel obtains the catch or sample. A sub-sample is used by the observer to extrapolate total catch weights from the sample or catch.
Sample Weight Multiplier: Illustrates a comparative numeric proportion that is used to extrapolate total catch weights. Record to the hundredths, figure not rounded.
Short Radius (r_1): Short radius is measured when a circular shape is irregular (*i.e.*, oval) to obtain an average radius. The short radius is defined as the distance from the center of a circle to the closest point on the perimeter. Record in feet.
Short Width (W_1): Short width is measured when an angular shape is irregular (*i.e.*, trapezoid) to obtain an average width. Record in feet.
Sub-sample: A sub-sample is used in lieu of actual weights to determine catch composition and extrapolate the total catch weight of individual sea life and/or debris for a large catch. As a guideline, a sub-sample is random and must represent $\geq$ 20% of the total catch size.
Sub-sampling Container: Any container used to hold a sub-sample.
Tally: Stroke tally is a method where fish of a similar size (*i.e.*, dogfish) are accounted for by taking an average weight and multiplying by the collected tally.
Total Sub-sample Volume: The total volume of the sub-sample. This number is obtained by multiplying the total number of sub-sampling containers collected by the flush volume of the container used (*i.e.*, 10.5 orange baskets x 1.47ft^3 flush). Recorded to the hundredths, figure not rounded.
Volume (ft^3): The amount of three dimensional space occupied by an object. Area (ft^2) x Depth (ft) = Volume (ft^3).
Volume to Volume: Uses a sub-sample from the catch, two comparative volumes, a sample weight multiplier and actual weights from sorted sea life and/or debris within a sub-sample to calculate total catch weights of sea life and/or debris. Can be combined with actual weights (*i.e.*, partial haul sampling) or other catch estimation methods (*i.e.*, basket or tote counts) to illustrate total catch weights and catch composition on a haul log.
Weighed (Actual): An actual weight taken of sea life and/or debris of a particular fish disposition code and catch disposition by NMFS issued scales.
Whole haul sampling: The sample size is the entire haul or the haul log consists of all actual weights.
Width (W): The greatest dimension at right angles to length or depth (height). Record in feet.

INSTRUCTIONS

For instructions on completing fields **A-B**, refer to the Common Haul Log Data section of the NEFOP Manual.

1. **HAUL #:** Record the haul number associated with this Catch Estimation Worksheet.

2. **CATCH ESTIMATION METHOD:** Record the method used to estimate total catch weights of sea life and/or debris for this haul by placing an "X" next to the appropriate code:

   1 = Weighed (Actual)
   2 = Volume to Volume
   3 = Basket or Tote Count
   4 = Captain
   5 = Tally
   8 = Combination, record all catch estimation methods on line 2A.
   9 = Other, record the catch estimation method on line 2A. Illustrate why and how this method was used in the comment section of this worksheet.

3. **CATCH SHAPE, MEASUREMENTS & VOLUME:** Record the catch shape and measurements for this haul by placing an "X" next to the appropriate code. Record each measurement in feet and calculate all measurements or the total catch volume as cubic feet. Use the appropriate equation to calculate the volume.

   1 = Rect./square
   2 = Trapezoidal
   3 = Triangular
   4 = Circular
   5 = Oval
   8 = Combination, record all catch shapes on line 3A
   9 = Other, record the other catch shape(s) and measurements on line 3A

   NOTE: An observer might encounter a combination of shapes. Irregular shapes can be divided into simpler shapes to make calculations easier. Record all calculations, measurements and shapes used in the comment section of this worksheet. Add all shape volumes to obtain the total catch volume. Record all measurements and calculations in the comment section.

   NOTE: "D" means catch depth not bin height. Likewise if sea life and/or debris are removed first before sub-sampling take the catch depth measurement afterwards.

   NOTE: Note that catch depth is not a constant but record an "X" on line 3B if catch measurements are same as the previous haul.

4. **# SUB-SAMPLING CONTAINERS USED:** Record the number of sub-sampling containers used to the hundredths place if necessary (*i.e.*, 10.25), do not round this number. Record when volume to volume is used as a catch estimation method.

   NOTE: Remember to subtract or tare the container weight used to organize the subsample

NOTE: If a fish bin is used to sort a sub-sample this is considered one sub-sampling container.

NOTE: If sub-sampling containers are not available or a fish bin, *i.e.*, the sub-sample is organized on deck and circular measurements are taken, record a dash (-) in the field.

5. **VOLUME SUB-SAMPLE CONTAINER:** Record the volume of the sub-sampling container used to organize the sub-sample by placing an "X" next to the appropriate code. Record when volume to volume is used as a catch estimation method. Record in cubic feet (ft^3) and to the hundredths place if necessary. Do not round this figure.

   1 = 1.47 ft^3 (Orange basket)
   2 = 2.65 ft^3 (Fish tote)
   9 = Other (ft^3), record the volume of any other sub-sampling container on line 5A in cubic feet.

NOTE: The volume of the sub-sample container is equal to the volume of the sub-sample flush to the wall of the container. However, if a fish bin is used to organize a sub-sample *i.e.*, containers are not available, record the volume of the sub-sample in the fish bin on line 5A and place an "X" next to other. If no containers are available, record a (-) in the field.

6. **TOTAL SUB-SAMPLE VOLUME:** Calculate the total volume of the sub-sample used for this haul. Record when volume to volume is used as a catch estimation method. Record in cubic feet (ft^3) and to the hundredths place if necessary. Do not round this figure.

7. **SAMPLE WEIGHT MULTIPLIER:** Calculate the sample weight multiplier used to estimate total catch weights. The sample weight multiplier is calculated by dividing the total catch volume by the total sub-sample volume. Record when volume to volume is used as a catch estimation method. Record to the hundredths place if necessary. Do not round this figure.

8. **SPECIES:** Record all species and/or debris of a particular fish disposition and catch disposition code within the sub-sample. The estimated weight of sea life and/or debris on the catch estimation worksheet should mirror what is recorded on the trawl haul log. Record when volume to volume is used as a catch estimation method.

9. **SUB-SAMPLE WEIGHT (LBS):** Record the actual weight of a species or debris sorted from the sub-sample by fish disposition code and catch disposition. Record in pounds and to the tenths place if necessary.

COMMENTS

Record any additional information associated with this log (*i.e.*, description of irregular shapes or other shapes, other catch estimation methods, safety concerns or time constraints).

Using Combination of Catch Estimation Methods

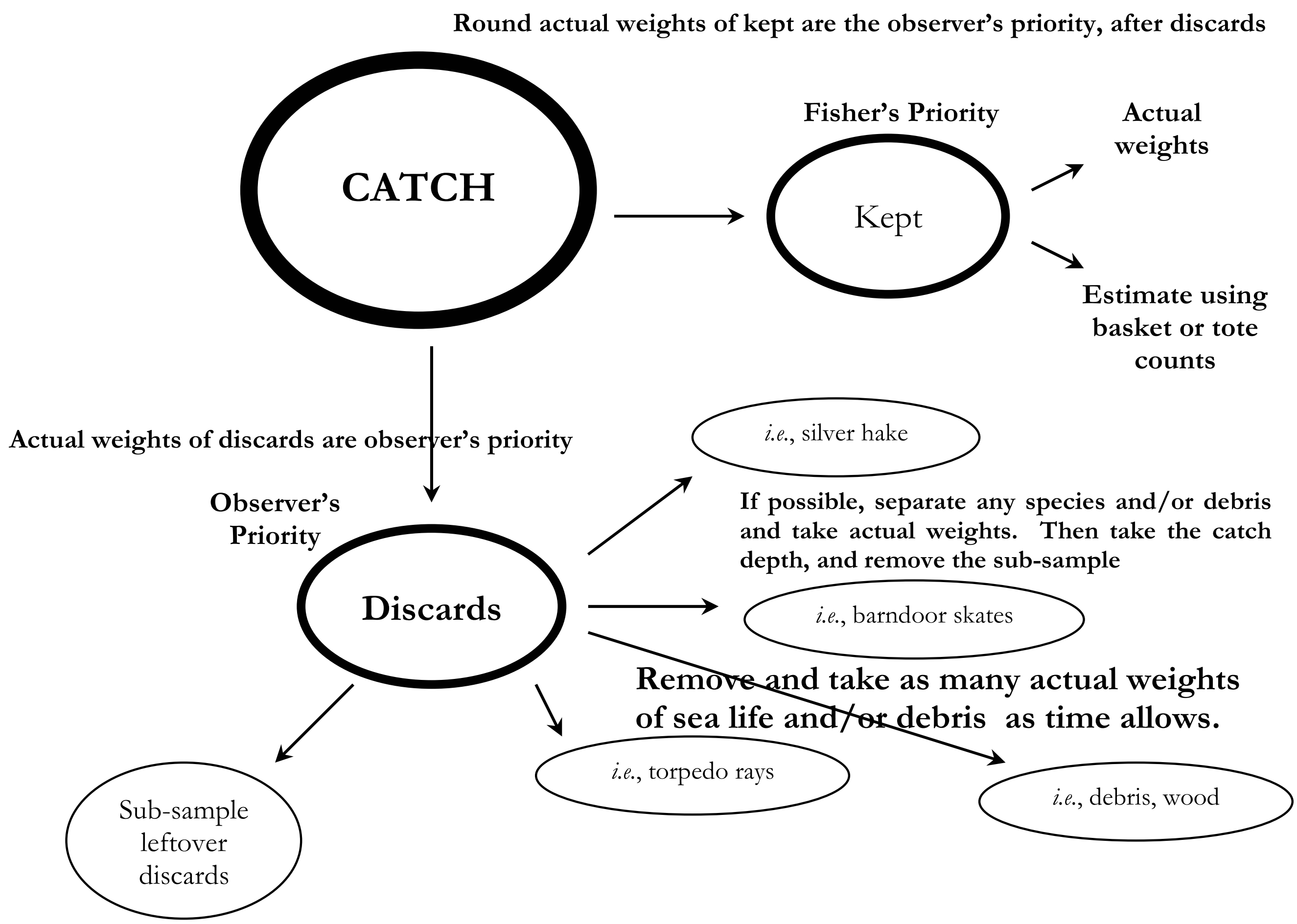


Figure 1 shows a schematic diagram of partial haul sampling

Formula	Other Shape
πr^2 x D	Bucket, cylinder
r_1 x r_2 x π x D	Ellipse (Oval)
$[(W_1 + W_2) \div 2]$ x L x D	Oblong-Shaped Oval
L x W x D	Milk Crate

Table 1.

Table 1 illustrates other shape formulas

CALCULATION, CATCH ESTIMATION, & SAMPLING GUIDELINES

Practical Knowledge for Fisheries Observers

INTRODUCTION

Due to the nature of commercial fishing vessel practices, it can be difficult for fisheries observers to obtain actual or the most approximate estimated weights to illustrate the catch composition. Therefore, the purpose of this document is to give advice on how to obtain actual weights, the most approximate estimations possible and when necessary, how to extrapolate weights by volumetric measurements. This document also provides guidance on how to conduct approved catch estimation techniques and manage the catch onboard commercial fishing vessels. The information collected and presented in this document was obtained by reviewing and updating past Northeast Fisheries Observer Program (NEFOP) information on catch estimation, implementing recommendations put forth by observers via an in-house workshop on catch estimation in addition to a literature review of journal articles and of other observer manuals. The catch estimation techniques discussed can be implemented in a variety of fisheries including, gillnet, longline, scallop dredge and trawl as appropriate.

In addition to estimating the catch, observers must collect biological samples from the catch. Biological sampling includes collecting actual weights, age structures, and length frequencies. These data are very important information gathered and recorded by observers. Therefore, it is crucial that the samples and weights collected and recorded by observers are representative of the haul being observed. Any non-randomness or bias that is introduced when sampling affects the quality of data collected. Bias can easily arise from a sampling scheme, which is not systematically executed.

To eliminate bias completely, all fish caught would be sampled. Sampling all sea life (as required) and/or taking all actual weights of everything occurring in a haul is known as **whole haul sampling**. However, due to the nature of commercial fishing practices and the environment, which these practices occur, whole haul sampling can be infeasible and impossible so obtaining a **subsample** is sometimes necessary to extrapolate total catch weights. According to Heales *et al* (2003), "with large trawl catches, subsampling is often the only cost effective or feasible way to describe the bycatch composition". Contrary to whole haul sampling, partial haul sampling includes sampling of some sea life (as required) and/or taking some actual weights of some things occurring in a haul is known as **partial haul sampling**. Appendix IV illustrates partial haul sampling.

By first collecting area and volumetric catch measurements in addition to a random subsample and using a simple mathematical method called Volume to Volume, total catch weights can be extrapolated as an estimate. Since these estimates are extrapolated, the observer must take accurate measurements and perform correct calculations in addition to working up a random and representative subsample. It is equally important for observers to understand how to work successfully alongside fishing vessel operations and know how to manage special scenarios that may arise if they are to quantify and sample the catch accurately.

BASIC CALCULATIONS

1. Calculating Surface Area & Volume

Observers must routinely take measurements and perform calculations of the **surface area** and **volume** of containers where the catch is dumped (*i.e.*, **fish bins**). In addition, the observer must calculate the volume for the container or **subsampling container**, which they use to organize their subsample. Appendix II illustrates some examples on how to calculate the surface area and volume of some shapes and containers observers might encounter. Some standard flush volumes are given for containers commonly encountered on commercial fishing vessels.

***Note** – Observers must know the **order of operations** when completing a mathematical formula. It is required to first complete what is in brackets [ ] and/or parenthesis ( ); exponents first then multiplication and division from left to right, then addition and subtraction from left to right.*

2. Calculating Surface Area (ft²)

To calculate surface area for angular objects two measurements must be taken – length and width. However, for circular objects the radius must be measured in addition to using Pi π (3.14) to complete the calculation. It is easier to measure the **diameter** and ÷ 2 to find the radius.

3. Calculating Volume (ft³)

The surface area (two-dimensional) multiplied by a **height** in feet (one dimension) gives the three dimensions needed to calculate volume. Therefore, to calculate the volume, multiply the surface area by the **catch depth** or height. If the depth is inconsistent or multiple depths occur, the observer must take an average depth.

***Note** – It is important to calculate the catch volume within the fish bin. Therefore, the catch depth is needed and not the fish bin height, when making volumetric calculations and estimating total catch weights, unless the catch evenly fills or flushes the fish bin completely.*

4. Examples Illustrating Surface Area and Volumetric Calculations

Appendix II illustrates some examples of surface area and volumetric calculations. To obtain the catch volume occupied within the shapes the observer needs to measure the catch depth within the fish bin. To obtain the subsample volume, the observer should measure the depth of the subsample within the subsampling container. Volumetric standards of flush containers commonly used (orange bushel baskets and fish totes) are given in Appendix II. These standard volumes are given to save the observer time.

CATCH ESTIMATION GUIDELINES & METHODOLOGIES

***Note** – NEFOP is an accountable and transparent program and must remain so through documentation of how observers obtained their estimates. Therefore, the observer must document how their estimates were obtained, whether extrapolating through the Volume-to-Volume method or obtaining using basket or tote counts (approximate estimations) or tallying or combining methods, documentation is very important in maintaining the quality of data collected and managed through NEFOP.*

1. The Catch

Fishers process the catch by deciding which species to keep and which to discard (**target species** versus **non-target species**; however, non-target species can be kept too). The observer sorts the catch by species, then into a **catch disposition** (K/D) and **fish disposition code**. The observer's priority is to obtain **actual weights** of the **discarded** portion of the catch, then obtain round actual weights of **kept** species. Sometimes the catch is too large. Therefore, the observer must estimate the **total catch weight** of sea life and/or debris through a subsample of the catch or by using other catch estimation methods (*i.e.*, basket or tote counts). It is possible for the observer to combine catch estimation methods to support their work.

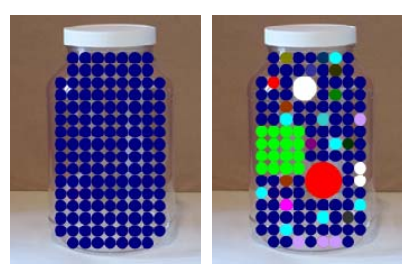


Figure 1 – The figure illustrates homogeneity versus heterogeneity. The jar of marbles to the left is uniform or

homogeneous while the jar of marbles to the right illustrates many diverse marble types in addition to stratification thus heterogeneity.

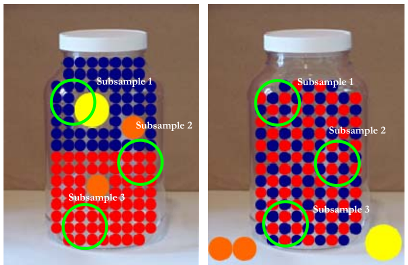


Figure 2 – The figure illustrate the importance of being **random and representative** when taking a subsample. In this example, mixing the marbles and removing the few occurring marble types provides a better way to estimate the composition of marbles via actual measurements (removing the few and counting them) and then taking a subsample after mixing occurs. Removing few occurring species and mixing the catch before subsampling will help avoid over extrapolation and provide a more representative subsample when compared to the actual total catch.

2. The Observer's Options Prioritized

The observer's priority is actual weights of discards followed by round, actual weights of the kept catch. However, sometimes it is difficult to obtain actual weights because the catch is too large, time constraints occur, rough weather arises or other safety concerns. Observers have the following methods or tools (listed by priority or preference) to help them record total catch weights (these methods may be combined):

→ Actual weights
→ Basket or tote counts (approximate estimations)
→ Stroke tally method (approximate estimations)
→ Volume to volume method (extrapolated estimations)
→ Visual estimates (observer's visual estimates based on previous experience of working with actual weights; should be used during special circumstances only)
→ Captain's estimates (vessel estimate)
→ Cumulative sum weight method (situation dependent)

3. Catch Estimation Methodologies

Obtaining all **actual weights** is the observer's number one priority. An actual weight means a complete weight account of an identical grouping of a particular species of sea life or debris occurring in a haul. One individual left out of an **identical grouping** (*i.e.*, same species, catch disposition and fish disposition code), in a haul for any reason (*i.e.,* tossed over by a fisher), will make the total catch weight an estimate. If all individuals are accounted for in an identical grouping then the weight is actual. The observer must use their NMFS issued scales only to take weights of sea life and debris.

Using the **basket or tote count method** provides an **approximate estimation**. An approximate estimation differs from an estimation derived through subsampling in that the entire catch or catch of a species is explicitly accounted for as opposed to extrapolated. An example of an approximate estimation is when all individuals of a certain species (in addition to catch disposition and fish disposition code) are sorted in baskets (*i.e.*, kept scallops). The observer obtains an average basket weight by weighing at least three baskets (or more) and averaging the weight. The observer then counts the number of total baskets and applies the average weight. Since the observer did not actually weigh all the baskets, the weight is an estimate but it is a very approximate estimate, as opposed to a mathematically extrapolated estimate calculated from a subsample. This spatial basket sampling is very effective at producing highly approximate weight estimations.

In some situations aboard commercial fishing vessels of the Northeast and Mid-Atlantic regions, it will not be possible to obtain approximate estimations. In these situations, the observer must subsample the catch in an effort to obtain catch composition estimations for the total catch.

When using the basket or tote count method, the observer should not forget to tare or subtract the container weight used to hold the catch. For the observer to perform the basket or tote count method, (**A x B + C**), they should take an average weight per container (**A**); multiply this average weight by the total number of containers filled to the same level (**B**). Then if necessary, the observer should add a container weight (**C)** that is different (*i.e.*, ½ filled container). The observer can refer to the *Biological Sampling Manual* under "Catch Estimation Guidelines" for an illustration of this method.

TOTAL ESTIMATED WEIGHT BASED ON BASKET OR TOTE COUNTS = Average Weight per Tote (lbs) x Number of Totes Filled to the Same Level and Same Species + Any Tote Not Full (lbs)

Sometimes it may be necessary for an observer to use the **stroke tally method** as a catch estimation tool. This method is commonly used in the gillnet and longline fisheries, however it may be employed in other fisheries when appropriate. As a guideline, 20% or more of the total stroke tally should be represented as actual weights, then an average weight can be calculated and multiplied by the total tally, thus a total estimated catch weight can be approximated. However, it is often impossible to know what quantity will be available to equal 20% or more. Therefore, as a further guideline, if the lengths and weights of an individual species to be tallied are very diverse then the observer should try to obtain as many fish as possible. However, if catch diversity is lower or the sizes are less diverse then less fish will be needed to obtain an approximate estimation but the observer should still try and obtain as many fish to sample as time allows. The observer should always try to obtain as many fish randomly to represent the average weight.

In the longline fishery, if the observer knows the total number of hooks in a tote (*i.e.*, 350) then the observer can take 20% of the total number of hooks (*i.e.*, 350) to calculate that 70 fish or more should be randomly sampled and used to obtain an average weight to calculate the total estimated catch weight of an identical grouping. Some bias may occur during stroke tallying. For example, while the observer is sampling a fish, other fish may be processed quickly by the fisher thus not tallied or noticed by the observer. The observer can ask the captain and make notes in the comment section otherwise the observer should position him or herself so the catch can easily be reached and be ready to multitask and be quick.

TOTAL ESTIMATED WEIGHT BASED ON TALLY OR CENSUS = Average Weight per Species x Total Number of Individuals Tallied or the Census

When the observer cannot obtain an approximate estimation, they should subsample the catch in an effort to obtain extrapolated weight estimations for the total catch. After obtaining a random subsample, the observer calculates an **extrapolated estimate** by using the **Volume to Volume Method**. Section 10 on "calculating catch weights using the volume to volume method" gives an example.

The observer can use **vessel estimates** for specific situations. For example, if the haul is unobserved the observer should only record kept catch information on the Trawl Haul Log. On the reverse Catch Estimation Worksheet, "captain's estimates" should be checked off as the catch estimation method used. Some other examples of when an observer may use the captain's estimate includes when estimating weights for large objects or fish such as a rock or basking shark or for specific reasons when the catch composition sampling method is employed (see Catch Composition Log instructions in the NEFOP Fisheries Observer Program Manual). The use of the captain's estimate should be a rare event in most fisheries except when the Catch Composition Log is being used.

Visual estimates are the least preferred option for obtaining weights but are sometimes the only option available. Visually estimating should be used during special circumstances only. Such circumstances include accounting for seaweed, which may be attached to the fishing gear, very large items such as rocks in addition to very fine or unevenly distributed items such as sand and clay. The observer should not visually estimate sea life or debris, which can be weighed or estimated by employing one or more of the approved catch estimation methods.

Most often, it is appropriate for the observer to combine catch estimation methods. Combining catch estimation methods is very common but all methods must be recorded and detailed in the comments section or in the Catch Estimation Worksheet. If other method is used, the observer must thoroughly document how the catch was estimated.

The **Cumulative Sum Method** is a method that allows for the cumulative actual weight for kept and/or discarded yellowtail flounder and the cumulative count for the number of bushels of kept scallops during observed hauls when deckloading occurs. This method should be used for kept and/or discarded yellowtail flounder in addition to kept scallops during observed hauls when deckloading occurs instead of the subsample estimation process. Refer to section ten under "Special Scenarios" of this document for directions to complete Cumulative Sum Weight Method specifically for Scallop Access Area trips requiring tally sheets.

Kept and/or Discarded Yellowtail Flounder: The cumulative actual weights for yellowtail flounder is a sum of actual weights obtained during observed hauls only when deckloading occurs. This value will be obtained by the observer setting aside all yellowtail flounder for each observed deckloaded haul. The observer will then obtain an actual weight for all the yellowtail flounder (sorted by disposition code) after the deckloading period has concluded. Observers use the cumulative actual weight to obtain an estimated weight of the kept and/or discarded yellowtail flounder that is represented on the Scallop Haul Log by dividing the total weight equally amongst the participating deckloaded hauls. The final weight recorded on the Scallop Haul Log is an estimated weight. Observers are to calculate the Cumulative Sum Method by using the Catch Estimation Worksheet.

Kept Scallops: The cumulative count for the number of bushels of kept scallops must be an actual number of bushels obtained during observed hauls when deckloading occurs. This value will be obtained after the observed deckloading period has concluded and the observer can count the total number of bushels of kept scallops on deck. There are two methods allowed when dividing the total sum equally amongst participating hauls. The first method is to multiply the cumulative count of kept scallop bushels by the average weight of those bushels to obtain the cumulative estimated weight. Observers use this cumulative estimated weight to obtain an individual haul estimated weight of kept scallops by dividing the total weight equally amongst the participating deckloaded hauls. Another option for observers is to initially divide the **cumulative count** of kept bushels onto the participating hauls and then multiply the number of bushels of kept scallops by the average weight of those bushels to achieve the estimated weight for each participating haul log. The final weight recorded on the Scallop Haul Log is an estimated weight. Observers should comment on the process on the corresponding haul log's Catch Estimation Worksheet.

Note – *For Scallop Access Area trips requiring Tally Sheets, NEFOP allows for the cumulative actual weights for kept and/or discarded yellowtail flounder weights and the cumulative count for the number of bushels of kept scallops over the entire deckloading period of observed hauls. Scallop Access Trips and Open Area Trips that do not require Tally Sheets are only allowed to use the cumulative count for the number of bushels of kept scallops over the entire deckloading period of observed hauls.*

4. What is a Subsample?

The total catch taken by the fishing vessel from the ocean is synonymous to a sample. A subsample is used in lieu of actual weights or approximate estimates to determine catch composition and extrapolate the total catch weight of sea life. According to Heales *et al* (2003) "with large trawl catches, subsampling is often the only cost-effective or feasible way to describe the bycatch composition [but] how well these subsamples represent the total catch depends on how diverse the catch is, how well the catch is mixed before the subsamples are taken, and what proportion of the catch is taken as a subsample."

Since the Northeast and Mid-Atlantic marine areas contain much lower marine diversity when compared to tropical regions, a **random** subsample of ≥ 20% of the total catch size is needed to get the most accurate extrapolated weight estimates as possible. Obviously, the larger the subsample from the sample and more care taken to facilitate randomness, the more accurate the estimations and representative the subsample will be to the total catch.

***Note** – When observers take their subsamples, they should fill or flush the container(s) used to hold their subsamples with mixed species taken randomly throughout the catch. Afterwards, observers must sort each species and take an actual weight according to catch disposition and fish disposition code. Next observers must use the actual weights from their subsample and the Volume-to-Volume method to estimate the total catch weights for the sea life found in their subsample. Observers should not forget to tare or subtract the container weight, otherwise over-extrapolation will occur.*

Figure 3 – An example of an orange bushel basket flushed with fish and not heaped. Fishers often heap the catch.

5. Advice on How to Obtain a Random Subsample

It is important for an observer to take a random subsample to eliminate bias thus obtain the most accurate extrapolated weight estimates as possible. Therefore, each fish from the entire catch should have an equal chance of being selected for the subsample. No favoritism is given to exceptional fish (*i.e.*, particularly large or small fish) as it must be equally likely that these and the typical members will be chosen. Repeated random sampling over time will provide representative catch data. Here are a few tips to help observers take a random subsample:

→ In order to achieve a random sample, the observer should find a position that will enable them to reach all fish as opposed to only some. This is necessary since the catch can separate by size during trawling or within a pile. To further eliminate bias the catch can be mixed if the observer shuffles through the pile

→ The observer should collect subsamples throughout the pile. The greater the catch diversity or species composition or range of fish sizes, the greater the number of subsamples (or the larger the subsample) that will be needed to represent the total catch

→ When selecting individual fish, the observer should choose them in a systematic and non-calculated manner, until an adequate subsample size is obtained

→ The observer should **always** remove few large or small fish and/or debris of an identical grouping first and take actual weights. By taking as many actual weights as possible before subsampling, the observer will reduce introducing bias into their weight calculations.

→ If available, the number of subsampling containers used should be relative to fish size and catch volume. Consequently, catches with all or mostly small fish require less subsampling containers and catches with large fish require more subsampling containers

→ The observer should take the largest subsample from the catch as possible (time and conditions permitting). As a rule, the observer must obtain a subsample that represents at least 20% or more of the total catch size. If the observer obtains less than 20% they must comment on the circumstances

***Note –** The observer can calculate how many baskets or totes 20 percent or more equals. For example:*

Total catch of 100 ft^3 x 20% = 20 ft^3, which needs to be removed randomly to give an adequate subsample size. To figure out the number of orange bushel baskets needed to represent a 20 ft^3 subsample consider:

20 ft3 ÷ 1.47ft3 = 13.60 or 14 orange flush bushel baskets will be needed to represent a little more than 20%.

NUMBER OF SUBSAMPLING CONTAINERS NEEDED TO REPRESENT 20% = [Total Catch Volume x 20%] ÷ Flush Volume of Subsampling Container Used

→ The observer should take their subsamples from the top, middle and bottom layers of the pile since the catch can stratify. The observer can mix the catch by shuffling through the catch

→ The observer can collect their subsamples from multiple areas of the catch. They should try to collect many, small portions for their subsample. Collecting many small portions is superior to collecting portions that are few and large. The observer can divide the catch into a mental grid and take many small portions throughout.

→ The observer can use a shovel if available to help them scoop up their subsample. A shovel is superior to hand collecting. For example, when an observer collects scallops for length frequencies human nature tends to grab the largest or "best looking" scallops. Therefore, dividing the catch into a mental grid and shoveling scallops throughout the catch pile and the catch depth is superior then just hand collecting.

→ Once the subsample is speciated and weighed, it must be extrapolated to the entire catch mathematically by using the subsample and total catch volumes, actual weights sorted from the subsample and Volume to Volume Method.

→ If estimated weights seem too large due to unintentional bias, the observer should comment. The observer can compare estimates with the captain and record the captain's estimates as a note in the comment section of the Catch Estimation Worksheet or haul log.

→ The observer should always check for potential bias and math errors before, during and after their work

6. Handling the Catch

The observer will encounter five typical working scenarios when trying to estimate the catch or illustrate the catch composition:

→ The observer can **let fishers sort the kept catch first** then **get actual weights of the discards**. Afterwards, the observer can get as many actual weights of the kept catch as possible and/or estimates by using the basket or tote count method. *(i.e., large volume of kept with a small volume of discarded species)*

→ The **observer can subsample from the entire catch thus** their subsample will contain both catch dispositions (kept and discarded). *(i.e., large volume of kept and discards* *with time constraints occurring)* For this option, the observer will need the cooperation of the captain and crew, which will require good communication as the observer will need to remove the subsample before the crew begins sorting. Otherwise, bias will be introduced into their weight estimates. Furthermore, the observer should pay attention to the catch disposition of the species in their subsample. Sometimes if the kept species are large, they can be hard to manage into a subsampling container; therefore, it is perhaps best to let the fishers sort the kept catch/species first. Observers may subsample from both catch dispositions and then compare their extrapolated kept estimations (via the Volume to Volume Method) with estimations based on the Basket or Tote Count Method. Observers often note significant differences between the two weight estimates because the weight estimate derived from the Basket and Tote Count Method is an approximate estimation while the estimation derived from the Volume to Volume Method is extrapolated. It can be difficult for the observer to obtain a representative subsample from larger catches. As a result, it is best to let the fishers remove the kept first. <u>The observers should ask the fishers not to toss discards overboard</u>.

→ The <u>**observer can estimate the kept catch by the Basket or Tote Count Method**</u> when the kept is separated by species into containers. This provides an approximate estimation. (*i.e., large volume of kept species, although in some circumstances, if baskets are available and time allows, this method can be used for discarded species such as dogfish or skates, which occur in large quantities)*

→ The <u>**observer can get all actual weights**</u> – the observer's priority (*i.e., small to medium sized catches, time dependent)*

→ <u>**Observers can**</u> let fishers start sorting the kept catch first then begin getting actual weights (*i.e.*, removing few occurring or large species first) and/or <u>**subsample to extrapolate estimates of the discards**</u>. Afterwards, the observer can get actual weights of the kept catch (*i.e., large volume of discarded species with a small volume of kept species)*

Figure 4 – This photo illustrates a very large volume of discards (skates and starfish) with very few kept species. Although, the catch is large, it is not very diverse when compared to other trawl catches of other areas. Leveling the catch in the fishbin once the net is on the reel or is fished again is necessay in this situation. In the above situation subsampling is probably the only cost effective means to describe the catch composition due to time and commercial fishing vessel practices. The fishers may choose not to work the catch due to few or no kept catch being avaliable. The observer can obtain some actual weights (for few occuring species) if possible and/or subsample the catch to extrapolate estimates (depending on time). The observer must show <u>all</u> of their work on the Catch Estimation Worksheet.

Figure 3 – This photo illustrates a large volume of kept (haddock) but a small volume of discards (skates, longhorn sculpins) therefore it should be possible to obtain all actual weights of discards but depending on the kept volume and time, the kept may be estimated by using the basket or tote count method or actual weights collected. The fishers will remove the kept portion of the catch for the observer since the kept is the fisher's priority. The observer must show <u>all</u> their work on the Catch Estimation Worksheet.

7. How the Observer Can Determine Kept Versus Discarded

The observer's subsample might contain both catch dispositions (*i.e.*, kept and discards). To determine kept versus discards the observer should consider:

→ The observer can put their subsample in a separate area and have the captain and/or crew sort the kept and discards for them
→ The observer can show questionable species to the captain or a crew member and ask if the species in question will be kept or discarded
→ If possible, the observer can use one of the crew's measuring boards or paddles, which have tick marks to illustrate catch disposition based on regulations for a particular species. The observer should take great care as not to get confused when using this tool. In addition, the observer should record what the captain and crew are doing thus not introduce subjectivity into the data collection. For example, if an observer knows that the crew is keeping undersized fish and the observer has taken measurements, they should not question the crew's intentions but record the data as is.
→ If the disposition code is unclear for certain species (*i.e.*, 012 versus 002) the observer should ask the captain or crew why they are discarding or keeping the species in question

8. Guidelines for Working the Catch

Here are some basic guidelines the observer must consider before working any catch:

→ The observer should determine how they will manage the catch. They should discuss with the crew their action plan. If the observer communicates their action plan when the catch is on deck, it is too late.

Figure 5 – The observer should allow the fishers to remove the kept portion first as this will help them work both the discarded and kept portions of the catch easily. After working the discards, observers can get actual weights of the kept and/or obtain estimates by using the basket and tote count method. Based on an observer's actual measurements, they can subtract the total kept volume (after fishers sort) from the total catch volume to obtain the total discarded volume. Observers can use standard container flush volumes to help them calculate the total volume of kept. For example:

(10 flush orange bushel baskets of haddock x 1.47 ft^3) + (8 flush orange bushel baskets of winter flounder x 1.47 ft^3) = (14.7 ft^3) + (11.76 ft^3) = 26.46 ft^3 = Total Kept Volume

Therefore:

Total Discard Volume = 45 ft^3 – 26.46 ft^3

Total Discard Volume = 18.54 ft^3

Total Discard Volume = Total Catch Volume – Total Kept Volume

→ The observer should determine their appropriate formulas and obtain all relevant measurements before the first haul begins (*i.e.*, subsampling container, fish bin and deck area measurements or dimensions…*etc*)
→ If possible, the observer should evenly spread the catch pile before measuring the catch depth in the fish bin or obtain an average depth
→ The observer should be in the pile and be mentally and physically flexible
→ Practicing good time management in addition to multitasking skills is an essential tool when observing. For example, if haul back is consistent throughout the trip, the observer should know this schedule and work with and around it

- → The observer needs to determine how they will handle the catch (*i.e.*, separate it by catch disposition, obtain actual weights, extrapolate estimates through subsampling, combine catch estimation methods…*etc*)
- → The observer should always remember to subtract or tare the container weight with which they collect their subsample before making calculations. Not doing so will inflate their weight estimates
- → The observer should carry a tool to measure the catch depth
- → The observer must do their calculations and illustrate their methodology on the Catch Estimation Worksheet located on the back of their Haul Log. Observers cannot substitute another worksheet such as a spreadsheet to show their work
- → Due to the nature of commercial fishing practices and the need to obtain unbiased data the observer must work hard. When the crew is working the observer should be working but they should not hinder the crew's clean up. However, an observer should not be on deck when vessel gear is in motion
- → The observer should adapt protocols and learned material as appropriate to their real world situation but must **comment** on their processes and their methodology on the Catch Estimation Worksheet

9. Scales

For management purposes, it is important for the observer to get real actual weights and the most approximate estimates as possible. Therefore, it is important to use scales that work properly. Fishers may check an observer's scales or ask if the scales are calibrated. To help observers maintain their scales they must consider this advice:

- → For every haul the observer should make sure their scales sit at zero, if not the observer should make adjustments so it reads at zero
- → Scales can be tested with a known weight like a bushel basket or alternatively the observer can carry a certified weight in their observer kit to test scale accurateness
- → The observer should consistently or constantly oil their scales and keep them wrapped in a somewhat oily rag thus away from the salty corrosive ocean air
- → The observer needs to send in their scales to their contractor every six months for replacement or recalibration
- → If possible, the observer should carry and properly store an extra set of scales for emergencies

10. Calculating Catch Weights Using the Volume to Volume Method

Note – *The observer should never use an estimated weight to calculate an estimate. The observer must use an actual weight via subsampling to extrapolate an estimate.*

To estimate a total catch weight for a particular species using a subsample and the Volume to Volume Method the observer must calculate the total catch volume within the fish bin, total subsample volume collected, and a **sample weight multiplier**.

Consider this example of the Volume to Volume Method:

- → **Fish bin = 6.2 ft (L) x 4 ft (W) x 2 ft (D)**
- → **Catch depth = 1.5 ft**
- → **Number of subsampling containers flushed with random catch material = 6 orange baskets**
- → **Volume of the subsampling container = 1.47ft^3 (the NEFOP standard volume of an orange basket flush with subsampling material).**
- → **For this example, the 6 sorted orange baskets resulted in the following actual weights (container weight already subtracted):**

5 lbs	**Redfish**	**kept (100)**
11 lbs	**Pollock**	**kept (100)**
42 lbs	**Witch FLD**	**kept (100)**

38 lbs	Am. Plaice	kept (100)
27 lbs	White Hake	kept (100)
8 lbs	Am. Lobster	kept (171)
1 lb	Jonah Crab	discarded (001)
1 lb	Sea Raven	discarded (001)
14 lbs	Little Skate	discarded (001)
200 lbs	ATL Cod	kept (100)
90 lbs	Haddock	kept (100)
10 lbs	Haddock	discarded (012)
35 lbs	Sea Scallops	kept (100)

***Note** – To be consistent and eliminate error when making calculations the observer should round to a whole number **after** making all calculations when performing the volume to volume method. Therefore, during the calculations the observer must keep the numbers to the hundredths place and not round. The observer must drop all numbers to the right of the hundredths place and not round. However, the observer must round the final number if necessary. The total estimated catch weight must be a whole number since estimated haul log weights must be whole unless the number is less than one.*

To round the final number, the observer must find the rounding digit and look at the digit to the right. If the digit is less than 5, they should not change the rounding digit but drop all digits to the right of it. If the digit is greater than or equal to 5, the observer should add one to the rounding digit and drop all digits to the right of it. This rule was created to "break the tie" when you are rounding a number that is exactly between two other numbers. These kinds of rules are called "conventions" and are important so we all get the same answer when doing the same problems.

a. **First, the observer must calculate the *total catch volume within the fish bin*. This means the observer will need the catch depth within the fish bin not the total fish bin height unless the catch is completely flush within the fish bin.**

Depth measurements must be precise. For example, if the kept catch is removed first and then few small and/or large fish and/or debris are further removed from the discarded portion (to take actual weights of); the observer must take the catch depth afterwards to obtain an actual catch depth. Otherwise, estimated catch weights will be inflated when extrapolated.

TOTAL CATCH VOLUME (ft^3) = Total Catch Area (ft^2) x Average Catch Depth (ft)

Example

L x W x D (6.2 ft x 4 ft x 1.5 ft) = 37.2 ft^3

***Note** – Once the kept catch is arranged in baskets and/or totes the observer can use the given flush volumes for orange bushel baskets or fish totes (1.47 ft^3 or 2.65 ft^3 as necessary) to obtain a total kept volume. The actual total kept volume can be subtracted from the total catch volume (kept and discards included) to calculate the total discarded volume if the observer is doing the Volume to Volume Method based on separating the catch by catch disposition. The observer should keep in mind fishers often heap the catch in bushel baskets thus the volume will not be the standard flush volume given for orange bushel baskets or fish totes. Furthermore, the fishers may not use baskets or totes at all. The observer must take note of the situation and make the necessary adjustments to their calculations. Observers can take the heaped portions of a container and place in another container to make their calculations easier. Observers must show all calculations and measurements on the Catch Estimation Worksheet. If observers remove any discards to take actual weights, then the method of subtracting volumes described above cannot be used since the total discard volume will change from the action of removing sea life and/or debris first to take actual weights from before subsampling, unless what was removed can be expressed as a volume. However, large fish and debris can be difficult to manage in containers. See figure 9.*

b. **Next, the observer must calculate the *total subsample volume*. The total subsample volume is equal to the number of subsampling containers taken to organize your subsample multiplied by the volume of the subsampling container used. The observer must make sure all subsampling** containers are flush and contain the same amounts of material or volume, if not observers must make the proper adjustments in their calculations

TOTAL SUBSAMPLE VOLUME = Number of Subsampling Containers Used x Subsampling Container Volume

Example
6 baskets x 1.47 ft^3 = 8.82 ft^3

Note – *The observer can divide their total subsample volume by the total catch volume to get a percentage of how their subsample compares to the total catch volume. For example:*

8.82 ft^3 ÷ 37.2 ft^3 = 0.2371 x 100 = 23.71% of the total catch volume is represented by the subsample

c. Third, the observer needs to calculate the ***sample weight multiplier***. The sample weight multiplier is used to extrapolate the total catch weight for each species. To obtain the sample weight multiplier, the observer must divide the total catch volume within the fish bin by the total subsample volume taken.

SAMPLE WEIGHT MULTIPLIER = Total Catch Volume ÷ Total Subsample Volume

Example
37.2 ft^3 ÷ 8.82 ft^3 = 4.21

Note – *The lower the sample weight multiplier the higher the percentage the observer's subsample volume represents to the total catch volume. A large sample weight multiplier indicates a subsample that is comparatively small to the total catch volume. Therefore, inaccurate catch estimations are likely to occur when a comparatively small subsample is used to extrapolate weights, especially if species diversity is great. Bias estimations will cause the observer to inaccurately describe the catch composition. The sample weight multiplier also illustrates the volumetric percentage the subsample compares to the catch. For example, a multiplier of 2 indicates that 50% of the catch was subsampled*

For example:

PERCENTAGE OF TOTAL CATCH SUBSAMPLED = TOTAL CATCH VOLUME ÷ TOTAL SUBSAMPLE VOLUME

37.2ft^3 ÷ 18.6 ft^3 = 2 multiplier
18.6 ft^3 ÷ 37.2ft^3 = 0.5 x 100 = 50%

d. Last, the observer needs to calculate the ***total catch weight of each species***. To do this, the observer must multiply the ***actual weight*** of each species in their subsample by the sample weight multiplier. The observer must <u>remember to always subtract or tare the container weight used to organize their subsample.</u>

The observer needs to round the final calculation for two reasons. First, it is standard to round the final calculation. Second, since the observer is estimating, they need a whole number to represent the weight for the haul log so they must round the final total estimated catch weight as necessary. The example below is already rounded.

OBSERVER TOTAL CATCH ESTIMATES = Speciated Actual Weight x Sample Weight Multiplier

Example

5 lbs	Redfish	x 4.21 =	21 lbs
11 lbs	Pollack	x 4.21 =	46 lbs
42 lbs	Witch FLD	x 4.21 =	177 lbs
38 lbs	Am. Plaice	x 4.21 =	160 lbs
27 lbs	White Hake	x 4.21 =	114 lbs
8 lbs	Am. Lobster	x 4.21 =	34 lbs

1 lb	Jonah Crab	x 4.21 =	4 lbs
1 lb	Sea Raven	x 4.21 =	4 lbs
14 lbs	Little Skate	x 4.21 =	59 lbs
200 lbs	ATL Cod	x 4.21 =	842 lbs
90 lbs	Haddock	x 4.21 =	379 lbs
10 lbs	Haddock (012)	x 4.21 =	42 lbs
35 lbs	Sea Scallops	x 4.21 =	147 lbs

Note – *It is important to note that the Volume to Volume Method should be used to estimate large trawl catches or when other catch estimation tools are not feasible to employ. If a large catch is dumped in sections out of the trawl, the catch composition method may be used to illustrate stratification and extrapolate weights. The larger and more representative the subsample, the more accurate the observer's extrapolated estimations will be. Therefore, the Volume to Volume Method should be reserved for large catches when many estimated weights are expected, otherwise the observer should get actual weights or use other methods and comment. Observers can separate the catch by catch disposition (kept versus discarded) and combine catch estimation methods or take actual weights of few big and/or small fish before subsampling…etc.*

Figure 6 – If more than one fish bin is used then measurements can be taken of each beforehand, then catch depths after the catch is dumped, and the resulting volumes can be added together to calculate catch estimates.

Special Scenarios (Examples of Potential Biases)

The observer's work is often restricted to the nature of commercial fishing vessel practices and the observer's sampling protocols and priorities. Below are some scenarios that require special discussion since bias can be easily introduced when observers are sampling during these situations.

Note – *On a trawl vessel the catch is either available spatially or temporally. Therefore, the subsample is obtained spatially when the catch is in one place such as on deck or in a fish bin. The observer should use units of time (i.e., 5 minute increments) to obtain their subsample when the catch is not available in one place but passes at one point such as on a conveyor belt.*

1. Conveyor Belt Sorted Catch

When a conveyor belt is used to sort the catch, the observer should first obtain the total catch volume before the conveyor sorts the catch.

By using units of time (*i.e.,* 5 minute increments), the observer can obtain a random subsample throughout the sorting process. The unit of time they decide to use will depend on the catch size and crew/conveyor work speed. The observer can ask the captain the estimated time it will take to sort the catch via the conveyor belt (the observer should record this time and other information in the comments section of the Catch Estimation Worksheet). For example:

<u>60 minutes</u> (the time it will take to sort the catch via the conveyor belt) ÷ <u>15 orange bushel baskets</u> = every <u>4 minutes</u> the observer should fill up one subsampling container with catch material.

The number of baskets the observer decides to use will depend on the catch size. The observer should review the information on page six to determine the number of subsampling containers needed to represent 20% or more.

WHEN TO TAKE THE SUBSAMPLE FROM THE CONVEYOR = Captain's Time to Sort the Catch by the Conveyor ÷ Number of Bushel Baskets Being Used to Sort the Subsample

To obtain a subsample from catch sorted on a conveyor the observer has three options:

→ The observer can get the subsample before the conveyor is turned on as the catch sits in the fish bin. This requires cooperation from the captain and crew. Both catch dispositions will be in the subsample. The observer should keep in mind the subsample in relation to catch size and species diversity.
→ The observer can obtain the subsample randomly throughout the sorting process (beginning, middle, and end). The subsample can either be taken from the beginning of the belt before any catch is sorted or discarded by the crew thus both catch dispositions will be in the subsample or at the end if discards are just subsampled (*i.e.*, the crew picked out the kept only). The observer must communicate to the crew not to toss over discards. The observer should note that the conveyor belt would most likely run the discards directly into the ocean. However, the conveyor sometimes can be manipulated so the subsample is collected directly in the basket. Alternatively, the observer can pick out the subsample with a fish pick before it empties into the ocean (depending on conveyor work speed and catch size).
→ If fishers sort the kept catch only with the conveyor (*i.e.*, to gut the kept catch), the observer can get actual weights or subsample the discards left in the bin (depending on discard volume). Afterwards, the observer can get actual and/or estimated weights (depending on kept volume) of the kept portion of the catch, which the crew already sorted.

Figure 7 – Fisher's may use a conveyor to sort the catch. The observer must get the total catch volume before the catch is sorted. If discards are just subsampled, then the observer can use the baskets and totes used to sort the catch as seen above to calculate the total kept volume so they may subtract the total kept volume from the total catch volume to obtain the total discard volume. The total catch volume must be obtained before the conveyor starts sorting the catch. The observer can sort/combine baskets together which are not flush (*i.e.*, when the fishers heap the catch in baskets) to use the given flush volumes. The observer can subtract flush container volumes by ½ if they are only half full.

2. Deckloading

Sometimes multiple tows are piled together to save fuel and time. This scenario is commonly seen in the scallop fishery. Finfish deck loading is rare. Even when the weather is cool, the crew must get the fish into the hold as quickly as possible to preserve the catch on ice and prevent drying. The captain has control over haul set and haul back so normally he/she would not choose to deck load finfish. However, it can occur if large schools of fish are discovered (*i.e.*, haddock). If finfish deck loading occurs, the observer should consider:

→ The observer has time between hauls to work so they can get their subsample or actual weights before a second tow is dumped onto the preceding catch. The observer must work hard and fast.
→ If a tow is dumped onto a previous catch, the observer must make sure they have taken their

subsample beforehand and noted the remnants or remaining depth of the first catch. Next, the observer should work their subsample for the subsequent haul, keeping in mind the remnants of the first catch. The observer must remember to subtract the catch depth from the previous haul to get accurate calculations for the haul, which they are working.

Figure 8 – Deckloading occurs when a vessel discovers a school of fish or an abundance of sea scallops. As a result, fishing time will be quicker, the catch clean and few discards occurring. When a vessel discovers an abundance of catch and deckloads, normally catch diversity is very low but the volume very large. If the diversity is low and the catch is largely homogenous, then it is more important for the observer to take the correct catch volume rather then trying to obtain 20% of a very large catch. If catch diversity is low, the observer will be able to get by with a smaller subsample than if the catch diversity was higher. Refer to Heales *et al* (2003) for discussion on subsample size and species diversity within a trawl vessel's catch.

3. Scallop Vessels & Shoveling

In the Sea Scallop Fishery if the catch is very clean, it can save fishers time if they shovel the unsorted pile into baskets instead of shacking (or picking out) individual kept scallops. To deal with this scenario:

→ The observer will need to find the catch volume. To find the volumetric calculations, the observer must take deck measurements *or* use the total number of baskets to obtain the catch volume

→ The observer will obtain the subsample volume. As time permits, the observer will fill or obtain baskets of subsample material ($\geq$ 20% for accurate representation) shoveled by the observer or the crew. If the observer shovels the baskets, they must ensure that all of the baskets are flush to the top of the baskets' wall. If the crew shovels and fills heaping baskets, for the consistency of comparing basket to basket, the observer must leave the baskets heaping for that particular subsampling situation. Comment about any heaping situation calculation.

→ If there are two dredges, the observer should get an equal number of baskets from each dredge; this will ensure a representative account of the total catch

→ Normally, scallopers will not shovel larger fish into the baskets. Therefore, the observer should attempt to obtain an actual weight of these fish (separate first by catch disposition (K or D) and then fish disposition code). If time permits and the observer is able to obtain an actual weight for an entire species they should not include this weight as part of the subsample weight (since it would be counted twice and inflate the weights). The observer must record the weight on the corresponding haul logs' species list as an actual weight

→ The observer must sort the subsample by species, then catch disposition (K or D) and finally fish disposition code, then obtain actual weights for each of these species. The subsample weights should always be actual and *never* estimated. To avoid over extrapolation the observer must remember to subtract, or tare, the basket weight

→ Observers will need to decide which scallops are kept or discarded. They can do this by verifying with the captain or crew. The observer should adjust the recorded values as necessary to reflect the discarded scallops (i.e. discard for small size, quality etc)

→ If shell heights are taken, the observer should not mix the scallops from different dredges.

As a reminder, when recording scallop shell heights on the Length Frequency Log, the port and starboard dredges must be recorded separately. (To avoid this potential error, the observer should take the scallop heights *prior* to subsampling.)

4. Flooding Fish Bin

The fish bin is commonly pumped with sea water to wash the catch. Two scenarios will occur with the first being more common:

→ Water will accumulate and leak out of the bin or checker boards and will level the catch. The observer can facilitate leveling and mixing of the catch by going into the fish bin and moving the catch around. It should be possible for the observer to note when collecting water does not affect the catch depth if it is leaking out quickly. This is an easy observation to make.

→ If water accumulates in a fish bin and does not leak out, the volume of water in the fish bin may be significant enough to inflate the observer's total catch estimates. Therefore, the observer should take the subsample before the crew starts pumping water into the catch. If obtaining the subsample is not possible then the observer should let the crew remove the kept first. However, a large discard volume can cause problems for the observer since fishers may want to toss the discards over. The observer must communicate with the crew not to toss the discards overboard

→ If the observer lets the crew sort the kept catch first, the observer can manage the discards and seawater afterwards. This is an easier method to do if the discard volume is small since fishers may want to remove discards of a larger volume to get to the kept catch. The observer must ask the crew to set aside the discards for them and not throw them overboard. Normally, the crew will not throw discards over maliciously but out of habit. The observer should be polite when asking for assistance.

5. Catch Overflowing from Fish Bin

Sometimes when the catch is dumped into a fish bin the catch is so big it overflows out onto or covers the entire aft deck area. Usually the catch will be clean and uniform if the fishing vessel located a school of fish (*i.e.*, haddock). The observer should be practical, work hard, and comment. For these larger catches, the observer can compare their estimates with the captain. If their estimates are drastically different from the estimates of the captain, the observer should not be controversial but simply make notes on their logs and make sure their calculations are correct. The observer should always keep their estimate and not replace it with a vessel's estimate unless the vessel's estimate was used first for other reasons. Observers should consider:

→ First measuring the deck area that could potentially hold catch (*i.e.*, the aft region of the boat) to obtain area and depth measurements throughout the vessel. Observers should ask the captain about likely scenarios

→ Splitting larger heaping catches placed into a single fish bin into multiple fish bins or containers

→ If only a few fish overflow, these can be placed them back into the bin. Afterwards, it is possible to get an average height of the catch within the fish bin since leveling might be difficult and result in more fish falling out. Observers can also place the catch into smaller bins or containers and add given volumes together to get the total catch volume.

→ Fishers can remove the kept catch first then the observers can organize all the discards in the fish bin. Next, observers can either subsample or get actual weights of the discards, depending on the discard volume and time available. For discards thrown overboard, observers should tally or census them. Afterwards, the observer can get the kept catch information – actual and/or estimated weights depending on time and kept catch volume. Observers need to make sure the crew does not throw any discards overboard.

6. Handling Large Fish, Few Large Fish and Few Small Fish

Observers should not deliberately choose particularly large or small fish and add these fish to their subsample because observers are biasing their sampling efforts. The observer's subsample must be random and representative of the total catch.

If all species are accounted for of an identical grouping, (few large or small fish), observers can set these aside first and take an actual weight before subsampling. This can make subsampling easier since large fish can be difficult to manage in subsampling containers. Therefore, observers are separating the actual weight of few occurring sea life and/or debris by catch disposition and disposition code before subsampling. If observers do remove anything before subsampling, they must remember to take the catch depth afterwards and before subsampling to obtain a precise catch depth to use in their calculations. Removing large fish and/or debris can significantly influence the catch depth.

Alternatively, if actual weights cannot be obtained from large fish or debris that are difficult to manage in subsampling containers, the observer can dump the entire subsample into a smaller bin if one is available or on deck as a separate pile (keep in mind where the fishers work). Next, the observer can take angular (*i.e.*, if a smaller fish bin is available) or circular area measurements (*i.e.*, no fish bin and containers available) according to catch shape and obtain a depth to calculate the volume.

Figure 9 – Remove large sea life and debris first or few occurring sea life and debris will make subsampling easier and reduce bias. When removing sea life and/or debris before subsampling, all sea life and debris of an identical grouping must be removed.

7. Catch Not Dumped into Fish Bin or No Subsampling Containers Available

In some regions or fisheries, it is common for fishers to dump the catch on deck and not into a fish bin. Normally in regions such as the south, tow time is long enough so actual weights can be obtained from larger catches or approximate estimations can be obtained by using the basket or tote count method. However, as necessary, it is still possible to use the Volume to Volume Method.

Although the catch is not dumped into a fish bin, the volume can be calculated by determining the type of shape formed by the dumping action (usually a circle or oval). Then by determining the appropriate formula, the observer can calculate the surface area. The observers should leave the dumped catch as is or level somewhat if too deep to manage and obtain the catch depth by calculating an average depth measurement of the catch. The observer should be careful and not spread the catch too much. Then the observer can use the calculated surface area and average catch depth to calculate the volume.

Note – *The observer can take the average depth by finding the maximum or greatest depth (highest point) and minimum depth (zero). The observer should obtain a depth measurement from the highest point (which may or may not* *be the center) lengthwise every foot in either direction until reaching the perimeter of both ends.*

Likewise, if no subsampling containers or a small empty fish bin is available to manage the subsample, observers can arrange their subsample on deck as a circular shape and follow the previous methods. The observer should make detailed notes on their calculations and methods employed on their Catch Estimation Worksheet.

Trawl and scallop catches are sometimes small and relatively easy to manage so actual weights can be obtained or combined with other more approximate catch estimation methods such as the basket or tote count and tally count methods. Subsampling is not always needed nor is the best method to use when estimating total catch weights.

Figure 10 – The catch is not always dumped in a bin. In the picture above the catch is very clean and looks like all kept catch. Therefore, the observer can use the basket or tote count method to obtain an approximate estimation if actual weights cannot be obtained.

8. Managing A Very Large Pumped Catch or a Very Large Catch Dumped in Sections

Catch composition sampling is a technique used to estimate catch that occurs in very large quantities. This technique consists of obtaining a minimum of 10 catch composition sampling containers (baskets) evenly spread throughout pumping time so that stratified material is observed. This method differs from subsampling in that 20% or more of the catch is not used to extrapolate the total catch weight. It is the best method considering the circumstances.

When observing trawl vessels that pump the catch, the observer should pay attention to critically important species such as haddock and dogfish in addition to certain anadromous herrings like Alewife, American Shad, and Blueback Herring that can be overlooked and misidentified. These anadromous herrings have similarities to other herring species so pay attention to detail. The observer should refer to their Herring ID cheat sheet. Therefore, the observer must thoroughly check their catch composition baskets for these herrings.

As necessary, the observer can deliberately pick these critically important species to sample but **should not** add the sample weight into their catch composition log calculations when extrapolating total catch weights because their final estimated weight will be inflated. However, observers can add their sample weight to the final extrapolated total catch weight. Observers can add sample weights to a final calculated weight when using the catch composition sampling method or log. If a trawl vessel is dumping a very large catch in sections onto the vessel then the observer can use the catch composition basket method for this circumstance. For more information on protocols and examples, see the "Catch Composition Log" in the "Fisheries Observer Program Manual".

Figure 11 – Catch that occurs in the 10's or 100's of thousands of pounds, on a single haul requires a special catch estimation method and protocols to accurately observe the haul.

Figures 12 – Catch composition sampling is designed to categorize the catch on vessels when extremely large quantities of fish occur.

9. "Factory Trawlers"

Factory trawlers are large boats that target species such as squid. Because of the target species, pelagics such as Ocean Sunfish and Swordfish may be caught and sometimes kept. These boats can be difficult to observe because the catch is dropped or pumped and sorted out of sight, sometimes quickly below deck. Observers should consider:

→ Foremost, communicate with the captain and beforehand, obtain fish bin measurements, take the catch depth after the catch is dumped and then take the subsample.

→ As necessary (*i.e.*, very large catch is pumped or dumped in sections) the observer can use the catch composition basket sampling method, which can be easier than using the standard subsampling method for the bottom otter trawl trips.

→ If a haul is impossible to observe because the catch is sorted below deck quickly, record the haul as unobserved but obtain the kept catch weights from the captain. The observer should always be practical and make comments.

Helvoort (1986) notes:

> Past experience…has shown that while some vessel types may prove difficult, there are very few…ships that have factory layouts that totally prevent biological sampling. In the rare case that an observer does encounter such a vessel, the only course of action remaining would be to try to find a safe location on the trawldeck and gather fish to be sampled before the catch is dumped. Of course certain allowances in the sampling program would have to be made for such factors as weather and trawl operations.

10. US/Canada Area, Special Area Programs (SAPs) & Scallop Access Areas.

When documenting total catch weights in the US/CA Area, a SAP or Scallop Access Areas the observer's priority is to record actual weights for the kept and discarded critically important or managed species. The critically important species are defined by the Area, SAP, or Scallop Access Areas being observed.

For these managed areas, it is best to let the fishers separate the kept catch first. Therefore, the observer can easily prioritize the critically important species easier by determining if they can get actual weights for the discards and kept or one or the other, depending on the discard and kept volumes of each. Observers should **always** keep in mind the critically important species. For example, when fishers separate the kept first, the observer should obtain actual weights of the critically important discard species first and if necessary subsample the leftover discards afterwards which should contain all non-critically important discards. As soon as critically important kept species are available, the observer should obtain the actual weights of these before other species, which are not listed as a priority. Observers should manage their time and priorities wisely.

For **Scallop Access Area trips** requiring Tally Sheets the Observer Program allows for the cumulative actual weights for kept and/or discarded Yellowtail Flounder weights and the cumulative count for the number of bushels of Kept Scallops over the entire deckloading period of observed hauls. Observers are then to record the individual weights of each species (kept

Yellowtail Flounder (Tally Sheet areas only), discarded Yellowtail Flounder (Tally Sheet areas only) and kept scallops by dividing the total sum weight equally among participating hauls (Refer to the Training Manual Scallop Section for additional information). This cumulative sum method for kept Yellowtail Flounder, discard Yellowtail Flounder, and kept Scallops should be used instead of the subsampling estimation process. The observer must comment on the process on each of the corresponding Haul Logs' Catch Estimation Worksheet.

Observers should always show their work even when taking actual weights (*i.e.*, list the actual basket weights that were taken in the comment section of the Catch Estimation Worksheet).

11. Day Trawl and Day Scallop Vessels

The catch of day trawlers is normally small and these day trawlers typically carry one, two or three fishers including the captain with one or two fishers being most common. Therefore, larger catches on these one, two, or three day trips may take a long time to process because the person-power to process the catch can be limited. As a result, the observer should have plenty of time to get actual weights of the discards and/or the kept catch. Subsampling small catches will produce bias and error in estimating. These day trawl vessels fish daily because they are usually under some type of daily possession limit or quota.

Figure 13 – Day boats are normally small thus work under quotas therefore the catches are usually small and number of hauls can typically be no more than 12 on a long day with 1 – 6 hauls being the norm. Even if large catches occur, the captain may be the sole crew member so the observer has a lot of time to take actual weights. As a result, these trips should consist primarily of actual weights.

12. Potential Biases – Problems & Solutions

→ Problem: bin volume bias because the bin may hold fish and indeterminate amounts of water
→ Solution: get subsample before water is pumped into the catch or remove water and manage discards after kept catch is sorted by crew first
→ Problem: the catch depth may be too shallow to obtain an accurate volume because the catch is too small (indicates that actual weights should be taken)
→ Solution: take actual weights
→ Problem: few occurring fish are subsampled too often and the estimated weight is inflated
→ Solution: few big and small fish should be removed first and actual weights taken before subsampling
→ Problem: purposeful presorting or accidental discarding of discards by a crew member is occurring
→ Solution: the observer should communicate with the captain and crew. The observer can let the crew remove kept first as it will make the observer's job easier but the observer must make sure the crew knows to leave discards onboard so that the observer can get those actual weights and/or estimate.

Random Sampling Guidelines

In addition to subsampling, observers must pay attention to their biological sampling priorities (*i.e.*, length frequencies). When taking length frequencies from the subsampled portion of the catch, an observer is creating a random approximation of the actual length frequency of the total catch. Additionally, the age structures collected from these measured fish are used to construct an age-length key. Ideally, at least one fish per length in the total catch should be represented in a length frequency subsample and one fish per length in the subsample should be represented in an age subsample. For these reasons, selecting fish for measurement and age structure collection must be random.

In situations where there is a small amount of large fish mixed into a large catch of small fish, the large fish should be removed prior to taking random subsamples of the rest of the catch. Conversely, if there are only a few small fish in a large catch of large size fish, those few small fish should be removed prior to subsampling the large catch. If the catch is mixed with fish of all sizes, no fish should be intentionally picked out; a random subsample of the entire catch must be taken. If after the random sample is taken, the observer notes a species in the catch that was not represented in the subsample, that species should be counted individually and not as part of the subsample. In many situations on trawl vessels, the observer will be shoveling or kicking all discarded species overboard. In these situations, the observer is able to view the entire catch and is often able to pick out individual species that may only number 2, 3, or so individuals in the entire catch. If the observer sees this and feels confident that those individuals can be accurately quantified separately from the subsample, it is appropriate to do so. However, by intentionally hand picking individuals for the subsample, the observer would be introducing bias. Hand-selecting individuals should only occur for the species occurring in small, manageable numbers therefore actual weights can be obtained. It is always best to get actual weights or approximate estimations over extrapolated estimations if possible.

The only time that fish should be selected in a non-random fashion is when biological information is being collected from tagged fish. Tagged fish may be taken from either inside or outside of a species composition sample or subsample.

It is also important to be aware that vessels will often create a subsample/stratum in their sorting procedures. The observer must work with the crew to ensure that his/her sampling does not before biased by the vessel sorting their catch into size or market categories before the observer conducts biological sampling.

The observer's random and representative subsample is not only used to extrapolate weights for the total catch but must represent the catch composition for the total catch as well. Observers can take biological samples from outside the subsample (*i.e.*, other portions of the catch, sorted and/or unsorted by them or the crew) if an insufficient number of priority species occur within their subsample however in order to be representative of the total catch the observer should select **all** individuals that occurred within the entire haul. As a result, the total catch weight for those individuals would no longer be an extrapolated estimated weight via the subsample but a complete weight account for that species thus represented as an actual weight for the haul.

It is important to sample from within a species composition sample or subsample because if individuals are selected from outside the species composition sample or subsample, bias can occur unless all individuals are picked. Therefore, the round actual weight of sampled individual(s) on the Length Frequency Log might be represented from the subsample or randomly from a portion of all individuals taken from a haul. When biological sampling is done from a portion of a total population (*i.e.*, where an actual weight was obtained for the total population or an approximate estimation via basket or tote counts or tallying but the entire population was not subsampled), the observer must still take a random and representative sample. For example, if the fisher's sort kept haddock in a number of baskets the observer should randomly pick baskets to sample systematically. The observer can use the random number table to generate which baskets will be sampled. Otherwise, the observer should sample all individuals within a population.

It should be noted that the weight recorded on the Length Frequency Log should be round/actual and **not rounded** (*i.e.*, 43.5 lbs **should not be rounded** to 44).

In conclusion, likewise when the observer is obtaining a subsample, the observer's sampling must be representative of the total catch unless all individuals are weighed and sample. No favoritism should be given to particularly large or small species. Repeated random sampling over time will provide representative catch data.

Figure 14 – Biological Sampling if often restricted to the nature of commercial fishing vessel practices.

Comments? Questions? Concerns? Ideas? Corrections? Be Involved! Contact Buck at: buck.denton@noaa.gov, 508 495 2005

FREE ADVICE

Be good to the fishing crew and they will be good to you. Communicate with the fishing crew and they will communicate with you. Help the fishing crew and they will help you!

APPENDIX I

Document Terms

Actual weight(s): An actual weight taken of sea life and/or debris of a particular disposition code and catch disposition by NMFS issued scales.

Approximate estimation: Approximate estimation differs from an estimation derived through subsampling in that the entire catch or catch of a species, is explicitly accounted for as opposed to extrapolated. An example of an approximate estimation is one, which all individuals of a certain species are sorted into baskets. The observer then obtains an average basket weight by weighing at least three baskets (or more) and averaging the weight. The observer then counts the number of total baskets and applies the average weight. Since the observer did not actually weigh all the baskets the weight is still an estimated one, but it is a very approximate estimation as opposed to a mathematically extrapolated estimation calculated from a subsample. This spatial basket sampling is very effective at producing highly approximate weight estimations. In many situations aboard commercial fishing vessels of the Northeast and Mid-Atlantic regions there will be times during which obtaining such an approximate estimate will not be possible. In these situations, the observer must subsample the catch in an effort to obtain catch composition estimations for the total catch.

Area (A) (ft^2): The amount of space in a flat surface measured in square units. Recorded in square feet.

Basket or Tote Count (A x B + C): Estimates of kept catch can be calculated by basket or tote counts when the kept is separated by species into containers. If time allows, the observer can estimate large amounts of discarded species such as little skates by using the basket or tote count method. [Note: Do not forget to tare or subtract the weight of container used to hold the catch.] To perform this method the observer must take an average weight per container (**A**), multiply this average weight by the total number of containers filled to the same level (**B**) and add any container weight that may be different, *i.e.*, ½ filled container (**C**).

Vessel estimates: Sometimes due to safety concerns, weather conditions, or large catch volumes, total catch weights can be obtained from the captain. This method should **rarely** be used. Comments must be made as to why this method was chosen. Observers can compare estimations with the captain and record the captain's estimations in the comments section of this Catch Estimation Worksheet.

Catch Depth (D): The actual depth of the catch from which the observer intends to calculate a volume. If the catch is first sorted by catch disposition and/or if species and/or debris are removed in order to take actual weights before subsampling, the catch depth should be taken afterwards to obtain the actual depth in order to calculate an accurate volume. Record in feet.

Diameter (d): A straight line that passes from side to side thorough the center of a circular object. Record in feet.

Fish Tote: Commonly known as the 70 liter or 100 lb. fish tote, which is the standard for seafood handling in the North Atlantic. Equivalent to fish totes commonly seen in the gillnet fishery. NEFOP standard flush volume for a fish tote is 2.65 ft^3.

<u>Flush</u>: means catch or subsampling material flush to the walls of a checker bin or subsampling containers as opposed to heaping.

<u>Heterogeneous</u>: means catch containing many different species of sea life and/or debris and fish or shellfish of different lengths.

<u>Homogeneous</u>: means catch that is composed of parts or elements that are all of the same kind.

<u>Identical groupings</u>: means of the same species catch disposition code and fish disposition code.

<u>Length (L)</u>: Distance from one end to another.

<u>Long Radius (r_2)</u>: Long radius is measured when a circular shape is irregular (*i.e.*, ellipse) to obtain an average radius. The long radius is defined as the distance from the center of a circle to the furthest point on the perimeter. Record in feet.

<u>Long Width (W_2)</u>: Long width is measured when an angular shape is irregular (*i.e.*, trapezoid) to obtain an average width. Record in feet.

<u>Orange Basket</u>: Equivalent to orange bushel basket commonly seen on scallop and trawl fishing vessels. NEFOP standard flush volume of 1.47 ft^3.

<u>Partial haul sampling</u>: A portion of the haul is sampled or actual weights are taken for a portion of the haul only. The rest of the haul is represented by estimated weights.

<u>Pi (π)</u>: The ratio of the circumference of a circle to its diameter. The value of π is 3.14.
Radius (r or $r = d \div 2$)

<u>Radius (r)</u>: The distance between the center of a circle and any point on the circle's perimeter. Record in feet.

<u>Sample</u>: A small part of something intended to represent the whole. The fishing vessel obtains the catch or sample. A subsample is used by the observer to extrapolate total catch weights from the sample or catch.

<u>Sample Weight Multiplier</u>: is used to extrapolate the total catch weight for each species found in a subsample. Record to the hundredths, figure not rounded.

<u>Short Radius (r_1)</u>: Short radius is measured when a circular shape is irregular (*i.e.*, oval) to obtain an average radius. The short radius is defined as the distance from the center of a circle to the closest point on the perimeter. Record in feet.

<u>Short Width (W_1)</u>: Short width is measured when an angular shape is irregular (*i.e.*, trapezoid) to obtain an average width. Record in feet.

Stroke Tally: Stroke tally is a method where the weight of a species (*i.e.*, dogfish) is estimated by taking an average weight and multiplying by the collected tally. The number of individuals used to obtain an average weight should be ≥ 20% of the tally.

Subsample: A subsample is used in lieu of actual weights to determine catch composition and extrapolate the total catch weight of individual sea life and/or debris for a large catch. As a guideline, a subsample is random and must represent ≥ 20% of the total catch size.
Subsampling container

Subsampling Container: Any container used to hold a subsample.

Total Subsample Volume: The total volume of the subsample. This number is obtained by multiplying the total number of subsampling containers collected by the flush volume of the container used (*i.e.*, 10.5 orange baskets x 1.47ft^3 flush). Recorded to the hundredths, figure not rounded.

Volume (V) (ft^3): The amount of three dimensional space occupied by an object. Area (ft^2) x Depth (ft) = Volume (ft^3).

Volume to Volume Method: Uses a subsample from the catch, the total catch volume, total subsample volume, a sample weight multiplier, and actual weights from sorted sea life and/or debris within the subsample to calculate total catch weights of sea life and/or debris. Can be combined with actual weights (*i.e.*, partial haul sampling) or other catch estimation methods (*i.e.*, basket or tote counts) to illustrate total catch weights and catch composition on a haul log.

Whole haul sampling: The sample size is the entire haul or the haul log consists of all actual weights.

Width (W): The greatest dimension at right angles to length or depth (height). Record in feet.

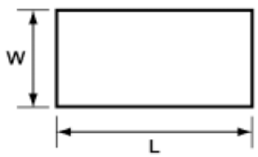
APPENDIX II

Observer Area & Volume Cheat Sheets

AREA CALCULATION EXAMPLES

Area of a Rectangle or Square

Area = L x W



3 ft

6 ft

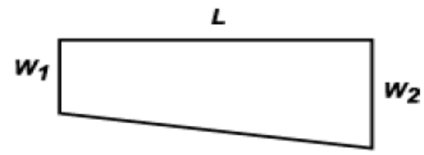
Example: L = 6 ft W = 3 ft

Area = 6 ft x 3 ft
= 18 ft^2

Area of a Trapezoid

Area = [(W_1 + W_2) ÷ 2] x L

Note: For a trapezoid the short and long widths are equal to the parallel sides



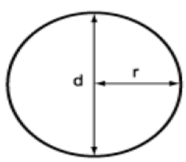
Example: W_1 (short width) = 3 ft
W_2 (long width) = 4 ft
L = 7.5 ft

Area = [(3 ft + 4 ft) ÷ 2] x 7.5 ft
= [7 ft ÷ 2] x 7.5 ft
= 26.25 ft^2

Area of a Circle

Area = πr^2 or 3.14 x r x r
(Remember: r = d ÷ 2)

d = 5 ft



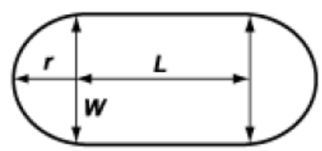
r = 2.5

Example: d (diameter) = 5 ft.
r = 5 ft ÷ 2 ft = 2.5 ft

Area = 3.14 x 2.5 ft x 2.5 ft
= 19.63 ft^2

Area of an Oblong- Shaped Oval

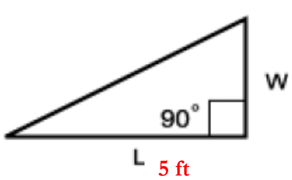
Area = (L x W) + (πr^2)
or
(L x W) + (3.14 x r x r)



Example: L = 5 ft W = 4 ft r = 2 ft
Area = (5 ft x 4 ft) + (3.14 x 2 ft x 2 ft)
= 20 ft + 12.56 ft
= 32.56 ft^2

Area of a Triangle

Area = [L x W] ÷ 2



2.5 ft

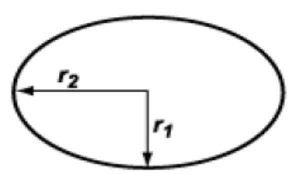
5 ft

Example: L = 5 ft W = 2.5 ft

Area = (5 ft x 2.5 ft) ÷ 2
= 12.5 ft^2 ÷ 2
= 6.25 ft^2

Area of an Ellipse (Oval)

Area = r_1 x r_2 x π
or
= r_1 x r_2 x 3.14



Example: r_1 (short radus) = 4ft
r_2 (long radius) = 6 ft

Area = 4ft x 6ft x 3.14
= 75.36 ft^2

Converting inches to decimal form & feet to inches

For example: 6" ÷ 12 = .5 ft or

$$\frac{60 inches}{1} x \frac{1 foot}{12 inches} = \frac{60}{12} ft = 5 ft$$

Standard volumes of containers flush to the top with a subsample:

orange bushel basket = 1.47 ft^3

fish tote = 2.65 ft^3

VOLUME CALCULATION EXAMPLES

Volume of a Standard Orange Bushel Basket

$V = \pi [R^2 + Rr + r^2] H/3$

R = Top radius

r = Bottom radius

(Remember to convert inches into feet)

Volume = 3.14 [0.71^2 + (0.71)(0.56) + 0.56^2] 1.17/3
= 3.14 [0.5 + 0.39 + 0.31] 1.17/3
= 3.14 [1.2] 1.17/3
= [3.77] 1.17/3
1.4695 ft^3 = 1.47 ft^3 = NEFOP Standard

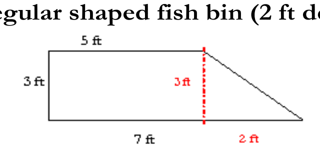
Volume of a Standard Trapezoidal Fish Tote

$V = [(W_1 + W_2) \div 2] x L x D$

Volume = (15.75 in + 16.75 in) ÷ 2 x 26 in x 11 in
= (1.31 ft + 1.39 ft) ÷ 2 x 2.16 ft x 0.91 ft
= 2.70 ft ÷ 2 ft x 2.16 ft x 0.91 ft
= 1.35 ft x 2.16 ft x 0.91 ft
= 2.65 ft^3 = NEFOP Standard

Volume of Irregular Shapes

Example 1
Irregular shaped fish bin (2 ft deep)



Rectangle
L = 5 ft   W = 3 ft   D = 2 ft
V = L x W x D (5 x 3 x 2) = 30 ft^3

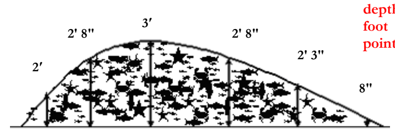
Triangle
A = [L x W] ÷ 2
3 ft x 2 ft ÷ 2 = 3 ft^2

V = A x D
3 ft^2 x 2 ft = 6 ft^3

Total volume of irregular shape
30 ft^3 + 6 ft^3 = 36 ft^3

Volume of Irregular Shapes
(*i.e.,* Fish not dumped into a bin)

Find the highest point of the catch (sometimes the center). Take a depth lengthwise every foot from the highest point in either direction



First, obtain an average catch depth

Calculate the average depth by using n + 1 (*i.e.,* if six depths are taken add one, then divide the total for all depths by seven)

n = number of depth measurements taken

$$\frac{depth_1 + depth_2 + depth_3 \ldots + depth_n}{n + 1}$$

Add feet and inches

$$\frac{2' + 2' 8" + 3' + 2' 8" + 2' 3" + 8"}{6 + 1}$$

11′ 27″ = 13′ 3″

$$\frac{13' 3"}{7}$$

NOTE!
Convert feet into a decimal by dividing the inches by 12

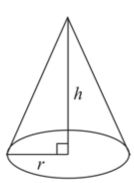
$$\frac{13.25 ft}{7} = 1.89 ft = average catch depth$$

Applicable when catch not dumped in fish bin or uneven depths occur

Second, determine the catch shape (angular, circular, ellipsoidal…) and calculate the area.
Next, multiply the area by the average catch depth to calculate the total catch volume
Area (ft^2) x Depth (ft) = Volume (ft^3)

Volume of a Circular Cone

$$V = \frac{1}{3}\pi r^2 h$$

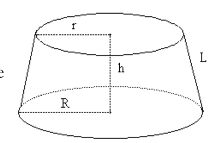


Applicable in the pot & trap fisheries but not limited to

Volume of a Frustum of a Right Circular Cone

A frustum is the part of a conical solid left after cutting off a top portion with a plane parallel to the base. The volume of a frustum of a right circular cone is given by:

r = radius of upper base
R = radius of lower base
h = height

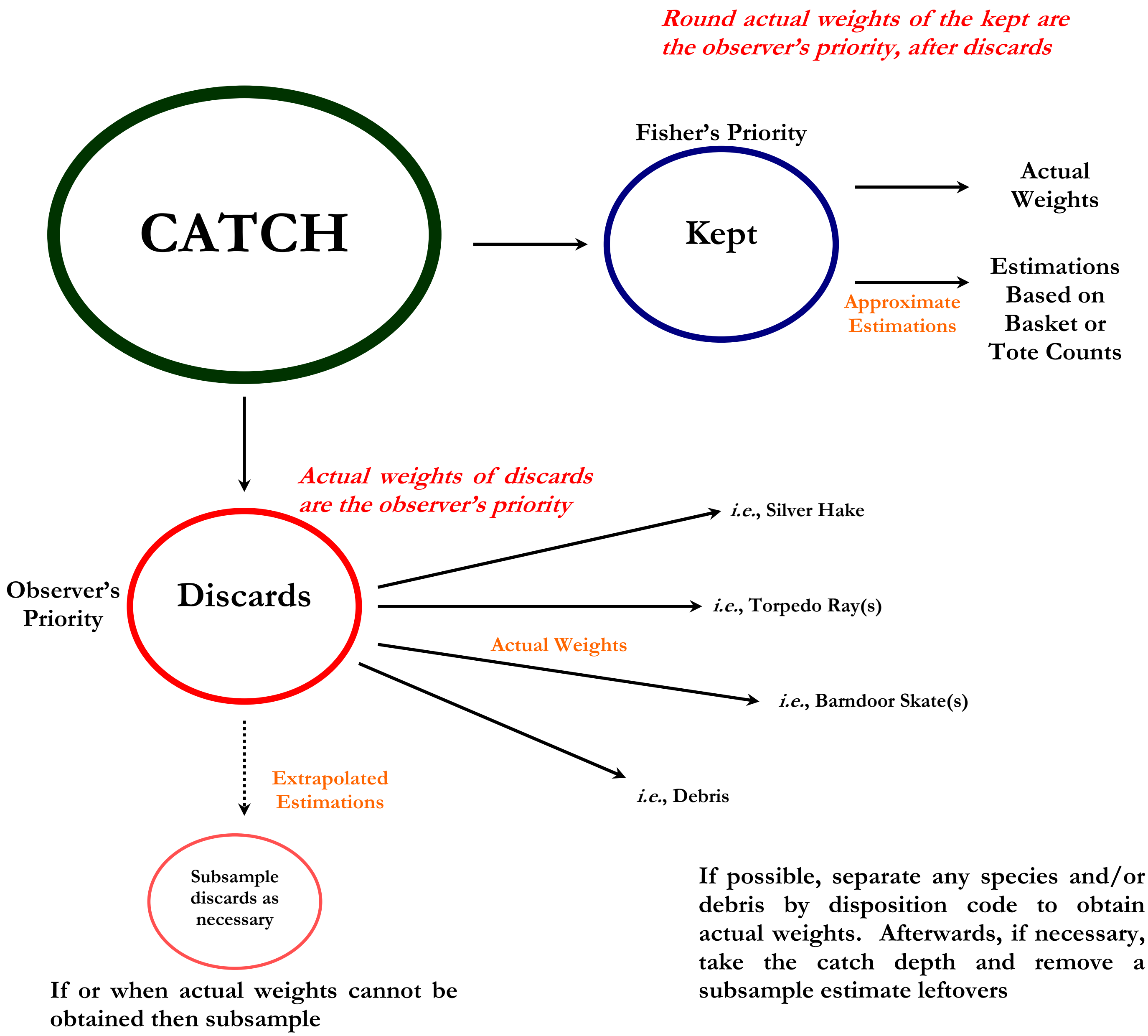


$$V = \frac{1}{3}\pi h(r^2 + rR + R^2)$$

Applicable in the pot & trap fisheries but not limited to

APPENDIX III

Schematic Diagram Illustrating Catch Estimation and Management



APPENDIX IV
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