# DATA PROCESSING METHODS FOR GROUNDFISH SURVEYS

by

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## INTRODUCTION

The purpose of this report is to describe the methods used in processing groundfish survey data. These methods have been evolving over the past few years along with the development of our ADP (automatic data processing) system at the Woods Hole Laboratory.

Our capacity to process the survey data has gradually increased with the expansion and improvement of our ADP facilities, and now we have reached a point where we can efficiently process all of the routine catch data obtained on groundfish surveys. However there are a fair number of different operations required, and they must be done in a definite sequence in order to achieve an efficient flow of data and make the best use of people and machines. This report will serve as a guide to the present processing scheme and perhaps also as a stimulus toward improvement of our system.

By processing essentially we mean producing a basic deck of data cards containing all of the information on survey catches, and for which all significant errors have been corrected. What represents a significant error depends upon the demands made upon the data, and this will be discussed in the report. Elimination of all errors of course is virtually impossible, and in our case is not necessary. It will suffice to say that with respect to our objectives, we believe we are near the point beyond which further time and effort spent searching for errors would not yield sufficient benefit to justify the cost.

In addition to a description of the processing which leads to the basic deck of data cards, I have included a brief description of the available computer programs which were designed to analyze groundfish survey data. None of these programs are currently run routinely on a cruise-by cruise basis. Their description in this report is merely to indicate the potential at hand.

Data processing begins the moment the vessel returns to the dock with distribution of various kinds of data to various places. The principal categories of data and their disposition are summarized in Figure 1. In this report we are primarily concerned with the processing of trawl catch data and associated temperature observations.

Many details of the processing are related to the sampling procedures used on groundfish surveys, and parts of this report will not be clear without an understanding of the stratified random sampling design used to select stations, and the methods of sampling trawl catches. These sampling procedures are described in another report (Grosslein, 1969 Lab. Report #69-2 ).

Part I of this report describes the arrangement of data on cards and the various coding schemes employed. Parts II and III describe the general features of the two basic phases of routine processing, initial hand processing and machine processing. Part IV is a detailed outline of specific processing steps in proper order, and is intended as a guide for use within the laboratory.

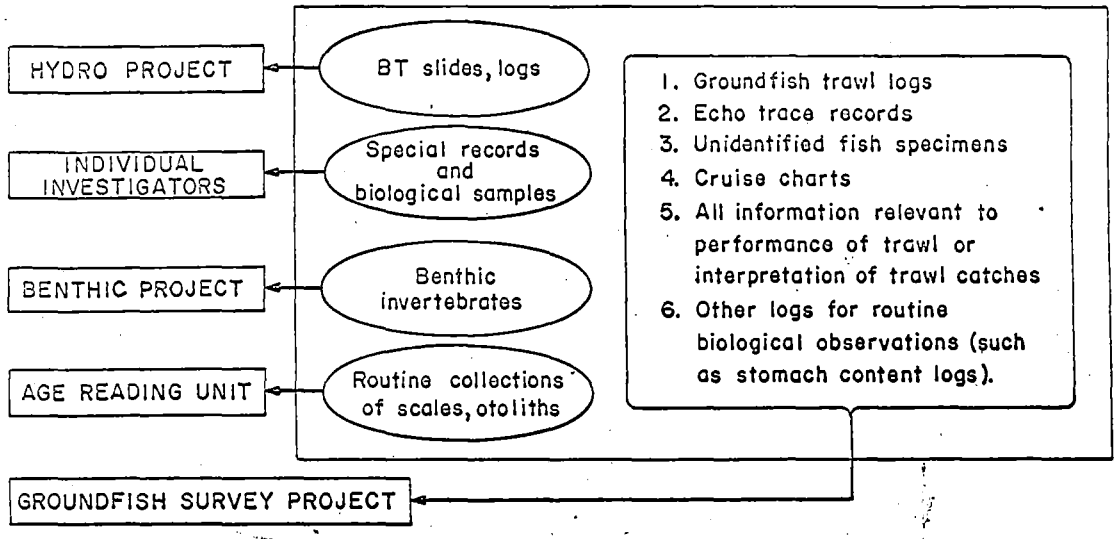
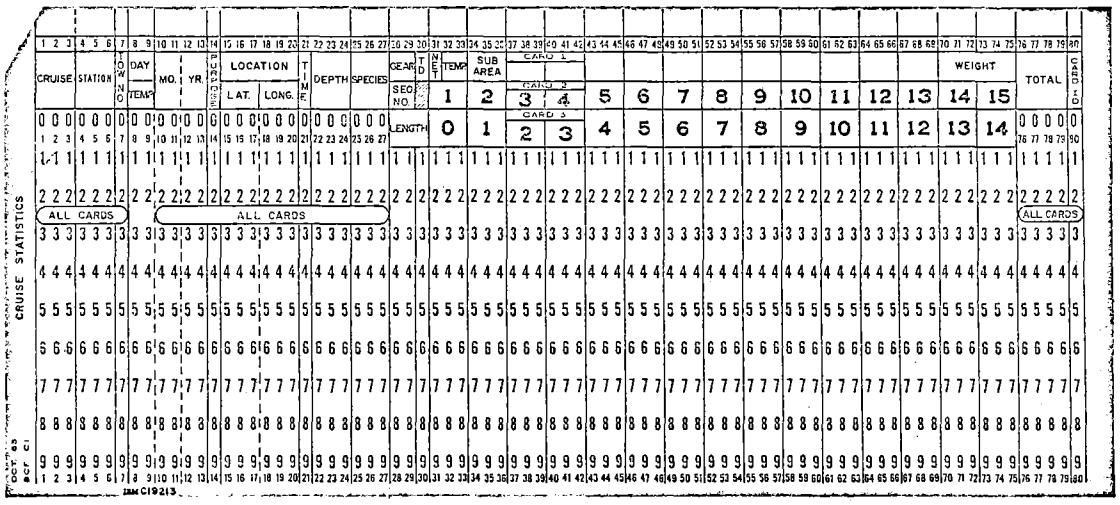



Figure 1. Types and distribution of data from groundfish surveys.

# PART I

## CARD FORMATS AND CODE SCHEMES

The basic catch data card format used for groundfish survey data is shown below. Any single card contains catch data for only one species in a single tow; however, usually more than one card is necessary to contain all the available data for a single species in a single tow. Three different card types (using different parts of the basic card shown) have been designated to hold the following data: total weight and number of a species in a single catch (card type 1), length frequency (card type 2),




and age-length frequency (card type 3).

There is only one type 1 card per species per tow, but usually there will be more than one type 2 card per species per tow. If age-frequency data are collected on a species there will be one type 3 card for each centimeter length interval in the sample. The arrangement of data on each of the three types of card is illustrated in Figure 2. Details of coding these three card types including changes made from time to time are shown in Tables 1, 2 and 3.

The data from all type 2 cards combined for a single species in a single tow, represent the length frequency (actual or estimated) of the total catch of that species in the tow. That is, sample length frequencies are expanded before transfer to final type-2 cards. In contrast, age-length

data on type 3 cards usually represent only a sample of the fish in a catch; these data are to be expanded with the age-frequency computer program (see Table 10, Part III).

Note that except for columns 6-9, columns 1-27 and 76-80 are identical. This similarity in format simplifies the problem of simultaneous processing of different card types, particularly in the case of the initial machine audit which, among other things, checks for discrepancies among corresponding columns.

In addition to the three basic catch data cards, there are two other card types (4 and 5) containing principally station data with only one card for each station (Figure 3).

Station cards (type 4) contain exactly the same data (and in the same columns) on location and characteristics of each trawl station which appear on the #1 card, but the total otter trawl catch of all species combined is put in the place of catch of individual species (Figure 3). The station cards are useful in a variety of ways including analysis of factors such as scope and weather on the efficiency of trawling.

Station Index cards (type 5) contain sequential trawl station numbers, and corresponding numbers for other types of data (BT, plankton) taken at the given trawl station. The first seven columns (cruise, stratum-tow) are identical to the other card types. Index cards also contain data on position (nearest minute), depth (meters) and bottom and surface temperature, in the same format as used by Hydro project for temperature analysis. Thus the Station Index provides a useful cross-reference listing (particularly by matching corresponding stratum-tow and sequential trawl station numbers), and at the same time it provides all the temperature records (bottom and surface) for a survey including those without corresponding trawl stations. Note that the data cards required by the Hydro project for bottom temperature analysis, can be produced by machine directly from the Station Index cards. Details of coding for card types 4 and 5 are given in Tables 4 and 5. Format of the station index (initially filled out by hand) is shown in Table 6.

Current statistical subareas coded on survey cards are shown in Figure 4. These areas are drawn onto a standard plotting chart which is used as an overlay for the cruise track, thereby providing a quick visual determination of subarea for each station. Subareas can also be added by machine. Codes used for bottom types are shown in Table 7. This system was used by the Benthos project prior to 1 June 1966.

A 3-digit species code is employed which is to a large extent arbitrary, although an attempt was made to arrange number series in some phylogenetic order (Table 8). Bony and cartilaginous fishes are coded with numbers between 1 and 299; invertebrates are coded with numbers $\geq$ 300.

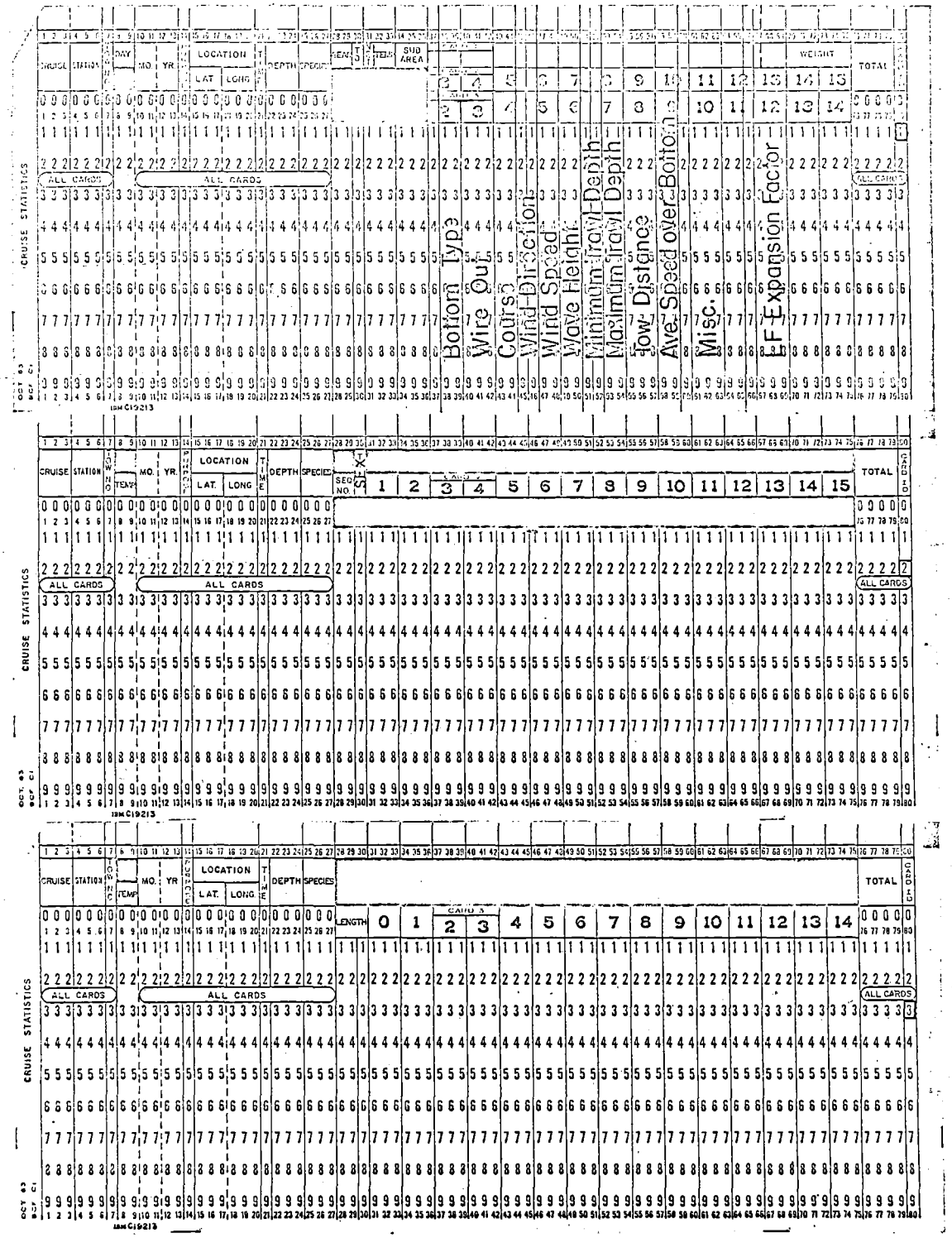



Figure 2. Formats for groundfish survey data card types 1, 2 and 3.

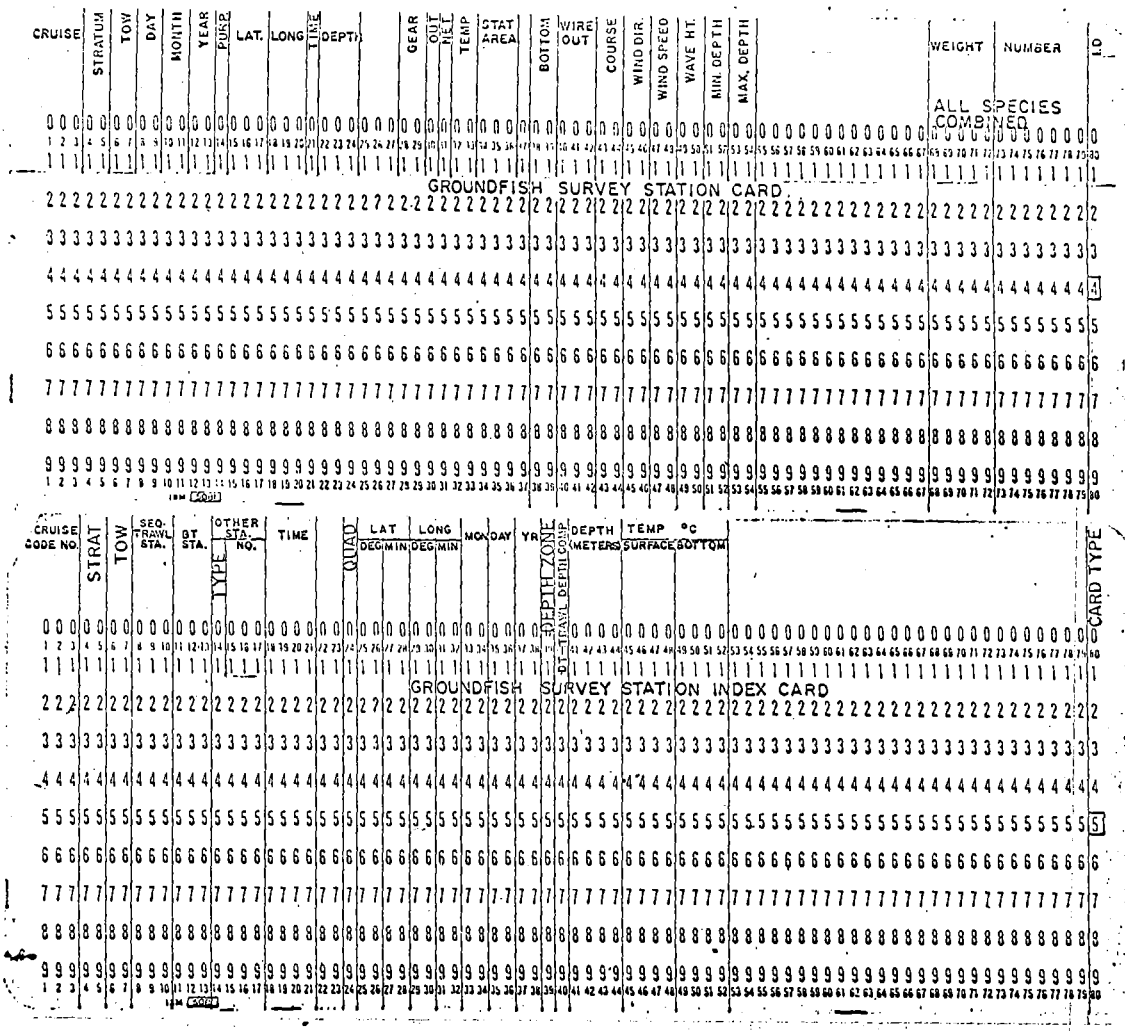



Figure 3. Formats for groundfish survey data card types 4 and 5.

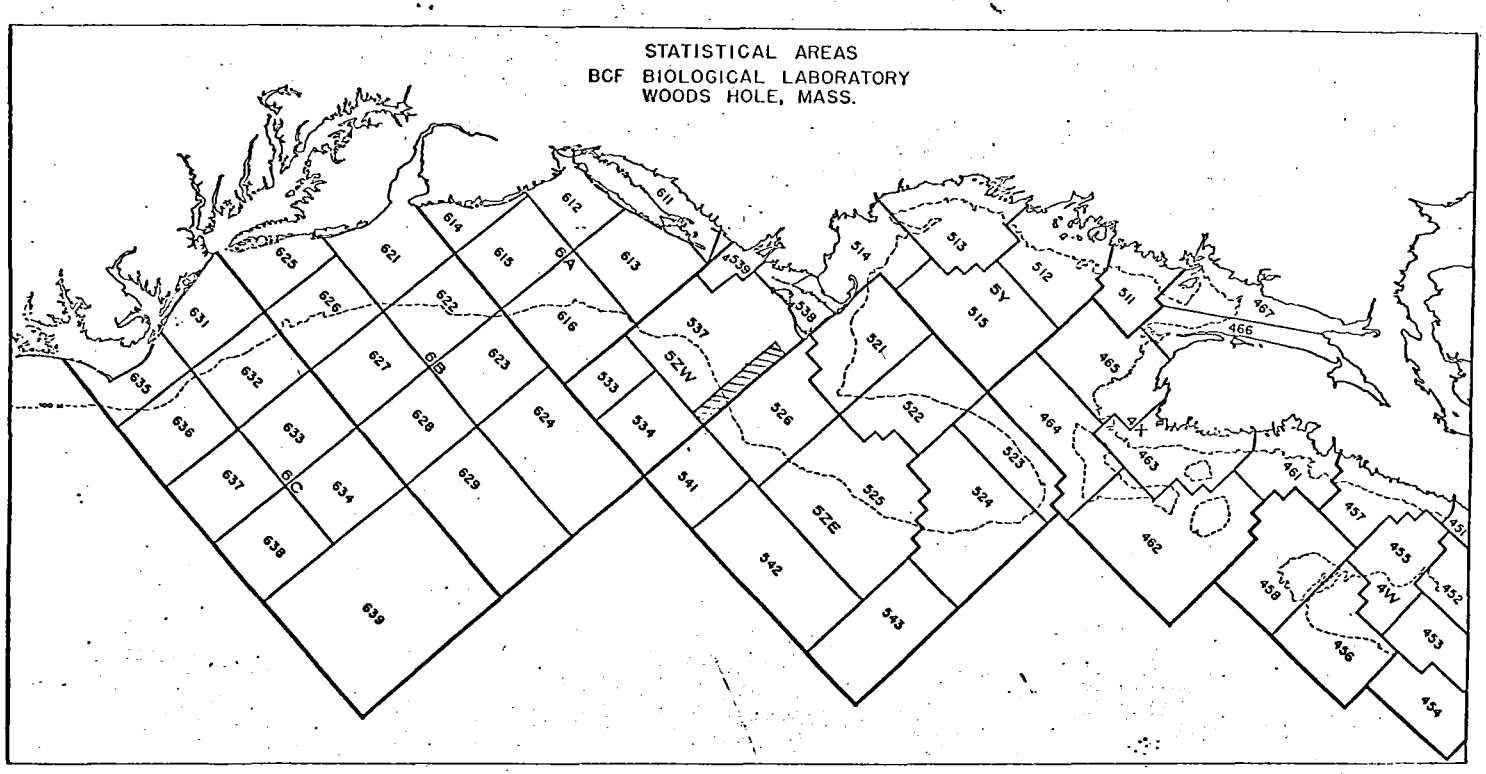



Figure 4. Statistical areas coded on groundfish survey cards. See Table 1 for explanation of shaded area within subarea 537.

Table 1. Format of card type 1. Station data including total catch of each species in numbers and pounds.

| Type of Information | Columns | Possible number of digits | Coding Details |
|---|---|---|---|
| Cruise Code Number | 1-3 | 3 | Consecutive listing of all cruises, 1948-1962. Beginning in 1963 (with Albatross IV cruise 63-5) listed cruises consecutively within each calendar year. See Inventory (Lab Report #69-3 ) for cruise code numbers. |
| Station Number | 4-7 | 4 | Station (cols. 4-6) and tow (col. 7), 1948-1962. Stratum (cols. 4-5) and tow (cols. 6-7) beginning with Albatross IV 63-5. Note that tow numbers within strata usually do not reflect cruise track. |
| Day of Month | 8-9 | 2 | Numbers 01-31. |
| Month | 10-11 | 2 | Numbers 01-12. |
| Year | 12-13 | 2 | Numbers 48-99 (20th century) |
| Cruise Purpose | 14 | 1 | All routine survey cruises coded with digit 1. Any other number in col. 14 indicates cruise of different type. In the following special cases (Albatross IV 64-6, 65-4, 68-10; and Delaware 65-6, 68-6) col. 14 was punched 1 but cruise was not a routine survey. See trawl log files for details on individual cruises. |
| Latitude | 15-17 | 3 | Latitude in degrees (2 digits) and 6- or 10- minute units (1 digit) as follows: |

| Pre - 1963 | | Begn. 1963 | |
|---|---|---|---|
| Minutes | Code | Minutes | Code |
| 03-08.9 | 1 | 0- 9.9 | 0 |
| 09-14.9 | 2 | 10-19.9 | 1 |
| 15-20.9 | 3 | 20-29.9 | 2 |
| 21-26.9 | 4 | 30-39.9 | 3 |
| 27-32.9 | 5 | 40-49.9 | 4 |
| 33-28.9 | 6 | 50-59.9 | 5 |
| 39-44.9 | 7 | | |
| 45-50.9 | 8 | | |
| 51-56.9 | 9 | | |
| 57-02.9 | 0 | | |

Table 1. (Cont.)

| Type of Information | Columns | Possible number of digits | Coding Details |
|---|---|---|---|
| Latitude (Cont.) | | | Prior to Albatross IV 68-7, coded approximate midpoint of tow. Begin with 68-17 and thereafter, coded position at begin of tow. |
| Longitude | 18-20 | 3 | Same as for Latitude. |
| Time | 21 | 1 | Time Interval / Code<br>2400-0359 / 1<br>0400-0759 / 2<br>0800-1159 / 3<br>1200-1559 / 4<br>1600-1959 / 5<br>2000-2359 / 6<br><br>Prior to 1969, eastern daylight saving time was used whenever in effect (usually April to October - check records for individual years); beginning with 1969 punch Eastern Standard Time on all cards. "Use time at beginning of trawl haul." |
| Depth | 22-24 | 3 | Midpoint between beginning and ending depth during trawl haul. Note this may not represent average depth if bottom very irregular. |
| Species | 25-27 | 3 | See species code list, Table 8. Prior to 1962 coded yoy haddock separately as 071. Beginning with Delaware 62-12 included all haddock under code 074. The species code system is somewhat arbitrary, and often cannot be expanded in a systematic fashion as new species are added because all the numbers are used up within the original interval assigned to a group. |

Table 1. (Cont.)

| Type of Information | Columns | Possible number of digits | Coding Details |
|---|---|---|---|
| Gear | 28-29 | 2 | Code with 2 digits. |

| TRAWL Type | Code (1st digit) | RIGGING Type | Code (2nd digit) |
|---|---|---|---|
| #36 Yankee | 1 | Liner, rollers | 1 |
| 1-1/2 Iceland | 2 | Liner, chain sweep rope | 2 |
| #35 | 3 | Unlined, rollers | 3 |
| #41 | 4 | Unlined, chain sweep | 4 |
| Isaac-Kidd | 5 | Liner, rollers, 10 fm ground cable | 5 |
| M & M Midwater | 6 | | |
| Mark II Universal | 7 | | |
| 27.1 m (Soviet) | 8 | Unlined, comb. sweep | 8 |

| Duration of Tow | 30 | 1 |
|---|---|---|

| Pre - 1968 Minutes | Code | Begn. Alb. IV 68-3 Minutes | Code |
|---|---|---|---|
| 10 | 1 | 20 | 1 |
| 15 | 2 | 20-24 | 2 |
| 20 | 2 | 25-35 | 3 |
| 30 | 3 | 35 | 4 |
| 40 | 4 | | |
| 50 | 5 | | |
| 60 | 6 | | |
| 70 | 7 | | |
| 80 | 8 | | |
| 90 | 9 | | |
| Other | 0 | | |

| Condition of Gear | 31 | 1 |
|---|---|---|

| Code | Gear Condition |
|---|---|
| 0 | No damage, haul representative. |
| 1 | Slight damage, haul representative. |
| 2 | Serious damage or malfunction, haul not representative. |
| 3 | Possible damage or malfunction, but insufficient information - catch data may not be representative. |

Table 1. (Cont.)

| Type of Information | Columns | Possible number of digits | Coding Details | |
|---|---|---|---|---|
| Bottom Temperature | 32-33 | 2 | Coded to nearest whole degree. °F prior to Albatross IV 63-5. °C beginning with Albatross IV 63-5. | |
| Statistical Subarea | 34-36 | 3 | Correspond with statistical areas used for commercial data. Beginning coding with Albatross IV 63-5. Prior to Albatross IV 64-13, the entire area west of 71°40' was coded 600; beginning with Albatross IV 64-13 and thereafter, the statistical subareas used are shown in Figure 3 with the following exception: From cruise 64-13 through cruise 67-20 (including Soviet Albatros 67-20), the hatched part of subarea 537 was coded 526, and the unhatched part of 537 was coded 527. Beginning with Albatross IV cruise 68-3, subarea 537 was used as shown on Figure 3. | |
| Bottom (sediment) Type | 38-39 | 2 | Coded only for following surveys (when bottom sample obtained with pipe attached to trawl): Albatross IV 64-13, 65-2, 65-10, 65-14, 66-1. See sediment code, Table 7. | |
| Wire Out | 40-42 | 3 | Main trawl wire out in fathoms. | Begin coding with Albatross IV 68-17. |
| Coarse | 43-44 | 2 | Midpoint of ship's heading while towing, degrees/10; for example 140° = 14. If course changed more than 90°, punch 99. | " " " |
| Wind Direction | 45-46 | 2 | Direction from which wind is blowing in degrees/10. If no wind punch 99. | " " " |
| Wind Speed | 47-48 | 2 | Speed of wind in miles per hour. If no wind punch 00. | " " " |
| Wave Height | 49-50 | 2 | Height of waves in feet. If no waves, or less than 1 foot, punch 00. | " " " |

Table 1. (Cont.)

| Type of Information | Columns | Possible number of digits | Coding Details | |
|---|---|---|---|---|
| Minimum Trawl Depth | 51-52 | 2 | Minimum depth recorded (fathoms/10) during trawl haul, e.g. 85 fathoms = 08. Requires that an echo trace record be available. | Begin coding with Albatross IV 68-17. |
| Maximum Trawl Depth | 53-54 | 2 | Maximum depth recorded (fathoms/10) during trawl haul, e.g. 195 fathoms = 20. | " " " |
| Tow Distance | 55-57 | 3 | Distance towed over bottom in miles and hundredths. Data not yet available. | Space available on card. |
| Average Towing Speed Over Bottom | 58-59 | 2 | Speed over bottom in miles and tenths. Data not yet available. | " " " |
| Miscellaneous | 60-65 | 6 | Perhaps tidal currents and trawl configuration. Data not yet available. | " " " |
| Length Frequency Expansion Factor | 66-69 | 4 | Factor (to two decimal places) by which sample length frequency must be multiplied. | Begin coding with Albatross IV 68-17. |
| Weight of Catch | 70-75 | 6 | Total net weight (lb) of catch of species in given tow. | |
| Number of Catch | 76-79 | 4 | Total number of species in given haul; will require two cards if number $>9999$. | |
| Card Type | 80 | 1 | Punch 1 for card type 1. | |

Table 2. Format of card type 2. Length Frequency data.

| Type of Information | Columns | Possible number of digits | Coding Details |
|---|---|---|---|
| Cruise Code Number | 1-3 | 3 | SAME AS FOR CARD TYPE 1 |
| Station Number | 4-7 | 4 | |
| Bottom Temperature | 8-9 | 2 | |
| Month and Year | 10-13 | 4 | |
| Cruise Purpose | 14 | 1 | |
| Latitude and Longitude | 15-20 | 6 | |
| Time | 21 | 1 | |
| Depth | 22-24 | 3 | |
| Species | 25-27 | 3 | |
| Length Frequency Sequence | 28-29 | 2 | Sequence 01, 1-15 cm; sequence 02, 16-30 cm, etc. |
| Sex | 30 | 1 | Male = 1, female = 2, unsexed = blank. |
| Length Frequency | 31-75 | -- | Note there are 3 columns for each length, therefore if frequency at any length exceeds 999, need more than one card for the sequence. |
| Total Number Fish on Card | 76-79 | 4 | Represents total number of fish for given length frequency sequence number on card - may need more than one card. |
| Card Type | 80 | 1 | Punch 2 for card type 2. |

Table 3. Format of card type 3. Age frequency data.

| Type of Information | Columns | Possible number of digits | Coding Details |
|---|---|---|---|
| Station Data and Species Code | 1-27 | -- | Same as card type 2. |
| Length of Fish | 28-30 | 3 | Length (to nearest whole centimeter) of group of fish. |
| Age Frequency | 31-75 | -- | Three columns for frequency at each age; ages are from 0-14 as shown on card. |
| Total Number Fish at given Length | 76-79 | 4 | Sum of age frequencies for specified length. |
| Card Type | 80 | 1 | Punch 3 for card type 3. |

Table 4. Format of card type 4. Station data identical with card 1; total catch in numbers and pounds for all species combined.

| Type of Information | Columns | Possible number of digits | Coding Details |
|---|---|---|---|
| Station Data | 1-57 | | Exact duplicate of card #1 except that there is nothing in columns 25-27 (species code); there is only one station card for each trawl station. |
| Weight of Catch | 68-72 | 5 | Weight of total catch in pounds of all species combined for given trawl station. |
| Number in Catch | 73-79 | 7 | Total number fish (all species combined) in catch at given trawl station. |
| Card Type | 80 | 1 | Punch 4 for card type 4. |

Table 5. Format of card type 5. Station Index. (First used for Albatross IV 69-2).

| Type of Information | Columns | Possible number of digits | Coding Details |
|---|---|---|---|
| Cruise Code Number | 1-3 | 3 | Same on all card types. |
| Stratum | 4-5 | 2 | Same on all cards beginning with Albatross IV 63-5. |
| Tow Within Stratum | 5-6 | 2 | Same on all cards beginning with Albatross IV 63-5. Note again that numbering of tows within strata is chiefly to provide identification and a count, and bears no relation to the actual cruise track. |
| Sequential Number of Trawl Station | 8-10 | 3 | Number of bottom trawl station following sequence of cruise track. |
| BT Station Number | 11-13 | 3 | Number of BT station following sequence of cruise track. |
| Other Station Type | 14 | 1 | To be used for routine stations such as: Plankton (1), Midwater trawl (2), hydrographic (3), etc. |
| Other Station Number | 15-17 | 3 | Number of other station following sequence of cruise track. |
| Time | 18-21 | 4 | Station time to nearest minute, Eastern Standard Time, on 24-hour clock basis. Represents start of trawl (or other) station; or time of cast if only BT taken. |
| Quadrangle | 24 | 1 | 1° blocks are subdivided into four 30-minute quadrangles numbered as follows: 4 3 / 2 1 Leave blank if no BT taken. |
| Latitude | 25-28 | 4 | Latitude of station in degrees and minutes represents BT latitude if within 2 minutes of corresponding trawl (or other) station. |
| Longitude | 29-32 | 4 | Longitude of station in degrees and minutes, represents BT longitude as for latitude. |
| Month | 33-34 | 2 | As on other cards. |
| Day | 35-36 | 2 | As on other cards. |
| Year | 37-38 | 2 | As on other cards. |

Table 5. (Cont.)

| Type of Information | Columns | Possible number of digits | Coding Details |
|---|---|---|---|
| Depth Zone | 39 | 1 | Depth of bottom in meters as indicated by BT and coded as follows:<br><br>Code — Depth (meters)<br>1 — 1-20<br>2 — 21-40<br>3 — 41-60<br>4 — 61-80<br>5 — 81-100<br>6 — 101-150<br>7 — 151-200<br>8 — 201-250<br>9 — > 250<br><br>If no BT record, col. 39 should be left blank. |
| Comparison of BT and Trawl (or other) station depth | 40 | 1 | Column 40 left blank if BT and coded trawl (or other) station depth within 20 meters or if no BT record. If depths of corresponding BT and trawl (or other) stations differ by more than 20 meters, punch 1. See station card listing for trawl station depth. |
| Depth | 41-44 | 4 | Depth of bottom in meters as indicated by BT. If BT did not reach bottom, or if no BT taken, punch depth (in meters) fished by trawl. If neither BT nor bottom trawl station made, depth at other station alone is coded. |
| Bottom Temperature | 45-48 | | Temperature at bottom in degrees and tenths, centigrade. Column 48 represents tenths of a degree - decimal point is not punched. |
| Surface Temperature | 49-52 | | Temperature at surface, same format as for bottom temperature. |

Table 6. Groundfish Survey Station Index[1/]

Vessel _____ Cruise _____

| Cruise Code No. (3) | Survey Stratum (2) | Bottom trawl tow (2) | Seq. bottom trawl sta. (3) | BT Sta. (3) | OTHER STA. Type (1) | OTHER STA. Seq. No. (3) | Time (4) | Quad (1) | LAT. Deg. (2) | LAT. Min. (2) | LONG. Deg. (2) | LONG. Min. (2) | Mo. (2) | Day (2) | Yr. (2) | Depth zone (1) | Depth meters (4) | TEMP °C[2/] Bottom (4) | TEMP °C[2/] Surface (4) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

1/ Note that this index and corresponding card format were first designed in January 1969, and they were used for the first time on Albatross IV 69-2. Numbers in ( ) represent number of columns on data card.

2/ Last digit of temperature represents tenths of °C.

Table 7. Codes for Bottom types

| SEDIMENT TYPES | IBM CODE | SEDIMENT TYPES | IBM CODE |
|---|---|---|---|
| Gravel | 01 | Clay | 27 |
| Sandy gravel | 02 | | 28 |
| Muddy gravel | 03 | | 29 |
| Silt gravel | 04 | Shell | 30 |
| Gravelly sand | 05 | Gravelly shell | 31 |
| Pebbly sand | 06 | Sandy shell | 32 |
| Tilloid (S Si C G) | 07 | Shelly gravel | 33 |
| | 08 | | |
| | 09 | | |
| Sand | 10 | | |
| Silty sand | 11 | | |
| Muddy sand | 12 | | |
| Clayey sand | 13 | | |
| | 14 | | |
| | 15 | | |
| | 16 | | |
| | 17 | | |
| | 18 | | |
| | 19 | | |
| Sandy silt | 20 | | |
| Silt | 21 | | |
| Clayey silt | 22 | | |
| Sand-silt-clay | 23 | | |
| Sandy mud | 24 | | |
| Sandy clay | 25 | | |
| Silty clay | 26 | | |

Table 8. Species code list used for groundfish surveys (cumulative list up through February, 1969).

80-80 LISTING PREPARED BY BCF ADP UNIT ON 0 PAGE 1

| | |
|---|---|
| HAGFISH | 001 MYXINE GLUTINOSA |
| SEA LAMPREY | 002 PETROMYZON MARINUS |
| DUSKY SHARK | 003 CARCHARHINUS OBSCURUS |
| | 004 DASYATIS CENTROURA |
| UNCL RAY | 005 |
| BASKING SHARK | 006 CETORHINUS MAXIMUS |
| BLACK DOGFISH | 007 CENTROSCYLLIUM FABRICII |
| ROUGH SAGRE | 008 ETMOPTERUS PRINCEPS |
| BROWN SHARK SANDBAR SHARK | 009 CARCHARHINUS MILBERTI |
| DOGFISH UNCL | 010 |
| SHARK UNCL | 011 |
| SAND SHARK | 012 CARCHARIAS TAURUS |
| SMOOTH DOGFISH | 013 MUSTELUS CANIS |
| CHAIN DOGFISH | 014 SCYLIORHINUS RETIFER |
| SPINY DOGFISH | 015 SQUALUS ACANTHIAS |
| ANGEL SHARK | 016 SQUATINA DUMERILI |
| BLUE SHARK | 017 PRIONACE GLAUCA |
| BLUNT NOSE STING RAY | 018 DASYATIS SAYI |
| BULL NOSE RAY | 019 MYLIOBATIS FREMINVILLEI |
| SKATE UNCL | 020 |
| TORPEDO | 021 TORPEDO NOBILIANA |
| BARNDOOR | 022 RAJA LAEVIS |
| BIG SKATE WINTER SKATE | 023 RAJA OCELLATA |
| BRIER SKATE CLEAR NOSE | 024 RAJA EGLANTERIA |
| LEOPARD SKATE | 025 RAJA GARMANI |
| LITTLE COMMON SKATE | 026 RAJA ERINACEA |
| SMOOTH TAILED OR PRICKLY SKATE | 027 RAJA SENTA |
| THORNY SKATE | 028 RAJA RADIATA |
| STING RAY | 029 DASYATIS AMERICANUS |
| HERRING UNCL | 030 |
| POUND HERRING | 031 ETRUMEUS SADINA |
| SEA HERRING | 032 CLUPEA HARENGUS |
| ALEWIFE | 033 ALOSA PSEUDOHARENGUS |
| BLUEBACK | 034 ALOSA AESTIVALIS |
| SHAD | 035 ALOSA SAPIDISSIMA |
| MENHADEN | 036 BREVOORTIA TYRANNUS |
| HICKORY SHAD | 037 ALOSA MEDIOCRIS |
| CAPELIN | 038 MALLOTUS VILLOSUS |
| ANCHOVY | 043 ANCHOA MITCHILLI |
| STRIPED ANCHOVY | 044 ANCHOA HEPSETUS |
| SMELT | 045 OSMERUS MORDAX |
| ARGENTINE | 046 ARGENTINA SILUS |
| CHLOROPTHALMID | 047 |
| GLACIER LANTERN FISH | 051 BENTHOSEMA GLACIALE |
| MADEIRA LANTERN FISH | 052 LAMPANYCTUS SP |
| HUMBOLDTS LANTERN FISH | 053 MYCTOPHUM HUMBOLDTI |
| HORNED LANTERN FISH | 054 CERATOSCOPELUS MADERIENSUS |
| SPOTTED LANTERN FISH | 055 MYCTOPHUM PUNCTATUM |
| KROYERS LANTERN FISH | 056 NOTOSCOPELUS KROYERI |
| EEL UNCL | 060 |

Table 8. (Cont.)

80-80 LISTING PREPARED BY BCF ADP UNIT ON 0 PAGE 2

| | |
|---|---|
| AMER CONGER EEL | 063 CONGER OCEANICUS |
| SLIME EEL | 064 SIMENCHELYS PARASITICUS |
| SHARP EEL | 065 OMOCHELYS CRUENTIFER |
| HALFBEAK | 066 HYPORHAMPHUS UNIFASCIATUS |
| DEEP SEA SNIPE EEL | 067 NEMICHTHYS SCOLOPACEUS |
| GARFISH | 068 ABLENNES HIANS |
| OFFSHORE HAKE BLACK | 069 MERLUCCIUS ALBIDUS |
| YY HADDOCK | 071 |
| SILVER HAKE WHITING | 072 MERLUCCIUS BILINEARIS |
| COD | 073 GADUS MORHUA |
| HADDOCK | 074 MELANOGRAMMUS AEGLEFINUS |
| POLLOCK | 075 POLLACHIUS VIRENS |
| WHITE HAKE | 076 UROPHYCIS TENUIS |
| RED HAKE SQUIRREL | 077 UROPHYCIS CHUSS |
| SPOTTED HAKE | 078 UROPHYCIS REGIUS |
| LONG FINNED HAKE | 079 UROPHYCIS CHESTERI |
| HAKE UNCL | 080 |
| BLUE HAKE | 081 ANTIMORA ROSTRATA |
| HAKELING | 082 PHYSICULUS FULVUS |
| 4 BEARDED ROCKLING | 083 ENCHELYOPUS CIMBRIUS |
| CUSK | 084 BROSME BROSME |
| 3 BEARDED ROCKLING | 085 GAIDROPSARUS ENSIS |
| GRENADIER UNCL | 090 |
| COMMON GRENADIER MARLIN SPIKE | 091 MACROURUS BAIRDII |
| RGH HEADED GRENADIER | 092 MACROURUS BERGLAX |
| LG NOSED GRENADIER | 093 COELORHYNCHUS CARMINATUS |
| GREENLAND HALIBUT | 099 REINHARDITUS HIPPOGLOSSOIDES |
| FLOUNDER UNCL | 100 |
| HALIBUT | 101 HIPPOGLOSSUS HIPPOGLOSSUS |
| AMERICAN DAB | 102 HIPPOGLOSSOIDES PLATESSOIDES |
| FLUKE | 103 PARALICHTHYS DENTATUS |
| 4 SPOTTED FLOUNDER | 104 PARALICHTHYS OBLONGUS |
| YELLOWTAIL FLOUNDER | 105 LIMANDA FERRUGINEA |
| WINTER FLOUNDER | 106 PSEUDOPLEURONECTES AMERICANUS |
| WITCH FLOUNDER GREY SOLE | 107 GLYPTOCEPHALUS CYNOGLOSSUS |
| SAND FLOUNDER WINDOWPANE | 108 SCOPHTHALMUS AQUOSUS |
| GULFSTREAM FLOUNDER | 109 CITHARICHTHYS ARCTIFRONS |
| DEEPWATER FLOUNDER | 110 MONOLENE SESSILICAUDA |
| LONG SPINE SNIPE FISH | 111 MACRORHAMPHOSUS SCOLOPAX |
| JOHN DORY | 112 ZENOPSIS OCELLATA |
| ATLANTIC SILVERSIDE | 113 MENIDIA MENIDIA |
| | 114 HYPOCLYDONIA BELLA |
| 3 SPINED STICKLEBACK | 115 GASTEROSTEUS ACULEATUS |
| PIPEFISH | 116 SYNGNATHUS FUSCUS |
| SMALLMOUTH FLOUNDER | 117 ETROPUS MICROSTOMUS |
| HOGCHOKER | 118 TRINECTES MACULATUS |
| TRUMPET FISH | 119 AULOSTOMUS MACULATUS |
| CORNET FISH | 120 FISTULARIA TABACARIA |
| MACKEREL | 121 SCOMBER SCOMBRUS |
| SAUREL | 122 TRACHURUS TRACHURUS |

Table 8. (Cont.)



| | |
|---|---|
| COMMON BONITO | 123 SARDA SARDA |
| CHUB MACKEREL | 124 SCOMBER COLIAS |
| WAHOO | 125 ACANTHOCYBIUM SOLANDERI |
| ATLANTIC CUTLASSFISH | 126 TRICHIURUS LEPTURUS |
| | 127 PROMETHICHTHYS PROMETHEUS |
| JOHNSON SEA BREAM | 130 TARACTES PRINCEPS |
| BUTTERFISH | 131 PORONOTUS TRIACANTHUS |
| MOON FISH | 132 VOMER SETAPINNIS |
| ATLANTIC LOOK DOWN | 133 SELENE VOMER |
| BIG EYE | 134 PRIACANTHUS ARENATUS |
| BLUEFISH | 135 POMATOMUS SALTATRIX |
| CROAKER | 136 MICROPOGON UNDULATUS |
| | 138 CHEILODIPTERUS SPP |
| STRIPED BASS | 139 ROCCUS SAXATILIS |
| WHITE PERCH | 140 ROCCUS AMERICANUS |
| SEA BASS | 141 CENTROPRISTES STRIATUS |
| PIGFISH | 142 ORTHOPRISTIS CHRYSOPTERUS |
| SCUP | 143 STENOTOMUS CHRYSOPS |
| WEAKFISH | 145 CYNOSCION RAGALIS |
| KINGFISH | 146 MENTICIRRHUS SAXATILIS |
| BLACK DRUM | 147 POGONIAS CROMIS |
| SILVER PERCH | 148 BAIRDIELLA CHRYSURA |
| SPOT | 149 LEIOSTOMUS XANTHURUS |
| TILEFISH | 151 LOPHOLATILUS CHAMAELEONTICEPS |
| SCALY HEAD SCORPION FISH | 154 PONTINUS LONGISPINIS |
| REDFISH ROSEFISH | 155 SEBASTES MARINUS |
| BLACK BELLIED REDFISH | 156 HELICOLENUS DACTYLOPTERUS |
| BOARFISH | 158 ANTIGONIA CAPROS |
| HOOK EARED SCULPIN | 159 ARTEDIELLUS UNCINATUS |
| SCULPIN UNCL | 160 |
| MAILED SCULPIN | 161 TRIGLOPS OMMATISTIUS |
| SHT HORNED SCULPIN | 162 MYOXOCEPHALUS SCORPIUS |
| LG HORNED SCULPIN | 163 MYOXOCEPHALUS OCTODECEMSPINOSUS |
| SEA RAVEN | 164 HEMITRIPTERUS AMERICANUS |
| ALLIGATOR FISH | 165 ASPIDOPHOROIDES MONOPTERYGIUS |
| GRUBBY LITTLE SCULPIN | 166 MYOXOCEPHALUS AENEUS |
| STRIPED SEA SNAIL | 167 LIPARIS LIPARIS |
| LUMPFISH | 168 CYCLOPTERUS LUMPUS |
| SPINY LUMPFISH | 169 EUMICROTREMUS SPINOSUS |
| SEA SNAIL | 170 NEOLIPARIS ATLANTICUS |
| NORTHERN SEA ROBIN | 171 PRIONOTUS CAROLINUS |
| STRIPED SEA ROBIN | 172 PRIONOTUS EVOLANS |
| ARMORED SEA ROBIN | 173 PERISTEDION MINIATUM |
| SEA ROBIN UNCL | 174 |
| FLYING GURNARD | 175 DACTYLOPTERUS VOLITANS |
| CUNNER | 176 TAUTOGOLABRUS ADSPERSUS |
| TAUTOG | 177 TAUTOGA ONITIS |
| | 178 HYPSICOMETES GOBIOIDES |
| NORTHERN STARGAZER | 179 ASTROSCOPUS GUTTATUS |
| ROCK EEL | 180 PHOLIS GUNNELLUS |

Table 8. (Cont.)

80-80 LISTING PREPARED BY BCF ADP UNIT ON D PAGE 4

| | | |
|---|---|---|
| SAND LAUNCE | 181 | AMMODYTES AMERICANUS |
| SNAKE BLENNY | 182 | LUMPENUS LUMPRETAEFORMIS |
| SHANNY | 183 | LEPTOCLINUS MACULATUS |
| RADIATED SHANNY | 184 | ULVARIA SUBBIFURCATA |
| TOADFISH | 185 | OPSANUS TAU |
| POLKA DOT CUSK EEL | 186 | OTOPHIDIUM OMASTIMUM |
| RED GOATFISH | 187 | MULLUS AURATUS |
| STRIPED CUSK EEL | 188 | RISSOLA MARGINATA |
| ARCTIC EEL POUT | 189 | LYCODES RETICULATUS |
| WOLF EEL | 190 | LYCENCHELYS VERRILLII |
| WRYMOUTH | 191 | CRYPTACANTHODES MACULATUS |
| WOLF FISH | 192 | ANARHICHAS LUPUS |
| OCEAN POUT EEL POUT | 193 | MACROZOARCES AMERICANUS |
| CUSK EEL | 194 | LEPOPHIDIUM CERVINUM |
| DEEP SEA PUFFER SMOOTH PUFFER | 195 | LAGOCEPHALUS LAEVIGATUS |
| NORTHERN PUFFER | 196 | SPHAEROIDES MACULATUS |
| AMERICAN GOOSEFISH | 197 | LOPHIUS AMERICANUS |
| PORCUPINEFISH | 198 | CHILOMYCTERUS SCHOEPFII |
| FROGFISH ATLANTIC BATFISH | 199 | DIBRANCHUS ATLANTICUS |
| GUTTAR FISH | 200 | RHINOBATOS LENTIGINOSUS |
| PLANE HEAD FILE FISH | 201 | MONACANTHUS HISPIDUS |
| TRIGGERFISH | 202 | BALISTES CAROLINENSIS |
| GREATER AMBERJACK | 203 | SERIOLA DUMERILI |
| RUDDERFISH | 204 | SERIOLA ZONATA |
| NEEDLEFISH | 205 | SCOMBERESOX SAURUS |
| BATFISH | 206 | OGCOCEPHALUS VESPERTILIO |
| BARRELFISH | 207 | PALINURICHTHYS PERCIFORMIS |
| MACKEREL SCAD | 208 | DECAPTERUS MACARELLUS |
| BIG EYE SCAD | 209 | SELAR CRUMENOPTHALMUS |
| HEADLIGHT FISH | 210 | DIAPHUS DUMERILII AETHOPRORA METOPOCLAM |
| ROUND SCAD | 211 | DECAPTERUS PUNCTATUS |
| ROUGH SCAD | 212 | TRACHURUS LATHAMI |
| STROMATEOID | 213 | ARIOMMA BONDI |
| HOUNDFISH | 215 | STRONGYLURA RAPHIDOMA |
| LANTERN FISH UNCLASS | 220 | |
| TONGUE FISH | 221 | SYMPHURUS SP |
| | 227 | NESIARCHUS NASUTUS |
| | 228 | STOMIAS AFFINIS |
| | 229 | MAUROLICUS MUELLERI |
| PEARLSIDES | 230 | MAUROLICUS PENNANTI |
| | 231 | CHLOROPTHALMUS CHALYBEIUS |
| GREEN EYE | 232 | CHLOROPTHALMUS AGASSIZII |
| LONG TOOTH ANGLE MOUTH | 235 | GONOSTOMA ELONGATUM |
| | 239 | BENTHODESMUS ATLANTICUS |
| VIPERFISH | 240 | CHAULIODUS SLOANI |
| | 245 | PARALEPIS BOREALIS ATLANTICA |
| | 246 | NOTOLEPIS RISSOI |
| | 247 | NOTOLEPIS RISSOI KROYERI |
| STOMIATID UNCLASS | 248 | |
| SILVER HATCHET FISH | 250 | ARGYROPELECUS ACULEATUS |

Table 8. (Cont.)

80-80 LISTING PREPARED BY BCF ADP UNIT ON D PAGE 5

| | | |
|---|---|---|
| HATCHET FISH | 251 | POLYIPNUS ASTEROIDES |
| | 260 | CAREPPOCTUS RANULAS |
| | 261 | HOPLOSTETHUS MEDITERRANEUS |
| SOFT POUT | 262 | MELANOSTIGMA ATLANTICUM |
| BEARD FISH | 263 | POLYMIXIA LOWEI |
| | 264 | POLYMIXIA NOBILIS |
| GULF SEA ROBIN | 274 | PRIONOTUS PARALATUS |
| AMERICAN STRAPTAIL GRENADIER | 280 | MALACOCEPHALUS OCCIDENTALIS |
| | 281 | YARNELLA BLACKFORDI |
| SWORDFISH | 290 | XIPHIAS GLADIUS |
| LOBSTER | 301 | HOMARUS AMERICANUS |
| SHRIMP UNCL | 305 | |
| SEA SCALLOP | 401 | PLACOPECTEN MAGELANICUS |
| SQUID UNCLASS | 501 | |
| SHORT FINNED SQUID | 502 | ILLEX ILLECEBROSUS |
| LONG FINNED SQUID | 503 | LOLIGO PEALEI |
| BRIEF SQUID | 504 | LOLLIGUNCULA BREVIS |

CARD COUNT 217

## PART II

## INITIAL HAND PROCESSING

### A. Need for Hand Processing

The data routinely recorded for each trawl catch represents a considerable quantity of information, and we have found that accuracy and completeness of the catch records require the use of a simple log format as well as minimizing the actual amount of recording at sea (see Lab Report #69-2 for discussion of trawl log format in relation to recording and sampling procedures). However as a result of simplifying the recording process at sea, it is necessary to do some coding and computing by hand back at the laboratory to put the data in a form suitable for efficient punching onto cards. At the same time it is desirable to check by hand all the data on each log for gross errors, some of which cannot be detected by existing computer audits.

There are basically two kinds of data on the trawl log, station data and trawl catch data. Station data are recorded on one side of the trawl log along with length frequency data (Figure 5), and the data on weight, volume and length frequency of the catch including sampling information, are recorded on the other side (Figure 6). Both types of data must be checked and coded for punching. Station data are coded in a special array of "boxes" along the bottom of the log (Figure 5). Coding of catch data involves simply entering species code numbers as shown in figures 5 and 6.

In addition to species code numbers, the total catch (lb. net, and number of fish) of each species and factors for expanding length frequency samples, must be computed by hand, and recorded on the log (Figure 6). These steps are specifically omitted from the recording process at sea because of the high probability of error. This is the most time-consuming and one of the most important steps in the entire processing sequence since these hand-computed values are compared with values generated by computer, and these comparisons form the basis for the computer audits of the catch data. This hand processing is referred to as initial because the later computer audits also require checking by hand, but usually this task is small relative to the initial hand processing.

| | Silver hake | | Haddock | |
|---|---|---|---|---|
| 1 | 1 | | 1 | |
| 2 | 2 | | 2 | 1 |
| 3 | 3 | | 3 | |
| 4 | 4 | | 4 | |
| 5 | 5 | | 5 | |
| 6 | 6 | 2 | 6 | |
| 7 | 7 | | 7 | |
| 8 | 8 | | 8 | 1 |
| 9 | 9 | 1 | 9 | |
| 0 | 30 | 1 | 30 | |
| 1 | 1 | 2 | 1 | 2 |
| 2 | 2 | 2 | 2 | |
| 3 | 3 | 2 | 3 | 1 |
| 4 | 4 | 1 | 4 | 2 |
| 5 | 5 | 1 | 5 | 3 |
| 6 | 6 | 1 | 6 | 5 |
| 7 | 7 | 4 | 7 | 7 |
| 8 | 8 | 2 | 8 | 6 |
| 9 | 9 | 3 | 9 | 3 |
| 0 | 40 | 5 | 40 | 4 |
| 1 | 1 | 4 | 1 | 3 |
| 2 | 2 | 7 | 2 | 2 |
| 3 | 3 | 2 | 3 | 1 |
| 4 | 4 | 3 | 4 | |
| 5 | 5 | 2 | 5 | |
| 6 | 6 | 1 | 6 | 1 |
| 7 | 7 | | 7 | |
| 8 | 8 | | 8 | |
| 9 | 9 | 1 | 9 | 47 |
| | | 47 | | |

| Round Herring | |
|---|---|
| 10 | 13 |
| 11 | 25 |
| 12 | 2 |
| | 40 |

| VESSEL | CRUISE | TRAWL STATION | STRATUM-TOW | BT SLIDE NO. |
|---|---|---|---|---|
| Alb IV | 68-3 | 88 | 08 01 | 122 |

| DAY | MONTH | YEAR | OTHER STATION |
|---|---|---|---|
| 15 | III | 68 | Plankton 83 |

| TRAWL | WIRE OUT | SPEED | COURSE |
|---|---|---|---|
| #36 Stand. Survey | 450 fm | 3.5 Kts | 075-090° |

| → | TIME | DEPTH | LATITUDE | LONGITUDE | LITTON LOG |
|---|---|---|---|---|---|
| START | 2133 | 165 | 40-00.5 | 71-16 | 8458.35 |
| END | 2203 | 170 | 40-01 | 71-13.5 | 8460.49 |

| → | IH 4 | LORAN IH 5 | COND. OF TRAWL |
|---|---|---|---|
| START | 5330 | 1959 | Small tear in lower belly |
| END | 5347 | 1941 | |

| OTHER GEAR | WIRE OUT | SPEED | COURSE |
|---|---|---|---|
| Plankton (Bongos) | 65 m | 3.5 Kts | Simultaneous with trawl haul |

| → | TIME | DEPTH | LATITUDE | LONGITUDE | LITTON LOG |
|---|---|---|---|---|---|
| START | 2134 | To 50 meters | | | 8458.77 |
| END | 2151 | | | | 8459.84 |

NOTES ON SHIP OPERATIONS

Cod end of port Bongo untied - no sample

SPECIAL SAMPLES COLLECTED

Preserved Myctophids
One *Merluccius albidus* frozen
" white hake frozen

| CRUS | STR | TOW | DAY TEMP | MON | YEAR | PU | LAT. | LONG. | TM | DEPTH | GEAR | DR | NT | TEMP | AREA | BOT | WIRE OUT | CRSE | WIND DIR | WIND SPD | WAVE HT | DEPTH MIN | DEPTH MAX | TOW DIST | AVE SPEED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 803 | 08 | 01 | 1/0 5/4 | 03 | 68 | 1 | 400 | 711 | 6 | 168 | 11 | 3 | 1 | 04 | 537 | | 450 | 08 | 12 | 10 | 04 | | | | |

Figure 5. Sample groundfish survey trawl log, showing one side with station data and length frequencies.

| LENGTHS OF INDIVIDUAL FISH (CM) | SPECIES (use every other line when possible) | SPP CODE NO. | WEIGHED PART OF CATCH 1/ 1 BU. (lb. gross) | 2 BU. (lb. gross) | OTHER (lb. net) | DISCARD (Vol. or No.) | TOTAL CATCH (Vol.) | LF Expan. Factor | TOTAL CATCH LB(net) | NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Haddock | 074 | 62, (59), 65, 63 | | | | | 4.25 | 217 | 178 |
| | Round herring * | 031 | 45 | | | | | 15.00 | 37 | 600 |
| | Silver hake | 072 | 69, 62, (66) | | | 8 bu. | 11 bu. | 10.93 | 634 | 514 |
| | Scup * | 143 | 68, 66, 48 | | | 5 bu. | 7½ bu. | 26.65 | 453 | |
| | Spiny dogfish ♀ | 015 | | 113, 116, 116 | | 91 ♀'s | | 2.42 | 756 | 155 |
| | " " ♂ | 015 | 24 | | | | | 1.00 | 16 | 5 |
| | Mixed Species | | 68, 75, 74 2/ | | | 2 bu. | 5 bu. | | 322 | |
| | 3/ Spotted hake | 078 | 32 | | | | | 4.88 | 117 | 810 |
| | Butterfish * | 131 | | | 30 | | | 26.54 | 146 | 1776 |
| | Loligo | 503 | | | 12 | | | 4.88 | 59 | 444 |
| 63, 69, 78 | Cod | 073 | 39 | | | | | | 31 | 3 |
| | Sea herring | 032 | | | 3 | | | | 3 | 12 |

| Spiny Dogfish ♀ | | | Spiny Dogfish ♂ | | Loligo | | |
|---|---|---|---|---|---|---|---|
| | 015 | | | 015 | | | 503 |
| 1 | | | 1 | | 1 | 1 | |
| 2 | | | 2 | | 2 | 2 | |
| 3 | | | 3 | | 3 | 3 | |
| 4 | 1 | 1 | 4 | | 4 | 4 | |
| 5 | 1 | 1 | 5 | | 5 | 5 | |
| 6 | 1 | 1 | 6 | | 6 | 6 | |
| 7 | | | 7 | | 7 1 | 7 | 1 |
| 8 | | | 8 | | 8 ~~||||~~ || | 8 | 7 |
| 9 | // | 2 | 9 | | 9 ~~||||~~ ~~||||~~ ||| | 9 | 13 |
| 70 | 1 | 1 | 70 | 1 | 10 ~~||||~~ ~~||||~~ ~~||||~~ | 0 ~~||||~~ ~~||||~~ | 24 |
| 1 | /// | 3 | 1 | | 1 ~~||||~~ ~~||||~~ ~~||||~~ | 1 ~~||||~~ 1 | 21 |
| 2 | | | 2 | | 2 ~~||||~~ ~~||||~~ | 2 | 10 |
| 3 | 1 | 1 | 3 | | 3 ~~||||~~ ||| | 3 | 8 |
| 4 | 1 | 1 | 4 | 1 | 4 |||| | 4 | 4 |
| 5 | |||| | 4 | 5 | 5 ||| | 5 | 3 |
| 6 | // | 2 | 6 | 1 | 6 | 6 | |
| 7 | // | 2 | 7 | 1 | 7 Sea Herring | 7 | 91 |
| 8 | ~~||||~~ | 6 | 8 | | 8 | 8 | |
| 9 | ~~||||~~ | 6 | 9 | 1 at 89 | 9 | 9 | |
| 80 | |||| | 4 | 80 | 20 (032) | 0 | |
| 1 | /// | 3 | 1 | 5 | 1 1 | 1 | |
| 2 | ~~||||~~ | 5 | 2 | | 2 3 | 2 | |
| 3 | // | 2 | 3 | | 3 2 | 3 | |
| 4 | |||| | 4 | 4 | 4 3 | 4 | |
| 5 | // | 2 | 5 | | 5 2 | 5 | |
| 6 | // | 2 | 6 | | 6 1 | 6 | |
| 7 | // | 2 | 7 | | 7 | 7 | |
| 8 | /// | 3 | 8 | Spotted Hake | 8 12 | 8 | |
| 9 | /// | 3 | 9 | | 9 | 9 | |
| 90 | | | 0 | | 0 | 0 | |
| 1 | | | 1 | | 1 | 1 | |
| 2 | 1 | 1 | 2 | | 2 Butterfish | 2 | |
| 3 | | | 3 | (078) | 3 | 3 | |
| 4 | | | 4 | | 4 | 4 | (131) |
| 5 | 1 | 1 | 5 | | 5 | 5 | |
| 6 | | | 6 | 5 | 6 | 6 | |
| 7 | | | 7 | 11 | 7 | 7 | |
| 8 | | | 8 | 34 | 8 | 8 | |
| 9 | 1 | 1 | 9 | 33 | 9 | 9 | |
| 0 | | | 20 | 35 | 10 | 0 | |
| 1 | | 64 | 1 | 20 | 1 | 1 | 3 |
| 2 | | | 2 | 11 | 2 | 2 | 43 |
| 3 | | | 3 | 10 | 3 | 3 | 20 |
| 4 | | | 4 | 4 | 4 | 4 | 1 |
| 5 | | | 5 | 1 | 5 | 5 | |
| 6 | | | 6 | | 6 | 6 | 67 |
| 7 | | | 7 | 1 | 7 | 7 | |
| 8 | | | 8 | | 8 | 8 | |
| 9 | | | 9 | | 9 | 9 | |
| 0 | | | 30 | 1 | 0 | 0 | |
| | | | | 166 | | | |

1/ Always indicate: 1) Discard (vol. or no. neither weighed nor measured) and 2) measured part of catch if less than weighed part — circle gross wt. basket(s) measured, otherwise record net wt. (or vol.) measured if less than entire contents of basket.

* - Measured 1 container Rd. herring - counted 14 containers over the side

* - Measured 17 lb (net) of scup

2/ - Sorted only this basket and reweighed

3/ - Mixed species enclosed by bracket

* - Measured 5½ lb (net) butterfish

INVERT. CATCH NOT SHOWN ABOVE

2 bu. sponges

ON DUTY: Grosslein et. al.

Figure 6. Sample log showing other side with weight, volume and length frequency of catch including sampling information.

B. Computing Expansion Factors and Total Catch.

After entering species code numbers the first step in hand processing the trawl catch data is computation of expansion factors. These factors are used to estimate weight and (or) number, and length frequency of the total catch of individual species when only a sample of the catch is processed. It is suggested that this step be done as soon as possible following a cruise to maximize the chance that confused sampling records might be straightened out via recall by the people who were out at sea. Mistakes in interpretation of the size of sample relative to the total catch, have the potential for very large errors in the final expanded estimates - hence the reason for putting this step first and emphasizing timing.

Weight expansion factors are not recorded on trawl logs, and they are used only for hand computations and are not punched on cards. The length frequency (LF) expansion factor is the only expansion factor put on cards and it is punched on the #1 card. In routine production of the basic data deck of #1 and #2 cards with the present ADP system, only one LF expansion factor can be used per species per tow. This occasionally requires that expansions be done by hand rather than by computer. For example, if the catch of one species was sorted into two size groups, and a different fraction taken in the LF sample from each size group, the LF expansion must be done by hand and the code box for LF expansion factor left blank.

In the event that LF data are required by sex, as is presently the case for spiny dogfish, the LF data must be punched for each sex separately as if the two sexes were different species, and the resulting cards must be treated as special decks and filed separately from the basic deck of #1 and #2 cards. Whenever dogfish LF expansion is to be done by machine, it will be necessary to punch a #1 card for each sex for each haul, and to indicate sex on the #1 card by a special punch. The details of the coding and punching procedures are still being worked out. Whether or not LF expansions are required, the dogfish data must be combined by sex before it is put into the basic data deck of #1 and #2 cards.

The basic quantity represented by an expansion factor is the ratio of total catch to size of sample and units of weight are preferred because they are usually more accurate. Some examples will serve to illustrate the computations, and it will be convenient to refer to the sample log shown in Figure 6.

When the total catch is weighed and measured, as is frequently the case on Albatross IV, no expansions are necessary and this is shown for the last two species (cod and sea herring) which have no expansion factors recorded.

The most common case involving sampling is where the total catch of a single species is weighed but only a sample is measured, thus requiring only a LF expansion. For example 4 bushels of haddock were caught and weighed, and only one bushel (circled) was measured. This required calculation of a LF expansion factor as the ratio of total catch (lb, net) to LF sample (lb, net):

$$\frac{62 + 65 + 59 + 63 - (32)}{59 - (8)} = \frac{217}{51} = 4.25$$

Note that 1- bushel baskets weigh about 8 lb. and 2-bushel baskets weigh 11 lb.

Another variant of this procedure is where the total catch is weighed, but only a very small volume (too small to be weighed accurately by shipboard scales) is measured. In this case it is necessary to use a ratio of volumetric units to compute the LF expansion factor. For example, about 3/4 bushel of round herring were caught and weighed, but only one small plastic container was measured. It was necessary to determine the volume of total catch in terms of the number of full plastic containers. As shown in the notes on the log, 14 containers of round herring were counted over the side, and 1 container was measured. The LF expansion factor was therefore 15.

When a portion of the catch of a species is discarded, and only a sample is weighed and measured, it is necessary to estimate the total weight of the catch as well as expand the sample length frequency. On our sample log, 3 bushels of silver hake were weighed (one of which was measured, as indicated by the circle) and 8 bushels were discarded. The estimate of total weight of the catch is simply the average weight (lb, net)

of sample bushels times the total number bushels in the catch:

$$\frac{69 + 66 + 62 - 24}{3} \times 11 = 634 \text{ lb.}$$

The LF expansion factor for silver hake is:

$$\frac{634}{(66-8)} = 10.93$$

In the case of scup, about 7-2/3 bushels were caught of which 5 full bushels were discarded, 2-2/3 were weighed and of the partially full bushel, approximately 1/2 (i.e. 1/3 bushel) were measured. Here the estimated weight of the total catch would be computed as:

$$\left(\frac{68 + 66 - 16}{2}\right) (7) + (48 - 8) = 453 \text{ lb., net.}$$

Note that average weight per bushel was based only on the two full bushels in the sample, and the observed weight of the partially full bushel was simply added to the total. It is felt that weight is a more accurate measure of sample size than are estimates of the fullness of baskets. Therefore weight should be used routinely for computing expansion factors. Following this same reasoning the LF expansion factor for scup is computed as follows:

$$\frac{453}{17} = 26.65$$

Note that the subsample (17 lb., net) measured was recorded at the bottom of the log in the remarks section since it was already included in the recorded sample weight (48 lb., gross) of the partially full basket.

If weights are not available then expansion factors must be based on ratios of counts or volumes. For example if only the relative volume (approximately 1/3 bushel) of measured scup had been recorded, the approximate LF expansion factor would have been:

$$\frac{7\text{-}2/3}{1/3} = 23$$

Generally it is advisable to compare the expansion factor based on weight with that based on volume, as a check. If there is a large discrepancy, either weight or volume is incorrect, and at least the weight of sample can be compared with an independent estimate of weight based on average length-weight data.

In the case of large catches of large fish, chiefly spiny dogfish, it is often more convenient to count the total number of individuals and weigh and measure a sample. This procedure is illustrated on the sample logs for female dogfish, where 6 bushels (64 fish) were weighed and measured, and 91 females were discarded.

The total weight of the female catch must be estimated as the product of average weight of individual female dogfish in the sample, times the known total number in the catch:

$$\left(\frac{113 + 116 + 116 - 33}{64}\right) \times 155 = 756 \text{ lb.}$$

The LF expansion factor for females is:

$$\frac{756}{312} = 2.42 = \frac{155}{64}$$

Male dogfish were weighed and measured in entirety and therefore no expansions were required. Note that a separate #1 card is punched for each sex.

The most complicated type of sampling involves mixed species. On our sample log 5 bushels of "mixed" species were caught and 3 bushels were included in the weighed sample. Therefore estimated total weight of the mixed catch was:

$$\left(\frac{68 + 75 + 74 - 24}{3}\right) \times (5) = 322 \text{ lb.}$$

Only one bushel (74 lb., gross) was sorted into separate species, and the species composition was:

| Species | Sample (lb, net) | Proportion | Estimated Total (lb, net) |
|---|---|---|---|
| Spotted hake | 24 | .364 | 117 |
| Butterfish | 30 | .454 | 146 |
| Squid (Loligo) | 12 | .182 | 59 |
| | 66 | 1.000 | 322 |

The estimated total weight of each species is obtained by pro-rating the total (mixed species) on a proportional basis as shown here. Assuming that all baskets were uniformly filled it is clear that a simple ratio of total number baskets to the number of baskets sorted, would be a satisfactory weight expansion factor - in this case approximately 5. However baskets are not always uniformly filled, and furthermore the sum of weights of individual species often will not add up exactly to the same weight recorded

for the sample before sorting. Hence it is recommended that the proportional method illustrated above be used routinely when sampling mixed species.

Turning now to the LF expansions, all of the spotted hake and Loligo in the sorted sample were measured, therefore the LF expansion factor for both these species is:

$$\frac{322}{66} = 4.88$$

Note that this is the ratio of total weight to sample weight of the mixed species category, where sample weight refers only to the one bushel which was sorted. The factor is slightly less than 5 because the sorted basket was slightly heavier than the average weight of the three baskets that were weighed.

In the case of butterfish only 5-1/2 lb (net) were measured out of the 30 lb. derived from the sorted basket. The LF expansion factor for butterfish is estimated by the single ratio:

$$\frac{146}{5.5} = 26.54$$

The same ratio can be estimated as the product of (1) the proportion of the total mixed species catch that was sorted, on a weight basis (i.e. 4.88) and (2) the proportion of the sorted catch of butterfish that was measured, on a weight basis (i.e. 30/5.5 = 5.45). The product, 4.88 x 5.45 = 26.60, is the same as that computed above except for rounding errors. The former method is preferred since it is simpler.

C. Processing Length Frequencies.

After computation of total catch weights and LF expansion factors, the next step is to assemble LF tallies for punching. Species code numbers are entered, tally strokes are converted to number frequencies and summed and estimates of total numbers of individual fish are computed where expansions are required. The latter computation involves the product of the sample total (number of fish measured) and the LF expansion factor as illustrated on the sample log.

The vertical lines separating tally strokes or boxes from number frequencies should be used because they help increase the speed and accuracy of punching. Unordered lengths of individual fish (see Cod at extreme left of log) may be left in their original form although it is best to convert them to frequency format before punching.

D. Miscellaneous Instructions

Note that there is no code number recorded for mixed species even though there are entries on the line indicating sample size and estimated total weight. This is because none of this information is punched on cards - only the final estimates of catch of individual species. This should not be confused with the category "miscellaneous", code number 000, which is a legitimate code number sometimes used for fish without adequate identification. It is desirable to punch a separate weight ($\geq$ 1 lb) for each species even if you guess the approximate weight at the time you check the log; in cases of large catches the guessed weight can be replaced with a calculated weight from the final audit.

With the completion of hand processing of trawl catch data (including the coding of previously unidentified fish), and assuming all station data have been checked and coded, the trawl logs are ready to be sent to ADP for punching data onto cards. Further details on punching are discussed in Part III.

Concurrent with development of the final audit, the initial audit was made more comprehensive. That is, all of the station data were included in the #1 vs #2 card checks, and this expanded version of initial audit has also been applied to all Albatross IV survey decks.

B. Initial Audit

This audit is performed on a UNIVAC 9200 computer and it detects punching and recording errors by (1) matching the first 27 columns (exclusive of columns 8-9) on the #1 card with the same columns on the #2 cards for the corresponding species and tow, (2) comparing station data punched on both card types with a master card containing values specific for the cruise such as cruise code number, or acceptable limits for general items such as depth, temperature and location for each stratum, and (3) matching the total catch (number) of each species on #1 cards (columns 76-79) with the total number derived from corresponding #2 cards for each tow.

Item (1) checks for consistency of station data between card types #1 and #2, and item (2) checks for correctness of the station data relative to the master card. The consistency check is a valid verification because station data for each card type are punched independently - usually by different operators, or at different times if by the same operator. This check is important not only for eliminating errors but also because basic station data on both types of cards must match exactly for a given species and tow, in order that both types of card can be processed simultaneously by computer.

Item (3) is useful for detecting errors in punching, recording and (or) hand computations in the data on length frequency, expansion factors and total catch in numbers; missing data can also be detected (e.g. a #1 card without corresponding #2 cards or vice versa will appear as an error). Recall that the total number of each species measured is computed by hand, and these totals (or appropriate expansions) are entered on the log, and are punched on the #1 card along with any LF expansion factors. The only catch data punched on the #2 cards are the recorded sample length frequencies. Length frequency subtotals (for 15 cm intervals) are not punched onto the #2 cards by the keypunch operators, but are computed and punched later by the computer, after any expansion. Thus the actual comparison on the initial audit between the #1 and #2 card totals (number of fish) is between the #1 card total and the sum of sub-totals for all the #2 cards for the corresponding species and tow.

## PART III

## MACHINE PROCESSING

A. Development of Audit Procedures.

Prior to 1963 there were no machine audit procedures used on survey data and both #1 and #2 card listings (80-column) were laboriously compared with original data by eye. This was extremely inefficient and it was impossible to detect all errors, large or small. The situation improved considerably with development of the first version of the initial machine audit which compared #1 and #2 cards of corresponding stations, and detected discrepancies in part of the station data and in the total numbers of fish on #1 and #2 cards.

However, it was clear that a length frequency still could be grossly in error (e.g. offset 10 or 20 cm) even though the total number of fish was correct. Thus #2 card listings continued to be checked against original records by eye, tow by tow and species by species. This was still laborious and could not guarantee detection of all major errors in total weight or length frequency because occasionally the original records themselves were wrong. This was a problem chiefly where sample data had been incorrectly expanded to estimates of total catch. Such errors can be overlooked even when they involve hundreds of pounds or individuals.

The obvious need was for a computer audit to compare the observed average weight of individual fish with a theoretical average weight based on the observed length frequency and a length-round weight equation for the species. A computer program for such an audit was written in 1967 and was first used on data from the 1967 joint US-USSR survey. All Albatross IV cruises prior to and following the '67 survey have been put through this final audit.

The important gains achieved with the final audit are offset slightly by the fact that we no longer compare length frequency data listings against original records by eye. We have sacrificed some completeness in checking length frequency data in exchange for security against large errors in catch data which could not be detected with previous methods. We believe the gain far outweighs the loss because it is the large errors in terms of biomass of commercially important species with which we are primarily concerned.

A minor problem exists in that small discrepancies between these totals can arise simply because of "rounding errors" in applying fractional expansion factors, particularly when length frequencies are spread out and when the tails contain a substantial proportion of the total frequency. The initial audit will pick up any discrepancy, but in many cases these prove to be rounding errors only. In such cases the discrepancy need not be rectified. The only rounding errors spotlighted by the final audit are those where the discrepancy exceeds 10 percent of the #1 card total; therefore there is no problem of checking the same rounding errors twice.

Output of the initial audit is a listing of #1 and corresponding #2 cards in that order for each species and tow, with any discrepancies indicated by error flags on the listing (Figure 7). Definitions of error flags are given in Table 9. Discrepancies indicated on the initial audit listing are checked against original trawl logs and necessary corrections marked on the data cards for repunching. When corrections have been verified the #1 and #2 cards are ready for the final audit.

C. Final Audit.

1. General Description. The primary purpose of the final audit is to detect gross mistakes in weight or length frequency which cannot be detected by the initial audit, and at the same time re-check for the same errors looked for by the initial audit, in the event any may have slipped through (including missing cards, or cards out of order, either of which can foul up computer runs). The principal new feature in the final audit is the comparison of "observed" vs "calculated" weight for each total catch of each species, where "observed" weight is calculated by hand at the time the original logs are checked and coded, and "calculated" weight is derived from the total length frequency and a length-round weight relation. Stations for which deviations between "observed" and "calculated" weights exceed $\pm$ 25% are listed at the end of a run for each species, along with stations for which other kinds of discrepancies were detected. The final audit program requires considerable memory space and therefore a large computer is needed; currently we are using a GE 415.

CRUISE AUDIT LISTING PAGE 15

| CRU | STR | TOW | DY | MO | YR | P | LAT | LONG | TM | DEPTH | GEAR | TD | NET | TEM | AR | BTM | SP | SEQ | WGT | NO 1 | NO 2 | FLD2 | ERROR DIAGNOSTIC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 017 | 66 | 01 | 14 | 10 | 68 | 1 | 363 | 744 | 6 | 31 | 88 | 3 | 0 | 15 | 632 | 0 | 171 | | 9 | 15 | | | |
| 017 | 66 | 01 | | 10 | 68 | 1 | 363 | 744 | 6 | 31 | | | | 15 | | | 171 | 2 | | | 16 | 16 | |
| | | | | | | | | | | | | | | | | | | | | 15 | 16 | * | 0 |
| 017 | 66 | 01 | 14 | 10 | 68 | 1 | 363 | 744 | 6 | 31 | 88 | 3 | 0 | 15 | 632 | 0 | 503 | | 52 | 156 | | | |
| | | | | | | | | | | | | | | | | | | | | 156 | | * | 0 |
| | | | | | | | | | | | | | | | | | | | | 426 | 272 | * * | |
| 017 | 66 | 02 | 14 | 10 | 68 | 1 | 365 | 365 | 4 | 44 | 88 | 3 | 0 | 11 | 632 | 0 | 015 | | | 1 | | | I |
| 017 | 66 | 02 | | 10 | 68 | 1 | 365 | 365 | 4 | 44 | | | | 11 | | | 015 | 2 | | | 1 | 1 | I |
| | | | | | | | | | | | | | | | | | | | | 1 | 1 | * | |
| 017 | 66 | 02 | 14 | 10 | 68 | 1 | 365 | 365 | 4 | 44 | 88 | 3 | 0 | 11 | 632 | 0 | 077 | | 2 | 4 | | | I |
| 017 | 66 | 02 | | 10 | 68 | 1 | 365 | 365 | 4 | 44 | | | | 11 | | | 077 | 2 | | | 3 | 3 | I |
| 017 | 66 | 02 | | 10 | 68 | 1 | 365 | 365 | 4 | 44 | | | | 11 | | | 077 | 3 | | | 1 | 1 | I |
| | | | | | | | | | | | | | | | | | | | | 4 | 4 | * | |
| 017 | 66 | 02 | 14 | 10 | 68 | 1 | 365 | 365 | 4 | 44 | 88 | 3 | 0 | 11 | 632 | 0 | 171 | | 8 | 18 | | | I |
| 017 | 66 | 02 | | 10 | 68 | 1 | 365 | 365 | 4 | 44 | | | | 11 | | | 171 | 2 | | | 17 | 17 | I |
| 017 | 66 | 02 | | 10 | 68 | 1 | 365 | 365 | 4 | 44 | | | | 11 | | | 171 | 3 | | | 1 | 1 | I |
| | | | | | | | | | | | | | | | | | | | | 18 | 18 | * | |
| 017 | 66 | 02 | 14 | 10 | 68 | 1 | 365 | 365 | 4 | 44 | 88 | 3 | 0 | 11 | 632 | 0 | 503 | | 11 | 28 | | | I |
| 017 | 66 | 02 | | 10 | 68 | 1 | 365 | 365 | 4 | 44 | | | | 11 | | | 503 | 1 | | | 12 | 12 | I |
| 017 | 66 | 02 | | 10 | 68 | 1 | 365 | 365 | 4 | 44 | | | | 11 | | | 503 | 2 | | | 13 | 13 | I |
| 017 | 66 | 02 | | 10 | 68 | 1 | 365 | 365 | 4 | 44 | | | | 11 | | | 503 | 3 | | | 3 | 3 | I |
| | | | | | | | | | | | | | | | | | | | | 28 | 28 | * | |
| | | | | | | | | | | | | | | | | | | | | 51 | 51 | * * | |
| 017 | 66 | 03 | 14 | 10 | 68 | 1 | 370 | 744 | 4 | 60 | 88 | 3 | 0 | 14 | 626 | 0 | 015 | | | 2 | | | |
| 017 | 66 | 03 | | 10 | 68 | 1 | 370 | 744 | 4 | 60 | | | | 14 | | | 015 | 2 | | | 1 | 1 | |
| 017 | 66 | 03 | | 10 | 68 | 1 | 370 | 744 | 4 | 60 | | | | 14 | | | 015 | 3 | | | 1 | 1 | |
| | | | | | | | | | | | | | | | | | | | | 2 | 2 | * | |
| 017 | 66 | 03 | 14 | 10 | 68 | 1 | 370 | 744 | 4 | 60 | 88 | 3 | 0 | 14 | 626 | 0 | 078 | | 5 | 8 | | | |
| 017 | 66 | 03 | | 10 | 68 | 1 | 370 | 744 | 4 | 60 | | | | 14 | | | 078 | 2 | | | 8 | 8 | |
| | | | | | | | | | | | | | | | | | | | | 8 | 8 | * | |
| 017 | 66 | 03 | 14 | 10 | 68 | 1 | 370 | 744 | 4 | 60 | 88 | 3 | 0 | 14 | 626 | 0 | 171 | | 87 | 194 | | | |
| 017 | 66 | 03 | | 10 | 68 | 1 | 370 | 744 | 4 | 60 | | | | 14 | | | 171 | 2 | | | 193 | 193 | |
| 017 | 66 | 03 | | 10 | 68 | 1 | 370 | 744 | 4 | 60 | | | | 14 | | | 171 | 3 | | | 3 | 3 | |
| | | | | | | | | | | | | | | | | | | | | 194 | 196 | * | 0 |
| 017 | 66 | 03 | 14 | 10 | 68 | 1 | 370 | 744 | 4 | 60 | 88 | 3 | 0 | 14 | 626 | 0 | 503 | | 75 | 247 | | | |
| 017 | 66 | 03 | | 10 | 68 | 1 | 370 | 744 | 4 | 60 | | | | 14 | | | 503 | 1 | | | 163 | 163 | |
| 017 | 66 | 03 | | 10 | 68 | 1 | 370 | 744 | 4 | 60 | | | | 14 | | | 503 | 2 | | | 73 | 73 | |
| 017 | 66 | 03 | | 10 | 68 | 1 | 370 | 744 | 4 | 60 | | | | 14 | | | 503 | 3 | | | 8 | 8 | |
| | | | | | | | | | | | | | | | | | | | | 247 | 244 | * | 0 |
| | | | | | | | | | | | | | | | | | | | | 451 | 450 | * * | |
| 017 | 67 | 01 | 14 | 10 | 68 | 1 | 364 | 744 | 6 | 65 | 88 | 3 | 0 | 11 | 632 | 0 | 015 | | 9 | 52 | | | |

Figure 7. Sample output sheet for initial computer audit on UNIVAC 9200.

Table 9. Definitions of error diagnostics used on initial computer audit (see Figure 7).

```
80-80 LISTING PREPARED BY BCF ADP UNIT ON

A     CRUISE NUMBER WRONG
B     YEAR WRONG
C     PURPOSE CODE
D     TEMPERATURE ZERO OR BLANK
E     TEMPERATURE LESS THAN MIN
F     TEMPERATURE MORE THAN MAX
G     TEN MINUTE SQ MORE THAN 5
H     LATITUDE OUTSIDE RANGE
I     LONGITUDE OUTSIDE RANGE
J     TIME CODE MORE THEN 6
K     DEPTH MORE OR LESS THAN LIMITS
L     GEAR CODE NOT CORRECT
M     SPECIES CODE NOT IN TABLE
N     TOW DURATION MORE THAN 4
O     DAY PUNCHED MORE THAN 31
P     CROSSFOOT OF FIELDS INCORRECT
Q     NO 1 TOTAL NOT EQUAL TO NO 2
R     NET CONDITION NOT ZERO
S     SEQUENCE NUMBER LARGER THAN 8
T     MONTH CODE NOT CORRECT
U
V,    TOW DURATION OTHER THAN 3
W     NUMBER OF TOWS MORE THAN 9
X     NUMBER OF TOWS NOT EQUAL TO LAST
Y
Z

          CARD COUNT    26
```

The final audit is not foolproof in that certain types of discrepancies are not spotlighted by the computer. In particular the computer cannot be depended upon to detect length frequency errors for catches less than about 10 pounds, partly because weighing methods at sea are not precise. This limitation applies chiefly to small catches of small species. However since data for each catch is listed and since visual scanning of individual catch data is a necessary part of the final audit procedure, some of these discrepancies can be detected by eye. For example the final audit output lists length frequencies in column form, displaying individual catches within a given sampling stratum on one page. This format is convenient for quick scanning of length frequencies for abnormalities in positions of modes.

Another limitation of the final audit is that gross discrepancies between "observed" and "calculated" weights are not isolated by the computer if the length-round weight relation is not representative of the catch. This situation complicates interpretation of the final audit and it will be discussed below following a description of the final audit output. An outline of procedures for checking the final audit is given in Part IV.

2. Output of Final Audit. There are two types of output -- (1) data listings, and (2) punched cards (representing a portion of the summary data listed at end of the run for each species). The data listings are described first and punched output is described at the end of this section.

A single run of the catch audit usually will consist of all the major species (the more abundant species <u>and</u> those for which we have adequate length-round weight data) for a single cruise. An independent audit is performed on each species and the format for each species is as follows:

1. Listing of catch data for each stratum
   a. Length frequency (LF) of each catch in a given stratum, and the combined LF for all catches in the stratum, on one output page (require more than one page if $>$ 9 catches.
   b. Station data and other catch data including relative deviations (D values) between observed and calculated weights for the same catches of the same stratum, on adjoining output pages.
2. Summary of audit results for all catches in the cruise for the given species, at end of the listing of all strata.

a. Frequency distribution of relative deviations (D values) between observed and calculated weights of catches, for catches with observed weight $\geq$ 10 lb.

b. Grand total LF of all catches of the species on the cruise.

c. Listing of stations in which "errors" were detected, and including a description of type of "error."

The LF listing for each individual stratum (Item 1 a. above) is largely self-explanatory (see Figure 8), except for the following details. For each species a range of lengths is specified (input data) within which lengths are printed out in unbroken sequence from the smallest to the largest fish in the stratum. For example in the sample output, the specified range for haddock is 10-70 cm., and within this range the smallest and largest haddock in the stratum happened to be 34 and 70 cm respectively; therefore the interval 34-70 cm is printed out in unbroken sequence (even though there were no haddock caught at certain lengths within this interval). Outside the specified range of lengths for a species, only those lengths are printed out which are represented in the actual stratum catch. In this example, there were two haddock outside the specified range, one at 71 cm and one at 76 cm. Note that if printed, the limits of the specified range (upper limit of 70 cm in this example) are marked with an asterisk. However if no fish as small or large as these limits are actually caught, the limits of the specified range are not printed out. Finally, note that fish $\geq$ 200 cm will be listed in the summary as an "error."

The second part of the data listing for each stratum (Part 1 b. above) is also largely self-explanatory (Figure 9). Note that mean values of depth, temperature and time represent only those tows (stations) within the stratum where the given species was caught. Average lengths and weights of fish in each stratum are computed in two ways: "stratum ave." refers to the total stratum catch without regard to variation between individual tows, and "tow ave." represents the average of individual tow means. The three categories of total numbers are as follows:

1-crd T -- Total number punched on #1 card.

2-crd T -- Sum of totals punched on #2 card(s).

Sum Int -- Sum of individual frequencies on #2 card(s).

Part c of Item 2, the audit summary, is self explanatory as shown in sample output (Figure 10). Part b is simply the total length frequency for all catches and is not illustrated. Part a of the audit summary presents the frequency distribution (in table form) of the relative deviations between observed and calculated weights (Figure 11). The primary significance of this frequency distribution is discussed in the next section. Note that the deviations are classified according to average size of fish, and according to size of total catch (observed weight) resulting in two tables.

The punched card output simply duplicates the data shown in these two tables, to make it more convenient to analyze results of several cruises (with respect to deviations). The card format is described in the final audit program description filed with the Population Dynamics unit.

3. Observed vs Calculated Weights in Final Audit. For each catch the final audit computes the relative deviation between observed and calculated weights, (observed-calculated) divided by the observed, where the observed weight is that recorded on the trawl log (and punched on the #1 data card) and the calculated weight is derived from the total length frequency (#2 data cards) and a length-round weight equation. At the end of a block of data for a given species (usually all the catches for one cruise) the stratum and tow numbers are printed out for all catches where the observed weights are $\geq$ 10 lb. and the relative deviations are $\geq$ 25 percent. Under the ideal condition that the LW relation is perfectly representative of the population being sampled, the listing of these catches would contain most of the major errors in catch data (i.e. errors in weight or length frequency). This ideal condition can only be approximated, and for some species the approximation is very poor, because there is a large bias in the LW relation, relative to the sampled population. The bias could be due, for example, to the fact that the LW relation is based on a sample which does not accurately reflect the LW relation for the season and area of the cruise under consideration. Differences associated with sex and size of fish may also cause bias, particularly in cases where

GF SURVEY CATCH-DATA AUDIT, CRUISE ALB IV 68-03 MAR-APR 68 (CODE 803) SP 74 HADD STRAT 16 GE415SEPT2468GFA100

| LNTH(CM) | LF TOW 1 | 2 | 3 | 5 | 6 | 8 | 9 | 0 | 0 | TOT LF | PC LF |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 34 | | | | | | 1 | | | | 1. | 0.69 |
| 35 | | | | | | 2 | | | | 2. | 1.38 |
| 36 | | | | | | | | | | 0. | 0.00 |
| 37 | | | | | | 8 | | | | 8. | 5.52 |
| 38 | | | | | | 7 | | | | 7. | 4.83 |
| 39 | | | | | | 5 | | | | 5. | 3.45 |
| 40 | | | | | | 14 | | | | 14. | 9.66 |
| 41 | | | | | | 9 | | | | 9. | 6.21 |
| 42 | | | | | | 3 | | | | 3. | 2.07 |
| 43 | | | 1 | | | 4 | | | | 5. | 3.45 |
| 44 | | | | | | 5 | | | | 5. | 3.45 |
| 45 | | | | | | 7 | | | | 7. | 4.83 |
| 46 | | | | | | 3 | | | | 3. | 2.07 |
| 47 | | | | 1 | | 1 | | | | 2. | 1.38 |
| 48 | | | 2 | | | 2 | | | | 4. | 2.76 |
| 49 | | | 2 | | | 3 | 1 | | | 6. | 4.14 |
| 50 | | | 1 | | | 4 | | | | 5. | 3.45 |
| 51 | | | 2 | | | 3 | | | | 5. | 3.45 |
| 52 | 1 | | 4 | | | 1 | | | | 6. | 4.14 |
| 53 | | | 1 | 1 | | 3 | | | | 5. | 3.45 |
| 54 | | | 1 | 1 | | 3 | | | | 5. | 3.45 |
| 55 | | | | 1 | | 2 | | | | 3. | 2.07 |
| 56 | 2 | | 3 | | | 2 | | | | 7. | 4.83 |
| 57 | | 1 | 3 | | | 1 | | | | 5. | 3.45 |
| 58 | | | 3 | 1 | | | | | | 4. | 2.76 |
| 59 | | | 2 | | 1 | | | | | 3. | 2.07 |
| 60 | | | 1 | | | 1 | | | | 2. | 1.38 |
| 61 | | | 4 | | | | | | | 4. | 2.76 |
| 62 | | 1 | 2 | | | | | | | 3. | 2.07 |
| 63 | | | | | 1 | | | | | 1. | 0.69 |
| 64 | | | 1 | | 1 | | | | | 2. | 1.38 |
| 65 | | | | 1 | | | | | | 1. | 0.69 |
| 66 | | | | | | | | | | 0. | 0.00 |
| 67 | | | | | | | | | | 0. | 0.00 |
| 68 | | | | | | | | | | 0. | 0.00 |
| 69 | | | | | | | | | | 0. | 0.00 |
| 70 | | | | | | | | | | 0. | 0.00 |
| 71 | | 1 | 1 | | | | | | | 2. | 1.38 |
| 76 | | | 1 | | | | | | | 1. | 0.69 |

Figure 8. Sample output page from final computer audit, illustrating length frequencies of haddock catches in a single sampling stratum.

GF SURVEY CATCH-DATA AUDIT. CRUISE ALB IV 68-03 MAR-APR 68 (CODE 803) SP 74 HADD STRAT 16 GE415SEPT2468GFA100

| TOW | 1 | 2 | 3 | 5 | 6 | 8 | 9 | 0 | 0 |
|---|---|---|---|---|---|---|---|---|---|
| DEPTH | 34. | 40. | 40. | 46. | 47. | 55. | 35. | 0. | 0. |
| BOT TEMP | 4. | 3. | 3. | 3. | 3. | 4. | 5. | 0. | 0. |
| TIME | 5. | 6. | 6. | 1. | 5. | 1. | 5. | 0. | 0. |
| TOT. NO. | | | | | | | | | |
| 1-CRD T | 3. | 3. | 35. | 6. | 3. | 94. | 1. | 0. | 0. |
| 2-CRD T | 3. | 3. | 35. | 6. | 3. | 94. | 1. | 0. | 0. |
| SUM INT | 3. | 3. | 35. | 6. | 3. | 94. | 1. | 0. | 0. |
| AVE LNTH | 54.7 | 63.3 | 56.4 | 55.3 | 62.0 | 43.8 | 49.0 | 0.0 | 0.0 |
| TOT WT | | | | | | | | | |
| OBSV | 14.0 | 17.0 | 161.0 | 29.0 | 20.0 | 195.0 | 3.0 | 0.0 | 0.0 |
| CALC | 12.0 | 19.3 | 160.4 | 25.6 | 17.7 | 201.6 | 2.9 | 0.0 | 0.0 |
| D | 0.141 | -.137 | 0.004 | 0.116 | 0.115 | -.034 | 0.048 | 0.000 | 0.000 |
| AVE WT | | | | | | | | | |
| OBSV | 4.7 | 5.7 | 4.6 | 4.8 | 6.7 | 2.1 | 3.0 | 0.0 | 0.0 |
| CALC | 4.0 | 6.4 | 4.6 | 4.3 | 5.9 | 2.1 | 2.9 | 0.0 | 0.0 |

| | |
|---|---|
| TOT NO. CATCHES | 7 |
| MEAN DEPTH | 42.4 |
| MEAN TEMP | 3.6 |
| MEAN TIME | 4.1 |
| STRATUM TOTAL NO | |
| | 145.0 |
| | 145.0 |
| | 145.0 |
| STRT AV LN | 48.4 |
| TOW AV LN | 54.9 |
| OBS STR WT | 439.0 |
| CAL STR WT | 439.6 |
| STRAT M AVE WT | |
| OBS | 3.0 |
| CALC | 3.0 |
| TOW AVE WT | |
| OBS | 4.5 |
| CALC | 4.3 |

Figure 9. Sample output of final computer audit illustrating remainder of data printed out for each catch of a species in a single stratum. Note comparisons of totals between #1 and #2 cards, and between observed and calculated weights (both total and average).

GF SURVEY CATCH-DATA AUDIT. CRUISE ALB IV 68-03 MAR-APR 68 (CODE 803) SP 74 HADD STRAT ALL GE415SEPT2468GFA100

KEY TO ERROR LISTING

| CODE | ERROR |
|---|---|
| 230 | WRONG CRUISE OR SPECIES ON DATA CARD. X=CRUISE ON CARD, Y=SPECIES ON CARD. |
| 265 | TYPE-2 CARD NOT PRECEEDED BY TYPE-1 CARD. |
| 270 | TYPE-2 CARD NOT PRECEEDED BY TYPE-1 CARD. |
| 275 | TYPE-2 CARD NOT PRECEEDED BY TYPE-1 CARD |
| 280 | LN. INTERVAL OVER 200 CM. X=INTRVL, Y=FREQNCY. |
| 305 | TYPE-1 CARD WITH NO CORRESPONDING TYPE-2 CRDS. MAY BE A DUPLICATE FOR LARGE CATCH. |
| 625 | DEV GRTR THAN .25. X=OBS.WT, Y=CALC.WT, Z=DEV |
| 630 | OBSV WT=0, CAL WT OVER 5 LBS. X= CAL WT. |
| 685 | 1-CRD.TOTL NO. DIFFERS FROM 2-CRD TOT BY MORETHAN 10 PCNT. X=1CRD TOT,Y=2CRD TOT,Z=MAGNITUDE OF REL DIFF. |
| 695 | 2-CRD TOT NO. .NE. SUM INTVL FRQS. X=2CRD TOT,Y=SUM INTVL FRQS.,Z=ABS DIFF |

| CODE | CARD NO. | STRATUM | TOW | X | Y | Z | |
|---|---|---|---|---|---|---|---|
| 625 | 65 | 17 | 2 | 0.14000000E+02 | 0.19869357E+02 | -.58693569E+01 | OK |
| 625 | 234 | 31 | 4 | 0.29500000E+03 | 0.37005425E+03 | -.75054249E+02 | Use Calc. Wt. |
| 625 | 234 | 31 | 5 | 0.52000000E+02 | 0.66297336E+02 | -.14297336E+02 | OK |
| 625 | 310 | 37 | 5 | 0.32000000E+02 | 0.15069107E+02 | 0.16930893E+02 | Use Calc. Wt. |

Figure 10. Sample output sheet from final computer audit illustrating summary listing of "errors" detected by computer.

GF SURVEY CATCH-DATA AUDIT. CRUISE ALB IV 68-03 MAR-APR 68 (CODE 803) SP 74 HADD STRAT ALL GE415SEPT2468GFA100

GRAND TOTAL ALL STATIONS OBSV WT 4359.0 CALC WT 4554.3 DEVIATION -.0448 DEV=(OBS-CALC)/OBS

TABLE OF DEVIATIONS (OBSV.WT - CALC.WT)/ OBSV.WT (WITH 10LB. MIN OBSV.WT )

NUMBER OF STATIONS IN AVERAGE LENGTH GROUPS

| SIGNED DEVIATIONS | LT.10 | 11-15 | 16-20 | 21-25 | 26-30 | 31-35 | 36-40 | 41-45 | 46-50 | 51-55 | 56-60 | 61-65 | 66-70 | 71-75 | 76-80 | GT.80 | CRUISE TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.261 1.000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0.221 0.260 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.181 0.220 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 0.141 0.180 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0.101 0.140 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 5 |
| 0.061 0.100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 7 |
| 0.021 0.060 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 5 | 1 | 1 | 0 | 0 | 0 | 0 | 8 |
| -.019 0.020 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 2 | 2 | 3 | 0 | 1 | 0 | 0 | 12 |
| -.059 -.020 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 3 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 11 |
| -.099 -.060 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 10 |
| -.139 -.100 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 5 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 9 |
| -.179 -.140 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| -.219 -.180 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| -.259 -.220 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| -.*00 -.260 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| CRUISE TOT | 0 | 0 | 0 | 0 | 0 | 1 | 5 | 8 | 23 | 17 | 8 | 10 | 1 | 1 | 0 | 0 | 74 |
| REL FRQ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.07 | 0.11 | 0.31 | 0.23 | 0.11 | 0.14 | 0.01 | 0.01 | 0.00 | 0.00 | |

NUMBER OF STATIONS WITH OBSERVED WEIGHT

| | 10-19 | 20-29 | 30-39 | 40-49 | 50-100 | 101-500 | GT.501 | CRUISE TOTAL | REL FRQ |
|---|---|---|---|---|---|---|---|---|---|
| 0.261 1.000 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0.01 |
| 0.221 0.260 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| 0.181 0.220 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 3 | 0.04 |
| 0.141 0.180 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.01 |
| 0.101 0.140 | 1 | 2 | 1 | 0 | 1 | 0 | 0 | 5 | 0.07 |
| 0.061 0.100 | 1 | 3 | 1 | 0 | 0 | 2 | 0 | 7 | 0.09 |
| 0.021 0.060 | 2 | 1 | 3 | 0 | 2 | 0 | 0 | 8 | 0.11 |
| -.019 0.020 | 3 | 4 | 1 | 2 | 1 | 1 | 0 | 12 | 0.16 |
| -.059 -.020 | 2 | 0 | 1 | 1 | 5 | 2 | 0 | 11 | 0.15 |
| -.099 -.060 | 1 | 0 | 2 | 0 | 4 | 3 | 0 | 10 | 0.14 |
| -.139 -.100 | 3 | 0 | 0 | 1 | 4 | 1 | 0 | 9 | 0.12 |
| -.179 -.140 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.01 |
| -.219 -.180 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0.03 |
| -.259 -.220 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 0.03 |
| -.*00 -.260 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0.03 |
| CRUISE TOT | 20 | 12 | 10 | 4 | 18 | 10 | 0 | 74 | |
| REL FRQ | 0.27 | 0.16 | 0.14 | 0.05 | 0.24 | 0.14 | 0.00 | | |

Figure 11. Sample output from final computer audit illustrating summary table of deviations between observed and calculated weights (arranged first by average length groups and second by observed catch weights).

the LW relation is based on a small sample. The important point here is that the audit run cannot be interpreted properly with respect to the differences between observed and calculated weights, without first examining the frequency distribution of relative deviations (printed at end of output for each species) which indicates the representativeness of the LW relation.

Given a perfectly representative LW relation and no errors in the catch data, the expected frequency distribution of relative deviations would be approximately like curve A shown in Figure 12. Note that the distribution is centered about zero with the bulk of deviations small or moderate in size. Remember also that the plotted deviations (shown in table form on actual computer output) represent only catches where the observed weight was at least 10 lb. (below which our shipboard weighing procedures are no more than 25 percent accurate).

Curve B would be the type expected if the LW relation was representative but some gross errors were present; the excess of deviations in the tails of the distribution (shaded areas) normally would include the major errors, and in this hypothetical case the logical interpretation is that positive and negative errors were equally abundant. Note that the scale is truncated at $\pm .25$, that is, all deviations $\geq .25$ ($\pm$) are plotted at the point corresponding to .25.

Curve C is similar to B in shape but the mean is shifted away from zero indicating a non-representative LW relation; in this case some of the positive deviations included in the shaded area may represent significant errors even though the deviations are $< .25$, and thus would not be listed at end of the run. On the other hand some of the moderately large negative deviations (.25 to .50, say) are less likely to represent significant errors than in the case of Curve B.

Curve D shows an even greater shift of the distribution away from zero but in the other direction. Here the isolated group of negative deviations probably represent errors; but since they are $< .25$ they would not be listed. The problem of interpreting the positive deviations $\geq .25$ is exactly the same as described for the negative deviations in Curve C, except that even more deviations larger than .25 will be listed that do not represent gross errors.

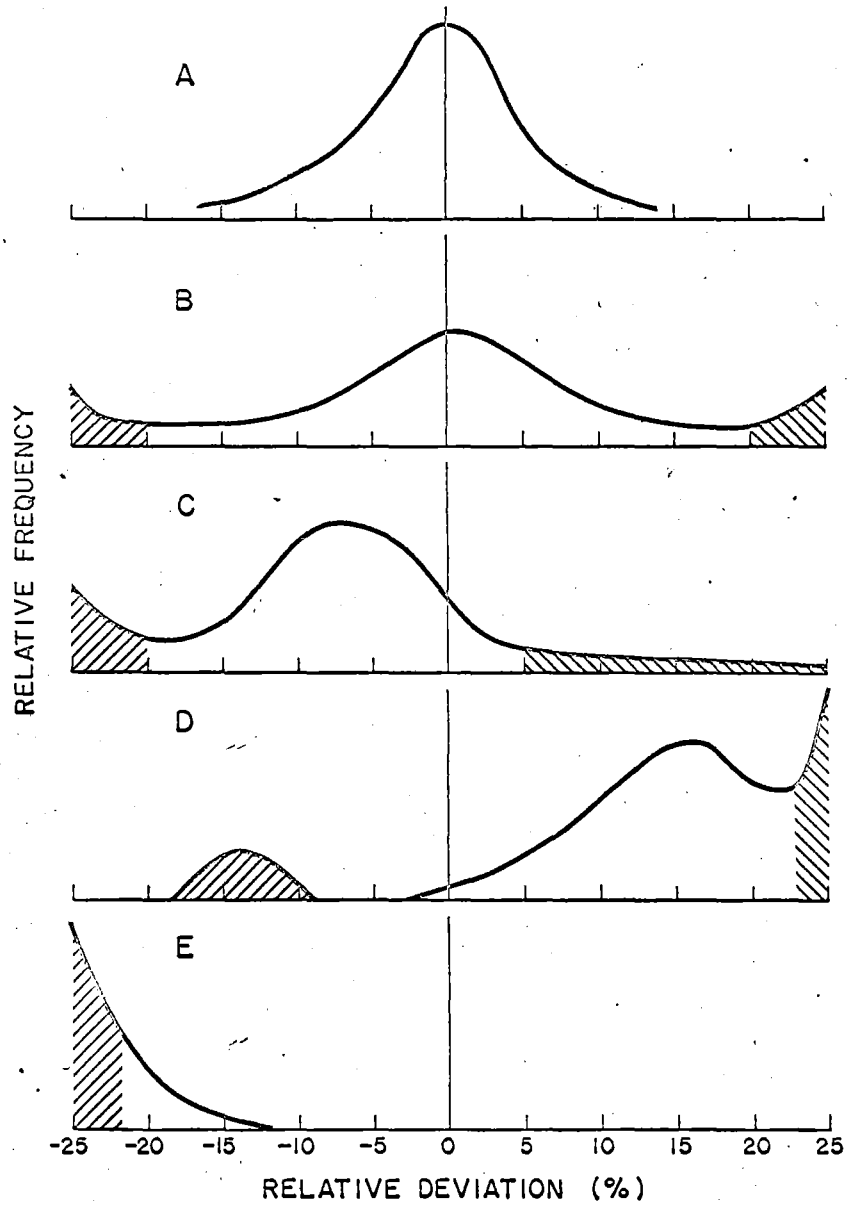



Figure 12. Hypothetical frequency distributions of deviations between observed and calculated weights.

Curve E represents extreme bias in the LW relation and in such a case the listing of catches with deviations $\geq$ .25 will represent mostly data which is correct. Only very large deviations are likely to be mistakes.

Thus in any case where the LW relation has a large bias, the detection of either positive or negative errors (depending upon whether bias is positive or negative) will require visual inspection of unusual deviations for individual catches; and what constitutes an outlier or unusually large deviation for one species (or cruise) may not be unusual for another species (or cruise). The problem will diminish as additional length weight data are collected.

D. Routine Catch Data Listings.

After the final audit is checked and errors corrected, then the #1 and #2 cards are listed giving station data and catch data for each species in every haul. The #1 card listing contains numbers and pounds and the #2 card listing numbers and length frequency (but length frequencies are arranged by 15 cm intervals in rows rather than in columns). At the same time that the #1 card listing is made, a deck of station cards is punched on the UNIVAC. Each station card contains all the station data plus the total catch (numbers and pounds) of all species combined for the trawl haul. This deck is also listed routinely.

In addition to the above listings and the audit listings, there are also listings of station index cards and #3 cards. A summary of all data listings and other output of routine processing is presented in Table 11 in Part IV.

E. Analytic Computer Programs.

A number of programs have been written to provide analysis of various aspects of the distribution and relative abundance of fishes, within the framework of the stratified random sampling design. Basically these programs compute average catch per tow (in terms of numbers, pounds, numbers per length group, or percentage length frequency; linear or log scale) and its associated variance. In some cases either linear or log scale is available but not both, and in some cases variance is not computed (or is not applicable).

A very brief description of each program is included in Table 10. Further details on the potential of each program, including samples of output, are presented in the program descriptions filed with Population Dynamics.

Table 10. Summary of available computer programs for analysis of groundfish survey data (stratified random sample design).

| Name of Program (or Subroutine) | Type of Analysis | Scale | Type of card used |
|---|---|---|---|
| List-Weight | Percentage species composition of catches in both numbers and pounds, mean catch per tow in numbers and pounds, average weight per individual for each species. | Linear | #1 |
| Subroutine 210 | Mean catch per tow in numbers and pounds and associated variance. | Optional transformation (natural log) | #1 |
| Subroutine 215 | Mean catch per tow in numbers by variable length groups (any length intervals may be chosen up to a limit of six different intervals on any one run) and associated variance. | Optional transformation (natural log) | #2 |
| List-length | Mean catch per tow in numbers and percent by fixed length groups. Any length interval may be chosen but only one interval can be used on any one run, i.e. could use either 1 cm intervals, or 3 cm intervals, or 18 cm intervals, etc., but interval is fixed on any one run. | Linear | #2 |
| Domain | Stratified mean and variance of numbers or weight per tow based on post-stratification (over and above original stratification) by one factor (e.g. temperature, statistical area). | Optional transformation (natural log) | #1 |
| Stress | Mean and variance of numbers and weight per tow, mean temperature and mean depth by individual sampling strata. Printed and punched card (2 types) output. | Optional transformation (natural log) | #1 and station cards (for all species combined) |
| Age Frequency | Relative age frequency in terms of stratified mean numbers of fish per tow per age-length group derived from stratified length frequency analysis of the List-length subroutine. Cannot be run without List-length. | Linear | #2 and #3 |

## PART IV

## OUTLINE OF DATA PROCESSING

A. Scope of Outline.

This outline is intended for use in the laboratory as a guide to the proper sequence of processing steps. Familiarity with the earlier parts of this report is a necessary prerequisite to efficient use of the outline, but it should be noted that there are a number of details described in the outline which are not given elsewhere.

In order to insure orderly progress in processing and to keep track of operations, it is recommended that an operations schedule be kept, showing date of completion of each step from beginning to end of processing for each cruise.

B. Initial Hand Processing.

1. Accuracy of station data (position, time, depth, etc.)

   a. Record BT station numbers, time and BT positions (to nearest minute) from BT log onto the Station Index (see format of Index in Table 6, Part I). This index is an expanded version of a previous station index and it was first used for Albatross IV 69-2. Note also that this was the first cruise for which station index data was put on cards.

   b. Check and record station data for each trawl station in following concurrent steps:

      (1) Plot positions recorded on trawl logs onto track charts used in pilot house and compare with original pre-selected stations. If positions do not agree within 2 minutes (and, or, if recorded depth differs substantially from chart depth at pre-selected station) then check loran bearing.[1/] Do not erase original entries on field logs. Cross out any incorrect entry, enter corrected version, and make appropriate explanation. Note that we code position on basic

1/ This represents the approximate limit of accuracy of our navigation system.

data cards only to the nearest 10 minutes. Positions to the nearest minute are punched on station index cards.

(2) Compare time and position (to nearest minute) at beginning of trawl haul with BT time and position already recorded on Station Index. These positions usually correspond exactly, and times usually are within 30 minutes, since the BT is routinely taken just before a trawl haul. If positions differ by more than 2 minutes or time differs by more than 1 hour, treat the trawl and BT stations as separate entries. That is, each will appear on a separate line in the Index. If differences are less than this use data recorded from BT log as is.

(3) Note time elapsed between successive station and check date and station numbers (stratum-tow, and sequential numbers for all types of station, including BT) for proper sequence. Record all station numbers on Station Index. Note that a code number is required to identify type of "other" stations. See Table 5, Part I.

c. Plot trawl station positions on standard plotting chart showing sequential station numbers and cruise track (trawl station charts filed in Groundfish Biology).

d. Plot BT station positions on separate standard plotting chart showing sequential BT station numbers and cruise track. (BT station charts are filed in Hydro project).

e. Compare cruise tracks of trawl stations and BT stations (overlay one over the other) to pick up errors in recording and (or) plotting. Plot final cruise tracks in ink.

2. Summarize temperature data.[1/]

   a. When BT records are returned from WHOI, compare BT positions on these records with positions on Station Index for each BT station. They should be exactly the same. Complete the remainder of the Index, for each BT station, which includes date, time, depth, and bottom and surface temperatures. File completed Station Index with trawl logs.

   b. Prepare chart (standard plotting) of bottom temperature contours, and file with Groundfish Biology.

3. Code trawl station data.

Enter trawl station data (cruise, stratum and tow no., position etc., and including bottom temperature, gear condition, and other information) in code boxes shown on sample log, Fig. 5, Part II. Card code formats and coding conventions are described in Part I.

4. Check and code trawl catch data.

This is the most time consuming and the most important phase of processing and it must not be rushed. Sloppy work at this stage either wastes time later through excessive corrections, or worse, perpetuates errors which the computers may not detect, and which unnecessarily reduces the overall quality of the punched data.

Processing the trawl catch data (see sample log and further details, Section II, appendix) breaks down into the following steps:

   a. On the side of log with weight data, enter species code numbers, and compute and enter total catch (lb), and length frequency expansion factors (if any). Check any total weight estimates or expansion factors which were recorded at sea. Expansion factors are simply ratios of total catch to sample size in terms of weight, volume or numbers, with the same units for both numerator and denominator of the ratio.

---

1/ Processing of temperature data including plotting of BT station positions, is currently done routinely by Hydro project.

b. Enter species codes above length frequency tallies, convert tally strokes to number length frequencies and record total number of each species measured at the bottom of each length frequency.

c. Compute total catch in numbers for each species and enter in appropriate boxes on trawl log (check any figures in these boxes which were recorded at sea). Note that these hand-computed totals are an essential part of the comparison between observed (hand-computed) and calculated weights in the final computer audit.

C. Routine Machine Processing.

1. Punching #1 and #2 cards.

The basic catch data cards (types 1 and 2) are punched, and necessary format conversions and length frequency expansions are performed by the UNIVAC 9200.

2. Initial Audit of #1 and #2 Cards.

a. This audit detects punching and recording errors as described in Part III, and prints out error flags on a listing identifying the type of discrepancy.

b. Each potential error must be checked against the original log and appropriate corrections made on the log and on the Station Index if station data are involved. Corrections should be marked directly on the data cards for repunching, and the preferred marking of a card is in large bold writing as follows:

"Columns 52-54 should be 048"

If a large number of columns need to be re-punched it will often be preferable to repunch from the original data, as for a whole length frequency.

c. A re-audit of corrected cards is desirable to verify the corrections. Note that the audit listing is a convenient record of the frequency and type of errors encountered, which can indicate weak points in the processing sequence.

3. Punch and List Station Index Cards.

At this point it may be assumed that all errors in station data have been eliminated and the Station Index data may be punched (Station Index deck) and listed by sequential trawl haul numbers and also by stratum-tow numbers of trawl stations. The cards should be verified either by 1) comparing the listing with the Station Index, or 2) by punching deck twice and comparing cards.

4. Final Audit of #1 and #2 Cards.

After corrections from the initial audit are completed, the basic deck of #1 and #2 cards is put through the final audit. In this audit the principal check is a comparison of "observed" vs. "calculated" weight for each total catch of each species, where "observed" weight is calculated by hand at the time the original logs are checked and coded, and "calculated" weight is derived from the total length frequency and a length round weight relation. Stations for which deviations between "observed" and "calculated" weights exceed $\pm$ 25% are listed at the end of a run for each species, along with stations for which other kinds of discrepancies (similar to initial audit) were detected.

As with the initial audit, the output of the final audit is in the form of a listing. In addition to the deviations noted above, the final audit gives a tow by tow listing of length frequency of each species in column form. Other data such as numbers and pounds in each catch, and average length and weight are also listed for each catch. A detailed description of the final audit and the listing, are given in Part III.

5. Procedures for Checking Final Audit.

a. Examine the frequency distribution of relative deviations between observed and calculated weights which is printed at the end of the run for each species. This distribution will indicate how the summary listing of deviations $\geq$ .25 should be interpreted, and it will also indicate what smaller deviations (not included in the summary listing) should be considered unusual and looked for in the listing of individual catches.

b. In addition to checking discrepancies listed in the "error" summary, examine output for each stratum and tow for the following kinds of irregularities:

(1) Tows out of sequence.

(2) Large discrepancies between average length and printed LF.

(3) Missing observed weights (resulting in dev. = 0).

(4) Unusual discrepancies between observed and calculated weights (either total or average) as suggested in part a. above.

Remember that regardless of the relative size of the discrepancy, deviations are not put in the summary listing for catches $<$ 10 lb. Given that a discrepancy is judged to be "unusually large," and the catch is $\geq$ 10 lb and (or) $\geq$ 10 fish, then it will be worthwhile to go back to original trawl records to check for possible error.

Pull out data cards requiring correction and mark cards and correct original logs as before. Also make corrections to the audit run listing itself since it will rarely be necessary to re-run the final audit.

c. Repunch cards and verify corrections.

6. #1 and #2 Card Listings.

When the last step of the final audit is completed, the basic data (#1 and #2 cards) should be listed immediately or at least before the cards are made available for any analysis. This is to insure that the listings are complete, and also to produce a deck of station cards at the same time the #1 cards are listed. After the data deck becomes available for analysis there always is a chance that cards will be lost or misplaced no matter how elaborate the control system. This problem will be largely avoided when it is possible to put the data directly into tape or disc storage.

7. Age-Length Data.

The routine scale-otolith collections from survey cruises are processed by the age-reading unit. The sampling and processing are most complete for haddock, and are at various stages of development for yellowtail, red and silver hake. Occasional samples of other commercial species are also being processed as time permits.

Age readings are currently being put on cards (#3 type) only for haddock. After the age reading unit tallies the ages and lengths on special forms, the data are coded and sent to ADP where they are punched, run through a partial audit (compared with station, #4, card deck), and listed. A more complete audit should be developed.

D. Summary of Routine Processing Output.

A summary of the output from the various steps in the routine processing is shown in Table 11. Eventually a basic data report may be published for each cruise containing part of data shown on data listings.

Table 11. Summary of data listings and other output of routine processing (both *hand and ** machine) of groundfish survey data.

| Name of Output | Type of data and its arrangement |
|---|---|
| Station Index* | Lists position, date, time, depth and bottom and surface temperatures at each station and matches all corresponding station numbers. Includes trawl stations, BT stations and other types of station occupied routinely on the survey. |
| Trawl Station Chart* | Trawl stations and cruise track on standard plotting chart. |
| BT Station Chart* | BT stations and cruise track on standard plotting chart. |
| Bottom Temperature Chart* | Bottom temperature contours on standard plotting chart. |
| Initial Audit** | Lists #1 and #2 cards with error flags (in addition to detection of mistakes, this listing is useful as record of type and frequency of errors). |
| Final Audit** | Lists length frequencies in columns and also catches in numbers and pounds. Data are arranged by individual species (i.e. one species at a time), and within a species, data are arranged by stratum and tow in that order. Stratum summaries of LF's and numbers and pounds are provided as well as grand summaries for all strata combined. Average weights and lengths for strata and individual tows within strata are also computed. At end of run for each species, prints out several summaries of discrepancies detected. |
| #1 Card Listings** | Lists individual trawl hauls giving station data for each tow and catch of each species in numbers and pounds; one listing arranged by stratum and tow, and one listing arranged by species. |
| #2 Card Listings** | Same as #1 card listing arranged by species except gives length frequency (in row format) and total number in each tow. |
| Station Card Listing** | Lists station data for each trawl haul and gives total catch (all species combined) in numbers and pounds. |
| Station Index Listing** | Lists all station data shown on Station Index in sequential order. Note that sequential station numbers for all types of station, appear only on Station Index cards. However stratum-tow numbers (used only for trawl stations) appear on all types of data cards used in the groundfish survey program, including station index cards. |
| #3 Card Listing** | Lists length-at-age for all fish sampled (so far only haddock) at each station. |