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GROUNDFISH SURVEY PROGRAMMES OF THE ST. ANDREWS BIOLOGICAL STATION, FISHERIES RESEARCH BOARD OF CANADA – OBJECTIVES AND CHARACTERISTICS

by

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INTRODUCTION

The St. Andrews Biological Station of the Fisheries Research Board of Canada (FRB) has been involved in groundfish research since its beginnings in the early 1900's. The manpower and facilities available for this work have varied greatly over the years. Since 1945, field research into the offshore groundfish fisheries has increased steadily. In the post-war years a 65' side trawler, the *J.J. Cowie*, was used as a research vessel. In addition, FRB personnel made many trips on vessels fishing commercially to sample fish catches. In the early 1950's commercial boats were often chartered, usually for 10-day trips, to carry on the research programme. In 1958 and 1959 the research vessels *Harengus* (85 feet) and *A.T. Cameron* (170 feet), both side trawlers, became available and greatly increased the potential for work at sea. Offshore research capabilities were further increased in 1966 with the acquisition of the stern trawler *E.E. Prince* (130 feet). The Groundfish Investigation currently consists of four research scientists with support staff whose concern is the entire field of groundfish ecology, including stock assessment, in subarea 4 of the ICNAF area as far north as, and including, the southern Gulf of St. Lawrence (ICNAF Div. 4T).

This document describes our major otter trawl survey programmes. It particularly concerns the nature of data collected, and the methods and logistic requirements of collection and processing.

RESEARCH VESSEL TRAWL SURVEYS

Otter trawl surveys have played an important part in groundfish investigations since 1957. Initially, primary objectives were to investigate fish distribution in relation to hydrographic and geographic factors and to describe the life histories of the major commercial species. Most activity was in ICNAF Divisions 4T, 4V, and 4W. In recent years it has become apparent that our research vessel surveys should also provide information on changes in stock and community structure and fish abundance which is essential for fisheries management, yet is not available from other sources.

Of the many survey programmes undertaken in the years of offshore operation, three series have been undertaken with some consistancy throughout the period and now compose the bulk of our survey operations. A series of winter-spring surveys in 4V–W have been undertaken. Currently the main objectives of this programme are to survey the 4W haddock spawning stock, and to investigate the uses of an echo counting system (Dowd, 1967) in groundfish surveys. A series of summer surveys in 4V–W developed into surveys of juvenile haddock abundance in 4W in the late 1960's. In 1970 this survey was expanded to provide abundance indices and biological data on all major groundfish species for all of the Nova Scotia banks and the Bay of Fundy. The third series is one of autumn surveys of cod abundance in the Gulf of St. Lawrence in the region of Gaspé and Bay of Chaleur which has been expanded in 1970 to include most of the southern Gulf of St. Lawrence and to complement current survey operations on the Nova Scotia banks.

VESSEL AND GEAR CHARACTERISTICS AND OPERATION

Three Atlantic coast vessels of the FRB and a variety of commercial vessels under charter have been utilized in groundfish survey work. However, of the FRB vessels only the *E.E. Prince* and *A.T. Cameron* have adequate research facilities for current survey operations. The relevant specifications of these two vessels are given in Table 1.

The *E.E. Prince* carries only one deck crew, restricting trawling operations to approximately 12 hours per day. She is also underpowered for otter trawling and this limits these operations to depths less than 100 fathoms with the #36 Yankee trawl or smaller gears. Her design precludes winter offshore operations in subarea 4 when there is a chance of facing heavy icing conditions.

The *A.T. Cameron* has sufficient crew for trawling 24 hours per day and is capable of operating year round in subarea 4. She can tow gear at least as large as the #41 Yankee trawl to depths of 400 fathoms.

Trawls used on the *Harengus* and *E.E. Prince* are #36 Yankees; on the *A.T. Cameron* the #41 Yankee has traditionally been used. Originally these were made of manilla but were changed to synthetic material when the commercial fleet made this change in the early 1960's. Small mesh liners are normally used in survey operations but the amount of the trawl lined, and the mesh size of the liner, have varied. Usually the codend and lengthening piece were lined with 1¼" mesh nylon liner and a further ¼" mesh nylon liner in the codend. In 1969 a #36 Yankee trawl, with specifications as shown in Table 2, Fig. 1, was adopted as a standard survey trawl to be used by all vessels during groundfish survey operations.

DATA COLLECTED AND METHODS OF COLLECTION

Sampling design

A variety of sampling designs have been employed in groundfish surveys, particularly sampling along transects, and fixed station patterns established in relation to popular areas for commercial fishing. A stratified-random sampling design was adopted for the 1969 and subsequent summer surveys on the Nova Scotia banks. In 1970 this sampling design was also adopted for the spring Div. 4W haddock spawning stock survey and the autumn survey in the Gulf of St. Lawrence. In the latter case, a series of geographically fixed stations (the long-term sampling design) was also occupied to calibrate the two methods.

Concern over the suitability of previously used sampling designs for geographically extensive quantitative surveys, and exposition of the advantages of a stratified-random sampling design by Grosslein (1969), led to this change over. Particularly important advantages of this design are provision of population parameters free from the potential biases of systematic sampling and ability to calculate valid variance estimates. At minimum, stratification guarantees a wide distribution of randomly selected stations suitable for describing fish distribution in relation to environmental factors. Potentially, stratification can minimize variance within strata and maximize variance among strata, providing population estimates with minimum variance. Realization of this important advantage of stratification is dependant on how meaningful stratum boundaries are in relation to boundaries in fish distribution.

The stratification scheme used in 1970 (Fig. 2) was drawn up by Canadian, U.S.A., and U.S.S.R. scientists on the basis of previous research experience on fish distribution on the Scotian Shelf and in the Gulf of St. Lawrence. Depth, with which hydrography varies closely, was the predominant factor used, boundaries being placed at 50, 100, and 200 fathoms. Other boundaries agree closely with ICNAF Division boundaries, which were themselves set up with major stock divisions in mind. The success of this preliminary stratification scheme in reducing variance of population estimates has yet to be tested, and no doubt modifications will be desirable in the light of experience.

Station selection

In current cruise planning, first the strata to be occupied are selected, then stations are randomly selected within strata. The number of stations in a stratum varies with the importance of that stratum to the objectives of the cruise, with a minimum of two stations per stratum, this being the minimum number required to calculate variances. Master charts for each stratum are used in station selection. These charts are divided into units equal in area to squares 5' latitude x 10' longitude, and each of these units is divided into 10 trawling locations each 2½' latitude x 2' longitude. The sampling units are numbered consecutively in each stratum and the trawling locations are numbered consecutively within units. Stations are selected by choosing unit, then trawling location, numbers from random number tables. This station selection scheme is based on that used by U.S. scientists of the Biological Laboratory, Woods Hole (Grosslein, 1969).

Station occupation

When trawling locations are occupied at sea the ground is first surveyed by echo sounder to check the location's suitability for trawling operations unless we have prior knowledge that the area is suitable. If the ground is deemed too rough, or if a trawl set results in severe net damage, the location is abandoned. A search for a suitable trawling location is then instituted, staying within the same stratum and moving in the general direction of the next pre-selected station. If a search of one to two hours duration is not fruitful, the station is abandoned completely. The originally selected trawling location is suitably marked on the master chart and is not considered for selection on future occasions.

To meet the theoretical requirements of the sampling design an abandoned station should be replaced by another randomly selected station within the stratum. In practice this would frequently result in a considerable time loss backtracking to the replacement station. As the frequency of abandoned stations is not high (see LOGISTIC REQUIREMENTS) the compromise described above should not significantly affect the results. The starting point and direction of search being predetermined by the original random selection of stations lends some objectivity to this procedure.

At each station a 30 minute trawl tow, a bathythermograph cast, surface and bottom temperature observations, are made, and surface and bottom water samples taken for salinity determinations. At a number of stations, which form approximate transects across the banks, water samples and temperature observations are also taken at a standard series of intermediate depths. Data on ship's position and meteorological and sea conditions are also recorded.

Catch data collected

Basic data required from each catch are estimates of numbers, length-frequency, and weight, of each species. Length measured is fork length, or total length when the tail is not forked, to the nearest centimetre using an offset board. Weights are recorded in metric units.

On release of the fish catch into a pen on deck, it is sorted into one bushel baskets by species. Baskets of fish are then weighed using a suspended dial scale with tare adjustment which allows fish weight to be read directly. Small catches of a species are weighed either as individuals or in smaller containers on hand held spring balances. Length-frequencies are recorded separately for each sex for species whose length or catch composition differs greatly with sex. Currently these species are: all flatfish and skates, dogfish, redfish, and silver hake. Squid catches are treated as are fish catches, mantle length being the measurement used. Invertebrates which are of commercial importance to Canadians, shrimp, spider crabs, and lobsters, are also recorded as numbers and/or weight caught. Euphausiid catches are recorded for a special research project.

Detailed biological observations are invariably made on a number of species, the emphasis varying from area to area, and with changing priorities within the Groundfish Investigation. Biological observations on individuals include some or all of: length, weight, sex, maturity, ovary collection for fecundity estimation, stomach contents analysis, collection of ageing material, and observations on parasitic infection. Species which receive detailed examination include haddock, cod, halibut (almost invariably); plaice, yellowtail, witch, silver hake, pollock(usually); argentine, sand launce, winter flounder, red and white hake, wolffish, skates (periodically).

Subsampling methods

Whenever possible, the entire catch of a species is sampled. It is usually possible to basket and weigh all fish caught, but it is frequently necessary to subsample for estimation of numbers and length-frequency.

Exact criteria for decisions on when to subsample and on the size of subsamples are difficult to determine, depending largely on the species involved, the size composition of the species catch, and time available. When practical (usually when the catch of a species does not exceed 10 baskets) and necessary, the baskets of fish are lined up on deck and an equal number of empty baskets are lined up beside them. Each of the full baskets is divided as equally as possible into the empty baskets (i.e. if there are 10 baskets of fish, 1/10th of each full basket is put in each of the 10 empty baskets). This mixing process is repeated and those baskets of fish which are to be examined in detail are then chosen randomly. On the rare occasions when a species catch exceeds 10 baskets, the baskets are roughly stratified in order of filling into first, middle, and last, thirds, and two or three baskets are selected arbitrarily from each third. These are then mixed and subsampled as described above, if necessary.

We have yet to establish that our present methods of mixing result in representative subsamples, and intend to give the problem further attention. A subsampling technique which gives adequate estimates of length-frequency probably also gives adequate estimates of total numbers caught.

When making detailed biological observations it is frequently necessary to subsample the length-frequency sample. The usual subsampling technique involves selection of subsamples by stratification by length groups, effectively spreading detailed observations over the entire length range of the species catch. Normally one, two or three observations are made per length group, although more observations are sometimes made on specimens from the upper size range of a species. As mentioned above, some species are stratified by sex as well as length.

Data records

Five different data recording sheets are used to record observations on the fish catch and associated station information.

The Groundfish Deck Sheet (Fig. 3), printed on waterproof paper, is used on deck and in the wet laboratory for recording the initial stages of sampling.

Length-Frequency Tally Sheets (Fig. 4) are used if all individuals of a species catch are not to be subjected to detailed examination.

Detailed examinations of individual fish are recorded on Groundfish Fish Sheets (Fig. 5). This sheet is also subsequently used for data coding. The black dots indicate the number of computer card columns used to store the various types of information collected.

The first stages of data processing are undertaken immediately on completion of sampling. Length-frequency data are transferred from Length-Frequency Tally Sheets, or summarized from Groundfish Fish Sheets, onto Groundfish Length-Frequency Transfer Sheets (Fig. 6). This data sheet is also a coding form. At this stage, length measurements are summarized into one, two, or three, centimetre groups depending on maximum size of the species. Species which seldom exceed 60 cm. in length are recorded in 1 cm. groups, haddock is recorded in 2 cm. groups, and large species (listed on bottom of Length-Frequency Transfer Sheet) are recorded in 3 cm. groups.

Ship's officers on watch enter station, gear, and meteorological information on the front of the Groundfish Station and Set Sheet (Fig. 7). Fish catch and sampling data are subsequently entered on the back of the sheet (Fig. 8) by scientific personnel. Both front and back of the Station and Set Sheet are used for coding. Hydrographic data are recorded in one of two logs originally designed by the Hydrographic Investigation. A detailed log is used for full hydrographic stations (Fig. 9) and an abbreviated version for stations where only bathythermograph and bottom and surface temperature and salinity observations are made (Fig. 10).

We believe that the amount of detailed data processing undertaken at sea should be kept to a minimum because the reduced efficiency of personnel working at least a 12-hour day in an unsettled environment results in greater incidence of errors than under shore laboratory conditions. However, undertaking the first summarization of length-frequency and catch data immediately on completion of sampling, when memories are fresh, proves invaluable in rectifying errors due to mislabelled or unlabelled data sheets and erroneous or imcomplete recording. The summarized data are subsequently checked for accuracy in the laboratory.

DATA PROCESSING

Hydrographic data

On returning to shore, all temperature observations are corrected on the hydrographic logs and the corrected temperatures entered on the appropriate fish data sheets. The results of salinity determinations are also entered on the fish data sheets. All hydrographic data, including bathythermograph slides, are then coded on special forms and sent, along with the actual BT slides, to the Canadian Oceanographic Data Centre in Ottawa. After some months the BT slide data are returned by CODC in computer card form with a negative of the corrected trace mounted in the card, and are filed in this form. The cards carry identification number, position, time, and meteorological information, as well as the BT negatives. The entire recording and processing system for hydrographic data will be revised in the near future.

Ageing material

At sea, cod, haddock, and pollock otoliths are placed dry in small manilla envelopes labelled with cruise, species, anc fish number. All other otolith collections are placed in vials containing 50% glycerine, 50% water, with thymol added, and similarly labelled. We do not currently make scale collections. On return to the laboratory, collections are checked for completeness and correct and adequate labelling, and entered into an inventory. Cod and haddock otoliths are passed immediately to age readers who subsequently enter their age determinations on the appropriate Groundfish Fish Sheets. Otoliths from other species are stored and read as required for special projects.

Station data

The navigational charts used on the cruise and marked up with the station locations and vessel track, are returned to the laboratory. The positions at beginning and end of each set determined from Decca bearings, are used to calculate distance travelled over the bottom, and also ship's speed over the bottom, at the same time giving a check on positional information. Annotated echo sounder traces are used to check and correct depth information recorded on the Groundfish Station and Set Sheet.

Coding and punching for computer processing

Once the summarizations of station and fish catch data on the three coding sheets (Fig. 5–8),which were started at sea, have been checked and completed, they are coded and passed to a key-punch operator for punching on computer cards. Four different card formats are used in the handling of these data.

The Groundfish Station and Set Card (Fig. 11) carries station, gear, meteorological, and hydrographic data, and catch data in terms of total number of species and weight caught.

The Groundfish Catch Card (Fig. 12) carries details of a species catch in terms of numbers, weight, and baskets and associated hydrographic data. It also provides an inventory of detailed observations made on individuals of that species catch.

Several Groundfish Length-Frequency Cards (Fig. 13) may have to be used to record the length-frequency of a species catch which has a large length-range, each card recording 14 consecutive length-groups. The "starting length-group" and "grouping" (i.e. 1, 2, or 3, cm-groups) define the length-groups recorded. The "card number" describes its position in the series of cards recording that species catch.

The Groundfish Fish Card (Fig. 14) records detailed observations made on individual fish. When stomach contents are examined there may be several such cards for a fish, one for each item in the stomach contents list, each card for that fish being numbered consecutively and containing data on species, volume, and percent of total content of food items.

Columns 2–20 of all four cards are identical. These card formats were adopted in January 1970, replacing a three format system which had been in use for 12 years.

Auditing

Prior to 1970, data coding was checked manually by an individual other than the coder, prior to punching, and machine verified after punching, usually by the puncher. The obvious deficiencies of this auditing system - in particular, it was very time consuming, it was unlikely to catch all coding or punching errors, and it gave no check on recording errors — led to its replacement by an auditing system based mainly on computer checking, for all 1970 and subsequent cruise data. Manual checking is now restricted to data which cannot be adequately checked by computer, but which, if wrong, could produce major errors in subsequent analyses. These data are on the Station and Set cards which are listed and proofread (a process taking only four man hours for July 1970 survey data). The remaining data are checked by computer for inconsistencies, a procedure which, for some data, catches all errors, while for others catches all major errors. We believe that the small errors we miss will not significantly affect the results of subsequent data analyses. In return for this small sacrifice we can be confident of catching all large errors, not only in coding and punching, but in many cases also in the original recording.

In summary, our computer audits do the following: list Station and Set cards, checking for inconsistencies between distance towed and ship's speed; checking for inconsistencies among stratum, ICNAF Division and depth fished; and checking number of species and total weight of fish caught against totals of these from Catch cards. After proofreading and correction of Station and Set cards, data on Catch, Length-frequency, and Fish cards which are in common with those on the Station and Set cards (i.e. columns 2–38, 2–20, 2–30 respectively) are checked against it. Totals of biological observations from Length-frequency and Fish cards are checked against the inventory on the Catch card for each species. Also for each species separately, the parameters of the exponential length-weight equation are calculated from length and weight data on Fish cards when these data are available. If the number of observations is less than 50 there is the option of feeding in substitute parameters. The observed weight of each fish is compared with the expected weight for its length and all cases where these differ by more than 25% for fish >1000 g. expected weight or 50% for fish $\leq$ 1000 g., are listed. The expected weight of the species catch in each tow is calculated from the length-frequency

distribution and length-weight parameters and differences from this of the observed weight which are greater than 2 kg are listed. Numbers caught recorded on Catch cards are checked against numbers caught calculated from Length-frequency cards. The average weight of one basket of the species is calculated and divided into the weight caught in each set to obtain an estimated number of baskets caught. Differences between estimated and observed numbers greater than 20% or 1 basket (whichever is the larger) are listed. Those species for which length-frequencies are required by sex are checked to establish that this has been done. For those species with age data, the recorded age and year-class are checked from the recorded number of annuli, edge type and date of capture. Mean lengths at age are calculated and fish whose length at age lies outside two standard deviations from the mean are listed. If no coding and punching errors are found, the otoliths are re-read by the same age reader (without reference to the initial reading) to check for recording errors. No checks have yet been devised for stomach content and parasite data, other than for number of observations. Few of these observations are currently made and visual scanning of listings by persons concerned with the collection of the data being checked would probably catch all important errors.

Of course, the data listed by these programmes are not all in error. Some do represent coding and punching errors which can easily be corrected. Others represent the natural extremes of variation in the parameters measured and in the measuring technique, while others represent recording errors. Only the most extreme outliers are judged tc be recording errors and are discarded or an estimated value substituted.

LOGISTIC REQUIREMENTS

Logistic requirements of survey operations are dependent on survey objectives, vessel capabilities, and season and area of operation. The summer 1970 survey of the Nova Scotia banks from the head of the Bay of Fundy to St. Paul Island in the Cabot Strait can be taken as an example of summer operations in the area of interest of the St. Andrews Groundfish Investigation. As described above, this was a general survey aimed at providing abundance indices and biological data on all major groundfish species in the area, using a stratified-random sampling design.

An area of approximately 43,000 square nautical miles was surveyed in 21 days at sea working 24 hours per day aboard the *A.T. Cameron*. A total of 137 stations were successfully occupied, an average of about 6.5 stations per day, giving a sampling intensity of about one station per 315 square nautical miles. Time per station required to survey the proposed trawling location and complete a half-hour trawl set and associated hydrographic work was between one hour and one hour and a half. Steaming time between stations was approximately two hours, averaging 20 nautical miles. We were fortunate that loss of time due to bad weather was zero and that the frequency of severe net damage was low, at 4% of tows. Obviously, the number of stations successfully completed per day depends on intensity of sampling, (i.e. steaming time between stations), frequency of net damage which controls number of repeat tows and time spent mending gear, and frequency of weather unsuitable for fishing. In winter and spring months, bad weather conditions have not infrequently reduced the average number of stations occupied per day to between 2 and 3. It is prudent to anticipate that, on the Nova Scotia banks, 30–50% of sea time will be unworkable in winter and 5–10% in summer.

The normal requirement for scientific personnel aboard the *A.T. Cameron* for these survey cruises is nine. The July 1970 *A.T. Cameron* survey thus required 36 man-weeks to complete when travel time is included. However, this does not adequately convey the demands of the survey on our manpower and monetary resources. Under present FRB overtime regulations, a technician can conceivably earn (although it will usually be less) as much as three week's salary in one week at sea, which may be taken either as salary or as vacation in lieu of salary. Scientists do not earn overtime, students earn time-in-lieu on a straight-time basis, and guests earn nothing. Thus, the composition of the scientific party has a considerable influence on the cost of operations. Pre-cruise planning and preparation utilized 4 man-weeks. Coding and punching of data for computer processing required a further 14 man-weeks (excluding time required in processing hydrographic data and in age reading), and auditing procedures took one man-week. Thus, this particular survey required a minimum of 55 man-weeks to complete, plus the equivalent of 24 man-weeks earned as overtime and taken either as salary or vacation by technicians and students. Introduction of new codes and coding procedures increased coding time on this occasion. With experience, coding time may well be reduced by 2—4 weeks.

Computer processing facilities at the St. Andrews Biological Station consist of an I.B.M. 1130 16K computer with additional disc storage of 0.5 million words, and with card reader/punch and printer facilities. Auditing procedures for the July 1970 survey data required approximately 25 machine hours.

FUTURE SURVEY OPERATIONS

Plans even for the immediate future are essentially tentative as allocation of research funds and vessel time is on an annual basis within FRB on the Atlantic coast and research priorities are also liable to change from year to year. We hope to expand the autumn Gulf of St. Lawrence cod survey into a survey of all major groundfish species throughout ICNAF Div. 4T while maintaining our other survey operations at their present level. The summer Nova Scotia banks survey which is the 1970 contribution to our cooperative survey programme with the U.S.A. and U.S.S.R., shall likely continue as our principal contribution to any ICNAF sponsored cooperative programmes. Plans for research ancillary to our survey programme include engineering performance tests of our #36 Yankee survey trawl on the *A.T. Cameron* and *E.E. Prince*, a comparative fishing experiment with these two vessels, and further evaluation of echo counting systems for quantitative survey work.

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GROSSLEIN, M.D. 1969. Groundfish survey methods. U.S. Bureau of Commercial Fisheries, Biological Laboratory, Woods Hole, Mass. Laboratory Reference No. 69-2, 34 pp.

TABLE 1. SPECIFICATIONS OF THE CANADIAN FISHERIES RESEARCH VESSELS *A.T. CAMERON* AND *E.E. PRINCE*

SPECIFICATION	*A.T. CAMERON*	*E.E. PRINCE*
Length overall	177 ft. (54 m.)	130 ft. (39.6 m.)
Gross tonnage	753	406
Year built	1958	1966
Vessel type	Steel side trawler	Steel stern trawler
Cruising speed	approx. 11 knots	approx. 11 knots
Cruising range	7000 nautical miles	3000 nautical miles
Normal duration of trip	10–15 days	10–15 days
Maximum duration of trip	6 weeks	3 weeks
Accommodation:		
Officers and crew	25	14
Scientists	10	6
Refrigerated fish hold	1,500 ft^3 (42.5 m^3)	None
Scientific freezer	200 ft^3 (5.7 m^3)	175 ft^3 (5 m^3)
Engine horsepower	1,000	600
Propeller	controllable	controllable
Navigation and fish location equipment	Gyro compass and two repeaters; automatic pilot; radio; radar (2) Loran; Decca navigator; direction finder; echo sounder (5); Sal log	Gyro and magnetic compasses; radio, radar (2); Loran; Decca navigator; echo sounder (3); sonar; Sal log; automatic pilot
Trawl winch:		
type	Electric-3 barrels	Hydraulic-2 barrels
power	240 h.p.	90 h.p. each barrel
speed	250 ft/min.	250 ft/min.
cable	main barrels - 1000 fm. 1 inch diam.	600 fm. 5/8 inch diam.
	centre barrel - 3350 fm. ½ inch diam.	
Hydrographic winch:		
type	Hydraulic - single barrel	Hydraulic - single barrel
power	14 h.p.	40 h.p.
speed	600 ft/min.	600 ft/min.
cable	1000 fm., 5/32 inch diam.	1000 fm., 5/32 inch diam.
Laboratory space		
number	6 (wet, hydrographic, chemical, general, darkroom, sounder room)	3 (wet, hydrographic, general)
area	665 $ft.^2$	390 ft^2
Standard oceanographic and meteorological equipment	Bathythermographs; water samplers; barometer; barographs; anemometer; psychrometers	Bathythermographs, water samplers; facsimile; barometers; barograph; anemometer
Special features	Strengthened for navigation in ice	Flume stabilization system

TABLE 2. SPECIFICATIONS OF #36 SURVEY TRAWL

PART	MATERIAL	MESH SIZE (inches)	LENGTH (meshes)	WIDTH (meshes) FORE	AFT
Upper wings	3000 tex polythene twine	5"	60 (fly-meshes)	10	60
Lower wings	"	5"	100 (fly-meshes)	30	45
Square	"	5"	33	180	140
Square extension piece	"	5"	5	140	140
Bellies	"	4½"	79	140	40
Lengthening piece	"	4½"	79	40	40
Cc nd	white braided nylon	4½"	46	40	40

. . . . . .

Chafer — Buffalo hide covering aft half of underside of codend.

Groundwarps — 120' x ¾" wire.

Bridles — Top: 60' x 5/8" wire.
Bottom: 59' x 5/8" wire.

Headrope — Total length 60' x 7/8" combination wire rope in three 20' sections.

Floats — 8" spherical (no collar) aluminium Phillips Deep Sea model.
Ten floats evenly spaced on each wing, fourteen evenly spaced on square.

ootrope — Total length 80' x ¾" wire in seven sections, 10', 5 x 12', 10'.

ollers — Hard rubber, 5" wide by 16" diameter, rubber bunt rollers, 14" diameter, and iron rollers, 12" wide by 14" diameter.
Outer two sections of footrope with 7" spacers only.
Third section with three bunt rollers kept 2½' apart by spacers.
Centre section with five rollers, three iron, two rubber, spaced alternately 1½' apart by spacers.
One iron roller at each of outer ends of footrope.
No dan-leno.

oors — 7'6" x 4'2" x 2½" wooden, metal bound, with three 4" wide x 1" thick shoes, 1200 lb. each.

iners — 1. 1¼" mesh black knotless nylon throughout lengthening piece.

2. ¼" white knotless nylon throughout codend.

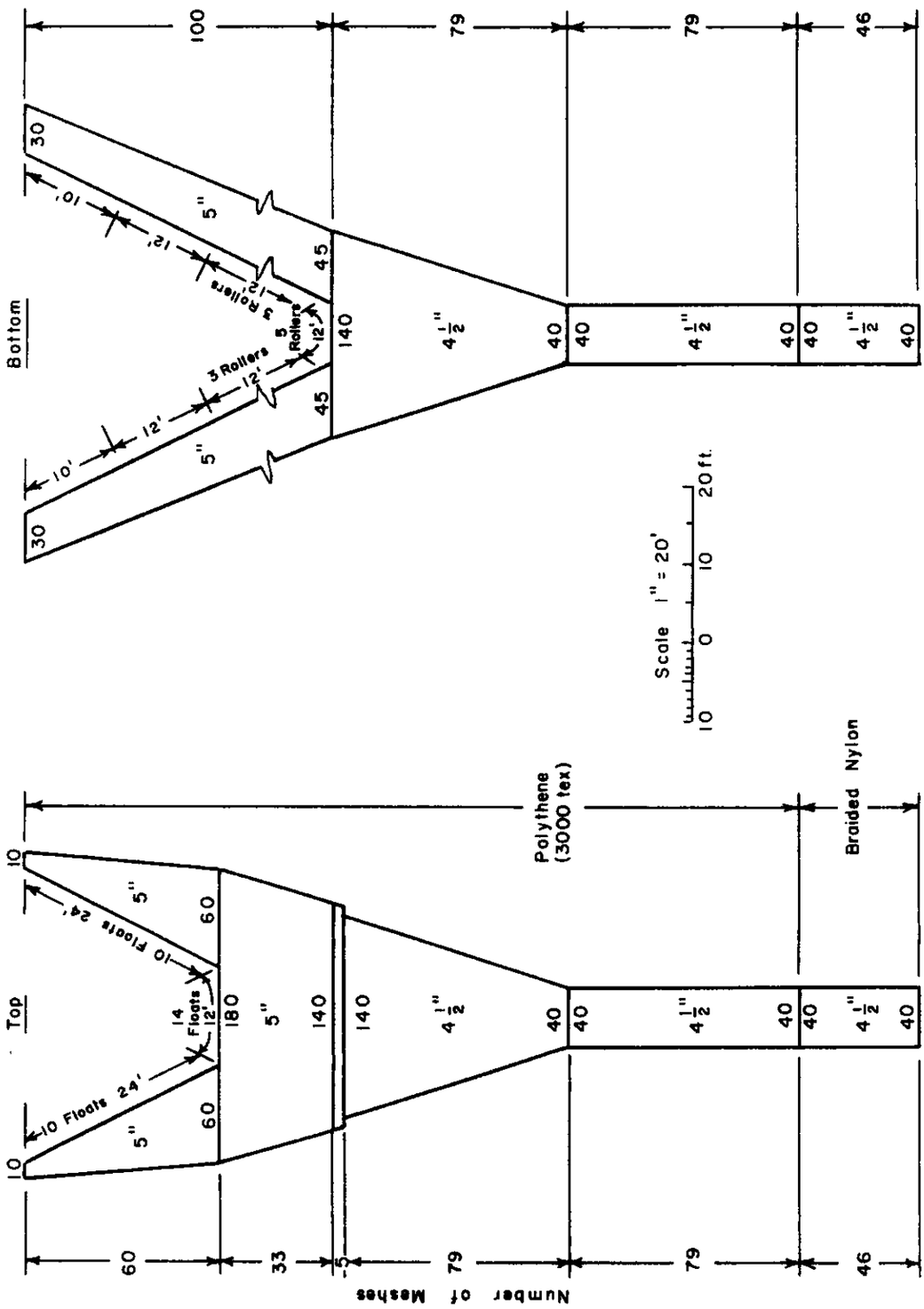

Fig. 1. Specifications of #36 Yankee survey trawl

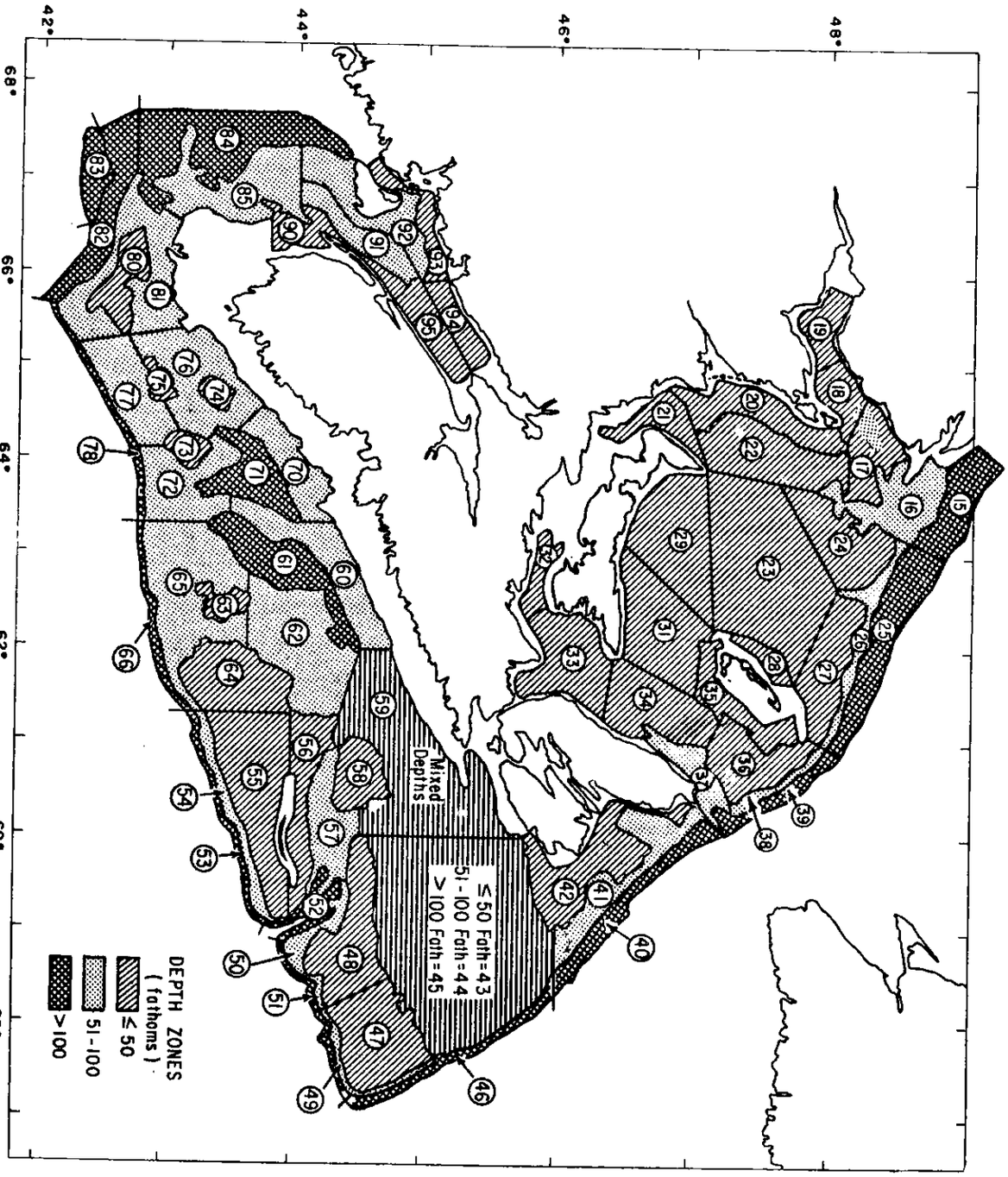

Fig. 2. Stratification and numbering system of ICNAF Divisions 4-V-W-X adopted January 1970.

FIG. 3 GROUNDFISH DECK SHEET

STATION: _____

SET: _____

RECORDER: _____

NET DAMAGE:

BOTTOM TYPE:

NOTES on interesting aspects or peculiarities of catch.

BIASES (eg. Discards before sampling and other mistakes. Estimates of fish carried over from previous tow. Suspicions that net not fishing properly, etc.)

SPECIES	BASKET WEIGHT AND COUNT (Include basket weight) Weighed in pounds ☐, in kilograms ☐ (✓-check)										TOTAL	
											BASKETS	WEIGHT

N.B. 1. Circle baskets sampled.
2. Denote fractions of baskets as follows: 3/10 ths. of a basket weighing 20 lbs. 20/3

FIG. 4 LENGTH-FREQUENCY TALLY

Cruise No. _____ Station No. _____ Set No. _____

Species _____ Date _____ Sampler _____

. Measured _____ Sample Wt. _____ kg. Ratio measured _____

			60		
			61		
			62		
6			63		
7			64		
8			65		
9			66		
10			67		
11			68		
12			69		
13			70		
14			71		
15			72		
16			73		
17			74		
18			75		
			76		
20			77		
21			78		
22			79		
23			80		
24			81		
25			82		
26			83		
27			84		
28			85		
29			86		
30			87		
31			88		
32			89		
33			90		
34			91		
35			92		
36			93		
			94		
			95		
39			96		
40			97		
41			98		
42			99		
43			100		
44			101		
45			102		
46			103		
47			104		
48			105		
49			106		
50			107		
51			108		
52			109		
53			110		
54			111		
55			112		
			113		
57					
58					
59					

Form G.13 (Jan./70)

FIG. 5 GROUNDFISH FISH SHEET

CRUISE :	STN OR STRATUM :	SET :	DATE : Day Mo. Yr.
ICNAF Sub. Div. Unit	TYPE OF EXPERIMENT :	GEAR : DEPTH (fm) :	TEMP AT GEAR °C :
TIME BEGIN	BOTTOM TYPE :	SPECIES :	SAMPLER : RECORDER : TYPE OF SAMPLE :

FISH NO.	Length	Sex	Maturity	Wt. gm.	STOMACH CONTENTS: Cond	Total Volume	No. of Spec	Species	Parts	Species Code	AGING MATERIAL: Type	Reading	Age	Yr Class	Read by	REMARKS	Parasites

FIG. 6 GROUNDFISH LENGTH-FREQUENCY TRANSFER SHEET

CRUISE	STN. OR STRATUM	SET	DATE Day Mo. Yr.	ICNAF Sub Div. Unit	TYPE OF EXPT.

NO. OF SHEETS:	SHEET NO.:	SAMPLERS:	CHECKED:

SPECIES	HADDOCK
CODE	
WT caught	
WT sampld	
BKTS caught	
BKTS sampld	
NOS caught	
NOS sampld	
RATIO	
SEX	
Grouping	

1	0.5	0
4	2.5	1
7	4.5	2
[illegible]	6.5	3
13	8.5	4
16	10.5	5
19	12.5	6
22	14.5	7
25	16.5	8
28	18.5	9
31	20.5	0
34	22.5	1
37	24.5	2
40	26.5	3
43	28.5	4
46	30.5	5
49	32.5	6
52	34.5	7
55	36.5	8
58	38.5	9
61	40.5	0
64	42.5	1
67	44.5	2
70	46.5	3
[illegible]	48.5	4
[illegible]	50.5	5
79	52.5	6
82	54.5	7
85	56.5	8
88	58.5	9
91	60.5	0
94	62.5	1
97	64.5	2
100	66.5	3
103	68.5	4
106	70.5	5
109	72.5	6
112	74.5	7
115	76.5	8
118	78.5	9
121	80.5	0
124	82.5	1
127	84.5	2
130	86.5	3
133	88.5	4
136	90.5	5
		6
		7
		8
		9
		0

Use 3 centimeter grouping for: cod, white hake, pollock, cusk, dogfish, angler, barndoor skate, thorny skate, eyed skate, wolffish, and halibut.

FIG. 7 GROUNDFISH STATION AND SET SHEET (Revised 1970)

Recording Personnel	Bridge:	Hydrography:	Fish:

Cruise:	Stn. or Stratum:	Set:	Day Mo. Yr.	tion & Set Catch Card Data
ICNAF Sub. Div. Unit	Type of Experiment:	Time Beginning:	Duration:	
Gear:	Aux. Equip.	Ship Speed:	How Obtained:	

	Latitude	Longitude	How obtained & Reading
Start	° ' "	° ' "	
End	° ' "	° ' "	

Bottom Depth (Fm)		Log Reading	
Start:	Maximum:	Start:	
End:	Minimum:	End:	
Average:	Range:	Distance or Water Strained:	How Obtained:

Ship Direction:	Barometer:	Weather:	Sea:
	Air Temp.:	Clouds:	Swell:
Wind Direction:	Force:	Tide and Current in Relation to Ship Direction:	
Surface Temp.:	Bottom Temp:	Bottom Salinity:	Light (Metered):
BT Slide Number:	Start:	Hydro. Stn. No.:	Bottom Type:
	End:		
Drift Bottles:		Seabed Drifters:	

No. of Fish Species:	No. of Invert. Species:	Total Weight of Fish Catch (kg):

REMARKS: (i.e. Note fish returned to lab., unusual characteristics of catch, details of gear damage, etc.)

CATCH CARD DATA

Depth of Gear:	Temp. at Gear:	Salinity at Gear:	Light:	Bottom Type:

FIG. 8 GROUNDFISH STATION AND SET SHEET (back)

SPECIES		TOTAL CAUGHT			NO. SAMPLED FOR:						
		NOS.	WEIGHT kg	BAS-KETS	Length	Sex	Maturity	Weight	Otoliths	Para-sites	Stomachs
COD	0010										
HADDOCK	0011										
WHITE HAKE	0012										
SILVER HAKE	0014										
LONG-FIN HAKE	0112										
RED HAKE	0013										
POLLOCK	0016										
CUSK	0015										
REDFISH	0023										
HALIBUT	0030										
TURBOT	0031										
PLAICE	0040										
WITCH	0041										
YELLOWTAIL	0042										
WINTER FLOUNDER	0043										
BARNDOOR SKATE	0200										
THORNY SKATE	0201										
SMOOTH SKATE	0202										
LITTLE SKATE	0203										
WINTER SKATE	0204										
SPINY DOGFISH	0220										
ARGENTINE	0160										
HERRING	0060										
SHAD	0061										
GASPEREAU	0062										
MACKEREL	0070										
SAND LAUNCE	0610										
LONG-HORN SCULPIN	0300										
MAILED SCULPIN	0304										
HOOK-EAR SCULPIN	0306										
SEA RAVEN	0320										
WOLFFISH	0050										
ANGLER	0400										
LUMPFISH	0501										
OCEAN POUT	0640										
PANDALID SHRIMP	2210										
SPIDER CRAB	2522										
EUPHAUSIDS	2600										
LOBSTER	2550										
SQUID	4511										

FIG. 9 HYDROGRAPHIC LOG SHEET NO. 1

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LOG SHEET

STATION AND THERMOMETER DATA

CRUISE NO	STATION NO		LATITUDE	LONGITUDE	WIND		AIR TEMP		CLOUDS		SEA		SWELL		B.T
					DIR.	SPEED	DRY	WET	TYPE	AM'T.	DIR.	AM'T.	DIR.	AM'T.	
VESSEL	CAST	TIME MESS. DOWN	WIRE ANGLE	DEPTH	WIND FORCE BEAUFORT										
	1 ST.						HUMIDITY	VISIBILITY	WEATHER		TRANS.	COLOUR	OBSERVERS		
DATE	2 ND			MAX. SAMPLE DEPTH	BAR. (MBS.)										
	3 RD.														

CAST	SAMPLE BOTTLES				METER WHEEL	WIRE DEPTH (L)	WATER BOTTLE NO.	LEFT THERMOMETER							RIGHT THERMOMETER							AVERAGE T_w	DIFF. $T_u - T_w$	THERMO-METRIC DEPTH Z	L - Z OR COSINE	ACCEPTED DEPTH	REMARKS ICE CONC. ETC
	SAL.	O_2						THERM. NO.	MAIN (T')	AUX. (t)	V_0	I	C	T_w	THERM. NO.	MAIN (T' OR T')	AUX t OR t_u	V_0	I	C	T_w OR T_u						

CRUISE No. ....

AREA ....

VESSEL ....

MONTH AND YEAR ....

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FIG. 10 HYDROGRAPHIC LOG SHEET NO. 2

DECK SHEET

Observers: ....

Slide No.	B.T. No.	Day	Time GMT	Latitude	Longitude	Sounding		Wind		Bar.	Air Temp. °C		Wea.	Cloud		Sea	Swell		Water Bottle	Therm. No.	Temp. °C		Corr. Temp.	Time Down	Sample No.		Salinity %		Remarks
						Fms	Metres	Dir.	Force	Mbs.	Dry	Wet		Type	Amt.		Dir.	Amt.			Main	Aux.			Surf.	Bott.	Surf.	Bott.	

FIG. 11 GROUNDFISH STATION & SET CARD

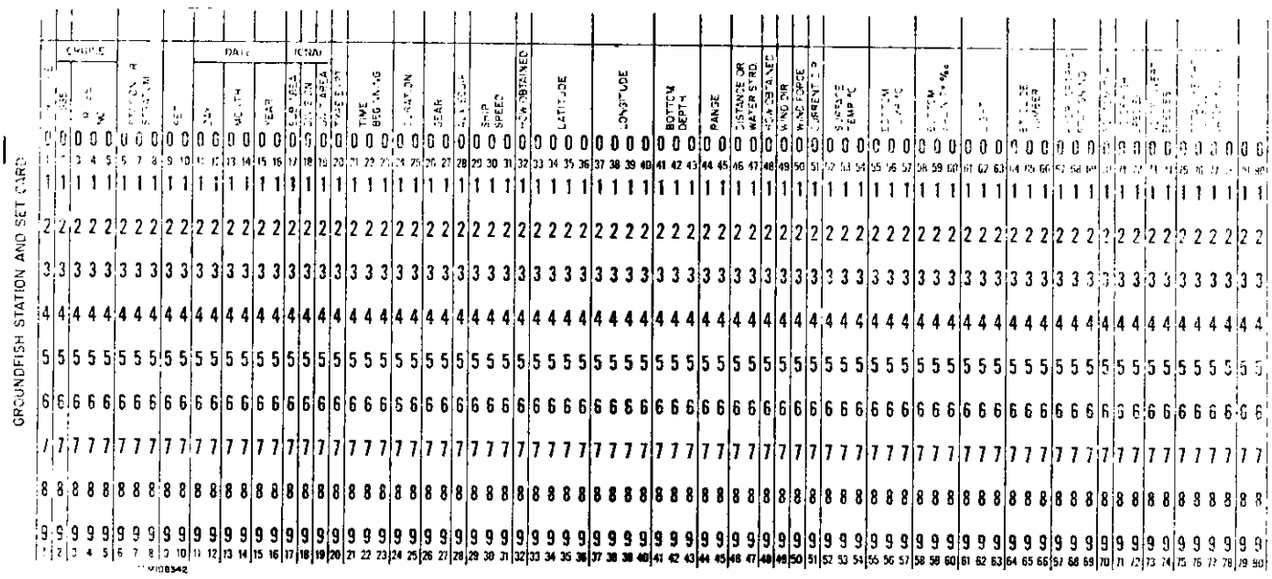

FIG. 12 GROUNDFISH CATCH CARD

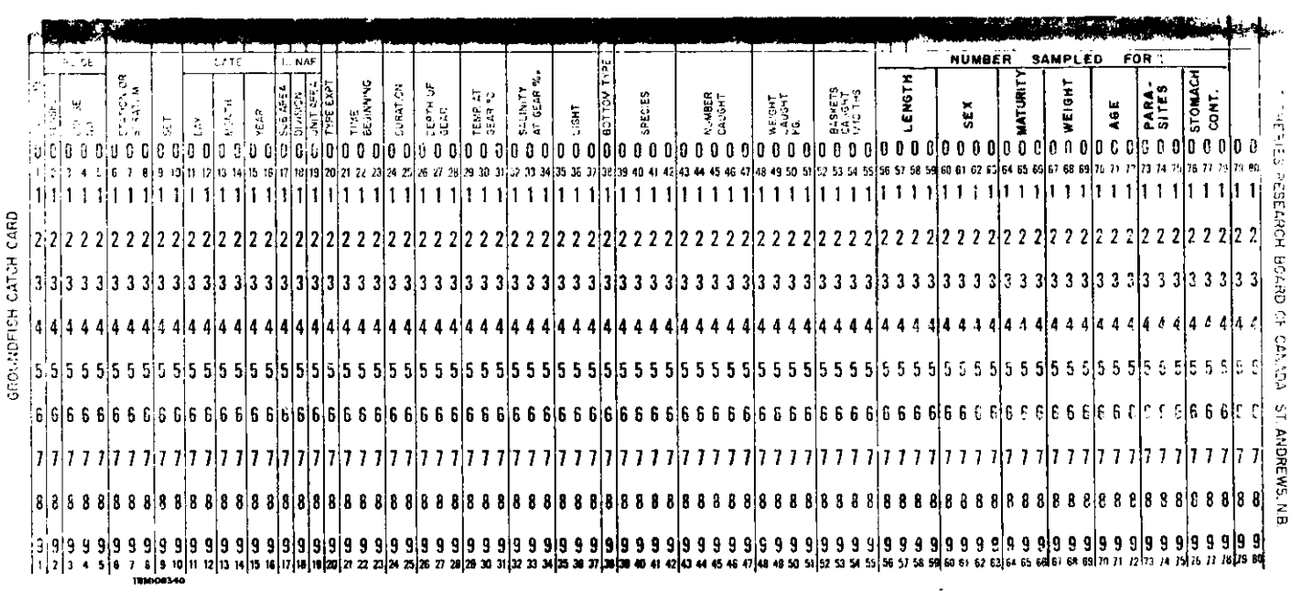

FIG. 13 GROUNDFISH LENGTH–FREQUENCY CARD

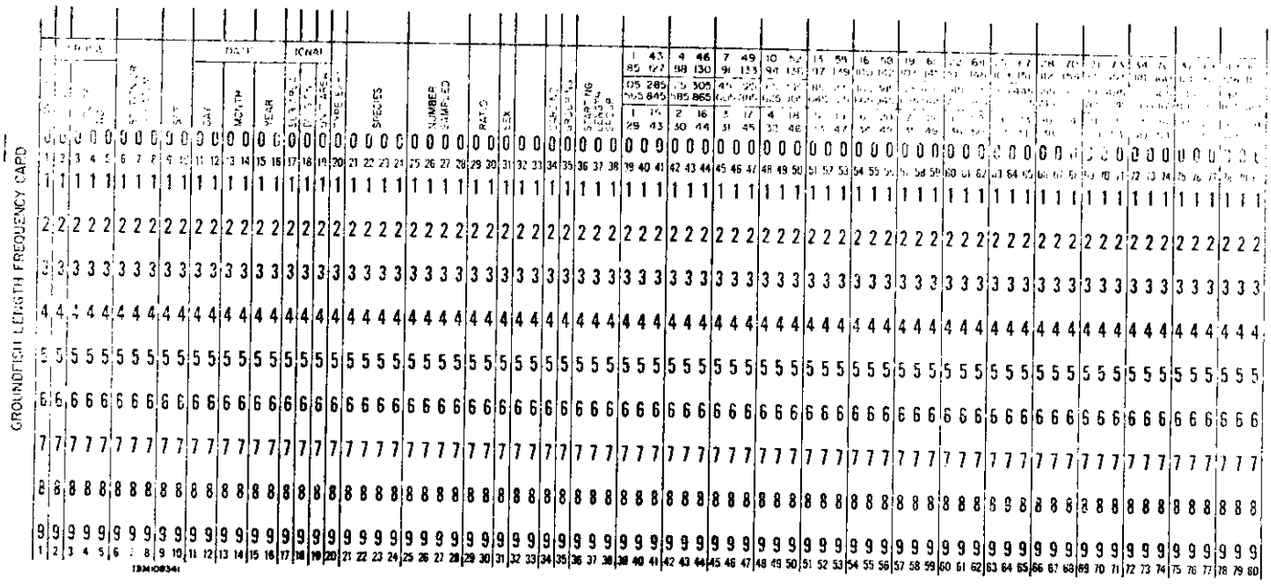

FIG. 14 GROUNDFISH FISH CARD