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**Biostatistical Data Acquisition
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ABSTRACT

Methods of recording and processing data from collections of Atlantic menhaden (*Brevoortia tyrannus*) and Gulf menhaden (*B. patronus*) from commercial menhaden landings are described. Keys to efficient data handling are (1) a system of two data cards and (2) a code system for information about the sampled fish. The data are stored on magnetic tape and can be displayed in many useful arrays by a number of computer programs written in American Standard Cobol for the IBM 360 (Model 65).

SPECIES	<input type="text"/>	LENGTH	<input type="text"/>	U.S. DEPARTMENT OF COMMERCE NATIONAL MARINE FISHERIES SERVICE Mid-Atlantic Coastal Fisheries Research Center Beaufort, North Carolina 28516
YEAR CAUGHT	<input type="text"/>	WEIGHT	<input type="text"/>	
SCALE READER	<input type="text"/>	SEX	<input type="text"/>	
VESSEL NO.	<input type="text"/>	AREA	<input type="text"/>	
LOCATION CAUGHT	<input type="text"/>	MATURITY	<input type="text"/>	
MONTH	<input type="text"/>	GONAD WEIGHT	<input type="text"/>	
DAY	<input type="text"/>	<input type="text"/>	<input type="text"/>	
PLANT	<input type="text"/>	SCALE SAMPLE NO.	<input type="text"/>	
COLLECTION NO.	<input type="text"/>			

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PLANT	SCALE SAMPLE NO.
RING 1 _____	7 _____
2 _____	8 _____
3 _____	9 _____
4 _____	10 _____
5 _____	EDGE _____
6 _____	
20 30 40	
READER _____	

FIGURE 1.—Data cards used in processing samples from the menhaden fisheries. The sample card is above, the scale card below.

INTRODUCTION

A prominent feature of the National Marine Fisheries Service menhaden research program, begun in 1955, is intensive and extensive sampling of menhaden landings at ports from Maine to Texas. The fisheries for the two commercially important menhaden species, *Brevoortia tyrannus* on the Atlantic coast and *B. patronus* in the Gulf of Mexico, comprise 19 ports on two coasts, approximately 150 vessels, and around 5,000 vessel unloadings per year. The record annual catch of both menhaden was 1,033,000 metric tons, representing an estimated 10 billion individual fish, in 1961.

Sampling this large fishery has involved processing as many as 50,000 fish, scale samples, and sets of associated data per season. An efficient system of data acquisition and management is essential to the success of the research program. A description of our present data management system, the product of an expensive evolution, should be of value

to others planning research on large commercial fisheries.

Data acquisition begins with sampling fish landed by the purse seine vessels. Sampling procedures are essentially those reported by June and Reintjes (1959). Samplers, located at most ports, obtain samples, each of 20 fish, from a minimum of 10 landings during each week.

Effective data management must begin upon processing the fish samples to ensure an orderly, efficient flow of information to the data processing unit and ultimately to data users. Our keys to efficient data transmission are two data cards (Fig. 1) and a code system (Table 1) for pertinent information about the samples. One data card, a sampling card, is for catch and morphometric information; the other, the scale card, is for scale and age information. The cards measure 3½ inches by 11¼ inches and cost less than 1 cent each.

To simplify operations for the sampler we

TABLE 1.—Format and code numbers for recording data on sampled fish

Field name	Field size	Limits	Code and observation
Species	1-1	0-9	0 <i>B. tyrannus</i> and <i>B. patronus</i> , 2 <i>B. smithi</i> , 3 <i>B. gunteri</i> , . . . 6 <i>Opisthonema oglinum</i> , etc.
Year caught	2-3	0-99	last two digits of year
Scale reader	4-4	0-9	number assigned
Vessel	5-7	001-999	number assigned
Latitude	8-9	01-99	degrees latitude caught
Longitude	10-11	01-99	degrees longitude caught
Alpha coordinate	12-12	A-F	10 minutes of latitude
Number coordinate	13-13	0-6	10 minutes of longitude
Month	14-15	00-12	1 January, 2 February, etc.
Day	16-17	0-31	day of month
Plant	18-19	01-99	number assigned
Collection number	20-23	001-999	number of 20-fish collection
Number of rings	24-25	01-19	number of annuli on scales
Year-class	26-27	01-99	year hatched or year caught minus number of annuli, 20 no fish sampled, 30 no scale, 40 illegible scale
Sex	28-28	01-9	1 male, 2 female, 3 unknown
Large area along coast	29-29	0-9	1 North Atlantic, 2 Middle, 3 South, etc.
Sexual maturity	30-30	0-9	1 immature, 2 resting, 3 ripening, 4 ripe, 5 spent, 6 unknown
Gonad weight	31-33	0-999	weight to tenth of gram
Gear	34-34	0-9	0 purse seine, 1 pound net, 2 gill net, 3 trawl
Blank	35-35	—	—
Blank	36-36	—	—
Scale sample	37-41	0-99999	number assigned each sampled fish, consecutive for year
Length	42-44	0-999	fish fork length in mm
Weight	45-47	0-999	fish weight in grams
Scale measurement (1-10)	48-50-75-77	0-999	distance in mm of each annulus from focus
Scale edge	78-80	0-999	distance in mm of scale's margin

supply bundles of 20 (to match sample size) sampling cards with a collection number and individual fish number printed on each. Spaces for these numbers are located near the bottom of the sampling card to permit easy number insertion with handheld printing machines. When processing a sample, the sampler writes on the first card of the collection the code numbers that apply to all fish in that sample (species, vessel, location caught, date, and plant) as well as the codes describing the first fish (length, weight, sex, sexual maturity stage, and gonad weight). On each of the subsequent 19 cards he writes only the code numbers describing the respective fish. Key punch operators add the information common to all fish in a sample (from the first data card to the information unique to each fish in that sample when the data are prepared for storage on magnetic tape).

The sampler removes and cleans several scales from each fish and mounts them between two glass slides (June and Roithmayr, 1960). Scale mounts are numbered in accordance with the sampling cards and receive both a plant number and scale number. Collections of data cards and of mounted scales are mailed in padded envelopes to our research center at Beaufort, N. C., where collections are logged in and cards and scales

are examined to ensure that field personnel are keeping their collections in order.

The scale card is completed at the laboratory. For each sampling card and associated scale mount there exists a scale card bearing the same scale number. As the reader views the enlarged (40×) scale image, he marks the annuli and edge measurement on the ruler edge of the scale card (Fig. 2). Processing of scale cards is completed when the scale measurements and appropriate plant code number is written on the face of the card.

The two-card system has two advantages: (1) it spreads the work load of key punch operators evenly over the year. As sample cards arrive at the laboratory during the fishing season, all information except age, year-class, and scale measurements are key punched and stored on magnetic tape. After the scales have been read, the additional information, plus plant and scale number, are punched and stored on another tape. Data from each tape are matched electronically by plant and scale number to create a third tape on which a complete record for each fish is recorded. (2) the two-card system allows the practice of the system of scale reading in which readers have no knowledge of the size of the fish, date of capture or other informa-



FIGURE 2.—Scale reader marking annulus measurement on the edge of a scale card.

tion, and are supposedly less prone to bias in their aging.

Once the data are on tape they are available for display in many useful arrays, and we have a large library of computer programs (written in American Standard Cobol for the IBM 360 model 65) for generating these arrays. Source decks and documentation of

these programs are available to those with genuine interest and need. An annotated partial list of these programs follows.

BST 10; Calculated fish lengths. For each fish, estimated length at each year (annulus is computed. $L_n = \left(\frac{L}{S_e}\right)$

(S_n), where L = length at capture, Se = scale edge, S_n^{th} = scale measurement to the n^{th} annulus, and L_n = estimated length at n^{th} year.

- BST 11; Collection summary by plant. Summarizes each collection by age, listing number of males, females, average length, and weight, date, and boat number.
- BST 12; Mean weight by length. Prints for each age and sex, frequency distributions and mean weight in 5-mm length intervals. Options for monthly summaries are by plant, port, large area, latitude, and longitude, and subcoordinates.
- BST 14; Length frequency. Prints length frequency distribution, in 5-mm intervals or ungrouped, by sex within age by semi-monthly, monthly, or season by plant, port, large area, or longitude.
- BST 15; "Back" calculated length at age-I. Prints frequency distributions of estimated fish lengths at age-I of ages II-X as per formula in BST-10.
- BST 16; Weight frequency. Distribution of weight in 5 or 10-gram intervals, by sex, and age, for semi-monthly, monthly, or season.
- BST 18; Number of species and fish sampled. Lists species, number per age of fish sampled monthly by plant, port, and season as well as those not aged and those not measured for length or weight.
- BST 22; Growth equation. Calculates growth equation by sex in $\frac{1}{2}$ -year intervals as estimated by von Bertalanffy equation.
- BST 23; Length-weight relation. A linear regression of converted natural logarithmic values of length and weight.
- BBL 01; Estimated number of fish in landings. Calculates number of fish of each age, caught each week at each plant, on basis of weight of sampled fish and their ages, and

daily landings of vessels. Weekly values are added to get monthly and annual totals.

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