SOME USES OF PUNCH CARD METHODS IN THE TABULATION AND ANALYSIS OF FISHERY RESEARCH DATA

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Most fishery management agencies are faced with the problem of an ever increasing workload and a demand for more accurate and reliable information. Research programs are being expanded and their standards are rapidly rising, necessitating more detail and complex analyses of data, while at the same time, there is a shortage of trained fishery personnel. Therefore, it has become necessary to increase the efficiency of collecting and processing data.

The problem of assimilating the mass of material accumulated in normal biological surveys, determining the relationships and evaluating the relative weights of data, led to the investigation of methods other than manual for more rapidly and effectively making these recapitulations and computations. Our approach, and the one which we feel is most practical at the present time and at our present volume, has been to introduce the field data into punch cards for machine manipulation. The present report describes punch card methods, some of the problems connected with the method and some of its applications in fishery research.

The punch card itself is the basic instrument; its dimensions are maintained to very close physical tolerances. Because of these tolerances, careless handling, storing and subjection to extremes of humidity may greatly hamper smooth machine operation. The Remington Rand punch cards which we use, have ninety columns; that is, positions for ninety digits of information. Each column contains six punching positions and combinations of these six possible positions give all basic numerical and alphabetical values.

The columns may be grouped into "Fields" of any size from one column up. They must be titled and must always be in the same position on all cards in the group. These fields have two general classifications: designative and accumulative. The designative fields will contain codes indicating descriptive data, such as location, sex, etc.; and the accumulative field will contain quantities whose totals has significance, such as weight, number, etc.

In order to insure a smooth and efficient punching operation, the punch card and the field form should be designed together. This is basic but is very often overlooked. The data should appear in the same sequence on the punch card and the field report.

The most efficient arrangement of the punch cards and the source documents are not always easily determined, but a lot of study devoted to the symmetry and efficiency of field reports and card forms can yield great dividends when several thousand entries are being handled.

The data taken in the field should be arranged, if practical, in a series of blocks, in sequences either vertically or horizontally and those items not coded in the field (such as body of water, county, etc.) should be in a space to the left of the block provided for their codification. Whenever possible, codes should be included on the field form and decoded clearly so there will be no confusion.

Field reports, or source documents, should be serially numbered and this number entered on the punch card in one of the designative fields. This makes it possible to compare at any time the data on the punch card with the source document entries. Comparison is often necessary when correcting punching errors or when it is suspected some of the punch cards have been lost.

Any coding not done in the field should be done in the office before the work is given to the punch operator. The punching operation should be completely automatic and the operator should not have to interpret information, code information, make any computations or have any personal choice as to what should be punched in the cards. The moment the punch operator begins to think rather than automatically transcribe by touch, it tends to introduce more errors into the work and slows down production.

In most research, it is necessary that the punch cards be 100 percent accurate. In order to obtain this accuracy it is necessary to verify all data placed on the cards.

There are many different ways of determining the accuracy of entries made on punch cards, most of which depend upon reading back the data either from the cards or from printed tabulations. However ,the most rapid method and the one most independent of human error, is to have the data repunched into the same cards by another operator using the verifying attachment of the punch machine operative. The cards are then run through a verifying machine which checks all punching and flags all error cards. This method of verifying is for the Remington-Rand punch card system; however, other systems have somewhat similar methods of verifying the punched cards.

When the cards have been punched and verified, the resultant documents can be rapidly rearranged and counted. For small installations, most of the tabulation can be handled by a mechanical sorter which sorts cards at the rate of 420 per minute per column. When, large volumes of data are handled, other machines, such as electronic sorters and printing tabulators, are more efficient and rapid.

The most helpful of all the auxiliary machines in punch card analyses is the electronic computer such as the Univac 120 Computer. The Univac Computer can be programed to make any mathematical calculations in any sequence and procede or change its procedure in a predetermined way as a result of any calculation. These computations are carried on at almost unbelievable speeds. To illustrate this speed, consider the creel census cards (Fig. 2). In order to make certain statistical analyses, we are interested in the number and pounds of fish per hour for each fishing party. These analyses are to determine the validity of certain creel census procedures and to estimate sample sizes needed. The number of divisions necessary for the volume of data to be analyzed would require one man working steadily for a full year with a desk calculator. The Univac can make these same calculations in a single work day.

Most punch card methods depend on punching from a prepared form; however, there are variations which better fit other conditions. One is for the field personnel to prepare the cards themselves. IBM provides for this by what is known as "Marked Sensing"; Remington Rand provides "Spot Punching." These have some advantages and some disadvantages which are worth considering before utilizing or discarding. The most obvious advantage is that the card requires no manual punching to be utilized. The disadvantages are, first, restricted card capacity. The IBM method requires three card columns for each character indicated, reducing the total capacity of the card to 27 columns if all columns are marked sensed. The Remington Rand Spot Punch requires two columns, reducing its total capacity to 45 columns.

Either operation is slower than writing Arabic numerals and there is no easy verification if the wrong position is marked or punched in the field. The first of these objections may not be important if the field personnel have plenty of free time, but the second can be serious. Another important factor is that the cards are accurate instruments requiring moderately careful handling, and abuse or excessive moisture can cause machine trouble. Special containers must be provided for their use in the field and personnel carefully cautioned as to their proper use.

A compromise which often works very satisfactorily is to design the card so that the data can be entered directly on it in normal alphabetical and numerical characters (Fig. 4). When cards are designed to be the document of original entry, certain precautions must be taken in using the IBM cards because of limited visibility of the card when in position in the key-punch for punching. The Remington Rand card has full visibility in the punch so the sequence planning is the controlling factor.

One of the greatest advantages of mechanical manipulation of data is the relative ease with which exploratory studies may be made. When a tally of ten thousand cards can be made in less than half an hour, studies of questionable value can be investigated without a feeling of great waste when that particular agenue proves fruitless, and thus gives courage to investigate fields of uncertain potential.

Another advantage of punch cards is that the cards themselves can serve as a method of filing or storing data until needed. The data, once punched and verified, is readily available whenever needed, and it is possible to extract any information that might be needed with a minimum of effort.

Punch card tabulation is very applicable in any type of analyses where the same data is to be classified in many different ways. Take for instance the creel census card. It might be necessary to determine the catch per unit of effort by area, date, day of week, time of day, non-resident fishermen, resident fishermen, sex, race, license holder, non-license holder, bait used, etc. The cards can be sorted by any of the above classifications and the catch per unit of effort determined with relative ease. For any volume of field data, the effort to determine these same statistics by manual tabulation would be much greater and much less accurate.

Standards of research are constantly rising and more precise and detailed analyses of data are being undertaken. Statistical methods of analyses are being applied to fishery research data much more frequently. This requires many more calculations; requires correlating different qualities; and necessitates cross classification of data and solving of complicated formulas. Some sort of machine tabulation of data is necessary if this trend is to continue. Punch card methods offer a reasonable solution. If a research organization has access to an electronic computer, the computation of standard deviations, standard errors, correlation coefficients, etc., for masses of data which man power consideration could not allow us to do by usual methods, can become a relatively simple matter.

In the course of our work with punch cards, we have found that the basic installation needed is a punch machine and a counting sorter. As the volume of work increases and when funds become available, a tabulator should be added to the setup. The use of a tabulator makes it possible to count and record one or more fields of information simultaneously; whereas with a counting sorter, only one column can be counted at a time. Also, the tabulator prints the resulting values on a form; whereas with the sorter the values have to be manually sorted.

Undoubtedly the best ownership arrangement is for the research section to own the basic machines. In this way, the installation is directly under their control and close supervision can be maintained over the personnel. Better scheduling of the work load and increased accuracy results from this arrangement.

In our operation, we find it necessary to borrow the use of machines from other state agencies. These machines include the Verifier, the Interpreter and the Univac 120 Computer. Excellent cooperation has existed between our Commission and the Department of Highways and Department of Labor in this matter. However, it is necessary to fit our work into their schedules; and therefore, considerable time lapses are involved between punching and the verification and computing of punched data.

Some research agencies are dependent upon their accounting section for the use of machines. If this becomes necessary it is far better than no machines at all. However, the same limitations are present here as are encountered with borrowed machinery. The accounting work comes first. Also, if the punch operators are not closely supervised, there will be too many errors in the work since many of these operators feel that research work is just an added burden.

We have applied punch card methods to the processing of creel census, fish sampling, age and growth, length-weight, condition and sex data. Other applications have been planned. A brief description of the procedure that we have used in the above mentioned applications follows:

Creel Census Data

Our primary use of punch cards has been in the tabulating of creel census data. Figures 1 and 2 illustrate the field form and punch card used. The form and the card are largely self-explanatory, however, a few items need clarification.

Fig. 1 Sample of creel census field form.

LOUISIANA WILD LIFE AND FISHERIES COMMISSION

A 4004 **CREEL CENSUS**

SERIAL NO.	LOCATION	AREA	DATE	DAY OF WEEK	TIME OF DAY	
					A.M.	P.M.

NO. IN PARTY	RES.	NON-RES.	SEX		RACE		LICENSE		BOAT		FINISHED	
			M.	F.	W.	C.	YES	NO	YES	NO	YES	NO
											(1)	(2)

ANY FISH CAUGHT	YES	NO	PARTY TOTALS	HOURS FISHING	MAN HRS.	NO. CAUGHT	LBS.
	(1)	(2)					

BAIT	LURE				LIVE BAIT					DEAD BAIT		OTHER
	B. CAST.	SPINNING	F. CAST.	TROLLING	FISH	WORMS	CRICKETS	CRAYFISH	GR. SHRIMP	CUT FISH	SHRIMP	
	(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(99)

CODE	HOURS FISHED	MAN HRS FISHED	NO. CAUGHT	LBS.		INDIVIDUAL SPECIES	CODE	NO. CAUGHT	LBS.
						LARGE MOUTH BASS	1		
30					BASS	KENTUCKY BASS	2		
						WHITE CRAPPIE	3		
40					CRAPPIE	BLACK CRAPPIE	4		
						BLUEGILL	5		
						REDEAR	6		
						WARMOUTH	7		
						LONGEAR	8		
						GREEN	9		
						STUMPKNOCKER	10		
						ORANGE SPOTTED	11		
50					SUNFISH				
						YELLOW BASS	12		
60					STRIPPED BASS	WHITE BASS	13		
70					PICKEREL	PICKEREL	14		
75					ROCK BASS	ROCK BASS	15		
						BULLHEAD	16		
80					CATFISH	OTHER CATS	17		
85					CHOUPIQUE	CHOUPIQUE	18		
90					DRUM	DRUM	19		

CHECKED BY: ______________________

REMARKS: ______________________

In conducting creel censuses, we use the fishing party as our sampling unit. In addition to the general descriptive data such as sex, race, etc., we attempt to determine what class of fish the fishermen are fishing for—*e. g.,* bass, crappie, sunfish, etc. The hours fished, number caught for each class of fish and the number and pounds of each species caught are also recorded.

In transferring the data from the field forms to the punch cards, it is usually necessary to use several cards for each fishing party. After punching the necessary information in columns 1 through 53 on the first card for a fishing party, the operator enters a 9 into the "Stat. Code" column 54. This card is designated as the *statistical* card (or party summary card) for the fishing party.

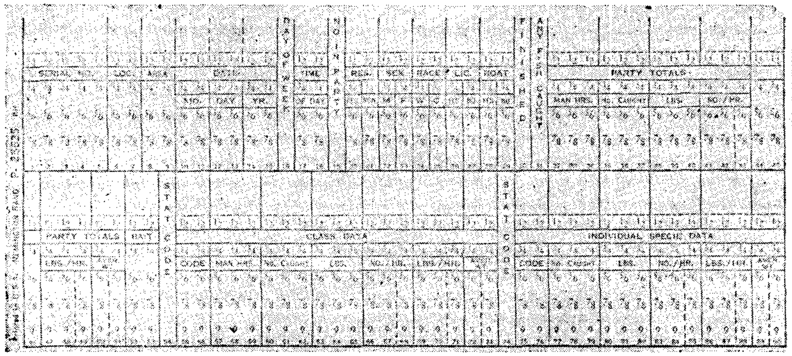

FIGURE 2. Creel census punch card.

Only this card will be used in accumulating any of the information contained in columns 1 through 53. After entering the "Stat. Code" 9 in column 54, the operator punches the class date into the card (columns 55 through 65). The first card for the class data has a 9 punched into "Stat. Code" column 74. The operator then punches the species data (columns 75 through 82) into the card. If more than one species of fish was caught for a class of fish, the operator enters the second fish into the next card according to the following procedure. In punching the second card, the operator deletes the "Stat. Code" 9 from column 54 and column 74 and then enters the data for the second species. The class and party data are repeated automatically in the second card. If a third or fourth species of fish was caught for a class of fish, the operator enters the data for the third species in the third card, the fourth species in the fourth card and so on. The class data and the party data are repeated automatically in each card. If a second type of fish was fished for, the operator enters the new class data into the card and places a "Stat. Code" 9 in column 74. The party data preceding the class data are repeated automatically. The data for the first species are then punched into the card. If a second species was caught, the "Sat. Code" 9 is deleted and the new species data are entered in the next card and so on. Only the first card for each party has a 9 in "Stat. Code" column 54, and only the first card for each class will have a "Stat. Code" 9 in column 74. Therefore, a sort on column 54 determines all party summary cards and enables us to accumulate party totals in additional sorts. Sorting on column 74 will isolate all class data cards, and will enable us to accumulate any class information. To accumulate species data, all cards are used. When the number of fish per hour, pounds of fish per hour, and the average weight are desired, these values are calculated by the Univac Computer and automatically punched into the card.

This arrangement of the cards with the "Stat. Code" columns make it possible to place an unlimited amount of information relative to a fishing party on the punch cards. It is also possible to make almost any type of correlation.

Fish Sampling Data

We have introduced data obtained from wire traps, fyke nets, gill nets, trammel nets, and similar gear to punch cards. The card form is shown in Figure 3. The same general procedure as described for the creel census data is followed in punching the cards. The group data fields (Fig. 3, columns 47 through 58) are not used except in certain gill net sampling where the gill net used consists of various mesh sizes. In these cases, each mesh size is treated as a separate group.

Age and Growth, Sex and Condition Data

Figure 4 shows the card form used in recording all or any combination of age and growth, sex and condition data. The cards are also used as a catalogue for our fish scale samples and for filing any of the other information.

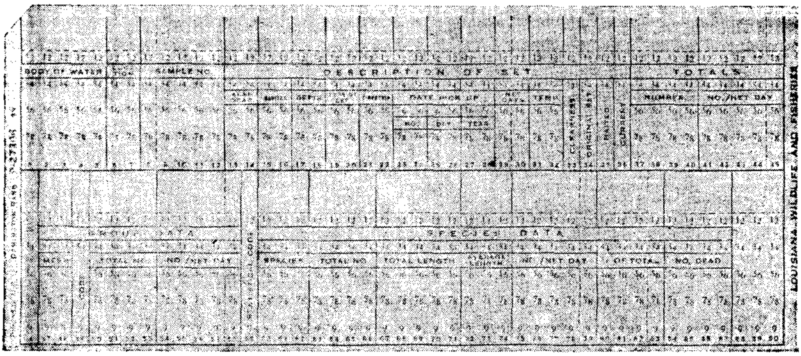

FIGURE 3. Fish sampling punch card.

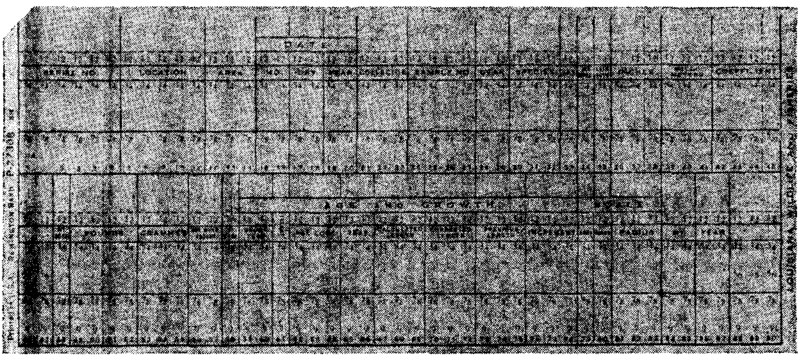

FIGURE 4. Age and growth, sex and condition data punch card.

Length-Weight Data

The card form used in calculating the length-weight relationship is shown in Figure 5. Columns 1 through 58 of the card are the same as that for the age and growth card. The data from these cards are changed to logarithms and punched into the Length-Weight relationship cards. This operation is done automatically by the Univac Computer, and the data can be summed and fitted into the length-weight relationship formula.

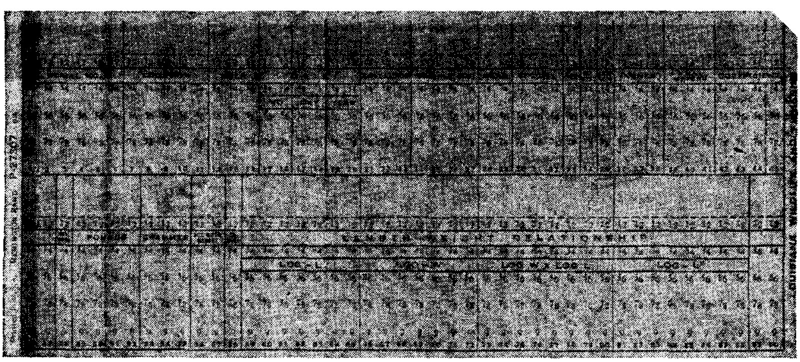

FIGURE 5. Length–weight relationship punch card.

In summation, some rapid methods of processing data have been presented. These methods and their applications are not "cure alls"; they entail considerable planning, control and supervision. However, we do feel that punch card methods are a practical approach to the problem of processing large amounts of fishery research data.

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Question: Is more than one card prepared when a party is creeled?
Answer: Yes. Four cards for this illustration.

Question: Where is the original card prepared?
Answer: In the field but no figures are totaled or coding inserted.

Question: What is the cost of installation and operation?
Answer: Basic machines are punch machine and sorter. These would cost about $6,000 but the total operating cost would depend upon the volume of work done.

Question: How many cards were prepared when nothing was caught?
Answer: One card.

COMPARISON OF THE AGE AND GROWTH OF FOUR FISHES FROM LOWER AND UPPER SPAVINAW LAKES, OKLAHOMA

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INTRODUCTION

Purpose of Study

This study of the fishery resources of Lower and Upper Spavinaw Lakes was begun in January, 1952, and continued through December, 1954. Special effort was made to compare the growth rates of four species of fish common to both lakes—the gizzard shad (*Dorosoma cepedianum*), the spotted sucker (*Minytrema melanops*), the largemouth bass (*Micropterus salmoides*), and the white crappie (*Pomoxis annularis*). Without a basic understanding of the age and growth of the various species of fish present, as well as other factors of population dynamics, these reservoirs cannot be intelligently managed as a sport fishery.

Management procedures which have been undertaken in these two reservoirs in the past years included (1) prior to 1951, annual stocking of largemouth bass, white and black crappie, and miscellaneous sunfishes from the municipal hatchery (Aldrich, 1943); (2) rough fish removal by gill-netting, trapping, seining, and rotenoning; (3) construction and maintenance of brush shelters; (4) imposing size and creel limits; (5) imposing closed seasons on portions of the lake during spawning periods. These methods were instituted without adequate knowledge of the existing populations and little attempt has been made to evaluate their effectiveness.

Location, Purpose, History, and Description of Spavinaw Lakes

The drainage basins of the two Spavinaw Lakes, located in northeastern Oklahoma, include approximately 400 square miles of Ozark foothills, 80 percent of which is timbered land (McMurray, 1945)—principally the dry, oak-hickory forest that covers the chert-mantled hillslopes and crests (Blair and Hubbell, 1938). Both lakes are water supply reservoirs for the city of Tulsa, Oklahoma. No attempt is made here to delimit the drainages of the two lakes, but the total drainage encompasses the entire watershed from the head of