COMPUTERIZED SYSTEM FOR ORGANIZING AND MAINTAINING FILES OF BANDING DATA

By Lewis M. Cowardin and D. Alan Davenport

INTRODUCTION

Bird banding can produce large volumes of raw data and records which are difficult to maintain in a manner leading to rapid and accurate analyses. Data collection usually involves several types of information from different sources. The Bird Banding Laboratory of the U. S. Bureau of Sport Fisheries and Wildlife serves as the regulatory office and clearinghouse for bird banding data in North America where information generated by the bander and by persons recovering bands is processed. The transmission of data to and from this central clearinghouse should be as rapid and error-free as possible. The advantages of computerized methods of processing large amounts of ornithological data have been demonstrated by Taylor (1966: 151) and King et al. (1967), and have been employed at the Bird Banding Laboratory for five years.

This paper describes a computerized system designed to handle detailed research data on banded ducks in addition to the standard data required by the Bird Banding Laboratory. The objectives of the system are: (1) development of an easily accessible file for data gathered when a bird is banded or recovered, (2) reduction of errors introduced during the recording and transposing of data, (3) maximum use of data sent to the bander from the Bird Banding Laboratory, and (4) ease of data analysis from bandings. We believe this system has applicability to the needs of many other banders.

DESCRIPTION OF THE SYSTEM

There are two inputs to the system: data recorded by the bander, and data gathered from the person who recovers a banded bird. The outputs from the system include various lists of the records for individual birds and analyses of population parameters such as recovery rates, distribution of recoveries, and mortality.

Data are recorded on a form designed to meet our needs in the field. The form (Fig. 1) is a 5- x 8-inch card with spaces printed on one side for recording the desired information. The band numbers are filled in prior to use, and the cards are kept on a small clipboard in the same order as the series of bands in use. One clipboard of cards is kept for each band size. Numerical codes, most of which are printed on the face of the card for reference, are used to record all appropriate data. A card is filled out for the original capture and for each subsequent recapture or for the death of the bird. To aid in maintaining the file of field data records, cards are coded with different colors for each type of encounter with the bird. All records for an individual bird are filed together in chronological order.

The "Report to the Bander" cards issued by the Bird Banding Laboratory and giving the name and address of the person recovering a bird are taped to the back of 5 x 8 cards with the coded recovery data on the face and stored with the field data records.

FIGURE 1. Field record with data recorded at time of banding. Incorrect entries were detected by error-checking (see Fig. 3, record 5).

This "Report to the Bander" should not be confused with the "Recovery Statistical Record" card, also supplied by the Bird Banding Laboratory. The latter is used as input to a computer. The "Recovery Statistical Records" are kept as a card file or their images can be stored on magnetic tape or disk. The cards punched from the field data records, hereinafter referred to as the Banding Records, are also stored on magnetic tape or disk. The latter are created by the bander and are not obtained from the Bird Banding Laboratory.

The system (Fig. 2) functions by means of a set of computer programs designed for our needs. However, these programs can easily be modified to fit the needs of other banders.
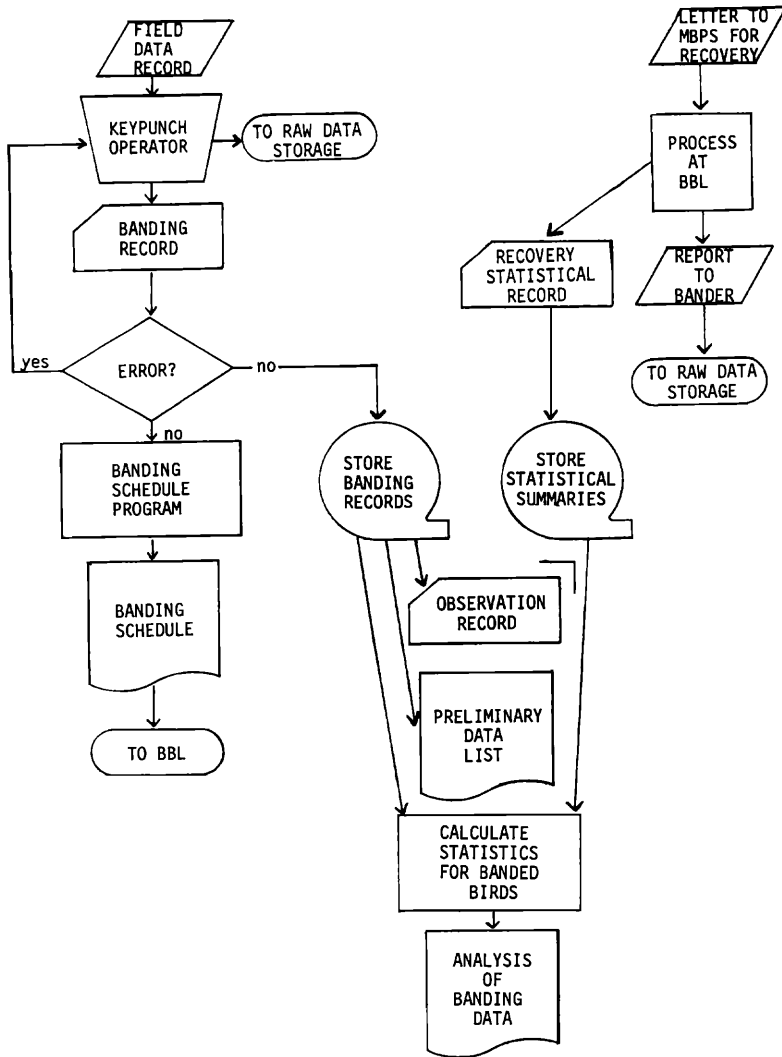
FIGURE 2.   Flowchart illustrating operation of system for processing banding data.

After the field data records are punched and verified, the banding records created from them are run through an error-checking program which searches for omissions and detects inconsistent or illogical combinations of codes. For example, if one of our birds was marked with colored patagial tags, it must be reported as experimental (status code 6). The program checks to determine that each color-marked bird is coded as status 6 and also to determine that each bird banded as status 6 received some type of experimental treatment. When an erroneous record is found, the record is printed with

a message identifying the nature of the error and its location (Fig.
3). It is possible to develop a large number of logical checks for
coding errors.

We also use a program to produce banding schedules directly
from the banding records (Fig. 4). This program was developed as
an aid to the bander in order to increase speed, economy in use of
manpower, and accuracy. However, we realized the potential ad-
vantages to the Bird Banding Laboratory and, on an experimental
basis, have been producing card output as well as the schedule in
order to save the keypunching step at the Bird Banding Laboratory.
A simple subroutine reads the banding records and transmits the
parameters needed for the banding schedule to the main program.
This permits banders with different types of field data to use the
same program. Users need only to prepare subroutines for their own
field form. We have found that in research applications of banding
it is unrealistic to require standardized field forms for projects with
widely differing objectives. For example, the form shown in Figure 1
was used for a study in which small numbers of experimental birds are
banded at one time, and would not be efficient for banders who pro-
cess large samples at once. For the latter type of operation, a field
form with one line per card is more practical than the type we used.
The type and format of the field data sheet are dictated by the needs
of the bander rather than the requirements of the system.

The file of banding records is used for numerous applications,
both by itself and in conjunction with "Recovery Statistical Sum-
maries" from the Bird Banding Laboratory. For example, periodi-
cally we produce lists from the file of banding records with the records
sorted by band number and date. These lists furnish a handy catalog
of the history of each banded bird. We also use the banding records
to produce observation records that have a different format and are
used in a separate part of our studies. For example, our studies
of radio-marked birds produce observations such as locations of
birds during the day. Original capture, recapture, and reported
death of a bird are considered special types of data that can be pro-
duced by the computer from the banding records.

We have developed a number of programs for the analysis of
banding data. These programs use either the "Recovery Statistical
Records" obtained from the Bird Banding Laboratory, data from
our file of banding records, or both. An example of an analysis using
both files is presented in Figure 5. The banding records may be used
to select band numbers from the Recovery Statistical Record file.
For example, we might wish to obtain the recovery records of duck-
lings banded as age class IIC (Gollop and Marshall, 1954). Since
these data do not appear on the "Recovery Statistical Records",
the band numbers for birds banded as age IIC are selected from the
file of banding records and used to select the corresponding records
from the Recovery Statistical Record file.

<div align="center">RESULTS</div>

We have been using this system for maintaining the banding
records from one project in which 200 to 1,200 birds are banded each
year. The system has accomplished its objectives and has sufficient

```
      ERROR  AOU         CARD BELOW
1     02A35 74614299 ____ 03 7150473 94147907050 72971   1123 1   0 0   0501000001 100
      ERROR  LAT         CARD BELOW
2     02A35 79751417132061015074 2 9434986654 41871      1122 1   0 0   5198555000003 200
      ERROR  STATUS      CARD BELOW
3     02A35 797514181320310150472 94331346265 41971      1117 5   0 0   5199654000003 500
      ERROR  LAT         CARD BELOW
      ERROR  LONG        CARD BELOW
4     02A35 7975141913206102 50 031346265 41971           1117 5   0 0   5200654000003 500
      ERROR  HEADER      CARD BELOW
      ERROR  STATUS      CARD BELOW
      ERROR  BANDER      CARD BELOW
      ERROR  METHOD      CARD BELOW
5     2A35  7975141913206102504 72 94331516254 61371      2124 0   0 0   060100003 000
      ERROR  YEAR        CARD BELOW
6     02A35 79751420132061025047 2 94365973267 427 0      1216 1   0 0   520440521224 500
```

FIGURE 3. Portion of output from error-checking program showing rejection messages. Explanation of errors: 1. AOU number not filled in; 2. Latitude out of range (number transposition); 3. Status coded 3 (normal) when presence of bird number indicates experimental treatment (Status should be 6); 4. Header not correctly punched, status coded 6 when no indication of experimental treatment, bander I.D. and method of capture not filled in (See Fig. 1); 5. Year not filled in.

```
PERMIT NO:  9352  BANDING SCHEDULE  BANDER: NPWRC - JAMESTOWN, N. D. INCL. BAND NOS.
                                          (COWARDIN)              706-99451
                                                                  THRU  99500
                          BANDING LOCATIONS
A BIG RICE LAKE 4 MI. NW PENNINGTON, MINN  E
B RABIDEAU L. 7 MI. SSE BLACKDUCK, MINN.   F
C N END RABIDEAU L 6 MI SSE BLACKDUCK, MN  G
D                                          H
```

BAND NUMBER 706	COMMON NAME	AOU #	S	AGE-SEX	F	STATE PROV.	LAT-LONG	LOC	DATE
99451	BAND DESTROYED								
99452	WOOD DUCK	(1) 144.0	6.85	AHY M	2	50	473-0943	A	08-01-72
99453	"	"	3.70	L "	"	"	"	"	"
99454	"	"	"	" F	"	"	"	B	"
99455	BAND DESTROYED								
99456	WOOD DUCK	(1) 144.0	6.85	L M	2	50	473-0943	B	08-01-72
99457	"	(1) "	"	AHY F	"	"	"	"	"
99458	"	(1) "	"	" "	"	"	"	"	"
99459	"	"	3.00	L "	"	"	"	C	08-04-72
99460	"	"	3.70	" M	"	"	"	B	08-02-72
99461	"	"	"	" "	"	"	"	"	"
99462	AMERICAN WIDGEON	137.0	"	" F	"	"	"	"	"
99463	BAND DESTROYED								
99464	WOOD DUCK	144.0	3.70	L F	2	50	473-0943	B	08-02-72
99465	"	"	"	AHY M	"	"	"	"	"
99466	"	(1) "	6.85	L "	"	"	"	"	"
99467	"	"	3.70	" F	"	"	"	"	"
99468	"	(1) "	6.85	" "	"	"	"	"	"
99469	AMERICAN WIDGEON	137.0	3.70	" M	"	"	"	"	"
99470	"	"	"	" "	"	"	"	"	"
99471	"	"	"	" "	"	"	"	"	"
99472	"	"	"	" F	"	"	"	"	"
99473	WOOD DUCK	144.0	"	" "	"	"	"	"	"
99474	"	"	"	" "	"	"	"	"	"
99475	"	(1) "	6.85	" "	"	"	"	"	"
99476	"	"	3.70	" M	"	"	"	"	"
99477	"	"	"	" "	"	"	"	"	"
99478	"	"	"	" "	"	"	"	"	"
99479	RING-NECKED DUCK	150.0	"	" F	"	"	"	"	"
99480	WOOD DUCK	144.0	"	" M	"	"	"	"	"
99481	RING-NECKED DUCK	150.0	"	" F	"	"	"	"	"
99482	"	"	"	" M	"	"	"	"	"
99483	"	"	"	" M	"	"	"	"	"
99484	WOOD DUCK	144.0	"	AHY F	"	"	"	"	"
99485	"	"	"	L "	"	"	"	C	08-03-72
99486	"	"	"	" M	"	"	"	"	"
99487	"	"	"	" F	"	"	"	"	"
99488	"	"	"	" F	"	"	"	"	"
99489	"	"	"	" M	"	"	"	"	"
99490	"	"	"	" F	"	"	"	"	"
99491	"	"	"	" M	"	"	"	"	"
99492	AMERICAN WIDGEON	137.0	"	" F	"	"	"	"	"
99493	"	"	"	" "	"	"	"	"	"
99494	WOOD DUCK	144.0	"	AHY M	"	"	"	"	"
99495	"	"	"	" "	"	"	"	"	"
99496	"	"	"	L "	"	"	"	"	"
99497	"	"	"	AHY "	"	"	"	"	"
99498	"	"	"	" F	"	"	"	"	"
99499	"	"	"	" "	"	"	"	"	"
99500	"	"	"	" "	"	"	"	"	"

```
REMARKS
1 MARKED WITH RADIO TRANSMITTER        4
2                                      5
3                                      6
```

FIGURE 4. Portion of computer-generated banding schedule.

flexibility for other banders to use either part or all of the system.
Time has been saved since data are recorded only at the time of
banding and there is no need to recopy the data, hand sort the cards,
and type the banding schedules.   Transposition of data by hand
invariably leads to errors. Our ability to check for errors by means
of the computer has eliminated many errors that otherwise might
have gone undetected when the data were analyzed. Nevertheless,
some errors in recording cannot be caught by the computer program,
and careful recording in the field is as essential as ever. On the other
hand, we find that despite careful recording and hand-checking the
field forms prior to keypunching, errors are still detected by the
computer.

```
BANDRCOV SAMPLE RUN - TITLE CARD 1
BANDRCOV SAMPLE RUN - TITLE CARD 2
RECOVERY RATES SHOWN IN PARENTHESES

YEAR OF BANDING                          BIRDS BANDED AS

   1968
```

MALES	ADULT	IMMATURE	LOCAL	ALL AGES
NUMBER BANDED	201	129	7	337
1ST SEASON RECOVERY	3(0.0149)	8(0.0620)	0(0.0)	11(0.0326)
2ND SEASON RECOVERY	6(0.0299)	2(0.0155)	0(0.0)	8(0.0237)
3RD SEASON RECOVERY	8(0.0398)	5(0.0388)	0(0.0)	13(0.0386)
4TH SEASON RECOVERY	0(0.0)	0(0.0)	0(0.0)	0(0.0)
2-N SEASON RECOVERY	14(0.0697)	7(0.0543)	0(0.0)	21(0.0623)
1-N SEASON RECOVERY	17(0.0846)	15(0.1163)	0(0.0)	32(0.0950)

FEMALES	ADULT	IMMATURE	LOCAL	ALL AGES
NUMBER BANDED	371	210	4	585
1ST SEASON RECOVERY	5(0.0135)	8(0.0381)	0(0.0)	13(0.0222)
2ND SEASON RECOVERY	9(0.0243)	5(0.0238)	0(0.0)	14(0.0239)
3RD SEASON RECOVERY	5(0.0135)	5(0.0238)	1(0.2500)	11(0.0188)
4TH SEASON RECOVERY	0(0.0)	0(0.0)	0(0.0)	0(0.0)
2-N SEASON RECOVERY	14(0.0377)	10(0.0476)	1(0.2500)	25(0.0427)
1-N SEASON RECOVERY	19(0.0512)	18(0.0857)	1(0.2500)	38(0.0650)

TOTAL	ADULT	IMMATURE	LOCAL	ALL AGES
NUMBER BANDED	572	339	11	923
1ST SEASON RECOVERY	8(0.0140)	16(0.0472)	0(0.0)	24(0.0260)
2ND SEASON RECOVERY	15(0.0262)	7(0.0206)	0(0.0)	22(0.0238)
3RD SEASON RECOVERY	13(0.0227)	10(0.0295)	1(0.0909)	24(0.0260)
4TH SEASON RECOVERY	0(0.0)	0(0.0)	0(0.0)	0(0.0)
2-N SEASON RECOVERY	28(0.0490)	17(0.0501)	1(0.0909)	46(0.0498)
1-N SEASON RECOVERY	36(0.0629)	33(0.0973)	1(0.0909)	70(0.0758)

FIGURE 5. Sample analysis of banding data showing numbers of birds banded and recovered. Data from banding records and statistical records are used by the program to generate this analysis.

We also find that the system permits maximum use of data available from the Bird Banding Laboratory. Fortunately, these data are furnished to the bander in a form that is suitable for input to a computer. The flexibility of the system is such that we are able to continue developing programs and to maintain our files in a readily available and up-to-date fashion. The punched records are machine-readable, thus permitting the format of the banding records to be modified if the need arises. With appropriate modification of software, the use of this system or certain parts of it should be advantageous to other banders.

The program used to print banding schedules is available from the Bird Banding Laboratory, Laurel, Maryland, and permission to use this program or similar programs must be obtained from that office. Listings of all other programs developed at the Northern Prairie Wildlife Research Center are available on request from Jamestown, North Dakota. The programs are written in FORTRAN IV and are executed on an IBM 360 model 50 computer with 128K bytes of storage. A brief description of the programs is presented in the Appendix. A more detailed discussion of the use of these programs for processing banding data will be the subject of a later paper.

LITERATURE CITED

GOLLOP, J. B., and W. H. MARSHALL. 1954. A guide for aging duck broods in the field. Mississippi Flyway Council Tech. Sect. 14 p. mimeo.
KING, W. B., G. E. WATSON, and P. J. GOULD. 1967. An application of automatic data processing to the study of seabirds. I. Numerical coding. *Proc. U. S. Natl. Museum,* **123**(3609): 1-29.
TAYLOR, S. M. 1966. Recent quantitative work on British bird populations. A review. *Statistician,* **16**(2): 119-171.

Bureau of Sport Fisheries and Wildlife,
Northern Prairie Wildlife Research Center,
Jamestown, North Dakota 58401.

APPENDIX

Programs for analysis of banding developed at the Northern Prairie Wildlife Research Center.

BANDRCOV

This program produces a series of tables from banding recovery and summary cards showing the numbers of birds banded, numbers recovered, and recovery rate by year of banding, sex, age, and season of recovery for up to 20 recovery seasons. Separate totals are accumulated for seasons 1-N and 2-N.

LLPLOT

This program produces a 10 x 10 grid of band recovery locations by 10-minute block, degree block, or 10-degree block. Each grid is labeled with the appropriate latitude and longitude designations, and each cell of the grid contains the numbers of recoveries at that location.

RCOVTAB

This is a tabulation program to list band recoveries according to a specified option:

List total recoveries by year of recovery over a 10-year period by:

    1.   State of banding within recovery state
    2.   State of recovery within banding state
    3.   Banding permit number within recovery state
    4.   State of recovery within banding permit number

Each of the above can also be listed according to seasons-survived code rather than year.

List total recoveries by seasons-survived code according to year or season of banding within:

    1.   State of banding
    2.   Banding permit number

List recoveries by 10-day periods from September through January by:

    1.   State of banding within recovery state
    2.   State of recovery within banding state
    3.   State of recovery within banding permit number

BANDAREA

This program tabulates band recoveries within a banding area defined by latitude and longitude or banding state. Output consists of tables showing numbers and percentages of recoveries by sex inside and outside specified banding areas. New tables are printed for each species and optionally for age classes within species.

EDITOR

This is a subroutine package that is used to read and select the input data for the above four programs.

PERMSCAN

This program tabulates banding permit numbers from banding recovery or summary cards and tallies the number of records for each permit number.

MAP

This program uses optional output from LLPLOT to plot degree blocks of recovery and the numbers within the blocks on an overlay for a map of North America.

PLOT

This program plots " + " at recovery locations on an overlay for a map of North America.

SURVIVAL

A program to estimate survival and recovery rates from returns of birds banded as adults and juveniles. Developed by Douglas H. Johnson.