A SYSTEM SURVEY OF A BIRD OBSERVATORY: PART II. THE PROCESSING OF BANDING DATA

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INTRODUCTION

The recording form described by Salvadori and Youngstrom (1973) is now widely used throughout North America for the recording of bird-banding data. Indeed this form is now one of those recommended by the Canadian Wildlife Service and the U.S. Fish and Wildlife Service (1977). This paper outlines methods by which banding data recorded in such a format, or similar formats (e.g., Cowardin and Davenport, 1973), may be transformed to a machine readable form, edited, summarized, and maintained. This is particularly useful for large scale banding operations whose volume approaches or exceeds 10,000 birds/yr. The computerized system may be used to generate automatically banding schedules, notes for file, and magnetic tapes required by the Bird Banding Laboratories in Laurel, Md. and Ottawa, tasks that for large scale banders present gigantic problems and a high cost in time and personnel.

The system has been designed with several objectives in mind. Because erroneous data entering the scheme would render subsequent analysis meaningless, the foremost objective was the elimination of coding errors wherever possible. Simplicity was another important factor. The system will only become popular if it is easy to use and understand. This is particularly important where the data processing is performed by amateurs, not necessarily from the ornithological point of view, but in the data processing field. In Guelph a group of interested people, with some high school education, run the system.

Although useful information may be derived by readers lacking access to a computer, the system was developed and is of the greatest benefit for those who have access to a machine, however small. Computers, which can readily process and analyze banding data, are now readily available for less than $1,000 from such places as Radio Shack which has sold more than 100,000 in the United States in 1979. Because the benefits are potentially fairly great, several small scale banders may find it worthwhile to pool their resources for such an investment.

The various programs will only be functionally described here. More complete descriptions together with listings are readily available from the authors.

OVERALL SYSTEM DESCRIPTION

The system is broken down into six parts as shown in Figure 1. Before each part is fully described in a subsequent section, it is important to understand the relationship and dependencies among each of the parts.

The field data must first be converted to a machine readable form. This is a costly process but is necessary if any type of analysis is to be

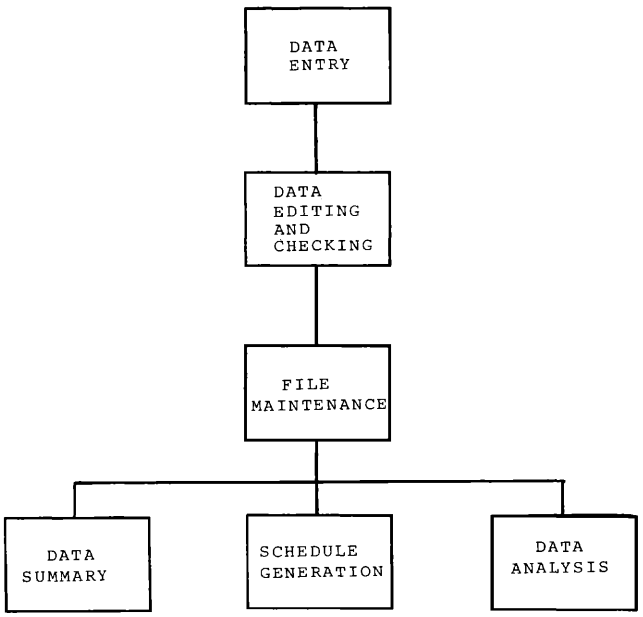

FIGURE 1. The main parts of the system.

done on a large scale basis. The cost is also partially offset by the automatic production of schedules. The data then have to be checked thoroughly for errors. This forms the most crucial step in the operation, and consequently a great deal of time and care should be devoted to this task. Several programs are employed in the system to check the data at various stages. The checked data are sorted and merged with any other nonprocessed data. Backup duplicate files are created in case any accident might happen to the data or anything goes wrong in the processing. The unprocessed data are then processed by the schedule generation program and schedules together with summaries are produced. The data summary and analysis programs may be run at will to produce listings of the current status of the total operation. Further details are given in the next sections.

DATA ENTRY

Data entry is the conversion of the field forms into a machine readable medium such as computer cards or records on magnetic disk/tape. Keypunching the information onto cards is a relatively straightforward process and can be done by any individual who knows how to type. Most colleges/universities will readily allow banders to use their keypunching facilities as part of their public relations service. Banders should ap-

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bandpunch

        BANDING FORM INPUT PROGRAM

Answer all questions with y or n. Otherwise type in the
respective numbers. If you want to change the settings
just type in Q till system responds.

If you make a mistake just type on. Mistakes can be
corrected when you are finished.

RETURN can be pressed if the information to be typed
is the same as in the previous line.

Permit number :10288

Is permit number the same?y

Repeat :1

Is repeat column the same?y

Band number :148075253

How many digits change?2

Species/AOU :amgo5290

Are all species same?n

Age :6

Are all ages the same?n

     •      •      •

Is additional information present?n

102881148075253amgo529061 41 07000185300002107908317aas-- 4--pt

Last two band digits :54

     •      •      •

Species/AOU :trsp5590

Age :0

Sex :0

Last two wing digits:75

Last three weight digits :215

Day :_

Time :103

Skull :2

102881148075254trsp55900  0  07500215300002107910 3momlw-- 2--pt

Last two band digits :0

Do you want to change settings?n

Do you want to stop?y

GOOD BYE FOR NOW
```

FIGURE 2. Sample keying of records. Items underlined are typed by the user.

proach the computer center staff for such permission and then train volunteers to do the keypunching.

Professional keypunching of the records costs between 10 and 15 cents per record. This is very costly and is outside the reach of most banders or organizations. Any organization with this type of budget should seriously consider the purchase of a small minicomputer and key their records as presently described.

A more satisfactory alternative is the use of a mini- or microcomputer for partial editing and control of the keying process. This is now being done at Guelph with satisfactory results. The person entering the data sits at a terminal and is queried about the data to be entered. Certain options are activated and entries that do not change are automatically generated after the first record. A sample session is shown in Figure 2. Entries are checked with respect to length and numeric/alphabetic content, and may be edited if necessary. To reduce keying errors in one of the most critical fields, band numbers are automatically generated.

This process has cut down the time required for keying records by a factor from 2 to 5 depending on the data. In less than 30 min 100 banding records may now be keyed. A rough cost comparison to keypunching may be done by allowing $6.00/hour for an operator, making the cost per record approximately 3 cents: a significant saving.

The program used at Guelph is written in C, and runs on a PDP 11 minicomputer using the UNIX timesharing system.

DATA CHECKING AND EDITING

Once the data are keyed they are extensively edited to try to remove all possible errors. The error checking process within records falls into two main categories: checks for the validity of the codes and checks for biological validity.

In the former category checks are made for permit number, band disposition code, species code, AOU number, sex, age, validity, etc. For example, a sex code of "2", a wing measurement of "3a6," or a time code of "253" would be all rejected. A check is also carried out for valid location and bander codes that are peculiar to any given operation. All possible errors are noted and listed. A record is checked for biological consistency only when no coding/keying errors have been detected.

The criteria for the biological checks are based on Part 6 of Volume 2 of the CWS and FWS North American Bird Banding Techniques (1977), Wood (1969), the authors' personal experience, and communications with the banding office and other banders.

The items checked are many and varied and only a few examples will be illustrated here. Has the correct band size been put on the bird? If not, a warning is issued. Is the time of occurrence correct? For example, a Purple Martin in January in Ontario would be rejected. A Red-tailed Hawk female sexed on wing/weight measurement would also be rejected. So would a Downy Woodpecker aged on skulling. A second-year female American Goldfinch, unless skulled, would be changed to after-

hatching-year. A Dark-eyed Junco female with a wing chord of 77 mm would be changed to male. As can be seen, these tests all fall into the type in which the bander has not followed standard, well-known methods. Some records, which might be unsound, are not rejected, such as a Black-capped Chickadee male in December, since no standard method exists for sexing chickadees in December, even though a bander may have developed one or be experimenting with one.

All records for which no errors are detected are written on an internal disk file while all the incorrect records are written in a separate file for correction. The operator must then correct the erroneous records and resubmit them to the checking process. The process continues until no more errors are detected.

Further checking may take place when edited records are merged together with other previously checked records. This merging program checks between records to make sure that, e.g., no duplicate bands exist, no gaps occur in the band sequences, dates are in correct order unless appropriately noted, etc.

At this point it should be emphasized that thorough checking can never be a complete substitute for care in the field and proper data entry. Some errors, such as the wrong species code *and* AOU number, the wrong age, or wing length, may never be detected by machine checking, although visual checking of some of the summaries may occasionally reveal anomalies. Nevertheless, computer checking detects many errors that might otherwise have gone completely unnoticed, and greatly increases the integrity of the data.

The checking program is written in COBOL and is constantly under review. To date it contains approximately 2,000 statements and requires a medium-sized computer to execute. The merging program is written in PL/I.

FILE MAINTENANCE

File maintenance is crucial in any data processing application. If files are not maintained properly, the integrity of the data they contain may easily suffer. Once erroneous records enter the system, they are very costly in both time and effort to remove. The checking process described above is relatively complete and theoretically no problems should occur. However, problems arise even in the most perfect systems; thus, the file structure proposed here facilitates correction and analysis by keeping several small files of manageable size.

Three main banding files exist. The first contains all edited unprocessed records. Unprocessed records are those for which a banding office schedule has as yet not been generated by the system. These records are kept separate to facilitate schedule generation and also to answer the inquiries that are received from time to time about these records from the banding office. The second file consists of edited processed records belonging to the particular calendar year in question. These are kept separate until the end of the year at which time they are merged

into the third file containing all the records of the banding station to date.

All records are kept in their original format and length and are ordered by band number. Whenever the system is run, appropriate back-up files are generated on magnetic tape in case anything should happen, such as errors by the operator, power failures, system failures, etc.

SCHEDULE GENERATION

The schedule program is similar to that described in Cowardin and Davenport (1973) except for some slight format changes which may simplify the readability, ease of use, and filing process. Notable exceptions may be summarized as follows. A CP-1/2 in the top left hand corner reminds the reader that it is page 1 or 2 of a computer produced schedule. Only the last two digits of the band number appear. The status is a four-digit number. The region represents both the flyway and state/province. Birds with exceptional footnotes are marked with an asterisk. The input is more versatile allowing a continuous unlimited stream of records sorted by band number with any number of different species and location codes. The schedules produced by the program have been approved by both the Canadian and U.S. banding offices. A sample schedule is shown in Figure 3.

The program is written in COBOL and handles all exceptional cases such as records lost, bands destroyed, bands removed and replaced, etc. Up to 99 footnotes/remarks can be generated. A special footnote file is created containing the footnotes and these are printed at the bottom and/or on a separate sheet if more than four occur. The last two digits of the band to which the footnote applies are printed immediately before the footnote message.

The birds, if any, banded by a subpermittee are noted in the remarks section. The initials appearing in columns 53–55 of the banding form are used to search a subpermittee file and find a match. This is particularly useful when many individuals combine to form a group such as at Guelph where the station is operating with seven subpermits. These birds are not marked with an asterisk.

A magnetic tape of the records processed is generated for the Banding Office according to their specifications. Sending this tape to the banding office saves them the expense of keying the records, thus reducing errors, leading to a more cordial relationship.

DATA SUMMARY

Most banders wish to keep track of the progress of their activity on a year-to-year and species-to-species basis. Several programs exist in the system to produce such listings.

First, and foremost, a so-called Note for File is produced by the Schedule program whenever it is run. This is a requirement for Canadian banders and the note summarizes the bands used and the number of

CP-1 BANDING SCHEDULE INCLUSIVE BAND NOS
MASTER PERMIT NO: 10288 MASTER PERMITTEE: A SALVADORI 1143-51213
BANDING LOCATIONS THRU 51246

A MOUNTSBERG 6KM W CAMPBELLVILLE ONT. D
B ABERFOYLE WELL CO., ONT. E
C F

BAND NUMBER 1143<-----	COMMON NAME	AOU #	STATUS	AGE	SEX	REGION	LAT-LONG	LOC	DATE MO-DAY-YR
01									
02									
03									
04									
05									
06									
07									
08									
09									
10									
11									
12									
51213	AMERICAN WOODCOCK	2280	3000	L	U	668-ON	432-0800	A	05-02-78
14	"	"	"	"	"	"	"	"	"
15	"	"	"	"	"	"	"	"	"
16	"	"	"	"	"	"	"	"	"
17	AMERICAN KESTREL	3500	"	"	F	"	"	"	06-05-78
18	"	"	"	"	M	"	"	"	"
19	"	"	"	"	F	"	"	"	"
20	"	"	"	"	M	"	"	"	06-15-78
21	"	"	"	"	F	"	"	"	"
22	"	"	"	"	"	"	"	"	"
23	"	"	"	"	M	"	"	"	"
24	"	"	"	"	F	"	"	"	"
25	BAND DESTROYED	----------							
26*	AMERICAN KESTREL	3600	4000	HY	M	668-ON	432-0800	A	07-11-78
27*	"	"	"	"	F	"	"	"	"
28*	"	"	"	"	"	"	"	"	"
29*	"	"	"	"	"	"	"	"	"
30*	"	"	"	"	"	"	"	"	"
31*	"	"	"	"	M	"	"	"	07-24-78
32*	"	"	"	"	"	"	"	"	"
33*	"	"	"	"	F	"	"	"	"
34*	"	"	"	"	"	"	"	"	"
35*	"	"	"	"	"	"	"	"	"
36*	"	"	"	"	"	"	"	"	"
37	BELTED KINGFISHER	3900	3000	"	U	"	"	"	08-03-78
38*	AMERICAN KESTREL	3600	4000	"	F	"	"	"	08-18-78
39*	"	"	"	"	M	"	"	"	"
40*	"	"	"	"	F	"	"	"	"
41*	"	"	"	"	"	"	"	"	"
42*	"	"	"	"	M	"	"	"	"
43	"	"	3000	"	"	"	"	"	09-13-78
44*	"	"	4000	"	"	"	"	"	09-21-78
45*	"	"	"	"	F	"	"	"	"
51246*	"	"	3000	AHY	M	"	"	B	02-11-78
47									
48									
49									
50									

REMARKS
#13-24,26-36,43-45
BANDED BY MARTIN WERNAART (10288D)
#37-42 BANDED BY CHARLES M FRANCIS (10288H)
CONT.

CP-1 PERMIT: 10288 EXCESS FOOTNOTES FOR SCHEDULE 1143-51213 THRU 51246

#46 BANDED BY LEN SIMSER (10288G)
#26-36,38-42,44-45
THE BIRD WAS BROUGHT IN BY THE PUBLIC AS A NESTLING, RAISED,
TRAINED AND RELEASED
#46 DATE SEQUENCE IS CORRECT

FIGURE 3. Sample schedule.

birds of each species banded in that particular schedule run. It is of limited use except for the checking of records sent to the banding office.

Three other summary programs exist. The first summarizes the contents of the year file. It produces a summary of the birds banded to date in the specific year, together with a list of the numbers banded under each subpermit, a list of the numbers banded at each location used by the group, the numbers banded in each month, and totals for each category. This particular summary has proved useful because the current status of the yearly operation can be quickly ascertained and comparisons quickly made with operations in previous years. One aspect of this summary that has proved unpleasant is the "quantity banded" competition which it necessarily promotes between the banders and the "beating the previous record" syndrome which it encourages. However, in spite of these limitations, if it is used judiciously, it can be useful.

Another program summarizes the total number of birds of each species banded and recovered for the station for all of the operational years. The recovery rates are also produced for each species. This program directly uses the punched card recovery information obtainable by request from the banding office. This summary has proved useful to note population fluctuations from year to year as well as recovery rates between the various similar species.

The final summary program sorts the information recorded about each bird into species and lists out each record. Totals for each species are recorded together with a bar graph of the numbers trapped per month if >10 birds of the species were captured in any given period. A simple averaging of some statistics is also done. Extensive use is made of this particular information as several types of migration comparisons can be readily made. Visual study of the data is also facilitated, permitting banders in the field to look up immediately unusual recaptures or check previous records of a species. Sample results are shown in Figure 4.

DATA ANALYSIS

Several programs have been written to examine different aspects of the data, e.g., plotting of migration routes, wing/weight comparisons, statistical analysis, etc. Because each of these programs is of special interest in itself, subsequent papers in this and other publications will explain the details.

DISCUSSION

This system has now (May 1979) been in use at Guelph for two years, and over 45,000 records have been processed and maintained, a task that would have been totally impossible by any manual system. The system is run by amateurs under the supervision of one of the authors. People have been trained to use readily the system quickly and therefore, free their time for field activities rather than the tedious task of

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SPECIES: BALTIMORE ORIOLE AOU: 5070

BAND NUMBER	AGE	HOW AGED	SEX	HOW SEXED	WING LTH	WEIGHT	STATUS	DATE	TIME	LOC	BANDER	F T	ECT	S K	C P	B P	TRAP	ADDITIONAL
0761-54918	AHY	9	F	1	094	34.6	3000	05/14/77	09:30	HP	AAS	-	1	-	-	-	MN	
0761-54930	ASY	1	M	1	100	34.2	3000	05/21/77	08:00	HP	AAS	-	1	-	-	-	MN	
0761-54937	SY	1	M	1	092	35.4	3000	05/21/77	15:00	HP	AAS	-	1	-	-	-	MN	
0761-54981	HY	1	U		094	34.4	3000	07/17/77	10:10	MC	AAS	-	1	-	-	-	MN	
0761-54982	AHY	12	F	1	092	35.7	3000	07/18/77	19:40	17	AAS	-	1	-	-	-	MN	
0761-54985	AHY	1	F	1	093	35.6	3000	08/07/77	12:00	HP	AAS	-	1	-	-	-	MN	
0761-54986	HY	7	M	1	092	34.0	3000	08/07/77	04:00	HP	AAS	-	1	-	-	-	MN	
0761-54987	U		M	1	092	33.2	3000	08/07/77	17:30	HP	AAS	-	1	-	-	-	MN	
0761-54988	U		M	1	093	33.4	3000	08/07/77	18:40	HP	AAS	-	1	-	-	-	MN	
0761-54989	U		F	1	091	34.6	3000	08/07/77	18:40	HP	AAS	-	1	-	-	-	MN	
0791-24281	HY	7	M	1	096	36.4	3000	08/13/77	21:00	HP	AAS	-	1	-	-	-	MN	
0791-24282	HY	7	F	1	094	31.4	3000	08/13/77	21:00	HP	AAS	-	1	-	-	-	MN	
0791-24283	HY	7	M	1	094	32.7	3000	08/13/77	21:10	HP	AAS	-	1	-	-	-	MN	
0791-24284	HY	7	F	1	090	32.6	3000	08/13/77	21:10	HP	AAS	-	1	-	-	-	MN	
0791-24291	HY	1	M	1	095	32.5	3000	08/20/77	14:10	HP	AAS	-	1	-	-	-	MN	

TOTAL FOR SPECIES BALTIMORE ORIOLE = 15

THEIR AGE AND SEX BREAKDOWN IS:

	AHY	HY	U	L	SY	ASY	TY	ATY	TOTAL
M	0	4	2	0	1	1	0	0	8
F	3	2	1	0	0	0	0	0	6
U	0	1	0	0	0	0	0	0	1
TOTAL	3	7	3	0	1	1	0	0	15

THEIR BREAKDOWN BY MONTH CAUGHT IS:

JANUARY		0
FEBRUARY		0
MARCH		0
APRIL		0
MAY	***	3
JUNE		0
JULY	**	2
AUGUST	**********	10
SEPTEMBER		0
OCTOBER		0
NOVEMBER		0
DECEMBER		0

THE MEAN WING LENGTH ON 15 MEASURED BIRDS WAS: 93.46
THE STANDARD DEVIATION WAS: 2.52

FIGURE 4. Partial listing from one of the summary programs.

processing records. Information from our large data bank has been supplied for research purposes to several people in a machine readable format which they could readily use. As the price of computers decreases and access to them increases, more and more banders will want to process their records automatically. Readers who may wish to use the system but have no access to computers are encouraged to write to the authors.

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