Part III

THE MAPS ANALYTICAL MANUAL

Instructions for Verification, Preparation, and Analysis of
Data Collected in the MAPS Program

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INSTRUCTIONS FOR VERIFICATION, PREPARATION, AND ANALYSIS OF DATA COLLECTED IN THE MONITORING AVIAN PRODUCTIVITY AND SURVIVORSHIP (MAPS) PROGRAM

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INTRODUCTION TO THE MAPS ANALYTICAL MANUAL

Initial methods of data analysis for the MAPS Program were described in DeSante and Burton (1994) and DeSante et al. (1996). Revised methods of data analysis were developed during the evaluation of the MAPS Program and were described by DeSante (1996) in his "General Evaluation of the Monitoring Avian Productivity and Survivorship (MAPS) Program" and by Rosenberg (1996) in his "Evaluation of the Statistical Properties of the Monitoring Avian Productivity and Survivorship (MAPS) Program." These revised methods are described in this Handbook.

The current MAPS analytical methodology consists of three aspects: (A) Data Entry and Verification; (B) Data Preparation; and (C) Data Analysis. These three aspects are described in detail in the following three chapters.

We will be happy to provide, on diskette, the programs discussed in this manual for data verification, preparation, and analysis written for dBASE4 or STATA upon request. In addition, we would also be pleased to provide MAPSPROG, the data entry/import, verification/editing, and error-tracking program developed by The Institute for Bird Populations in conjunction with the Bird Banding Lab, upon request.

CHAPTER I

DATA ENTRY AND VERIFICATION

Current MAPS protocol requires that four types of data sheets (exclusive of vegetation data) be submitted from each MAPS station (or group of MAPS stations [i.e., a MAPS location] that utilize the same string of bands): (1) MAPS Banding Data Sheets (for recording capture data on each bird captured) of three types for: (a) newly-banded birds (organized by band size), (b) recaptured birds, and (c) unbanded birds; (2) MAPS Summary of Mist-netting Effort Sheets (for recording the times of opening and closing each net on each day of operation); (3) MAPS Summary of Netting Results Sheets (for recording the number of newly-banded, recaptured, and released unbanded birds captured during each day of operation; and (4) MAPS Daily Breeding Status List (for recording the apparent breeding status for each species seen, heard, or captured during each day of operation).

Data from the MAPS Summary of Netting Results and from the MAPS Daily Breeding Status List are used during data verification to assure that all banding data has been received and entered and during data preparation to make final breeding status determinations, respectively; they are never computerized. Data from the MAPS Summary of Mist-netting Effort Sheets are entered into the computer during data preparation (see below under “Effort Standardization Procedures”).

The Institute for Bird Populations (IBP) makes use of two quite different approaches to data entry and verification, both designed to produce similar, consistent data files. In the traditional approach, MAPS station operators are urged to computerize the data from their MAPS Banding Data Sheets as a dBASE or an ASCII text file according to the file structure specified in the MAPS Manual and to submit this file to IBP for verification. The computer entry of all banding data not entered by the station operators is provided by IBP, John W. Shipman of Zoological Data Processing, Socorro, NM., or the Electronic Data Processing Unit of the Bird Banding Laboratory, Biological Resources Division of the United States Geological Survey, Patuxent, MD. Entered data are checked for accuracy. Until recently, the general approach was to proof the critical data for each banding record (capture code, band number, species, age, sex, date, time of capture, station, and net number) manually against the raw data and correct any computer-entry errors. The Bird Banding Laboratory is likely to check for data entry errors by "double entry" (entering the data twice) and comparing the resulting files against each other.

In the traditional approach, all banding data are then verified for validity and consistency by IBP biologists using a series of verification programs as follows:

(1) clean-up programs that check the validity of all codes entered and the ranges of all numerical data;

(2) Cross-check programs that compare species, age, and sex determinations against degree of skull pneumatization, breeding condition (extent of cloacal protuberance and brood patch), and extent of body and flight-feather molt, primary-feather wear, and juvenal plumage within individual records (IBP refers to the Identification Guide to North American Passerines by Pyle et al., 1987 to define the allowable parameters for ageing and sexing, and beginning in 1998 we will use the newly published Identification Guide to North American Birds, Part I by Pyle, 1997); and

(3) verification programs that screen banding and recapture data over one or more years for inconsistent species, age, or sex determinations for each band number.

Any discrepancies or suspicious data identified by any of these programs are examined manually and corrected if necessary. Wing chord, weight, station of capture, date, and any pertinent notes are used as supplementary information for the correct determination of species, age, and sex in all of these verification processes. If more than one station is run by a single operator (i.e., using the same band strings), data from these stations are pooled into a single location and verified together. Data files containing data from a single location for the current year are referred to as A-files. Data files containing one or more previous years of data from a location or station, or the current year after verification has been completed, are referred to as B-files. Detailed instructions for completing this three-pronged verification procedure, including all of the dBASE4 programs or procedures used in the verification process, are presented below in Section A.

IBP, in cooperation with the Bird Banding Laboratory, is currently developing a new approach to data entry and verification. MAPSPROG is a multi-platform program designed by IBP and the Bird Banding Laboratory that allows station operators to take on more responsibility for data processing. The program includes a data entry module, data import functions (for dBASE and ASCII files), and data verification modules that incorporate the full range of data verification steps previously performed by MAPS biologists. Providing operators the opportunity to enter and verify their own data will expedite these steps and should actually improve the quality of the data, as operators are in a better position than MAPS biologists to correct the errors identified by verification. A detailed description of the rationale for, procedures involved in, and instructions for using MAPSPROG is provided in Section B below, which consists of the MAPSPROG User's Manual. During the development phase of MAPSPROG (1997-1999) we will be applying both approaches to selected data sets to compare the resulting files. Once the program operates satisfactorily, each data set will, of course, be subjected to only one verification procedure.

A. IBP'S Traditional Verification Procedures

1. Programs that examine data contained within a single record and check the validity of all codes entered and the ranges of all numerical data:

Step 1.

Copy all programs, empty file structures, A<LOCA><YR>.DBF (the current year's unverified data), and B<LOCA><YR>.DBF (the previous years' data) into the work directory in which you are working.

USE A<LOCA><YR>

DO PROOF.PRG

This program prints out fields that require proofing before verification.

PROOF THE PRINTOUT FROM PROOF.PRG AGAINST THE RAW DATA

DO BNUPDATE.PRG

This program ensures that the current year's A-file has the current database structure.

DO BROWPROO.PRG

This program facilitates the correction of computer-entry errors found during proofing.

Step 2.

DO CLEANUP.PRG

This program checks the validity of all codes, by comparing those entered to the allowable codes defined by MAPS protocols (including net number designations) and the ranges for all numerical and date data. A printout is provided listing all unacceptable codes. Please see the "Code Definitions of MAPS Banding Data" that follow these instructions.

Correct any unacceptable codes.

Revise SPECIES.DBF if a species new to the MAPS Program is encountered. SPECIES.DBF provides BBS species sequence numbers for all species in the banding file.

If there are any capture code 'C's, complete Step 3. Otherwise, skip to Step 4.

Step 3.

DO BANDCHNG.PRG

If a recaptured bird's band is changed there will be two records for that capture in the banding data sheets. One record will appear on the recapture page and the second on the new banding page. Each will have a capture code 'C' to indicate that a band change occurred. This program replaces all previous records of the old band number with the new band number (including those in the B<LOCA><YR>.DBF file), changes the capture code for the recapture record to 'R', but leaves the capture code for the new band record as 'C' to account for the band being changed. This program also makes a record of the changed band so that appropriate changes can be made at any other location where that bird may have been captured.

Step 4.

DO DEADBAND.PRG

This program assigns each unbanded bird that died a unique (but fictitious) band number so that the record of the bird can be used in productivity analyses.

Step 5.
DO CAPCNT<YR>.PRG

This program facilitates the comparison of the total numbers of captures of each species at each station in the current year's data to the numbers on the Summary of Mist-netting Results Sheets in order to ensure that all data have been received.

If the numbers do not match, find and correct discrepancies. CAPFIND.PRG is an optional program that aids in identifying errors causing discrepancies.

Step 6.
DO BANDCT.PRG

This program prints out the number of bands used for each band size. Compare the printout against the band inventory. Correct any discrepancies that are found.

2. Programs that examine data contained within a single record and check for accuracy and internal consistency:

In performing within-record consistency checks, the **original** code(s) given in the fields SPEC, AGE, HA, SEX, and HS fields must be put into each field's corresponding (O)riginal field: OSP, OA, OHA, OS, and OHS, *whenever* changed; DO NOT OVERWRITE any codes already placed in these fields, for these codes are the original codes.

Step 7.
USE A<LOCA><YR>
DO CHHOW

This program checks the HA/HS codes to determine if they are allowable according to MAPS protocols. A printout displays the codes in HA/HS if either or both HA/HS are completely blank, contain unknown codes, or contain unallowable combinations of codes. The program also cross-references age and sex determinations against the HA/HS fields to acertain whether the determinations, the HA/HS codes, and the raw data all coincide. For example, a bird can not be AGE="1" with HA="S" and S="1".

Step 8.
SORT ON NUM,DATE TO A<LOCA><YR>N
USE A<LOCA><YR>N
DO CHSK.PRG

This program identifies questionable data or discrepancies between data on extent of skull pneumaticization and the age determination of the individual bird within a single record, and outputs such records for further examination. Thus, it enables one to verify that species are aged by appropriate methods.

Make any necessary age (and, perhaps, associated sex) corrections. Put original age/sex determinations in the OA/OS fields and original 'how aged'/'how sexed' codes in the OHA/OHS fields.

Step 9.
DO CHBC.PRG

This program identifies questionable data or discrepancies between data on breeding condition (extent of cloacal protuberance and brood patch) and the age and sex determination of the individual bird within a single record, and outputs the record for further examination. It thus enables one to verify that species are sexed by appropriate methods.

Make any necessary age/sex corrections. Put original age/sex in OA/OS and original 'how aged'/'how sexed' codes in OHA/OHS.

Step 10.
DO CHMO.PRG

This program identifies questionable data or discrepancies between data on extent of body and flight feather molt, flight feather wear, and juvenal plumage and the age of the individual bird within a single record, and outputs that record for further examination. It thus enables one to verify that age determinations agree with species molt patterns.

Make necessary age (or, perhaps, associated sex) corrections. Put original age/sex in OA/OS and original 'how aged'/'how sexed' codes in OHA/OHS.

3. Programs that utilize within-year recapture data to verify banding data

Step 11.
SORT ON BAND,DATE,C,TIME TO A<LOCA><YR>B
USE A<LOCA><YR>B
DO VERI.PRG

This program inspects banding and recapture data within a given year for each band number to ensure that all records for the same band number have the same species, age, and sex determinations, that there are no duplicate records for newly-banded birds, and that all within-location station changes are correct. The program flags and outputs all discrepancies.

DO BROWVERI.PRG

This program provides a truncated version of the database on screen to facilitate making corrections.

Make necessary species, age, sex, BBS sequence number, station number, and station name corrections in the SPEC, AGE, SEX, NUM, STA, and STATION fields, respectively. Put original data in OSP (original species), OA, OHA, OS, and/or OHS fields as appropriate. If a species, age, sex, BBS sequence number, station number, or station name conflict arises due to a misread band number and one is able to determine the correct band number, enter the original band number in the original band number field (OBAND) and replace the BAND field with the correct band number.

1) DO NOT OVERWRITE any codes already placed in OBAND, OSP, OA, OHA, OS, or OHS fields. These codes are the original codes and show that there has already been at least one change made.
2) Put 'R' into HA and/or HS fields as appropriate.
3) If you change SPEC, ensure 'SP' is placed into the V1 field.
4) If you change BAND, ensure 'BN' is placed into the V1 field.

If there are any unresolvable species discrepancies, place a '?' in the "N" field for those discrepancies.

Remember...

1) The VERI printout shows only those records, for a given band number, where a change occurs. There may be more records than those indicated in which a change will need to be made.
2) The VERI printout gives only one error code. There may be more than one discrepancy between flagged records.

DO VERICHK.PRG

This program ensures that all relevant fields for all relevant records are correct.

Run this program until there is no printout or only acceptable status and station changes remain.

<u>Step 12</u>.

DO STATUS.PRG

This program outputs all status changes in order to allow band scheduling to be done correctly.

4. Programs that utilize between-year recapture data to verify banding data

<u>Step 13</u>.

a) If a new location;

USE A<LOCA><YR>B

SORT ON BAND,DATE,C,TIME TO B<LOCA>B<YR>

Skip to Step 17

b) If not a new location;

USE B<LOCA>N96

MODI STRU

Change fieldname DIED to DISP

DO CLEANUP.PRG

<u>Step 14</u>.

USE B<LOCA>N<YR>
DO CHHOW.PRG

Step 15.
DO DEADBAND.PRG
CLEANUP.PRG, CHHOW.PRG, and DEADBAND.PRG are done at this time on the previous years' data to ensure that no errors remain from previous years. See Steps 2 and 4.

Step 16.
USE A<LOCA><YR>B
APPE FROM B<LOCA>N<YR>
SORT ON BAND,DATE,C,TIME TO B<LOCA>B<YR>
USE B<LOCA>B<YR>
These steps takes the previous year's B-file appends it to the current year's A-file and sorts this on BAND,DATE,C,TIME to B<LOCA>B<YR>.DBF.

Step 17.
USE B<LOCA>B<YR>.DBF
DO RONLY<YR>96.PRG
This program outputs all recapture records for band numbers for which no original banding record exists. Because data from a location only include bands from MAPS station operation, there should be no band number that does not have an original banding record. This aids in determining misread band numbers and correct recovery data.

If bands at a location are used for non-MAPS data, DO RUNIQ<YR>.PRG instead of RONLY<YR>.PRG.

This program outputs all unique records for a given band number that first appear in the multi-year database as recaptures. (If there are recaptures of such a band number, the band number is not output.)

If there are any records output by either RONLY<YR>.PRG or RUNIQ<YR>.PRG, try to reconcile these records.

If a band number is determined to be misread and the correct number can be determined, enter the misread number in OBAND and replace BAND with the correct number and place 'BN' in the V(yr) field.

Step 18.
If band numbers were changed in the previous step, then the file must be re-sorted as follows:

```
SORT ON BAND,DATE,C,TIME TO S
ZAP
Y
APPE FROM S
```

DO VERI<YR>.PRG

This program screens banding and recapture data between years for each band number to ensure that all records for the same band number have the same species and sex determinations, have appropriate age determinations, that there are no duplicate records for newly-banded birds, and that all within-location station changes are correct. Thus, it is analogous to VERI.PRG but examines all data from all years for the station. See Step 11.

DO BROWVERI.PRG

See Step 11. Again, make necessary corrections to the SPEC, AGE, SEX, NUM, STA, and STATION fields, and put original data in OSP, OA, OHA, OS, and/or OHS as appropriate. Again, if a band number is determined to have been misread and the correct band number can be determined, enter the misread band number in OBAND and replace BAND with the correct number.

Again, if there are any unresolvable species discrepancies, replace the "N" field with '?' for those discrepancies.

Again, remember...

1) The VERI<YR> printout shows only those records, for a given band number, where a change occurs. There may be more records than those indicated in which a change will need to be made.
2) The VERI<YR> printout gives only one error code. There may be more than one discrepancy between flagged records.

DO VERI<YR>CK.PRG

This program is analogous to VERICHK.PRG but examines all data from all years for the station. See Step 10. Again, in order to make sure that all relevant fields for all relevant records are correct, run this program until there is no printout or only acceptable station and status changes remain.

<u>Step 19</u>.
DO STATION.PRG

This program outputs within-location station changes for records of birds that have changed stations and is used to provide banding schedules with correct lat.-long. block.

<u>Step 20</u>.
DO NCODES.PRG

This program inputs 'H', 'G', 'U', and 'R', respectively, into the "N" field for hummingbirds, gallinaceous birds, unbanded birds that did not die, and recaptures whose band numbers were not read so that these records can be excluded from analyses.

Step 21.
DO NCHECK<YR>.PRG

This program prints all records for which the "N" field does not equal blank for the current year. This helps ensure that all N-coded records are coded correctly, particularly those coded with a '?', which indicates a misread band number that causes a species discrepancy that could not be resolved.

Make sure all N-coded records are correct.

Step 22.
DO VERIEND
USE B<LOCA>B<YR>
SORT ON NUM,BAND,DATE,C,TIME TO B<STA>N<YR> FOR STA='___'

Step 23.
Delete all obsolete files from work directory and backup diskettes.

2. Data Entry and Verification Using MAPSPROG

The MAPSPROG Version 2.0 User's Guide and Documentation follows in its entirety in Appendix A.

CHAPTER II

DATA PREPARATION

A. Determination of Breeding Status

In order to facilitate analyses of productivity and survivorship, we classify the species captured in mist nets at each station into groups based upon their breeding (actually, summer resident) status at the station. Keep in mind that our breeding status classifications are specific to the area within the station's boundary. This area is called the study area. Consider a perimeter 100 meters beyond the outermost nets and/or 75 meters beyond the outermost census points (whichever is farther out) to define the station's boundary.

Classifications are made on an annual basis at each station. Annual species- and station-specific classifications are:

B = Breeder -- positive or strong probable evidence exists that at least one individual was a definite summer resident within the boundaries of the MAPS station (i.e., the study area) in the year under consideration;
P = Probable Breeder -- weak probable evidence exists that at least one individual was a probable summer resident within the boundaries of the station in the year under consideration;
T = Transient -- the station lies within the breeding range of the species, but no individual of the species was considered to be a summer resident at that station in the year under consideration;
M = Migrant -- the location of the station falls outside the established breeding range of the species;
\- = Absent -- no record of the species occurs in banding, point count or breeding status list data for the year under consideration; the species was presumably absent from the station that year;
? = Unidentified -- individuals not identified to species; thus, no breeding status could be assigned.

We use all available information to make these annual breeding status determinations, including banding data, point-count data (if they exist), daily breeding status lists (if they exist), and the breeding status classifications provided by station operators. This is accomplished by recording pertinent information from the banding data, point counts (where applicable), and breeding status lists on a series of worksheets. The worksheets are essentially a series of boxes in which one fleshes in the above information for each species/year combination.

We use the following criteria, in order of importance, to classify a species as a breeder (summer resident) in the study area: (1) nest found in the study area with eggs or young or in the process of being built; (2) adult seen carrying nest material, food, or fecal sacs to or away from a likely nesting location in the study area; (3) distraction display or injury feigning by an adult in the study area; (4) very young (stub-tailed) fledglings found being fed by parents in the study area or a young bird incapable of sustained flight (a "local") captured in the study area; (5) an adult individual recaptured in the study area during the height of the breeding season more than a week after first capture during the height of the breeding season or in a subsequent year; (6) a territorial (singing or drumming) male repeatedly present in the study area during the height of the breeding season (point-count data were invaluable for this criterion); or (7) multiple individuals of a species captured in breeding condition throughout the breeding season (this criterion provides only a P classification). Any bird captured during the season that does not meet at least one of the above criterion, but is captured within its breeding range, is receives a transient designation.

We use the Check-list of North American Birds (AOU 1983, 1957), The Distributional Checklist of North American Birds (DeSante and Pyle 1986), and range maps in a Field Guide to North American Birds (National Geographic Society 1987) and the Field Guides to Eastern (Peterson 1980) and Western Birds (Peterson 1990) to facilitate migrant (M) determinations.

These annual classifications are then converted into comprehensive (long-term), station-specific classifications which can be updated if a species' breeding status changes over time. Comprehensive (long-term) breeding status classifications are as follows:

B = Regular Breeder -- summer resident in all years the station was operated; that is, the annual breeding status for the species was B or P (as opposed to T) for every year that the station was operated;
U = Usual Breeder -- summer resident (annual breeding status B or P) for more than half of the years that the station was operated;
O = Occasional Breeder -- summer resident (annual breeding status B or P) for half or less than half of the years that the station was operated;
T = Transient -- the station lies within the species' breeding range, but no individual of the species was considered to be a summer resident at that station in any year; that is, annual breeding status T or - in every year the station was operated;
M = Migrant -- station falls outside the species' breeding range;
? = Unidentified -- individuals not identified to species; thus, no breeding status could be assigned.

When single-year determinations have been made and input into the database, a computer program 'summarizes' these to come up with the comprehensive breeding status determinations as follows:

Any array of only B's and P's	= B
More than 1/2 years with B's and P's	= U
1/2 or less years with B's and P's	= O
Any array of T's and -'s	= T
Any array of M's and -'s	= M

In subsequent years, all new single-year determinations will be added, and the program will re-calculate the comprehensive breeding status.

For the purpose of mark-recapture survivorship analyses, we only include data from a given station for a given species if the species' comprehensive classification is a regular (B) or usual (U) breeder at the station. In contrast, for most productivity analyses, we include data from a given station for a given species if the species was not classified as a migrant (M), that is, that the station was within the breeding range of the species (i.e., the species was classified as B, U, O, or T). Data from stations where a species was classified as a migrant (M) are not included in any analyses.

1. Programs and procedures that update structures and display species new to the banding data.

Step 1.
USE S<STA>N<YR>.DBF
MODI STRU
Add BS<YR> and B<YR> fields for current year.
DO UPDATESN.PRG

This program will update the species list and place X's in the appropriate B<YR> fields. (X's indicate that a given species was captured in that particular year.)

Step 2.
DO NEWLIST.PRG

This program displays new species on the screen. New species will need to be assigned a breeding status code not only for the current year but for all previous years as well.

Add the new species' names to the end of the worksheets.

Scan the new species names for migrants using the range maps and references given above.

2. Programs and procedures that allow one to examine the available evidence for breeding (summer residency) contained in the banding, point-count (if any exist), and breeding status list data for each species for the current year, and for each new species for all years:

NOTE: The worksheets already show the historical evidence using the banding and point count data (Steps 3 and 4). Currently, one need only refer to the breeding status lists, which should ideally represent the most conclusive bird activity for each day the station is operated, and the final, end-of-season breeding status determination for each species. Thus, steps 3 and 4 are only necessary if one suspects the breeding status lists are inadequate.

Step 3. Review Banding Data

USE B<STA>N<YR>.DBF
DO BROWMIG.PRG

This program allows one to browse pertinent breeding status information present in the banding file. Scan the banding data and note the pertinent information in the appropriate sp./yr. box next to "Band". (See worksheet shorthand.)

Remember: An age-class "4" (local) bird also qualifies as a summer resident, as long as you feel the bird was aged correctly. These are the only data that qualify for a " " in the "Band" category. Other pertinent information for this category would include birds captured in breeding condition, especially a male and female, or an adult bird and a young bird, captured in the same net at the same time mid-season. Generally speaking, one wants to summarize the bulk of the information in the banding file using worksheet shorthand. (See "Sample" sheet)

Step 4. Review Point Count Data (if any are available)
USE <LOC>PC<YR>.DBF for stations that completed point counts this year.
INDE ON STA='___'.
DO BROWPT.PRG or DISP FOR SPEC='____'

This program (or procedure) allows one to browse the point count file. Scan the point count data and write pertinent information in the appropriate sp./yr. box next to "Point". (See worksheet shorthand.)

USE <LOC>PC<YR>.DBF on all years previous for any species that is new on the SPECLIST printout and follow the above instructions.

Remember: A species that occurs at the same point(s) between periods is probably a summer resident. These are represented by a circled number (the number being the point number), and are the only data that qualify for a " " in the "Point" category. Generally speaking, one wants to summarize the bulk of the information in the point count file using worksheet shorthand. (See also "Sample" sheet.)

Step 5. Review Breeding Status Lists (BSLs)

Scan the current year's Breeding Status List for the station on which you are working. Summarize the information in the appropriate sp./yr. box next to "BSL". (See attached sheet for worksheet shorthand.) Be sure to distinguish between species not observed and those simply not on the list (indicating possible oversight) by using "none" or "NOL" (not on list), respectively.

Scan BSLs for all years previous for any new species and follow the above instructions. NOTE: The breeding status lists have evolved quite a bit over time - early years may be non-existent or inadequate. In such cases, point count data and banding data must be looked at.

Remember: A species that has a "C" even once on the Breeding Status List qualifies as a summer resident. These "C"'s are the only data that qualify for a " " in the "BSL" category. Other pertinent information in this category would be the number of "P"s and "O"s recorded, and their dates (if necessary.) Generally speaking, one wants to summarize the bulk of the information on the breeding status lists using worksheet shorthand. For breeding status lists beginning in 1997, one need only verify that the daily codes given on the breeding status list do indeed "add up" to the final determinations.

3. Programs and procedures that update the breeding status file and check for undetected summer residents.

Step 6. Make Determinations

Using the information gathered on the worksheets, assign the appropriate single-year breeding status code to each species for the current year and to each new species for all years. In many cases, of course, breeding status will remain the same as in years previous. In cases with an acute lack of evidence either way, you can only supply your best guess. The station's habitat map may be helpful for gaging the likelihood of summer residency of a given species.

Update the sn file
USE S<STA>N<YR>.DBF
DO BSREPL.PRG

This program will pop up species/year combinations for which there are currently no BS<YR> codes, and prompt you for the code. You will work directly from your worksheets when responding to the prompts. When the program has gone through all possible combinations, it will call up another program (BRSTAT) which automatically calculates the comprehensive breeding status codes and spit out a printout. Make sure to proof the codes.

Step 7. Check for Miscoded Summer Residents

The following program is run to ensure that no species with hard evidence in the banding data was mis-coded (i.e. given a "T" instead of a "B".)

DO RCHECK.PRG

This program displays individuals recaptured 7 days or more after their first capture in the current year, and individuals captured both in the current year and a previous year. Any §adult§ bird captured at least 7 days after a previous capture qualifies as a summer resident. (An exception to this would be if both captures take place in August.)

If any species called up by this program were given the code "T" for the year(s) displayed, these must be changed to "B"s, and BRSTAT should be re-run to ensure that the brstat field reflects these changes.

BREEDING STATUS FIGURE 1

EXPLANATION OF TERMS AND SYMBOLS USED ON THE WORKSHEETS (Worksheet Shorthand)

BAND:

✓~~✓ = Hard evidence: same individual recaptured in different years. ('s tied between different year columns.)

✓ = Hard evidence: same adult individual recaptured at least 7 days after previous capture in the same year.

✓local = Hard evidence: local young captured.

} = same net, same time, on a given date (e.g. HY, BP4}6/24, 2 CP}7/3.).

≈≈ = "wave" (as in juvy wave)

none = no records found for that species.

POINT:

= (Circled point #). Species detected at this point at least 8 days apart.

✓ = Plenty of evidence in Point category. (Circled points qualify).

Date - #,# = Date and points at which spp. occurred.

- Date = How many individuals of a given spp. occurred on a given date.

______ = (Point counts) not done this year.

BSL:

© = Confirmed breeder.

✓ = Plenty of evidence in BSL category. (Confirmed breeders qualify).

- P(O) = # of days sp. considered probable breeder (observed). (e.g. 5 - P, 3 - O)

thru = Throughout. (e.g. P - thru).

none = Species name on list, but not encountered this year.

NOL = Species name not on list.

______ = (BSL) not done this year.

BREEDING STATUS FIGURE 2

EXAMPLE OF A BREEDING STATUS WORKSHEET

BREEDING STATUS WORKSHEET File: *367*

Note: No PC's in '96, '96 BSL oldstyle - - not daily list

SPEC: *BEWR*	1996 *B*	1997 *B*	1998 *B*
BAND	✓~~~~~~~~~	~~~~~~~~~✓	*HY, ♀BP } 6/27, 3♂♂CP-Jul*
POINT			*3* *1*
BSL			*7*

SPEC: *GCKI*	1996 *P*	1997 *B*	1998 *B*
BAND	*3HY -JUN*	*♀♂ } 6/12, 3♀♀, 2♂♂ -JUL*	*♀BP4 -6/15; ♂CP3 -7/2*
POINT	_______	*1* *, 3, 7*	*3 -5/27; 2 -6/15*
BSL	*P*	*2 O 4 P*	*5-O, 3-P*

SPEC: *SWTH*	1996 *B*	1997 *B*	1998 *B*
BAND	✓~~~~~~~	~~~~~~~~~~~~~~~~~~~~~~	~~~~~~~~~~~✓ *(97)*
POINT			
BSL			

SPEC: *HETH*	1996 *T*	1997 -	1998 *T*
BAND	*3 AHY - 5/27*	*NONE*	*2 AHY - JUN*
POINT	_______	*NONE*	*NONE*
BSL	*T*	*NONE*	*1-O (6/3)*

SPEC: *WAVI*	1996 *B*	1997 *B*	1998 *B*

BAND *lots ♀♀,♂♂ BP,CP* POINT ______ BSL *B*	✓~~~~~~~~~~~~~	~~~~~~~~~~✓

2. Effort Standardization Procedures

This set of procedures identifies the suitability of records for comparative analyses across years based on constant effort assumptions. The database is flagged so that records of birds caught during netting effort in one year with no corresponding effort in the adjacent year can be excluded from further analyses between those two years. In addition, all records that are not from a MAPS program net, not captured during the MAPS season (May 1 to August 08), or not captured at a usual MAPS time of day are also marked for exclusion. During the effort standardization process databases containing the amount of effort expended at each net are created, and programs are run that check data entry and create files with information on netruns and net hours. These programs also flag the banding database in the appropriate fields, the A, B, and N fields.

There are many inherent problems with the above mentioned process, as there are with most methods, so we are exploring, in conjunction with Patuxent Wildlife Research Center and the British Trust for Ornithology (BTO), alternate methodologies to allow us to compare data from year to year. Often a full effort session cannot be completed during a period, so the techniques we are developing involve filling in these truncated or missing sessions with data using simulations. When we have simulated standardized effort we can use the indices thus created in loglinear poisson regression models to assess trends the in numbers of adults and young. Unfortunately loglinear poisson regression cannot be used when dealing with productivity indices (which are indices of the ratio between young and adults), but other efforts are under way to find a method of indexing productivity.

Using our current method of year-to-year comparisons, if a capture occurred at a time or in a net not comparable to netting effort expended in the year after, an A is placed in the A field (for year ↨a↨fter). Similarly, if the capture is not comparable to effort in the year before, a B is placed in the B field (for year ↨b↨efore). The N field is used to identify groups of birds and types of effort not used in analyses. The set of instructions and programs that place data in the A,B and N fields is called the A&B process. Even if the A&B programs are not run, Steps 1-4 must be completed to create an effort file for the current year for use in analyses.

1. Procedures that review the data involved in the analysis:

<u>Step 1</u>. OVERVIEW

Precise records must be available concerning net location, running dates and running times for each net for every year to allow valid year to year comparisons to be made. The information is summarized in the effort files, which are created in Steps 1-4. Without this information, the comparability of effort expended from year to year cannot be determined and efforts to standardize for capture probability are useless.

Therefore, an overview of the operation during the MAPS season may be the most important step of the entire effort standardization process. During the overview most problems you may encounter can be dealt with proactively. A record of the information found and files created should be kept on an Analysis Summary sheet for use during the process and for reference in future years (see A&B Fig. 1).

Read any correspondence included in the file.

Letters will often mention if any stations were dropped or added that year and, most importantly, will tell you if any nets were dropped, added or moved or if net lengths changed. Often this information is not listed anywhere else so this step is very important. Such changes affect comparability significantly and must be taken into account during creation of the effort files.

Determine the stations' alpha and numeric codes and numbers for the stations run and in which years they were run.

Combine the banding files of the stations being compared and/or for which effort must be entered into B<LOCA>N<YR>.

USE B<LOCA>N<YR>
DO MYNCODES.PRG

This program is run on the combined banding data file to determine if N-codes were entered correctly in previous years. Records with incorrect N-codes will be displayed by the program and they should be corrected before continuing (for instructions on how to enter N-codes see step 4 "Enter N-codes").

Scan the Summary of Effort sheets and check for completeness.

Determine if all information (nets and times run for each net) is listed for each day the station was run; if not, contact the operator for this information.

Step 2. NET CONVERSIONS

Net designations from the raw data are entered into the ONET field of the database and often include letters or identical numbers for two completely different nets at the same station. Following sets of programs work on the basis of unique, numeric net designations, therefore, conversions of non-allowable codes must be made. Conversions are completed in the office after the field season, and a written record is kept so the same conversions can be made consistently from year to year. This history is essential to allow translation of data from year to year from the raw data sheets. The converted, unique, numeric net designations are entered into the NET field of the banding data file; the same designations are used in the effort files. If no conversions are necessary the ONET field is directly copied into the NET field.

Create a unique list of ONET codes for each station and year being analyzed.

This list should be created from a combination of the banding data file and the effort sheets submitted by the operator. Ensure you make use of any information listed in the correspondence, since nets are often incorrectly re-numbered using numbers from nets that have previously been discontinued.

Consult the net conversion folder from the previous year to determine how to convert the nets, if it was necessary in the past. If no conversions have yet been made, and are required, each net should receive a unique number that remains constant throughout the years.

All conversions should have a hard copy placed in the net conversion folder. The conversions made for the years currently being compared should also be entered onto the Analysis Summary sheet for use in the following steps.

2. Programs and procedures that create EFFORT files:

<u>Step 3</u>. CREATE BLANK FILE STRUCTURES

A number of file structures are needed to create the effort files and run the A&B programs. A single program, MAKEFILE, will create these structures from templates you must have in your directory. A list of how the files were named should be entered onto the Analysis Summary sheet.

DO MAKEFILE.PRG

This program assumes that you are entering only one year worth of effort. Re-run the program to create templates for other years as required.

<u>Step 4</u>. FILLIN, EFFORT, NOTIMRNT, SOEVSBAN, EFFTOT

During this step the effort for all stations run in each year is entered and marked. Marking the effort files allows the computer, and the operator, to know which comparisons in the subsequent A&B process must be done by hand and which can be done by the program. This involves checking the submitted effort sheets and assigning periods and sub-periods, entering the data for each net and day, determining days of broken and divided effort, and inserting N-codes appropriately. Total net hours for each station are also calculated as a check on the effort entry and the calculations on the submitted effort sheets.

Broken effort is netting effort completed in a single day on which at least one net was opened and closed more than once. Divided effort is when the netting effort required to complete a subperiod is spread over two or more days with no overlapping times.

Assign periods

On the effort sheets ensure there are as close to equivalent numbers of complete days of operation in each period as possible. Shifting may be required if effort was not able to be completed during the designated dates. We allow effort to be made up five days before or after the set dates of a period. By doing this we believe the make up days are still biologically similar to the designated dates of a period and five days on either side should allow enough time for the period to be made up. If more than one day is run within the five day grace period and the days have unequal numbers of hours of operation, the day(s) with the most hours should not be shifted.

Assign subperiods

This should be done after the periods have been assigned and each period contains approximately the same number of days of effort. The days are then ranked. Subperiods are ranked by the number of hours and then by when they occur in the period with the day having the most hours completed first in the period ranked as subperiod A. If only one day is run per period then all the subperiods are ranked as A. Period and subperiod designations should be marked on the effort sheets. Any effort included in the datasets that is considered non-MAPS data will be marked with N=S, E, D, or T (see Step 4 "Mark the effort files" and "Enter N-codes") in the effort files and should be clearly marked on the effort sheets with its N-code designation. Such effort does not receive a subperiod designation.

DO FILLIN.PRG

This program calls for the file to be filled in and will ask for the number of periods, subperiods, number of nets, net lengths, etc. The average 20 (most common) values should be entered; any discrepancies must be adjusted manually, i.e. another set of nets must be added to the database for divided effort. All of the above factors should be adjusted before the EFFORT.PRG program is run as this program fills in the fields according to the template created in FILLIN.PRG.

USE <LOCA>EF<YR>
DO EFFORT.PRG

This program enters the date and times of netting effort for each subperiod. Once again if any non-stereotypical times or nets are present or absent the file must be corrected manually. Effort that is considered non-MAPS can be included in the effort files, but it must be entered manually. Often only partial information is known for this effort, so unknown information should be estimated as nearly as possible and a "?" entered in the MAN field. The contributor should be contacted about any unknown information, but in the case of non-MAPS effort it is not essential.

Mark the effort files

The files are marked so that no comparability assessments are conducted by the computer for periods with broken or divided effort as it is incapable of doing so. The MAN field is filled with "B" for broken effort or the number, "#", of days required to complete divided effort. The MA and MB fields are filled with A and B respectively for either of the previously mentioned situations. Furthermore, if either one of the previous situations arises, an A must be placed in the MA field of the same period, subperiod, and net of the effort file of the previous year so the computer is instructed to skip these records in its comparisons. Similarly a B must be placed in the MB field of the effort file of the year after. In cases where "?"s are placed in the MAN field the record must be marked with an A & B in the MA and MB field. Non-MAPS effort is marked in the N-field with the same codes that are used in the banding data file, i.e. S,E,D,T (see Step 4 "Enter N-codes"). Effort marked in the N-field is not included in net hour calculations. An E is placed in the E field for subperiod rankings that were not included in every period in which the station was run.

PROOF YOUR DATA ENTRY!!!

Things to check include:

1) dates, particularly the year
2) that the IP and SP are correct
c) that all net designations are correct, missing when not used and present when used
4) that all times are entered correctly and in the correct 24hr format
e) lastly, that the periods and subperiods to be ignored by the computer are marked correctly in the current years AND in the adjacent years.

DO NOTIMRNT.PRG

This program prints out all records in the banding database with the fields TIME and/or NET blank. These records are ignored by the A&B programs so at the end of the A&B process they all must be checked and marked manually for comparability (Step 7). At this point, these records should be checked against the raw banding data to ensure that data was entered correctly.

DO SOEVSBAN.PRG

This compares the effort data and the banding data. Any records in the banding data with dates not included in the effort file are included in a datafile the program creates called BADDATA.DBF. Records with blank nets are also shown; these should have appeared on the NOTIMRNT printout as well. Other records shown as a result of SOEVSBAN should be checked in the raw data for data entry errors.

Enter N-codes

N-codes serve to identify types of records that are excluded for various analyses. The different possibilities for the field are listed separately (important: see A&B Fig. 2: N-codes definitions sheet). During the verification process, N-codes are entered for hummingbirds (N='H'), gallinaceous birds {chickens} (N='G'), unbanded birds (N='U'), and recaptured birds for which no band number was recorded (N='R'). Any other records not suitable for MAPS analyses must be marked in the N field manually. Since N-codes are prioritized to allow a selective inclusion of records in analyses if desired, N-codes should be entered in the following order. Records of birds acquired by means other than a MAPS net receive an "S". Records of birds caught at MAPS nets at a suitable MAPS date and time but not intended as MAPS effort receive an "E". Records of birds captured outside of the normal range of dates of MAPS operation (May 1 - August 08, +- 5 days) receive a "D". Records of birds captured during appropriate MAPS dates but at times inconsistent with the regular operation of that MAPS station receive a "T".

Records requiring marking should be apparent on the SOE sheets, but if not they will be expelled by the SOEVSBAN program. By comparing the output from this program, BADDATA.DBF, against the raw data, it should be clear if there are banding records included in the database which cannot be accounted for by entries on the effort sheets. Such records could require adjustment of the effort files (say, a forgotten subperiod), but usually such records simply deserve an N-code. Banding-records assigned N-codes must be given an A in the A-field and a B in the B-field of the banding database.

Various parts of Step 4, Assigning periods and subperiods, marking the effort files, and entering N-codes, must be conducted somewhat in conjunction. Once N-codes are changed, the corresponding N-field in the effort or banding file must also be changed and the assigned subperiods consulted. This process is complete, however, when running SOEVSBAN produces no BADDATA (or all BADDATA records are accounted for on the NOTIMRNT printout), all banding file records' N-codes and associated A and B codes are satisfactory and the effort file has been scrutinized for appropriate codes in the MA, MB, MAN, N, and E fields. Be sure to label N-codes assigned for effort on the effort sheets as well (as explained in Step 4 "Marking the effort files").

DO EFFTOT.PRG

Efftot calculates the number of hours of effort per subperiod per station and enters this into a database. Comparing these totals to those on the summary of effort sheet helps detect errors in data entry or in addition on the summary of effort sheets. The second and third dates of divided effort must be entered manually into the file as only the first date is listed.

3. Programs and procedures that complete effort standardization and mark the database accordingly:

<u>Step 5</u>. NETRUNS, DELAY

This set of programs calculates the average delay time between the time a netrun was begun and the time the birds from that netrun were recorded. According to MAPS protocol these times should be equivalent and the delay time should be zero. Often this is not the case; then it is necessary to calculate the delay time in order to assess comparability of records between years.

DO NETRUNS.PRG

This fills in database (<LOCA>NT<YR>.DBF) that tallys up the times of every capture at every net. In effect, it provides a basis for determining netrun times.

DO DELAY.PRG

Using the database created by NETRUNS and the effort files, the computer compares recorded capture times to closing times. Any capture times more than ten minutes after a recorded closing time will cause the computer to pause. This allows for a check to ensure that the time of the record has been entered correctly and/or the effort has been entered correctly.

Remember that correction of banding record times must be made both in the B<LOCA>N<YR>.DBF file and in the <LOCA>NT<YR>.DBF files. Once the capture times have been checked and any necessary corrections made, the program will provide a printout of the time delays that occurred and an average delay time. This delay time MUST be rounded DOWN to the nearest ten minutes.

Step 6. Effort standardization - the A&B process

This set of programs looks at each net at each station for each period and subperiod and makes a year to year comparison at the level of ten minute intervals, allowing a maximum shift time of one half hour (Step 7i), to determine if the effort expended in both years is comparable. The computer follows the same procedure described in Step 7.

DO A&BY1Y21.PRG

This program calls a series of programs that completes the A&B analysis. The actual logorithims can be found in the program and a brief overview is described in Step 7. The program replicates the banding database and fills in the A and B fields as appropriate. The new database is saved as ABOUTPUT.DBF. **Any further processing should be conducted on this file!** The program also prints out a summary of the computer analysis.

Step 7. Manual A's & B's including split and divided effort, NOTIMRNT, and N=D, T, S, E

As mentioned above comparisons are done on a net by net, period and subperiod by period and subperiod basis. Records from times that are not considered comparable are marked with either an A or a B. If the capture record is non-comparable to the year after, an A is placed in the A field. Similarly if the record is non-comparable to the year before, a B is entered into the B field. Time lines should be drawn for the net(s) and netting effort in question with the opening and closing times marked for each year. See the examples provided for creating the timelines used for effort comparisons (A&B Fig. 3).

If an average delay time was calculated the banding data times should be shifted back by that amount of time. ie. Delay=20m, Original time=9:30, Adjusted time=9:10.

If the effort indicated on the time lines matches completely across the years, no records need be marked. If the time lines do not completely match, records from the non-overlapping time must be marked. The protocols used by the program are as follows:

1. An allowable difference in starting time is set at half an hour. In other words, banding from 600 to 1100 is the same as banding from 630 to 1130 but is not comparable to 640 to 1140. Blocks of time during the banding day may also be shifted around by one half hour to make the effort in one year comparable to that in the other.
ii. A ten minute difference in running time is also allowed so the nets are still considered comparable if one set was run 10 minutes longer in one year than the other year.
iii. Using the NT file, note any captures at the net and date at which records must be marked for exclusion. This will give an estimate of how often netruns were completed. If no or few birds were caught assume that the nets were checked at least

once an hour. Generate a list of theoretical netrun times from these records, and insure that you adjust these times by the delay time above, if one was calculated.

iv. Compare the potential cutoff times from above to the theoretical cutoff times. We do not simply flag all records after the cutoff time (or before as the case may be) because a capture time does not reflect just captures at that instant, but all captures from the previous netrun up to that instant.

Because of netrun time discrepancies between years, records must be marked for capture times where the difference between the capture time and the potential cutoff time is greater than the difference between the potential cutoff time and the previous netrun time. The potential cutoff time (i.e., the dividing line between non-comparable and comparable time) is the time, after or before, the net in question was NOT run in the other year of the comparison. For example, if a capture time is 1100, the previous netrun occurred at 1010, and the potential cutoff time was 1030 (the time at which banding terminated in the other year), the 1100 records should be flagged. If the capture time was 1040, all other things remaining equal, the records would not be flagged. If the cutoff time is exactly equidistant between the two netrun times, be generous and retain all records from that netrun by not marking them.

Records from the printout of the NOTIMRNT program must also be checked manually as the program cannot deal with them.

Each record must (unfortunately) be checked against the raw data to determine if time of day or net can be estimated. The E<LOC><Y1><Y2> file is filled in by the A&B programs and it contains the cut off times calculated during the algorithims. The NOTIMRNT records in question should be checked against this file and the manual calculations made above, and flagged as appropriate.

Records marked with and S, E, D, T in the N field must receive an "A" and a "B" in the A and B fields respectively as these records are not considered comparable to any other year.

<u>Step 8</u>. NET HOURS

The total number of hours was calculated above during the EFFTOT step. The number of comparable hours for each station can be found in the H<LOC><Y1><Y2> file. Comparable hours must be calculated manually for the effort in which the algorithims were calculated manually. Simply determine the number of hours of overlap between the two years and multiply by the number of nets that were compared. This number is added to the hours calculated by the program for that station. Finally the hours must be adjusted according to the length of the nets. A twelve meter net is considered one unit, a 9m net 0.75 units etc.

<u>Step 9</u>. AFTERA&B

All the records flagged in the two years are printed out by this program. On this printout the reason the record was flagged should be defined. THIS IS A VERY IMPORTANT as it is the final check to ensure that the effort was entered correctly and the only check to ensure that the program ran correctly. The reasons records can be eliminated are listed at the end of the A&B printout, and although more than one may apply, choose the most appropriate for the situation.

USE ABOUTPUT.DBF
DO AFTERA&B.PRG (be sure to run AFTERA&B on the ABOUTPUT file)

Step 10. A&BREPL

This program puts in dashes and asterisks into the N, A and B fields so the files are correctly marked for use in final analysis. The dash is used for records that have been analyzed but don't require any marking, the asterisk to indicate the first or last year in the B or A field, respectively, that the station was run. These marks also inform the analyst that all of the previous programs have been completed. Before running A&BREPL the file ABOUTPUT file should be split into its component stations, since not all stations always began and ended in the same years.

USE ABOUTPUT.DBF
SORT ON NUM, BAND, DATE, C, TIME TO B<STA>N<YR> FOR STA='<STA>'
USE B<STA>N<YR>.DBF
DO A&BREPL.PRG

Step 11. ENDA&B

DO ENDA&B

This program scans the fields involved during the effort standardization process to ensure only allowable codes and no blanks (except where appropriate) exist in the file's final form.

Step 12. Suitability of year for survivorship and/or productivity analyses

Files must meet minimum effort requirements before they can be used in survivorship and productivity analyses. These minimum requirements are summarized below.

Each station is assigned a starting date according to the latitude and elevation at which it is located. The MAPS season is then split into an adult and young superperiod (in which we expect to capture more adults or young, respectively). The split was determined after pooling all species and years for all stations that have the same designated starting period and examining the capture rates of each age class. The breakdown of the MAPS season into adult and young superperiods by intended geographic start date is as follows:

Geographic Starting Period	Adult Superperiod (Periods)	Young Superperiod (Periods)
1	May 01 - Jun 29 (1-6)	Jun 30 - Aug 08 (7-10)
2	May 11 - Jul 09 (2-7)	Jul 10 - Aug 08 (8-10)
3	May 21 - Jul 09 (3-7)	Jul 10 - Aug 08 (8-10)
4	May 31 - Jul 19 (4-8)	Jul 20 - Aug 08 (9,10)
5	Jun 10 - Jul 19 (5-8)	Jul 20 - Aug 08 (9,10)

For a year's data to be used in survivorship analyses the station must have run at least three periods in the adult superperiod. For a year's data to be used in productivity analyses the station must have run for a minimum of five complete periods, once again with at least three of these in the adult superperiod and at least two in the young superperiod. The same five-day grace period used for assigning intended periods applies to extending the adult and young superperiods.

The determination is then entered into the CNTRL.DBF file for the appropriate year, D<YR>. The acceptable codes are listed below:

B - usable in both survivorship and productivity analyses
S - usable only in survivorship analyses
X - data not usable for either type of analyses
N - station not run that year

A&B FIGURE 1: A&B ANALYSIS SUMMARY SHEET

A&B Analysis Summary

Location________________________________ Year _____________vs_______________________

Stations and Sta:

Summary of Effort files:

Net run files:

H and E file:

Nets used:
Year 1
Year 2

A&B Results

	Flagged Records	Comparable
Net hours		
A&B Program..................		
Manual A&B's.................		

Total

Net hours

Net hours

Station Total

Comparable

Station Total

Comparable

A&B FIGURE 2: DEFINITIONS OF CODES USED IN THE N FIELD

NOTE: These codes are listed in priority order, that is, each code overrides the codes further down the list.

"S" - Record not from a MAPS net. For example, bird found dead, picked up by hand, captured in a trap, banded at a nest, recorded at a non-MAPS net, or not at a MAPS station. This code should override all other codes as these records may be desired someday for survivorship analyses. Currently, though, these records, and all those where the N field contains something other than "-" or " ", will be excluded from all analyses.

"E" - Recorded at a MAPS net at a date and time that would be considered normal for that particular station in that year except that it resulted from effort that was not intended as a part of MAPS operation for that year. It is always necessary to examine the Summary of Effort data for the year in question as well as the preceding and following years in order to assign E codes correctly. This code should override codes "D" and "T" as these records may be desired for survivorship analyses someday.

"D" - Record occurred in a MAPS net on a date outside the normal range of dates for MAPS operation at that station in that year. DO NOT use "D" for records on dates between the first and last day of MAPS operation in that year. To determine whether dates close to the normal beginning or end of a season should receive a "D", the Summary of Effort data for the current, the preceding, and the following years must be consulted. As before, this code overrides "T".

"T" - Record occurred in a MAPS net and during the normal MAPS range of dates for that station in that year, but at a time inconsistent with the regular operation and collection of data at the MAPS nets at that station in that year. For example, if nets were generally run in the first six hours after sunrise, but they were opened for two hours in the evening once in the same year, records from the evening banding should receive a "T". For times close to the normal net opening and closing times, it will be necessary to examine Summary of Effort data (and may even be necessary to run DELAY to assess delay times) in order to apply this code correctly.

"?" - Uncertain species identification. This code should override the following four codes as it is less obvious from the data. Such records (and all records with the following four codes) will never be included in any analyses (except for simple total numbers of captures).

"H" - All hummingbirds.

"G" - All gallinaceous birds (grouse, quail, pheasant, turkey, "chickens")

"U" - Live, unbanded bird.

"R" - Recapture whose band was not read and therefore has no band number.

"-" - Record has been checked for appropriate N code but did not require one.

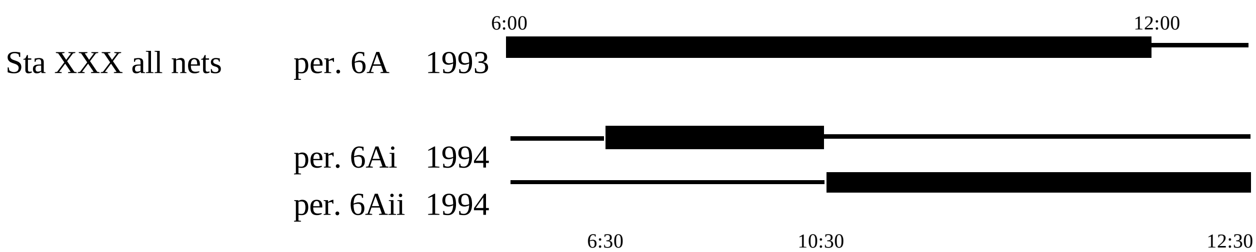
" " - Record has not been checked for appropriate N code yet.

"+" - 1989-1991 records; not usable for comparisons.

A&B FIGURE 3: INSTRUCTIONS FOR CONSTRUCTING A MANUAL A&B-COMPARABILITY TIMELINE

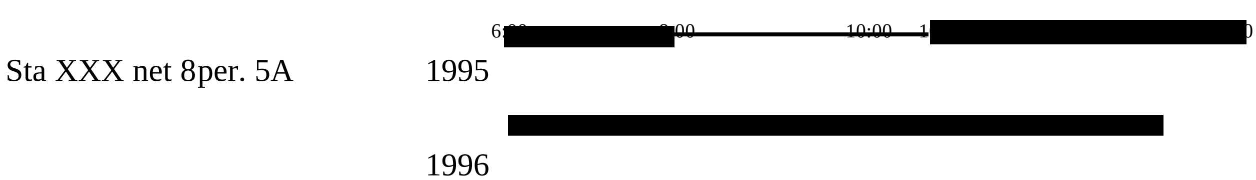
This figure demonstrates how to construct the timelines for manual A&B comparisons in the two most common situations, divided and broken effort. The thick lines represent the duration of actual netting effort.

Example 1: Divided Effort
During Period 6A in 1993 all nets were run regularly from 0600 to noon. In the following year, the nets were opened at 0630, but a rainstorm interrupted the banding during period 6A at 1030; the next day was a make-up day, and the same nets were run from 1030 to 1220. In both years delay=0. The timeline for the comparison would look like this:



In this case, all effort is comparable and no records need to be marked. This is because in 1994, in effect, banding during period 6A took place from 0630 to 1220. As mentioned in Step 7ii, a 10-minute difference in length of running time is allowable. Also, a shift in starting time of one half hour is allowable with no impact on comparability (Step 7i). Thus, for the purposes of analysis, running a station from 0600 to 1200 in one year is like running it from 0630 to 1030 and from 1030 to 1220 on two days in another.

Example 2: Broken Effort
During period 5A in 1995 net 8 at station XXX was run from 0600 to 0800, closed, then reopened at 1030 and run until 1230. In 1996, during the same period and at the same station, ←net 8 was run regularly from 0600 to 1200. In 1996, delay=20min. This is a more complex situation. The timelines would look like this:



In this case, some of the effort expended in 1996 has no comparable effort in 1995, so some records in 1996 may have to be deleted. To determine the cutoff times take the following steps: first, adjust the banding block times by the allowable shift time to maximize the amount of overlap between years. Thus, the second block of banding time in 1995 is shifted up one half hour (the typical maximum allowable shift time, Step 7i) to 1000-1200. Second, the times when banding stopped and restarted in 1995 become the potential cutoff times for considering which records to mark in 1996 (marked with a dotted line on the 1996 timeline). Third, any 1996 delay time must be applied to the potential cutoff times. Thus, the 20-minute delay in 1996 would shift the potential cutoff times to 0820 and 1020. At this point, the <LOCA>NT<YR> file (filled in by NETRUNS in Step 5a) is consulted to find any records at station XXX at net 8 on the date in question. Let us assume records with the following capture times are found there:

0800
0830
0900
1040

Following procedures set forth in Step 7iii, insert a theoretical netrun time at 0950, equidistant from the capture times at 0900 and 1040, since more than 1 hour passed between the two capture times. Then the set of capture times is compared to the potential cutoff times (adjustment for delay should only be done once; here the adjusted potential cutoff times, 0820 and 1020, take delay into account. Alternatively, the delay time could be applied to each capture time): the capture at 0800 is clearly comparable and need not be marked. The capture at 0830 is after the first potential cutoff time, 0820; however, most of that netrun was during the comparable period, 0800 to 0820, so the 0830 record is retained as well. The 0900 record was certainly captured during the non-comparable period so it must be marked (it gets a B in the B field). Finally, the 1040 record must be considered: the 1040 netrun covers the entire time from the theoretical 0950 netrun to 1040. Most of that time falls in the non-comparable period (to 1020), so this record receives a B in the B field as well. These final steps are described in Step 7iv.

CHAPTER III

DATA ANALYSIS

The ultimate goal of the MAPS program is to provide information on the demographic parameters regulating bird populations. This information can be condensed into indices of productivity and estimates of survival for the populations sampled. This chapter describes the procedures developed to extract such information from data collected and processed according to MAPS protocol.

Five analytical approaches are used to extract this information from the prepared data. The first step is descriptive, providing tabular summaries of the banding effort invested and the banding results of the current year's data. The descriptive tables also show the age structure of the population sampled for each species in the current year.

The second step presents constant-effort year-to-year changes in indices of adult population size and post-fledging productivity. These changes are calculated comparing the current year's to the previous year's data. Such comparisons could be undertaken for any set of two years; however, the data would need to be prepared for constant-effort comparability for those years (Chapter II, part B).

Step three also addresses productivity, but, unlike the previous step, it models year and station effects as well as effort as part of the analysis. Using logistic regression, it assess how factors in the model affect the probability that any bird captured is a young bird. The lowest AIC is used for model selection and the significance of variables are tested with likelihood-ratio tests.

The fourth step uses mark-recapture analysis techniques to estimate survival rates of adult birds. Recapture probability and the proportion of residents in the population are also estimated.

Finally, the mean productivity index and time constant survival rate are used in a simple demographic model to produce a trend index for each species. These trend indices can be compared to population trends calculated from year-to-year changes in the in the index of adult population size to provide inferences as to which demographic variable is driving the population trend.

The standardization inherent to the MAPS program allows for pooling of data from different stations. This is important for increasing sample sizes and lowering variation. These issues affect productivity and survivorship differently, however. Variation in the productivity indices can be detected for both temporal and spatial comparisons at a single location (group of stations). For survivorship, however, four years of data are necessary to generate an initial estimate; assessing temporal variation at one location may demand ten years or more of data. Furthermore, spatial comparisons of survivorship are rarely, if ever, possible within one location; differences can be detected, however, between locations.

1. Analysis of Current Year's Data

The programs and procedures described in this section use the current year's data to create a series of tables outlining the breakdown of captures at a location. The first table is simple description of the physical characteristics of each station and a breakdown of the effort expended in the current year. The second table provides a summary of the species captured and the number of birds newly banded, recaptured or unbanded at each station. The third table provides an index of adult population size (the number of adult birds captured per six hundred net hours) and indices of post-fledging productivity (the number of young birds per six hundred net hours and the proportion of young in the catch). By providing the captures per six hundred net hours we standardize the effort expended at each station and are able to compare the numbers of birds captured between stations. Table 4 provides the same information provided by Table 2 and 3, but on a location, not station, basis.

1. Physical description of stations and summary of netting effort.

Step 1. Create database structures

A number of blank file structures are required during the process so this program was written to create the structure as efficiently as possible.

DO ANLFILES.PRG

Skeleton structures requiring modification are presented by the program to the user. The program prompts the user to modify the structures appropriately for the years and stations involved in the comparisons. Insure you fill in the station numbers in the same order they will appear in Table 1 and the remaining tables

Step 2. Station summaries

Basic physical characteristics of the stations are entered into the template for Table 1 called TABLE1.TXT. Using a text editor call up TABLE1.TXT and fill in the blanks in each section.

For each station in the table, you must fill in:

1) the full name of the station
b) the station's four letter code
3) the station number
d) a physical description of the station
5) the elevation
f) the number of hours the station was run in the current year
7) the number of netting hours directly comparable to the previous year
h) the number of periods the station was run in the current year
1) the inclusive dates the station was run in the current year

2. Programs that summarize the numbers of new captures, recaptures, and unbanded captures at each station.

Step 3. Summary of total captures

DO CTNRYRA.PRG

This program totals the number of new captures, recaptures, and unbanded captures for each species at each station. The program must be run once for each station. The information is summarized in a database that is converted into a table in later steps.

DO CTTNRYRA.PRG

This program summarizes the newly captured birds, recaptures, and unbanded birds for each species caught at the entire location. This information is put into a database which is converted into a summary table in later steps.

USE NUR<LOC>TB.DBF
SORT ON NUM TO S
ZAP <Y>
APPE FROM S

This sorts the output file (NUR<LOC>TB) according to phylogenetic order (as set out by BBL numbers).

DO SPEC1.PRG

This replaces the four letter species alpha code in the SPEC field with the full species names.

DO NURTOT.PRG

This program provides a sum of newly captured, recaptured, unbanded and total numbers of species at each station at the bottom of the file.

USE NUR<LOC>TB.DBF
MODI STRU
When the structure appears delete the NUM field
COPY TO NUR<LOC>TB.TXT SDF

After deleting the NUM field the file is converted into a text file. It can now be appended to the template TABLE2.TXT in a text editor and with some simple editing Table 2 is complete.

In DOS: ED TABLE2.TXT

Fill in the location name and years in all the correct places.
Fill in the station abbreviations in the same order they appear in Table 1.
Append NUR<LOC>TB.TXT to this template.

1) replace _0 with __ (_ = a space)
b) replace $ with '

3) place all unidentified species into taxonomic order
d) subtract from species totals for unidentified species

3. Programs that analyze the age structure of each species.

To allow easily seen comparison of stations within a year we standardize the effort expended at each station by estimating the number of birds that would be captured per 600 net hours. 600 net hours is the average number of nethours MAPS stations are run in each year. The number of individual adult birds, young birds and the proportion of young in the catch are estimated at each station.

Step 4. Numbers of adults, young and the proportion of young in the catch per 600 net hours.

DO CTYR.PRG
This program summarizes the number of individual adults, the number of individual young, and the proportion of young in the catch of a species at a station per six hundred net hours. The program prompts the user for a variety of information including station number and the number of hours the station ran this year. The information is added to a database that is converted into a table in later steps.

DO CTTYRA.PRG
This program summarizes the number of adults, the number of young and the proportion of young in the catch for each species at the entire location. This information is put into a database which is converted into a summary table in later steps.

USE SUM<LOC>TB.DBF
SORT ON NUM TO S
ZAP <Y>
APPE FROM S
This sorts the output file (SUM<LOC>TB) in phylogenetic order.

DO SPEC1.PRG
This fills in the full species name for the species alpha code in the SPEC field.

DO SUMTOT.PRG
This provides the number of species caught as adults or as young birds at each station. It also provides the total number of species caught at each station at the bottom of the file.

USE SUM<LOC>TB.DBF
MODI STRU
Delete the NUM field from the structure.
COPY TO SUM<LOC>TB.TXT SDF

Now the file is in a text format and it can be appended into the template TABLE3.TXT in a text editor. With some simple editing Table 3 is complete.

In DOS: ED TABLE3.TXT

Fill in the location name and years in all the correct places.
Fill in the station abbreviations in the same order they appear in Table 1.
Append SUM<LOC>TB.TXT to this template.

1) replace _0.0__0.0__0.00 with _______________ (15 spaces)
2) replace $ with '
c) replace .0 with __ after the line with ALL SPECIES POOLED
4) place all unidentified species into taxonomic order
e) subtract from species totals for unidentified species

Step 5. SINGLE YEAR SUMMARIES - SUMMARY FOR ALL STATIONS COMBINED

The above Tables 2 and 3 summarize the captures at each station. Table 4, which is completed in the following steps, provides a summary of the entire location. The number of birds and species that were newly captured, recaptured and unbanded captures, as well as the number of adults, the number of young and the proportion of young in the catch are all summarized.

USE TOT<LOC>TB.DBF
SORT ON NUM TO S
ZAP <Y>
APPE FROM S

This sorts the file according to phylogenetic order.

DO SPEC1.PRG

This fills in the full specie names for the species alpha code in the SPEC field.

DO TOTTOT.PRG

This program provides a summary of the number of species over all stations at the bottom of the database.

USE TOT<LOC>TB.DBF
MODI STRU
Delete the NUM field from the structure.
COPY TO TOT<LOC>TB.TXT SDF

After deleting the num field, the file is changed to a text file and can be appended into the template TABLE4.TXT. With some simple editing Table 4 is complete.

In DOS: ED TABLE4.TXT

Fill in the location name and years in all the correct places.
Append TOT<LOC>TB.TXT to this template.

1) replace _0.0_(6 sp)_0.0_(6 sp)_0.00 with ____ (23 spaces)
b) replace _0_ with ___
3) replace 8888.8 with ___0.0
d) replace 88.88 with _0.00
5) replace .0 with __ after the line with ALL SPECIES POOLED
f) replace $ with '
7) place all unidentified species into taxonomic order
h) subtract from species totals for unidentified species

B. Analysis of Year-to-Year Changes

One of the main goals of the MAPS program is to track changes and trends in populations. Calculating between-year changes is, therefore, a vital component of this analysis. The current year and previous year are compared to determine changes in the indices of adult population size and post-fledging productivity and to determine the statistical significance of the changes.

Table 5 provides the percent change in the number of adult birds captured, Table 6 provides percent change in the numbers of young birds captured, and Table 7 provides absolute change in the proportion of young in the catch. The comparisons are made in a constant-effort manner by using the data set marked in the Chapter II B, Effort Standardization Procedures. The first series of programs compares the above mentioned indices at a station level and prints them in the first half of Tables 5-7. The second set series of programs compare the indices at a location level. The number of stations at which each species is breeding and the number of birds captured each year are provided in the second half of the table along with the changes from year to year. A method developed by Peach et al. (1996) is used to estimate the confidence intervals and to determine the statistical significance of these changes. Unfortunately, with the small sample sizes that are often dealt with, the calculation of the confidence intervals becomes invalid and the equations break down.

<u>Step 1</u>. Changes in the indices of adult population size and productivity.

DO CEDIFF.PRG

DO NOT hit <ENTER> until after the all of the individual station information has been entered for the entire set of stations as this will send you into the next section of the program too early.

This compares the numbers of individuals of a species at each station in each year and calculates the percent change between the two years. This information is then presented in tabular form. Only breeders and transients for each station (non-migrant species) are used in this analysis. This program calls a number of sub-programs during its course. Three output files, SAD<LOC>TB, SYG<LOC>TB, and SPY<LOC>TB, are created and make up the bulk of

Tables 5, 6, and 7 respectively.

USE SAD<LOC>TB.DBF
SORT ON NUM TO S
ZAP <Y>
APPE FROM S

The data is now sorted in phylogenetic order.

DO SPEC1.PRG

USE SAD<LOC>TB.DBF
MODI STRU
Delete the NUM field
COPY TO SAD<LOC>TB.TXT SDF

The file is now in a text format that can be appended to the template TABLE5.TXT.

DO SADTOT.PRG

This totals the number of species that increased, decreased, and remained the same between the two years at each station and at all stations combined.

USE BOTTOM.DBF
COPY TO SAD<LOC>BT.TXT SDF

This text file is appended to the bottom of the partially filled template TABLE5.TXT, and with some editing, Table 5 is complete.

In DOS: ED TABLE5.TXT

Fill in the location name and years in all the correct places.
Fill in the station abbreviations in the same order they appear in Table 1.
Append SAD<LOC>TB.TXT and SAD<LOC>BT.TXT to this template.

1) replace _0.0 with ____ (4 spaces)
b) replace 9999.9 with ______ (6 spaces)
3) replace 8888.8 with ___0.0
d) replace 8888 with ___0
5) replace 7777.7 with __++++
f) replace $ with '
7) fill in sample size for each species (0 to however many stations are combined)
h) add + to all positive increases in the change columns
1) look up significance of each change (for all stations combined), using SE as a SD, determine significance from a T-table and enter it in the far right column
10) subtract from species totals for unidentified species

11) calculate the proportion of increasing or decreasing number of species (increasing if ALL SPECIES POOLED is +, decreasing if it is -) = # sp/ tot # sp

l) Using STATA: **bitesti tot#sp #sp 0.5**
 - this is the significance of the change (use a one-sided test)
 - if the proportion <0.5, P must be >0.5

13) edit the table with the appropriate footnotes

In DBASE:
USE SYG<LOC>TB.DBF
SORT ON NUM TO S
ZAP <Y>
APPE FROM S
The data is now sorted in phylogenetic order.

DO SPEC1.PRG

USE SYG<LOC>TB.DBF
MODI STRU
Delete the NUM field
COPY TO SYG<LOC>TB.TXT SDF
The file is now in a text format that can be appended to the template TABLE6.TXT.

DO SYGTOT.PRG
This totals the number of species that increased, decreased and remained the same between the two years at each station and at all stations combined.

USE BOTTOM.DBF
COPY TO SYG<LOC>BT.TXT SDF
This text file can be appended to the bottom of the partially filled template TABLE6.TXT, and with some editing, Table 6 is complete.

In DOS: ED TABLE6.TXT
Fill in the location name and years in all the correct places.
Fill in the station abbreviations in the same order they appear in Table 1.
Append SYG<LOC>TB.TXT and SYG<LOC>BT.TXT to this template.

a) replace _0.0 with ____ (4 spaces)
2) replace 9999.9 with ______ (6 spaces)
c) replace 8888.8 with ___0.0
4) replace 8888 with ___0
e) replace 7777.7 with __++++
6) replace $ with '

g) fill in sample size for each species (0 to however many stations are combined)

8) add + to all positive increases in the change columns

1) look up significance of each change (for all stations combined), using SE as a SD, determine significance from a T-table and enter it in the far right column

10) subtract from species totals for unidentified species

k) calculate the proportion of increasing or decreasing number of species (increasing if ALL SPECIES POOLED is +, decreasing if it is -) = # sp/ tot # sp

12) Using STATA: **bitesti tot#sp #sp 0.5**
- this is the significance of the change (use a one-sided test)
- if the proportion <0.5, P must be >0.5

m) edit the table with the appropriate footnotes

In DBASE:
USE SPY<LOC>TB.DBF
SORT ON NUM TO S
ZAP <Y>
APPE FROM S

The data is now sorted in phylogenetic order.

DO SPEC1.PRG

USE SPY<LOC>TB.DBF
MODI STRU
Delete the NUM field
COPY TO SPY<LOC>TB.TXT SDF

The file is now in a text format that can be appended to the template TABLE7.TXT.

DO SPYTOT.PRG

This totals the species that increased, decreased and remained the same between the two years at each station and at all stations combined.

USE BOTTOM.DBF
COPY TO SPY<LOC>BT.TXT SDF

This can be appended to the bottom of the partially filled template TABLE7.TXT, and with some editing, Table 7 is complete.

In DOS: ED TABLE7.TXT

Fill in the location name and years in all the correct places.
Fill in the station abbreviations in the same order they appear in Table 1.
Append SPY<LOC>TB.TXT and SPY<LOC>BT.TXT to this template.

1) replace _0.000 with ______ (6 spaces)
b) replace 99.999 with ______ (6 spaces)
3) replace 88.888 with _0.000
d) replace $ with '
5) fill ----- ----- into
f) fill in sample size for each species (0 to however many stations are combined)
7) add + to all positive increases in the change columns
h) look up significance of each change (for all stations combined), using SE as a SD, determine significance from a T-table and enter it in the far right column
1) subtract from species totals for unidentified species
10) calculate the proportion of increasing or decreasing number of species (increasing if ALL SPECIES POOLED is +, decreasing if it is -) = # sp/ tot # sp
11) Using STATA: **bitesti tot#sp #sp 0.5**
    - this is the significance of the change (use a one-sided test)
    - if the proportion <0.5, P must be >0.5
l) edit the table with the appropriate footnotes

Step 2. Short term trends in year-to-year changes
DO CHANGES

This table displays the total number of birds captured each year and the constant-effort changes between each pair of adjacent years. The between year changes are not calculated using the total number of birds (which are displayed in the table), but the number of birds captured during constant effort time periods (which are not displayed in this table).

In DOS: ED TABLE8.TXT

Fill in the location name and years in all the correct places.

Append ADCH<Y1><Y2>.TXT, YGCH<Y1><Y2>.TXT, and PYCH<Y1><Y2>.TXT to this template.

a) add + to all positive changes
b) add appropriate footnotes

3. Logistic Regression Analyses of Productivity

The techniques outlined above for calculating annual changes in indices of adult population size and productivity only allow comparative analyses of productivity to be done between the current year and a previous year. While this provides valuable information regarding between-year changes, a consistent relationship between productivity and year cannot be obtained using this method over a longer period of time. Differences in productivity indices among stations are also outside the scope of the above analyses. The use of logistic regression overcomes these short-comings and provides an analytical framework for examining productivity in an multivariate manner as a function of year and station. Moreover, by incorporating each year's effort (on a period-by-period basis) the need to convert capture data into constant-effort data can be eliminated. A more detailed explanation of logistic regression principles and methodology, than is provided below, is described in Hosmer and Lemeshow (1989).

Logistic regression, when used in productivity analyses, determines the probability of a captured individual being a juvenile. The "odds ratio", the term for the probability value produced by logistic regression, is the probability of a captured individual being a young bird after the variables incorporated into the model (e.g., year, station, and netting effort) have been accounted for. If for example, the odds ratio calculated for a model incorporating effort and two years of data (e.g., 1995 and 1996, using 1996 as the reference year) for a given species was 1.2, then the probability, in 1995, of a captured individual being a juvenile instead of an adult was 1.2 times as great as in 1996; in other words, after effort has been accounted for, there were 1.2 times as many juveniles in 1995 as 1996. We can, of course, determine the same information using the method of constant effort year-to-year comparisons but, as mentioned above, adding a third year of data or comparing stations is not an option. Any number of variables can be incorporated into the logistic regression analyses, but we concentrate on how productivity is affected by space (station effects) and time (year effects).

Because station and year are incorporated into the logistic regression model as non-continuous variables, the analysis format requires the designation of a reference year and reference station against which the odds ratios are compared. For the year variable, we used the current year as the reference because it is the focal year of interest. For the station variable, we choose the station with the most target species in common with the other stations included in the analysis. This method of selection generally produces a reference station at mid-elevation within a forest or a station that generally has a representative mixture of the habitats found at most of the other stations, thus having the advantage of maximizing the number of comparisons with other stations.

These analyses require a combination of programs using both dBASE and a statistical package. The programs listed below are written for use by STATA, but the logistic regression calculations should be available through most current statistic programs including SAS.

1. The following programs prepare the data for use in the analyses

<u>Step 1</u>. Preparation of the banding file

DO PRODPREP.PRG

This program creates a file containing only the appropriate information from the banding data file. Only data from stations that were determined usable for productivity in all years, species that breed or are transient at the station, and one record per band per year are included in the file. Non-constant effort data can be used as effort is taken into account during the analysis.

Step 2. Determining species for analyses

As all species captured are not captured often enough to create estimates, a decision should be made at this stage to narrow down which species the models will be run on. We attempt logistic regression analyses of productivity for those target species for which at least 10 aged birds were captured each year with an average of five birds per station per year, if station factors are being considered. In order to run the model on a given species, a minimum of two stations must be included. We have found that these minimum requirements generally provide valid estimates and with any fewer bird the models tend to break down.

DO PRODCOUN.PRG

This program displays the number of birds per year per station so they are easily viewed and the above mentioned weeding out can be completed.

Step 3. Creating logistic regression structure

DO PRODLOGR.PRG

Many fields are added to the database in this step, using relational databases, as all factors that may be considered important are not included in the banding data. If factors other than the ones we have chosen are considered relevant to the analysis they are easily entered at this step with simple program modifications.

USE <LOCA>LGR.DBF
MODI STRU
Change the STA field to a numeric field
COPY TO <LOCA>LGR.TXT TYPE DELIM

The text file created here is comma delimited to be imported into the STATA statistics program. If another package is used the file can also be created as a SDF file.

2. The following programs complete the logistic regression analyses and the graphical representation of the data.

Step 4. Productivity analysis

We use the STATA software package to complete logistic regressions. The basic procedure involves running a set of global models that include station, year, and effort as factors. Effort in each year is modeled in five ways: (1) by period; (2) by paired-period; (3) by triplet-period; (4) by adult and young super-period; and (5) summed over the entire year. Thus a maximum four or five global models of station, year, and effort are fit to the data, provided that the degrees of freedom are greater than 0 (i.e., the number of covariate patterns [unique lines of data] > the number of effort variables). The goodness of fit is tested using a Pearson's goodness-of-fit test. Of the global models that fit the data (P>0.05), the one that produces the lowest Akaike Information Criteria (AIC) is chosen as the most appropriate global model. The AIC is calculated by summing the log-likelihood deviance for the given model plus two times the number of estimable parameters in the model. Occasionally, no model including both station and year fits the data, but models that include one variable but not the other do fit the data; final models thus can be run on only one of these two variables.

Once the most appropriate global model is selected (by lowest AIC) the model is then split onto a subset of nested, component models. Likelihood-ratio tests are done to determine which factors of the global model are significant. To do this, the chi^2 value from the model missing the factor under investigation is subtracted from the chi^2 value of the global model. The degrees of freedom are subtracted in the same manner, and the significance of the new chi^2 value is determined with the new degrees of freedom. Variables, including those of effort, are considered "important" to the model if the significance of the chi^2 values is $P<0.10$. If effort is not an important variable, new AIC values are calculated with reduced models that exclude effort. For each species, the model having the lowest AIC among all models examined is considered the most appropriate model.

THE PROGRAMS IN THESE STEPS ARE STATA STATISTIC PROGRAMS. If another statistics package is used similar procedures can be used to obtain the same results presented here. Unless otherwise noted all of the commands are for use within the STATA program.

Edit PRODLOGR.DO

Information that must be edited includes:

1) the input file;
2) the species num;
3) station numbers; and
4) the non-global models should be tagged as they are not run until later steps.

DO PRODLOGR.DO

The program creates a log of the results which should be examined. The "best" global model can be chosen by the AIC goodness-of-fit method. (The model with the lowest AIC is considered to best fit the data.) After a global model is chosen a subset of models can now be run to determine if all factors in the model play significant roles.

Edit PRODLOGR.DO so the appropriate models are now untagged. Re-run PRODLOGR.DO.

Once again examine the log of the results. The small models are compared to the global models and using a likelihood ratio test. The values can be entered and a probability of significance determined using the CHIPROB.DO program.

Re-run PRODLOGR.DO as often as necessary to determine the model that best fits the data. The final log window should be printed out and retained as a hard copy of the results.

To easily visualize the trends it is best to graph the results. The GPHLOGR.DO program can be edited to create graphs of the appropriate model. In its current state, it graphs the odds ratio year factors, and the odds ratio for each station. These graphs can then be imported into STAGE, a graphics editor, to be modified, and then into a word processor for text to be added.

4. Survivorship Analyses using Mark-Recapture Techniques

Modified Cormack-Jolly-Seber mark-recapture analyses are conducted using the fortran program SURVIVE. To prepare the data for analysis, preliminary programs create capture histories and cohort matrices. Maximum-likelihood estimates and standard errors for adult survival probability, adult recapture probability and the proportion of residents in the population are all estimated using time-constant models. Recapture probability is the conditional probability of recapturing a bird in a subsequent year that was banded in a previous year, given that it survived and returned to the place it was originally banded. The estimates are derived from the species-specific capture histories of all adult birds captured at all stations at which they are classified as breeders; a minimum of three years of data is required for this analysis.

The use of four years of data allows the evaluation of two models for each species: the first is a basic, non-transient model of constant survival and recapture probabilities in all years. The second is a transient model (also constant survival and recapture probabilities in all years) that adjusts the estimates to account for the presence of transient adults which tend to deflate survivorship and recapture estimates. The transient model also provides an estimate of the proportion of residents in the population. Finally, the model that best fits the data is selected using the Akaike Information Criteria (AIC). The AIC is calculated by summing the log-likelihood deviance for the given model plus two times the number of estimable parameters in the model; the model with the lowest AIC is the optimal model.

1. Programs and procedures to prepare the data for survivorship analyses.

Step 1. Species choice

Not all species are captured frequently enough to provided enough data to create valid estimates. To cut down on futile effort expenditure pre-selection of species is done. Basic guidelines include insuring that the total number of captures adds up to about eight birds per year, the species is found at least two stations and it must have at least one between year recapture. Even with these guidelines non-valid estimates may still be produced but the guidelines reduce the number of these non-valid estimates.

DO SPECVIEW.PRG

This program counts and displays on the screen the number of adult individuals of each species captured at the location being analyzed. A list including the species with enough captures to attempt survivorship analysis can be compiled.

Step 2. Preparation of the data

DO SURVPREP.PRG

This program creates a data file that contains only the fields required in the analyses. Only species that breed or usually breed at the super-station in question are included. Stations must meet the criteria for either survivorship or both survivorship and productivity analyses for all years, and only records for the years being analyzed are included. This program also insures that the species that may have different alfa-codes, but are considered one species for analysis purposes are assigned a single NUM, e.g. SCJU, ORJU = DEJU = 840.

USE <LOCA>SU.DBF

COPY TO <SPEC>.TXT SDF FOR NUM='###'

A text file(s) is created from the dBASE file above (fn.txt) for the following programs to use. Depending on the type of survivorship analysis the text files may be species specific or the file may be left as a whole. For basic analyses it is best to split the file into species specific forms.

2. Programs and procedures to calculate survivorship estimates.

Step 3. Prepare capture histories

A fortran program is used to create a capture history matrix from the text files created above. The files must be in the correct structure as the program cannot be modified. This program is run from the dos prompt.

type HISTDANI

Enter the information as follows:

1. first year (enter last 2 digits of the year, e.g. 92)
ii. last year
iii. species (in CAPS, type 4 letter code; ie. <SPEC>)
iv. input file (ie. <SPEC>.txt)
22. output file (ie. <SPEC>.ch)

Step 4. Create a cohort matrix.

This program is run from the dos prompt.

type TRIN.BAT

This calls the program CNVTROG3.BAS

1) enter the input file (ie. <SPEC>.ch)

A fortran program, that cannot be modified, is used in this step as well. The capture histories created above are grouped into cohorts which are used in the SURVIV program. This program also creates the series of models which the SURVIV program runs. The program can not be modified to change the models, so any alterations or additional models are added to the text file after the program has run.

type RENAME CNVTROGR.OUT <SPEC>.SUR

This statement renames the output file from CNVTROGR.OUT to fn.sur (ie. <SPEC>.sur)

Insure the models to be run are included in the text file. Using only three years of data only the SP model can be run. Using Four years of data the SP and SPG models can be run. When using greater than four years of data more model possibilities become available. ED <SPEC>.SUR

Step 5. Provide survivorship estimates.
This program is run from the dos prompt.

type SURVIV
Enter the files as follows:

1) type i=<SPEC>.sur l=<SPEC>.out

This program calculates the estimates of survivorship, recapture probability, and the proportion of residents in the population according to the models set out in the steps above using the program SURVIV.

Step 6. Enter values into a database.
This program is run in dBASE.

DO SURVENTR.PRG

These values are required to create trend indices in later steps. If no trend indices are to be developed this step can be eliminated.

5. Analyses of Population Dynamics

To examine trends in indices of adult population size adult population indices are calculated for each species, beginning with an arbitrary starting index of 100. Constant-effort changes (as defined above) are used to calculate the indices in each subsequent year by multiplying the percent change between the two years divided by 100 times the index of the previous year. A linear regression analysis is then done to determine the slope of these indices. The slope of the regression line provides an estimate of the population trend (PT) for each species, which is defined as the average change per year, over the period being analyzed, in the index of adult population size, as determined from mist-netting capture-rate data. These methods can also be used to examine trends in indices of juvenile population size and trends in productivity indices.

Describing trends using this chaining technique includes certain biases in the analyses. The two main inherent flaws in chaining are: (1) the slope of the regression line relates to the reference year of the index, and hence the visible trend is be biased steeper or shallower than it would be if a different year was chosen; and (2) because of the mathematical properties that allow an infinite amount of increase in population size, but only a zero to one proportion of decrease, the regression line shows a slight increase over the long term, even in stable populations. For these reasons we are exploring indexing techniques (see under Effort Standardization Procedures) that will avoid these problems. Unfortunately the new indexing techniques cannot be used to examine changes in productivity indices because the indices are ratios, making logistic regression still the most effective method for modeling productivity. We are hoping, in the near future, to develop a method that does not include the effort covariates required in logistic regression. Until these new analyses are fully developed our current chaining methodology is effective for short term trends and provides the necessary information needed to calculate trend indices.

A trend index (TI) is defined as the expected number of adult birds present at the beginning of the breeding season in any year (assuming that the number of adults present in the previous year was 1.0). This trend index is calculated from the species-specific mean reproductive success (R; given as young per adult) and the species-specific average annual survival probability of adults (S_a using the constant-survival, constant-recapture probability model) estimated from mark-recapture data. The mean reproductive success is calculated as:

$$R = P/(100-P)$$

where P is the mean percentage of young in the catch. The trend index is then calculated as:

$$TI = 1.0*S_a + R*S_y$$

where S_a is the annual survival probability of adults and S_y is the annual survival probability of young which is given as:

$$S_y = f*S_a$$

where f is the fractional survival probability of young relative to adults and can vary between 0.0 and 1.0. We model the survival probability of young in three ways: the first model assumes that survival of young is equal to that of adults (f = 1.00), while the second and third models assumes it to be three-quarters (f = 0.75) and one-half (f = 0.50) that of adults, respectively.

Thus, a total of six trend indices are generated, three for each of the survivorship models. These are then correlated to the observed population trends, based on constant-effort, year-to-year changes in the adult population.

Productivity indices and survival rate estimates are also correlated to the short term population trends. Examination of all of these correlations will allow inferences to be made regarding the extent to which productivity and survivorship influence population trends at each location. Hopefully, such information will be of significance in making management decisions.

1. Programs and procedures that create short term population trends.

Step 1. Year-to-year changes.

DO BTWNFILS.PRG

This creates the banding file used in the comparison programs. It contains only the fields required during year to year comparisons, and adds some fields not in the original banding data file.

DO BYPRGS.PRG

This does the between year comparisons for any designated set of years. If doing only a single comparison only run the program once, for multiple years of comparisons enter the appropriate years at the prompt. Only species that are breeders at a station are used in the calculations of trend indices as the survivorship data the trend indices are paired with in later steps uses only breeders. The option is available, however, if the user desires, to include transient species as well.

Create a species list

This species list must be put into the structure of the SPLIST database as it is called by the trend program. The species that should be included are those for which minimum survivorship requirements were met.

USE SPLIST
Enter the appropriate information.

DO TREND.PRG

At the current time the program is set up to map the short term trend from 1992-1996. If other years are to be used the program must be modified.

DO POPTREND.PRG

This program fills in the structure REGOUT<LC>.DBF with the species, BBL number, survival estimates, etc. previously entered into other files. This file is then used on regression analyses and in graphing the population trends.

Graph the results.

In the statistics program of choice the RELPOP values for each species are plotted against year. A regression line is estimated and also plotted by the program. This provides a clear representation of the short term population trend.

In DOS:

ED POPTREND.DO
Fill in location and delete any species not being graphed.
In STATA:
DO POPTREND.DO

2. Programs and procedures that provide average productivity values.

Step 2. Productivity values

DO COUNTM.PRG
For each species, this program counts the number of adults and young for each year and station, and calculates a productivity value for each year and station.

DO PSUM.PRG
This program sums and averages the productivity values for each species and year.

DO RSMEAN.PRG
This program calculates the average productivity value over the all years a species was present.

3. Programs and procedures that create trend indices.

Step 3. Trend indices
The creation of the trends, putting together the component parts created above, is completed in this section.

DO TIRSANAL.PRG
The survival and mean productivity information gathered in previous sections is added to the REGOUT<LC>.DBF file (created above). The combined information is then used to calculate trend indices for six models. The two primary demographic parameters, mean annual productivity indices and the two time-constant adult survival estimates {the SP and SPG models}, are combined with variable survival estimates of young birds {100%, 75%, and 50% as compared to adults} to create theoretical trend indices.

4. Programs that compare the calculated trend indices to the actual population trend.

Step 4. Correlation analyses.

In STATA:
! ED TIREG.DO
Enter the appropriate location name.
DO TIREG.DO

This program runs correlation analyses between the population trend indices calculated above and the actual population trends of adults calculated from constant-effort year-to-year changes in numbers of adults captured. This allows us to determine the models we wish to plot in the following step.

Graph the results
! ED TIGRAPH.DO
Enter the appropriate location and models to be graphed.
DO TIGRAPH.DO

To provide a clear display of the above calculated values the trend indices are plotted against the population trend. This can be done in any statistics program. The four values we most commonly plot are: the trend index with the strongest correlation coefficient; the mean productivity; the survival rate estimated from the SP model; and the survival rate estimated from the SPG model. By comparing the visual representations and the correlation coefficients the user should be able to determine if the population trend is driven by a combination of productivity and survivorship or if one of the components provides most of the driving force.

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