
History of “Computerization” of Bird-Banding Records

C. Stuart Houston
863 University Drive
Saskatoon, SK S7N 0J8
stuart.houston@usask.ca

M. Kathleen Klimkiewicz
USGS Patuxent Wildlife Research Center
12100 Beech Forest Road
Laurel, MD 20708
kklimkiewicz@usgs.gov

Chandler S. Robbins
USGS Patuxent Wildlife Research Center
12100 Beech Forest Road
Laurel, MD 20708
crobbins@usgs.gov

INTRODUCTION

Computerization of bird-banding data began in 1955. Experimentation with using desktop computers began in 1978 but did not become generally available until 1989. However, CSH (in preparing Houston 2008) came to realize that no chronology of the changing technology of banding record keeping and reporting in North America is available.

Tautin’s interesting and comprehensive account of the history of the Bird Banding Laboratory (BBL), 1920 - 2002 (Tautin 2008), emphasizes that the BBL, with a rich and productive history, was and still is “one of the longest running, most successful offices in the history of wildlife conservation.” His paper should be consulted for the general aims, premises, and history of the basic infrastructure of the North American banding program, details of which will not be repeated in this paper. However, space and time did not allow Tautin to mention details of the development of computerization and the changing record management methodology.

The chronology of the varying patterns of operation in the BBL in Laurel, MD, and the Bird Banding Office (BBO) in Ottawa, Ontario, is not well known nor well documented in government records. Not only are these changes of historical interest, but they also may help one to understand the changing limitations of banding data as methodology advanced and are relevant to the curation of historical records since the storage media vary greatly in durability. To fill that gap, CSH reviewed

the complete set of *Bird Banding Notes*, 1922 - 1965, the series of *Memorandum to All Banders* (MTAB) beginning with #1, 14 May 1965, and *Memorandum to Canadian Banders* (MTCB) beginning in late 1968. Even more valuable were the *Annual Progress Reports*, Migratory Bird Populations Station (Crissey 1962 – 1972).

We will first describe the changes in terminology and the methods used for managing data in the early years of banding, 1920 - 1954. Our major focus is on changes in the machinery and methods of handling banding data between 1955 and 1981. Finally, we discuss innovations occurring since the first use of desktop computers in 1978. Changes in the band sizes and inscriptions are provided in an Appendix.

HISTORY

The origins of government-controlled bird banding in North America - In the winter of 1907 - 1908, a committee of the New Haven Bird Club in Connecticut purchased 5,000 bands to help initiate a nationwide bird-banding project (Lincoln 1928). Few birds were banded in 1908, but the number rose to over a thousand in 1909. At the annual meeting of the American Ornithologists’ Union (AOU) in 1909, the American Bird Banding Association (ABBA) was formed, with 34 charter members. In 1911, the Linnaean Society of New York provided financial assistance (Cole 1922, Lincoln 1927). In 1920, the work of the ABBA was

taken over by the U.S. Biological Survey, which was within the U.S. Department of Agriculture. Frederick C. Lincoln was in charge of the BBL until 1946 (Tautin 2005, 2008). The Canadian BBO opened in 1923 as part of the Canadian Government's Parks Branch (Brewer et al. 2000). On 1 Nov 1947, the BBO became part of the new Dominion Wildlife Service, which changed its name to Canadian Wildlife Service in 1950 (Burnett 1999). The BBO had the same function as the BBL, particularly the issuing of permits and bands, and the maintaining of a set of banding and encounter data. The U.S. Biological Survey was transferred from the Department of Agriculture to the Department of the Interior on 1 Jul 1939 and was merged with the Bureau of Fisheries to form the U.S. Fish and Wildlife Service on 30 Jun 1940 (Lincoln 1940).

Changes in terminology: repeats, returns, recoveries, and encounters - A *return* initially referred to any subsequent report of a banded bird, until Gillespie (1930) suggested that *return* be restricted to a bird returning to its place of banding in a subsequent season, that *repeat* be used for a bird returning in the same season, and that *recovery* be the term for a bird retaken at a distance. Even scientists at the BBL continued the original, wider usage of *returns* in publications (Lincoln 1933, Cooke 1937); but by 1936, Lincoln was using *recovery* and May Thacher Cooke (1938) mixed the two terms in a title. The bird-banding instructions issued 30 Jun 1961 (page BBM-A-1100) included a glossary listing *recovery*, *repeat*, *return*, and *foreign retrap*, but not the term *encounter*. The glossary in the 1971 edition of the *Bird Banding Manual* introduced *encounter* as the preferred term for a bird encountered dead or alive, and reported to the BBL. Encounters occur through finding birds dead (*recoveries*), trapping (*repeats*, *returns* and *retraps*), or sightings by observers. This became increasingly important as more birds were being captured alive (often in mist nets) and released unharmed. This 1971 glossary also restricted use of *recovery* to a bird "killed or found dead, and reported to the banding offices as a *terminal record*." Both *return* and *encounter* continue to be used, sometimes inappropriately with broader connotations, in article titles and in journal indices.

EARLY YEARS OF BANDING: 1920 THROUGH 1954

Cards and schedules used to report the banding of birds, 1920–1954 - Examples of band report cards used by the ABBA until 1920, as well as an early Biological Survey record for a band used by Alexander Wetmore, are illustrated (Fig. 1). For at least the first four years of banding under the U.S. Biological Survey, the bander filled out a paper card (form Bi-137), measuring 3" x 5" (7.5 x 12.5 cm), for each bird handled (Fig. 2). There was room to enter four additional captures of that bird that year (Lincoln 1924:24), and to enter data for any subsequent local encounters either live or dead (Tautin 2008). The back of the card was reserved for a subsequent recovery, which then received a metal flag at the top of the card. Use and submission of similar size National Parks Branch (NPB) #9 cards for each band persisted in Canada through 30 Apr 1953. These were in addition to the schedule the bander prepared for submission to the U.S. BBL. Thus, for 27 years, 1926 - 1952, Canadian banders had almost twice as much paperwork to complete.

A newly designed schedule for 1926 and subsequent years allowed dates and localities of 60 individuals of *the same species* to be entered in two columns on both sides of a single sheet (Fig. 3) (Lincoln 1924). From 1950 through 1960, the schedule allowed an increase to 70 band entries. Beginning in 1961, schedules allowed 100 bands of a single band size to be reported and thus were no longer restricted to a single species.

Early bands - In 1914, Alexander Wetmore had aluminum poultry bands manufactured with the inscription and address of the U.S. Biological Survey. Wetmore pioneered government bird banding by using these bands on 1,241 waterfowl in the Bear River marshes of Utah between 1914 and 1916 (Wetmore 1918). These bands wore thin in two to three years, so subsequent waterfowl bands were made twice as thick (Reeves 1984).

Reports to band finders and banders, 1920 – 1954 - At least until 1946, the bander received a typed 3" X 5" (7.5 x 12.5 cm) card telling where, when, how, and by whom a bird had been found (Fig. 4); the finder received a similar card that told

Fig. 1. Two examples of the ABBA card (1912 and 1914) to report banding of a single bird and an ABBA band reported on Wetmore's Biological Survey card (1916). (digitized courtesy of Lynda J. Garrett).

No. 1103	Species <i>Franklin's Gnatcatcher</i> <i>Wood Thrasher</i>
Locality <i>Fish G. Mine (Near Ocala, Marshall Co.)</i>	
Date <i>July 13, 1912</i>	
Banded by <i>O. A. Linvath, Ocala, Minn.</i>	
Approximate age (nestling, fledgling, adult, etc.) <i>Fledgling</i>	
Remarks <i>Caught in a house.</i>	
AMERICAN BIRD BANDING ASSOCIATION, American Museum of Natural History, New York City.	

No. 1051	Species <i>Piping Plover</i>
Locality <i>Bay Point, Ottawa Co., Ohio (Near Marblehead)</i>	
Date <i>July 3, 1914</i>	
Banded by <i>Lynda Jones</i>	
Approximate age (nestling, fledgling, adult, etc.) <i>Probably about 5 days old.</i>	
(Remarks)	
AMERICAN BIRD BANDING ASSOCIATION, American Museum of Natural History, New York City.	

FORM BI-127 RECORD OF BIRD Banded	
No. <i>1103</i>	
Species <i>Ardea h. treganzai</i>	
Where banded <i>Mouth of Bear River, Utah</i>	
Date <i>July 5, 1916</i>	Banded by <i>Siex Wetmore</i>
Remarks <i>young.</i>	
Where recovered	
Date	, 191
By whom	
Remarks	

where and when the bird had been banded. In the late 1940s and until 1953, the report to the finder, with a carbon copy to the bander, was in the form of a letter, measuring 6" x 9" (15.3 x 23 cm) (Fig. 5). By November 1953, the finder received the top copy of a typed report measuring 8" x 10.5" (20.5 x 26.7 cm), and the bander received a "flimsy," the pink carbon copy (Fig. 6). Other color-coded copies were assigned to FILE, SPECIES, STATE OF BANDING, and SPECIAL.

Tabulators and IBM Punch cards, 1929 - 1954- In 1929, as the number of birds banded and the numbers of encounters increased, it became apparent that manual systems of recording would soon not be sustainable. The first 80-column IBM punch card was introduced by IBM in 1928 (Wikipedia 2007) and was adapted by the BBL as a form labeled "Bird Banding Return 3-137" in April 1929. Banding and return information were handwritten on the left half of the card and then key-punched on the right half, beginning with column 37 (Fig. 7 demonstrates this on an April 1950 card for a Laysan Albatross, *Phoebastria immutabilis*). Within the BBL office, each return was transcribed onto a 3-137 punch card; records of original banding were not carded until an encounter was recorded. The BBL acquired a single keypunch machine and a card sorter, adopted AOU numbers for species designations, and accepted state/province codes and three-digit locality codes provided by IBM. Appropriate codes were added for other continents and the oceans. Codes for other fields were developed by Lincoln and expanded as needed by the BBL staff (CSR).

In addition to the key punch, there was a verifier machine in which the punched card was inserted, and the operator punched the keys a second time. If the strokes were identical, the card passed through and received a confirmation nick in the right margin. If not, it was corrected. Each card could then enter the permanent file (CSR).

A large, noisy IBM 403 tabulator, useful for calculating year-end totals, accompanied the punch card machine and was programmed using interchangeable plug-boards. A few such boards were maintained for standard operations; others were re-wired by investigators as needed.

Fig. 2. Biological Survey banding card including space for four recaptures on the front. Figure 27, p. 24 in Lincoln 1924.

RECORD OF BIRD Banded

No. 237483 SPECIES Robin Ad.

WHERE Banded Washington, D.C.

DATE May 5, 1923 Banded BY John M. Jones

REMARKS National Zoo Park, Substation "B"
1 white feather in left wing.

RECORD OF RECOVERY			REMARKS
DATE	LOCALITY	BY	
<u>5/6/23</u>	<u>Same</u>		
<u>5/10/23</u>	<u>Same "C"</u>		

(US/DA)

Form B1-137

Fig. 3. Bander's carbon copy of the first version of the 60-line banding schedule to carry the Laurel, Maryland address; form 3-860, 1951.

<p>COMMON NAME <u>Bronzed Grackle</u></p> <p>SCIENTIFIC NAME <u>Coccyzus uttiscula</u></p> <p>Number of new banded birds on this sheet: <u>25</u></p>	<p>UNITED STATES DEPARTMENT OF THE INTERIOR FISH AND WILDLIFE SERVICE PATUXENT RESEARCH REFUGE LAUREL, MD.</p> <p>Receipts: Do not write in this space</p>	<p><u>G. STUART HUNSTON</u> COOPERATOR OR UNIT PERMIT</p> <p><u>Box 278</u> STREET ADDRESS OF UNIT LEADER</p> <p><u>YORKTON</u> <u>MD</u> CITY STATE OR PROVINCE</p>							
<p>SUBSTATIONS: Locality, operator, type of trap, bait, remarks, etc.</p> <p>A) <u>Backyard, 122 Second Ave., Yorkton, Sask. 4-coll Patter and 4-coll Richardson</u></p> <p>B)</p> <p>C)</p>									
BAND NO. (Series—number)	Aob	SEX	DATE Banded (Month, day, year)	SUBSTATION (Locality, remarks, brood data)	BAND NO. (Series—number)	Aob	SEX	DATE Banded (Month, day, year)	SUBSTATION (Locality, remarks, brood data)
<u>42-301820</u>	<u>A</u>	<u>F</u>	<u>May 4, 1951</u>		<u>42-301826</u>		<u>F</u>	<u>Sept 16, 1951</u>	
<u>821</u>	<u>A</u>	<u>M</u>	<u>"</u>		<u>820</u>		<u>M</u>	<u>"</u>	
<u>822</u>	<u>A</u>	<u>F</u>	<u>"</u>		<u>827</u>		<u>F</u>	<u>"</u>	
<u>823</u>	<u>A</u>	<u>F</u>	<u>"</u>		<u>828</u>		<u>F</u>	<u>"</u>	
<u>824</u>	<u>A</u>	<u>M</u>	<u>"</u>		<u>829</u>		<u>F</u>	<u>"</u>	
<u>825</u>	<u>A</u>	<u>F</u>	<u>"</u>		<u>840</u>		<u>M</u>	<u>Sept 17, 1951</u>	
<u>42-301826</u>	<u>A</u>	<u>M</u>	<u>May 5, 1951</u>	<u>Rebanded New band for 42-362589 first banded Aug. 2/51</u>	<u>841</u>		<u>F</u>	<u>"</u>	
<u>42-301827</u>	<u>A</u>	<u>F</u>	<u>May 5, 1951</u>		<u>842</u>		<u>F</u>	<u>"</u>	
<u>826</u>	<u>A</u>	<u>M</u>	<u>May 5, 1951</u>		<u>843</u>		<u>M</u>	<u>"</u>	
<u>829</u>	<u>A</u>	<u>F</u>	<u>"</u>						
<u>820</u>	<u>A</u>	<u>F</u>	<u>"</u>						
<u>831</u>	<u>A</u>	<u>F</u>	<u>"</u>						
<u>832</u>	<u>A</u>	<u>M</u>	<u>May 6, 1951</u>						
<u>833</u>		<u>F</u>	<u>Sept 16, 1951</u>						
<u>834</u>		<u>M</u>	<u>Sept 16, 1951</u>						

3-860 (July 1948)—Bird Banding Schedule. (OVMS) 16-41447-2

Fig. 4. Typical 3 x 5 card reporting band recovery to bander (Fredeen), 1941.

38-685628-Swainson's Hawk

Banded 7/7/40; shot 5/10/41 at Leedey, Okla.

R. E. Clay
Leedey, Okla.

F. J. H. Fredeen

Fig. 5. Bander's carbon copy of letter to finder, 1952 (Form 3-624).

Band No.: **42-800854** Reference: *[initials]*

**UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
PATUXENT RESEARCH REFUGE
LAUREL, MARYLAND**

August 28, 1952

Mr. Andy Lizon
Yorkton, Saskatchewan
Canada

Reference is made to your letter of 8-2-52 regarding a bird wearing a band with the above number and which you report was: shot

on: July 16, 1952

at: vicinity of Yorkton, Yorkton District, Saskatchewan
Canada

and: *510-1022-511-1022* OR *510-1022?*

Our information on the banding of this bird is as follows:

species: Great Horned Owl age: Local sex:

banded at: Yorkton, Yorkton District, Saskatchewan
*EAST OF OTTHON
510-1022*

date: May 11, 1952

by: Dr. Clarence Stuart Houston

On behalf of this Service and the bander may we thank you for your cooperation in contributing this information to our studies and investigations of the migrations and life histories of the birds of North America.

Very truly yours,
Seth H. Low
SETH H. LOW, Biologist,
Section of Distribution and Migration of Birds,
Branch of Wildlife Research.

distance

cc: Ottawa, Canada

Was band submitted and number verified? **No**

Band was filed: returned to reporter:

This report prepared by: *mt/sh*

condition
phoned
likely same quadrant

3-624
Dec. 1949

16-60791-1 GPO

Fig. 6. Bander's pink carbon copy of letter to finder, as revised 1958.

copy

Band No. : 508-96480
File Ref. : Houston
Date : Jan. 27, 1959

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
PATUXENT RESEARCH REFUGE
LAUREL, MARYLAND

Mr. Billy Horseman
Box 22, Saltecoats,
Saskatchewan, CANADA

Thank you for your communication regarding a bird wearing a leg band with above number. Our information on the banding of this bird is as follows:

Species: Great Horned Owl - local
Banded At: 2½ miles north of Saltecoats, Saskatchewan, CANADA
Date: May 19, 1958
Banded By: Dr. Stuart Houston
And:

*3 miles SALTECOATS
510-1020*

The information from the addressee above is as follows:

Species: Great Horned Owl
Taken At: Saltecoats, Saskatchewan, CANADA 510-1020
Date: September 1, 1958
How: trapped and released by Mr. Billy Horseman
And: as reported by Dr. Stuart Houston

*or 3
2 1/2 miles south of
where banded
condition 7
re research band*

The first mention of "business machines" and "IBM Summary Punch Card files," used initially for research purposes, appeared in an annual report that described waterfowl mortality and Mourning Dove (*Zenaida macroura*) band recovery data (Anonymous 1953). Banders began to receive reports of current encounters on punch cards in 1962.

INITIAL COMPUTERIZATION: 1955 - 1978

Business Machines and Punch cards at BBL, 1955 - 1978 - Full computerization began in 1955, the first year that game bird bandings were summarized on punch cards by five-day periods (Aldrich 1956). All game-bird banding data (location, age, dates), for the 1921 - 1954 period were entered retroactively onto punch cards. This required nearly 10 yr for the BBL staff to complete (Crissey 1969). However, when a recovery resulted, the exact date of banding was entered into that record. When researchers later required such information, they were provided with printouts that summarized numbers of that species banded in each 10-minute block of latitude and longitude.

When the banding office acquired a Xerox 9124 Copier in early 1965 and used the data on a copy of each schedule to make the punch card, banders were then admonished to submit schedules only in black ink, since the copier did not copy light-blue ink or carbon copies adequately (Baysinger 1965, 1966). Pre-1955 non-game birds were not entered onto punch cards because this effort would have been very labor-intensive and costly, and hence are available only in the form of the original paper schedules (most of which still exist, but are not on computer). Non-game birds represented only 27.4% of the encounter entries through the end of 1953, but would have contributed 71.15% of the banding data entries (CSH). Encounter data, 1921 - 1954, for both game and non-game species, were retroactively entered onto 80-column punch cards.

Disastrous 1959 fire at BBL - On Saturday, 13 Jun 1959, Brooke Meanley discovered a fire in the BBL (CSR). Although very few punch cards burned, because they were tightly packed together in steel cabinets, a large number were darkened by the heat and misshapen by the water used to extinguish the fire. Many would no longer feed

through the sorter. Most were salvaged, hand fed and duplicated and some had to be manually re-punched. A few cards lying loose on desks were burned. It required more than 18 months to restore and edit half a million game-bird recovery records against the original banding records (Robbins 1961).

Beginning use of magnetic tape at BBL, 1961 -

The next step, first mentioned in 1961 - 1962, was to send the half million punch cards to the Service Bureau Corporation for transfer to magnetic tape (Crissey 1962). In 1963, the remaining backlog of non-game entries was given to an outside contractor to enter onto punch cards (Crissey 1963). This was associated with an unacceptably high error rate and required additional time and effort for the BBL staff to correct (Tautin 2008). On 18 Jul 1966, a system of quality control checks of records reduced the incidence of one or more key-punching errors per card from 12% to 4% (Crissey 1967). Conversion of past records was 95% complete by the end of 1969 (Crissey 1969). However, it was 1982 before magnetic tape was used exclusively for direct data entry from the schedules, finally eliminating the intermediate step of punch card entry (MKK, Crissey 1972).

Use of first main-frame computers at BBL, 1963

- 1966 - In September 1963, the IBM 408 computer was replaced by a Univac 1004 (Crissey 1964). In 1965, two additional magnetic tape drives were added to the system. The use of automatic data processing reduced the need for additional staff, but the estimated savings of over \$1 million in annual salary costs may be exaggerated (Crissey 1965). Microfilming of encounter letters compressed contents of a dozen or more file cabinets into 14 rolls of microfilm (Crissey 1965). Microfilming was generally perceived as a permanent solution; but after 40 years, varying degrees of deterioration are evident in most reels of microfilm (Smithsonian National Air and Space Museum 2007), and in the microfilm readers and printers, evident to many microfilm users worldwide.

Changes in filing of schedules at BBL, 1966 -

2007 - From 1926 through at least March 1966, schedules were filed numerically by species under the master permit holder's name. This required a

Fig. 7. The original punch card, "Bird Banding Return 3-137" of April 1929, was nearly identical to this 1941 revision. Banders used the left side to report station returns and BBL staff used it for recording encounters; after coding species and permit numbers, key punch staff punched the right half directly from the information at the left.

BAND NUMBER					A O J NO					AGE					SEX					PERM Y - C																		
44-725254					82.1					Jr					6520																							
SPECIES																				BAND NO		SPECIES		ICL		OPERATOR		WHERE BANDED		DATE BANDED		WHERE RETAKEN		DATE RETAKEN		MILES OF DISTANCE		
Laysan Albatross 96643																				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mina Grenside Hatch																				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
East & Willardson Sawyer																				2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Sand Is., Midway Islands																				3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Pacific Ocean.																				4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
7-3-49																				5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
36° 56' N, 144° 09' E off																				6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Coast of Japan, Pacific Ocean																				7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
1-9-51																				8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Omazaki Enya Fisheries Co-operative.																				9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
51																				9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Caught on fishing line																				9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9

BIRD-BANDING RETURN 3-137 (4-50)

Fig. 8. Interpreted punch card reporting a band encounter to the bander, 1973.

0800036810438730121030108805251454095310045037503001041										File 3		map		ok			
ORIGINAL BAND NUMBER										608-03681		REPORTED BAND NUMBER		REPORT TO THE BANDER			
YOUR BAND NUMBER NOTED ABOVE WAS ENCOUNTERED BY:																	
NAME			STREET			CITY OR TOWN			STATE/PROV.								
MRS RALPH MEIER			BOX 23			GRACEVILLE			MN								
ZIP CODE		HOUSTON		C S DR		SPECIES		GREAT HORNED OWL									
56240																	
BANDING DATA:																	
LOCATION						DATE											
THEODORE						SASK (512-1025)						05/20/72					
ENCOUNTER DATA:												FOUND DEAD					
LOCATION						DATE											
LOWRY MN						MINNESOTA (454-0953)						04/30/73					
PLEASE READ THE BACK OF THIS CARD FOR FURTHER INFORMATION.												FOUND DEAD					

time-consuming manual search each time an encounter was reported, especially when the species was not known. The BBL then began filing schedules by band number, which greatly increased the speed of finding banding data (Baysinger 1966).

Purchase of a new, top-of-the-line computer at BBL, 1967 - During the summer of 1967, a much larger and faster IBM 360-20 computer was purchased for use by the Migratory Bird Populations Station; a full-time IBM representative was available during the first year (Crissey 2006). This made sophisticated automatic data processing possible, transferring all game bird banding data and all encounter data for both game and non-game species from punch cards onto magnetic tape.

During the data transfer in 1968 and early 1969, the computer was operated day and night, for three 8-hour weekday shifts, 1.5 Saturday shifts, and 2 Sunday shifts (Crissey 1969). In spite of this stupendous effort, a six-month backlog of current work resulted during the changeover. In 1969, upgrades allowed data to be processed at twice the initial speed (Crissey 1970). The computer supported the work of a number of migratory bird programs, including the Breeding Bird Survey, in addition to the BBL. Hence, important reports based on large data sets were run during the night on an even larger IBM 360/65 computer (Crissey 1969). During fall 1969, the Data Entry Unit entered 1,867,053 banding records onto magnetic tape, using six NCR 736 tape recorders (Crissey 1970). The "re-punch" of old format schedules remained incomplete in 1972 when, although eventually completed, there were 14 drawers of old format banding schedules still to be pulled, 19 drawers to be edited, and 27 to be batched for key-punching (Crissey 1972).

Reports to band finders and banders, 1955 - 2007 - By 1956, the disposition of each page of the "flimsy" was confirmed by large print at the bottom of the page (e.g., COPY - BANDER). In October 1967 (although applied at first only to encounters of birds banded after 1 Jan 1967), a Certificate of Appreciation was automatically printed by the computer for the band-finder, a "report-to-bander" punch card was issued (Fig.8), and a statistical

record was entered for each encounter received (Baysinger 1968). The Certificate of Appreciation is still in use today and a digital certificate is sent via e-mail to band-finders who report via e-mail. The appearance of the tri-lingual certificate changed from time to time as the Canadian flag was replaced by the CWS logo and Bureau of Sport Fisheries and Wildlife was replaced by the U.S. Fish & Wildlife Service logo. Punch cards used to report encounters to *banders* had several different formats, but a standard 80-column size was used from 1962 through mid-1981, the only years that punch cards were distributed to banders (MTAB #46, 23 Oct 1961). On 1 Jan 1982, the format changed drastically; banders then began to receive encounter reports for multiple species, monthly, on paper 37.5 cm wide, with perforations on each side that when removed left a 35 cm wide page (Hyslop 1981). Since March 2006, the Report-to-Bander lists have been on standard 21.5 x 28 cm paper and since 2007 have been sent electronically to those banders who have e-mail. Since the summer of 2007, band-finders who submit encounters via the web have had the choice of receiving their Certificate of Appreciation electronically.

Separate Processing Unit at BBL, 1962 - 1978 - The name of the processing unit, separate from the BBL but in the same building, changed from Machine Data Processing Unit (1962 - 1965), to Automatic Data Processing Section (1966 - 1967), to Electronic Data Processing Section (1968 through 1997). In 1997 this section was merged into the BBL, reflecting the changes in technology that no longer required a separate unit (Buckley et al. 1998).

MODERN METHODS: 1979 TO PRESENT

Use of personal computers by private banders to enter banding schedule data - The first series of programs used by banders to submit computerized banding schedules in Canada were written by Tony Salvadori and Charles Francis in programming languages C, COBOL, and PL/1, and first used by them to submit schedules to the Canadian BBO in 1978 (Salvadori and Francis 1980). The Canadian prototype program was updated to an all-COBOL system by Francis in 1980 and then to the *dbentry* program written in PASCAL by Francis and first offered to Canadian

banders in December 1986. The BBO reported in April 1987 that only a few banders had chosen to submit their 1986 banding data by computer. These banders found the program to be complicated, as did CSH, even with help from a graduate student in Computer Science. The BBO correctly commented that "the production of banding schedules is not a good introduction to computing. You must have a good background in file maintenance on your machine before you use this system." (Demers et al. 1987).

The BBL proceeded more cautiously in developing their procedures. U.S. banders first used the *Computer-Generated Schedule (CGS)* program created by the Northern Prairie Wildlife Research Center in North Dakota in 1989. A second program, *Band-Ops*, was developed by B.H. Powell in 1995 and first used for the pre-season waterfowl banding in Canada (MKK).

A program called *Band Manager*, written in FoxPro by Sandy Dobbyn and Charles Francis through Bird Studies Canada, was distributed to all master permittees in both Canada and the U.S. in August 1999. In addition to schedule generation, *Band Manager* allowed comprehensive error checks and had features for summarizing and analyzing data. These records were submitted by diskette or as an e-mail attachment (the latter in Canada only, at first). By the summer of 2001, over 70% of both Canadian and U.S. banders were submitting schedules using *Band Manager*.

On 16 Mar 2006, the BBL completed a 19-month transfer of all banding and encounter records from a hierarchical HP Database System to a relational Oracle Database System, aided by a programmer from the USGS Geographic Information System section. A more sophisticated program, named *Bandit*, developed in-house in the BBL to take advantage of its new Oracle potential, was released in 2006. Unlike *Band Manager*, *Bandit* is fully compatible with both Macintosh and IBM-type computers and makes it possible to notify banders when additional information becomes available after the initial entry (MKK). It also allows banders to electronically submit corrections to their data. In 2006, the BBL no longer required banders using *Bandit* to submit paper schedules. In 2007, the BBL discontinued paper schedule submission with *Band Manager* files (MKK).

Reporting band encounters through a toll-free telephone number, 1-800-327-2263

In 1995, the BBL initiated a toll-free number project in which people could report band encounters to the BBL free of charge. This telephone number was inscribed on size 7A bands and a reporting-rate study was done on Mallards (*Anas platyrhynchos*). The one-year trial went well, raising the number of bands reported to a new high; this toll-free number became well known to the general public, especially among hunters. A further increase in reporting of bands occurred in 1996 when the BBL and the BBO recalled old waterfowl bands and replaced them with 1-800 bands. The telephone number was added gradually to the inscription on all bands as new bands were manufactured. At that time the postal address was shortened as necessary on smaller bands and the Laurel, Maryland postal ZIP code, 20708, was added.

The BBO first offered banders access to e-mail communication in mid-1995, soon followed by the BBL. Both the BBO and BBL are moving rapidly to maximize electronic communication with banders, band finders, and the public.

In 2007, Mallard bands were inscribed with a web report URL (www.reportband.gov) and bands were applied to Mallards during the pre-season banding as part of a reporting-rate study. This allows waterfowl researchers to assess any resulting changes in reporting rates. All banders now receive bands with the toll-free telephone number and the web address on the outside of the larger bands and on the inside of band sizes 2 and below. The postal address has been removed.

Since some of the microfilm reel copies have deteriorated, and as the microfilm reader in the BBL ceased functioning, a microfilm scanner was purchased in 2007. This now allows the BBL staff to scan original microfilm reels that had been stored in mint condition off-site (MKK). The microfilm includes not only encounter records but older bander correspondence folders and banding data. In unusual circumstances, when verification is required, the information can be located and printed.

DISCUSSION

Are we there yet? - We do not think so. Continuing improvements in technology will change the

emphasis of the BBL and BBO from data gathering to information sharing. Processing that once took months is now accomplished in minutes. In the future, sightings of birds with auxiliary markers, recapture data, and birds monitored by satellite could be added.

Reasons for success - The BBL has had a series of dedicated leaders: Frederick C. Lincoln (1920 - 1946); John W. Aldrich (acting, 1947); Seth H. Low (1948 - 1954); Allan J. Duvall (1955 - 1964); Earl B. Baysinger (1964 - 1971); George M. Jonkel (1971 - 1988); John Tautin (1988 - 2002); Randolph Perry (acting, 2002 - 2003); Mary Gustafson (acting, 2003 - 2004); Monica Tomosy (2004 - 2008).

The BBO in Canada has not had a designated chief, but Hoyes Lloyd appointed T.S. ("Sars") Hennessy as the first supervisor of the BBO about 1931 (Cooch 1984). Since Hennessy retired in 1959, several dedicated individuals have carried out this leadership role, including banding biologists Steve Wendt, Colleen Hyslop, Connie Downes, Ellen Hayakawa, Lucie Metras, and Lesley-Anne Howes. In January 2002, Charles Francis became Chief of the Migratory Bird Populations Division at the CWS. In December 2002, the BBO moved with the remainder of the National Wildlife Research Centre, from Hull, Quebec, across the Ottawa River to the campus of Carleton University. The staffing and monetary considerations in an overworked office forced the BBL in January 1980 to cease processing returns of birds recaptured and released within the 10-minute block of banding (MTAB #41, 10 Apr 1980). Much valuable data are thus unavailable, but *Bandit* should allow it to be entered in the future.

Continual improvement in equipment and an extremely dedicated and hard-working staff in the BBL and BBO have provided superb service to the several thousand banders across North America. Computerization was initiated early and longevity records for each species continue to be broken as a result of the systematic record-keeping. A wealth of scientific information is available upon request from:

<http://www.pwrc.usgs.gov/bbl> [for USA]
<http://www.cws-scf.ec.gc.ca/nwrc-cnrf/default.asp?lang=en&n=B197CA34> [for Canada]

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**APPENDIX: BIRD BANDS,
 SPECIFICATIONS AND NUMBERING**

Beginning in 1920, individuals who found a bird band wrote to the address on the outside of larger bands, "BIOLOGICAL SURVEY, WASHINGTON, D.C.," or "BIOL SURV WASH DC" stamped on the inside of smaller bands. Beginning in 1967, "AVISE" (which loosely translates to "advise" in French, Spanish and English) was added to each new manufactured band, in case a French, Spanish or Portuguese person found a band (Crissey 1967).

In the first decade, band numbers proceeded sequentially from 1 to 6 digits (999,999). Next, A was added before a number of up to six digits, the first digit of which indicated band size. As numbers became exhausted, some sizes moved to prefix letters B and C and finally the smaller bands used letters F, H and L, avoiding D, E, I, which might be confusing on badly worn bands. Starting in 1934, a separate two-digit prefix number indicated the year of manufacture, such that 368 indicated year, 1936 and band size, 8. From 1927 forward, band size was always the 6th-from-last-digit. Representative archive bands have been saved in a "band bank" at the BBL from each manufacturing batch (for possible comparison with worn bands of that series) (CSR).

In 1964, lock-on bands (with a fold-over flange) in sizes 6 through 8, first became available for larger raptors. "Hard metal" (e.g. monel, titanium and incoloy) bands were first issued in 1966, and stainless steel bands in 1968 (MTAB #10, 17 Jun 1968). Size 9 rivet bands were issued for eagles in 1976. Special adjustable size X bands for large birds were first issued in 1938 but photographically processed bands starting with X, Y, T, R, N, C and

E did not become available for hummingbirds under special permit until 1986 (MKK, CSR).

Since 1950, band numbers have had a standard five-digit suffix. The gradual evolution from a three-digit prefix in 1950 to four digits is demonstrated in Table 1, with sizes 8 and 9 still at the three-digit stage in 2008.

Table 1. Band Size Prefixes (compiled by CSR)

Size	3-digit	4-digit
0	1960	1970
1	1970	1982
1B	1963	1982
1A	1971	1987
2	1950	1996?
3	1950	1966
3A	1949	1966
3B		1968
4	1950	1987
4A	1965	
5	1947	1987
6	1945	1986
7A	1948	1971
7B	1951	1973
7D		1977
8	1948	
9	1951	
9C	1974	