

A Centrifuge of Calculation: Managing Data and Enthusiasm in Early Twentieth-Century Bird Banding

by *Etienne S. Benson**

ABSTRACT

Beginning in 1920, bird banding in the United States was coordinated by an office within the U.S. Biological Survey that recruited volunteers, issued permits, distributed bands and reporting forms, and collected and organized the data that resulted. In the 1920s and 1930s, data from thousands of volunteers banding millions of birds helped ornithologists map migratory flyways and census bird populations on a continental scale. This essay argues that the success of the bird-banding program depended on a fragile balance between the centripetal effects of national coordination and the centrifugal effects of volunteer enthusiasm. For various reasons, efforts to maintain this balance were largely abandoned by the Bird-Banding Office from the late 1930s onward. Nonetheless, the first two decades of the national bird-banding effort provide an example of how a “citizen-science” project that generates “Big Data” can produce significant scientific results without subordinating the enthusiasms of volunteers to the data-collecting needs of professional scientists.

Bird banding is the practice of attaching metal rings stamped with serial numbers to the legs of birds so that they can be identified at a later date. First adopted by European and North American ornithologists on a large scale in the early twentieth century, it can seem rather quaint in comparison to some of the techniques for studying birds that have since become available. It relies on decidedly low-tech instruments—bands, nets, pliers, notebooks—and on time spent in the field rather than seated before a computer. The amount of data produced by the technique was astounding and even sometimes overwhelming by the standards of the early twentieth century, but it can seem small next to the “Big Data” produced by some contemporary ornithological research methods. A satellite-linked electronic tag, for example, is capable of

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tracking the geographical position of a migrating bird on a daily or even hourly basis even in regions of the world, such as the high seas, where human observers are sparse. Such tags can produce hundreds or thousands of data points per tagged bird, in contrast to the one or two typically provided by banding. Meanwhile, citizen-science projects recruit thousands of bird-watchers with smartphones and Internet connections to share their observations of bird migrations and other phenomena. Such electronic instruments and networked citizen scientists produce much of the data upon which today's ornithological discoveries rest.¹

Nonetheless, bird banding continues to play an important role in studies of bird behavior, and its history offers insights into the dynamics of cooperation and conflict between professional ornithologists and amateur volunteers that are relevant to many of today's citizen-science projects. As I describe below, the American bird-banding effort of the 1920s and 1930s relied heavily on volunteer banders, whose efforts were coordinated by professional ornithologists at the Bird Banding Office (BBO) of the U.S. Biological Survey in Washington, D.C. Indeed, bird-banding efforts helped to strengthen the professional-amateur distinction in ornithology, where such boundaries remained fluid much longer than in many other scientific disciplines.² By the 1920s, however, the lines were being increasingly starkly drawn, so that professionals such as Frederick C. Lincoln, who headed the BBO from 1920 to 1946, could lay claim to greater authority than most amateurs who lacked specialized training and institutional support. In this context, the bird-banding effort was a typical early twentieth-century elaboration on the long tradition of observation networks in the sciences—one that harnessed the power of the state, ideals of civic participation, and the advantages of specialization to create a centripetal knowledge infrastructure that funneled data from peripheral amateurs to centrally located professionals.³

Narratives of professionalization and centralization do not, however, account for the full complexity of the early twentieth-century bird-banding effort, which cannot be reduced to a system for exploiting amateur enthusiasms for the accumulation of data in a center of calculation.⁴ The BBO's dependence on volunteers, whose main reason for participating was their "passion for birds,"⁵ meant that professional ornithologists at the center of the network spent a great deal of their time, especially in the early years of the project, encouraging activities that sustained volunteer enthusiasm

¹ On the history of bird banding in the United States, see Jerome A. Jackson, William E. Davis Jr., and John Tautin, eds., *Bird Banding in North America: The First Hundred Years*, Memoirs of the Nuttall Ornithological Club, no. 15 (Cambridge, Mass., 2008); Mark V. Barrow, *A Passion for Birds: American Ornithology after Audubon* (Princeton, N.J., 1998), 169–71; Robert M. Wilson, *Seeking Refuge: Birds and Landscapes of the Pacific Flyway* (Seattle, 2010), 72–5.

² Barrow, *Passion for Birds* (cit. n. 1).

³ The history of observation networks and knowledge infrastructures is large and growing. For a survey with a focus on nonprofessional observers, see Jeremy Vetter, "Introduction: Lay Participation in the History of Scientific Observation," *Sci. Context* 24 (2011): 127–41. On the relevance of nineteenth-century historical examples to present-day citizen-science projects, see Gowan Dawson, Chris Lintott, and Sally Shuttleworth, "Constructing Scientific Communities: Citizen Science in the Nineteenth and Twenty-First Centuries," *J. Victorian Cult.* 20 (2015): 246–54.

⁴ On the BBO as a "centre of calculation" that allowed the Biological Survey to "centralize the production of bird-banding data," see Wilson, *Seeking Refuge* (cit. n. 1), 74. See also Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society* (Cambridge, Mass., 1987), 219–37; Susan Leigh Star and James R. Griesemer, "Institutional Ecology, 'Translations,' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39," *Soc. Stud. Sci.* 19 (1989): 387–420.

⁵ Barrow, *Passion for Birds* (cit. n. 1).

but also generated a variety of centrifugal forces that ultimately worked against the BBO's own aims. One of the most prominent volunteer "cooperators," Margaret Morse Nice, publicly criticized the forms of banding research that mostly directly supported Lincoln's aims, for example, while regional associations of volunteer bird-banders established local data repositories and "emergency" stores of bands in direct violation of the BBO's wishes. The success of bird banding in the 1920s and 1930s depended on an inescapable interplay of centripetal and centrifugal forces.

Inescapable, that is, under particular social, economic, technical, and scientific conditions. Over the course of the 1920s and 1930s, it gradually became both desirable and possible for the BBO to reduce its dependence on volunteers and its vulnerability to their centrifugal enthusiasms. It is here that the issue of data management becomes central. In the early years of the BBO, there were clear links between volunteer enthusiasm, data collection, and scientific results: the more the BBO fostered the enthusiasm of volunteers, the more data was generated, and the easier it became to map migration pathways and census bird populations on a continental scale. As the volume of data flooding into the BBO increased, however, it became impossible for its limited staff to stay afloat; at times they fell literally years behind. For this and other reasons, the BBO was, by the 1930s, more concerned with disciplining volunteers than with fostering their enthusiasms. By the end of the 1940s, a dramatic shift away from reliance on volunteers had taken place. The history of the U.S. bird-banding program's embrace of and subsequent retreat from a balance between centrifugal and centripetal forces suggests the viability as well as the limits of alternatives to the centripetally oriented projects that dominate "citizen science" today.⁶

THE EMERGENCE OF ENTHUSIASM FOR BIRD BANDING IN NORTH AMERICA

Enthusiasm for bird banding emerged in Europe and North America at the turn of the twentieth century primarily in the realm of civic ornithology—that is, the study of birds outside of the universities and government agencies where highly trained professionals pursued scientific research.⁷ In Europe, the Danish schoolteacher Hans Christian Cornelius Mortensen's banding studies of the migration of starlings and other species inspired a wave of imitators in Germany, Great Britain, Hungary, Russia, and elsewhere.⁸ The ornithologist Johannes Thienemann, for example, recruited a network of volunteers to support banding-based studies of migration from his base at the Rossitten bird observatory in East Prussia.⁹ In North America, civic ornithologists similarly took the lead in developing bird-banding techniques and recruiting fellow enthusiasts into ad hoc regional networks. In 1902, for example, Paul Bartsch of the Smithsonian Institution began attaching aluminum bands inscribed with a serial num-

⁶ On issues raised by the boom in citizen-science projects since the 1990s, see Janis L. Dickinson and Rick Bonney, eds., *Citizen Science: Public Participation in Environmental Research* (Ithaca, N.Y., 2012); Abraham Miller-Rushing, Richard Primack, and Rick Bonney, "The History of Public Participation in Ecological Research," *Frontiers Ecol. Environ.* 10 (2012): 285–90.

⁷ Raf de Bont, *Stations in the Field: A History of Place-Based Animal Research* (Chicago, 2015), 147–74. See also Lynn Nyhart, "Civic and Economic Zoology in Nineteenth-Century Germany: The 'Living Communities' of Karl Möbius," *Isis* 98 (1998): 605–30.

⁸ Many of these European projects were cut short by World War I; Frederick C. Lincoln, "The History and Purposes of Bird Banding," *Auk* 38 (1921): 217–28, on 219. See also Harold B. Wood, "The History of Bird Banding," *Auk* 62 (1945): 256–65.

⁹ De Bont, *Stations in the Field* (cit. n. 7), 161.

ber, the year, and the instruction to “Return to Smithsonian Institution” onto herons at a breeding colony near Washington, D.C.¹⁰ Soon after, P. A. Taverner, a young Canadian architect and amateur ornithologist living in Ann Arbor, Michigan, began distributing bands to a small network of fellow enthusiasts.¹¹ In 1909, Jack Miner began banding geese and ducks at his farm in Ontario with bands handstamped with a serial number, his address, and a Bible quotation.¹²

In these early efforts, the frequency of “returns”—observations of previously banded birds—was quite low, and most returns concerned birds recaptured at the site of initial banding. While this discouraged some ornithologists from adopting the technique, it motivated others to coordinate banding over increasingly wide geographical scales. One of the key figures in this scaling-up process was Leon J. Cole, who had begun advocating bird banding in 1901.¹³ In 1908, Cole recruited fellow enthusiasts in the New Haven Bird Club to join him in a collective banding project. A year later, disappointed at the paltry rate of returns, he proposed establishing an association to carry forward the effort on a national scale at a meeting of the American Ornithological Union.¹⁴ By the spring of 1910, the American Bird Banding Association (ABBA) had distributed approximately 5,000 bands, of which 911 had been reported as used and thirty-one had subsequently been recovered. A recovery rate of 3.4 percent was still low, but it was already a significant improvement over earlier efforts.¹⁵ Over the following decade, approximately 22,500 birds were tagged with bands distributed by the ABBA.¹⁶

Sources of enthusiasm for bird banding during this early period can be divided into two kinds: an enthusiasm for amassing vast collections of data on bird populations, on one hand, and an enthusiasm for acquiring intimate acquaintance with individual birds, on the other. Cole was among those who were excited by bird banding as a technique for amassing vast quantities of data on many birds rather than as an opportunity to study a few birds in great detail. Looking back on the ABBA’s work from the perspective of the early 1920s, Cole described it as a scheme to “gradually build up an accumulation of accurate data on bird movements which would be of the greatest scientific value” by drawing on “the interest and coöperation of the large number of amateur bird students in the country.”¹⁷ After Cole took a position at the University of Wisconsin in 1910 and shifted his focus to genetics, the management of the ABBA fell to Howard H. Cleaves, who arranged for a ledger and filing

¹⁰ Paul Bartsch, “Notes on the Herons of the District of Columbia,” *Smithsonian Misc. Collections* 45 (1904): 104–11; Bartsch, “A Note on the First Bird-Banding in America,” *Bird-Banding* 23 (1952): 59–60.

¹¹ P. A. Taverner, “A Tagged Flicker,” *Wilson Bull.* 18 (1906): 21–2; Taverner, “Tagging Migrants,” *Auk* 23 (1906): 232; W. L. McAtee, “Percy Algernon Taverner, 1875–1947,” *Auk* 65 (1948): 85–106.

¹² On Miner’s banding work in relation to his conservation philosophy, see Tina Loo, *States of Nature: Conserving Canada’s Wildlife in the Twentieth Century* (Vancouver, 2006), 63–92.

¹³ Cole later claimed to have been inspired by the use of numbered tags for research on lobsters; Leon J. Cole, “The Early History of Bird Banding in America,” *Wilson Bull.* 34, no. 2 (1922): 108–44. See also Wood, “History” (cit. n. 8), 260.

¹⁴ Leon J. Cole, “The Tagging of Wild Birds: Report of Progress in 1909,” *Auk* 27 (1910): 153–68; Letter, Leon J. Cole, C. J. Pennock, Louis B. Bishop, Glover M. Allen, and Thomas S. Roberts (Executive Committee of the American Bird Banding Association), New Haven, Conn., 10 February 1910, *Wilson Bull.* 22 (1910): 53–5.

¹⁵ Cole, “Tagging” (cit. n. 14), 157–9.

¹⁶ Frederick C. Lincoln, “Some Causes of Mortality among Birds,” *Auk* 48 (1931): 538–46, on 539.

¹⁷ Cole, “Early History” (cit. n. 13), 109.

cabinet for banding data to be installed at the Linnaean Society of New York.¹⁸ Like Cole, Cleaves believed that “bird banding is not the work of a limited circle but the duty of many, and it is only by extensive banding that results of value can be obtained.”¹⁹ This was a clearly centripetal view of bird banding, in which a network of amateurs contribute data to a center of calculation where it will be used by a few highly trained professionals.

Through the 1910s, however, this centripetal vision remained more aspirational than real, with the ABBA’s slowly growing collection of bird-banding data languishing mostly unused except by banders eager to discover the fate of the birds they had banded themselves. One reason was that the rate of returns continued to be so low and the distribution of banders across the continent so uneven as to make any general conclusions drawn from them highly speculative. This was a function of the small number of people banding birds and of their tendency to band nestlings. Birds too young to fly were easy to catch and band but also very likely to die before they could be recaptured. Moreover, most of those involved in bird banding at this time seem to have had little interest in using the data for panoptic purposes. For them, the ABBA served as a registry or clearinghouse through which they could discover the fate of those few birds that they had banded themselves. The ABBA’s central files seem never to have been used as the basis for a published study, although the private data collections assembled by particular banders or research stations often were.²⁰

For most banders, the dream of accumulating massive amounts of data in a repository for centralized study was less appealing than the prospect of receiving free bird bands and instruction in the proper techniques for using them, which would allow them to learn more about the fate of individual birds, as well as to take personal credit for the scientific findings that resulted. S. Prentiss Baldwin, a businessman and amateur ornithologist who played a leading role in the development of bird banding in the United States between the 1910s and 1930s, is a case in point. Baldwin had first begun to trap live birds in the process of exterminating nonnative sparrows on his estate near Cleveland in the early 1910s. In 1914, after learning about the methods promoted by the ABBA, he began banding on what was then considered a very large scale, resulting in about 1,600 birds banded between 1914 and 1918.²¹ The publication of his methods and findings in 1919 was widely credited with inspiring a revival of interest in bird banding.²² In particular, by developing trapping and banding techniques for adult birds, which were harder to catch but more likely than nestlings to be recaptured, Baldwin’s research reopened the possibility of recovery rates that could sustain the enthusiasm of amateurs.²³

¹⁸ Howard H. Cleaves, “What the American Bird Banding Association Has Accomplished during 1912,” *Auk* 30 (1913): 248–61, on 248–9.

¹⁹ *Ibid.*, 253.

²⁰ For an example of a study that used the association’s bands but not the association’s collection of records, see Edward A. McIlhenny, “An Early Experiment in the Homing Ability of Wildfowl,” *Bird-Banding* 11 (1940): 58–60.

²¹ S. Charles Kendeigh, “In Memoriam: Samuel Prentiss Baldwin,” *Auk* 57 (1940): 1–12, on 4.

²² S. Prentiss Baldwin, “Bird-Banding by Means of Systematic Trapping,” *Abstr. Proc. Linn. Soc. N.Y.* 31 (1919): 23–56.

²³ Baldwin assisted with the preparation of the first instructional pamphlet issued by the BBO; Frederick C. Lincoln, *Instructions for Bird Banding*, U.S. Department of Agriculture, Department Circular 170, Bureau of Biological Survey (Washington, D.C., 1921).

Baldwin's interest in bird banding cannot be entirely separated from the dream of a massive, centralized, continent-wide data set, but neither can it be reduced to it. The research program he developed eventually led to the banding of tens of thousands of birds, and in the 1920s and 1930s he contributed significantly to the coordination of effort among bird banders across North America and to the growth of the federal bird-banding program. Still, the centripetal dreams that got Cole's and Cleaves's hearts pumping faster seem to have left Baldwin cold. As one of his field assistants recalled after his death, his goal was never to band "large numbers of individuals for the sake of a big record" but rather to "obtain all possible information from those that were handled."²⁴ Data was vitally important, in other words, but it was small data kept locally rather than Big Data gathered in Washington that mattered most. For such work, a centralized registry might be helpful, but a centralized data set was largely irrelevant. Like many other banders, Baldwin's enthusiasm for banding was sustained by the experience of handling individual birds, investigating their life histories, and associating with like-minded enthusiasts—not by the idea of handing data over to a distant center of calculation.

MANAGING DATA AND ENTHUSIASM AT THE BBO

In 1920, the ABBA was disbanded and its functions were taken over by the new Bird-Banding Office in the United States and by an equivalent office in Canada.²⁵ For its first two and a half decades, from 1920 to 1946, the U.S. office operated under the direction of Frederick C. Lincoln. In a memorial written after Lincoln's death in 1960, one leading American wildlife conservationist described him as someone who had had "no hobbies, other than work in his chosen field."²⁶ This paradoxical formulation suggests the depth of Lincoln's commitment to ornithology and the blurring of lines between professional and amateur that it entailed. His passion for birds was already evident during his adolescence in Colorado, where he spent summers working at the Colorado Museum of Natural History and made the acquaintance of Alexander Wetmore, an ornithologist with the Biological Survey. In 1920, after becoming the museum's curator of ornithology and serving as a pigeon expert in the U.S. Signal Corps, Lincoln was recruited by the Biological Survey to head the bird-banding effort. The U.S. government's interest in bird banding was a result of the Convention for the Protection of Migratory Birds signed with Canada in 1916, which obligated both nations to manage bird populations with "due regard to the zones of temperature and to the distribution, abundance, economic value, breeding habits, and times of migratory flight" of the species concerned.²⁷ Bird banding promised to provide the data required for such management, but only if it could be successfully coordinated on a national scale.

²⁴ Kendeigh, "In Memoriam" (cit. n. 21), 5.

²⁵ E. W. Nelson, "Bird Banding Work Being Taken over by the Biological Survey," *Wilson Bull.* 32 (1920): 63–4.

²⁶ Ira N. Gabrielson, "Obituary," *Auk* 79 (1962): 495–9, on 495.

²⁷ U.S. Department of Agriculture, Bureau of Biological Survey, *Migratory Bird Treaty, Act, and Regulations* (Washington, D.C., 1920), 5. See Kurpatrick Dorsey, *The Dawn of Conservation Diplomacy: U.S.-Canadian Wildlife Protection Treaties in the Progressive Era* (Seattle, 1998), 165–237; Mark Cioc, *The Game of Conservation: International Treaties to Protect the World's Migratory Animals* (Athens, Ohio, 2009), 58–103.

After arriving in Washington, Lincoln threw himself into the work of promoting bird banding as a revolutionary technique for ornithology. “Occupying a position with the shotgun, the field glass and the scalpel,” he wrote in 1926, banding “bids fair to become the court of last appeal in the determination of many facts concerned with the migration and life histories of birds.” (fig. 1)²⁸ Lincoln’s proselytizing efforts were most intense during his first few years on the job, when he devoted himself to inspiring and recruiting a voluntary corps of bird banders while also educating hunters and bird lovers about the importance of reporting recovered bands. In addition to writing popular articles, he gave interviews to the press and delivered numerous presentations before Boy Scout troops, Audubon societies, nature clubs, and other organizations. Lincoln emphasized the utilitarian purposes of bird banding but also sought to position it as a way for ordinary citizens to contribute to science while enhancing their own enjoyment of birds. In an account of the origins of bird banding in the United States titled “The Romance of the Numbered Band,” most likely written in the late 1930s, Lincoln noted that the “charm of intimate acquaintance with birds, brought about by the repeated handling of the same individuals, started a wave of interest and enthusiasm unparalleled in the history of American ornithology.”²⁹

Rather than discouraging volunteers’ enthusiasm for “intimate acquaintance” with individual birds, Lincoln actively encouraged it, even while insisting that banders send their reports to Washington in formats that could be efficiently processed for the purposes of waterfowl management. This balance between encouraging volunteer enthusiasm and disciplining their data collection was reflected in an article on “The History and Purposes of Bird Banding” that Lincoln published in *The Auk* in the spring of 1921.³⁰ The article explained the importance of bird banding for large-scale migration studies, but it also sought to link bird banding research to popular enthusiasm for bird-watching. It noted the ease with which the nation’s thousands of bird-feeding stations could be converted into banding stations, the variety of research questions that could be answered, and the harmlessness of the practice. Even the bird lover most concerned about the welfare of humanity’s feathered friends, it suggested, could band birds in good conscience. By way of conclusion, the article predicted that with “the element of anticipation always present, expecting and watching for a bird marked at some other station or during a previous year, it seems that this new system of bird banding should find a host of enthusiastic participants.”³¹ This was a message that Lincoln repeated before a variety of audiences in the early years of the federal bird-banding program.³²

Lincoln’s advocacy efforts soon paid off. In fact, the practice had soon garnered so much interest that the BBO was forced to limit the number of banding permits it is-

²⁸ Frederick C. Lincoln, “Bird Banding—In Progress and Prospect,” *Auk* 43 (1926): 153–61, on 153.

²⁹ The manuscript was written and submitted to *Collier’s Magazine* but never published; Robert McCormick to Frederick C. Lincoln, 2 June 1941; Lincoln, “Bird Banding,” n.d., 34 pp. [pages missing], on 13, Box 37, Folder: The Romance of the Numbered Band, Record Group 22, Office Files of Dr. Frederick C. Lincoln, 1917–1960, National Archives and Records Administration, College Park, Md. (hereafter cited as “Lincoln Files”).

³⁰ Lincoln, “History” (cit. n. 8).

³¹ *Ibid.*, 227.

³² See, e.g., his presentation to the Naturalist Field Club of Johns Hopkins University in 1924; Frederick C. Lincoln, “Report of Trip to Baltimore, Maryland, Apr. 30, 1924,” n.d., manuscript, 3 pp., on 2, Box 36, Folder: Reports 1924, Lincoln Files.

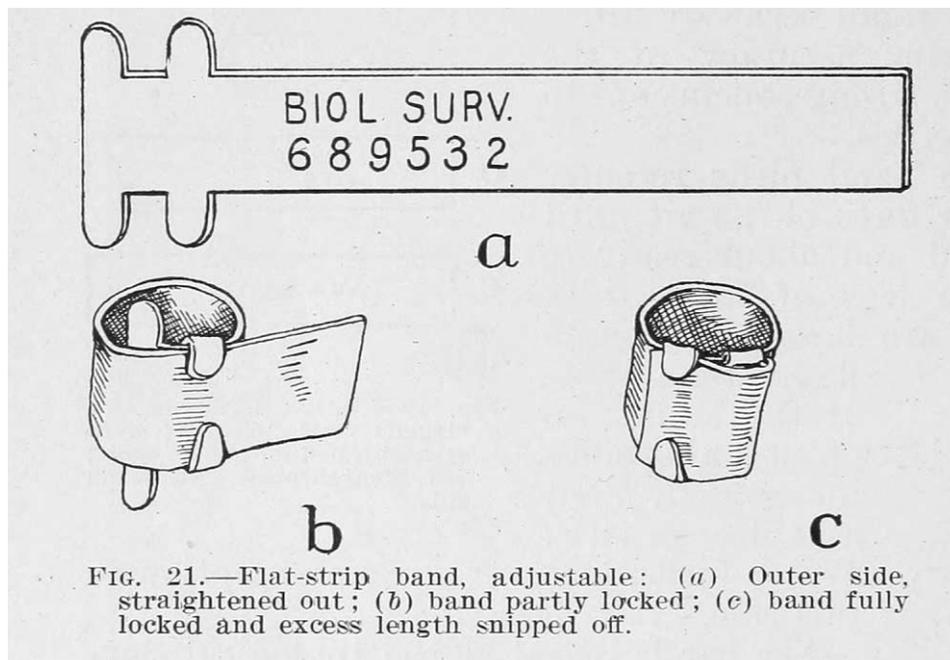


FIG. 21.—Flat-strip band, adjustable: (a) Outer side, straightened out; (b) band partly locked; (c) band fully locked and excess length snipped off.

Figure 1. A diagram showing one of the stamped, numbered bands distributed by the Bird-Banding Office to its cooperators in both open and locked (i.e., attached) states. Source: Frederick C. Lincoln, *Instructions for Banding Birds* (Washington, D.C., 1924), 20, fig. 21.

sued. This was not because the would-be banders were unqualified or because the data they planned to collect would not have been useful, but because the office was unable to process the flood of data with which it was already being inundated. By the summer of 1926 there were 1,133 active cooperators and around one hundred more planning to begin banding soon. Since the establishment of the BBO, volunteers had banded more than 203,000 birds, from which more than 9,300 returns had been received (a rate of about 4.6 percent).³³ The BBO's inability to manage this flow had direct consequences for Lincoln's efforts to generate enthusiasm for the new technique. In the late 1920s, the BBO began to "handle the banding work 'with brakes on,' that is, definite effort [was] made to refrain from undue publicity or campaigns that would have the effect of greatly increasing the number of cooperators."³⁴

Facing practical limits to the amount of data that could be collected, processed, stored, and analyzed given available resources, Lincoln shifted his focus from inspiring interest in banding to recruiting precisely the right kind of cooperator and ensuring that the work of existing cooperators was maximally useful for the BBO. In light of the office's origins in the 1916 convention, Lincoln believed the ideal bander was one who operated a feeding station at which hundreds or thousands of waterfowl were banded yearly and who submitted accurate banding reports and returns in a timely manner, thereby contributing to the continental-scale surveys upon which water-

³³ Frederick C. Lincoln, Memorandum for Chief of Bureau, 19 June 1926, 1 p., Box 36, Folder: Reports 1926, Lincoln Files.

³⁴ Frederick C. Lincoln, Memorandum for Dr. Bell, 13 July 1928, 3 pp., on 2, Box 36, Folder: Reports 1928, Lincoln Files.

fowl management depended. From the mid-1920s onwards, the BBO sought to discourage the applications of would-be cooperators who did not intend to establish large-scale trapping stations and to revoke the permits of those whose work it deemed to be of a “desultory character.”³⁵ By the late 1930s, it was rejecting more than one permit application per day.³⁶ Nonetheless, because Lincoln found it difficult to turn down candidates who promised to add coverage of important species or geographical areas, the number of permit-holding volunteers and unprocessed reports continued to increase.

Over the course of the 1920s and 1930s, the focus of Lincoln’s attention thus shifted from publicity and recruitment toward clerical workflow and data management. Within the first few years of the BBO’s founding, for example, he recognized that writing to contributors individually to acknowledge receipt of their data was consuming an inordinate amount of his time. By 1923, about 59 percent of the 4,687 communications that crossed his desk were in the form of preprinted postcards rather than letters or memos.³⁷ For more complex communications, Lincoln established *Bird Banding Notes*, which disseminated trapping and banding techniques and reported exemplary or particularly exciting returns. *Bird Banding Notes* was also used to encourage cooperators to complete reporting cards with pen rather than pencil, to submit reports at regular time intervals, to avoid duplicating reports, and to ensure that all information sent was correct and complete. Failing to comply with any of these requirements, cooperators were regularly warned, could result in revocation of their banding permits.³⁸ In this way, the challenges of data management helped to reorient the relationship between the BBO and its cooperators from individual, idiosyncratic, and encouraging to collective, standardized, and disciplinary.

The flood of data also inspired a series of efforts aimed at reforming data-management practices within the BBO. At first, when the number of banders remained in the hundreds rather than thousands, the clerical work of transcribing and filing banding reports seemed manageable (fig. 2). In 1922, Lincoln confidently told his supervisor that the “system for the mechanical part of the work is now very nearly automatic, and appears to admit of infinite expansion.”³⁹ As the number of cooperators’ reports grew, however, he was forced to implement further reforms because of “the greatly increased volume of work and lack of additional assistance.”⁴⁰ Some of these reforms addressed minor matters of workflow; others involved significant reorganizations of the data. In 1925, for example, the BBO began separating the “dead” files of birds banded so long ago that they were unlikely to be observed again from more recent “live” records.⁴¹ In 1926, Lincoln reported that “a complete change in

³⁵ Frederick C. Lincoln, Memorandum for the Chief of Bureau [E. W. Nelson], 20 September 1924, 2 pp., on 2, Box 36, Folder: Reports 1925, Lincoln Files.

³⁶ Frederick C. Lincoln, Memorandum for Mr. Leichhardt, 18 September 1939, 2 pp., on 1, Box 39, Folder: Statements of Policy, Lincoln Files.

³⁷ Frederick C. Lincoln, Memorandum for Major Goldman, 19 December 1923, Box 36, Folder: Reports, Memos, etc., FY 1921 and 1922, Lincoln Files.

³⁸ “General Information to Cooperators,” *Bird Banding Notes* 10 (1924): 1–4, on 1.

³⁹ Frederick C. Lincoln, Memorandum for Major Goldman, 22 July 1922, 2 pp., on 2, Box 36, Folder: Reports, Memos, etc., FY 1921 and 1922, Lincoln Files.

⁴⁰ Frederick C. Lincoln, Memorandum for Chief of Bureau [E. W. Nelson], 2 July 1924, 3 pp., Box 36, Folder: Reports 1924, Lincoln Files.

⁴¹ Frederick C. Lincoln, Memorandum for Dr. Jackson, 18 November 1925, 2 pp., Box 36, Folder: Reports 1926, Lincoln Files.

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

Form B1-137

Figure 2. A sample record card reporting the tagging of an adult male robin at the National Zoological Park in Washington, D.C., on 5 May 1923, and its recapture at the same site on 6 and 10 May. Source: Frederick C. Lincoln, *Instructions for Banding Birds* (Washington, D.C., 1924), 24, fig. 27.

system” for the banding files was speeding the work of banders and clerical staff.⁴² But none of these reforms remained satisfactory for long. In 1929, the office fell a full year behind schedule, and Lincoln admitted that “we are totally unable to adequately handle the volume of work with the personnel available.”⁴³ In the midst of an unprecedented economic disaster, funds for additional personnel were not forthcoming. The BBO continued to fall behind, and the tone of Lincoln’s memos became increasingly desperate.⁴⁴

With no additional personnel forthcoming, mechanization offered a ray of hope. In 1929, the BBO acquired an electric card-sorting machine that promised to facilitate the censusing of bird populations.⁴⁵ The American Wild Fowlers, a private conservation association, donated funds to hire a card puncher who spent five weeks coding,

⁴² Frederick C. Lincoln, Memorandum for Dr. Jackson, 24 June 1926, 3 pp., Box 36, Folder: Reports 1926, Lincoln Files.

⁴³ Frederick C. Lincoln, Memorandum for Dr. Bell, Bird Banding Report—Fiscal Year 1929, 12 July 1929, 4 pp., on 1, Box 36, Folder: Reports ~1929 (Memos), Lincoln Files.

⁴⁴ Frederick C. Lincoln, Memorandum for Dr. Bell, Bird Banding Report—Fiscal Year 1930, 9 July 1930, 4 pp., Box 36, Folder: Reports, Memos, etc., FY 1930, Lincoln Files.

⁴⁵ C. Stuart Houston, M. Kathleen Klimekiewicz, and Chandler S. Robbins, “History of ‘Computerization’ of Bird-Banding Records,” *North Amer. Bird-Bander* 33 (2008): 53–65, on 55. As Christine von Oertzen argues, the success of mechanical punch card systems depended on particular configurations of human labor and on the more fundamental innovation of using “movable paper tools” to represent information about individuals; see von Oertzen, “Machineries of Data Power: Manual versus Mechanical Census Compilation in Nineteenth-Century Europe,” in this volume. See also Markus Krajewski, “Tell Data from Meta: Tracing the Origins of Big Data, Bibliometrics, and the OPAC,” in this volume; Lars Heide, *Punched Card Systems and the Early Information Explosion, 1880–1945* (Baltimore, 2009).

punching, and sorting about 30,000 cards, and the Machine Tabulating and Computing Section of the Bureau of Agricultural Economics offered the use of its tabulating machine.⁴⁶ Lincoln described the turn to mechanization in practical but also moral terms; it would allow the BBO to meet its “responsibility” to cooperators to analyze the data it had accumulated.⁴⁷ While most bird banders remained interested mainly in the fates of their own birds, the credibility of the BBO depended on its making some use of the data it was collecting. At the same time, mechanization provided a new opportunity to tighten the BBO’s control over cooperators. At the beginning of 1930, cooperators were informed that new reports and returns were to be submitted only on simplified cards that could be directly coded and punched at the BBO.⁴⁸ As data processing became mechanized, cooperators’ flexibility decreased.

Automation offered some real increases in efficiency and reliability, but it did little to solve the problem of information overload. A few years later, Lincoln was still begging his superiors for at least one more clerk.⁴⁹ Triage became necessary: reports of newly banded birds were given priority, since they were required for making sense of later returns; meanwhile, the processing of returns was postponed to the indefinite future. By the summer of 1938, the BBO had accumulated approximately 40,000 unprocessed reports, amounting to the entirety of the returns from the previous two years.⁵⁰ This could be seen as a product of poor management and insufficient resources, but it can also be understood as the almost inevitable result of seeking to accumulate as much data as possible. Given the frictions and unexpected challenges of data management, it was easy for “as much as possible” to become “a bit more than possible.” Lincoln shared some responsibility for this state of things, inasmuch as his annual request for additional staff was usually accompanied by the admission that the number of cooperators and banded birds continued to increase.⁵¹ Information overload and data hunger went hand in hand.

CENTRIFUGAL ENTHUSIASMS ON THE AMATEUR PERIPHERY

The volunteers who flooded the BBO with data were often highly educated, passionately committed to ornithology, and hungry for data in their own way. Among them was Margaret Morse Nice, who, like many other American women of her generation, was forced to end her formal scientific training before completing her doctorate. Nonetheless, she succeeded in becoming one of the most respected American ornithologists.

⁴⁶ Lincoln, Memorandum for Dr. Bell, Bird Banding Report—Fiscal Year 1930 (cit. n. 44). See also J. E. Law, “Electric Sorting Machine for Banding Data,” *News from the Bird Banders* 5 (1930): 15.

⁴⁷ Lincoln, Memorandum for Dr. Bell, Bird Banding Report—Fiscal Year 1929 (cit. n. 43). On moral and emotional economies of science, see Lorraine Daston, “The Moral Economy of Science,” *Osiris* 10 (1995): 3–24; Lorraine Daston and Peter Galison, *Objectivity* (Cambridge, Mass., 2007); Paul White, “Introduction” to Focus Section on “The Emotional Economy of Science,” *Isis* 100 (2009): 792–7.

⁴⁸ Lincoln, Memorandum for Dr. Bell, Bird Banding Report—Fiscal Year 1930 (cit. n. 44). See also Law, “Electric Sorting Machine” (cit. n. 46), 15.

⁴⁹ Frederick C. Lincoln, Memorandum for Doctor Bell, Re: Bird Banding Report; Fiscal Year, 1931, 2 July 1931, 6 pp., on 5, Box 36, Folder: Reports, Memos, FY 1931, Lincoln Files.

⁵⁰ Frederick C. Lincoln, Annual Report—Fiscal Year 1938, Distribution and Migration of Birds, Division of Wildlife Research, n.d., 13 pp., on 10, Box 38, Folder: Section Reports, Memos, etc. (Including memos from Div. Chief) FY 1938, Lincoln Files.

⁵¹ I have found no evidence that volunteers were ever asked to assist with clerical tasks in the BBO.

thologists of the mid-twentieth century on the basis of rigorous empirical studies and wide reading of North American and European ornithological literature.⁵² Nice achieved this status while serving as one of the BBO's cooperators and, for many years, as an associate editor of the journal *Bird-Banding*. Like many of her fellow banders, Nice both depended on and contributed to the BBO's centralizing efforts, which exploited the enthusiasm of volunteers like herself to produce data for professionals while also providing tools that enabled amateurs to pursue their own research interests. Nice played a leading role in fostering practices that pulled away from centralized data gathering and encouraged each bander to tackle important scientific problems that could be addressed using a small set of carefully observed birds. Though harder to track through the historical record, such centrifugal practices were as important as the centripetal practices that pulled banding data into Lincoln's office in Washington.

Implicit in many of her research articles, Nice's vision of banding as a centrifugal, peripheral, and individual practice was rendered explicit in an article titled "The Opportunity of Bird-Banding," which appeared in *Bird-Banding* in 1934. As exhortatory in tone as some of the newsletters published by the BBO around the same time, the article upbraided Nice's fellow banders for "apparently believing that banding is merely a means of studying migration" and thus being satisfied to "capture as many birds as they possibly can, simply attaching the numbered band and that is the last they see or hear of the vast majority of their subjects."⁵³ Although Nice mentioned neither Lincoln nor the BBO by name, it was precisely their approach to banding that she was attacking. Willing to sacrifice quantity for quality and breadth for depth, Nice argued that significant scientific discoveries would emerge if banders would only "study a few birds carefully."⁵⁴ What Nice meant by this was life-history research of the kind that had occupied Baldwin, whose most striking result had concerned the mate fidelity of house wrens—a topic for which the individual identification provided by banding was essential but the collection of data in a centralized repository was irrelevant.⁵⁵

Nice's studies of song sparrows similarly depended on individual identification over multiple seasons, for which bands from the BBO and a federal banding permit were essential but the centralized data set that Lincoln was painstakingly assembling was not.⁵⁶ Using additional colored celluloid bands that allowed her to identify individual birds from a distance, Nice conducted a study of breeding behavior that was widely recognized upon its publication in 1937 as "the finest and most comprehen-

⁵² Nice later received an honorary doctorate from Mount Holyoke College; David W. Johnston, "Margaret Morse Nice (1883–1974)," *Bird-Banding* 45 (1974): 360. On the position of women in American science during this period, see Margaret W. Rossiter, *Women Scientists in America: Struggles and Strategies to 1940*, vol. 1 (Baltimore, 1982), 129. On Nice's career, see Margaret Morse Nice, *Research Is a Passion with Me* (Toronto, 1979); Gregg Mitman and Richard W. Burkhardt Jr., "Struggling for Identity: The Study of Animal Behavior in America, 1930–1945," in *The Expansion of American Biology*, ed. Keith R. Benson, Jane Maienschein, and Ronald Rainger (New Brunswick, N.J., 1991), 164–94; Barrow, *Passion for Birds* (cit. n. 1), 195–8.

⁵³ Margaret Morse Nice, "The Opportunity of Bird-Banding," *Bird-Banding* 5 (1934): 64–9, on 64.

⁵⁴ *Ibid.*

⁵⁵ S. Prentiss Baldwin, "The Marriage Relations of the House Wren (*Troglodytes a. aedon*)," *Auk* 38 (1921): 237–44.

⁵⁶ Margaret Morse Nice, "Studies in the Life History of the Song Sparrow, Vol. I: A Population Study of the Song Sparrow," *Trans. Linn. Soc. N.Y.* 4 (1937): 1–247.

sive study ever made of any North American bird.”⁵⁷ By disseminating her own note-taking and data-recording methods through *Bird-Banding*, Nice helped to promote such studies among her fellow volunteer banders.⁵⁸ She was not opposed to studies of migration, to cooperative work, or to submitting data to the BBO, but she was most passionate about the opportunities that banding opened up for local observation of phenomena such as territoriality. Sending reports to Washington was a bureaucratic obligation that had to be fulfilled before the real work of closely observing a few individual birds could begin.

Nice’s example suggests that cooperators could participate in the federal banding program even while pursuing research objectives that were independent of it or even opposed to it. The centrifugal forces that created tension between the BBO and the volunteers upon whom it depended are also visible in the role played by regional bird-banding associations in the 1920s and 1930s. In addition to administering a registry of bird bands, the ABBA had served as a form of sociability for bird banders. After its dissolution in 1920, a social void was created that the BBO could not fill, even though it recognized that such associations could help it achieve its data-gathering goals. In the early 1920s, with Lincoln’s encouragement, volunteers filled this void by establishing the Western Bird Banding Association, the Northeastern Bird Banding Association, the Eastern Bird Banding Association, and the Inland Bird Banding Association. These associations collected dues, distributed bulletins or newsletters, organized meetings of banders, publicized banding in the press, and defended bird banding against its critics.⁵⁹

Lincoln encouraged these organizations as a way to swell the ranks of banders, coordinate “chains of stations” that could trap migrating birds repeatedly, and encourage the public to report found bands.⁶⁰ In small ways, the BBO even offered material support for the regional associations. In 1923, for example, to help the Inland Bird Banding Association recruit members who were not themselves active banders, Lincoln offered to include them on the mailing list for *Bird Banding Notes*.⁶¹ Nonetheless, tensions between the regional associations and the BBO sometimes posed a real threat to the harmonious functioning of the federal bird-banding program. The Western Bird Banding Association, for example, whose members tended to see their needs as distinct from those in other regions of the country, established an “emergency” reserve of bird bands that it distributed to its members during periods of heavy migration. The BBO only grudgingly tolerated such emergency stores, since they put the re-

⁵⁷ Lawrence E. Hicks, Review of “Studies in the Life History of the Song Sparrow I,” *Bird-Banding* 8 (1937): 137–8, on 137.

⁵⁸ See, e.g., Margaret Morse Nice, “The Technique of Studying Nesting Song-Sparrows,” *Bird-Banding* 1 (1930): 177–81.

⁵⁹ Sara R. Morris, Brenda Dale, and Mary Gustafson, “Roles and Contributions of Banding Organizations to the North American Banding Program,” in Jackson, Davis, and Tautin, *Bird Banding* (cit. n. 1), 31–64. For a defense of bird banding from the director of the Biological Survey against criticisms that it harmed birds, see E. W. Nelson, “Danger in Bird Traps,” *Auk* 42 (1925): 304–7.

⁶⁰ On the BBO’s support of regional associations, see “Bird Banding Associations,” *Bird Banding Notes* 4 (1923): 5. On “chains of stations,” see “Directory of Bird Band Cooperators,” *Bird Banding Notes* 11 (1924): 3.

⁶¹ Frederick C. Lincoln, “Report of the Annual Meeting of the Inland Bird Banding Association, held at Indianapolis, Ind., Nov. 2 and 3, 1923,” n.d., unpublished manuscript, 5 pp., on 2, Box 36, Folder: Reports 1924, Lincoln Files.

gional association in the position of knowing who was using a particular set of bands before the office itself did.⁶²

In addition to tensions over emergency bands, the establishment of regional data repositories also raised hackles at the BBO, particularly when cooperators began sending their original data first to the regional repository and only subsequently to Washington, if at all. “There is no objection to cooperators’ sending copies of their records to their local organizations if they so desire,” the BBO stressed, “but the original records should be sent direct to the Bureau.”⁶³ The regional associations also sometimes resisted the BBO’s attempts to limit the number of cooperators. In 1930, for example, as the BBO was turning down applications from would-be banders on a daily basis, one of the leaders of the Northeastern Bird-Banding Association argued in the pages of *Bird-Banding* that “more collaborators are needed” to fill the gaps in the existing coverage of trapping stations.⁶⁴ Volunteers who responded to this call must have been disappointed when they received a form letter from the BBO informing them that it could not accept new cooperators. Volunteers’ desire to study the life histories of individual birds rather than the migrations of populations, to maintain local autonomy and the ability to respond quickly to changing conditions, and to expand coverage in their own regions regardless of the number of cooperators nationally thus sometimes came into direct conflict with the BBO’s aims.

THE TURN AWAY FROM VOLUNTEERS

Throughout the 1920s and 1930s, the BBO sought to balance its desire for data suited to the management of continental waterfowl populations with the necessity of sustaining the enthusiasm of its volunteer cooperators, whose own priorities sometimes pulled in contradictory directions. Certain frictions were generated by the very activities that helped to lubricate the flow of data.⁶⁵ The result of this conflictual cooperation was several decades of remarkable scientific productivity. Under Lincoln’s leadership, the BBO used banding data collected by volunteers to make two major contributions to the challenges of continental waterfowl management. The first was the mapping of waterfowl migration along four North American “flyways,” which made it possible to develop management plans tailored to each population. The management of volunteer banders on a continental scale thus made possible the management of waterfowl on a continental scale.⁶⁶ The second major contribution was a method for calculating the size of each of these distinct populations on the basis of the ratio between banded and unbanded birds in a particular sample. The fact that

⁶² On the Western Bird Banding Association’s “emergency” band store, see Harlan H. Edwards, “Emergency Supply of Bands,” *News from the Bird Banders* 2 (1927): 4. The BBO urged cooperators to instead send requests for new bands marked “Emergency” to Washington, to which it promised to give “prompt attention”; “Bands,” *Bird Banding Notes* 6 (1923): 11–12.

⁶³ “General Information to Cooperators,” *Bird Banding Notes* 9 (1924): 2. See also “General Information to Cooperators,” *Bird Banding Notes* 10 (1924): 1.

⁶⁴ Charles B. Floyd, “A List of the Active Banding Stations in the Territory of the Northeastern Bird-Banding Association,” *Bird-Banding* 1 (1930): 127–36.

⁶⁵ Cf. the varying uses of the concept of “friction” in Anna Lowenhaupt Tsing, *Friction: An Ethnography of Global Connection* (Princeton, N.J., 2005); Paul N. Edwards, *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming* (Cambridge, Mass., 2010), 83–110.

⁶⁶ For a popular summary of the flyway findings, see Frederick C. Lincoln, *The Migration of American Birds* (New York, 1939). On the origins of flyway-based management, see Wilson, *Seeking Refuge* (cit. n. 1), 75.

this statistic is still known among wildlife biologists as the “Lincoln index” is largely a consequence of his ability to marshal and discipline the enthusiasm of the volunteers who produced the data that made it useful.⁶⁷ At the same time, volunteer banders such as Nice made major contributions to the study of life histories and behavior that dovetailed with the emerging field of ethology in Europe.⁶⁸

The dynamic tension between centripetal and centrifugal forces that characterized the bird-banding program during its first two decades was neither inevitable nor permanent. It was the result of particular conditions and choices that began to change in the late 1930s. In 1938, the BBO decided to concentrate the banding of ducks, geese, and other waterfowl in federal and state wildlife refuges, effectively limiting volunteers to the banding of nongame birds. This was a response to a prohibition on the use of decoys and bait by hunters that had been implemented following a catastrophic drop in continental waterfowl populations during the drought years of the early 1930s.⁶⁹ Without decoys or bait, many banding stations could no longer attract waterfowl. A decade earlier, the loss of these volunteer-operated banding stations would have severely damaged the bird-banding program, but by the late 1930s an expanding federal and state bureaucracy for wildlife management was available to take up the slack. Ironically, this wildlife bureaucracy was one of the results of the success of the volunteer-driven bird-banding program, which had provided data supporting the establishment of new regulations and refuges.⁷⁰

In the early 1940s, the shift from volunteers to professional banders continued with the reorganization of the federal government’s conservation agencies and the onset of World War II. In 1940, the Biological Survey was moved from the Department of Agriculture to the Department of the Interior, where it became part of the new Fish and Wildlife Service.⁷¹ After the move, survey employees faced increased pressure to focus on management-relevant research. Within the BBO, this had the effect of accelerating the shift to large-scale, professional waterfowl banding. The onset of war further de-emphasized volunteers and research on nongame birds, while also hampering the bird-banding effort as a whole. Following the U.S. declaration of war in December 1941, Lincoln attempted to justify bird banding by characterizing waterfowl as a meat source that would help to “fill the national larder,” but bird banding was not a high priority for the U.S. government in the early 1940s.⁷² Even before 1941, many

⁶⁷ For an early, unpublished discussion of both the flyway idea and the Lincoln index, see Frederick C. Lincoln, Memorandum for Mr. Redington, 9 November 1927, 2 pp., Box 36, Folder: Reports 1928, Lincoln Files. For an example of a late twentieth-century reference to the Lincoln index, see John R. Skalski and Douglas S. Robson, *Techniques for Wildlife Investigations: Design and Analysis of Capture Data* (San Diego, 1992), 62.

⁶⁸ On Nice’s mediating role between American animal behaviorists and European ethologists, see Richard W. Burkhardt Jr., *Patterns of Behavior: Konrad Lorenz, Niko Tinbergen, and the Founding of Ethology* (Chicago, 2005), 58.

⁶⁹ Frederick C. Lincoln, Annual Report, Section of Distribution and Migration of Birds, Division of Wildlife Research, Fiscal Year 1939, n.d., 37 pp., on 26, in Box 38, Folder: Section Reports, Memos, etc. (Including memos from Div. Chief), FY 1939, Lincoln Files.

⁷⁰ On the expansion of the wildlife refuge system, see Wilson, *Seeking Refuge* (cit. n. 1), 66–71; Charles G. Curtin, “The Evolution of the U.S. National Wildlife Refuge System and the Doctrine of Compatibility,” *Conserv. Biol.* 7 (1993): 29–38.

⁷¹ On the early years of the Fish and Wildlife Service, see Ira N. Gabrielson, “The Fish and Wildlife Service,” *Sci. Monthly* 65 (1947): 181–98.

⁷² Frederick C. Lincoln, Memorandum for Dr. Bell, Re: Changes in emphasis on research due to the defense program as per memo of the Director dated 31 December 1941, 2 pp., on 1, Box 38, Folder: Section Reports, Memos, etc. (Including memos from Div. Chief), FY 1942, Lincoln Files.

volunteer banders had already been drafted into the military or were engaged in other defense-related activities that prevented them from contributing.⁷³ During the war, aluminum for bird bands became scarce, and it became virtually impossible for BBO staff to travel.⁷⁴ Reduced to a skeleton crew, the BBO suspended its research work and devoted itself entirely to data management in the hope that the records would be useful when research resumed after the war.⁷⁵

Under these conditions, the BBO relied even more heavily than before on banding work at federal wildlife refuges, and it contemplated establishing new banding stations of its own to “replace volunteer stations that were formerly in operation,” although these plans were also hindered by the war.⁷⁶ After wartime restrictions were lifted, the number of birds banded annually quickly recovered, but the shift from volunteers to professionals that had begun in the late 1930s continued. In 1949, the BBO reported that the total number of cooperators had doubled over the previous year, bringing it nearly back to prewar levels. One thing had changed, however: “Whereas before the war the cooperators were almost all volunteers, more and more professional wildlife workers are now utilizing banding.”⁷⁷ More than half of the banding was now being done by employees of the Fish and Wildlife Service, state game agencies, or university-based research units.⁷⁸

The professionalization of bird banding that began in the late 1930s and was accelerated by wartime conditions had the effect of changing the BBO’s cost-benefit calculation such that the cost of discouraging volunteers was now outweighed by the benefits of standardizing data. This changing calculation was reflected in the tone of the BBO’s communications with cooperators. The first postwar issue of *Bird Banding Notes* in 1946 included several pages of cautions, warnings, and requests, among them the reminder that “bird-banding cooperators should remember that this is a scientific study and that their own pleasure in the work is incidental.”⁷⁹ Admonishments of this kind were not entirely unprecedented, but they were soon accompanied by strictly enforced new reporting requirements that took even some veteran banders aback. In the June 1948 issue of *Bird Banding Notes*, the BBO introduced a number of new rules effective by the end of the month and threatened to withhold new bands from cooperators who failed to immediately comply. At the same time, it

⁷³ Lincoln, Annual Report, F.Y. 1941, n.d., 11 pp., on 9, Box 38, Folder: Section Reports, Memos, etc. (Including memos from Div. Chief), FY 1941, Lincoln Files.

⁷⁴ On aluminum, see Frederick C. Lincoln and John W. Aldrich, Annual Report, Section of Distribution and Migration of Birds, Division of Wildlife Research, Fish and Wildlife Service, [Fiscal Year 1945], n.d. [August 1945], 15 pp., on 5; on travel funds, see Letter, Charles B. Floyd [Secretary, Northeastern Bird-Banding Association] to Director, Fish and Wildlife Service, 22 November 1944, both in Box 38, Folder: Section Reports, Memos, etc., FY 1945, Lincoln Files.

⁷⁵ This was a variety of “planned hindsight” under conditions of labor shortage and limited resources; see Joanna Radin, “Planned Hindsight: The Vital Valuations of Frozen Tissue at the Zoo and the Natural History Museum,” *J. Cult. Econ.* 8 (2015): 361–78.

⁷⁶ Lincoln, Annual Report F.Y. 1941, n.d., 11 pp., on 10, in Box 38, Folder: Section Reports, Memos, etc. (Including memos from Div. Chief), FY 1941, Lincoln Files.

⁷⁷ “Where Do We Stand?” *Bird Banding Notes* 4 (1949): 2–4, on 3.

⁷⁸ Between May 1949 and April 1950 (omitting schedules submitted late), 318,221 birds were banded by fewer than 700 individual and institutional cooperators. Of these, more than 55 percent were banded by state game departments, national wildlife refuges, or “special units”—a mixed category covering banding stations associated with universities, private conservation organizations, and the federal government; Seth H. Low, “Cooperator Participation for the 1950 Bird Banding Year,” *Bird-Banding* 22 (1951): 64–71, numbers drawn from table on 71.

⁷⁹ “General Information to Cooperators,” *Bird Banding Notes* 3 (1946): 71.

pruned from its mailing list hundreds of cooperators who had been “delinquent” in submitting data.⁸⁰ Volunteers who did not hastily compile and submit their records in the new format found themselves suddenly cut off from the free bands, banding permits, forms of sociality, and scientific legitimation offered by the bird-banding program.

The new tone of the BBO’s communications did not go unnoticed by its volunteer cooperators. In the wake of the June 1948 announcement, the editor of the Western Bird Banding Association’s newsletter complained that the office’s high-handed approach “tends to make the volunteer give thought to other fields of endeavor where the demands are less binding.” After all, he added, volunteers were contributing their time, expertise, and often significant financial investments in equipment and supplies to the national bird-banding program; it hardly seemed fair to ask them to reformat their data on a moment’s notice.⁸¹ Lincoln’s replacement as head of the BBO, Seth H. Low, defended the need for strict standards given the limited staff available to handle reports, asking volunteers to “place the good of the program as a whole ahead of individual inconveniences.”⁸² In subsequent years, when Low canceled plans to attend their annual meeting or denied their requests for “emergency” stores of bands, members of the Western Bird Banding Association detected clear signs that the value of their contributions had declined in the eyes of the BBO.⁸³

In the postwar decades, many American bird lovers continued to find banding rewarding, but they no longer played the central role in the BBO’s research efforts that they had in the interwar years. Volunteers continued to make unique contributions by focusing on nongame birds and providing coverage in regions where professional and institutionally based banders were thin on the ground. As its dependence on volunteers decreased, however, the BBO became less interested in facilitating centrifugal activities that had been a source of both tension and enthusiasm in the prewar decades. The postwar expansion in federal support for wildlife research flooded the BBO with reports from professional banders and exacerbated the sense among volunteers that their work was of secondary importance.⁸⁴ Meanwhile, employees of state fish and game agencies began to take a serious interest in banding when they realized it could help them challenge restrictive federal hunting regulations.⁸⁵ In the 1950s, the Bird Banding Laboratory (as it had been renamed after moving into new facilities at the Patuxent Wildlife Research Center in Maryland) devoted an enor-

⁸⁰ “Schedules,” *Bird Banding Notes* 4 (1948): 2–5; “Mailing List,” *ibid.*, 8.

⁸¹ Paul H. Steele, “Memorandum from Banding Headquarters,” *News from the Bird Banders* 23 (1948): 27.

⁸² Seth H. Low, “A Report to the Cooperators from the BBO,” *News from the Bird Banders* 24 (1949): 31–2, on 32.

⁸³ On Low’s canceled visit, see Mrs. E. C. Baltzar, “Notice of the Annual Meeting,” *Notes from the Bird Banders* 26 (1951): 1; Evelyn Baltzar, “Items from the Los Angeles Chapter Meetings,” *News from the Bird Banders* 26 (1951): 29–31, on 29. On emergency bands, see “Minutes of the Annual Meeting,” *News from the Bird Banders* 25 (July 1950): 30–2.

⁸⁴ See, e.g., the following letter from the president of the Northeastern Bird-Banding Association to the chairman of the Senate Committee on Expenditures in the Executive Departments: Charles H. Blake to John L. McLellan, 15 February 1952, in *Federal Wildlife Conservation Activities, 1951: Report of the Committee on Government Operations*, 82d Congress, 2d Session, Report No. 1457 (Washington, D.C., 1952), 282–3.

⁸⁵ Remarks of Albert M. Day, Director, at Branch of Game Management Session, Fish and Wildlife Service Conference, Washington, D.C., 22 January 1952, 8 pp., on 2–3, Box 36, Folder: Reorganization through 1955, Lincoln Files.

mous amount of effort to recoding and punching records of waterfowl and other game birds gathered since 1921, but it decided not to do so for nongame birds.⁸⁶ This data-management decision reflected the main organizational challenge of the Bird Banding Laboratory in the postwar decades, which was to coordinate the work of government agencies and university research units and to resolve tensions between state and federal wildlife management—not to balance the needs of the federal data-collection effort with the enthusiasms of amateur volunteers.⁸⁷

The change in the BBO's approach to its volunteers resonated with broader post-war shifts in the role of experts in government and their relation to nonexpert citizens. As the cultivation of a corps of volunteer cooperators faded in importance for the Fish and Wildlife Service, and as new technologies of electronic tracking were developed that made it possible to study bird migration without needing to rely on a network of human observers, wildlife biologists and ornithologists increasingly directed their efforts toward “selling” conservation to an undifferentiated public that was increasingly emerging as the target of “public relations.”⁸⁸ The Fish and Wildlife Service's post-war leadership decided that fostering a network of thousands of committed, enthusiastic, and highly trained—if also sometimes fractious and unreliable—volunteers was a lower priority than it had been during the interwar years. Instead it focused on calculating ever more accurate estimates of waterfowl populations and maps of migratory pathways that could be used to overcome the resistance of state governments to federal regulation, as well as to sell conservation to a sometimes skeptical public.

DATA, DEMOCRACY, AND CITIZEN SCIENCE

Large-scale bird-banding programs have now been active in North America for nearly a century, and there are no indications that the practice will soon be abandoned. In recent years, more than a million birds have been banded annually in the United States.⁸⁹ In absolute terms, the number of banders is significantly larger than it was in Lincoln's day; one estimate published in the early 2000s put the total number of North American bird banders at more than 6,100 individuals.⁹⁰ Even as other techniques have grown in importance, the practice continues to be seen as essential to

⁸⁶ In 1959, many of these and other punch cards that had been painstakingly accumulated since the end of the 1920s were damaged by a warehouse fire. In subsequent years, records were increasingly recorded in digital form for easier processing; Daniel L. Leedy, “Some Federal Contributions to Bird Conservation during the Period 1885 to 1960,” *Auk* 78 (1961): 167–75, on 170; C. Stuart Houston, M. Kathleen Klimekiewicz, and Chandler S. Robbins, “History of ‘Computerization’ of Bird-Banding Records,” *North American Bird-Bander* 33 (2008): 53–65.

⁸⁷ E.g., in 1954 the Bird Banding Laboratory organized a cooperative project with wildlife biologists from twelve states; “Waterfowl Banding Operations Expanded,” Press Release, 2 June 1954, Department of the Interior Information Service, Fish and Wildlife Service, 1 p., Box 41, Folder: Waterfowl—Banding, Lincoln Files.

⁸⁸ For an example of the language of “selling conservation to the public,” see, e.g., Clarence Cottam, “Progress in Wildlife Research and Training,” Presented at National Wildlife Conference Montreal, Canada, 14 March 1955, 25 pp., on 14, Box 43, Folder: Wildlife Training, Lincoln Files.

⁸⁹ As of 2011, the Bird Banding Laboratory estimated that it received reports of approximately 1.2 million banded birds each year, along with 87,000 “encounter” reports of previously banded birds; “How Many Birds Are Banded?,” USGS Bird Banding Laboratory, <https://www.pwrc.usgs.gov/bbl/homepage/howmany.cfm> (accessed 30 June 2015).

⁹⁰ John Tautin, “One Hundred Years of Bird Banding in North America,” USDA Forest Service Gen. Tech. Rep. PSW-GTR-191, 2005, 815–6, http://www.fs.fed.us/psw/publications/documents/psw_gtr191/psw_gtr191_0815-0816_tautin.pdf (accessed 6 July 2017).

the management and conservation of waterfowl and other bird populations.⁹¹ Moreover, it continues to attract volunteers with deep expertise who are passionate about both birds and data. Nonetheless, much has changed since the interwar years. Not only is most banding done by professionals, as it has been since the late 1940s, but even volunteer banding has become more hierarchical and expert led, in part because of efforts to minimize the risk of harm to banded birds. Applicants for “master bander” permits are now required to go through extensive training and submit a “complete research proposal” to the Bird Banding Laboratory before they are issued a permit.⁹² Tellingly, the estimate of 6,100 banders cited above includes “federal and state conservation agencies; university associates; amateur ornithologists; bird observatories; environmental centers; non-governmental organizations; environmental consulting firms, and other private sector businesses.”⁹³ Volunteer banders of the kind who dominated the practice in the interwar years—particularly those who are unaffiliated with a research institution or nongovernmental conservation organization—make up a small proportion of this total.

Given these changes and the development of alternate ways of studying birds, the ongoing relevance of the early decades of large-scale bird banding in the United States might not be immediately apparent, especially given the extent to which the social conditions for volunteer participation in scientific research have changed. In the first half of the twentieth century, figures such as Baldwin, the retired businessman devoted to scientific research, and Nice, the highly trained ornithologist unable to advance professionally because of her gender, had the financial and intellectual resources necessary to transform their passion for birds into world-class research. Today, retired businessmen are more likely to donate money to scientific institutions than they are to practice science themselves, and it is less likely that a woman not only as passionate about research but also as highly talented and trained for it as Nice would be relegated to the position of volunteer or amateur. Moreover, today’s advocates of citizen science are eager to engage a much broader range of people than were targeted by bird-banding efforts in the early twentieth century—for example, those with casual interest, minimal scientific training, or social and economic disadvantages. The emergence of the concept of “citizen science” in the 1990s reflects the democratization of participatory hopes beyond the elitism of much early twentieth-century amateur science.⁹⁴

What, then, is to be learned from a way of structuring the relationship between volunteer amateurs and professional experts that depended, in part, on social conditions and aspirations that no longer exist? I have tried to capture one lesson with the awkward metaphors of centrifugal and centripetal force—awkward not least because the former is usually understood to be a fictitious or illusory force. The metaphor is none-

⁹¹ P. A. Buckley, Charles M. Francis, Peter Blancher, David F. DeSante, Chandler S. Robbins, Graham Smith, and Peter Cannell, “The North American Bird Banding Program: Into the 21st Century,” *J. Field Ornithol.* 69 (1998): 511–29.

⁹² “Banding Permit General Information,” Bird Banding Laboratory, Patuxent Wildlife Research Center, U.S. Geological Survey, Laurel, Md., https://www.pwrc.usgs.gov/bbL/homepage/gen_info.cfm (accessed 29 October 2015).

⁹³ Tautin, “One Hundred Years” (cit. n. 90), 815.

⁹⁴ The *Oxford English Dictionary* cites a first use of “citizen science” in an ornithological context in the late 1980s, but it only came into wide use a decade later; see also Dickinson and Bonney, *Citizen Science* (cit. n. 6).

theless apposite inasmuch as it expresses the twofold productivity and inherent contradictions of the nationally coordinated bird-banding program that was launched under the aegis of the BBO in 1920. The BBO operated as a classic center of calculation in Bruno Latour's sense of the term, accumulating data and power through the circulation and accumulation of "immutable mobiles" at an institution of centralized power.⁹⁵ At the same time, however—and in some cases despite itself—it also inspired and facilitated a burst in technical creativity and scientific sociality at the peripheries of professional ornithology, one that resulted in scientific insights that were no less valid and influential than those achieved by Lincoln in Washington. Arising within a single system of relationships and from some of the very same causes, these forces often pushed in opposite directions. Bird banding in the interwar period was simultaneously a means of collecting data and of empowering citizens, of making professionals and of making amateurs.

Today's citizen-science projects are motivated both by a desire to collect data by taking advantage of amateur enthusiasms and by a desire to educate and engage citizens in the production of scientific knowledge. Much of the scholarship on citizen science over the past decade or so seeks to address the tensions between these two goals. Projects that are equally successful at meeting professional scientists' data needs and at educating and engaging the public have proven difficult to fashion, though some do better than others. The professional scientists who lead some of the most successful centripetally oriented projects, such as the Cornell Laboratory of Ornithology's mapping of bird distributions on the basis of volunteer observations, tend to characterize the citizen scientist as a data collector rather than as a data interpreter, let alone independent initiator of scientific investigations. Citizen science becomes the process of "enlist[ing] the public in collecting large quantities of data across an array of habitats and locations over long spans of time."⁹⁶ In projects that take this approach, citizens can easily be reduced to sensors and the relationship between scientist and volunteer to quality control.⁹⁷ Meanwhile, centrifugal projects such as do-it-yourself pollution monitoring seek to provide tools to nonprofessionals in response to community needs. But the research they enable is similarly limited, in most cases, to the production of data that must be interpreted and endorsed by experts to become authoritative.⁹⁸

The boom in citizen-science projects since the 1990s, which has often been framed as a democratizing move, has thus had some ironically centralizing and hierarchizing consequences. Even as more and more citizens have been inspired to participate in scientific research, the scope of their participation has been increasingly narrowed. This narrowing is linked to the idea that the greatest opportunities and challenges

⁹⁵ Latour, *Science in Action* (cit. n. 4), 215–57.

⁹⁶ Rick Bonney, Caren B. Cooper, Janis Dickinson, Steve Kelling, Tina Phillips, Kenneth V. Rosenberg, and Jennifer Shirk, "Citizen Science: A Developing Tool for Expanding Science Knowledge and Scientific Literacy," *BioScience* 59 (2009): 977–84, on 977. See also Florian Charvolin, "Le Programme Feederwatch et la Politique des Grands Nombres," *Développement Durable et Territoires* (2004), <https://developpementdurable.revues.org/687> (accessed 6 July 2017).

⁹⁷ For an early example of positive use of "citizen sensor" language, albeit one in which "sensor" and "observer" are used more or less interchangeably, see Michael F. Goodchild, "Citizens as Voluntary Sensors: Spatial Data Infrastructure in the World of Web 2.0," *Int. J. Spatial Data Infrastructures Res.* 2 (2007): 24–32. See also Jennifer Gabrys, *Program Earth: Environmental Sensing Technology and the Making of a Computational Planet* (Minneapolis, 2016).

⁹⁸ See Gwen Ottinger, *Refining Expertise: How Responsible Engineers Subvert Environmental Justice Challenges* (New York, 2013).

for scientific research today arise from the possibility of accumulating vast amounts of data. In this data-centric vision of science, where quantity is privileged over quality and pattern matching is privileged over interpretation, citizens are seen as capable of contributing to science either as collectors of otherwise inaccessible data or as cognitive resources to be harnessed for purposes of classification and description. These activities are, of course, only a small subset of the range of activities that have conventionally been thought to constitute “science.” The interwar bird-banding program described here provides some perspective on this narrowing of scope for nonprofessional participation in science. It offers an example of an approach that explicitly, if sometimes begrudgingly, sought to satisfy both the centripetal data hunger of professional scientists and the centrifugal investigations and enthusiasms of amateurs. In practice, it seems likely that many of today’s centripetal citizen-science projects are, intentionally or not, already being subverted for purposes other than those intended by their designers. Embracing that possibility might be a way for such projects to avoid reinforcing existing hierarchies of expertise and contributing to the impoverishment of our collective notion of citizenship.