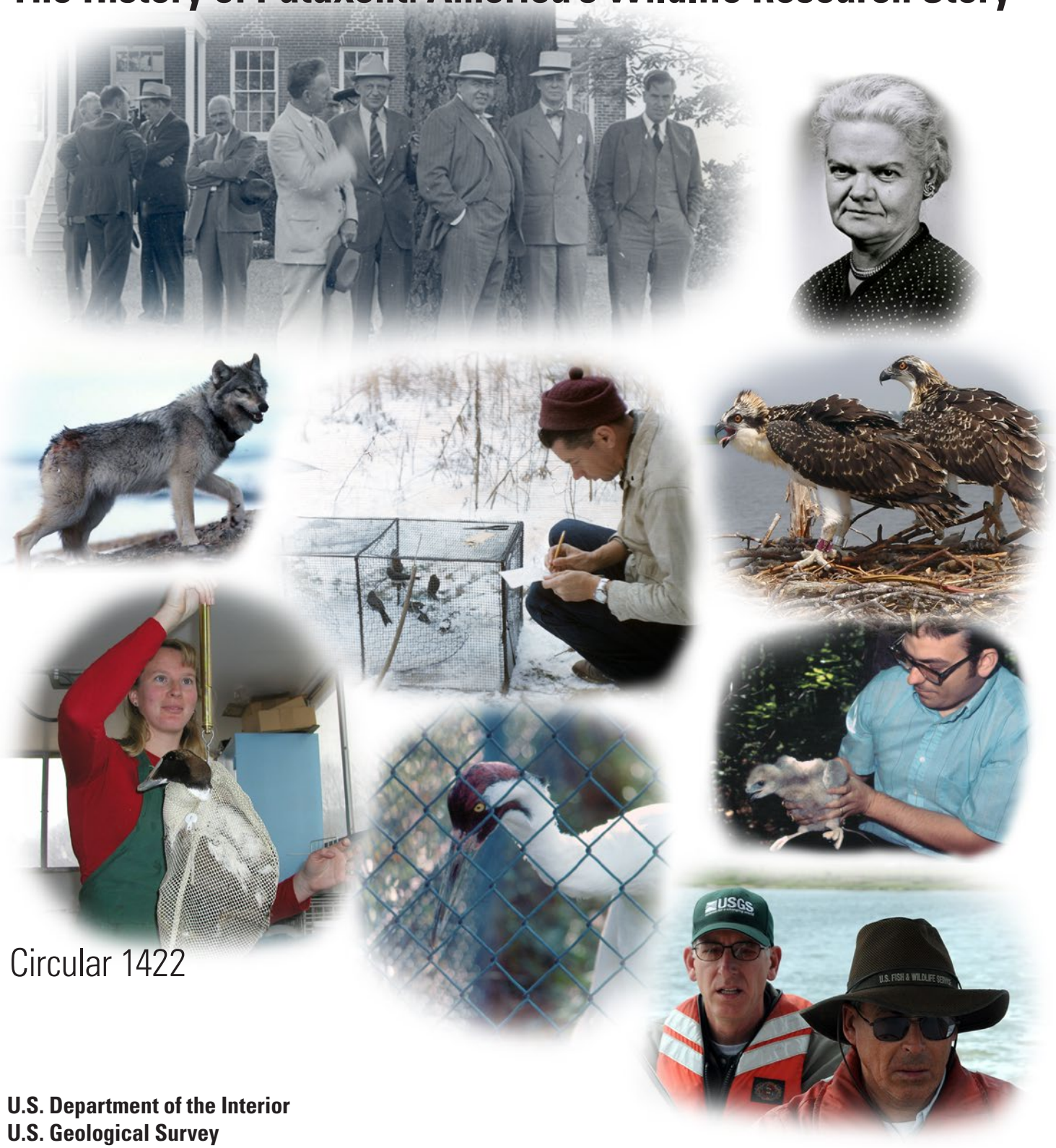
Prepared in cooperation with the U.S. Fish and Wildlife Service

The History of Patuxent: America's Wildlife Research Story



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Cover. Clockwise from top, left: Dedication of Patuxent Research Refuge at Snowden Hall, Laurel, MD, June 1939 (Photo by Bureau of Biological Survey); Dr. Lucille Stickel, U.S. Fish and Wildlife Service, an important research scientist in 1940s to 1960s and Director of Patuxent Wildlife Research Center in 1970s to 1980s (Photo by U.S. Fish and Wildlife Service); banded young ospreys on nest in Chesapeake Bay, 2012 (Photo by Rebecca S. Lazarus, U.S. Geological Survey); Chuck Henny, U.S. Fish and Wildlife Service, holding a red-tailed hawk prior to banding, Patuxent Research Refuge, spring 1972 (Photo by Matthew C. Perry, U.S. Fish and Wildlife Service); Barnett Rattner, U.S. Geological Survey (left), and Pete McGowan, U.S. Fish and Wildlife Service, Chesapeake Bay, 2013 (Photo by Reese F. Lukei, Jr., Center for Conservation Biology, College of William and Mary, Williamsburg, VA); whooping crane named Canus at Patuxent Wildlife Research Center, 1991 (Photo by Matthew C. Perry, U.S. Fish and Wildlife Service); Alicia Berlin, U.S. Geological Survey, weighing common eider in seaduck colony for selenium study at Patuxent Wildlife Research Center, 2004 (Photo by Matthew C. Perry, U.S. Geological Survey); wolf with collar-mounted transmitter being tracked by David Mech, U.S. Fish and Wildlife Service, in Minnesota (Photo by U.S. Fish and Wildlife Service). Center: Chan Robbins, U.S. Fish and Wildlife Service, recording data on birds in trap at Patuxent Research Refuge, late 1940s (Photo by U.S. Fish and Wildlife Service).

The History of Patuxent: America's Wildlife Research Story

Edited by Matthew C. Perry

Prepared in cooperation with the U.S. Fish and Wildlife Service

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U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
SALLY JEWELL, Secretary

U.S. Geological Survey
Suzette M. Kimball, Director

U.S. Geological Survey, Reston, Virginia: 2016

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Foreword

The facility known as Patuxent has evolved from the original Patuxent Research Refuge to the Patuxent Wildlife Research Center, and eventually to a two-agency facility with two clear, though distinct, missions. President Franklin D. Roosevelt established Patuxent as the Nation's first wildlife research station through an Executive Order in 1936. Originally, the research and wildlife conservation missions were conjoined; these missions continue today, but under two different agencies in a collaborative partnership. The U.S. Geological Survey (USGS) administers Patuxent Wildlife Research Center and the U.S. Fish and Wildlife Service (USFWS) administers Patuxent Research Refuge. Together, they are "Patuxent."

Great conservation icons such as Mr. J.N. "Ding" Darling and Dr. Ira N. Gabrielson were instrumental in establishing Patuxent and investing in America's great conservation future, even as the country was in the midst of the Great Depression. Through the years, the staff of Patuxent has been at the forefront of scientific achievement in the study of migratory birds, environmental contaminants, and endangered species. Innovations of Patuxent scientists have pushed the limits of techniques for field investigations, including the use of satellite telemetry, that have facilitated successful biological investigations throughout the world. Changes in research methods through the years have been prodigious, inasmuch as some naturalists early in Patuxent's history believed that banding and color-marking of birds were too invasive. Since then, USGS and USFWS staff at Patuxent have spearheaded the development and successful application of adaptive strategies and structured decision-making tools to real-world conservation and management issues. Patuxent's vision and mission define its purpose and direction. Working with a wide variety of partners is Patuxent's approach to ensuring that relevant, high-quality, objective science continues to support society's needs while maintaining its role as an active and productive Federal research institution.

Patuxent evolved from its origin in the U.S. Biological Survey to become the only research refuge of the USFWS, and then to assume its current position as one of 17 Biological Research Centers of the USGS, which is the natural resources research arm of the Department of the Interior. The USFWS, through the National Wildlife Refuge System, administers the Patuxent Research Refuge, and the two agencies remain focused on their primary mission of research and wildlife conservation. We invite you to explore Patuxent's history and the information presented in the pages that follow.

John B. French
Director, Patuxent Wildlife Research Center

Bradley A. Knudsen
Manager, Patuxent Research Refuge

Preface

Photo by Kinard Boone, U.S. Geological Survey.

This report, based on a symposium held on October 13, 2011, at the National Wildlife Visitor Center at the Patuxent Research Refuge in Laurel, MD, documents the history of the Patuxent Research Refuge and the Patuxent Wildlife Research Center, collectively known as Patuxent. The symposium was one of the many activities occurring at that time to celebrate the 75th anniversary of the creation of the Patuxent Research Refuge in 1936. The Patuxent Wildlife Research Center is located at the refuge, and the research center director, Dr. Gregory J. Smith, with great enthusiasm, personally supervised all aspects of the celebration. The symposium was coordinated by Dr. Matthew C. Perry, the editor of this report, with Dr. Smith's strong support. The refuge and the research center have been essentially synonymous for the almost 80 years of their history.

Dr. Smith's strong interest in Patuxent history and the symposium were major factors in the overwhelming success of the 75th anniversary celebration, in which he played a major role. Symposium attendees included a large number of dignitaries as well as virtually the entire staffs of the Patuxent Wildlife Research Center and the Patuxent Research Refuge.

Unfortunately, Dr. Gregory James Smith passed away at the age of 58 on April 11, 2014, while on official business in Beijing, China, where he was contributing to ongoing discussions on avian influenza and global climate change. Because of the importance of his contributions to wildlife science in general and Patuxent in particular, and because of his dedication to the publication of this report, a brief description of his life and career is included below.

Greg enrolled in Northern Michigan University and received his bachelor's degree in biology in 1978. He went on to earn a master's degree in wildlife ecology and a Ph.D. in wildlife ecology and veterinary science from the University of Wisconsin—Madison in 1984. Greg's passion for the environment directed his entire career path.

Having more than 35 years of ecological research and management experience, Greg spearheaded many environmental initiatives. His career began with post-doctoral studies at the Patuxent Wildlife Research Center and came full circle when he became the director of the research center in 2009. During his career, he also was appointed director of the National Wetlands Research Center in Lafayette, LA, in 2004, and the Great Lakes Science Center in Ann Arbor, MI, in 1996, making him the first and only person to direct three different U.S. Geological Survey wildlife research centers.

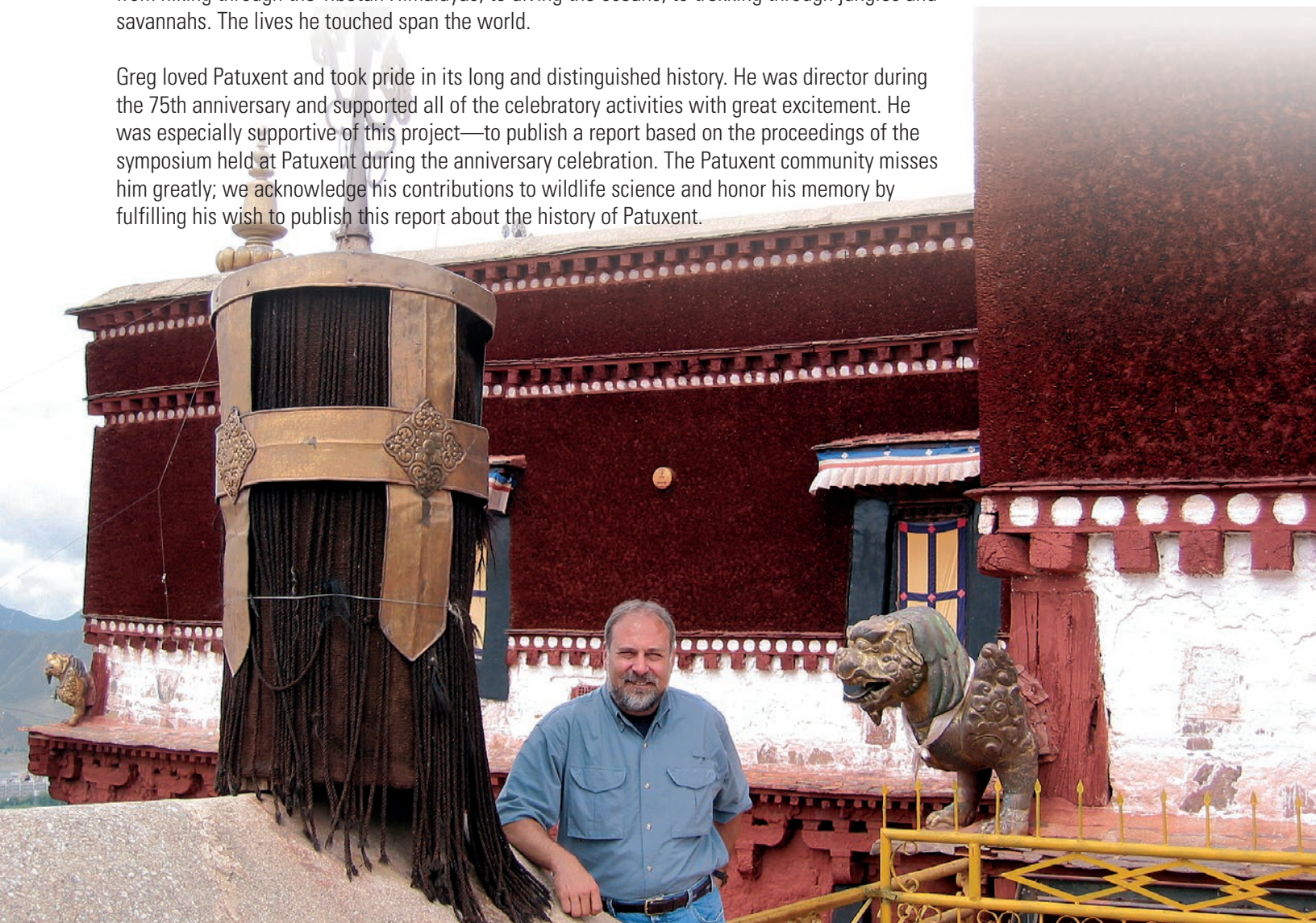
Greg felt privileged to work in partnership with scientists and friends in Russia and Southeast Asia. He was particularly proud of projects on the Mekong River and his relationships with the many partners who live and work there. He was honored to serve on the board of the National Wildlife Federation and devoted time and energy to the mission of that organization.

In his first year as director of the National Wetlands Research Center, the Gulf Coast and particularly New Orleans were ravaged by two hurricanes, Katrina and Rita. Greg rushed into action, using the Center's boats as life-saving vessels for New Orleans victims, and personally rescuing families in dire trouble during the aftermath. For these efforts, his team was awarded the Service to America Medal by the nonpartisan Partnership for Public Service, to honor excellence in Federal civil service.

Greg had not only a passion for his work, but also a passion for life. He loved the sea and was an avid sailor, building boats and chartering trips around the Caribbean during his college days. Greg continued to pursue this interest throughout his life, racing sailboats in Chesapeake Bay and around the world. He shared his love of the sea with his family, marrying Kathy, his wife, on their boat and spending weekends with their two children on the water.

He traveled to more than 65 countries, making friends and finding adventure with every step—from hiking through the Tibetan Himalayas, to diving the oceans, to trekking through jungles and savannahs. The lives he touched span the world.

Greg loved Patuxent and took pride in its long and distinguished history. He was director during the 75th anniversary and supported all of the celebratory activities with great excitement. He was especially supportive of this project—to publish a report based on the proceedings of the symposium held at Patuxent during the anniversary celebration. The Patuxent community misses him greatly; we acknowledge his contributions to wildlife science and honor his memory by fulfilling his wish to publish this report about the history of Patuxent.



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The authors gratefully acknowledge Shannon Beliew of the U.S. Geological Survey (USGS) Patuxent Wildlife Research Center (Patuxent) for logistical assistance; Lynda J. Garrett, USGS Patuxent librarian (retired), for invaluable assistance with literature searches and editing; and Dale L. Simmons, USGS, for outstanding editing.

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Conversion Factors

[Inch/Pound to International System of Units]

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
acre	4,047	square meter (m^2)
acre	0.4047	hectare (ha)
acre	0.004047	square kilometer (km^2)
square foot (ft^2)	0.09290	square meter (m^2)
square mile (mi^2)	259.0	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
gallon (gal)	3.785	liter (L)
cubic foot (ft^3)	0.02832	cubic meter (m^3)
	Mass	
ounce, avoirdupois (oz)	28.35	gram (g)
pound, avoirdupois (lb)	0.4536	kilogram (kg)
	Application rate	
pounds per acre per year [(lb/acre)/yr]	1.121	kilograms per hectare per year [(kg/ha)/yr]

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as:

$$°F = (1.8 \times °C) + 32.$$

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as:

$$°C = (°F - 32) / 1.8.$$

Datum

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Altitude, as used in this report, refers to distance above the vertical datum.

Abbreviations

<	less than
>	greater than
AHM	Adaptive Harvest Management
ALAD	aminolevulinic acid dehydratase
AOU	American Ornithologists' Union
ARM	Adaptive Resource Management
ARMI	USGS Amphibian Research and Monitoring Initiative
ARP	Accelerated Research Program
BARC	Beltsville Agricultural Research Center
BBL	Bird Banding Laboratory
BBS	Breeding Bird Survey
BDJV	Black Duck Joint Venture
BHC	benzene hexachloride
BLM	Bureau of Land Management
BRD	Biological Resources Discipline
BSFW	Bureau of Sport Fisheries and Wildlife
CBC	Christmas Bird Count
CCC	Civilian Conservation Corps
CCS	Call-Count Survey
ChE	cholinesterase
CPV	canine parvovirus
CSA	Cambridge Scientific Abstracts
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DEW	Distant Early Warning
DLNR	Department of Land and Natural Resources
DMBM	Division of Migratory Bird Management
DNA	deoxyribonucleic acid
DNR	Department of Natural Resources
DOI	Department of the Interior
EDTA	ethylenediaminetetraacetic acid
FEPCA	Federal Environmental Pesticides Control Act

FY	fiscal year
GAP	Gap Analysis Program
GPS	global positioning system
GS	General Schedule
HAB	harmful algal bloom
HCP	habitat conservation plan
HDFW	Hawaii Department of Forestry and Wildlife
HFBS	Hawaiian Forest Bird Survey
HIP	Harvest Information Program
IAFWA	International Association of Fish and Wildlife Agencies
IBCC	International Bird Census Committee
IBWO	ivory-billed woodpecker
IIT-RI	Illinois Institute of Technology-Research Institute
IITF	International Institute of Tropical Forestry
ILL	interlibrary loan
IPDS	Information Product Data System
IRM	Information Resources Management
IWBO	ivory-billed woodpecker
LSU	Louisiana State University
MBHRL	Migratory Bird and Habitat Research Laboratory
MBMO	Office of Migratory Bird Management (now, DMBM)
MBPS	Migratory Bird Population Station
MCP	minimum convex polygon
min	minute
MN	Minnesota
MOA	memorandum of agreement
MOS	Maryland Ornithological Society
MWI	Mid-winter inventory
NAAMP	Patuxent North American Amphibian Monitoring Program
NABCI	North American Bird Conservation Initiative
NAWMP	North American Waterfowl Management Plan
NBS	National Biological Survey
NGO	nongovernmental agency
NLCD	National Land Cover Data
NPS	National Park Service

NRDA	Natural Resource Damage Assessment
NWR	National Wildlife Refuge
OC	organochlorine
OCLC	Online Computer Library Center, Inc.
OP	organophosphate
PAH	polynuclear aromatic hydrocarbon
PBDE	polybrominated diphenyl ether
PC	personal computer
PCB	polychlorinated biphenyl
ppm	parts per million
PRDNR	Puerto Rico Department of Natural Resources
PRR	Patuxent Research Refuge
PWRC	Patuxent Wildlife Research Center
SAAMI	Sporting Arms and Ammunition Manufacturers' Institute
SDM	Structured Decision-Making
SE	standard error
SGS	Singing-Ground Survey
SNF	Superior National Forest
SOS	Save Our Shearwaters
TQM	total quality management
URL	Universal Resource Locator
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WBS	Winter Bird Survey
WMA	wildlife management area
ww	wet weight

Patuxent's Development: The People and the Projects

By Matthew C. Perry

Dedication of Patuxent Research Refuge at Snowden Hall, Laurel, MD, June 1939. Photo by Bureau of Biological Survey.

Early Wildlife Conservation Research

Although several conservation activities took place in the United States in the early 1900s, it was not until the 1930s that scientific wildlife management and the research to support it were initiated. The formation of Patuxent Research Refuge (Patuxent) was one of many wildlife conservation activities that occurred in the mid-1930s. On December 16, 1936, President Franklin D. Roosevelt signed Executive Order 7514, which transferred 2,670 acres of land that had been acquired (or would be acquired) by the United States to the Department of Agriculture (USDA) as a wildlife experiment and research refuge. The area delineated in the order was located in Anne Arundel and Prince George's Counties, MD, and was created "to effectuate further the purposes of the Migratory Bird Conservation Act." By order of the President, the area was to be known as "the Patuxent Research Refuge."

The refuge was dedicated on June 3, 1939, at Snowden Hall by Secretary of Agriculture Henry A. Wallace, who stated that "the chief purpose of this refuge is to assist in the restoration of wildlife—one of our greatest natural resources." Secretary Wallace recognized "the vision and foresight of Dr. Ira N. Gabrielson, Chief of the Biological Survey," and "the leadership of Dr. Leland C. Morley, superintendent of the refuge." He further stated that the Nation's first wildlife research station was "the manifestation of a national determination and a national ability to conserve and administer wisely the organic resources and products of the soil—a priceless heritage to the generations of Americans yet to come." Although Mr. Jay N. "Ding" Darling, former Chief of the Bureau of Biological Survey, was not present or mentioned in Secretary Wallace's address, many people also credit the formation of the Patuxent Research Refuge to his interest and support.

Superintendent Dr. Leland C. Morley in front of Log Cabin—Patuxent Research Refuge's first office building. Photo by Bureau of Biological Survey.

Snowden Hall at the Patuxent Research Refuge, Laurel, MD, about 1936. Photo by Bureau of Biological Survey.

Patuxent's location adjacent to the Beltsville Agricultural Research Center at Beltsville, MD, made it an appropriate area, according to Wallace, upon which to conduct "long-time studies on the interrelationships of wildlife with agriculture and forestry." Secretary Wallace and Dr. Gabrielson envisioned an area where wildlife could be studied in relation to the production of agricultural crops, and where lands poorly suited for agriculture could be turned back into forests, fields, and meadows, thus again becoming productive for wildlife.

An interesting change in the relation between humans and wildlife, however, had taken place during the 1930s. Previously, wildlife investigations in the USDA had focused on the impact of wildlife on activities of humans; however, the long drought of the 1930s coupled with decades of wetland drainage by humans devastated North America's waterfowl populations. Consequently, Americans were becoming more aware of the negative effects of their activities on wildlife. It was appropriate, therefore, that in 1939 the Bureau of Biological Survey was transferred from the USDA to the Department of the Interior (DOI). By 1940, the Bureau of Biological Survey was replaced by the Fish and Wildlife Service. It was not until 1956 that Congress renamed this agency the U.S. Fish and Wildlife Service (USFWS).

Dr. Leland C. Morley was superintendent of the refuge during the embryonic years from 1938 to 1948. He was responsible for the construction and development of the facilities to be used for wildlife research (Morley, 1948). Under his administration, three major buildings (Merriam, Henshaw, and Nelson Laboratories), named for the first three chiefs of the Bureau of Biological Survey, were constructed in 1939-41 through the efforts of the Works Progress Administration and the Public Works Administration headquartered in Washington, D.C. Some of the early Patuxent biologists traveled between Patuxent and their homes in Washington in trucks used to transport construction workers. On-site quarters were constructed for some biologists in the early 1940s to allow researchers to remain near their work. The first wetland area, Cash Lake, was built by the Civilian Conservation Corps (CCC) and was flooded in 1939 as a recreational area for fishing. The CCC was also responsible for transplanting many trees from the woods to landscape the new buildings.

With the outbreak of World War II, many of the Patuxent men were called for military service. Older male staff members and some women continued the wildlife conservation work and, beginning in 1943, were assisted by the Civilian Public Service Program, which established at Patuxent a group of conscientious objectors to the war. These men were credited with constructing Snowden Pond and several roads, and conducting surveys of wildlife and plants.

Dr. Morley supervised construction at Patuxent during the late 1930s and early 1940s. Research, however, was directed by administrators in Washington through their assistants, who were working at Patuxent. Dr. Alexander C. Martin was in charge of food habits research, which was located in Merriam Laboratory. Wildlife disease research, headed initially by Dr. J.E. Shillinger and later by Dr. Donald Coburn, was located in

Works Progress Administration workers at Patuxent Research Refuge, Laurel, MD. Photo by Bureau of Biological Survey.

Civilian Public Service Program members at Snowden Hall, Patuxent Research Refuge, Laurel, MD. Photo by Bureau of Biological Survey.

Henshaw Laboratory. All bird banding studies were administered in Nelson Laboratory and conducted at field locations throughout the country.

From 1942 to 1948, Mr. Arnold L. Nelson supervised all research at Patuxent from the Washington headquarters. In 1948, his office was moved to Patuxent, and he served as Patuxent's first official director until his retirement in 1959. Dr. Gustav Swanson became Chief of Research at headquarters. Mr. Nelson's responsibilities included both land management and research. The farm game research, which compared the diversity and numbers of wildlife under various farming practices, began under Mr. Nelson. Dr. Durward Allen headed this program, which compared two major farm practices, one that provided good wildlife habitat and one that did not (Warbach, 1958). The program was terminated before it reached its full potential for production of data, but many findings were published in popular outlets and used by farmers and refuges throughout the country. Dr. Allen authored "The Farmer and Wildlife," which was published by the Wildlife Management Institute and had seven printings (Allen, 1949). Dr. Allen also published "Our Wildlife Legacy," which includes much of the findings about optimum wildlife management techniques that were developed at Patuxent (Allen, 1954).

Long-term studies of certain single species forest wildlife, including box turtles (*Terrapene carolina*), black rat snakes (*Elaphe obsoleta*), and red-shouldered hawks (*Buteo lineatus*), also were initiated in the 1940s to 1950s. These species were optimum for long-term studies as they are common at Patuxent and can be captured and marked relatively easily. The box turtle studies initially were overseen by Dr. Lucille Stickel, but were later led by Dr. Russell Hall and then Dr. Paula Henry. Mr. William Stickel headed the black snake studies, which sometimes sent most of the staff searching for snakes. Mr. Elwood Martin and Dr. Charles Henny continued the red-shouldered hawk studies begun by Mr. Frederick Schmid. These programs represent some of the longest studies conducted on single species of wildlife. Extensive surveys were also conducted on all bird species at Patuxent during different seasons (Stewart and others, 1952).

Mr. Nelson was instrumental in continuing the development of the refuge for wildlife, while promoting research that would document habitat management techniques most beneficial for wildlife. Patuxent's first field station was established in Alabama to evaluate the interrelations between quail populations and habitat manipulations. Most of the waterfowl impoundments that exist today at Patuxent were developed during Mr. Nelson's tenure, and studies were begun to determine how best to manage those areas for wildlife. Techniques developed at Patuxent to help farm game and wetland species were widely adopted throughout the country.

In 1956, the Patuxent Research Refuge was renamed the Patuxent Wildlife Research Center to standardize the name with the adjacent Agricultural Research Center and with another USFWS facility in Denver, CO. The name change was done by administrative memorandum and did not supersede the original Executive Order designation as a Research Refuge.

Dr. Gustav Swanson (left), Research Chief, U.S. Fish and Wildlife Service, and Mr. Arnold Nelson, Director of Patuxent Research Refuge (PRR), at Cash Lake, PRR, Laurel, MD, on January 8, 1954. Photo by Francis M. Uhler, Patuxent Research Refuge.

The Environmental Movement and New Research

Dr. John L. Buckley became the director of Patuxent in 1959 and served until 1963. Under his leadership the pesticide research program, begun in the 1940s, was broadened to include other chemicals and became known as the Environmental Contaminants Research Program. An increased emphasis on experimental design and statistically controlled studies developed during this period. There was an increasing belief at Patuxent that field studies should receive less emphasis because of the difficulties inherent in controlling environmental and habitat variables that are not encountered in standardized pen studies. Observations in the field could now be tested under "laboratory" conditions.

Secretary of the Interior Stewart Udall dedicated a new building for the Environmental Contaminants Research Program in 1963. The building was originally named the Biochemistry and Wildlife Pathology Laboratory. Throughout his dedication speech, Secretary Udall referred to the work of Rachel Carson and her famous book, "Silent Spring," published in 1962. Ms. Carson never worked at Patuxent, but based some of her book on research done there. Interestingly, Ms. Carson never mentions Patuxent by name in her book, but refers to it as a laboratory near Laurel, MD. In 1989, the building was renamed Stickel Laboratory for Dr. Lucille and Mr. William Stickel, who had devoted a combined total of 78 years to research at Patuxent.

The bird control research program, which had been initiated by Mr. Nelson, was expanded during Dr. Buckley's tenure to become the Section of Animal Control Studies. The Wetland Ecology Section of Patuxent conducted waterfowl habitat management research, with major activities addressing water-level manipulation and artificial nesting structures taking place on the Patuxent grounds. Extensive studies of lead poisoning in waterfowl caused by the ingestion of spent lead-shot pellets began at this time and continued through the 1960s. In 1961, other migratory bird research and management programs, including the Bird Banding Laboratory, were consolidated in a newly established Migratory Bird Populations Station at Patuxent, headed by Mr. Walter F. Crissey (Crissey, 2006).

Dr. Eugene H. Dustman served as Patuxent's director from 1963 to 1972. During his tenure, Coburn Laboratory, the Service Building, and Gabrielson Laboratory were constructed. Gabrielson Laboratory was dedicated in 1969 in a well-attended celebration, and Dr. Gabrielson gave a speech. In 1969, Prince Charles of Great Britain and Mr. David Eisenhower, grandson of President Eisenhower, visited Patuxent and were given a tour led by Dr. Dustman and Dr. Stickel.

Prince Charles and David Eisenhower visit Patuxent Wildlife Research Center, Laurel, MD, 1969. Photo by U.S. Fish and Wildlife Service.

Dedication of Gabrielson Laboratory, Patuxent Wildlife Research Center, Laurel, MD, 1969. Photo by U.S. Fish and Wildlife Service.

Endangered Species Research

The Endangered Species Research Program began in 1965, headed by Dr. Ray C. Erickson, who also served as the first associate director of Patuxent. Although the first bald eagle arrived at Patuxent in 1961 as part of the contaminant program studies, the first bald eagle and whooping crane used in the endangered species program arrived at Patuxent in 1965 and 1966, respectively. This was the genesis of the captive propagation program that attained international prominence. The whooping crane was named Canus for Canada and United States, and reflected the close and long-lasting cooperation between the two countries with this species, which has continued since throughout the propagation program.

An additional 750 acres of land were purchased from the Shaefer family in 1970 as a buffer for the endangered species area, and several small support buildings, including a veterinary hospital, were constructed. A major endangered species laboratory was planned, but was never funded.

Innovative wetland management research was conducted during Dr. Dustman's era on approximately 300 acres of water impoundments that had been created at Patuxent. Improved nest boxes were designed for wood ducks, mallards, and black ducks, which greatly aided the nesting success of these species. Drawdown techniques for impoundments were perfected to optimize moist-soil management for waterfowl (Perry and others, 2000). A manual on wood duck habitat needs was disseminated and used extensively by managers across the country. These techniques were then employed in many states throughout the United States and in other countries. Mr. Frank McGilvrey published an article on starling deterrent nest boxes that could be used by wood ducks, but deterred nesting by the problematic starlings (McGilvrey and Uhler, 1971). Unfortunately, this optimum design was not widely accepted as a result of the ease of making wooden wood duck nest boxes originally designed by Mr. Frank Bellrose.

Patuxent's Wetland Ecology Section and part of the Migratory Bird Populations Station were combined in 1972 into a new group called the Migratory Bird and Habitat Research Laboratory (MBHRL) under the direction of Dr. Robert I. Smith and, later, Dr. Fant Martin. MBHRL personnel conducted extensive research on species of concern in specific geographic areas, including woodcock and black ducks in Maine, canvasbacks in Chesapeake Bay, and mourning doves in South Carolina.

Dr. Lucille F. Stickel became the director of Patuxent in 1973 and served in that capacity until her retirement in 1981. Under her leadership, environmental contaminants research expanded and attained national prominence. The expansion of this program is demonstrated by the average number of publications on contaminants produced per year, which increased from 4 in the 1950s to 7 in the 1960s, and then to 30 in the 1970s.

During the 1970s, all research and management activities related to the wetlands at Patuxent were curtailed because of new national priorities. This was a major turning point in the research on and management of the lands at Patuxent. Although biologists continued some activities with nest boxes and control of impoundment water levels on their own time, in general little on-site habitat research or management was conducted there during the 1970s.

Great egrets respond to moist-soil management, Patuxent Wildlife Research Center, Laurel, MD, 1987. Photo by Matthew C. Perry, U.S. Fish and Wildlife Service.

Frank McGilvrey and wood duck box, Patuxent Wildlife Research Center, Laurel, MD, 1972. Photo by Matthew C. Perry, U.S. Fish and Wildlife Service.

In 1975, 1,250 acres of surplus land were transferred from the USDA to Patuxent, increasing the protection of Patuxent's wetlands by ensuring control of more of the watershed. The MBHRL was disbanded in 1981, and migratory bird research staff and projects were returned to Patuxent Wildlife Research Center under the leadership of Dr. Stickel. Patuxent lands were used to study forest fragmentation and population modeling, which, along with statistical methodology development, were major migratory birds research thrusts in the 1980s.

Much of the other migratory bird research continued to be species-oriented (especially ducks), and little wetland habitat research was conducted on Patuxent lands during the 1980s, although research was conducted in other areas, such as the work on waterfowl in the Chesapeake Bay ecosystem.

Patuxent's first master plan was prepared in 1980. The research mission statement was "The professional staff is engaged in research and management activities that are directed at accomplishing the principal missions of the Center: evaluation of the effects of environmental contaminants on wildlife and the environment; endangered species research and propagation; and migratory bird research (including urban wildlife) and management." A private consulting firm (Sasaki Associates, Inc.. Watertown, MA) wrote the master plan.

From 1982 to 1983, two acting directors, Drs. Russell J. Hall and John G. Rogers, Jr., who had been serving as assistant directors at the time of Dr. Stickel's retirement, managed Patuxent. During this period, the Reagan administration was searching for Federal land that could be sold as surplus to meet government needs. Agencies were asked to identify land that could be considered surplus, and Patuxent complied by offering about 50 acres. Because Patuxent was officially part of the National Wildlife Refuge System, however, Congress controlled any land negotiations. With help from the Honorable Steny Hoyer, U.S. Representative from Maryland, loss of Patuxent land was forestalled. This threat to the land and pressures from the increasing human population around it (including housing development, road construction, and siting of a landfill) led administrators to reassess how the lands at Patuxent were being used.

Transition to Public Outreach

Dr. David L. Trauger was appointed Patuxent director in 1983, following a 4-year stint as Chief, Division of Wildlife Research, in Washington, D.C. In 1984, planning began on obtaining a building for visitors at Patuxent, which had been discussed initially in the 1960s. Outside threats had been made to take over some of the land, but they were halted by the recognition that Patuxent was part of the refuge system. However, administrators realized that it was important that the public be aware of the value of wildlife research and the work of the USFWS in order to receive public support. A draft Public Use Plan for Patuxent dated 1985 states, "Overall Patuxent Wildlife Research Center has most of the key attributes of high potential for an excellent public use and educational program (as suggested in the 1984 FWS report to Congress…)." Given Patuxent's location near two major metropolitan areas, it was ideally situated to comply with "....the policy of the Service to encourage resource-oriented public use on its lands that will provide the broadest array of opportunities for visitor enjoyment and that will facilitate understanding and awareness for natural resources within Service care." The Section of Buildings and Grounds began a major reorganization to accommodate increased planning and land management responsibilities, and the first facility manager was hired in 1986.

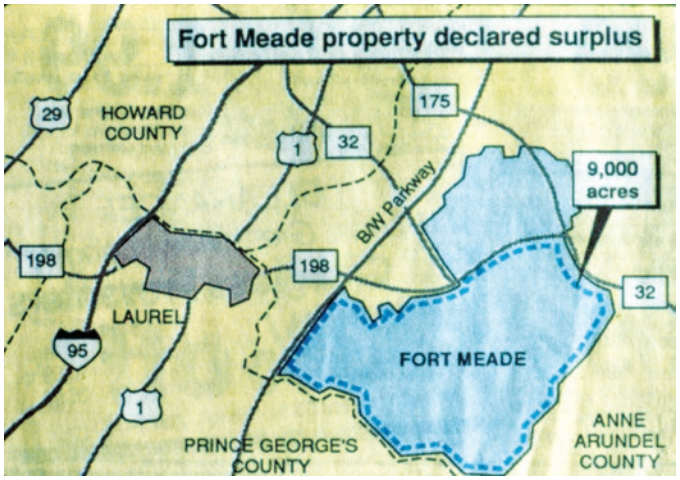
In August 1987, Mr. Harold J. O'Connor became director of Patuxent. Mr. O'Connor was the first director with experience in the management of national wildlife refuges, and he was also a member of the Senior Executive Service. One of Mr. O'Connor's first efforts was to obtain funding for the Visitor Center, which was being planned by his predecessor. Fifteen million dollars was obtained from Congress for this project, which evolved into a National Wildlife Visitor Center covering all wildlife research of the USFWS. The building was officially dedicated and opened to the public in October 1994, and has extensive exhibits depicting the wildlife research of the USFWS throughout the world. Researchers within and outside the Service are still conducting many of these research activities. Several support groups were established to help with fund raising and volunteer staffing of the Visitor Center, including the Prince George's County Foundation and the Friends of Patuxent.

In 1988, Patuxent staff prepared a second master plan. The new plan stated that the mission of Patuxent "has remained unchanged since the submission of the original Master Plan report. It is essentially the same as for the overall U.S. Fish and Wildlife Service." A later mission statement for Patuxent prepared in 1992 specifically included education and public use as important activities. This was a major change in the mission of Patuxent, but was responsive to public-use policies for the National Refuge System.

Several major rehabilitation projects involving impoundment control structures were undertaken under Mr. O'Connor's direction. New experimental pens and ponds were constructed and the appearance of the grounds around the buildings was improved. Many dignitaries, including U.S. Senator Paul Sarbanes and U.S. Representative Steny Hoyer, attended a major celebration of Patuxent's 50th anniversary on June 3, 1989. Senator Sarbanes, during his address, referred to the green forests of Patuxent as the "lungs of the Baltimore/Washington region."

Management of the wetlands and meadows became a formal activity with the implementation of impoundment and meadow management plans in 1989. A public fishing program in Cash Lake from June to October each year was initiated in 1991. A refuge biologist was hired to oversee all resource management activities, and the first refuge manager was appointed in 1992. These activities reflected the increased emphasis being placed on refuge management functions.

In 1991, 7,600 acres of land in Anne Arundel County that previously had been part of Fort George G. Meade, immediately adjacent to Patuxent to the north, were transferred to Patuxent because of the Military Construction Appropriations Act (U.S. Public Law 101-519). The U.S. Army, under the Base Closure and Realignment Act (U.S. Public Law 100-526), had declared the land excess. The transfer was based on the recommendations of a broad-based Fort Meade Coordination Council that had extensively studied the options and voted unanimously for the transfer. The transfer document specified that the intended priority uses of the property were preservation of the land, wildlife research, and compatible public use. In addition, the transfer document stated that the Secretary of the Interior "shall provide for the continued use of the property by Federal agencies to the extent such agencies are using it on the date of the enactment of this act." Some of these activities were not compatible with wildlife and would not have been allowed on Federal refuges without the added wording. An additional 500 acres, including four softball fields, were transferred to Patuxent in 1992. These transferred lands are now called the Patuxent North Tract.



Map included in newspaper article on surplus Fort Meade lands, Maryland, 1991. Reprinted with permission from The Baltimore Sun. All rights reserved.

Patuxent Visitor Contact Station on North Tract, Patuxent Wildlife Research Center, Laurel, MD, 1992. Photo by Matthew C. Perry, U.S. Fish and Wildlife Service.

The acquisition of these lands added the responsibilities of a major deer-hunting program (bow, gun, and muzzle-loader) and increased public use and education. Other existing natural resource programs, including fishing, trapping for furs, and small-game hunting, were continued. Approximately half of the existing firing ranges continue to be used by defense and law-enforcement personnel for training under special-use permits with the National Security Agency and the U.S. Secret Service. Sport shooters under a special-use permit also used a trap and skeet range with a Goddard Space Flight Center shooting club. The range was later closed owing to concerns of lead poisoning, and study and remediation of lead contamination of the soil were conducted. A large, modern equestrian center was run by the U.S. Army's Civilian Welfare Agency under a permit issued by Patuxent. The stable closed in 2004 at the direction of the Fort Meade commander.

A Visitor Contact Station was constructed in 1993 on the new land to control public-use activities. This building was funded in part by the Prince George's County Parks and Recreation Foundation, which was later instrumental in the establishment of the Friends of Patuxent, a 501(c)(3) refuge support organization. Minimal USFWS staff and volunteers operate the contact station, with occasional part-time support from USFWS law-enforcement personnel.

In 1990, when the major land transfer from Fort Meade was imminent, the Regional Director of Research and Development for the USFWS stated that no research funds would be used for management of the newly acquired lands. Administrators at Patuxent, therefore, were required to seek alternative funding for these activities. The extensive hunting program conducted at the North Tract of Patuxent was initially conducted through Fort Meade, but Patuxent assumed responsibility for the program after the transfer. The refuge initially issued a special-use permit and then entered into a Cooperating Association Agreement with a group of hunters who formed the Meade Natural Heritage Association (MNHA), which continues today (2016) to assist with day-to-day operations of the hunting program. MNHA assesses a permit fee for all hunters who are allowed to use the area after they have taken and passed the gun and (or) bow safety and proficiency training program.

Hunter fees are used to pay several employees, who manage daily hunting from the Hunting Control Station. Some remaining funds have thus far been put back into the Patuxent North Tract for erosion control, wildlife management, and other projects. Expenses borne by Patuxent for the hunting program are mainly for part-time salaries of law-enforcement personnel during the hunting season plus administrative support and oversight. The original directive from the Regional Director of Research and Development was subsequently changed, and Patuxent was authorized to spend $75,000 of research funding in fiscal years 1992 and 1993 to operate the North Tract.

The increased activities related to the Visitor Center and the increased use of public lands in the early 1990s exacerbated staffing problems at Patuxent and increased overhead expenses. The center's staff was concerned about the lack of additional funding for administering the North Tract property, as well as the increased staff time devoted to developing the Visitor Center. As a result, in 1992 the USFWS director decided to transfer the administration of the new Fort Meade lands (North Tract) (8,100 acres) and the Visitor Center lands (South Tract) (2,000 acres) from Research Region 8 to the Division of Refuges in geographic Region 5. This transfer was to be effective in October 1993. Patuxent research staff would maintain control of the Central Tract (2,700 acres), where traditionally the researchers had been located and most of the on-site research had been conducted. Research staff would also still be responsible for management and public use on Central Tract lands. This decision received a mixed reaction from Patuxent employees, however, because there was no indication that increased funding would be forthcoming.

Transfer to National Biological Survey and then to U.S. Geological Survey

In March 1993, the DOI, headed by Secretary Bruce Babbitt, announced plans to form a new National Biological Survey (NBS) that would combine all biological research and monitoring within DOI into one bureau, separate from existing management bureaus. Opinion was divided on whether lands associated with Patuxent would be staying with the USFWS and be managed by the Division of Refuges or be transferred to the new NBS.

In November 1993, all research staff, many refuge staff, and several sections of the Office of Migratory Bird Management were transferred to the NBS. The new NBS organization also resulted in the transfer to Patuxent of one research unit of the National Park Service and all USFWS staff assigned to the Smithsonian Museum of Natural History. Although Patuxent administered 10 field stations in late 1993, realignment in the new NBS reduced the number of field stations to 4 in late 1994.

All lands and buildings of Patuxent continued to be officially controlled by the USFWS and within the Northeast Region 5 refuge organization. The actual maintenance of the buildings and management of the lands remained under the control of the director of Patuxent and his staff. This arrangement, in principle, provided protection of the land under all regulations and policies of the National Wildlife Refuge System, but gave maximum flexibility for use of the land for research purposes. This arrangement between the USFWS and the NBS was approved by Under Secretary of the Interior George Frampton, Jr., and was commonly called the Frampton Agreement.

On October 5, 1993, the Patuxent director announced a new strategic plan, which was to guide Patuxent's activities in the NBS. The plan marked the beginning of the process to align Patuxent's organization more closely with the NBS structure, which included major initiatives in surveying and monitoring habitats and populations and in transferring information and technology.

The primary mission of Patuxent as stated in the strategic plan was "to conduct biological studies in response to programs and priorities of the National Biological Survey (NBS) to support land and resource managers within the Department of the Interior. The Center will operate a National Biological Research area as an outdoor laboratory and operate the NBS National Wildlife Visitors [sic] Center for the advancement of environmental education and biological science." A major change in the new mission of Patuxent in NBS was a reduced geographic responsibility to only the Eastern Ecoregion and a shift away from national and international initiatives. In May 1994, the name of the Patuxent Wildlife Research Center was changed to Patuxent Environmental Science Center. In late 1994, the name of the NBS was changed to the National Biological Service to address several concerns, including the assertion that new research was not supporting historical "customers."

In March 1995, Patuxent's director, Mr. O'Connor, retired from Federal service after 35 years. Dr. James A. Kushlan became director in late 1995 and, because of circumstances within the Federal government, Patuxent endured a disheartening period when budgets were cut and 26 personnel were officially relieved of their services (reduction in force). The Branch concept (three main groups: migratory birds, endangered species, and environmental contaminants) was abandoned and all research was placed under the control of a chief scientist. In the spring of 1996, the name "Patuxent Wildlife Research Center" was restored. In October 1996, the NBS was terminated and all research staff became part of the Biological Resources Division of the U.S. Geological Survey (USGS). Refuge staff returned to the USFWS under the Northeast Region (Region 5). The research operation (USGS) continued to be known as the Patuxent Wildlife Research Center, whereas the land ownership, management, and public-use operations were under the historical name of Patuxent Research Refuge. Each entity had its own administration and management, but they worked together to support Patuxent missions.

A Comprehensive Science Planning Process, which included five themes that overlap the scientific activity areas chosen by the Biological Resources Division, was developed under Dr. Kushlan's leadership. The new mission for Patuxent was "to excel in wildlife and natural resource science, providing the information needed to better manage the Nation's biological resources."

In 2001, Dr. Kushlan resigned his position as director of Patuxent Wildlife Research Center; later that year, Dr. Judd A. Howell became the new director. Dr. Howell conducted a review of the organization and made changes following guidelines from headquarters that provided more program managers and more accountability from the Patuxent Wildlife Research Center staff and activities. Research staff was consolidated into Gabrielson Laboratory and a rented building at the Beltsville Agricultural Research Center. In spite of the division into two agencies, Patuxent's staff was optimistic that problems with facilities and responsibilities would be resolved, and they continued to work closely together. A joint Facilities Modernization Program was developed over the years to address the future facilities and infrastructure needs of the agencies.

In 2009, Dr. Gregory Smith assumed the position of director of Patuxent Wildlife Research Center. During this period, due to economic recovery programs (American Recovery and Reinvestment Act) throughout the United States, Patuxent was involved in the removal of some buildings and the planning of construction of new buildings. Dr. Smith led this initiative in close coordination with Mr. Bradley A. Knudsen, manager of the Patuxent Research Refuge. The refuge was going through a major comprehensive planning process, so the timing of the activities complemented each other. Patuxent made plans for an addition (annex) to Gabrielson

Laboratory that would greatly increase the ability of the research facility to continue with its research mission. The USFWS continued planning for new facilities, some of which would accommodate USFWS personnel from other facilities, especially the Chesapeake Bay Program, now located in rental space in Annapolis, MD. In 2014, Dr. Smith died while on official travel in China. Former director Dr. Judd A. Howell volunteered to fill the director position temporarily. A new director, Dr. John B. French, was appointed on May 26, 2015.

From a humble beginning with 2,670 acres of land in 1936, Patuxent has increased in size over its 80-year history to the present (2016) 12,841 acres. Much of the early land development was done under the direction of a superintendent, Dr. Morley. Nine research directors have succeeded Dr. Morley in supervising the research program; most of them were in charge of land development and maintenance. In 1994, however, all land-management activities came under the jurisdiction of the refuge manager under the USFWS, with the research program being placed in the USGS. The Patuxent Wildlife Research Center and the Patuxent Research Refuge are closely related, and the facility has operated in most cases as one unit. After more than 80 years, the staff, collaborators, and friends around the world simply refer to this facility, with pride and respect, as "Patuxent."

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Snowden Hall, Patuxent Research Refuge, Laurel, MD. Photo by Bureau of Biological Survey.

Early Avian Studies at Patuxent

Chandler S. Robbins

When I arrived at Patuxent Research Refuge (Patuxent) in Maryland in the spring of 1943, I was amazed to find that the refuge, barely 6 years old, had already been surveyed with a 100-meter (m) (325-foot [ft]) grid. The presence of permanent survey markers every 100 m and trails throughout the grid provided an ideal situation for recording the precise position of all wildlife observations. The grid system was so well coordinated with construction of the laboratory buildings that wherever a grid line passed through a building, a marker showing the passage of the line through the building was inserted in the brick wall. Wherever a grid line crossed the Patuxent River, an extra survey marker was placed on the riverbank, but most of these river-crossing posts were washed away in subsequent floods.

I was impressed with the expertise and dedication of the young professional staff. Superintendent Leland Morley and veterinarian Don Coburn had veterinary degrees, but I do not believe a single staff member at that time had a Ph.D. degree, unless it was a chemist. I was also impressed with the national collections of bird and mammal skins, reptiles and amphibians, and seeds and pressed plants that were being used to identify stomach contents.

Four major programs of the former Bureau of Biological Survey had been moved from Washington, D.C., to Patuxent (which at that time had a Bowie, MD, address): the Bird Banding Laboratory and the Bird Distribution and Migration Files and species maps, under Frederick C. Lincoln; the Mammal Files, including bat banding records, under Hartley H.T. Jackson; and the Food Habits records. The bird and mammal offices were in the Bird and Mammal Laboratory (later called Nelson Laboratory), the Food Habits staff and all the specimen collections were in the Food Habits Laboratory (later referred to as Merriam Laboratory), and the veterinary staff was in the Disease Laboratory (which became Henshaw Laboratory).

The Biological Survey's Division of Economic Ornithology and Mammalogy had been conducting food habits studies of birds and mammals since 1885 to determine which species were useful to agriculture. By 1943, most of the effort was devoted to teaching biologists from various states the techniques of examining stomach contents and identifying the fragments of insects, arthropods, seeds, and other material. When Congress suspended all funding for food habits studies in 1943, this work suddenly stopped. The stomach material that had been examined was offered to the states from which it had come, but all the examination cards were retained at Patuxent.

U.S. Biological Survey plot marker at Patuxent Research Refuge, Laurel, MD. Photo by Matthew C. Perry, U.S. Fish and Wildlife Service.

Bird Banding

The Bird Banding Laboratory

Shortly after passage of the Migratory Bird Treaty Act with Canada in 1916, it was determined that bird banders should be licensed under Federal permits, so the banding program was moved from the auspices of the American Bird Banding Association to the U.S. Biological Survey in 1920 under the supervision of Fred Lincoln. When the program was moved to Patuxent in 1936, Fred Lincoln and his secretary, Myra Putnam, retained their offices in Washington, D.C., but Mr. Lincoln made frequent visits to Patuxent, where May Thacher Cooke (daughter of the late Wells W. Cooke of the Biological Survey) was in charge of the daily operations.

My first assignment at Patuxent was as a biologist in the Banding Laboratory, checking incoming schedules and coding

return records for keypunching. I was already familiar with the species codes (American Ornithologists' Union [AOU] numbers) and most of the other codes from my previous 6 years as a bird bander. The principal codes I had to look up on the code board were IBM Corporation's (IBM's) three-digit numerical code for North American localities (such as 717 for Patuxent); we were not using latitude and longitude in those days. In 1943, we did not yet have a keypunch or a card-sorting machine.

The only other people in the Banding Laboratory in the 1940s were processing clerks Margery Stewart and Lois Horn, and mail carrier and band issuer Russell Carpenter. Each morning Russell stopped at South Interior Building to pick up the mail on his way to work because the bands carried a Washington, D.C., address. After May Cooke retired and Fred Lincoln was moved to the Chicago office, John Aldrich at the National Museum of Natural History handled administrative matters for the Banding Laboratory and I continued as biologist. I had been concerned about the future of the songbird-banding program because our staff was insufficient for the workload and the waterfowl people insisted that processing of waterfowl records should take priority. We were accumulating a sizable backlog of unprocessed songbird records. When I heard that we were about to advertise a position for a banding chief, I telephoned Seth Low, Refuge Manager at Salt Plains National Wildlife Refuge in Oklahoma, whom I had known when he worked at the Austin Ornithological Research Station on Cape Cod, MA, and urged him to apply because of his interest in songbird banding as well as his lengthy experience as a waterfowl bander. Seth was offered and accepted the position, along with all its related problems, but songbird banding survived.

Ruth Richards worked part time with the Bird Distribution and Migration program, sending and acknowledging the 2-in. × 5-in. observation cards and assembling certain records for publication. She spent the remainder of her time working with Hartley Jackson's mammal files.

Chan Robbins banding songbirds, Patuxent Research Refuge, Laurel, MD, 1948. Photo by U.S. Fish and Wildlife Service.

Songbird Banding

Leonard Llewellyn, Royal Stewart, and R.N. Crack were the first to band a few Patuxent birds in 1940, 1941, and 1942. From 1943 to 1946, Robert Stewart, James Cope, John Brainerd, and I trapped and banded thousands of songbirds using conventional traps baited with grain or dripping water. We recorded the grid-cell number of each bird banded in order to study movements through the recaptures. Father Fabian Kekich at Catholic University in Washington, D.C., had been having amazing success in baiting migrating warblers with dripping water in top-opening traps. When he moved to another location he kindly gave us all his traps, but we could not match his wooded hilltop in an urban location and never had the concentration of migrating warblers that he enjoyed.

In 1959, Donald Stamm, David Davis, and I began a breeding bird study in deciduous forest in and near the flood plain of the Patuxent River (3600 block of the Patuxent grid), which continued through 1972. For 6 or more days each season, birds captured in mist nets were identified, banded, and released; the date, time, and location of all initial captures and recaptures were recorded. This study was among the first to use capture-recapture methods to estimate population size for various bird species (Stamm and others, 1960).

Raptor Banding

Ira Gabrielson had been impressed by the high density of hawks and owls at Patuxent, as had local falconers. John Hamlet, in particular, was a frequent visitor who helped us use various techniques to trap and band a few hundred resident and migrating raptors. We were most successful with the Verbail pole trap and operated these night and day, checking at sunrise and several times during the day in 1943–45. Nestling red-shouldered hawks (*Buteo lineatus*) were banded each year, and especially in 1947 when Burt Taurman was a summer student. Of 107 nestling red-shoulders banded in 1947 in stream

valleys in and near Patuxent, 9 were shot and another was found dead in the next 2 years, all in Maryland.

Operation Recovery

Shortly after Oliver L. Austin, Jr., introduced the use of Japanese mist nets to North America and banders began flocking to coastal beaches to capture grounded migrants, I joined Massachusetts Audubon Society scientists James Baird, Aaron Bagg, and John Dennis (Baird and others, 1958) in promoting a cooperative coastal banding program during fall migration. We called it Operation Recovery with the expectation that, with enough songbirds being banded at coastal sites, we should be able to recapture banded birds farther south in the same season and determine how far they were flying in a single night. Furthermore, to participate in the study, banders were required to keep a record of the number of net-hours of effort each day and to weigh their birds, record wing chord, and determine age and sex when possible. This was the first time banders had ever been required to keep track of banding effort, to weigh their birds, or to make a special effort to determine age and sex. This was just before I published my key to aging and sexing of wood warblers in fall (Robbins, 1964). To our surprise, the first recaptures of banded birds occurred north of where they had been banded, showing that many migrants routinely wander northward before initiating their southward migration.

Many other surprises followed. Considering only those from Maryland, on September 17, 1965, Operation Recovery captured at Ocean City the first hybrid between a northern waterthrush (*Parkesia noveboracensis*) and a blackpoll warbler (*Dendroica striata*) (Short and Robbins, 1967). Four western wood-pewees (*Contopus sordidulus*), the first for the Atlantic Coast, were caught at Ocean City on four September 1961 dates; a western tanager (*Piranga ludoviciana*; first Maryland record) was banded on October 21, 1962; a rufous hummingbird (*Selasphorus rufus*; first Maryland record) was banded on September 12, 1963; and a Hammond's flycatcher (*Empidonax hammondii*; first East Coast record) was captured on October 9, 1963. More first-year birds were captured at coastal locations, where survival rates were lower, than at inland ones (Robbins and others, 1959).

Operation Recovery also collected thousands of ticks from the ears of migrating birds (Clifford and others, 1969). When an impatient bander complained to the Director of the U.S. Fish and Wildlife Service (USFWS) that I was late in publishing a summary of results, the Director wrote me that we should not be studying fall migration of songbirds and I should cease immediately. Therefore, the large, bound tabulations of weights and wing chords of North American fall migrants lie unpublished in the Patuxent library. Several of the coastal banding stations eventually became full-time bird observatories, and I believe that one of the great contributions of the Operation Recovery program was the training of hundreds of banders in aging and sexing fall migrants and in recording their banding effort.

Evolution of the Bird-Banding Record Card

Houston and others (2008), in "History of 'computerization' of bird-banding records," discussed successive changes in the design of the bird-banding schedule, but we authors neglected to mention the changes that had been made to the design of the return card. The cards are now history. Essentially all were destroyed when we made the transition to totally electronic files.

Prior to 1929, a printed 3-in. × 5-in. card was used for each recapture and each recovery record of a banded bird. Beginning in 1929, each record was placed on an 80-column, 3.25-in. × 7.375-in. punch card on which the vital banding and recovery data were handwritten in labeled spaces in the first 36 columns, and the remaining columns were reserved for future keypunching of the same information. The card was reprinted, unchanged, in October 1939 and September 1941. In April 1950, the handwritten portion was redesigned to add an eighth digit to the band number, to include codes for

Jerry Longcore capturing woodcock with mist nets, Milford, ME, 1998. Photo by Daniel McAuley, U.S. Geological Survey.

hand-reared and sick or injured birds, to change the position of categories in the handwritten portion of the card, and to provide for the permit number, but the punch holes were not altered except to replace "FY Rec'd" with "Elapsed Time." In an August 1953 revision, the card was made more user friendly, providing for easy reading of an "interpreted" card; "Operator" was finally replaced by "Permit No," "Schedule No." was omitted, and the handwritten portion of the card was neatly rearranged with banding information at the top and recovery information below.

In January 1955, the handwritten portion of the card disappeared, the positions of all the columns were changed, and new categories were added for "Status," "Letter Received Date," and "Previous Reports." "Latitude" and "Longitude" were substituted for the alphabetical abbreviations of "Where Banded" and "Where Recovered." For the first time, "U.S. Fish and Wildlife Service" and "Canadian Wildlife Service" appeared on the punch card. Another revision in July 1959 added columns for "Additional Information," "Dir. Banding," "Dir. Recovery," "Who Reported," and "Hunting Season." The last seven columns of the card remained vacant.

Other Bird Monitoring

Initial Avian Studies on the Patuxent Grounds

The only avian publication that originated at Patuxent prior to 1943 was a Christmas Bird Count (49 species, 2,475 individuals). This count was conducted within the Patuxent boundaries on December 23, 1941, by bird enthusiasts John Aldrich, Leo Couch, Lucas Dargan, Herbert Deignan, John Hamlet, Neil Hotchkiss, Phoebe Knappen, Leonard Llewellyn, Alexander Martin, Franklin May, George Petrides, Robert Smith, Robert Stewart, and Francis Uhler. We resumed Christmas Bird Counts in 1943, and they are still conducted annually within the original 2,670 acres as part of the Bowie, MD, 7.5-mile (mi)-radius circle.

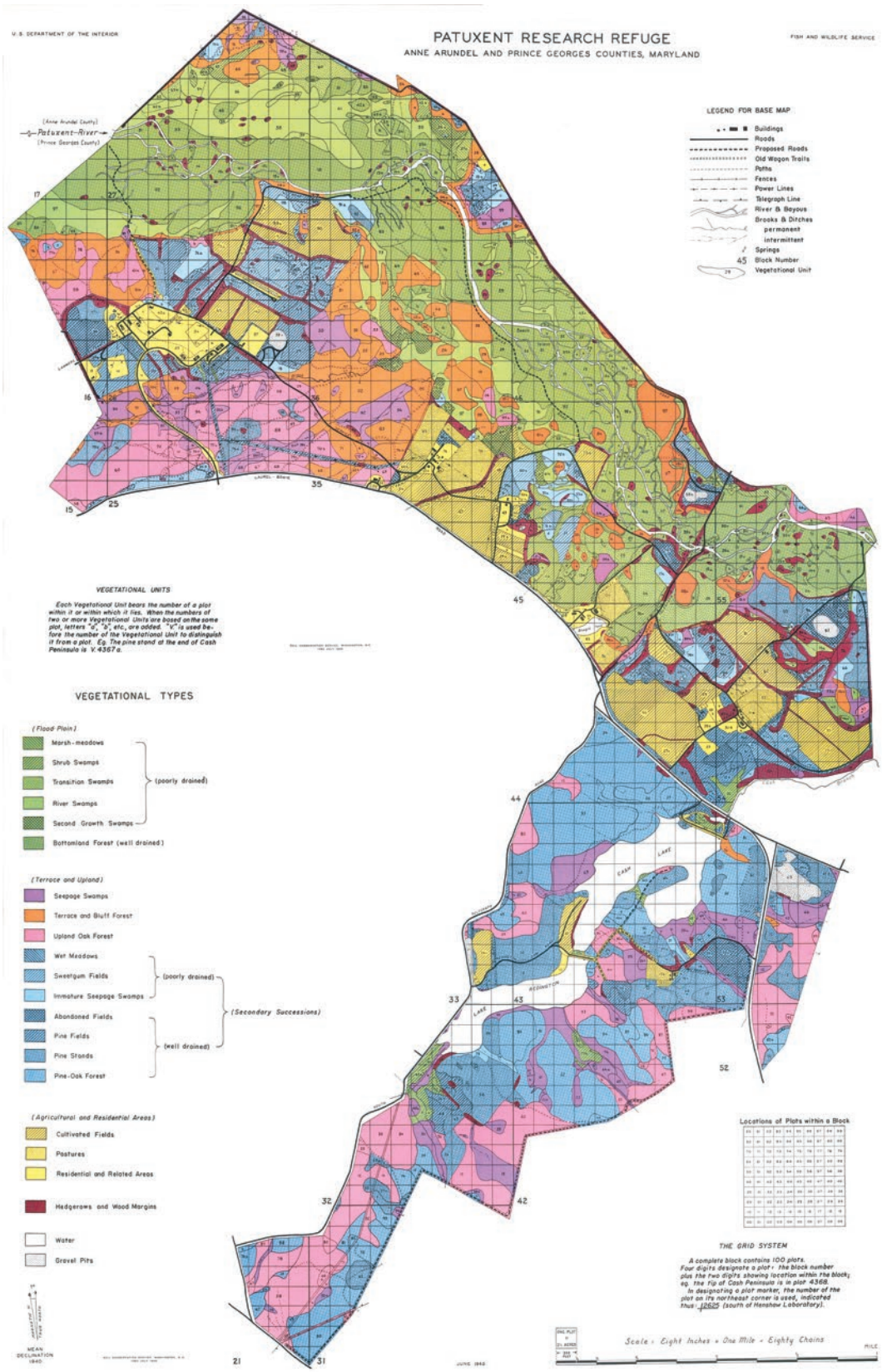
At the same time, Patuxent staff members (primarily Ira Gabrielson, Clarence Cottam, Francis Uhler, and Arnold Nelson) had been conducting a carefully controlled Christmas count in a 20-year study (1927–46) at Port Tobacco in Charles County, MD, to determine whether changes in winter bird populations could be detected if an area was carefully covered the same way on foot each year by (primarily) the same four people. One year, I was invited to be one of the four participants, and was shocked to find that they would not accept observations unless the bird was identified by sight. If a jay or an owl was heard, or if a woodpecker called, it could not be counted unless it was identified by sight. At the end of the 20 years, the observers did not detect changes over time and determined that their results were not worth publishing. If they had continued a few more years, they would have noted major changes in populations of eastern bluebirds (*Sialia sialis*), Carolina wrens (*Thryothorus ludovicianus*), loggerhead shrikes (*Lanius ludovicianus*), and several other species.

The Vegetation Map and Documentary Bird Surveys

A colored vegetation map of the entire refuge was completed in 1943 by observers walking the grid lines, pacing the distance to each change in habitat, and recording the results on 1-kilometer (km) (0.6-mi) field maps. The next major task was for biologists Robert Stewart, John Brainerd, James Cope, and me to hike the same grid lines during the 1943 nesting season, recording on the 1-km sectional maps the location where each bird was detected. The entire refuge was covered three times: in April for raptor and crow nests, in May for woodpeckers and early-nesting Passeriformes (passerines), and in June for most other nesting species. Special trips were made in July to areas where the late-nesting American goldfinch (*Carduelis tristis*) and cedar waxwing (*Bombycilla cedrorum*) were found. These detections were then transferred to black-and-white copies of the vegetation map to show the distribution of each species by habitat.

In the next two winters, the same four observers mapped the winter distribution of each bird species. Our awareness that winter populations are much more variable from year to year than are breeding populations explains the additional year of mapping in winter.

Botanist Neil Hotchkiss surveying plants, Patuxent Research Refuge, Laurel, MD, 1946. Photo by Francis M. Uhler, Patuxent Research Refuge.



Colored vegetation map of original 2,670 acres at Patuxent Research Refuge, Laurel, MD. Illustration by U.S. Soil Conservation Survey, Washington, D.C., 1945.

To continue studying changes in Patuxent bird populations, we conducted a "population fluctuation census" that tracked population changes by habitat weekly (twice weekly during the peaks of the spring and fall migrations) throughout 2 years over a 2.6-mi transect in the center's headquarters area. The transect began in the historic pear orchard of the Snowden family just north of Snowden Hall, proceeded due west through Ralph Nestler's quail pens to the west boundary fence, then extended north parallel to the fence into the flood plain, then east for nearly 1 mi through the flood plain, then south through the large fields to Snowden Brook, and west up the Snowden Brook valley to the new Entrance Drive. This survey was run by three observers walking parallel paths 100 m (325 ft) apart and keeping records by habitat. Results of the breeding and winter counts, population changes throughout the year, and a detailed species account for the 229 species that had been recorded at the refuge were published by Stewart and others (1952), but the habitat records from the population fluctuation census have never been published. Bob Stewart took the notebooks with him when he moved to the Northern Prairie Wildlife Research Center (Jamestown, ND), intending to publish the results; after his death in 1993 the notebooks were returned to Patuxent, but other priorities have prevented their publication.

Territory Mapping

The next field research was selecting study sites typical of each of the major Patuxent habitats (flood-plain forest, oak-beech river terrace forest, Virginia pine (*Pinus virginiana*) forest, upland oak forest, and abandoned field) and conducting spot-mapping censuses in each. From 8 to 40 or more census trips were made to each site using the method of Williams (1936), except that special emphasis was given to recording simultaneous registrations of males in adjacent territories. From repeated census trips to the same site, we could determine the probability of detecting each species on a single visit; probabilities ranged from 36 percent for worm-eating warbler (*Helmitheros vermivorum*) to 81 percent for hooded warbler (*Setophaga citrina*). I helped Donald Thatcher of Washington, D.C., Audubon Society to set up a long-term census site in the Potomac River flood plain for comparison with Patuxent, and Joan Criswell, one of my students at the U.S. Department of Agriculture Graduate School (now Graduate School USA) in Washington, D.C., set up a site in nearby Rock Creek Park that was censused for many years and was the first such site to demonstrate the decline in wood thrushes (*Hylocichia mustelina*) and other Neotropical migrants (Briggs and Criswell, 1979).

Nest Record Cards, 1940s–50s

Bob Stewart designed a two-sided 3-in. × 5-in. nest record card with space for species, location, habitat, contents, and observer name on the front and space for 10 subsequent observations on the back (Stewart and Robbins, 1958). The same card was used to record historical information from throughout Maryland. The file now contains tens of thousands of records that I hope can be digitized someday. This file was the basis for the nesting paragraphs in the first Maryland/D.C. breeding bird atlas. The second atlas contained primarily generalized nesting information from out-of-state sources.

Field-Testing of the Mourning Dove Call Count Procedures

Harold Peters and Leonard Foote had been designing procedures for a national call count survey of breeding mourning doves (*Zenaida macroura*). The plan was to have twenty 3-minute roadside stops 1 mi apart, but the best starting time was undecided. They planned to do final field testing in Georgia and asked Allen Duvall and me to run sample routes in Maryland and Pennsylvania, where the twilight time is longer and where early-morning traffic might be a greater problem. Their conclusion and ours were the same: that the best results were obtained when the survey started 30 minutes before sunrise. However, when we put the starting time to a vote, it was 3 to 1 in favor of starting at sunrise "because you can't ask the State biologists to get up that early." Now, 45 years later, we still begin the survey at sunrise.

"The DDT Years," 1945–49

On June 5, 1945, at the height of the breeding season, a 117-acre tract of the forested refuge just downstream from Duvall Bridge was sprayed just above treetop level with 1 pound of dichlorodiphenyltrichloroethane (DDT) per acre (Robbins and Stewart, 1949). We had insisted that this site, where the Patuxent River leaves the refuge, should be the site of the aerial spraying, in order not to contaminate the rest of the refuge. A study site had been established in the center of the sprayed area, and two control sites had also been established, one adjacent to the sprayed area and about 1 mi upstream. The bird crew (Stewart, Cope, Brainerd, and I) conducted breeding bird censuses in all three study plots before and after spraying. Except for the American redstart (*Setophaga ruticilla*), a treetop feeder, no change in breeding population or in hatchability of eggs or survival of nestlings could be demonstrated. Subsequent aerial sprayings of 2 pounds of DDT per acre in May or early June of 1946 through 1949 caused substantial declines immediately after spraying only in the American redstart. It was determined that most of the spray was captured by leaves in the canopy, so little of it reached the understory where many of the birds were foraging and nesting (Robbins and others, 1951).

In 1947, a 90-acre area of scrub forest on the nearby USDA Agricultural Research Center that was recovering from a 1942 forest fire was sprayed with 5 pounds of DDT per acre to study effects of DDT in an open environment. Bird populations were studied in a 30-acre plot in the center of the sprayed

area and in a 30-acre unsprayed plot 0.5 mi away. Of the five most common species in the sprayed area, the common yellowthroat (*Geothlypis trichas*), prairie warbler (*Setophaga discolor*), and house wren (*Troglodytes aedon*) were reduced 80 percent and the eastern towhee (*Pipilo erythrophthalmus*) was reduced apparently 65 percent, whereas there was no appreciable change in number of yellow-breasted chats (*Icteria virens*).

In the meantime, DDT studies based on manual applications on active bird nests were conducted to determine whether eggs and young would survive (Mitchell and others, 1953). With a nesting population of color-banded eastern bluebirds and house wrens available, I could not resist the temptation to follow two populations over a 3-year period. The bluebirds were especially interesting in that both adults and young returned to nest at the same site year after year. Soon most of the birds were related to each other. At a meeting of the North American Bluebird Society, I shocked the membership by showing that a 1-year-old male bluebird was mated to his grandmother. I started a long-term study of nesting barn swallows (*Hirundo rustica*) in the Hance Farm barn, but it was terminated in the second year when the barn was boarded up.

Studies of Nocturnal Bird Migration

Patuxent researchers installed a U.S. Navy (Navy) radar system outside Nelson Laboratory in 1945 in the hope of detecting songbirds flying at night, but it turned out to be the wrong type of equipment and I could not detect anything smaller than the Chesapeake Bay Bridge, so we had to resort to less technical methods.

Bob Stewart and I made many trips to the Washington Monument on cloudy, moonless evenings in the autumns of 1945 and 1946 to study migrating birds that struck the monument in the hours before midnight, while the spotlights were on. The birds were attracted to the monument by the spotlights; they tried to fly to one side or the other, but were swept by the wind against the backside with enough force to produce concussions, and they fell to the ground. We got permission from the Park Police to drive our vehicle to the base of the monument so we could immediately put the birds in cages. Any survivors were released the next morning at Patuxent. We made study skins of the casualties. We learned many of the night call notes (which were generally different from the familiar diurnal calls) by listening to and watching the birds as they collided with the monument.

In a separate study, I joined 2,500 observers throughout North America in a cooperative study of bird migration organized by George Lowery and Robert Newman of Louisiana State University (Baton Rouge). They solicited observers to make all-night counts of birds flying across the face of the full moon. The birds were visible for only an instant as they crossed the moon, but the birds seen provide an index to the vast number that are unseen. The organizers had developed equations to translate the number of birds seen to the number that had crossed a 1-mi-long line centered on the observer, corrected for the latitude of each observer. On the night of September 22–23, 1953, using a wire recorder, I counted 2,188 birds flying overhead, which translated to 230,000 birds crossing a 1-mi-long line centered on my driveway. That was the highest count ever recorded in North America (Lowery and Newman, 1955).

Breeding Bird Survey

In the early 1960s, DDT was still widely used to control insects on college campuses, and each application resulted in distressed and dying robins and other songbirds. One woman in the Midwest was concerned about the future of songbirds in North America and wrote to inquire whether the loss of nesting birds on campuses across the country was sufficient to affect continental populations. I replied that at present, there was no continental survey that could answer that question, but I said I would give it some thought. We did have waterfowl surveys, but they did not reveal anything about songbirds. There were Federal game agents and State agents, but most of them had no experience with songbirds. The only hope would be to find enough trained bird enthusiasts who would be willing to conduct rigid surveys over a period of years.

I proposed a plan to the Maryland Ornithological Society (MOS) that could allow me to hand-pick qualified observers; assign 50 random roadside routes of 50 stops each, 0.5 mi apart, throughout the State; and have each observer run a “check route” that I had run in addition to his or her own assigned route. Jack Linehan offered to recruit observers for 10 Delaware routes as well, and all 60 routes were run successfully in 1965. The number of birds recorded on the 50 Maryland routes was 50,373, or an average of 1,007 individuals per route. The observers enjoyed the experience and were prepared to run the same routes the next year.

The next question was whether Patuxent would be willing to take the responsibility of running a national breeding bird survey program and whether Canada would be willing to join in. I explained the success of the 1965 trial to John Aldrich, my supervisor; told him of my plan to expand gradually across the continent in the next 3 years; and asked his opinion. His considered reply was, “Go for it—just so it doesn’t cost the government any money.” I had all the help I needed: a full-time secretary (Romell Decker); a full-time, experienced map expert (Ceil Nalley); a programmer (John McDaniel); plenty of keypunch time (during the lax banding-recovery period of summer); free phone service; and free mail. We needed only to design forms to use in the field, select random starting points for the survey routes, and draw the route paths. Tony Erskine was eager to act as my Canadian counterpart. The rest is history. My brother Sam had already started a State monitoring program in Wisconsin based on observer-selected sites in 1961, but he recognized the value of a randomly distributed sample, so he was glad to change to our random design.

Data Bank of North American Breeding Bird Censuses

In 1973, the USFWS began a program of computerizing breeding bird census data (Robbins, 1977). Initially, data from 1,939 census studies representing 801 different plots from 1937 to 1970 were coded and keypunched onto magnetic tape. Subsequently, data from 1971 to 1975 were added. Each plot was assigned a permanent number. A bound computer printout of this file can be found in the Patuxent library.

Winter Bird Survey of Central Maryland

The Winter Bird Survey (WBS) was designed to sample midwinter bird populations and to determine how well the Audubon Christmas count sampled year-to-year changes. The validity of the Christmas count had been questioned because the areas covered were selected rather than random, coverage was a mixture of walking and driving, and the number of hours of effort varied among observers. To control the coverage, each WBS observer walked a predetermined 8-km (5-mi) closed-circuit course in 4 hours, beginning at 7:30 a.m. The area selected for this study extended from Chesapeake Bay west to the base of Catoctin Mountain and from the Potomac River north to the Pennsylvania border. Location of counting areas was by a systematic sample, with one route located at the center of each 7½-minute U.S. Geological Survey (USGS) quadrangle. Each of the 40 routes was covered one morning per winter from January 15 to February 15. The method was tested in the Laurel quadrangle in the winter of 1968–69 by Patuxent staff. We compared the WBS results with those of the four Christmas counts made each year in the same geographic area. For most species, the WBS totals were higher than the Christmas count totals because the WBS counts were made entirely on foot; it was primarily the feeding-station birds that were found in higher numbers on the Christmas count. The close correlation between the two methods in 1970–74 indicated that Christmas count data for past decades might be a valuable index to population change, even though these data cannot in themselves be subjected to critical statistical analysis.

Woodcock, Snipe, and Clapper Rail Surveys

Most of the woodcock survey work was conducted on the breeding grounds in the Northeastern States and eastern Canada, but the reports were compiled and edited at Patuxent (Aldrich and others, 1952). Bob Stewart estimated the breeding population of American woodcock (*Scolopax minor*) at Patuxent to be 25 territorial males in 1942, decreasing to 21 pairs in 1943, 8 in 1947, and 9 in 1951. The large reduction from 1943 to 1947 was probably almost entirely due to "clearing in connection with farm wildlife experiments, but partly also from natural succession" (Stewart, 1952). Roadside routes in the Maryland suburbs were later abandoned because of traffic noise.

Initially there were no consistent common snipe (*Gallinago gallinago*) surveys, but snipe hunting could not be permitted on the Gulf Coast wintering grounds unless a USFWS biologist was conducting population studies on this species. Therefore, I established a cooperative winter survey program in the Southern States in 1953; banded snipe at winter concentration spots including coastal Florida, Mobile Bay, and Sabine Refuge in Louisiana (1950–55); and spent the summers of 1952–54 studying nesting snipe at Midgic Marsh in New Brunswick, Manitoulin Island in Ontario, and across upper northwestern Canada.

Bob Stewart (1952) studied clapper rails (*Rallus longirostris*) nesting at Chincoteague, VA, in 1950–51, and trapped and banded 940 of them. Hunters reported 10 recoveries (5 percent) from the 198 birds banded in 1950.

Geographic Variation in Bird Song

I had long been interested in geographic differences in bird songs. As a teenager, a neighbor (Ingraham, 1938) had given me a tuning fork and encouraged me to record the exact pitch of songs of wild birds. In New England, the ovenbird (*Seiurus aurocapilla*) says "tea'-cher, Tea'-cher, TEA'-CHER," as described in the field guides, but in other regions it says "teacher', Teacher', TEACHER'," and in Maryland it says "teach, Teach, TEACH." In all geographic regions, the increase in volume as the song progresses is diagnostic of the species.

In the summer of 1954, when I was studying snipe distribution across Canada at dawn and dusk, I used the long summer days to make tape recordings of bird songs to study differences in dialect from east to west. When it was not convenient for me to access my tape recorder and parabola, I carried a supply of index cards in my pocket to record the cadence (songs per minute), temperature, and locality of singing birds because I had not seen this information published previously. I tried for a series of 11 consecutive songs (10 intervals) from each bird. Patuxent biologist Sam Droege subsequently digitized this file.

Many more interesting experiences followed, including my long-term banding and population study of the breeding birds in a 90-acre plot in the Patuxent River terrace forest and the effect of forest fragmentation on nesting songbird populations in a random sample of 469 Maryland forests. I also trained Latin American scientists in bird census and banding techniques in nine Latin American countries. I returned to six Allegheny County forest study sites I had censused 50 years previously to conduct wind turbine studies, and I helped with the Breeding Bird Atlases in Maine, New Hampshire, Pennsylvania, Maryland, and West Virginia to demonstrate the need for habitat protection here at home.

Collaboration

Collaboration with the Audubon Society of the District of Columbia

In 1947, Bob Stewart, John Aldrich, and I collaborated with three Washington, D.C., Audubon Society members to produce their first "A Field List of Birds of the District of Columbia Region." In 1951, Shirley Briggs and I edited their habitat pamphlet, "Where Birds Live: Habitats in the Middle Atlantic States." I wrote their monthly season reports from 1946 to 1948 and their bimonthly reports from 1948 to 1949, as well as a Hawk Watch article for their "Atlantic Naturalist" journal in 1956.

Collaboration with the National Audubon Society

Shortly after Joseph Hickey wrote his "Guide to Bird-watching," he and his wife, Peggy Brooks, were residing in Snowden Hall, while he used our Distribution and Migration files to compile a list of former breeding sites of the peregrine falcon (*Falco peregrinus*) and then used the banding files for a paper on survival rates of banded birds. Peggy had been editing the bird population studies (Christmas counts, breeding bird census, and winter bird population studies) for the publication "Audubon Field Notes," and she was very concerned that National Audubon Society would discontinue publishing the breeding and winter population studies when she resigned because they were not making a profit on them. John Aldrich, Bob Stewart, and I believed that these studies, especially the breeding bird censuses, which had been published since 1937, were important, so we agreed to serve on an editorial board with a few other scientists if the National Audubon Society would continue the publication.

I ended up editing the breeding bird censuses from 1952 to 1966. The principal advantage to us of this collaboration was that it kept us in touch with serious bird population researchers throughout the United States and Canada, and these were the people I later recruited as State and Provincial coordinators when I launched the Breeding Bird Survey.

Collaboration with American Ornithologists' Union

After Fred Lincoln retired, I was asked by Alexander Wetmore, Director of the Smithsonian Institution (Smithsonian), to update the range descriptions of the seabirds and shorebirds for the fifth (1957) edition of the AOU "Check-list of North American Birds." I also became caretaker of the supply of back issues of the "Auk" (in the Nelson Laboratory attic), which had been Fred Lincoln's duty as treasurer of the AOU. Back issues, as available, were distributed to U.S. and Canadian institutions; after that, the remainder was sent to the Smithsonian for their foreign exchange program. Another assignment was to compile the breeding and winter range descriptions and migration dates for the remaining volumes (warblers, blackbirds, finches, and sparrows) of A.C. Bent's "Life Histories of North American Birds."

Collaboration with other Conservation Organizations

I ran the Howard County mourning dove survey route for the Maryland Department of Natural Resources (DNR) from 1966 through 2008. I must admit that I would have been bored if I had recorded only the doves I heard and saw, so I recorded all species and reported only the doves to the DNR and the USFWS. The Howard County dove route had to be redrawn twice, first because of a permanent road closure and again because of traffic. The changes in route did not affect the dove counts, but did affect the counts of some of the songbird species. In 1982, I served on the DNR's Monie Bay Estuarine Sanctuary Committee. I served on the Governor's Executive Committee for Trees and Forests from 1992 to 1995, on the Regulations Review Team in 1991, and on the Belt Woods Advisory Committee during 1985–95.

I wrote the quarterly Season reports of bird observations for "Maryland Birdlife" from 1947 to 1977, and served as the MOS's State president from 1952 to 1955, as editor of "Maryland Birdlife" from 1947 to 2014, and as an MOS trustee during 1961–2000. In 1968, biologist Willet T. Van Velzen and I published "Maryland Avifauna Number 2, The Field List of the Birds of Maryland" (44 pages), which shows updated migration and nesting dates.

I served as a trustee of the Bleitz Wildlife Foundation (1967–70) and Secretary of the International Bird Ringing Committee (1966–74), and was a member of the International Bird Census Committee (1966–87). Beginning with the International Ornithological Congress meeting at Oxford in 1966, I was the U.S. representative on the International Bird Census Committee (IBCC) and the European Ornithological Atlas Committee and also Secretary of the International Bird Ringing Committee. I participated in IBCC meetings at Oxford in 1966; Hilleröd, Denmark, in 1968; Ammarnäs in Swedish Lapland in 1969; Oosterbeek, Netherlands, in 1970; Warsaw in 1973; Szymbark, Poland, in 1976; Göttingen, Germany, in 1979; Lyon, Spain, in 1981; Giles, Buckinghamshire, United Kingdom, in 1983; Dijon, France, in 1985; and Helsinki, Finland, in 1987. These meetings kept me in touch with all the latest international thinking and planning on bird census and atlas studies.

I wrote a chapter for Robert Shosteck's 1968 "Potomac Trail Book," and Bob Stewart and I wrote the Maryland/D.C. chapter for Sewall Pettingill's 1951 "Guide to Bird Finding East of the Mississippi." Patuxent's Earl Baysinger and I were on the three-member USFWS team that drafted the United

States/Soviet Union Migratory Bird Treaty using banding recoveries and the historic bird distribution and migration files. In 1976, we went to Moscow and Kiev to negotiate final details with our Soviet colleagues This treaty was unique in protecting not only the shared species, but also the habitats they required (https://www.fws.gov/le/pdf/MigBirdTreatyRussia.pdf, accessed December 17, 2015).

Cooperative Study of Hawk Migration

I had been intrigued by the regularity with which large numbers of migrating hawks were seen at Hawk Mountain, PA, and I thought there might be a more advantageous place than Monument Knob to intercept these flights in Maryland. Therefore, in the fall of 1949, I organized simultaneous counts at eight lookouts in the Catoctin/South Mountain range as well as a dozen along the more westerly ridges. I found that the raptor flight broke up into many minor flights along the low Maryland ridges, and then apparently became more organized along the higher Blue Ridge Mountains of Virginia. In the 1950s, I encouraged hawk migration enthusiasts to participate in coordinated studies throughout the Appalachian Mountains, and, in 1974, I was one of the founders of the Hawk Migration Association of North America, which has now been monitoring raptor migration throughout the continent for nearly 40 years.

The Albatross Problem on Midway Atoll

During World War II, the Navy took control of Midway Atoll (Midway) in the Hawaiian Leeward Chain as a base for Distant Early Warning (DEW) line flights from there to Adak in the Aleutian Islands. The nesting populations of Laysan albatrosses (*Phoebastria immutabilis*) and black-footed albatrosses (*Phoebastria nigripes*) at Midway posed a serious problem because of the large size of these birds, their huge numbers (tens or even hundreds of thousands), and the fact that they showed no fear of man or aircraft. Attempts to frighten the birds or transport their young to other islands had failed. The USGS Laboratory in Denver sent Phil DuMont and Johnson Neff to Midway in 1954 to survey the situation, set up a study site near the station hospital, and band a small portion of the population. Dale Rice and Karl Kenyon spent a year there conducting life-history studies. John Aldrich and I went to Midway in December 1956 when the adults were establishing nesting territories, studied the birds on the hospital plot, and recaptured as many previously banded birds as we could.

Laysan albatross Wisdom, alive and nesting in 2011, Midway Atoll. Photo by U.S. Fish and Wildlife Service.

I returned with an assistant for the next nine winters, conducting counts at various positions along the runways, trying different means of intimidation (none of which worked), and establishing study sites where nests were plotted to 1-ft accuracy on a permanent grid and adults and young were banded. On one such visit, I made an historic trip up the Leeward Chain with Gene Kridler, Win Banko, Ron Walker, and David Woodside on the buoy tender *Blackhaw*, stopping en route to survey the nesting birds on Nihoa and Necker, where few naturalists had ever landed. We also camped for a night in the Alakai Swamp, where I photographed an 'o'u (*Psittirostra psittacea*), a bird now extinct (Scott and Kepler, 2016).

I returned in 1967 to recapture and reband as many birds as possible, in hopes that they would be recaptured again before the information on their aluminum bands became illegible or the bands fell off from corrosion. Hundreds of these birds were later recaptured by other investigators, who removed my bands and replaced them with theirs. Because the Bird Banding Laboratory keeps their records by band number instead of by bird, there is no forward continuity in the records and therefore still no way to determine how long the birds live.

On a brief trip to Midway in February 2002, I recaptured a Laysan albatross that was at least 50 years old: a female, named Wisdom, which was marked with a special band for easy recognition and was still alive and nesting in 2014.
In the meantime, the Navy took two measures that we had

Chan Robbins (right) and banding crew, Midway Atoll. Photo by U.S. Fish and Wildlife Service.

recommended to reduce the strike rate: they paved large strips along both sides of the runway to keep birds from nesting anywhere near flying aircraft, and they flattened the dunes from which the birds were using updrafts to fly across the runways. Midway is now a National Wildlife Refuge; the birds are protected.

Publications

Birds of Maryland and the District of Columbia

Bob Stewart and I expanded our field of investigation to include the entire State of Maryland. Frank Kirkwood's 1895 "A List of the Birds of Maryland" was long out of date and out of print. When Kirkwood died in 1945, W. Bryant Tyrrell rescued his big files of Maryland bird records and lent them to us. We contacted Maryland and Washington, D.C., bird observers, and set about gathering published and unpublished records from the first half of the 20th century. No existing State bird book contained breeding density information, but we believed it was important to document breeding densities in principal habitats throughout the State. Therefore, we prepared to do this, from marsh habitats on the Eastern Shore to apple orchards around Cumberland, to bogs, forests, and farmlands in Garrett County. Our book (Stewart and Robbins, 1958) gives breeding densities for most breeding species, many derived from my Master's thesis (Robbins, 1950) at George Washington University. It also includes distribution maps where appropriate, cites maximum counts, and shows where birds banded in Maryland have been reported.

Field Guide, Birds of North America

I am indebted to Patuxent Director Arnold Nelson for allowing me to take some time off in 1965 to work on Golden Press's "Birds of North America" with Bertel Bruun and Herbert Zim (illustrated by Arthur Singer) (Robbins and others, 1966, 1983). I had initially refused to be involved with this field guide because I saw no need for it. Roger Peterson's eastern and western bird guides were both excellent for use in the field, he and I were good friends, and I felt it was unfair to produce a competing volume. When Dr. Zim told me later that he was going to find another author and publish it anyway, I told him I would agree if Golden Press would make some concessions regarding layout. I wanted to make the Golden Press volume distinct from Peterson's: birds would be shown against a background of their typical habitat; distribution maps, text, and illustrations would be on facing pages; and sonograms would be included, supplied from my personal collection of recordings. Golden Press resisted the sonogram idea, but I insisted that was not negotiable; there simply was not enough space to provide diagnostic verbal descriptions of bird songs and calls. I also parted with tradition by using actual live measurements of hand-held birds in natural positions rather than the published lengths of stretched-out museum skins. Few people have noticed the accent marks showing how to pronounce the Latin names and the typical number of songs per minute—which can be helpful to folks who are tone deaf (for example, 2–4 per minute [/min] for Acadian flycatcher [*Empidonax virescens*], 6–11/min for eastern wood-pewee [*Contopus virens*], 20–40/min for eastern phoebe [*Sayornis phoebe*], and 50–70/min for least flycatcher [*Empidonax minimus*]).

Birds in Our Lives

Nine Patuxent staff members were among the 61 authors who contributed to the impressive "Birds in Our Lives" volume edited by Alfred Stefferud and Arnold Nelson and published by the Bureau of Sport Fisheries and Wildlife in 1966 (Stefferud and Nelson, 1966). Notable was a chapter by Patuxent chief veterinarian Carlton Herman about the interesting way that studies of birds were improving our knowledge of human health issues, a chapter by Chief of the Bird Banding Laboratory Allen Duvall on bird migration, and a chapter by former Patuxent director John Buckley on how to avoid problems with birds. Two chapters written by me included one on the Christmas Bird Count and one on exotic bird species introductions, which I coauthored with Gardiner Bump.

Special Scientific Reports—Wildlife

The chief official outlet for progress reports in wildlife studies was the USFWS Special Scientific Report series. The first in this series (Aldrich and others, 1949) was a compilation of maps of banding recoveries of waterfowl, largely by Patuxent staff members. Status reports on waterfowl, doves, woodcock, snipe and rails, albatrosses, and the Breeding Bird Survey were among the early issues.

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Early Population And Contaminant Studies At Patuxent

By Russell J. Hall

I was asked to write on the topic "Early population and contaminant studies." By way of disclosure, I have to confess that I have no direct knowledge of this topic. I arrived at Patuxent Wildlife Research Center (Patuxent) in 1977, long after its major programs were well developed, so the information I provide here is secondhand. Of course, with the rare exception of research biologist Chan Robbins, who started work at Patuxent in 1946, few people still living have direct experience of those times. I was fortunate, however, to develop a close relationship with several other scientists who worked at Patuxent in the 1940s.

Much of my knowledge about Patuxent's programs in the 1930–40s was learned from random conversations with Lucille and William Stickel, who were fellow researchers during my tenure at Patuxent. In addition, I was privileged to have the opportunity to discuss the topic with Lucille a few months before her death in 2007. The remainder of what I know is derived from various written records—mostly scientific literature. While at Patuxent, I had two assignments that required me to summarize this information, and much of the discussion that follows is based on that past work (Hall, 1987, 1988). The written records are more objective, but perhaps less insightful, than the anecdotal information.

As you will read in other chapters in this volume, Patuxent was established in 1936 as a "research refuge." The term "habitat restoration" has been used (Perry, 2004), but I think there is more. Some understanding of Patuxent's purpose may be achieved by considering what was happening at that time in our Nation's history. Think of the Dust Bowl and the Great Depression, and keep in mind that many more people and much more of the landscape were involved in agriculture then than at any time since. The population was increasing, and it was expected that agricultural production would also need to increase. Agriculture already dominated much of the Nation's landscape and, by today's standards, was inefficient, wasteful, and destructive to the environment. Unless some major change occurred, America's wildlife would be subject to increasing pressure.

In response to the plethora of ongoing and impending problems, the U.S. Department of Agriculture (USDA) was gaining in size and influence, and was promoting scientific farming. Some of its units were working on the productivity side of the equation, whereas its Soil Conservation Service was engaged in applying the benefits of science to the urgent task of curtailing the wholesale wastage of natural resources that was then underway. The Bureau of Biological Survey was also deeply involved in conservation, because it was a unit of the USDA at the time of Patuxent's founding. Patuxent was not transferred to the Department of the Interior until 1940 and was developed in concert with the adjoining Beltsville Agricultural Research Center (Beltsville, MD), so it is not surprising that Patuxent's connection with agriculture was important from the beginning. Therefore, many of Patuxent's underpinnings and much of its initial focus were agriculture-related.

Dr. Durward Allen inspecting bicolor lespedeza (*Lespedeza bicolor*) at Patuxent Research Refuge, Laurel, MD, 1949. Photo by Francis M. Uhler, Patuxent Research Refuge.

One early program at Patuxent was a formal Farm Wildlife program. Two farms were operated on site, one of which was designed by the Soil Conservation Service to study enlightened farming practices that included many measures to promote wildlife. A comparable farm was designed and operated using the practices that were typical of the time. The scientists' task was to evaluate the results of the enlightened kind of farming. Many scientists believe that the program was never fully successful, mainly because of the long time needed for plants to grow and develop good wildlife habitat. One product of the studies was the booklet "The Farmer and Wildlife" by Dr. Durward Allen (Allen, 1949), based on his work at Patuxent. This document was published by the Wildlife Management Institute, Washington, D.C., and reprinted many times in response to requests by farmers.

Harvesting hay at Patuxent Research Refuge, Laurel, MD, 1952. Photo by Francis M. Uhler, Patuxent Research Refuge.

Unfortunately, however, no statistically reliable data on wildlife productivity were obtained, none of the anticipated impressive results materialized, and the program became an easy target for budget cutters. Reductions in force resulted in the termination of nearly all employees in the program. Some of the few who remained were able to grasp the emerging threats to wildlife posed by the new pesticides that were just becoming available, and their insights led to the development of what was to become the Environmental Contaminant Program.

Although the expression had not yet been coined at the time, the introduction of synthetic pesticides after the Second World War was one of the harbingers of what would later be called "the Green Revolution." These pesticides vastly increased agricultural productivity, permitting a reduction in the number of acres in cultivation, resulting in abandonment of farmlands that could later regenerate into wild lands, and ultimately contributing to wholesale population shifts from the countryside to urban areas. Only a few people appreciated the potential adverse side effects of pesticide use on wildlife at the time; fortunately, a small number of them were at Patuxent. With funding from the USDA, Patuxent became involved in a suite of studies of the new chemicals that were underway in many venues.

Think about the importance of this development for a moment, and consider why it was so fortunate that it all began at Patuxent instead of somewhere else. Patuxent had the already mentioned connection with farming practices that was fostered by the early connections with the USDA and the ill-fated Farm Wildlife program. Land was available for outdoor experiments in realistic surroundings. Facilities were, or would be in the future, available for maintaining and propagating wildlife in captivity, making large-scale, statistically valid experimental studies possible. A chemistry laboratory was present that was originally established for work on wildlife nutrition, but ultimately its emphasis could be shifted to chemical toxicology. Wildlife disease specialists who could diagnose pathologies and animal control specialists who were looking for ways to control nuisance wildlife, often with toxins, were available. The connection with wildlife population studies was also strong; methods for determining pesticide effects on populations in the field were needed, and Patuxent scientists, who were pioneering methods for estimating the abundance of bird and small mammal populations, could (and did) use their expertise to assess the results of pesticide applications. Any specialized expertise that was not available in-house could be obtained from the adjacent Beltsville Agricultural Research Center.

DDT was patented in 1940 and brought to market in 1942. It was immediately hailed as a great boon to humankind, and Paul Müller, discoverer of its insecticidal properties, was awarded the Nobel Prize in Physiology and Medicine in 1948. The first studies of DDT by Patuxent scientists were conducted in 1943, and the first papers were published in 1946, just after the end of the Second World War.

These original studies burst on the scene together in volume 10 of The Journal of Wildlife Management in 1946. They are—

- R.T. Mitchell—Effects of DDT spray on eggs and nestlings of birds;
- R.E. Stewart and others—Effects of DDT on birds at the Patuxent Research Refuge;
- N. Hotchkiss and R.H. Pough—Effects on forest birds of DDT used for gypsy moth control in Pennsylvania;
- D.R. Coburn and R. Treichler—Experiments on toxicity of DDT to wildlife; and
- L.F. Stickel—Field studies of a *Peromyscus* population in an area treated with DDT.

See the "References Cited" section below for the complete citations.

Some of the authors of these original studies were field ornithologists, but Hotchkiss was a wetland ecologist, Coburn was a disease specialist, and Stickel's ongoing research was on population ecology, emphasizing small mammals and reptiles.

Despite the apparent thoroughness of these very early studies, they failed to elucidate the true hazard to wildlife posed by DDT. For the most part, they demonstrated that DDT applications were relatively safe to wildlife when used judiciously and when application levels were conservative. Another 20 years and development of entirely new research methodologies would be required before the researchers were able to understand the effects of the chemical on bird reproduction and the mechanisms responsible for them. Studies of DDT continued through the 1950s, as did research on other synthetic pesticides, some with much more direct lethal effects.

Until passage in 1958 of the Magnuson-Metcalf Bill (Magnuson-Metcalf), which required testing of pesticides, the USDA funded most studies of pesticides at Patuxent. This outside funding was instrumental in keeping other research at

Patuxent afloat during lean times. Magnuson-Metcalf required acute and chronic studies of 200 pesticides on fish and wildlife species. Lists of publications from this period reveal that most Patuxent scientists were involved in one or more pesticide studies in addition to their permanent assignments. Passage of Magnuson-Metcalf permitted the recruitment of permanent staff for the research, and of course funding increased dramatically after the publication of "Silent Spring" by Rachel Carson (1962).

The Federal Environmental Pesticides Control Act (FEPCA) of 1972 amended the Federal Insecticide, Fungicide, and Rodenticide Act of 1947 to require manufacturers of new pesticides to perform a variety of tests to prove that the pesticide did not have "unreasonable adverse effects" on human health or the environment. Wildlife toxicity studies at Patuxent played a critical role in helping to enact FEPCA. In turn, once enacted, the statute helped provide further initiative and support for the development of additional avian toxicity tests at Patuxent.

As I noted in my book "Patuxent, Policy, and the Public Interest" (Hall, 2008), wildlife toxicology became a new career for me and for many others. It is now a recognized scientific field practiced by legions of investigators in many parts of the world. To the lists of "firsts" marking the history of Patuxent cited in this volume should be added that Patuxent was the birthplace of the wildlife toxicology discipline in the United States.

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Dusky seaside sparrow tagged at Merritt Island, National Wildlife Refuge, FL, 1970.
Photo by Paul Sykes, U.S. Fish and Wildlife Service.