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Mountaintop Science: The History of Conservation Ornithology at Hawk Mountain Sanctuary

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ABSTRACT.—Hawk Mountain Sanctuary, the world's first refuge for birds of prey, was founded in 1934 by Rosalie Edge to stop the shooting of thousands of migrating raptors along the Kittatinny Ridge in the central Appalachian Mountains of eastern Pennsylvania, 120 kilometers northwest of Philadelphia. Today, the Sanctuary maintains the longest and most complete record of raptor migration in the world. Hawk Mountain's early ornithological highlights focus on Maurice Broun's attempts to document the magnitude, species composition, and timing of raptor migration at the site. Broun's observations of a substantial Golden Eagle (*Aquila chrysaetos*) flight in eastern Pennsylvania (39 birds in 1934 alone), together with the rapid passage of Broad-winged Hawks (*Buteo platypterus*) in mid-to-late September and the relationship between the passage of cold fronts and the magnitude of visible migration at the site, rank among the Sanctuary's many significant contributions to ornithology. In midcentury, Hawk Mountain's long-term counts of migrating raptors were used by conservationists, including Rachel Carson, to document pesticide era declines in birds such as Bald Eagles (*Haliaeetus leucocephalus*) and Peregrine Falcons (*Falco peregrinus*). In the 1980s and 1990s, the Sanctuary solidified its role as a global information hub for raptor migration science, as well as an international mentor to raptor conservationists, with a successful international internship program and a global migration watch-site registry known as *Hawks Aloft Worldwide*. Recently, university-trained, professional ornithologists, working together with volunteer citizen scientists attracted to the site, have increased substantially Hawk Mountain's contributions to the ornithological, ecological, and conservation literature. Although ornithology at Hawk Mountain has changed over the years, Sanctuary efforts continue to focus on the central themes of long-term monitoring and ornithology in service to conservation biology.

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Hawk watching along the ridgetops of the central Appalachian Mountains of eastern Pennsylvania was serious business in the late 1920s and early 1930s. Most raptors were considered vermin. Vermin were to be killed, and the sooner the better. Shooting along the region's northeast-to-southwest oriented ridges appears to have begun around the time of World War I (Anonymous 1941). By 1932, thousands of raptors were being shot at accessible vantage-points along the region's southeastern-most promontory, the Kittatinny Ridge, a corduroy hill that runs largely uninterrupted from southeastern New York, through northern New Jersey, and eastern Pennsylvania, almost to the border with Maryland. Nowhere along the ridge was shooting more popular than at a series of rocky outcrops above Drehersville, Pennsylvania (Sutton 1928a, 1931; Broun 1949) (Fig. 1).

Although some of the gunners traveled from as far as Philadelphia, most were local coal miners and farmers who gathered along the ridgetops on weekends, particularly Sundays—which for many was their only day off—to do their civic duty and shoot as many hawks, eagles, and falcons as possible. Although reports of similar shooting galleries in southern New Jersey had raised the ire of conservationists in the early 1920s (Stone 1922), events above Drehersville in the late 1920s to the early 1930s galvanized a small but determined band of raptor protectionists, who helped create Hawk Mountain Sanctuary, the world's first refuge for birds of prey (Broun 1949).

Over the years, Hawk Mountain Sanctuary has grown to become a global leader in raptor conservation (Broun 1949, Council on Environmental Quality 1984, Bildstein et al. 1993, Bildstein 1998, Bildstein et al. 1998). Ornithology at the site, some of it conducted before Hawk Mountain Sanctuary was founded in 1934, continues to provide an essential knowledge base for many of the Sanctuary's conservation efforts.

PRE-SANCTUARY OBSERVATIONS

An irruptive migration of Northern Goshawks (*Accipiter gentilis*) in the winters of 1926-27 and 1927-28 (Sutton 1931) did more than evacuate large numbers of accipiters from the boreal forests of eastern Canada. The invasion triggered a series of events that eventually led to the creation of the world's first refuge for birds of prey.

Northern Goshawks were considered vicious killers in the early part of the 20th Century, even by many conservationists and ornithologists (e.g., Fuertes 1920, Sutton 1928b, Hornaday 1931). The movements of these birds into Pennsylvania during the winters of 1926-27 and 1927-28 was not

Fig. 1. Shot hawks gathered by Richard Pough, Harold Pough, William Jeans, and Henry Collins, one Sunday in late September 1932. (Photo by Harold Pough, Hawk Mountain Sanctuary Archives.)

a welcome event (Gerstell 1937). In eastern Pennsylvania, rural inhabitants along the Kittatinny Ridge, or Blue Mountain, 120 km northwest of Philadelphia, reported the "unfortunate" phenomenon to the local game protector, Archie C. Smith. Smith, in turn, alerted state ornithologist, George Miksch Sutton. The two visited the ridge two miles above Drehersville, Pennsylvania, on 19 and 20 October 1927. The site, which had been a popular blueberry (*Vaccinium* spp.) and huckleberry (*Gaylussacia baccata*) bald following a wood-burning-locomotive-sparked fire in 1898, had attracted the attention of shooters at least since the early 1920s. While there, Smith, Sutton, and their companions collected at least four goshawks and five Sharp-shinned Hawks (*Accipiter striatus*). Three days later, Smith and several shooters returned and "secured, in a remarkably short time, a total of ninety sharp-shins, sixteen Goshawks, eleven Cooper's Hawks (*Accipiter cooperi*)[sic], thirty-two Red-tailed Hawks (*Buteo borealis borealis*)[sic], and two Duck Hawks (*Rhynchodon peregrinus anatum*)[sic]." It is little wonder the place was known to local inhabitants as Hawk Mountain.

Sutton published his findings—including considerable information on body masses and stomach contents of Sharp-shinned Hawks, Cooper's Hawks (*Accipiter cooperii*), Northern Goshawks, Red-tailed Hawks (*Buteo jamaicensis*), and Peregrine Falcons (*Falco peregrinus*), along with data on age ratios and tail shape in accipiters—the following June (Sutton 1928a). The report, together with a second on the status of the Northern Goshawk in the state published in 1931 (Sutton 1931), had diametrically opposing effects. First, by 1929 the Pennsylvania Game Commission, for whom Sutton worked, was offering a $5 bounty on goshawks killed between 1 November and 1 May (Gerstell 1937), thereby substantially increasing the likelihood of shooting at the site. Second, the two reports drew the attention of the region's ornithological and conservation communities.

Upon reading Sutton's initial article, Earl Poole (1891-1972), then assistant director of the Reading Public Museum in Reading, Pennsylvania, 40 km south of the site, and author of *The Birds of Berks County, Pennsylvania* (Poole 1930), began visiting the mountain in 1929. Poole's observations, together with several accounts relayed to him by local gunners—including a Broad-winged Hawk (*Buteo platypterus*) flight of 2000 individuals on 22 September 1932—represents the first detailed description of raptor migration at the site (Poole 1934).

Sutton's articles also brought Philadephians Henry H. Collins, Jr., and Richard Pough to the ridge. The two confirmed and expanded Sutton's earlier descriptions of the shooting in first-hand accounts published in *The Hawk and Owl Society Bulletin* (Collins 1933) and *Bird-Lore* (Pough 1932).

Photographs of dozens of shot hawks accompanying the articles appear to have been especially effective. At the request of the Philadelphia Society for the Protection of Cruelty to Animals, State Policeman G. Barr spent three "nightmarish" days on the mountain in the autumn of 1933, watching as many as 400 shooters kill so many birds that that a "bad odor hung over the place" (Broun 1947). That same October, Pough showed slides of his photographs at a joint meeting of the Hawk and Owl, Linnaean, and National Association of Audubon societies in New York City (Fig. 1). Mabel Rosalie Barrow Edge, founder and head of the Emergency Conservation Committee (ECC), was in the audience the night Pough spoke (Fig. 2).

The following June, Edge, accompanied by Pough and her son Peter, toured the ridgetop above Drehersville with local realtor, Gordon Reed. Shortly thereafter, Edge leased the 565 ha that was to become Hawk Mountain Sanctuary for one year at $500. (By the mid 1990s, the Sanctuary had grown to 900 ha.) A final purchase price was set at $3500 (P. Edge 1974). That August, Edge engaged Maurice Broun as "ornithologist-in-charge" of the new Sanctuary (Fig. 3). With little money in the ECC treasury available for his salary, Broun "generously put all such considerations aside" and traveled to Drehersville with his wife, Irma, on 10 September. The two spent three nights in a leaky Schaumbochs cottage (Fig. 4) near the top of the mountain before finding more suitable lodging in Drehersville (Broun 1949).

DOCUMENTING THE FLIGHT

Maurice Broun (1906-1979).—Born in New York City of Romanian parents and orphaned at age two, Broun and his adoptive parents moved to Boston shortly thereafter. Maurice Broun became interested in birds at age 13, when a group of bird watchers in Boston Commons showed him a Magnolia Warbler (*Dendroica magnolia*). After finishing high school, Broun worked with Edward Forbush, and later helped John B. May edit the third volume of Forbush's *Birds of Massachusetts and other New England States* (Forbush 1929). Broun authored several of the work's species accounts, including those for Lawrence's Warbler (*Vermivora chrysoptera* x *pinus*) and Black-capped Chickadee (*Parus atricapillus*).

Maurice Broun was working for Oliver L. Austin, Sr., at Austin's banding station on Cape Cod in Wellfleet, Massachusetts, when Rosalie Edge visited the site in March of 1934. Broun, who had acquired his first pair of real binoculars—8x Zeiss—in May of 1934, enthusiastically accepted Edge's

Fig. 2. Rosalie Barrow Edge (1877-1962) at the trailhead to the North Lookout at Hawk Mountain Sanctuary. Edge founded Hawk Mountain Sanctuary in 1934, and Hawk Mountain Sanctuary Association in 1938. (Photo by Maurice Broun, Hawk Mountain Sanctuary archives.)

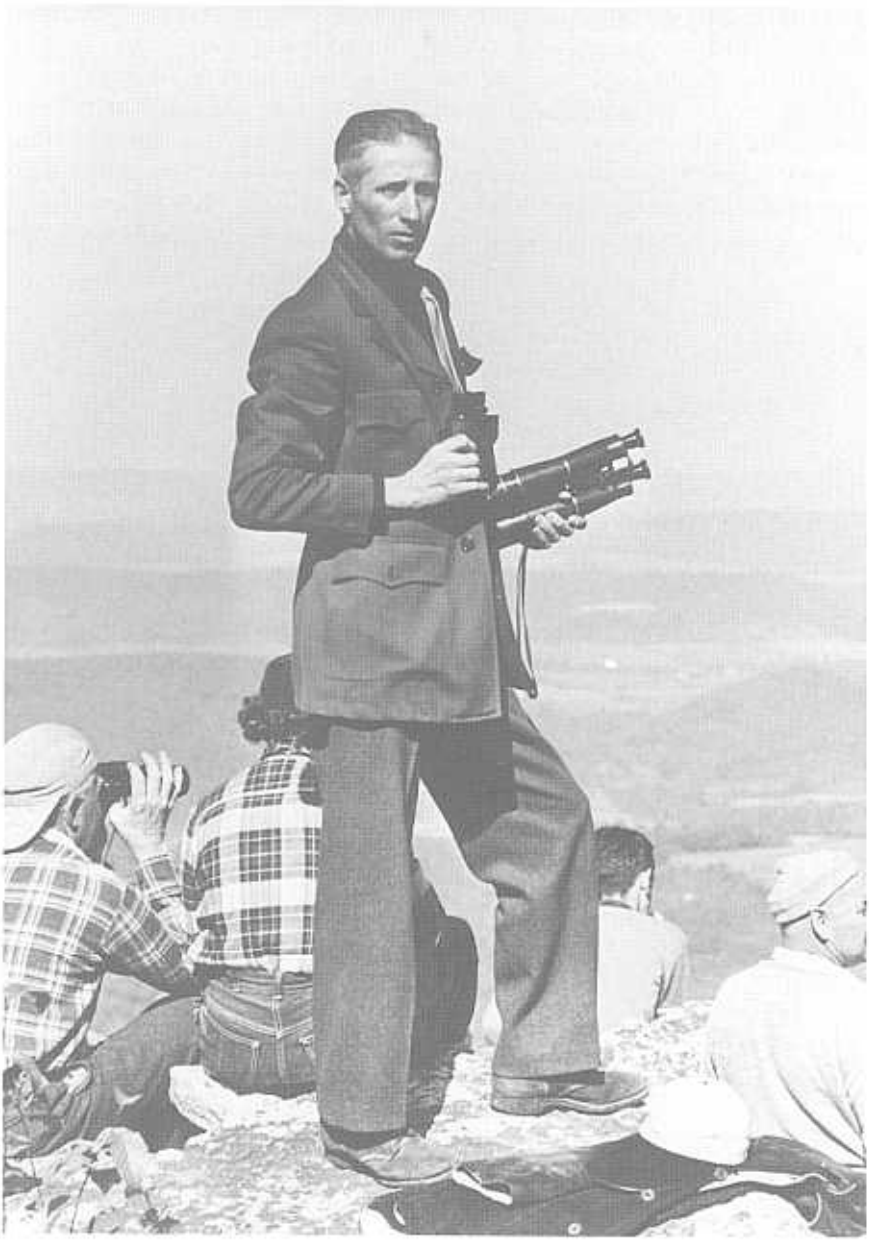

Fig. 3. Maurice Broun atop Observation Rocks (North Lookout). Broun began counting migrating raptors at Hawk Mountain on 30 September 1934. (Photo by Maurice Broun, Hawk Mountain Sanctuary Archives.)

offer later that summer to take a position as the newly established Sanctuary's ornithologist-in-charge. His title later was changed to curator.

Maurice Broun spent most of September 1934 posting the Sanctuary's boundaries and informing local inhabitants about the site's new status as a refuge for birds of prey (Broun 1949) (Fig. 5). He saw his first migrating raptors, "some fifty birds, includ[ing] three bald eagles [*Haliaeetus leucocephalus*], three peregrine falcons, a few broadwings and sharpshins..." while replacing vandalized no-trespassing signs along the road during his

Fig. 4. Schaumbochs cottage was acquired by the Sanctuary in 1938. The cottage served as Maurice and Irma Broun's residence until 1966, and Sanctuary "headquarters" until the visitor center was built in 1970. (Hawk Mountain Sanctuary Archives.)

Fig. 5. Irma Broun, the Sanctuary's "keeper of the gate" in 1935. (Photo by Maurice Broun, Hawk Mountain Archives.)

first week on the Mountain. On 30 September 1934, he began counting migrating raptors from what was then called Observation Rocks (Fig. 6), something he would continue to do on a regular basis for the next 32 years. His journal for the day summarizes his first-day's observations:

> "We were on the rocks, recorded but 128 hawks, considered an extremely low figure: 102 Sharp-shins, 2 Cooper's, 1 Duck [Hawk], 15 Turkey Vultures, 1 Bald Eagle, 1 Osprey, 2 Red-tails, 2 Broad-wings, and 2 Marsh Hawks."

Although Broun had initiated the counts primarily to document the magnitude of the flight to enlist financial support for conservation efforts at the Sanctuary (Broun 1935a,b), it quickly became apparent that a series of annual counts would enable the Sanctuary to monitor regional populations of the birds (Broun 1939). By its second year of operation, counts of migrating raptors had become a fixed feature of Sanctuary fieldwork (Broun 1949).

Like Poole (1934) before him, Broun (1935b) was quick to recognize the relationship between weather, particularly the passage of what are now called cold fronts—and which Broun characterized at the time as "cold, but not necessarily clear day[s], immediately after rainy weather"—and great hawk flights. In that first paper, Broun also discussed potential sources of the flight, as well as its relationship with hawk migration in coastal New York and New Jersey. His greatest and most controversial initial contribution, however, was his seasonal total of 39 Golden Eagles (*Aquila chrysaetos*). The species was then considered an extremely rare straggler in eastern North America in autumn (e.g., Poole 1930), and several years would pass before the ornithological establishment fully accepted Broun's finding.

Broun summarized his first three seasons of observations in an Emergency Conservation Committee pamphlet (Broun 1936a), and his first five years of counts in the *Auk* (Broun 1939). The latter mentions the growing number of birdwatchers visiting the by then internationally renowned birding venue, as well as several aspects of the migration, including a midday "lull" in the flight (see also Poole 1934), the timing of seasonal passages of individual species, and the fact that the overwhelming majority of migrating Red-tailed Hawks were adults (Broun 1939).

Broun, who also botanized at the time (Edge 1939), published an *Index to North American Ferns* in 1938 (Broun 1938), as well as an article on fern gardening in 1936 (Broun 1936b). His next published works on bird migration—aside from annual reports to Sanctuary members initiated in 1939, one year after Rosalie Edge had created the membership-supported Hawk Mountain Sanctuary Association—were brief accounts of migrat-

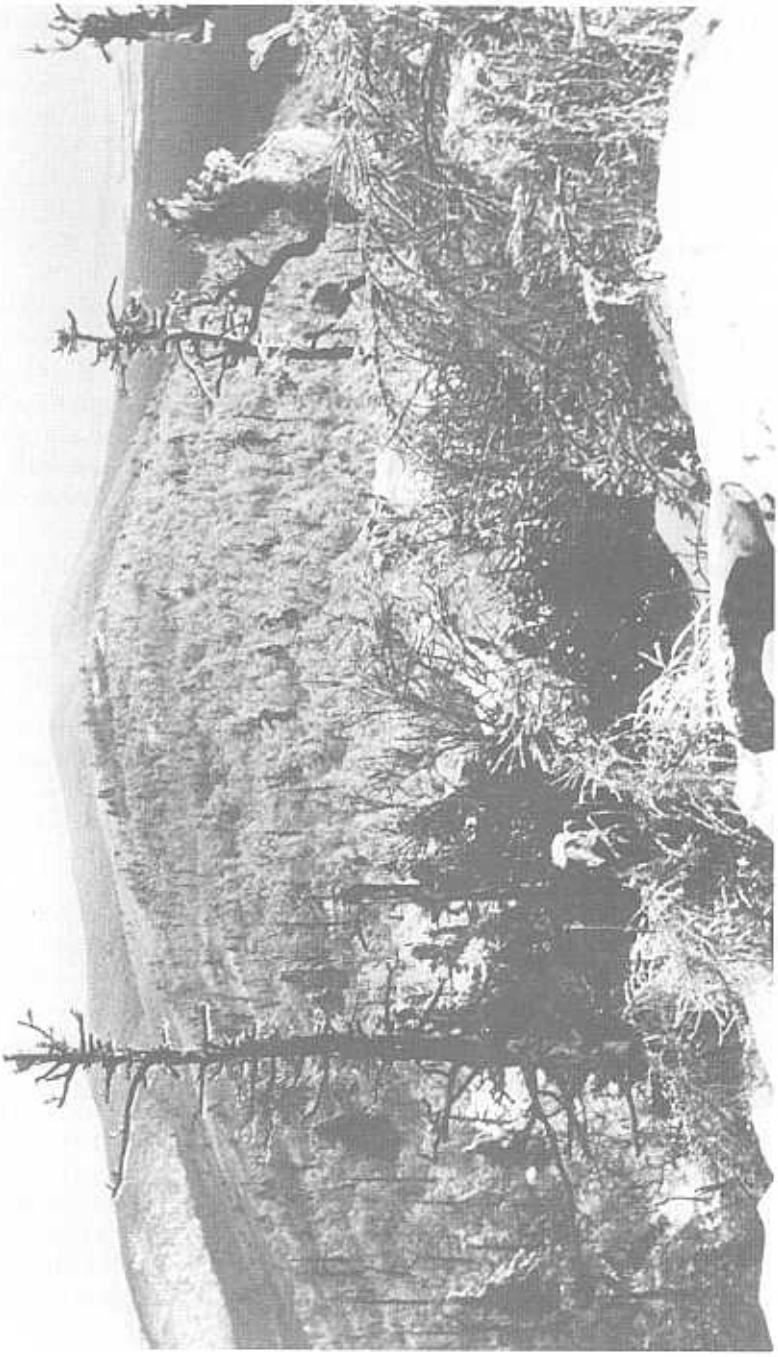

Fig. 6. The view to the east (up-ridge) from North Lookout, as seen in a 1939 Christmas card from Maurice and Irma Broun. (Photo by Maurice Broun, Hawk Mountain Archives.)

ing Blue Jays (*Cyanocitta cristata*) and other non-raptors at the site (Broun 1941a,b). In 1942, he and Ben Goodwin spent six weeks on field telephones in late September-early November recording the flight speeds of 152 hawks migrating along the Kittatinny Ridge past the Sanctuary (Broun and Goodwin 1943) (Fig. 6). An accomplished photographer, Broun produced a 125-meter, 16-mm color film about Hawk Mountain in 1941, which the Sanctuary then rented for $5. In 1943-45, three years for which there was no official count, Broun served as a photographer with the U.S. Navy SeaBees in the South Pacific.

A seasonal employee before World War II, Maurice Broun was hired as a live-in, year-round Sanctuary employee in 1946. It was then that Broun and his wife, Irma, moved into the newly acquired Schaumbochs cottage on-site, where Maurice spent the next two winters documenting the early history of the Sanctuary. *Hawks Aloft: the Story of Hawk Mountain* was published in 1949. The book, which has since become a conservation classic, set the stage for the Sanctuary's entry into international raptor conservation.

Schaumbochs cottage proved to be a surprisingly great place to observe spring warbler migration. Broun had banded his first bird near the site, a Mourning Dove (*Zenaida macroura*) in 1936. Although he banded no birds in the area again until 1954, by 1963 he had banded 11,814 birds, representing 82 species, on or near the Mountain, together with 2030 at other locations. Many of the birds, including 4881 Evening Grosbeaks (*Hesperiphona vespertina*) and 6228 Dark-eyed Juncos (*Junco hyemalis*), were captured near bird feeders at Schaumbochs. Ninety-five of the 102 raptors Broun and his assistants banded during this period were American Kestrels (*Falco sparverius*), which were breeding in nestboxes the Sanctuary had placed in farmlands surrounding the site.

By the early 1950s, Hawk Mountain was hosting close to 10,000 visitors annually. With most people arriving in autumn, visitor demands forced Broun to become increasingly dependent upon volunteers and assistants to conduct the fall count. Between 1934 and 1948 Broun had conducted the count largely on his own. In the early 1950s, volunteers were conducting a quarter of the counts (Bildstein 1998). Although Alex Nagy had been hired as Assistant to the Curator in 1953, attempts to protect raptors at other shooting sites up and down the ridge, mounting correspondence, speaking engagements, and managerial responsibilities slowed the pace at which Broun contributed to the literature. His last significant contribution to the ornithological literature—a summary of his observations on the effects of cold fronts on raptor migration—was published in the *Atlantic Naturalist* in 1951, and reprinted as a Sanctuary pamphlet in 1963 (Broun 1951, 1963).

Throughout the 1940s, 50s, and 60s, the Sanctuary continued to attract growing numbers of birding enthusiasts. Roger Tory Peterson, who served on the Sanctuary Association's board from 1949 to 1962, and Guy Mountfort conceived the idea to write A field guide to the birds of Britain and Europe (Peterson et al. 1954) while visiting the Sanctuary in 1949 (Fig. 7). The Eastern Bird Banding Association held its annual meeting at the Sanctuary in the recently completed Common Room in April 1955.

Fig. 7. Birders atop the North Lookout during the Sanctuary's 50th anniversary celebration in 1984. Dede and Howard Brokaw (then Sanctuary board member), and Ginny and Roger Tory Peterson (former Sanctuary board member), left to right. (Photo by Joe Snook, Hawk Mountain Sanctuary Archives.)

Although the 1950s and 60s saw the threat of hawk shooting along the ridge diminish substantially—the Pennsylvania Game Commission terminated the bounty on Northern Goshawks in 1951—another, new threat to raptors loomed on the horizon. As early as 1952, Maurice Broun began commenting on the substantial decline in the ratio of juvenile to adult Bald Eagles at the site. The decline, which first became apparent in the late 1940s, coincided directly with declines in the reproductive success of the species in Florida (Broley 1950, Broun 1952). Less than a decade later the Sanctuary's counts of juvenile and adult Bald Eagles were used by Rachel Carson to support her arguments for the impact of chlorinated hydrocarbons, particularly DDT, on bird populations (Carson 1962). Notably, the Sanctuary's records for the species since the mid-1970s—following bans on the widespread use of DDT in North America—have tracked a reversal in the decline, so much so, that by the late 1980s the ratio had returned to pre-World War II levels (Bildstein 1998).

Maurice Broun, who retired as Sanctuary Curator in April 1966, died on 2 October 1979, the same year Schaumbochs Cottage was added to the National Register of Historic Places.

Alexander C. Nagy (1924-1986).—Alex Nagy (Fig. 8), the Sanctuary's second curator, was born in Allentown, Pennsylvania, to Hungarian immigrants. In World War II, he attended the Merchant Marine Academy and served as an engineer on transport ships in the Mediterranean Sea and South Atlantic Ocean. After that he lived on a farm in Eckville, at the base of Hawk Mountain, with his father, Charles. A model enterprise, the Nagy farm had been one of the first in northern Berks County to use contour plowing to reduce soil erosion. In 1953, Alex Nagy joined the Sanctuary's staff as assistant to the Curator. Nagy became Curator in 1966 when Broun retired from the post.

Alex Nagy began erecting nest-boxes for American Kestrels on the family farm in the early 1950s (Nagy 1963). These early efforts represent the first in a series of Sanctuary contributions. The Sanctuary's kestrel project received a substantial boost in 1987 when Victor Apanius, a Ph.D. candidate at the University of Pennsylvania, erected 120 boxes in the area (Apanius 1991). Three additional graduate students have used the boxes for studies of kestrel ecology (Ardia and Bildstein 1997, Wiehn 1997, Wiehn et al. 1997, Rohrbaugh and Yahner 1997). By the early 1990s, Sanctuary volunteers, interns, and graduate students, particularly Sanctuary volunteers Sue and Chester J. "Bob" Robertson, were conducting almost all of the field-work and banding associated with the project.

In 1997, the Sanctuary initiated an adopt-a-kestrel-nest-box program for Pennsylvania school children; this allows students to practice real

Fig. 8. Alex Nagy, the Sanctuary's second Curator, worked on Hawk Mountain's American Kestrel nest-box program in the early 1950s. (Hawk Mountain Sanctuary Archives.)

wildlife biology and natural resource management, while collecting important ecology information. Today, the nest-box program Nagy began, has grown into the quintessential Sanctuary effort, with Sanctuary staff, volunteers, and interns, colleges students, and local land owners working together in practical and effective conservation biology.

Another of Nagy's significant activities involved attempting to boost migration count results by increasing the count effort to include sightings at Sanctuary lookouts in addition to the North Lookout, particularly South Lookout and Owls Head Lookout. Although this sometimes meant that birds were not counted at the North Lookout—the practice was discontinued in the late 1970s—it did produce the Sanctuary's highest single-day raptor count ever: an astounding 21,608 birds, including 21,448 Broad-winged Hawks, on 14 September 1978, approximately half of which were counted at the North Lookout.

In 1975 Nagy presented the Sanctuary's first analysis of the then 40-year hawk migration database in more than two decades at a world conference on birds of prey in Vienna, Austria (Nagy 1977).

Alex Nagy was curator until 1981, when, because of failing health, he retired to a geodesic-dome house he had built on the family farm in Eckville. He died on 24 November 1986.

EXPANDING THE SANCTUARY'S HORIZONS

James J. Brett (1940-).—Jim Brett, the Sanctuary's third Curator, was born in Shillington, Pennsylvania, 40 km south of Hawk Mountain. Brett, who grew up in a home with a worldly view that valued cultural exchange, played a central role in moving the Sanctuary from an unofficial continental center for raptor enthusiasts and conservationists into an internationally recognized center in the field of raptor conservation (Fig. 9). Brett, who became Assistant Curator in September 1971, had graduated with a B.S. in biology from then Kutztown State Teachers College in 1961 and had been teaching biology in the York, Pennsylvania, school system. He and Alex Nagy authored *Feathers in the Wind* (1973), the first real "field guide" to migrating birds of prey. Brett later revised and expanded the popular guide twice (Brett 1986, 1991). It was under Jim Brett's direction that the Sanctuary first offered "Three Saturdays at Hawk Mountain." The course, taught in conjunction with then Kutztown State College, was the first college-level offering taught entirely at the Sanctuary. Jim also was responsible for the Sanctuary's role in the formation of a California Condor (*Gymnogyps californianus*) Survival Group in 1983, and for helping to

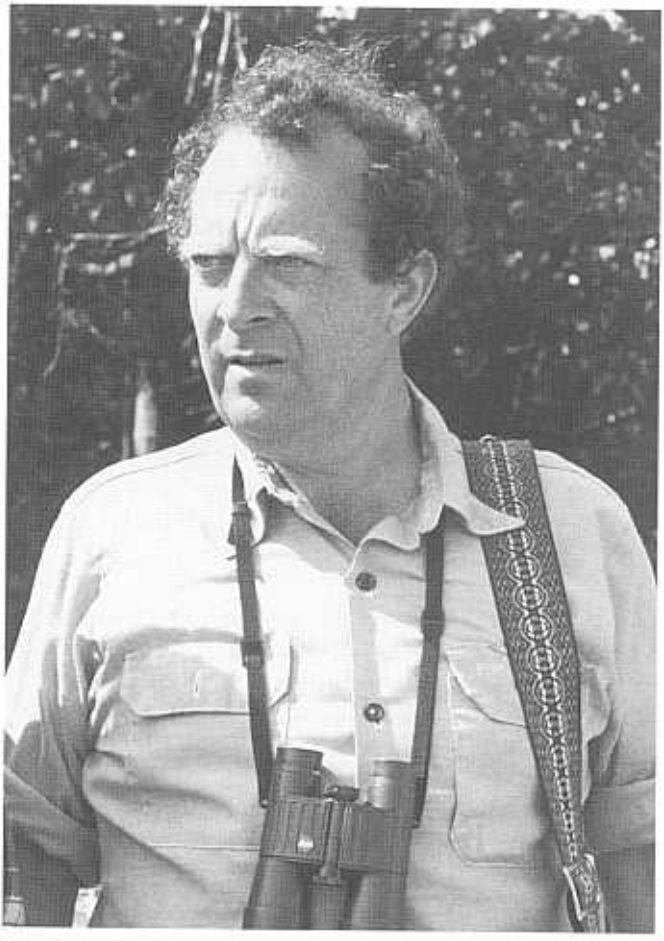

Fig. 9. Jim Brett, the Sanctuary's third Curator, established the Hawk Mountain's international internship program in 1985. (Hawk Mountain Sanctuary Archives.)

sponsor the World Working Group on Birds of Prey and Owls' Third World Conference in Elat, Israel, in 1987. Perhaps his most significant contribution was the role he played in initiating Hawk Mountain's International Intern Program.

Although Maurice Broun had been encouraging young people to help at the Sanctuary since the late 1940s, it was not until Jim Brett arrived that a formal "internship program" began to take shape. Brett started working with local high school and college students in the Sanctuary's education programs in 1974. Within a few years the successful program was attract-

ing regional and national candidates. In 1986 the Sanctuary welcomed its first international intern, Menachem Adar, from the Society for the Protection of Nature in Israel. By 1998, the International Intern Program had trained more than 170 young conservationists from 28 countries on six continents, many of whom are making substantial contributions in the field.

THE CURRENT PERIOD (1984-PRESENT)

As the Sanctuary's third and last curator, Jim Brett presided over one of the Sanctuary's great transitions: its move from informal mountaintop retreat for bird watchers and raptor enthusiasts, regional center for hawk protection, and informal source of guidance to raptor conservationists elsewhere, into a world-class center of raptor-migration science, conservation, and education. The end of the earlier era was punctuated by the arrival of two ornithologists, Stanley Senner in 1982 and Laurie Goodrich in 1984.

Stanley Epp Senner (1951-).—Stan Senner, the Sanctuary's first Executive Director, arrived at the Mountain in June 1982. Senner, a professionally trained migratory bird biologist, with an M.S. from the University of Alaska, Fairbanks, was hired by the Sanctuary's board to "devise general and specific programs, help raise money for them, build membership, strengthen [the Sanctuary's] role in wildlife research, and increase [its] impact on political decisions affecting wildlife and the environment" (Taylor 1982). Recognizing the value of the Sanctuary's second-growth forests as a base for long-term studies in Appalachian forest ecology, Senner nurtured Sanctuary efforts in the area, including increased use of two Breeding Bird Census and Winter Bird Survey plots, which had been surveyed and established at the site in the spring of 1982 by Seth Benz and Tom Leckey (Goodrich et al. 1998). He also hired Laurie Goodrich as the Sanctuary's first full-time research biologist.

Senner expanded the Sanctuary's national and international profile considerably, both by serving as Chair of the International Council for Bird Preservation's U.S. Section for 10 years in the late 1980s and early 1990s, and by initiating, together with Jim Brett, an international registry of important raptor migration watch-sites (Senner and Brett 1989, Bildstein et al. 1995, Bildstein and Zalles 1995, 1998). He also organized and helped edit the proceedings of a successful Sanctuary-sponsored symposium on "Raptor conservation in the next 50 years," which was held at Hawk

Mountain in October 1984 in celebration of the Sanctuary's fiftieth anniversary (Senner et al. 1986).

Laurie J. Goodrich (1955-).—Laurie Goodrich, a professionally trained ornithologist, with a M.S. in ecology from Rutgers University in New Brunswick, New Jersey, arrived at the Sanctuary in August 1984 (Fig. 10). Goodrich immediately assumed duties as coordinator of the Sanctuary's autumn migration counts, together with the responsibility of overseeing its spring migration counts, kestrel nest-boxes, Christmas Bird Counts, Breeding Bird Censuses, and Winter Bird Surveys. Laurie also helped to initiate the Sanctuary's first serious studies of songbird breeding biology. Under her direction, efforts in this area blossomed in the late 1980s and early 1990s into substantial and detailed investigations of Wood Thrush (*Hylocichla mustelina*) and Ovenbird (*Seiurus aurocapillis*) reproductive success on the Sanctuary's large contiguous forests and in a series of small second-growth woodlots in farmlands surrounding the site. The studies, several of which were conducted in association with Pennsylvania State University biologist Margaret Brittingham, have led to an impressive series of M.S. theses (Hoover 1992, Morgan 1995, Giacomo 1998) and publications (Porneluzi et al. 1993, Hoover et al. 1994, Noojibail 1995, Goodrich et al. 1998, Wilson et al. 1998). This new and exciting area of Sanctuary ornithology yielded considerable useful information on avian natural history as well as the effect of woodland size on Neotropical migrant reproductive success. The work also has provided rich insights into the value and limitations of "artificial nests" in studies of avian nesting success and—very much in line with the Sanctuary's long tradition of volunteer-collected databases (Bildstein 1998)—the use of continent-wide monitoring schemes such as the USGS's Breeding Bird Surveys and Cornell Laboratory of Ornithology's Breeding Bird Censuses in avian population biology.

Together with Senner, Goodrich also initiated a series roadside surveys of raptors in the Kempton Valley southeast of the Sanctuary. These have since become part of the Sanctuary's long-term database (Bunn et al. 1995). Goodrich also documented hummingbird migration at the site (Willimont et al. 1988), studied Great Horned Owl (*Bubo virginianus*) diets (Wink et al. 1987, Goodrich and Senner 1988), and prepared the Broad-winged Hawk species account for *The Birds of North America* (Goodrich et al. 1996).

At the same time that the Sanctuary was broadening the scope of its research efforts into forest songbird ecology, computer technology had reached a stage that enabled the Sanctuary to think seriously about more thorough analyses of its long-term raptor-migration database, which by

Fig. 10. Laurie J. Goodrich, the Sanctuary's senior naturalist, conducted Hawk Mountain's first biological inventory in 1996-1999. (Hawk Mountain Sanctuary Archives.)

the mid 1980s was more than half a century long. Initial efforts in the area involved having a data-entry service, Biometrics Incorporated of Bethlehem, Pennsylvania, begin key-punching the Sanctuary's daily (1934-) and hourly (1966-) counts onto computer cards. In 1984, Sanctuary board member and Muhlenberg College Professor of Biology, Daniel Klem, Jr., offered the services of the college's Office of Information and Technology to complete the process. Working together with Senner, Goodrich, and Seth Benz, Klem helped design the fields for data entry and oversaw the tedious process of data validation and analysis. By the early 1990s each year's data were being entered and validated at Muhlenberg College within a year of their collection. The Sanctuary bolstered its ability to take advantage of this now reasonably accessible resource by hiring

James Bednarz to fill the newly created position of Director of Higher Education and Research.

James C. Bednarz (1950-).—Jim Bednarz, the Sanctuary's first Ph.D.-level scientist and its first Director of Research, arrived at the Sanctuary in 1987 (Fig. 11). Bednarz, who in 1978 had been the initial recipient of the Sanctuary's now annual student research award, had studied nesting Red-shouldered (*Buteo lineatus*) and Red-tailed hawks for his M.S. at Iowa State University, and Harris' Hawk (*Parabuteo uncinatus*) social behavior for his Ph.D. at the University of New Mexico. The position Bednarz filled was made possible by a three-year grant from The J. N. Pew, Jr., Charitable Trust, together with several generous gifts from Sanctuary members. Jim had been hired to "expand and improve" Sanctuary research, and to increase opportunities for higher education at the Sanctuary (Anonymous 1987). Although Bednarz left the Sanctuary in 1990, he was remarkably successful in both areas. Working closely with Senner, Goodrich, and Klem, Bednarz helped oversee the first detailed analysis of the Sanctuary's long-term database. The results of that effort (Bednarz et al. 1990), clearly revealed the value of the Sanctuary's long-term database as a barometer of raptor population trends throughout the middle half of the 20th Century. Bednarz also was responsible for collecting information needed to make the Sanctuary more readily available to academic researchers, overall establishing an enviable record for his immediate successor.

Keith L. Bildstein (1950-).—Keith Bildstein's initial visit to Hawk Mountain as a Muhlenberg College undergraduate in 1969 inspired him to study raptors as a graduate student at The Ohio State University in the mid-1970s. He became Hawk Mountain Sanctuary Director of Research in July 1992 (Fig. 12). Bildstein had first come to appreciate raptors in the early 1960s while watching Cooper's Hawks pursue his father's homing pigeons in northern New Jersey. Trained under Thomas Grubb and Frances Hamerstrom, he had earlier studied raptors in Wisconsin, Ohio, Florida, and South Carolina. Bildstein immediately assumed responsibility for managing the Sanctuary's long-term migration data, transferring the database from the computer center at Muhlenberg College to the Sanctuary, where, together with Sanctuary intern Paul Allen, he began validating and analyzing it (Allen et al. 1996, Viverette et al. 1996, Bildstein 1998). Bildstein also directed the Raptor Migration Watchsite Registry project (Senner and Brett 1989), which, in 1993 was renamed *Hawks Aloft Worldwide*. By 1998 this global conservation initiative had identified 384 raptor migration watchsites in more than 80 countries worldwide (Bildstein et al. 1993, Bildstein and

Fig. 11. Jim Bednarz, the Sanctuary's first Ph.D. biologist and Director of Research helped elevate research ornithology at Hawk Mountain in the late 1980s. (Hawk Mountain Sanctuary Archives.)

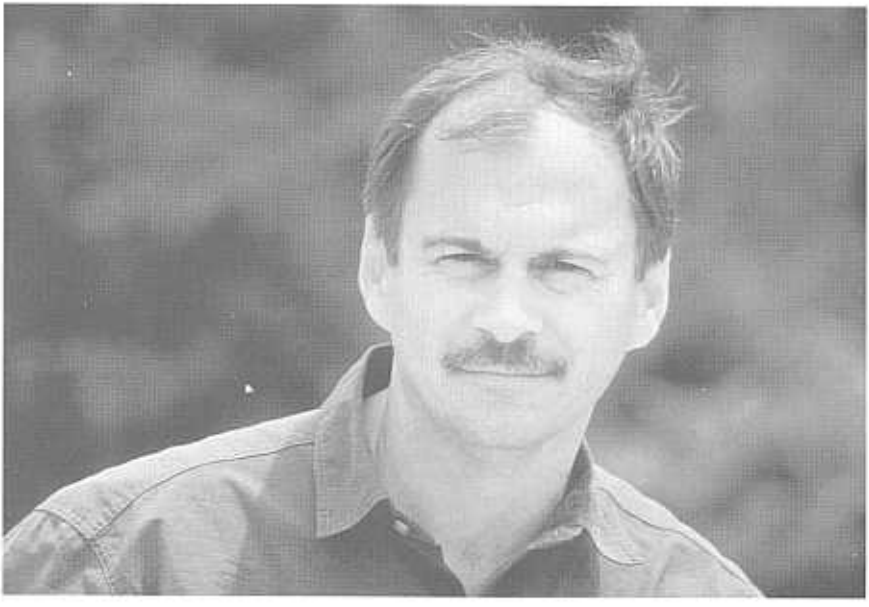

Fig. 12. Keith L. Bildstein helped solidify the Sanctuary's position as an international center for raptor migration science and conservation in the early 1990s. (Photo by Chuck Dressner.)

Zalles 1995, 1998, Bildstein et al. 1995, Zalles and Bildstein 1995). Bildstein also helped prepare the Northern Harrier (*Circus cyaneus*) and Sharp-shinned Hawk species accounts for *The Birds of North America* (MacWhirter and Bildstein 1996, Bildstein and Meyer in press), and in 1998, together with colleagues at the National Audubon Society and the Cornell Lab of Ornithology, he helped organize a worldwide web-based *International Broad-winged Hawk Survey* that tracked—in near-live time—the movements of Broad-winged Hawks from their breeding grounds in eastern Canada and the northeastern United States, to wintering areas in Central and South America (Bildstein 1999).

Today, Hawk Mountain Sanctuary is an international leader in raptor conservation, particularly in Central and Latin America (Bildstein and Zalles 1998), where it is collaborating with Pronatura Veracruz and HawkWatch International, at the world's most significant raptor migration watchsite in Veracruz, Mexico (Bildstein et al. 1995, Maxwell 1996, Bildstein and Zalles

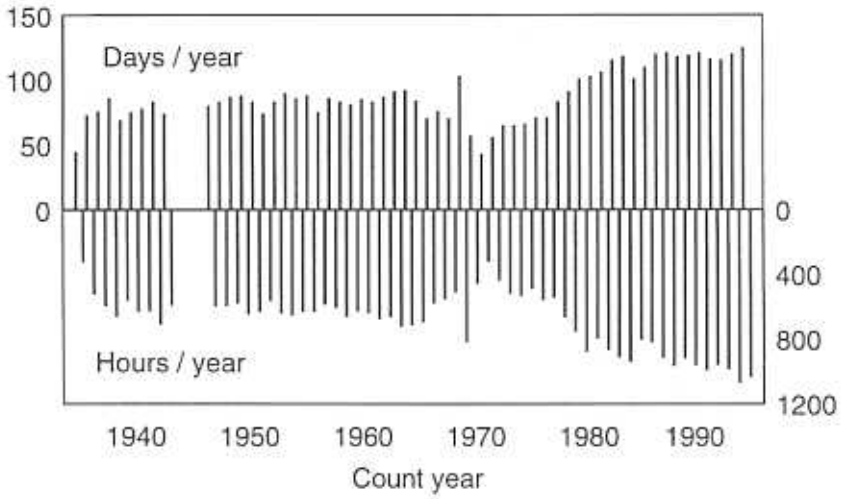

Fig. 13. North Lookout count efforts at Hawk Mountain Sanctuary, 1934-1995. No counts were made in 1943-1945 while Maurice Broun served with the U.S. Navy in the South Pacific. The decrease in count effort in the late 1960s and early 1970s is the result of moving the count among Sanctuary lookouts, principally North, South, and Owl's Head lookouts, depending upon daily weather conditions.

1998). By mid-1998, *Hawks Aloft Worldwide* was working together with more than 800 international cooperators in maintaining an active roster of close to 400 watchsites, 105 of which record or have the potential to record more than 10,000 migrants annually. In early 1998, Sanctuary authors, with the help of conservationists on six continents, published the first conservation status report for the world's 222 species of mainly or completely tropical raptors (Bildstein et al. 1998).

In sum, throughout its 65-year history, conservation ornithology at Hawk Mountain has focused on the central themes of long-term monitoring (Fig. 13) and ornithology in service to conservation biology (Fig. 14). Although each of the personalities involved has lent his or her own distinguishing characteristics to these efforts, the Sanctuary has remained faithful to the intentions of its founder, Rosalie Edge, who viewed Hawk Mountain as a place with "a duty to its human visitors no less important than its duty to its migratory and resident wildlife" (Edge 1939). That Hawk Mountain Sanctuary welcomed 80,000 visitors a year in the mid-1990s, while its staff members were asked to organize the scientific programs for the 2nd Raptor Research Foundation (RRF) International meeting in Urbino

Fig. 14. Joseph Taylor, left, and Peter Edge, right, at the Sanctuary Common Room in the early 1960s. Taylor, who was instrumental in founding the Hawk Migration Association of North America in 1974, was Sanctuary President from 1967 to 1992. Peter Edge, Rosalie Edge's son, and her successor as Sanctuary Association Board President, upon her death in 1962, was with his mother when she first visited the Sanctuary in June 1934. (Hawk Mountain Sanctuary Archives.)

Italy in 1996, and the 3rd RRF International meeting in Trebon, Czech Republic in 1999, as well as host the 25th Anniversary meeting of the Hawk Migration Association of North America in 2000, is indicative of this dual role.

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