Journal of Mammalogy, 101(6):1752–1780, 2020
DOI:10.1093/jmammal/gyaa100
Published online November 20, 2020

Obituary: Thomas Henry Kunz (1938–2020)

Dr. Thomas Henry Kunz (Fig. 1), an internationally recognized expert on the ecology and behavior of bats and Professor at Boston University, passed away on 13 April 2020 in Dedham, Massachusetts, at the age of 81 as the result of complications from COVID-19. Tragically, Dr. Kunz's career was cut short when he was the victim of a pedestrian–automobile accident on 26 October 2011. He was struck crossing a street in Toronto, Canada, while participating in his favorite annual meeting, that of the North American Society for Bat Research (NASBR). He never fully recovered from the head trauma suffered and was not able to live independently, but he enjoyed daily visits from his wife and frequent visits from his children and grandchildren as well as friends. His wife, Margaret, who he described in his autobiography as "a major influence on my life through her companionship, love, support, and encouragement," also became his advocate over this extended period (197:169; numbers appearing in parentheses without an author or year refer to articles in the accompanying bibliography). "Tom," to his many friends and colleagues, was born on 11 June 1938 in Independence, Missouri, to William H. and Edna F. (Dornfeld) Kunz. He married Margaret Louise Brown on 27 December 1962 in Faucett, Missouri, Margaret's hometown. Two children were born to Margaret and Tom—Pamela Kunz (Jeffrey Kwan) and David Kunz (Nicole, née D'Angelo) and five grandchildren. "Dr. Kunz was an inveterate handyman who built treehouses, created jigsaw puzzles, and taught his children to use power tools and drive cars with stick shifts. He loved canoeing, bicycling, traveling with his wife, and spending time with family. 'He was handy and he was hands-on,' said his son David, who works in finance in New York City. 'I might have seen him fall asleep at his computer, but he never missed a single one of my games'" (McKenna 2020).

The primary influence in Tom's early years was his father who worked for the Kansas City Power and Light Company. His father had played violin in a small local band and pitched softball for his company's team, but his true passion was for "Chinese-style" table tennis. In his youth, Tom also developed a zeal for table tennis even winning some local competitions, but as he progressed through elementary and high school, football and track captured his interests (197). His football career at East High in Kansas City, Missouri, culminated in a 10–0 season and the city championship in his senior year as a starting defensive end.

Tom's early interest in science was sparked by a fifth-grade teacher who had her students undertake a project raising silkworms. Tom commented in his autobiography that, "This experience left an indelible impression on me, and highlights the power of observational learning" (197:150). Tom also had an early experience with a bat colony inside a stove in a fishing cabin. After chasing and removing the bats from the cabin, Tom recalled, "being fascinated by these little winged 'critters'" (197:150). Tom became an Eagle Scout and remembered taking great pride in earning his nature merit badge, which required learning the names of local plants and animals. When Tom graduated from high school, he was planning to attend college and play football; however, offers to play did not come so he changed his plans and joined the U.S. Army in summer

Fig. 1.—Thomas H. Kunz (1938–2020) in his laboratory at Boston University on 5 February 2010. Photograph courtesy of Stephen Alvarez, Sewanee, Tennessee.

1956. After six months of basic training filled with physical exercise, he returned home in great condition having put on several pounds of muscle.

After working at several temporary jobs, Tom matriculated in fall 1957 at Central Missouri State College (now University of Central Missouri, Warrensburg) where he joined the "Mule" football program. Tom lettered during all four years in football, starting many games, but his playing time was occasionally limited because of recurring injuries. By his senior year, he was elected co-captain of the team. In academics, Tom had declared a double major in Biology and Physical Education. The Biology Department had a faculty of three that increased to four in his junior year. In his autobiography, Tom mentioned Drs. Laura Nahm and Oscar Hawksley as being particularly influential in his education as a biologist. During his college years, Tom and some of his friends started exploring caves in the Ozarks during winter weekends, for recreational purposes, and fortuitously these adventures also exposed him to hibernating colonies of bats. During one of these expeditions, they found a bat wearing a band from the U.S. Fish and Wildlife Service and were surprised to learn that it had been placed by their new faculty member Richard Myers. The culmination of his college biology education was Field Biology, a course taught by Hawksley and Myers. Major highlights of the class were a project and field trip that he rated, "the most memorable field experiences in my undergraduate college career" (197:153). In spring 1961, Tom graduated from Central Missouri with a B.S. in biology.

After graduation, Tom accepted a position to coach the freshman football team at Central Missouri and to scout opponents for the varsity team. This seemed to assure his plan to pursue coaching in the future. Coaching also allowed Tom to obtain a M.S. degree in education, which he received in spring 1962. It was in spring of 1962 that Tom began dating his future wife, Margaret, who had been appointed as an instructor in the Business Department at Central Missouri. In August 1962, Tom accepted the position of biology teacher and assistant football and track coach at Shawnee Mission West High School in the Kansas suburbs of Kansas City. He remained in this position for five years, but as he was advising the members of a new outings club, Tom discovered that he loved working in the field with students. He determined that he wanted to further his education and to consider teaching at the college level. With a stroke of good fortune, Tom received a grant for a summer biology institute in 1964 that allowed him to take two courses at the University of Nebraska-Lincoln. Dr. Thomas Thorson, an international expert on the physiology of sharks who taught both courses, "challenged me to think about the relationship between ecology and physiology" (197:154). One of the courses was an independent research project, and Tom's choice was a survey of the bats south of Lincoln that resulted in a shotgun-assisted total of 23 bats. One of the animals represented in his collection was an important distribution record of the evening bat *Nycticeius humeralis*, resulting in Tom's first publication—a 1965 note (1) in the *Transactions of the Kansas Academy of Science*.

Tom began investigating graduate programs that would allow him to study the ecology of bats and was surprised to learn that one of the premier programs in the country was a short trip down the Kansas Turnpike at the University of Kansas (KU) in Lawrence. He was aware of the work of a young new professor J. Knox Jones, Jr., because of Jones' work on Nebraska mammals. Jones encouraged Tom to pursue his interests in the ecology of bats and to consider beginning work on bats in Iowa because so little work had been done in the state. With this advice, Tom applied for and received a scholarship to a NSF-sponsored Summer Institute in Biology leading to a master's degree at Drake University in Des Moines, Iowa. For his thesis project, he studied bats in the nearby Ledges State Park, and, as always, Tom made the most of his opportunity. He received his M.A. in spring 1968 with a thesis entitled "The seasonal and nocturnal periodicity of bats in Boone County, Iowa" (Kunz 1968), and six of his next seven publications resulted from this research project (2–4, 6–8). During this time, Tom was particularly influenced by two papers published by Clyde Jones—"one of the first papers published on the ecology of an assemblage of bats in North America" (Jones 1965; 197:158) and one of the few studies that, "had reported on postnatal growth and development of North American bats" (Jones 1967; 197:161).

After much thought and planning, Tom entered the graduate program of Knox Jones at KU in fall 1967. Jones had secured him a three-year Kansas Biological Survey Fellowship to study bats in Kansas. The Fellowship provided funds for most of his academic expenses and fieldwork and supplied a vehicle for travel around the state. Tom was one of the later entries into a large cohort of active Ph.D. students working for Professor Jones who completed their degrees in the late 1960s and early 1970s, with Tom being the last to finish at KU in September 1971. A freelance reporter after interviewing Tom in 2011 wrote about this cohort, "They were country boys most of them Boy Scouts and high school athletes, the last of a breed that predated the lab rats most biologists are today. They were drawn to the sciences by a love of the outdoors and propelled upward by a surge of federal funding during the space race" (Genoways 2011:50). Hugh Genoways recalls that it did not take Tom long to fit into the group although his colleagues were primarily studying mammalian systematics. Because Tom and Margaret lived less than two blocks from Kansas Memorial Stadium, their home became the regular tailgating site before Jayhawk football games. Margaret's idea of tailgating set a standard seldom matched even today. Hugh's wife Joyce remembers that the first time that she ever had sirloin tip roast was at one of Margaret's pregame "brunches."

After a few early "learning experiences," Tom visited the Gypsum Hills in south-central Kansas with Stan Roth, a naturalist and teacher at Lawrence High School who Tom knew from his high school teaching days. Following this trip, Tom settled on a project involving the cave myotis (*Myotis velifer*) in that part of Kansas. He eventually gathered considerable data on the reproduction, growth and development, and feeding ecology of this species. He focused his work in large maternity colonies located in barns. His research was greatly enhanced by

using a harp trap designed by fellow graduate student Merlin Tuttle, which allowed the capture of large numbers of bats near the entrance to the structure thus reducing disturbance of the colony. Tom credited Robert Hoffmann, who joined the faculty at the University of Kansas in 1970 as a professor in the Department of Systematics and Ecology and curator in the Museum of Natural History, for assistance as he was preparing the discussion of his dissertation, stating, "I greatly benefitted from discussions on ecology and population biology with Bob" (197:164). After completing his dissertation, "Ecology of the cave bat, *Myotis velifer*, in south-central Kansas" (Kunz 1971), he was off to Boston University to begin a position as an assistant professor in the Department of Biology, where he actively pursued teaching and research for the next four decades.

At Boston University, Tom progressed through the academic ranks becoming an Associate Professor in 1977 and Professor in 1984 in the Department of Biology. He carried a heavy administrative load in the department serving as Associate Chair from 1981 to 1985 and again from 1998 to 2007 and as Chair from 1985 to 1990. Tom was the Director of the Graduate Program in Ecology, Evolution, and Behavior within the department from 1985 to 2007. He also was a member of University Chapter of Sigma Xi, serving as Vice President (1976–1977) and President (1977–1978) early in his academic career.

As chair of the department, Tom was deeply involved in oversight of planning and construction of what was then a new Biology Research Building of just under 60,000 square feet. Allen Kurta recalls that Tom along with the, "other organismal professors were the basement rats in the old biology building. The only window in the old lab was eye level with the Mass Turnpike (I-90), although you could see the lights of Fenway Park, if you looked up and over the cars. And, of course, the cockroaches fought us for our lunches every day …." One of his colleagues at the time, Fred Wasserman, observed, "Tom, took it upon himself to provide us with a better working environment. He meticulously worked with the architects on every aspect of the building, not just the labs and classrooms but the main office and lounge areas. He commissioned an artist, Spider Johnson from Mason, Texas, whom Tom met while doing field research, to create a wooden mural for the lounge outside the main office. If you look closely at it . . . there are representatives of animals we worked with—at the bottom of the mural is a soda can to signify our need to care for the environment. I remember that for about 2 years it was not unusual to see Tom walking through the building with rolled up designs for the building, heading to a meeting. It was a huge task. Unfortunately, we forget. He was special." Robert Tamarin, now an Emeritus Professor of Biology at the University of Massachusetts Lowell, followed Tom as chair of the Department of Biology at BU in 1990. He recalled, "Not only had Tom worked tirelessly to design our new biology building, but he put the whole department on a fiscally responsible budgeting system and introduced computer technology to the department. He brought the largest department in a very large university into the modern era. These were outstanding accomplishments to those of us in the department."

Over the years, Tom contributed his time to numerous committees at all levels within the University. He served on many departmental committees, including Chair, Student Activities and Advising (1971–1974); Graduate Admissions (1974–1978, 1991–1997); Appointments, Promotions, and Tenure (1996–1997, 1998–2003); Director of Graduate Studies (1978–1981); and Director (1990–2003) and Co-director (2003–2006) of the Stable Isotope Laboratory. At the level of the College of Arts and Sciences, he was a member of the committees for Appointments, Tenure, and Promotion (1994–1996, 2004–2005), Dean's Advisory (1988–1990), Radiation Safety (1985–1990), Academic Policy (1982–1985), Interdisciplinary (1979–1980), Honors (1978–1980), and Environmental Studies Planning (1976–1978). Tom served on the Graduate School Council (1974–1976) and as a member of the Executive Committee (1974–1977). He was an associate faculty member for the Center for Energy and Environmental Studies from 1980 to 2011. At the university level, Tom served on Appointments, Tenure, and Promotion Committee (1991–1992, 2002–2003), Science Advisory Committee of Boston University Academy, (1991–1998), and President's Council for Boston University and the Global Future (2005–2007).

Tom was involved in instituting two important ongoing programs within Department of Biology. He was the founding director of the Center for Ecology and Conservation Biology in 1996 and remained in that position until 2011. The goals of the Center were to promote an understanding of ecology and conservation biology through research, education, and outreach. From its inception, the Center was a leader in training the next generation of undergraduate students majoring in biology and environmental studies at Boston University. The other program for which Tom was one of the two co-founders was the Tiputini Biodiversity Station that was established in 1995 (he remained on the Board of Directors until 2011) by the Universidad San Francisco de Quito in collaboration with Boston University, to accommodate the training of students and promotion of research. The goal of the Tiputini Biodiversity Station was to enhance understanding of rainforest ecosystems through education, research, and ecotourism by providing an opportunity to experience a pristine environment. The isolated station is located in the Yasuni Biosphere Reserve, in the Eastern Ecuadorian Amazon, on a 650-hectare tract of lowland rainforest. In 2005, the National Science Foundation provided a grant that allowed upgrading of facilities, including an expanded laboratory, guest quarters, and improved communications. One of Tom's former colleagues, Professor Richard Primack, observed that, "Tom was an important leader at Boston University. He not only had this enthusiasm, but he was very successful at implementing things—he knew how to get things done administratively and financially" (Thurston 2020).

Although Tom made major scientific contributions through his research and administrative leadership, his greatest impact on the future of chiropterology and of science in America may well be through the students whom he trained. The entire impact of his students will not be fully realized in our lifetime. Some of the places where his students and postdoctoral

associates are employed include Arizona State University, Auburn University, Bat Conservation International, Bucknell University, Eastern Michigan University, Leibniz Institute for Zoo and Wildlife Research (Berlin), Lesley University, Rhode Island College, Smithsonian Tropical Research Institute–Panama, Tel Aviv University, Texas Tech University, U.S. Fish and Wildlife Service, Universidad de Costa Rica, Universidad Interamericana de Puerto Rico, Universidad Regional Amazónica–Ikiam (Tena, Ecuador), University of California Riverside, University of Rhode Island, University of Nebraska-Lincoln, and Winston–Salem State University. He served as the academic advisor or co-advisor for 30 (18 women, 12 men) graduate students who completed Ph.D. degrees, with all but one focusing on bats. In addition, he trained 16 students (9 women, 7 men), who completed master's theses (Table 1). Eighteen (6 women, 12 men) post-doctoral associates participated in research projects in Tom's laboratory for a cumulative total of about 40 years. The gender ratio of Tom's graduate students is an impressive record of supporting women in science. Winifred Frick opined, "Tom's welcoming, supportive attitude shaped the way I approached my own work–life balance. Alongside all the mentoring on grantsmanship, collaborations, research ideas, and passion for work, perhaps the greatest gift was his support of me as a woman in science."

In addition to training and supervising graduate students, Tom taught a broad array of courses in the Department of Biology including Introductory Biology (Ecology, Behavior, and Evolution), Biology of Mammals, Ecology, Evolutionary Ecology, Vertebrate Zoology, Population Biology, Mammalian Ecology, and Physiological Ecology. One of Tom's undergraduate students, Lesley Pepin (2010:3), wrote, "As a biology student, I have studied a broad range of topics from cells to ecosystems. Like most undergrads, I did my learning in the traditional fashion—was attentive in class, participated in lab, and toiled the days away in Mugar Library. Participating in the Undergraduate Research Opportunity Program . . . as a field assistant for Professor Tom Kunz's bat lab shook up this routine in a much-needed way. My experience using thermal imaging cameras to record the flight behavior of Brazilian free-tail bats at Davis Cave, Frio Cave, and James River Cave in Texas, and even to New Mexico's Carlsbad Caverns National Park allowed me to rediscover my curiosity and passion for the biological sciences." Brock Fenton expressed the opinion, "One way to better appreciate Tom and his role in science and education was to co-teach a field course with him. We did this in 1973, taking a group of undergraduate students from different universities to a cave in Puerto Rico. In a sense, such an intensive experience was just an extension of formal teaching. People sharing common enthusiasms and curiosities. In either setting, Tom was in his element." Tom also provided motivation much closer to home, as his daughter Pamela credited, "my dad inspired an early interest in science and ultimately my decision to pursue a career in science." Tom was excited to hear of Pamela's new position at Yale Cancer Center just before he died.

One of Tom's former graduate students, Polly Campbell, recalls that, "Tom approached teaching with the same child-like enthusiasm that he approached his research and life in general. I took one of his mammalogy courses . . . in my first semester as his Ph.D. student at BU. It was before PowerPoint took over lectures and I have a notebook full of notes that prove that he wrote stuff on the board, but what I really remember is his gleeful descriptions of the ecology and behavior of the animals he showed photos of, projected on the screen from an old-school slide carousel. I also remember him giggling like a pre-adolescent kid when describing aspects of reproductive biology. It was utterly inoffensive."

Table 2 is a listing of the grants received by Tom as a Principal Investigator or CoPrincipal Investigator, while he was employed at Boston University. The list of grants is prodigious by any measure. There are 109 grants from 28 agencies and organizations. Tom received the most grants (34) from the National Science Foundation (NSF) with funding from several programs: Biological Instrumentation; Collaborative Cross-Disciplinary Research in Ecology, Endocrinology and Molecular Biology; Doctoral Dissertation Improvement; Ecology of Infectious Diseases; Ecosystem Studies; Facilities Improvement; Information Integration and Informatics; Information Technology Research; International Conference; Major Research Instrumentation Program; NeTS-NOSS; Research Experiences for Undergraduates; and Small Grant for Exploratory Research. The total of these grants from NSF was at least $13,063,000 (converting each grant to 2020 dollars, the value would be $17,940,000).

Tom received multiple grants from 10 of the 28 funding agencies. Certainly, agencies being willing to provide two or more grants must be an indication of satisfaction with the work performed and the results obtained. The organizations with the second and third highest number of grants to Tom were two 501(c)(3) nonprofit groups—Lubee Foundation and Bat Conservation International. In addition to NSF, Tom received grants from six federal agencies. The real value of these grants was succinctly stated by Winifred Frick, one of Tom's former post-doctoral associates, "His instincts and skills at procuring grants helped secure significant funding that resulted in a lasting and substantial body of research on bats in North America."

To say that Tom was a prolific researcher and writer would be to understate the obvious. He published 347 items, running the gamut of scientific output from books to book chapters, journal articles, book reviews, project reports, and even popular articles (see bibliography below). The seven books that Tom edited and wrote were produced by leading scientific publishers, including Johns Hopkins University Press, Oxford University Press, Plenum Press, Smithsonian Institution Press, The National Academies Press, and University of Chicago Press. He was an author of 60 chapters in books and served as reviewer for 11 books. Tom published articles in at least 101 journals that covered the alphabet from *Acta Chiropterologica* to *Zootaxa*. He chose publications of the American Society of Mammalogists (ASM) most often as the outlets for his work, with 36 articles in the *Journal of Mammalogy* and 12 *Mammalian Species* accounts. Tom published five or more times in 10 other journals, reflecting the breadth of his interests—*Acta Chiropterologica*

Table 1.—Students completing graduate degrees and post-doctoral associates working under the supervision of Thomas H. Kunz at Boston University.

Year	Names
Students who completed master's degrees	
1974	Ralph Hamill
1976	Edythe L. P. Anthony and James G. Hallett
1977	Elizabeth M. Howell
1978	Robin F. Bernath, W. Timothy Rumage, and Marylou A. Tracy
1983	Karen M. Hoying
1986	Carlos A. Díaz
1988	Anne P. Brooke
1990	Jane M. Winchell
1994	Helen M. Papadimitrou
1998	Jason W. Horn and Jennifer Newmark
2000	Jamie B. Bender
2003	Pablo Jarrín-V.
Students who completed Ph.D. degrees	
1981	Peter. V. August
1982	Edythe L. P. Anthony and Christopher D. Burnett
1985	Margaret H. Stack
1986	Martha S. Fujita and Allen Kurta
1990	Armando Rodríguez-Durán
1995	April A. Stern
1998	R. Scott Reynolds and Ruth C. B. Utzurrum
2000	Johanna M. Bloss, Wendy R. Hood, Tigga Kingston, and Jay F. Storz
2001	Robert Hodgkison (with Zubaid Akbar and Paul A. Racey, graduated from University of Aberdeen, Scotland)
2002	Susan L. Nelson (with Steven R. Humphrey, graduated from University of Florida)
2004	Lizabeth O. Southworth
2006	Polly Campbell, Gloriana Chaverri, and Christopher S. Richardson
2007	Jason W. Horn and J. Benjamin Rinehart
2008	Mariana Muñoz-Romo
2009	Louise C. Allen
2010	Marianne C. Moore and Jonathan D. Reichard
2012	Pablo Jarrín-V.
2014	Elizabeth C. Braun de Torrez (with Michael D. Sorenson) and Aryn P. Wilder (with Michael D. Sorenson)
2015	Kate E. Langwig (with Winifred F. Frick and A. Marm Kilpatrick, graduated from University of California, Santa Cruz)
2016	Nathan W. Fuller (with Michael D. Sorenson)
Post-Doctoral Associates	
1981–1982	David Byman
1984–1985	Edward S. Stashko
1985–1987	Gary P. Bell
1986–1988	Allen Kurta
1997–1998	Tolibjon Khabilov
1998–2000	Christian C. Voigt
1999–2000	Noga Kronfeld-Schor
2001–2004	DeeAnn M. Reeder
2001–2005	Tigga Kingston
2003–2008	Robert Hodgkison
2004–2007	Nickolay I. Hristov
2006–2008	Daniel K. Riskin
2006–2011	Christopher S. Richardson
2007–2008	Jason W. Horn
2008–2010	Winifred F. Frick
2009–2012	Gloriana Chaverri
2010–2011	Marianne C. Moore
2010–2011	Jonathon D. Reichard

(10), *Journal of Comparative Physiology B* (9), *Journal of Zoology* (London) (9), *Biotropica* (8), *Canadian Journal of Zoology* (7), *Journal of Tropical Ecology* (7), *Public Library of Science* (*PLoS One*) (6), *Integrative and Comparative Biology* (5), *Journal of Wildlife Management* (5), and *Physiological and Biochemical Zoology* (5). His work also appeared in several leading publications of today, including *Nature* (1), *Science* (3), *Philosophical Transactions of the Royal Society B* (1), and *Proceedings of the Royal Society of London* (2). However, beyond the numbers and counts, the true value of Tom's research lies in the data generated, the ideas created, and the hypotheses tested.

Soon after arriving at BU, Tom began using Sargent Camp, near Peterborough, New Hampshire, as a field base for his research activities. Although owned by the university, the property was primarily a site for workshops in environmental education aimed at middle-school children. Nevertheless, Tom found the surrounding countryside ideal for bat research. He supposedly traded an old truck (an International Harvester Travelall) for exclusive use of a primitive cabin on the property and dubbed it the Mossy Grotto; the cabin ultimately provided housing for generations of undergraduate and graduate students, while using the nearby Nubanisit River, Half Moon Pond, and dozens of local maternity roosts as study sites (Fig. 2). The first paper based on research conducted at BU appeared in 1975 (14) with Carol Brock, a student, as coauthor. They compared the patterns of bat activity revealed by trapping and ultrasonic monitoring. In 1976, a second paper (16) from work done at Sargent Camp reported observations of responses of little brown myotis to playback of various sounds. Tom's pattern of publications through 1978, continued to reflect research opportunities pursued at Sargent Camp (17–19, 21, 22), as well as other endeavors. The diversity of topics and authorships reflected his broad interests and talents for identifying productive research topics, good field sites, and talented students. What also emerges from this period of research productivity is that whether it was identification of endoparasites, ecology of ectoparasites, or impact of insecticides on bats, Tom led from the front and was involved in every aspect of the work and writing. An impactful paper from this period was by Edythe Anthony and Tom (20), dealing with feeding strategies of the little brown bat, which drew on many of the projects they had undertaken at Sargent Camp.

In the late 1970s and early 1980s, research in Tom's lab expanded in two important directions—one involving approach and the other geography. The first direction consisted of a more thorough integration of ecological and behavioral observations on free-ranging bats with physiological measurements made on captive animals. This integrative approach ultimately generated a more holistic understanding of the strategies that these animals were using to survive and reproduce. Early attempts, for example, combined behavioral time budgets and profiles of roosting ambient temperature developed in the field by Tom and his students, with metabolic measurements of various activities from the literature, to yield some of the first energy budgets for free-living bats, including adults (29) and nonvolant young (57). As time went on, more of the laboratory analyses, such

Table 2.—Grants on which Thomas H. Kunz was the Principal Investigator (PI) or a CoPrincipal Investigator (CoPI), while he was on the faculty in the Department of Biology, Boston University. Granting agencies and organizations are in boldface. Graduate students are identified as "Grad."

Starting date	Title	Investigators
National Science Foundation		
1973	Undergraduate Research Participation Grant. $82,400	Kunz, PI
1978	Instructional Scientific Equipment: Ecological energetics.	Kunz, PI
1983	Doctoral Dissertation Improvement Grant: A latitudinal comparison of growth and development in the little brown bat, *Myotis lucifugus*, with implications for geographic variation in adult morphology.	Kunz, PI; Fujita, Grad
1984	Energy allocation and water flux in free-ranging bats. $93,990	Kunz, PI; Nagy, CoPI
1987	Collaborative proposal: Parental investment and mother–infant recognition in the Mexican free-tailed bat (*Tadarida brasiliensis*). $85,000	Kunz, PI
1988	Biological Instrumentation: Purchase of an isotope ratio mass spectrometer. $161,400	Lajtha, PI; Kunz, CoPI
1993	Research Experiences for Undergraduates: Collaborative, cross-disciplinary research in biology. $51,250	Kunz, PI
1994	Doctoral Dissertation Improvement Grant: Reproductive energetics of the greater spear-nosed bat, *Phyllostomus hastatus*. $11,940	Kunz, PI; Allgaier-Stern, Grad
1994	Research Experiences for Undergraduates: Collaborative, cross-disciplinary research in biology. $156,303	Kunz, PI
1997	Research Experiences for Undergraduates: Collaborative, cross-disciplinary research in ecology, endocrinology, and molecular biology. $159,000	Kunz, PI
1997	Doctoral Dissertation Improvement Grant: Evolution of socially-structured populations. $8,000	Kunz, PI; Storz, Grad
1998	Doctoral Dissertation Improvement Grant: Chemical ecology of bats. $7,866	Kunz, PI; Bloss, Grad
1998	Integrated modeling and assessment of natural populations using infrared and Doppler radar imaging. $368,684	Kunz, PI; Cleveland, CoPI
1998	Leptin and reproduction in free-ranging bats. $220,000	Widmaier, PI; Kunz, CoPI
2000	Research Experiences for Undergraduates: Collaborative, cross-disciplinary research in ecology, endocrinology, and molecular biology. $167,100	Kunz, PI
2001	Spatial determinants of insectivorous bat diversity and process in a Paleotropical rainforest. $387,901	Gopal, PI; Kunz, CoPI
2002	Regulation of leptin secretion in pregnant mammals. $424,781	Widmaier, PI; Kunz, CoPI
2002	An isotope mass spectrometer and autoanalyzer for environmental research. $232,137	Finzi, PI; Kunz, Murray, Valiela, CoPIs
2002	Acquisition of an infrared thermal camera for applications in ecology and behavior. $117,474	Kunz, PI
2002	Field site improvement at Sargent Center for education and research activities. $97,532	Phillips, PI; Kunz, Woodcock, Rubendal, CoPIs
2003	Information Technology Research (ITR): Advanced imaging and information technology for assessing the ecological and economic impact of Brazilian free-tailed bats on agroecosystems. $2,496,305	Kunz, PI; Betke, McCracken, Westbrook, Morton, CoPIs
2004	Doctoral Dissertation Improvement Grant: Testing limits of co-existence in Paleotropical cryptic bat species. $10,000	Kunz, PI; Murray, Grad
2004	Equipment Supplement (ITR): Advanced imaging and information technology for assessing the ecological and economic impact of Brazilian free-tailed bats on agroecosystems.	Kunz, PI; Betke, CoPI
2004	Ecology of Infectious Diseases: Ecological influences on rabies infections in bats. $1,520,000	McCracken, PI; Hallam, Kunz, CoPIs
2005	NeTS-NOSS: Semantic internet working of sensor systems for efficient in network information processing. $762,000	Little, PI; Kunz, Alanyali, Phillips, Saligrama, CoPIs
2005	Effects of leptin and its mechanisms of action on mammalian trophoblast cells. $450,000	Widmaier, PI; Kunz, CoPI
2005	Facilities improvements at the Tiputini Biodiversity Station in eastern Ecuador. $149,000	Kunz, PI; MacLatchy, Schneider, Swing, CoPIs
2005	International Conference: World summit on evolution in the Galapagos. $42,180	Kunz, PI; Valles, Quiroga, CoPIs
2006	REU Supplement, ITR: Advanced imaging and information technology for assessing the ecological and economic impact of Brazilian free-tailed bats on agroecosystems.	Kunz, PI
2006	REU Supplement, ITR: Advanced imaging and information technology for assessing the ecological and economic impact of Brazilian free-tailed bats on agroecosystems.	Kunz, PI
2008	Doctoral Dissertation Improvement Grant: Interactions between immune function, stress physiology, pathogens, and environmental contaminants in temperate bat species. $11,000	Kunz, PI; Moore, Grad

Table 2.—Continued

Starting date	Title	Investigators
2009	Small Grant for Exploratory Research (SGER): Death by starvation: a hypothesis based approach for addressing white-nose syndrome in hibernating bats. $34,999	Kunz, PI; Frank, Widmaier, CoPIs
2009	Intelligent tracking systems that reason about group behavior. $2,754,772	Betke, PI; Sclaroff, Kunz, Wong, CoPIs
2011	The effect of sociality on transmission and spread of a multi-host pathogen. $2,000,000	Kunz, PI; Foster, Frick, Kilpatrick, McCracken, CoPIs
Lubee Foundation, Inc.		
1991	Nutritional ecology and energetics of Old-World fruit bats: strategies for maintaining captive breeding colonies.	Kunz, PI
1991	Feeding and nutritional ecology of Philippine fruit bats.	Kunz, PI; Utzurrum, CoPI
1992	Physiological ecology and reproductive energetics of endangered fruit-eating bats.	Kunz, PI
1994	Conservation biology of bats in Malaysian dipterocarp forests.	Kunz, PI
1996	Social, reproductive, and feeding ecology of Old-World fruit bats.	Kunz, PI
2000	Ecology, behavior, and conservation biology of Paleotropical bats.	Kunz, PI
2004	Ecology and conservation of Old-World fruit bats.	Kunz, PI
Bat Conservation International		
2007	Using ultrasonic emissions to reduce bat fatalities at wind energy facilities.	Kunz, PI
2008	Foraging behavior and diversity of bats in a pecan agroecosystem in Texas.	Kunz, PI; Braun, Grad
2008	The effects of mercury contamination on immune function in two species of temperate bat species—*Myotis lucifugus* and *Eptesicus fuscus.*	Kunz, PI; Moore, Grad
2009	White-nose syndrome in bats: death by starvation.	Kunz, PI
2011	The impact of wing damage caused by white-nose syndrome in the little brown myotis. $10,000	Kunz, PI; Turner, Grad
2011	Host community susceptibility to white-nose syndrome. $10,000	Kunz, PI; Langwig, Grad
Boston University		
1974	Biomedical Research Grant: Bat predation and the periodicity of flying insects.	Kunz, PI
1975	Biomedical Research Grant: Responses of bats to their thermal environment.	Kunz, PI
1980	Biomedical Research Grant: Social organization and the evolution of mating systems in the bat *Artibeus jamaicensis.*	Kunz, PI
1988	Biomedical Research Grant: Maternal investment in two species of insectivorous bats.	Kunz, PI
1989	Biomedical Research Grant: Variation in social behavior and maternal investment in the Australian fishing bat.	Kunz, PI
U.S. Fish and Wildlife Service		
1979	Gray and Indiana Bat Recovery Plan.	Kunz, PI
2008	Effects of topography and weather in Vermont on bird and bat migration, and use of appropriate technology to support this investigation.	Kunz, PI
2009	Geographic distribution of the psychrophilic fungus (*Geomyces* sp.) associated with white-nose syndrome.	Blehert, PI; Hicks, Youngbaer, Kunz, CoPI
2010	Immune function, body composition and genetic correlates of bat white-nose syndrome.	Kunz, PI; Sorenson, CoPI; Reichard and Moore, Grads
2011	Monitoring the effects of white-nose syndrome on summer colonies of little brown bats.	Kunz, PI
Air Force Office of Scientific Research		
2007	Conference Support: Aeroecology: probing and modeling the aerosphere.	Kunz, PI
2009	Acquisition of an advanced thermal infrared imaging system for tracking multiple targets in three dimensions.	Kunz, PI; Betke, Swartz, CoPIs
2010	Workshop on radar aerocology: advanced radar imaging of the aerosphere.	Kunz, PI
National Geographic Society		
1985	The evolution of cooperative behavior in tent-making bats.	Kunz, PI; McCracken, CoPI
1996	Population genetic structure and social evolution of an Old-World tent-making bat.	Kunz, PI
2003	Habitat fragmentation and population genetic structure in an Old-World fruit bat.	Kunz, PI; Campbell, CoPI
Disney Wildlife Conservation Fund		
2000	Nutritional landscape ecology of Samoan fruit bats.	Kunz, PI; Nelson, CoPI
2001	Effects of habitat fragmentation on genetic structuring and behavioral adaptations in the lesser dog-faced fruit bat, *Cynopterus brachyotis* (Pteropodidae).	Kunz, PI; Campbell, CoPI
National Speleological Society		
2008	White-nose syndrome: a hypothesis-based investigation of white-nose syndrome in the little brown myotis (*Myotis lucifugus*).	Kunz, PI; Frank, Widmaier, Reichard, CoPIs
2010	Measuring cytokine profiles in hibernating *Myotis lucifugus* affected by white-nose syndrome: assessment of immunocompetence levels in bats affected versus unaffected bats.	Kunz, PI; Moore, Grad

Table 2.—Continued

Starting date	Title	Investigators
Woodtiger Fund		
2010	Research on white-nose syndrome. $50,000	Kunz, PI
2011	Research on white-nose syndrome. $75,000	Kunz, PI
American Philosophical Society		
1983	Social organization and the evolution of cooperative behavior in tent-making bats.	Kunz, PI
BioDiversity Research Institute		
2008	Effects of mercury contamination on immune function in bats.	Kunz, PI; Moore, Grad
Center for Field Research		
1976	Population genetics and ecology of domestic cats.	Todd, PI; Kunz, CoPI
Conanima Foundation		
1991	Travel Award: Reproductive energetics of the Old-World fruit-eating bat, *Rousettus aegyptiacus.*	Kunz, PI
Eppley Foundation for Research		
2010	Adaptive immune response against *Geomyces destructans* and variation at the major histocompatibility complex in the little brown myotis. $25,000	Kunz, PI
Morris Animal Foundation		
2010	Assessing population genetic structure and gene flow in the little brown myotis, *Myotis lucifugus,* to predict the route of spread of white-nose syndrome into the western United States. $196,230	Kunz, PI; Sorenson, CoPI; Wilder, Grad
National Cave and Karst Research Institute		
2002	A guide to bats of North America.	Kuna, PI
National Center for Ecological Analysis and Synthesis		
2002	An ecological-economic analysis of pest-control services: the Brazilian free-tailed bat as a model.	Kunz, PI; Cleveland, McCracken, CoPIs
National Park Service		
2002	Monitoring bat maternity populations in Lava Beds National Park.	Kunz, PI
National Wind Coordinating Consortium		
2007	Assessing impacts of wind energy development on nocturnally active birds and bats: a guidance document.	Kunz, PI
Oak Ridge Institute for Science and Education		
1997	Biological survey for the federally listed endangered Indiana bat (*Myotis sodalis*): Picatinny Arsenal, Morris County, New Jersey.	Kunz, PI
Office of Naval Research		
2010	Animal inspired robust flight with outer and inner loop strategies. BU Subcontract: $3,127,730	Morgansen, PI; Baillieul, Belta, Kunz, Paschalidis, Humbert, Hedrick, CoPIs.
Organization of American States		
1984	Social behavior of Neotropical bats.	Kunz, PI
Sigma Xi		
1972	Feeding behavior and ecology of bats.	Kunz, PI
U.S. Atomic Energy Commission		
1973	Avian radioecology on a nuclear power station site.	Levy, PI; Kunz, Tamarin, CoPIs
U.S. Environmental Protection Agency		
1979	Effects of microwave radiation on airborne fauna.	Battista, PI; Kunz, Wasserman, CoPIs
Western Electric Fund		
1976	Small Equipment Grant: Physiological ecology.	Kunz, PI
1978	Small Equipment Grant: Physiological ecology.	Kunz, PI
1980	Small Equipment Grant: Physiological ecology.	Kunz, PI
1982	Small Equipment Grant: Physiological ecology.	Kunz, PI
World Wildlife Fund—U.S.		
1984	The economic importance of bat-visited plants in Latin America.	Kunz, PI; Stashko, CoPI

as those involving milk components (43), body composition (127; Fujita 1986; Stack 1985), and oxygen consumption (59, 66; Stack 1985) were performed in the basement lab in Boston, at Sargent Camp, or even in the field, in an attempt to simulate natural conditions as much as possible.

As part of this integrative approach, Tom began a productive partnership with Kenneth Nagy of the University of California Los Angeles, in the early 1980s, which led to the pioneering use of doubly-labeled water with free-living bats. Doubly-labeled water was an elegant technique that used the turn-over of oxygen and hydrogen isotopes in an animal's body to determine daily energy expenditure and water flux, as an individual carried out its normal activities in the wild. A drawback of this innovative method was that it required samples of body water from the same individual at the start of a measurement period and again 1 to 3 days later; in other words, the same wild animal had to be caught on two separate occasions at about the same time of day. However, Tom realized that the high site fidelity displayed by bats made such recaptures possible, and he used his knowledge of nearby maternity roosts to orchestrate multiple successful projects using the technique, and ultimately shed light on energetic and

Fig. 2.—Thomas H. Kunz capturing little brown bats (*Myotis lucifugus*) in a barn in Framingham, Massachusetts, on 19 May 2009. Photograph by Vernon Doucette courtesy of Boston University Photography.

water requirements during the stressful periods of pregnancy and lactation (67–69).

During his years as a graduate student and new professor, Tom's research centered on temperate species of bats, but the second new direction to his program began when he expanded his geographic focus to include the tropics. His first research expedition was to Puerto Rico in 1981, along with graduate students Peter August and Christopher Burnett. The initial goal was to study litter size and related morphometrics of big brown bats on the island and to make comparisons with the bats back on the continent. Unfortunately, big brown bats were not sufficiently abundant on Puerto Rico, but rather than go home empty handed, Tom quickly designed a new project dealing with social organization of the Jamaican fruit bat, *Artibeus jamaicensis* (41), based on a paper that he had recently read. Armando Rodríguez-Durán later recalled that Tom, always the teacher, portrayed this experience to his new graduate student, "as an example of the importance of keeping up with the literature, and being flexible," when things did not go as planned. Later trips to Puerto Rico focused on folivory in fruit-eating bats (91).

Tom worked with tropical bats on Trinidad, between 1984 and 1990, collaborating with Gary McCracken of the University of Tennessee, Knoxville, with funding from the National Geographic Society. The impetus for going to Trinidad was to investigate the costs and benefits of tent construction among different age–sex groups of the Peter's tent-making bat, *Uroderma bilobatum*, and to assess possible kinship associations among individuals roosting beneath tents. Working out of Simla (the William Beebe Tropical Research Station), Tom, Gary, and their students amassed a wealth of natural history information on the structure and distribution of tents (80, 82, 84), as well as the identity and behavior of bats that roosted within these leafy shelters (100). In addition, Tom brought his integrative approach to Trinidad and used doubly-labeled water to examine the energetics of harem maintenance in a cave-dwelling species, the greater spear-nosed bat, *Phyllostomus hastatus* (126).

In 1987, Tom and Gary McCracken began a long-term collaboration that ultimately involved multiple research projects on Brazilian free-tailed bats (*Tadarida brasiliensis*). Their early work, funded by NSF's Collaborative Research Program, investigated parental investment and mother–offspring recognition in the huge maternity colonies of these bats in Texas (Fig. 3). Working with several students and collaborators, Tom integrated his interests in the energetics of lactation, postnatal growth, and behavior into the Texas system, resulting in a series of publications focused on *T. brasiliensis* (93, 95, 112, 114, 116), as well as a number of papers comparing maternal investment and growth in multiple species of bats (92, 94, 96, 98, 141). Tom and Gary were particularly delighted when the grants they received for this research were ridiculed in the tabloid, *The National Enquirer* (1987)—that article began, "Batty bureaucrats are milking American taxpayers out of $166,000 to find out how Mexican bats nurse their young." Tom's work on *T. brasiliensis* continued to occupy a considerable part of his research effort through the remainder of his career.

The 1980's also was the decade during which Tom cemented his worldwide reputation by developing and editing two books—*Ecology of Bats* (33) and *Ecological and Behavioral Methods for the Study of Bats* (61). Although he wrote some

Fig. 3.—Thomas H. Kunz (far left) joins Dan Riskin, Tatjana Hubel, and Sharon Swartz (from left to right) at the entrance to Davis Blowout Cave, Texas, on 9 August 2007. Photograph courtesy of Nickolay I. Hristov, Winston-Salem State University, North Carolina.

chapters himself, Tom was careful to involve leading experts from around the globe in both projects so that the books were exceedingly useful to workers on every continent. Both volumes were well received by the academic community, and the methods book, in particular, quickly took on a reputation as the must-have "bible" of all budding bat biologists. Decades later, Tom would be joined by Brock Fenton (179) and Stuart Parsons (253) as co-editors to produce updated and expanded versions of both books for the next generation.

In the 1990s, building from his work on phyllostomid bats in the Neotropics, Tom took his fascination with tent-roosting bats to the Paleotropics where studies of tent-roosting in pteropodid fruit bats in the genus *Cynopterus* were ongoing. Tom met his Indian collaborators, Johnson Balasingh (St. John's College, Tirunelveli) and Hari Bhat (National Institute of Virology, Pune) at an international bat conference. Both Johnson and Hari had detailed observational data on tent construction and occupancy by the greater short-nosed fruit bat, *Cynopterus sphinx*. The resulting publications included the first direct observations of tent-making behavior for any bat (89, 90). Meanwhile, Tom developed collaboration with Malaysian bat biologist, Akbar Zubaid (Universiti Kebangsaan Malaysia, Bangi), that resulted in publications on tent-roosting in the lesser short-nosed fruit bat, *Cynopterus brachyotis*, and Horsfield's fruit bat, *C. horsfieldii* (121, 139), based on data collected by one of Zubaid's students.

Ultimately, Tom's partnerships with researchers in India and Malaysia made it feasible for his students to work in the Paleotropics with considerable intellectual and logistical independence. Some of the resulting projects were in keeping with Tom's interests in roosting ecology and its influence on social structure (152, 153, 172, 202, 204). Much of the work, however, expanded into topics in ecology and evolution that were outside of his primary areas of expertise, including community ecology (145, 175, 187, 188), population genetics (164, 165, 203), and phylogenetics (186, 328). Tom's interests in tent-roosting bats were later brought back to the Neotropics by Latin American students working on phyllostomids in Costa Rica (224, 236) and Venezuela (244).

One of the interesting Paleotropical species that Tom encountered was the Dayak fruit bat (*Dyacopterus spadiceus*). Despite his many research achievements over his productive career, the one Tom was particularly fond of discussing, especially with colleagues who were young parents, was the discovery of male lactation in this species (78, 250, 252). He rarely missed a chance to explain to young fathers that they had the plumbing in place for lactation and only lacked some hormones and initiative to realize their true mammalian potential as parents.

Although most of Tom's research involved studies of free-ranging bats, he maintained a collaboration going back to the 1990's with the Lubee Bat Conservancy in Gainesville, Florida. The Lubee Conservancy maintained reproductively active captive colonies of Old World fruit bats and provided Tom and his collaborators, most notably Dee Ann Reeder, with ready access to that group of bats for comparative studies on subjects such as milk composition (156) and hormonal assays for stress responses (193, 194, 214).

When the U.S. Weather Service established a WSR-88 NEXRAD Doppler radar system in 1995 at New Braunfels, Texas, it became immediately apparent that Doppler radar was an excellent tool for monitoring emergences from major roosts and high-altitude flights of *T. brasiliensis*. After the diets and foraging altitudes of bats were linked to the migratory patterns of major agricultural pests, particularly corn earworm moths (*Helicoverpa zea*), Tom joined with Gary McCracken, John Westbrook (an insect migration expert with the U.S. Department of Agriculture), Cutler Cleveland (an economist at BU), Tom Hallam (an ecological modeler at the University of Tennessee), and others in pioneering efforts to quantify the economic value of the services that bats provide by consuming insect pests (207, 237, 291). This work was supported by a 5-year grant from the NSF Integrated Technology Research Program and involved a series of workshops at Selah Bamburger Ranch Preserve, Johnson City, Texas, and the NSF National Center for Ecosystem Analysis and Synthesis, Santa Barbara, California. There are now dozens of studies quantifying the ecosystem services of bats on all habitable continents, and it is evident that bats provide several billion dollars in pest-suppression services across the globe annually. These savings are often touted as major incentives for bat conservation.

Establishing the actual numbers of bats that were foraging over the Texan landscape was a major issue in quantifying their services. Working with computer scientists, Tom led efforts to use thermal imagery and computer science algorithms to estimate the size of some of the largest aggregations of mammals on the planet during exit flights of *T. brasiliensis* from cave roosts (219, 235, 241). Tom and collaborators also worked to integrate thermal imaging of the flights of bats (Fig. 4) with radar imagery for a better understanding of the behaviors and movements of bats as well as to establish the limitations of the technology (240, 241, 243, 249, 267, 268).

Tom, Gary McCracken, Tom Hallam, and Chuck Rupprecht (Centers for Disease Control, Atlanta) were funded

Fig. 4.—Thomas H. Kunz (left) and Nickolay I. Hristov viewing high-resolution footage of emerging Brazilian free-tailed bats (*Tadarida brasiliensis*) at a roosting site in Texas. The picture was taken on 9 August 2007. Photograph courtesy of Daniel K. Riskin, Toronto, Canada.

simultaneously on a multi-year NSF-funded project investigating the ecological impacts of rabies infections in *T. brasiliensis* (266, 269, 288, 311, 312). Tom's interest in integrating ecology and physiology again came into play, and his students were focusing on how physiological challenges (e.g., pregnancy, lactation, use of alternative roost sites) might impact disease susceptibility. These studies provided several field assays for stress that proved valuable in subsequent work on susceptibility of bats to the fungus that causes white-nose syndrome (234, 290).

During winter 2006–2007, Alan Hicks of the New York Department of Environmental Conservation discovered something unexpected and distressing while conducting annual counts of hibernating bats at underground sites in upstate New York—piles of dead bat bodies and unusual white fuzz on the faces of clustering bats during hibernation. That was the first detection of what became known as white-nose syndrome, a disease of hibernating bats caused by the fungal pathogen *Pseudogymnoascus destructans*, which has now killed millions of bats in North America and continues to threaten several hibernating species with regional or global extinction (275, 282, 308, 317, 326).

Tom Kunz was one of the first people that Al Hicks called when he saw dead bats and did not know why they were dying. Recognizing the severity and urgency of an unprecedented threat to bats, Tom became immediately involved in motivating a rapid, collaborative, and multi-disciplinary response. Working with Al, Tom used his extensive network to involve groups such as Bat Conservation International and the National Speleological Society, as well as to engage a diverse cadre of scientists. He helped organize the first Science Strategy Meeting on White-nose Syndrome, held in 2008 in Albany, New York, that brought together academic researchers, as well as biologists and managers from a mix of state and federal agencies, to discuss scientific questions concerning the novel disease and the management responses needed to combat it. He worked closely with the U.S. Fish and Wildlife Service and other federal and state agencies in organizing response efforts, including raising awareness and the need for increased funding for bat conservation. Tom recognized that varied scientific expertise—from population ecologists to veterinary pathologists—was needed to solve the complex problem of white-nose syndrome. His vision of pursuing scientific inquiry alongside a management response helped create a lasting legacy of a diverse and vibrant community of researchers and managers that continue working toward conservation and research for bats threatened by white-nose syndrome. To this day, the U.S. Fish and Wildlife Service organizes an annual research symposium on white-nose syndrome to share the latest efforts at scientific research and management, and often the topics and themes relate to ideas or efforts initiated by Tom.

White-nose syndrome hit close to home for Tom. Not only did the disease quickly become an existential threat to bats in North America, the malady started in one of Tom's long-term research systems. He and his students had studied little brown bats at maternity colonies in a network of sites in barns and attics across New England for decades, answering fundamental questions about ecology and physiology. In summer 2009, Tom took Winifred Frick on a tour of these colonies. The barns and attics that normally were filled with the social chatter of female little brown bats, clustered tightly together ready to give birth, were silent and empty. Intellectually, Tom swiftly pivoted his research agenda to address the threat of white-nose syndrome, advising his graduate students to shift dissertation projects, using newly available funding to start innovative lines of inquiry, and recruiting fresh students and post-doctoral associates to focus on the science behind white-nose syndrome, with an aim to inform the management response. Emotionally, the sense of personal loss weighed heavily that June day in 2009 when Tom took Winifred from barn to attic and the colonies of bats that he had known and studied for decades were simply gone.

Tom's research program on white-nose syndrome was growing rapidly at the time of his accident in 2011. He was the lead investigator on a new five-year grant from Ecology and Infectious Disease Program of NSF to study the ecology of white-nose syndrome and he had brought on new graduate students and post-doctoral associates to work on all aspects of the disease, including transmission dynamics, population impacts, and genetics. Much of that work continued to be published with Tom as co-author after his accident.

One of Tom's crowning achievements in the latter part of his career was his conceptualization and creation of a newly recognized scientific discipline he dubbed "aeroecology." Tom defined aeroecology as an emerging scientific discipline that integrates diverse fields, such as atmospheric science, earth

science, geography, ecology, computer science, computational biology, and engineering to broaden understanding of the ecological function and biological importance of the aerosphere (243). Aeroecology as a discipline reflects Tom's style as a scientist—it is inherently collaborative and combines use of technology with broad conceptual themes that interface with both advancing ecological science and conservation. Always keen to build diverse partnerships, Tom inspired a groundswell of interest in aeroecology by bringing together radar scientists, meteorologists, and biologists and ignited collaborations that continue to thrive (Chilson et al. 2017).

Although Tom was always at the forefront of new technologies and pushing boundaries of what could be done in the field with the latest models of computers and thermal cameras, his day-to-day habits were not always as sophisticated. In the last years of his active career, he traveled with two laptops weighing down his leather briefcase because he hadn't migrated all his information onto his newest laptop. While his graduate students were prepping the latest generation of thermal-imagery equipment for a night's fieldwork filming bats emerging from caves in Texas, Tom would be on the porch of the fieldhouse, calling his daughter Pamela for his password and asking for tech support with his personal laptop (Fig. 5).

Part of Tom's vision of aeroecology was identifying the aerosphere as a critical habitat and raising awareness about encroaching threats to bats (and birds) in that habitat. He published seminal papers in 2007 (226–228), drawing attention to the need to assess the ecological impacts of wind-energy development on bats and participated in a National Research Council committee on the topic. His efforts were not solely focused on academic publications. He was a key advisor and contributor to the Bats and Wind Energy Cooperative (BWEC) established by Bat Conservation International and served on the BWEC's Science Advisory Committee from 2004–2011, helping guide the scientific direction and research priorities funded and executed by the BWEC during that period.

Fig. 5.—Thomas H. Kunz takes a break from field studies to work on a manuscript about bats. Tom is at work in a ranch house on the outskirts of Uvalde, Texas, on 11 July 2006. Photograph courtesy of Nickolay I. Hristov, Winston-Salem State University, North Carolina.

Tom's research in both Neotropical and Paleotropical systems provided an opportunity to think about the diverse set of ecosystem services that bats provide globally, including consumption of insects, pollination, and seed dispersal. Tom always corrected anyone using the term "control" of insect pests and preferred the term "suppression" in any writing on the topic concerning the role bats play as predators of insects. Whether investigations in dietary energetics, or the vascularization of a "radiator" on Brazilian free-tailed bats (333), or quantifying colony sizes or movement patterns of the species in the aerosphere (243, 320–21, 324), Tom's curiosity and interests spanned molecular, organismal, and population-level patterns and processes.

Tom's primary scientific professional organizations were undoubtedly the American Society of Mammalogists and North American Society for Bat Research. He was a Life and Patron Member of the ASM. Tom served the ASM as President-elect (1999–2000), President (2000–2002), and then as a Past President member of the Board (2002–2020) (Merrick and Wilson 2019). He also served an earlier term as an elected member of the Board of Directors from 1990 to 1993. Tom gave the Society 40 service-years on committees of which 14 service-years were as a chair, including Animal Care and Use Committee (1990–1995; chair, 1990–1994), Development Committee (2003–2011; chair, 2003–2008), Honorarium Committee (1990–1999), Honorary Membership Committee (2002–2011; chair, 2008–2010), H. H. T. Jackson Award Committee (1982–1988; chair, 1985–1988), C. H. Merriam Award Committee (1988–1990), and Resolutions Committee (2003–2007).

Tom and Roy Horst acted as co-hosts for the 25th Symposium of the North American Society for Bat Research (NASBR) in a joint meeting with the 10th International Bat Research Conference at Boston University in August 1995. Horst (1995:132) commented in a history of the first 25 years of the Society that, "only Tom Kunz and I were at all twenty-five of these meetings." In fact, as Allen Kurta notes, Tom attended all meetings through Toronto (41st), except the 37th (2007) in Mérida, Yucatán, when Hurricane David interfered with travel plans. When the bat meetings were formalized with bylaws and a constitution in 1999, Tom was one of six original elected members of the board (1999–2001). Long-time friend and research collaborator Brock Fenton gave this evaluation, "From the outset in 1970, Tom Kunz was a strong supporter of, and contributor to the annual bat meetings (now NASBR). Supporter meaning attending annually, participating in the program and discussions. In a sense, Tom's career was tied to the meetings tracking through to the transition to the formal NASBR of today. Contributor meaning presenting papers at meetings and then, as his career progressed, bringing his students to the meetings and supporting them in their academic development. Tom was a stalwart member of NASBR and its precursor meetings, his engagement linking to the emerging NASBR."

The breadth of Tom's professional scientific interests can be judged by the other societies that he joined and gave his time—AAAS (Fellow, 1989); American Institute of Biological Science; Association for Tropical Biology and Conservation; Bats and Wind Energy Cooperative (Scientific Advisory Board, 2004–2011); Ecological Society of America (Honorary Membership Committee, 1997–2000); International Union for the Conservation of Nature (Board of Advisors, Bat Specialist Group, 1985–2011); Massachusetts Bay Marine Consortium (Advisory Board, 1983–1987); North American Bat Conservation Partnership (Board of Directors, 1999–2011); Society for Conservation Biology (President of Massachusetts Chapter, 1998–2000); and Society for Integrative and Comparative Biology. He was an associate editor for the *American Midland Naturalist* (1979–1981) and served on the editorial board of *Acta Chiropterologica* (1999–2011), *Biotropica* (1995–1998), *Ecology Research Letters* (2007–2011), *International Journal of Ecology* (2008–2011), and *Sains Malaysiana* (2006–2011).

Tom also provided professional service as a committee member for the National Wind Coordinating Cooperative (2006–2007) and National Research Council (2005–2007), both of which were studying the impact of wind-energy developments on populations of bats and birds. He participated first as a Recovery Team Member (1977–1988) and then as a scientific advisor (1988–1992, 2006–2007) for the Indiana and Gray Bat Endangered Species Recovery Team for the U.S. Fish and Wildlife Service. Tom also was member on several scientific advisory boards for such groups as the School for Field Studies (1982–1990), Bat Conservation International (1980–2011), and the Lubee Bat Conservancy (1991–2011), for which he was also a member of the Steering Committee (1993–2011). In addition, Tom served as a Trustee for Universidad San Francisco de Quito, Quito, Ecuador, from 1996 to 2011.

With his many accomplishments and active research and graduate programs, Tom received recognition from his home institution, other academic programs, and the professional organizations that he supported. In 2009, Tom was selected to present the University Lecture at Boston University. Since 1950, this annual lecture offered members of the BU community and the general public an opportunity to hear from distinguished faculty about their research and scholarly activities. The common theme of these lectures is excellence in scholarly inquiry and discovery. Tom spoke on his favorite topic, "Aeroecology: The New Frontier." Tom was again honored by Boston University when a William Fairfield Warren Distinguished Professorship was bestowed on him in 2011. This professorship, named in honor of the university's first president, was established in 2008 to recognize the most distinguished faculty members. The award is the highest distinction bestowed upon senior faculty members who remain actively involved in research, scholarship, teaching, and the University's civic life.

In recognition and appreciation of Tom's mentorship, his former graduate students established the Thomas H. Kunz Fund in Biology to serve as a lasting legacy of his contributions at Boston University and to support future graduate education in ecology at the institution. Donations were received from former students, Tom's family, his colleagues in the Department of Biology, Biology alumni, and friends and colleagues from around the world. The Thomas H. Kunz Fund became permanently endowed at Boston University when contributions exceeded $100,000 in 2019. Since 2015, the Fund has supported Ph.D. students working on diverse field topics, from glass frogs to coral reef fishes, in places such as Panama and Papua New Guinea.

In 2003, Tom was given the Distinguished Alumni Award from his alma mater, University of Central Missouri. This recognition honors alumni considered esteemed by their peers as the "brightest and most distinguished" in their field. In 2005, Universidad San Francisco de Quito, Ecuador, conferred an Honorary Doctor of Science Degree on Tom for his aid in creating cooperative programs with Boston University and developing the facilities at Tiputini Biodiversity Station. The proclamation placed particular emphasis on Tom's tireless efforts in promoting conservation biology in Ecuador.

Tom accepted the Gerrit S. Miller, Jr., Award from the North American Society for Bat Research in 1984, which is given for outstanding service and contributions to the field of chiropteran biology. The namesake of the award was an early 20th century bat biologist at the Smithsonian Institution whose work on the evolutionary relationships among chiropteran families and genera still strongly influences taxonomic thinking about bats today. In 2013, the Board of Directors of NASBR awarded Tom Lifetime Membership, a distinction given to very few in "recognition of a long and distinguished career in bat research." The Society also recently established the Thomas H. Kunz Award in his honor; this award "recognizes and celebrates exemplary contributions by an early or mid-career scientist to the study of bats, including measurable impacts on bat research and/or conservation, student mentoring, public education, and collaborations." The first recipient of the Thomas H. Kunz Award was to be announced at the 50th annual meeting of the Society, in Tempe, Arizona, in October 2020, but the COVID-19 pandemic has delayed this action for a year.

The American Society of Mammalogists honored Tom in 1998 with the C. Hart Merriam Award for outstanding research contributions to the science of mammalogy. Tom was asked to present a plenary talk on his research at the next annual meeting of the ASM, and colleagues in the audience still recall it as a very fascinating and engaging presentation. Later the organization conferred its highest distinction on him, electing him an Honorary Member in 2008 for a distinguished career in service to mammalogy. Tom was the 84th person to be so honored since the Society was established in 1919.

Tom earned two Wildlife Society Publication Awards for his editorship of books. The first award in 1999 was given for *Bat Biology and Conservation* (125) co-edited with Paul A. Racey. The second award was in 2011 for *Ecological and Behavioral Methods for the Study of Bats* (253) co-edited with Stuart Parsons. In 2008, Tom accepted a life-time achievement award from the Karst Waters Institute. The Institute is a 501(c)(3) nonprofit institution located in Lewisburg, Pennsylvania, whose mission is to improve the fundamental understanding of karst water systems for professionals and the public.

Fig. 6.—Margaret and Thomas Kunz pose for their 2019 holiday card. Photograph courtesy of the Kunz Family.

A form of honoring a person or persons that is unique to natural history and systematic biology is naming and describing a new species in their remembrance. These are known as patronyms and their formation and use are governed by the rules of the International Code of Zoological Nomenclature. Murray et al. (2018) described Kunz's bicolored leaf-nosed bat, *Hipposideros kunzi*, from Bukit Rengit, Krau Wildlife Reserve, Pahang, Peninsular Malaysia. The dedication stated, "The species is named after Thomas H. Kunz in recognition of his many contributions to the ecology and conservation of bats, and his dedication to the promotion of bat research in Malaysia" (Murray et al. 2018:21).

Four decades at the same academic institution . . . Scholar and writer of 347 scientific reports and books . . . Mentor and teacher of 16 master's students and 30 Ph.D. students . . . Colleague and role model for 18 postdoctoral associates . . . Conservationist working to protect his bats from such threats as wind-power development and white-nose syndrome . . . Honored leader of his chosen professional societies and educational institution . . . Creative thinker working to develop such biological concepts as aeroecology and environmental services of bats . . . Field biologist traveling the world to such places as Trinidad, Puerto Rico, Ecuador, India, Malaysia, and much of North America to study his beloved bats . . . Grant writer extraordinaire garnering millions of dollars to support his programs and institution. Thomas H. Kunz had all of these monumental accomplishments in a career shortened by tragedy; however, as his hometown newspaper correctly noted at his passing, "Although Tom's academic career was impressive, he was much more than a tally of publications and awards. He was described by colleagues and friends as kind, caring, sincere, and upbeat" (The Wellesley Townsman 2020). His long-time collaborator Gary McCracken noted at this time, "Tom was a great motivator and collaborator, and a genius in bringing people with diverse skill sets together." Of all the lessons Dr. Kunz taught Peter August, his first Ph.D. student, the most important was work–family balance. "He was such a good father and a good husband and a good person," August said. "He taught all his students that life is a complex equation. You have to live it in a balanced way" (McKenna 2020). In this final observation, we may see the strength of the family bond that carried Tom, Margaret, Pamela, and David through these last nearly 10 difficult years (Fig. 6). When his career had been taken away, the love of his family remained. In our opinion, a scientist can have no higher achievement.

Acknowledgments

We sincerely thank the Kunz family—Margaret, Pamela, and David and their families—for their support throughout this effort, for previewing a copy of this manuscript, and for sharing family photographs. We thank faculty members at Boston University Frederick Wasserman and Richard Primack for information on the Biology Research Building and Michael Sorenson for information on Tom's grants and an excellent lead on sources for photographs. Our gratitude goes to Elizabeth Braun de Torrez, Florida Fish and Wildlife Conservation Commission; Nathan Fuller, Texas Parks and Wildlife; Robert Michener, Boston University; Marianne Moore, Arizona State University Polytechnic Campus; Kristy Townsend, University of Maine; and Aryn Wilder, San Diego Zoo, for providing information about references for some of Tom's publications and Peter August, University of Rhode Island; Christopher Burnett, Upper Peninsula Land Conservancy; Tigga Kingston, Texas Tech University; Jonathan Reichard, U.S. Fish and Wildlife Service; Armando Rodríguez-Durán, Interamerican University; and Jay Storz, University of Nebraska-Lincoln offered insights into their time in the Kunz laboratory and participating in field studies with Tom. We are indebted to the following people for permission to use their photographs in this obituary: Andy Costello, Boston University Photography; Stephen Alvarez, Sewanee, Tennessee; Daniel Riskin, Toronto, Canada; Nickolay Hristov, Winston-Salem State University, North Carolina. We thank Ted Genoways for final preparation of the photographs for publication.

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