IRCF

REPTILES & AMPHIBIANS

CONSERVATION AND NATURAL HISTORY

VOL 17 NUM 1 MAR 2010

SPECIAL ISSUE:
A Tribute to Henry S. Fitch

R. WAYNE VAN DEVENDER

Scarlet Kingsnakes (*Lampropeltis elapsoides*) eat primarily elongate squamates, especially skinks and colubroid snakes (see article on p. 18).

FRANCIS L. LEMCKERT

Male calling sites of the Australian Toadlet (*Uperoleia laevigata*) are less densely shaded, more likely to be on bare ground, and farther from ponds than those of *U. fusca* (see article on p. 35).

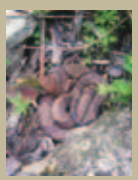
SUZANNE L. COLLINS, CNAH

Southern Pacific Rattlesnakes (*Crotalus helleri*) are one of six species of rattlesnakes that partition habitats at Joshua Tree National Park in California (see article on p. 42).

Front Cover: Thomas Kennedy

Fitch's Anole (*Anolis fitchi*), named in honor of Henry S. Fitch, was formally described by Ernest E. Williams and William E. Duellman in 1984 (*Anolis fitchi*, a new species of the *Anolis aequatorialis* group from Ecuador and Colombia. *University of Kansas Publications of the Museum of Natural History* (10):257–266).

Back Cover: George R. Pisani



Dr. Fitch's classical study of the Copperhead (*Agkistrodon contortrix*) is frequently cited by herpetologists as the single most influential publication that triggered their interest in snake ecology (Fitch, H.S. 1960. Autecology of the Copperhead. *University of Kansas Publications of the Museum of Natural History* (13):85–288).

IRCF REPTILES & AMPHIBIANS
CONSERVATION AND NATURAL HISTORY

TABLE OF CONTENTS

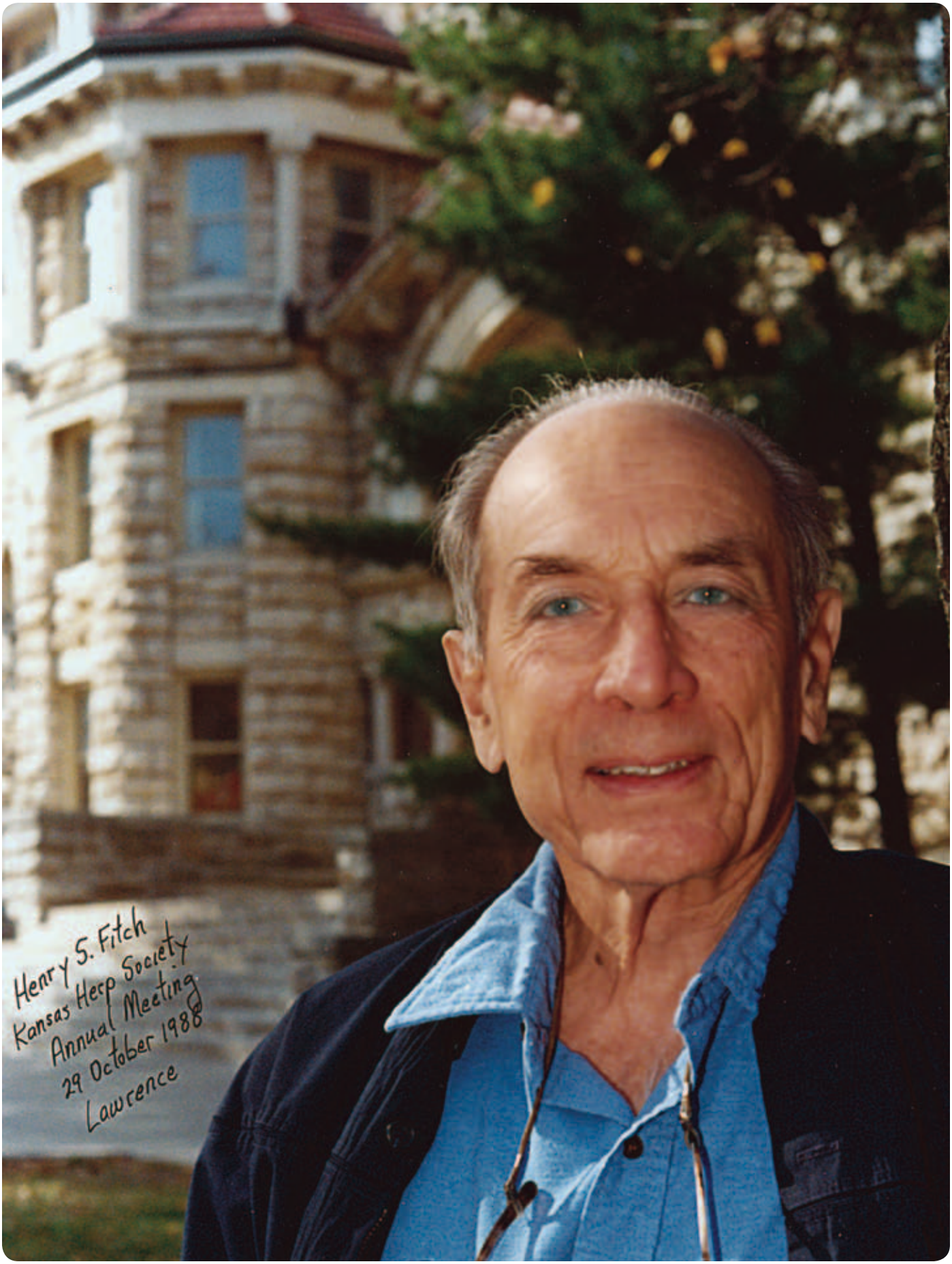
Special Issue: A Tribute to Henry S. Fitch

PROFILE

REMEMBRANCES

FEATURE ARTICLES AND NOTES

INVASIVE SPECIES



LARRY L. MILLER, KANSAS HERITAGE PHOTOGRAPHY

A TRIBUTE TO HENRY S. FITCH

This issue of *Reptiles & Amphibians* is devoted largely to the memory of Henry S. Fitch (HSF) who passed away on 8 September 2009, just short of his 100th birthday. Although we suspect that many of our readers are already well aware of Dr. Fitch's contributions, for those who may be relative newcomers to herpetology, we preface this tribute issue with some relevant background information (see also the "Profile" below and the remembrances beginning on p. 9).

As superintendent of the Natural History Reservation at the University of Kansas (now the Fitch Natural History Reservation), HSF accumulated more than 32,000 capture records of 18 species of snakes over a 50-year span of fieldwork from 1948 through 1997. Recaptures of marked individuals yielded information on growth, daily and seasonal movements, longevity, population density, and more. These data resulted in numerous publications providing many of the most detailed accounts of snake natural history that have ever been published or, for that matter, ever will be published. These include the classics *Autecology of the Copperhead* (1960) and *A Kansas Snake Community: Composition and Changes Over 50 Years* (1999). Dr. Fitch continued to conduct fieldwork in Kansas well into his 90s, especially with Timber Rattlesnakes. For these accomplishments, HSF is appropriately considered the "father" of snake ecology.

These feats alone would merit this tribute issue, but they represent only a fraction of Dr. Fitch's scientific contributions. His herpetological works also include long-term studies of several lizard species in California, Kansas, and the American Tropics. He spent considerable time in Mexico, El Salvador, Nicaragua, Costa Rica, Ecuador, and the Domincan Republic, where he studied the ecology and behavior of anoles (and also described several new species) and other small lizard species, and documented the commercial exploitation of iguanas (*Ctenosaura* and *Iguana*) for conservation purposes. Furthermore, he made major contributions to our knowledge of plant succession, spiders, birds, and mammals.

Biologists with the dedication, enthusiasm, energy, longevity, and breadth of knowledge of Henry Fitch are rare. Those of us who had the opportunity to collaborate with him, or just to have spent time with him in the field or at a professional meeting, consider ourselves among the fortunate. We are indeed pleased to dedicate this issue and portions of the next two issues of *Reptiles & Amphibians* as a tribute to the life and accomplishments of Dr. Henry Fitch.

The Editors of *Reptiles & Amphibians*

PROFILE

Henry S. Fitch[1]

Henry S. Fitch as told to Alice Fitch Echelle

I was born 25 December 1909 at the Fitch family home in Utica, New York, and two weeks later was named Henry Sheldon Fitch (after my grandfather, Henry Augustus Fitch). My father, Chester Fitch, graduated from Williams College in Massachusetts and briefly attended Harvard Medical School, preparing for a career as a medical doctor, but he abruptly switched directions in favor of an outdoor life as an agriculturist. My mother, Alice Ticknor Chenery Fitch, was from Belmont, a suburb of Boston, Massachusetts, where her family had lived since the 1600s. She had gone to finishing school, with training in music, poetry, and other cultural pursuits. In those days, young women rarely trained for a profession outside of the home. My mother enjoyed the outdoors, and it was quite an experience for her to move from the suburbs of Boston to fairly wild country in the west. As long as I can remember, she used to take long hikes, often by herself or with me and my siblings, Margaret, Ruth, and Chester, born, respectively, September 1908, December 1916, and March 1919.

When I was one year old, my parents moved from New York to southwestern Oregon where my father had bought a "ranch" of 116 acres, mainly a pear and apple orchard at the south end of the Rogue River Valley in the foothills of the Siskiyous, near the Oregon-California border. From our orchard to the south, there was scrub oak in the foothills and fir and pine in the mountains, rising more than 6,000 feet to the crest of the Siskiyous, and in my early years I ranged far and wide over the wild country and became interested in wildlife and especially reptiles. The common snakes in the vicinity of our orchard were the Gopher Snake, the Western Yellow-bellied Racer, and the Common Garter Snake; the one really common lizard was the Pacific Fence Lizard, *Sceloporus occidentalis*. We also had Western Skinks and alligator lizards on our land.

I attended a one-room school with grades one to eight, one teacher, and kids who were backwoods types. When I graduated and went to Medford High School, I found myself somewhat retarded in my academic qualifications, but after graduating from Medford, one of the larger high schools in the state, I was at least as well prepared as the average high school graduate. My zoological interests were innate and did not depend on any one person, but natural history was one of my father's many interests, and he encouraged my own interest by conversation and by having many books on the subject. I was fascinated by any kind of wild animal I saw and especially reptiles. I remember grabbing large bullsnakes, because they were common on the ranch. When I handled a bullsnake, I was enthralled and a little afraid, and often my hands would be bleeding from the bites. The real bonus was in seeing horrified adults scatter. It was quite a feeling of power for a five-year-old. I am sure it stimulated my interest in snakes. Feeling like a snake charmer, I could impress people and not quite understand why they were so afraid. We had few near neighbors. One of them, Earl Schuchard, was my buddy, but he didn't approve of my interest in snakes, and he once told me, "My Dad says that one of these times you will grab hold of the wrong kind of snake, and that'll be the end of you!"

I enrolled at the University of Oregon as a zoology major in 1926 when I was 16, but I did not excel as an undergraduate. I was disillusioned by the college courses that I had in biology and zoology, because the Zoology Department at the University of Oregon had a strong medical school orientation. Those who didn't make the grade to become doctors either had to change direction completely or teach biology. There was no professor in the department who had any interest in the native fauna or

[1] Originally published in *Copeia* 2000 (Historical Perspectives, p. 891), copyrighted material reprinted with permission of the American Society of Ichthyologists and Herpetologists (ASIH).

Postscript.[2]—Henry Fitch was interviewed by Alice Fitch Echelle, her husband Tony, and their children Tyson and Lena. The interview was conducted on 6 September 1998, the Fitch's 52nd wedding anniversary, at the family home on the Fitch Natural History Reservation, Lawrence, Kansas. Dr. Fitch has received many honors. In 1950, he received the George Mercer Award of the Ecological Society of America for the year's outstanding ecological paper, "Ecology of the California ground squirrel on grazing lands" (*American Midland Naturalist* 39:513–596). His publications span the period from 1933 to 1999 and are still in progress. In 1997, the American Society of Ichthyologists and Herpetologists established the Henry S. Fitch Award for Excellence in Herpetology, to be made annually by the society to a deserving herpetologist for field research. Dr. Fitch was the major advisor of 18 masters and 14 doctoral students. Several names are well known to herpetologists: John Legler, Russell Hall, Dwight Platt, Michael Plummer, Richard Seigel, Robert Webb, and Robert Henderson.

— Margaret M. Stewart, Historian

[2] This "postscript" was amended to this "perspective" when it was originally published in 2000.

who could identify a toad, a mouse, or a snake; thus, I had no stimulus to be a zoologist and no role model for a zoological career. Still, I persisted as a zoology major without any clear idea of my future profession. In fact I did, for a while, contemplate switching to geology as a major and took a number of courses in the Geology Department. As far as I was concerned, these courses were far more stimulating than any biology course I was able to find at the University of Oregon.

I knew that I wanted to be a biologist but had no concept of the career opportunities, which in those times were very limited compared with those available now. Professor Earl Packard, a paleontologist at the University of Oregon, knew my father and made geology field trips with summer classes to our part of the state. I took his course at the University of Oregon, and he strongly suggested that I go to the University of California for graduate work. When I first enrolled at U.C. Berkeley, I chose Joseph Grinnell, the director of the Museum of Vertebrate Zoology, as my graduate advisor. While still at the University of Oregon, I read the massive volumes on the reptiles of the Pacific Coast and Great Basin by John Van Denburgh, who was the herpetologist at the California Academy of Sciences. In his rather long species accounts, he quoted from publications of Grinnell, and especially those of Charles L. Camp, who had been a graduate student under Grinnell and who had written some papers that touched on natural history. Camp's main contribution to herpetology was his *Classification of the Lizards*, and his main interest was morphology. However, on one of the University of California field trips, he visited the Turtle Mountains of the Colorado Desert and wrote a paper on the desert lizards with quite a few behavioral notes and some taxonomy, and I was impressed by this. I planned to enroll under Camp for graduate study but was surprised and disappointed to find that Camp had become a paleontologist in the Geology Department and that he no longer worked with recent animals. I took two of Camp's courses in my first year at Berkeley: The Vertebrate Skeleton and Elementary Vertebrate Paleontology. I enjoyed both courses and found them profitable.

Graduate school was much more interesting and exciting than my undergraduate work at the University of Oregon. When I came to the Museum of Vertebrate Zoology (MVZ) in 1931, it had just moved from an overcrowded and inadequate building on the north side of the campus into the brand-new Life Sciences Building. The entire west end of the building was occupied by the museum with its large vertebrate collection. There were graduate students doing fascinating field studies of different kinds of animals, some of which were totally new to me, and I began meeting people with basic interests overlapping my own. My first day in the museum I met a student who was just finishing a master's degree studying Mountain Beavers, primitive aplodontid rodents that I had never heard of before. He had some in captivity, and I was fascinated by them. Alden Miller had just gotten his doctoral degree the year I came. During my first semester at MVZ, Grinnell met with me and three other new students in weekly orientation sessions; he presented each of us with Miller's published thesis (fresh off the press) on California Shrikes and suggested that we use this as a model for a detailed study of a vertebrate. We were all impressed and inspired by Miller's study. Grinnell himself was primarily an ornithologist and secondarily a mammalogist, but he knew very little about reptiles. He had published natural history notes on reptiles, but when I began studying alligator lizards, he could not have told me how to distinguish sex in these lizards.

Grinnell, up to this stage in his career, had a somewhat negative attitude toward graduate students and was reluctant to spend time on them, because he was very active in research on birds and mammals and always had field projects in progress. Over the years, however, his interest in graduate students grew stronger. I did not seem very promising at first, I am sure, but he sensed that I was highly interested in animals in general, and particularly in reptiles, and was quite tolerant of my shortcomings in other directions.

I always have admired some of Grinnell's methods with regard to graduate students. When I first talked with him, I supposed that he would have suggestions for my graduate research. Instead, he asked me what I was interested in and suggested that I list as many possible projects as I could think of and come back to see him in a few days. The next time I talked with him, he suggested that I cut this list down to the three that seemed the best of the lot, taking into consideration for each project practicality, predicted time to completion, potential scientific value, questions to be answered, travel and funding requirements, and prospects for successful completion. Following Grinnell's suggestions, I narrowed the possibilities by several stages and finally settled on alligator lizards for my master's research.

Among those who determined the course of my career, I should mention especially Professor E. Raymond Hall, who brought me to the University of Kansas (KU) to take charge of the Natural History Reservation (NHR) and to teach ecology. I first met him when he was a young assistant professor and curator of mammalogy at MVZ. He was one of Grinnell's early students and was so highly thought of that he worked into a permanent position in the museum. After my first academic year of graduate study at MVZ, I enrolled in a summer course taught by Hall. At the time, he was studying the mammals of Nevada, and he published a tome on this work a few years later. There were about eight or nine of us in the summer course, and the fieldwork consisted mainly of trapping, especially snap-trapping, small mammals and preparing them as study skins. We also collected other vertebrates, including a few birds, and for me, especially, reptiles and some amphibians. This was my first experience with the high desert herpetofauna of the Great Basin. The lizards and snakes were mostly new to me, and during the course of this field trip, we visited many localities, covering much of the state. Sampling by live-trapping in the high mountains and on the desert flats was a great learning experience for all of us in the class.

There were, of course, many other interesting people I got to know while in graduate school. One person who turned out to be my good friend during the course of graduate work was Don Hatfield, who got a master's degree at MVZ. He had a gift for writing, became involved in Hollywood movies, and evidently had a career there that was not mainly biological. Also, there was Ward Russell, Hall's field assistant, who devised the dermestid beetle method of cleaning vertebrate skeletons.

I joined ASIH (American Society of Ichthyologists and Herpetologists) in the early 1930s. In those days, getting to the national meeting could involve as much as two weeks' absence from the work place, and with my limited funding, the cost was prohibitive until the western division of the society met in Berkeley in June 1934. At this meeting, I first met Carl Hubbs and his wife and children. They were on a collecting trip covering many of the western

states. Hubbs was interested to know that I was working on garter snakes, and he gave me some localities for *Thamnophis elegans vagrans* that were farther east than the range was known to extend at that time.

George Myers was the ichthyologist at Stanford University, and I knew him from several visits to the museum there. Myers was a hot-shot ichthyologist who got his Ph.D. at Stanford and revitalized ichthyology there after Jordan passed on. Myers was friendly when I first met him. At Stanford, Victor Twitty was studying western newts, and found that "*Triturus torosus*" was a composite of three distinct species that overlapped in some areas but were really very different in color, habitat, and habits. The differences were quite sharply defined in the larvae, too. Two of the species were limited to California, but the third was much more widespread, and that was the one we had in Oregon. I found that Twitty's *Triturus* (now *Taricha*) *similans* had been named long before, as *T. granulosus*, and I published a note on this in 1938. After the note had been submitted, I proudly mentioned my discovery to Myers when he was visiting at MVZ, but he told me, "I'm working on *Triturus*," and he seemed very resentful that I had infringed on his territory. After that, he was consistently hostile. When my dissertation was published he wrote a scathing review. There was nothing good in it at all, according to him, and he even criticized my using the German word *Artenkreis* for the garter snakes (in those years before World War II, many people had a bias against anything Germanic). Subsequently, Carl Hubbs wrote a review for *American Naturalist* that was more positive and, in my opinion, more insightful. There was mutual antipathy between Hubbs and Myers, representing Michigan and Stanford, the main ichthyological centers in the country at that time.

I never met David Starr Jordan, but my brother- in-law, Gaeton Sturdevant, took a course in ichthyology from Jordan at Stanford in the late '20s or early '30s. Earl Herald and Robert Rush Miller came to MVZ for experience working with Grinnell my last year there (1937).

From 1934 on, I was employed as a teaching assistant in Grinnell's courses and taught Economic Vertebrate Zoology in the fall semesters. It was a course for forestry majors, and it emphasized animals such as beavers and woodpeckers that are important in forest ecology. In the spring semesters, I assisted in Zoology 113, a course in vertebrate natural history for zoology majors. This was a course in birds and mammals, with a smattering of herps, that was taught mainly by Grinnell, with Hall taking the mammal part of it. It was the best course I had ever taken in my student career. Grinnell gave excellent lectures. I assisted in it over a series of years and learned more each time.

My summers were spent in the field. Several times after the summer of 1931, when I worked in Nevada with Hall, I went on museum field trips as a member of an MVZ team. On these trips, the objective was to collect as complete a sample as possible of the vertebrate fauna of a specific locality or area. We spent part of a summer collecting in the vicinity of Lehman Cave in Nevada to sample the modern fauna as a basis for comparison with the Pleistocene cave deposits. Every summer I was also busy with my field research in several western states, but mostly in California, Oregon, and Nevada, with much less time in Utah and Wyoming. When I was collecting garter snakes for my dissertation, I often collected pocket gophers for Grinnell. He needed them from very specific localities and paid me by the gopher, not very much per gopher, but enough to finance my own fieldwork.

After the conferring of my doctorate in May 1937, I worked in the museum preparing my dissertation for publication in the University of California Publications in Zoology. During November 1937, I lived with Jean M. Linsdale and family at the newly dedicated Hastings Natural History Reservation in Monterey County, California, and was due to come back and spend more time in the spring of 1938. I was the first of many Linsdale field assistants at the Hastings Reservation. It became routine for MVZ graduate students to spend time with Linsdale at Hastings, benefiting from his guidance in taking field notes. But there were complaints from some that Linsdale's style of biting sarcasm often traumatized students. Linsdale's career ended tragically with deteriorating health, loss of memory and eyesight, and premature death (in the 1960s). I did not return to work with Linsdale as planned because I had qualified for a government job and was hired by the Bureau of Biological Survey (which later became the U.S. Fish and Wildlife Service). The bureau had started out as a research organization with a small cadre of leading naturalists under C. Hart Merriam. By the time I was hired, the survey had expanded and changed direction, with pest control as a major priority.

The bureau needed a field biologist to collaborate with the Forest Service at the Forest and Range Experiment Station's San Joaquin Experimental Range in the Sierra foothills south of Yosemite National Park. I went to work on this job early in 1938, studying the ecology of range rodents. In order of their importance on cattle range, these rodents were the California Ground Squirrel, the San Joaquin Pocket Gopher, and the Tulare Kangaroo Rat. Also the Audubon Cottontail was of some importance. In addition, there were several kinds of native rats and mice, including *Neotoma fuscipes, Peromyscus boylei*, and *Peromyscus truei*, that were common in the area, not to mention *Microtus californicus*, which was rather localized but abundant in the few places that were moist enough for it. Ground squirrels were the focus of my fieldwork. I had been familiar with ground squirrels in Oregon since early childhood and had shot and trapped many of them. At the San Joaquin Range, they were superficially the same but much wilier and harder to trap than their counterparts in southern Oregon. They were exceptionally alert and suspicious of any strange object, including steel traps placed in burrow entrances, and generally avoided traps by circling or jumping. In understanding this difference, I became aware that during the snake season, from early March through November, the ground squirrels were at constant risk of being bitten by rattlesnakes — their one most important natural enemy. These populations that had been exposed to rattlesnake predation for millions of years were behaviorally quite different from ground squirrels from more northern areas where rattlesnakes were either absent or were much more recent and less abundant. I had been interested in snakes from my start there, and more and more I became involved with rattlesnakes as predators on the local rodents. As a result, I started marking and studying local populations of the Pacific Rattlesnake.

Jesse Nelson, superintendent at the San Joaquin Range, disapproved of a natural history approach and thought that I should concentrate instead on so-called pest control. It got to the point where Nelson would assign a fieldworker the chore of timing my day in the field — how much time was spent on snakes, especially when we had a crew out. Soon the data seemed to indicate to my employers that I was spending 36 hours a day (my own time and that of crew members) on snakes rather than on rodent control, and I was ordered to stop the snake work. After that, I rarely brought live snakes to the headquarters. But whenever I caught one in the field, I would process it there, "bootlegging" this part of my research.

I was bitten twice by rattlesnakes in the course of my work at the Experimental Range. The bites were not life threatening but were traumatic experiences, and as a response, I changed my catching and handling tactics. For the first bite (spring of 1938), I went to a doctor's office and had a shot of serum. I was allergic to the shot, broke out in a rash, and suffered almost as much from the treatment as from the bite. I was bitten when I dropped the snake into a bag; the snake could strike faster than I could withdraw my hand. The second bite (spring of 1940) happened almost the same way. It was a first-year snake recently emerged from hibernation, and its shot of venom seemed even more potent than that of the larger snake that had bitten me in 1938. I had changed hands, from the time of my first bite, and never again grasped a snake with my right hand, which was left free to write. Since the second bite, I have never let go of a poisonous snake without first holding down the head, having learned the hard way. Besides a shot of serum, accepted treatment for a bite at that time was to cut at the site of the bite and then apply suction. For the first bite, I had to get back to my car and then drive back to headquarters. The car was about one-third mile distant, and I jogged back to it and drove to headquarters, and my friend Harold Biswell drove me to Madera for treatment. The second bite happened back at the headquarters. I dropped the snake, and it bit me on the finger, and reflexively, I jerked back and slung it 20 feet, which may

have caused more venom to be injected. I was working with Ben Glading, and he drove me in to Madera.

I was drafted in the spring of 1941, on four days' notice, and I think partly or maybe entirely because of my age (32), I was put in the Medical Corps and was assigned to a station hospital. During that summer, I was sent to William Beaumont General Hospital in El Paso, Texas, and had a three-month course of training as an army pharmacist. Soon after my return to Camp San Luis Obispo, California, in September 1941, I was released from the army on the grounds that I was too old to serve, being over 26, and this was when the one-year term of draftees (except for those 26 or older) was extended indefinitely. The term-extension triggered draftee resentment and rioting in army camps across the country, but I was glad to be out of the army and went back to my old job at the San Joaquin Range.

My relief was short-lived because I was recalled to active military duty soon after Pearl Harbor was bombed. I was at Camp San Luis Obispo for awhile, then assigned to a hospital at Sawtelle, California, subsequently assigned to the 348th Station Hospital at Camp Beale, California, and finally was shipped overseas in late 1942 on the Victory ship, KOKOMO. The ship carried about 5,000 of us across the stormy North Atlantic in quarters that were crowded and dirty and that reeked of sick odors because of lack of adequate ventilation. We were part of a large convoy and had destroyer escort. The hold of the ship was partitioned into many compartments that could be used as air space to keep the ship afloat after possible torpedo strikes, and the unannounced and frequent testing of the electronically operated sliding doors that sealed off our compartments was a grim and persistent reminder of the expendability of the individual in times of war. My unit was sent first to Cardiff, Wales, and after a period of months there, we were transferred to Llandudno on the northern coast of Wales, later to near Nottingham and to two or three other places in England. After D-Day, we were at Prestwick, Scotland, a first stop for flying casualties, and we were often routed out of bed during the middle of the night to carry the wounded into our hospital or transfer them onto another plane or train. Finally, after the invasion, we were sent to France and eventually to occupied Germany at Bremerhaven where I spent a spring, summer, and fall. By that time, the war was won; there was a point system for releasing veterans, and I got out of the army sooner than some of my colleagues on the basis of my advanced age. I was sent back to Camp Beale near Marysville, California, where I was released, and after a night of hitchhiking, I arrived back home at Medford, Oregon, in November 1945 after almost five years in the army.

Army life during the war was not very conducive to pursuit of zoological interests. When we had time off, I often watched birds. Along the coast near Llandudno, there were large colonies of nesting seabirds on a long rocky peninsula, and it was a great place for bird-watching. Earlier, when I was sent to Beaumont General Hospital, I drove my car to El Paso from San Luis Obispo. I had weekends free and explored far and wide. Because I had never before done fieldwork in that part of the country, there were many kinds of herps that were new to me, and I sent my collections back to MVZ.

While stationed at various places in England, I was able to make weekend trips to London, where I frequented the zoo, the British Museum, and many bookstores. At that time, London was being bombed intermittently. The infamous "buzz bombs" were a hazard, and I remember hearing many explosions, but none was ever very close to where I happened to be.

As soon as I got home to Medford, Oregon, after the war, I wrote to the Fish and Wildlife Service indicating that I was ready to return to my job. The U.S. President had promised that all GIs would be entitled to their former jobs upon being released, but I got a discouraging reply from the Fish and Wildlife Service saying that my old job no longer existed. They gave me the name and address of the director of River Basin Surveys. These surveys, initiated by the Soil Conservation Service, were inventorying vertebrates of economic importance in the central states. I talked with a person who had recently returned from the war and gone to work for them, and he was very encouraging. But I was considerably irked because I was not being allowed to return to my former job as had been promised, so I wrote a letter of complaint to the Fish and Wildlife Service. I told them that I was not at all interested in working on River Basin Surveys in a part of the country that was unfamiliar to me, and that I was disappointed that the government was not fulfilling its responsibility after having promised draftees that their jobs would be waiting for them. It seemed to me that the government, especially, should live up to its promise. In the letter, I mentioned that I was not applying for the River Basin Survey, but instead I was returning to the San Joaquin Experimental Range (SJER) on my own to salvage what I could of my research there. I don't know what became of that letter, but it must have caused some stir. After about three weeks, I received a reply: they had "found" some funds for salary and would be glad to have me go back to the SJER and finish up my projects there. I returned to the SJER, spent all of 1946 there and also the spring of 1947, dividing my time between fieldwork and writing. On 6 September 1946, I married Virginia Ruby Preston, whom I had met at a party soon after returning home from the war. We were allowed to live in a little house near the SJER headquarters. I completed a series of papers for publication, and production was in high gear. But dissension developed between my bosses in the Fish and Wildlife Service and the Forest Service, resulting in my transfer to Louisiana.

In May 1947, Virginia and I drove our own car and a government car from the San Joaquin Range to Alexandria, Louisiana, and lived in a housing project at nearby Leesville. During our year in Louisiana, I worked in the National Forest, 20–40 miles from Leesville, studying quail, mourning doves, armadillos, cotton rats, and deer. My work in Louisiana would have continued except that I was invited by E. Raymond Hall to apply for the position of ecologist at the University of Kansas (KU). Hall had been the mammalogist at MVZ at Berkeley, but when he lost out to Alden Miller for

Henry Fitch in Army Pharmacy School, William Beaumont General Hospital, El Paso, Texas, August 1941. The uniform was a World War I cavalry suit because that was all that was available at the camp at that time.

the directorship, he returned to his alma mater as director of the University of Kansas Natural History Museum and as chairman of the (then) Zoology Department. He knew me well from the trip to Nevada and from our association at MVZ. I had also worked for him on his major studies of American weasels. He was aware of my work with Linsdale at the Hastings Reservation and had me in mind for the job on the newly created reservation at the University of Kansas. This land had been owned since 1910 by the University of Kansas, and Hall had persuaded the chancellor that its best use might be as a natural history reservation. I came to KU and gave a seminar on my work at SJER and got the job. This was a very strategic time to start in university teaching because the GI Bill of Rights had been passed, and universities were full of returning veterans whose higher education was being financed by the government. At KU, at least half the courses in the department were being taught by graduate students. I started my teaching career with the title of instructor, as was customary then, in the fall of 1948. I was promoted to assistant professor after my first year, and finally to full professor in 1958. From July 1948 through February 1950, we lived on campus in the Sunnyside Housing Project near where Allen Field House stands now, and on 1 March 1950 moved into the new residence on the reservation.

I was brought to KU to be superintendent of the reservation and to teach ecology. Up to this point, KU did not have an ecologist. I think Professor Worthy Horr taught a course in plant ecology, and Mr. McNair had taught animal ecology a few years previously but had since deceased. Ecology was just beginning to come into its own; I had never had a course in ecology myself. I taught it during fall semesters, and for the first few years, I had large classes of about 30–35 students. In 1968, when we returned from sabbatical in Costa Rica, my teaching duties were switched from ecology to natural history, because KU was acquiring several ecologists of different types. To me, it has been much more satisfying to teach natural history than ecology.

As a mammalogist, Hall was anxious to have some mammal research done on the reservation. I was mammal-oriented after my work at the San Joaquin Range and started some large-scale studies of small mammals with live-trapping and marking, and that was how, for years, I spent a major part of my time. Also I studied lizards, including Five-lined Skinks and Great Plains Skinks, now almost gone because of habitat changes, but at earlier stages of succession, they were abundant and conspicuous. After several seasons, I developed a live-trap for catching snakes, and put out longer and longer trap lines for the snakes that came to hibernate at hilltop rock ledges. In 1957, I learned how to trap them in the fields, where they disperse in summer, by putting up drift fences, and this was labor intensive; a substantial portion of my fieldwork here on the reservation has consisted of live-trapping snakes.

Every part of the reservation's square mile has changed, to the extent that it is hardly recognizable as the same area I first saw more than 50 years ago. From almost any standpoint, it would look entirely changed, but the wooded part has changed relatively little compared to the originally open areas. The woodlands have changed through the dying out of the large American Elms that were the dominant trees. These were replaced by ash and a variety of other tree species with the climax species constantly gaining and spreading to places where they formerly had been absent. Osage orange, honey locust, and mulberry are pioneer invaders of the land that was formerly cultivated or that was overgrazed pasture, and on these former open areas, dense weeds, brush, shrubs, and seral trees became prominent as stages toward a climax forest.

Every animal species has changed in distribution and abundance, and in general, the grassland species, especially those of shortgrass, have disappeared. It has been a long time since I have found a bullsnake on the reservation, but in the first few years, they were common in the pasture areas. Tallgrass species like the Yellowbellied Racer and the Prairie Kingsnake are still here, but they are becoming much more scarce. Even some forest species, notably the Timber Rattlesnake, have disappeared completely from our square mile. Although its habitat is forest, it requires open sunny places to bask, and the continuous canopy that has developed has eliminated basking places. Despite considerable anthropogenic mortality, most of the Timber Rattlers, perhaps 20, caught in the last few years have been from the KU-owned Nelson Tract adjoining the reservation to the north or from farms immediately adjacent to the Nelson Tract. I remember only one record in recent years from the reservation, and that was near the headquarters. That one adult male Timber Rattler must have wandered far from his home range.

I had always wanted to do fieldwork with reptiles in the tropics and finally was able to do so at age 55 when, in 1965, I took the Organization for Tropical Studies course in Costa Rica. During the course, we covered most of the country and became familiar with its fauna, and I laid the groundwork for later study of local lizard populations. In 1967–1968, on sabbatical from KU, I returned to Costa Rica on a National Science Foundation grant with a truck and camper and my wife, daughter Alice (20), and son Chester (14). Our older son John was at that time based in Hawaii and working for the Smithsonian Institution on their Pacific Bird Project. With the help of my team, Alice and Chester, I established transects (north–south and east–west) spanning Costa Rica with 14 study areas with individually marked populations of 15 lizard species. Six of these species were represented at two or more of the study areas revealing the effects on reproductive cycles of contrasting climates, from rain forest and cloud forest to xeric scrub. Each area was revisited at six-week intervals in 1968, and sampling of these same areas was continued through the early 1970s.

Another major project was a comparative study of anoles, about 50 species, from Mexico to Ecuador, mostly on the mainland, but including several in the Dominican Republic. Habitat, seasonal schedule of activity, breeding season, dewlap displays, and sexual size difference were found to be closely related.

A third project was a natural history and conservation study of Green Iguanas (*Iguana iguana*) and ctenosaurs (*Ctenosaura similis*) in Nicaragua and other Central American countries. In many Latin American countries, these large lizards constitute an important food source, but overhunting and habitat loss have eliminated them or caused drastic reduction through much of the range. Appropriate conservation measures have the potential to restore populations of these hardy and prolific lizards, with a tremendous economic benefit to the local people. With my former student, Bob Henderson of the Milwaukee Public Museum, I began fieldwork in 1976; more than 1,000 ctenosaurs and 343 Green Iguanas were examined, measured, and weighed, mostly in the markets of Nicaraguan towns and villages. At that time, Nicaragua was still controlled by the Somoza dictatorship. Our study was sponsored by the Banco Central of Managua. The International Fund for Animal Welfare sponsored several more trips to Nicaragua in the 1980s. During these visits, I worked with the Government of Reconstruction (Sandinista) and their conservation organization, Instituto Nicaraguense de Recursos Naturales y del Ambiente (IRENA), and a Five-Year Plan for iguana conservation and restoration was instituted.

The three major thrusts of my tropical research, described above, overlapped in time and study areas. The fieldwork spanned 20 years with at least one trip annually to the countries involved, including Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, Panama, Ecuador, and the Dominican Republic.

I retired in 1980 and am enjoying life while continuing some of my former activities, the ones that I most relish, and that includes trapping snakes. In the 1980s and 1990s, I was involved with rattlesnake roundups in Oklahoma (Western Diamondbacks) and Kansas (Prairie Rattlers). Like most herpetologists and conservationists, I am opposed to the roundups, but they do offer great opportunities to learn more about the ecology of the species and how to conserve them.

When I retired, I was told by the KU administrators that Virginia and I could continue to live in the residence here on the Natural History Reservation as long as that was to the advantage of the university. We try to be useful, and anyone who has any interest in natural history or ecology is encouraged to visit and use the area.

My wife Virginia had no biological background except for a high school course in biology, but she has always had an avid interest in natural history. Snake hunts were prominent during our courtship, and she read up on herps

VADA SNIDER

Henry Fitch on the Fitch Natural History Reservation holding a Red-sided Gartersnake (*Thamnophis sirtalis parietalis*); 23 May 1991.

and became well versed in herpetology. During our early years on the reservation, Virginia often accompanied me in the field and helped in many ways, including making plant surveys and assembling spider collections. While tending traplines for both small mammals and snakes, Virginia recorded the field data, making my handling of live animals much easier and more efficient. She also typed most of my manuscripts, and we have always read proofs together, even on our wedding night. Virginia has not done as much fieldwork with me in recent years because of health problems and susceptibility to poison ivy, chiggers, and ticks. However, she still helps me in preparing live animal displays for visiting school children and in numerous other ways.

Our three children, John (the oldest), Alice, and Chester (the youngest), all enjoyed growing up on the reservation and helped me in various ways. John was a special help in policing the area during hunting seasons. Alice, even from the time when she was in junior high school, was a great help to me in recording field data on thousands of snakes and other animals. Chester was especially helpful in obtaining glass lizards when I was studying them in the 1970s. He organized his friends to help with the hunting, paying a small fee for each lizard caught, while still making a bit of a profit for himself. John now teaches environmental courses at Florida Gulf Coast University. He lives in Naples, Florida. Alice is a research associate in the Zoology Department at Oklahoma State University. She and her husband Tony Echelle have worked together as a research team for the past 30 years. Chester runs a rental management service in Lawrence, and he and his wife Deanna live about a half-mile from the reservation.

In retrospect, my main professional accomplishments have involved long-term field studies that usually entailed individual marking of live animals in natural populations (lizards, snakes, rodents) and collecting demographical data. These field studies have extended over 64 years: *Sceloporus occidentalis* at Berkeley, California, and at my former home in Jackson County, southwestern Oregon, mid-1930s; snakes (especially *Crotalus viridis* and *Pituophis catenifer*) and rodents (especially *Otospermophilus beecheyi* and *Dipodomys ordii*), late 1930s and early 1940s, at the San Joaquin Experimental Range, Madera County, California; snakes (18 species) and rodents (especially *Microtus ochrogaster* and *Peromyscus leucopus*) at the University of Kansas Natural History Reservation, 1948–1999; lizards of 15 species at 14 localities of contrasting habitats on north–south and east–west transects in Costa Rica, 1967–1973.

My field studies, as outlined above, have demonstrated that mark-recapture procedures, extending over periods of years, are useful for understanding species' demographies and demonstrating that erroneous ecological impressions may result from a short-term study or one confined to a specific locality. (Journals of my fieldwork are slated to be deposited at the Kansas Ecological Reserves Office where they will be accessible to future workers.)

My 1940 publication on the "Ordinoides Artenkreis" of Western Garter Snakes is now long forgotten, and taxonomy has undergone drastic changes, but I consider that paper to be by far the most scholarly and important of all my studies. From fieldwork over much of the western United States and examination of all available museum specimens, I was able to show that the morphological characters upon which classification was based were highly adaptive and were closely linked with behavior, habits, and habitat.

Economic constraints have prevented me from attending ASIH meetings regularly or frequently, but I have attended them whenever feasible over the past 64 years. In recent years, I have enjoyed making joint camping trips to some of the meetings with Tony and Alice. Attending the meetings has always been an exhilarating experience for me, because ASIH members have always been leaders in the field. Over the years, the cost of being a herpetologist has escalated, and I strongly recommend that ASIH do what it can to counter this trend, for example, by holding down costs of registration fees and housing at the annual meetings. It would be well always to hold meetings where camping facilities are available.

I have seen great changes in herpetology and herpetologists over the years. In the 1920s and 1930s, there were only a few individuals who were active in herp research in the United States. The field was dominated by those such as Stejneger, Barbour, Ruthven, and Klauber. Studies were almost entirely in systematics. Information on life histories and ecology accumulated mainly in the form of notes and was anecdotal. A common type of publication was an annotated county list. In the 1930s, when I first attended ASIH meetings, studies were oriented to morphology and systematics, almost exclusively. The major change has been a shift of interest to behavior, demography, and ecology. Fieldwork in the early 1900s consisted mostly of collecting animals that could be preserved for later study in the lab. Now, herpetology is thriving as never before, and the increased interest is very gratifying. A phenomenon of the present generation is the female herpetologist; there are now more women than men in some herpetology classes, and a high proportion of research publications have female authors. When I was growing up, I never saw a woman react to the sight of a live herp other than with horror and revulsion. Of course, there were a few pioneers even in the early 1900s like Doris Cochran of the National Museum and Helen T. Gaige at the Museum of Zoology, University of Michigan.

My father encouraged my early interest in reptiles and helped me build a large, outdoor screen cage in which I kept many different kinds which coexisted more or less harmoniously. These were mostly local species, but I obtained the name of a Texas dealer, the "Snake King," and purchased a variety of kinds from him, including Indigo Snake, Berlandier's Tortoise, Collared Lizard, and ctenosaur. Also, I made contact with a German herpetologist, Werner Schröder, and by mail sent him several local kinds in exchange for European species. Since then, herpetoculture has become a very popular hobby. Some species are best known from observations in zoos or private collections. This interest is commendable, but there is danger that rare and endangered species will be adversely affected by overzealous and illegal collecting.

For as long as I can remember, interest in reptiles and amphibians has been a dominant influence in my life, and other interests have seemed relatively minor. Finding and capturing herps has often involved strenuous exercise, and I always liked that. Distance running was one of my habits. At the University of Oregon in my sophomore and junior years, I was on the crosscountry team and ran the mile and two-mile in track. I especially enjoyed tennis, since we had a tennis court at the ranch where I grew up. In my high school years, I routinely played tennis with my father and in later years played with my sister, Ruth. Also, I enjoyed scrub soccer and basketball and would often assemble neighborhood kids, all younger than I, with my younger siblings, for games with three to six or seven participating. In 1923 (or '24?) when there was a local tennis tournament, I won the junior championship (under age 16) of Medford. As an adult in Kansas, I continued the gaming tradition, with intrafamily teams of my children, their friends, graduate students, and eventually my grandchildren. In more recent years, ping pong has partly replaced the more rigorous games.

REMEMBRANCES

Henry S. Fitch (1909–2009): Field Notes on a Wonderful Life[1]

Henry Sheldon Fitch passed away on 8 September 2009, just a bit shy of his 100th birthday (25 December). In lieu of a traditional obituary, and because an autobiographical account of his life recently appeared (Echelle and Stewart 2000), several former students and colleagues each describe their personal memories of the man deservedly referred to as the "father of snake ecology." Although each of the remembrances brings a different perspective, three common threads run through all of them, namely: Henry Fitch's energy, enthusiasm, and decency.

Henry Fitch and the Practice of Natural History

Harry W. Greene

Department of Ecology and Evolutionary Biology
Cornell University, Ithaca, New York 14853 (hwg5@cornell.edu)

Texas Alligator Lizards were first described from the Devil's River in 1858 and a century later, when I encountered them in photographs, there was still almost nothing known about those snaky, bright-eyed reptiles. As a Missouri youth, hungry for wilder places and imagining myself a trailblazing naturalist, I pored over accounts in Hobart Smith's *Handbook of Lizards* of two related West Coast anguids — especially field studies by Henry Fitch, who referred to them as "unusually intelligent" and saw a Southern Alligator Lizard hold off Yellow-billed Magpies by hissing and threatening with open jaws, tail curled forward like a shield. Someday, I thought, I'll roam the Mexican borderlands and learn something exciting about *Gerrhonotus infernalis*!

Fitch's photo also caught my attention among the "influential saurologists" profiled in Smith's *Handbook* because he wore a World War I cavalry hat and looked intense, as if distracted from some important task. His publications in our local college library provided a University of Kansas address, so I wrote announcing my upcoming herpetological career and asking questions about proposed Texas fieldwork. However pretentious that letter, right back came Henry's cordial, hand written explanation of how to sex alligator lizards: "By grasping the base of the tail, gently twisting it, and exerting pressure with the thumb ventrally, one can cause a hemipenis to be exposed. Failing in several such attempts, one may be reasonably sure the specimen is a female."

I knew ventral meant underside and penes were for copulation, but couldn't have realized a high school internship with Henry would set my course or that he would author almost 200 publications, more than 4,000 pages on plants, snails, spiders, and diverse vertebrates. This unassuming man started graduate work at Berkeley's Museum of Vertebrate Zoology in 1931, when the discoveries of Charles Darwin and Alfred Russel Wallace were still relatively fresh, and took his first academic position in 1948, five years before James Watson and Francis Crick unraveled DNA. Decades later, after Henry summarized half a century of fieldwork at a symposium in his honor, a graduate student wryly noted that thanks to him she couldn't call four years of horned lizard population research "long term." Applause typically occurs *after* presentations, but his arrival at the podium that day provoked a standing ovation before he began speaking.

With Henry's passing I want to honor his impact on biology and me personally by reflecting on a conundrum. Although Darwin, Wallace, and countless others have been drawn into nature by orchids, beetles, or whatever seized their fancy, and this is surely truer now than ever before, acclaim typically comes from generalizing rather than gathering facts. Ernst Mayr, for example, was renowned for evolutionary theory and less widely

COURTESY OF ALICE F. ECHELLE

Henry Fitch and Rainbow Trout; ca. 1920 at Klamath Lake, Oregon.

[1] Originally published in *Herpetological Review* 40:393–400 (2009). Reprinted with permission.

so for describing more than 400 new species and subspecies of birds. At first glance then, Henry's career-long focus on organisms seems anachronistic, the widespread esteem in which he's held a bit surprising. In a forthcoming book, *Tracks and Shadows: Field Biology as Art*, I've set out to illuminate that stature as well as more generally assess the enduring values of natural history. Here I'll draw on correspondence and interviews of my teenage mentor, with the goal of addressing a question: why did he do it?

One of our extended dialogs was soon after Henry had fallen and spent a chilly night stranded in a creek, and except for the incident's notoriety he seemed surprisingly unfazed — search dogs were hopelessly confused because his scent trail was *everywhere* on the Reservation, and he'd been conscious when helicoptered to a hospital. Daughter Alice was visiting her folks, and we talked all afternoon and late into evening. Almost 80, with raven black hair, Henry's wife Virginia served fried chicken, mashed potatoes with gravy, corn on the cob, and home-made rolls, and she fairly sparkled as conversation meandered from our first visit and the whereabouts of former graduate students to details of Fitch family life. When I smiled at her mention of "youthful indiscretions," Virginia said she married young and divorced the other guy. "Then," she exclaimed, grinning at me and hugging her husband from behind his chair, "I met this wonderful guy!"

From time to time I checked a list of questions, and although in correspondence Henry had been enthusiastic about my book proposal, his answers weren't effusive. I'd known this wasn't going to be easy, if for no other reason than constitutional reticence — as Randy Reiserer wrote in a dissertation acknowledgment of his undergraduate advisor, "I never met anyone who can say so much with so few words, or indeed, without any at all." But I wanted to understand why Henry does the work, keeps catching still more snakes, and what the practice of natural history meant to him, so finally I blurted out something about having my own problems shrink in the face of grandeur and diversity. "Sounds good to me" was all he said, with a soft chuckle and maybe a hint of irony.

I also hoped to learn how Henry knew what to record, given he began gathering data in the 1930s for which there were no guiding theories. His papers typically set forth the ecology of target species, with insights woven among empirical findings — the thesis work on alligator lizards, e.g., addressed advantages of viviparity by noting that "Eggs left in the ground are exposed to…egg-eating reptiles, mammals, and insects, and to extremes of temperature and danger of desiccation, while those carried by the female probably stand a better chance of developing into independently successful young." In 1949 he'd laid out in *Ecology* details of *what* to write down, but almost nothing as to *why* particular information would interest other biologists. And in 1966 Robert MacArthur and Eric Pianka's brilliant paper on optimal foraging would inspire widespread measurement of parameters that Henry had been recording for decades with no conceptual prompting.

So I kept coming at the questions from various directions, hoping Virginia and Alice would jump in with something definitive or nudge him for details. My query about god resulted in a slight pause and "I have no religious beliefs although raised in that environment. Natural history does it for me." Asked about favorite habitats, Henry attributed his preference for deserts, "because they are open and have interesting animals," to a Nevada field trip during graduate school. At the mention of favorite species, he responded "alligator lizards, Copperheads, and gartersnakes, because they have interesting natural histories." By evening's end the best I could get was "my initial interest in zoology was innate" and "I wrote down everything that interested me."

Two years later I was back trudging up a hill on the Reservation. Henry was audibly winded as we crested the familiar limestone ridge and explained without a trace of self-pity that he'd lost stamina but hoped to complete one more field season. Otherwise he seemed no different than my last visit and at 91 his hair was light brown. He walked slightly stooped, in work boots with visibly thin soles, and was wearing khaki pants, a Berkeley herpetology course t-shirt, and a baseball cap decorated with various university insignia. The tattered cotton bag stuffed through his belt, custom made

MICHAEL V. PLUMMER

Henry and Virginia Fitch in 1975 at the University of Kansas Natural History Reservation (now the Fitch Natural History Reservation).

by Virginia, was for carrying snakes back to the house. He used a smooth, sturdy stick with a nail head protruding on the bottom to steady himself, hold onto tree limbs, turn over cover items, and probe matted grass for the long narrow tin pieces he'd laid out to attract snakes.

As our conversation turned to current projects, Henry spoke with quiet fatherly pride of a paper with Alice about changes in tree diversity over the past 50 years at the Reservation. Their findings were thought-provoking: Once largely prairie, perhaps the best-known square mile in North America had lost a third of its fauna since he arrived because of fire prevention, lack of grazing, and forest encroachment. On the bright side, there were still Bobcats and Timber Rattlesnakes in the vicinity, and a Black Bear was seen near here recently. As we returned to the house he pointed out a large cedar by the driveway, planted many years ago as a tiny family Christmas tree.

That night Henry sat in the front row for my campus lecture on organisms as the central focus of biology, during which I held up his capstone opus, *A Kansas Snake Community*, and introduced my teenage hero. I praised Henry's contributions to ecology and systematics, then said his greatest legacies are immediate products of the work itself — tens of thousands of observations archived, many museum specimens collected — and that in the scholarly tradition of his Berkeley advisor, Joseph Grinnell, he'd bridged Darwin's synthesis with twenty-first century science. As it happens, those individual organisms he studied demonstrated such things as substantial shifts in Copperhead diets over the decades, as prey populations responded to the habitat changes he documented.

Henry's accomplishments amounted to several better-than-average careers, I told the K.U. crowd, given his California and Louisiana work, decades at the Reservation, and his tropical expeditions. In fact, although mainly known as a herpetologist, his publications on mammals would eclipse those of the average "mammalogist." During the lecture I showed photos of island Cottonmouths that eat fish regurgitated by seabirds and have exceptionally large young, exemplifying, I pointed out, unusual and unexpected opportunities for research and enlargement of theory. Afterward Henry asked about the number of young in island snake litters, said he'd enjoyed my talk and our hike, then added with a characteristic grin and swing of the chin, "Oh, and thanks for the plug!"

Work can be a job, a career, or a passion, and for Henry the practice of natural history was all three. When I complained about funding he responded, "I have always spent my time on whatever interested me — with or without grants — and have greatly enjoyed all my projects, especially the fieldwork." In his eighties he was quoted in a book on Kansas

personalities, "I wouldn't change a thing. People who work with animals in the field, whether snakes or birds or rodents or monkeys, find it deeply satisfying and wouldn't trade it for any other kind of career — even though it may not be very financially rewarding." And in 1995 he wrote Alice, "If as a young person I could have dreamed of my future and the world I would like to see, it would have been about the same as the life I have had. Getting a Ph.D., having a loving, supportive wife, children like you and John and Chester, grandchildren like Tyson, Lena, and Ben, living on the Reservation, teaching natural history, studying anoles and pitvipers, and making two dozen trips to nine countries in the tropics for herpetological research have all been great experiences."

One visit, after the Fitches walked me to my truck, I drove back to Lawrence on a sultry Kansas night. A huge moon shone through fog and orange lightning flashed over surrounding fields as I pondered my admiration and affection for Henry. What, I wondered, makes him *tick*? Certainly he marched to his own drummer, unmindful of fads, which makes it all the more fascinating to contemplate his accomplishments, as well as how that stance affected his life more broadly. Maybe verbal frugality reflected limited interest in analytic thought, personally and professionally, which if nothing else protected him from the pettiness so common in universities. Maybe he was always so much within himself that he simply didn't pay much attention to theorizing. And maybe those like Henry who go deeply into nature as children — he was catching snakes as a five-year-old — are especially prone to immersion as adults. We have to be out there.

Just weeks before Henry died he asked Alice and her husband Tony Echelle, if they might visit a local creek and catch watersnakes. When she replied, "Well, what then dad?" he said simply, "We'll mark and recapture them." Evidently the answers to my questions are equally straightforward: Henry was always driven by passionate curiosity and a penchant for detail, accentuated by parental encouragement, and those attributes combined in grad school with a framework for understanding biological diversity that harked back to Darwin and Wallace. That was enough. His approach worked, against formidable odds at times, and he was not inclined to do otherwise. A special gift for field biology and quiet but stubborn confidence must have been obvious to Grinnell in 1931, when an unusually shy but promising new student arrived at Berkeley, fresh off an Oregon pear ranch. Those traits were undiminished to the end, and Henry's long, happy life was inseparable from the quest to understand nature.

Reminiscences of Henry S. Fitch

William E. Duellman

Biodiversity Institute, University of Kansas
Lawrence, Kansas 66045 (duellman@ku.edu)

For the past half century I was fortunate to have been a colleague and friend of Henry S. Fitch. During that time, we served on doctoral committees of one another's students, co-advised some graduate students, and team-taught a graduate course in reptile biology. Although we never collaborated on a published paper, we each named a species of *Anolis* for the other. Henry avoided university politics and only reluctantly attended departmental meetings. Many of his colleagues mused that Henry lived in his own little world. But that world was much larger than they thought. He was at home on the University of Kansas Natural History Reservation (subsequently named for him), where he conducted intensive studies on the ecology and behavior of reptiles. Over the years he witnessed the succession of hardwood forest on the reservation, while methodically searching this square mile of land, capturing and recapturing thousands of snakes, and logging hundreds of pages of notes. His dedicated efforts culminated with the publication in 1999 of *A Kansas Snake Community: Composition and Changes Over 50 Years*.

However, Henry had a long and distinguished publication record before this finale. While at the University of California at Berkeley prior to moving to Kansas in 1948, he published a classic work on alligator lizards in 1935 and a highly perceptive work on western garter snakes (*Thamnophis*) in 1940. Two of his best-known works are on the natural history of reptiles, especially that on the Five-lined Skink in 1954 and his exhaustive study of the Copperhead in 1960. In addition to these systematic and ecological studies, Fitch provided us with important syntheses—reproductive cycles in lizards and snakes (1970) and sexual size differences in reptiles (1981). Consequently, his publications are cited extensively. A number of years ago, while Fitch was still an active member of the department, the chairman took it upon himself to tally citations to publications by all members of the department. For several consecutive years, Henry Fitch was the most cited.

During the warmer months of the year, the major exception to conducting field studies were the basketball games on the "sand lot" by the Fitch's residence. Games would involve all members of the family and anyone who happened to be visiting the reservation. Henry displayed his usual dogged determination from his fieldwork to the basketball "court," and one quickly learned to avoid his elbows under the basket.

In 1967 I introduced Henry to the tropical rainforest in Amazonian Ecuador, where he was the only member of the field party who would work in the field during the torrid afternoons, all the while lamenting the apparent absence of snakes. Customarily he went into his cabin and emerged a few minutes later with a towel wrapped around his middle and untied sneakers on his feet. To get to the dribbling bamboo spout loosely referred to as the shower, he had to cross the dirt "courtyard," the home territory of a very aggressive goose, which took particular delight in nipping at Henry's buttocks. One afternoon we heard Henry exclaim "ouch," as he stood naked snapping his towel at the goose. He was completely unaware that he was the "floorshow" in the middle of camp.

Here I learned that Henry had poor night vision and consequently was primarily a diurnal biologist, but he was constantly amazed that we found so many snakes at night. Only after much cajoling did he accompany us twice on nocturnal forays during a month in the forest. However, I like to think that I influenced much of Henry's subsequent work in the tropics, where he conducted numerous studies on the systematics and ecology of anoles and on populations and conservation of iguanas.

Henry Fitch was one of the last remaining naturalists. His breadth of knowledge was matched by very few of his contemporaries and scarcely imagined by his younger colleagues. His careful work on natural history is well worth emulating. Our knowledge of animals in nature would be far greater if many more biologists around the world followed in the footsteps of Henry S. Fitch.

COURTESY OF ALICE F. ECHELLE

Henry Fitch was modest and unassuming — but very competitive in basketball.

Henry Fitch at Home and in the Tropics

Robert W. Henderson

Section of Vertebrate Zoology, Milwaukee Public Museum
Milwaukee, Wisconsin 53233-1478 (henderson@mpm.edu)

I was, herpetologically speaking, incredibly green when I entered the University of Kansas as an undergraduate in 1967. The attraction of KU was its long history of herpetological fieldwork in the Neotropics, and I was aware of the ambitious research program of William Duellman and his students in, at that time, Ecuador. I was not, however, aware of the existence of Henry Fitch. I did know that I wanted to study the way snakes lived, but I had absolutely no idea of how to do it or that anyone was already doing it. Eventually, while browsing through the library in the herpetology division, I came across *Autecology of the Copperhead*. I read it from cover to cover, realized this was the kind of research I wanted to do, and I had to meet Dr. Fitch, who just happened to teach at KU.

The Fitches lived on the grounds of KU's Natural History Reservation and I became a frequent visitor, often making the rounds of coverboards (sheets of tin) in Quarry Field to collect the Prairie Ring-necked Snakes on which Dr. Fitch was then working. I have fond memories of the warm hospitality of Virginia Fitch, energetic basketball games played on the bare ground at the Reservation, the Fitch's yellow VW bug with the smiling happy face stuck to the roof, and of many seemingly carefree hours tramping over the Reservation and encountering Osage Copperheads, Eastern Yellow-bellied Racers, and Prairie Kingsnakes. Despite the time we spent together while I was an undergrad, I somehow convinced Dr. Fitch to take me on as a graduate student, and thus began a 30-year collaboration.

Although my primary interest was in snake ecology, and Dr. Fitch's long-term snake population studies continued to be the focus of his Kansas fieldwork, we never collaborated on a research project with an ophidian concentration. Our tropical fieldwork always had lizards as our primary objective. Mexico was the scene for our first field trip together, primarily in the states of Chiapas and Oaxaca, to collect ecological and morphological data on various species of *Anolis*. This was followed by travels in Nicaragua and Belize for work on the conservation of *Iguana* and *Ctenosaura*, and then more Mexican fieldwork (where one night he suggested we bathe in the Pacific at about 10 pm; I was terrified, certain some creature would lop off my legs while I tried to get clean). Aside from the many hours spent in a truck or jeep, once at a site there was little downtime. On weekends in Nicaragua, we did not have access to the jeep and driver provided for iguana work, but Dr. Fitch knew that anoles awaited us somewhere, so off we went with local transportation, never quite knowing where we were headed or if we'd get back to our quarters in Managua. It was exhausting fun.

I became enamored of the West Indies in the late 1970s, and was pleased when Dr. Fitch joined me in the Dominican Republic (DR) for a project with *Anolis bahorucoensis* in 1985. I know he had a good time in the DR because he kept commenting on the numbers of lizards encountered everywhere all the time. He came up with one wonderful idea after another on how best to study this elusive anole. He later returned to the DR to study the invasive *Anolis cristatellus* and its impact on native anoles in the La Romana area. Cumulatively, we spent months together doing fieldwork in the tropics. Dr. Fitch's energy and enthusiasm for looking for lizards and snakes never waned and, although I was much younger than he, it was not always easy to keep up with him. He had no qualms about sleeping in crummy hotels and, despite his diabetes, he could be pretty malleable when it came to food (although we ate Spam and boiled potatoes *every* night for six weeks in Mexico). I sense Dr. Fitch never lost the enthusiasm I last observed more than 20 years ago, and that's been borne out by his incredible productivity well into his 90s. As he noted in an interview conducted by his daughter in 2000 (Echelle and Stewart, 2000), "interest in reptiles and amphibians has been a dominant influence in my life, and other interests have seemed relatively minor." I recall him telling me about one of his KU colleagues who went off on a two-week fishing trip. He intimated that he would not be able to stand doing that, and seemed genuinely perplexed that his colleague could forego research for that long.

ROBERT W. HENDERSON

Henry Fitch and a Boa Constrictor; February 1972 in Chiapas, Mexico.

Dr. Fitch was the ideal collaborator: He always met deadlines (and expected the same from me), and was generous in sharing authorship. I'm sure I must have tried his patience many times (while a student, often showing up at his home unannounced to discuss some "important" issue), but he never visibly lost it. Even a minor falling-out was quickly forgotten. He did, however, at one time inform me that I was no John Lynch or Marty Crump!

While he was alive, Henry Fitch was an inspiration to me and I consider myself amazingly fortunate to have been one of his students and collaborators. He remains my herpetological inspiration and I'm confident that his incredible body of work will continue to inspire researchers for many decades to come. We spoke infrequently on the phone during his last years on the Reservation (and before moving in with his daughter and son-in-law in Stillwater, Oklahoma), but one of our last conversations was my favorite. I don't recall the exact wording, but you'll get the idea.

RWH: So, you must be, what, 91 or 92 now?
HSF (chuckling): No, 93.
RWH: Well, how're you doing?
HSF: Not so great. I have a bad hip and my back is painful, so getting around is difficult.
RWH: I'm sorry to hear that. No fieldwork, I guess.
HSF: Ah, well I just came back from radio-tracking six Timber Rattlesnakes.
RWH (shaking his head in awe and admiration): Amazing.

I always hoped he knew how much he had influenced my efforts and I was looking forward to sending him a copy of a forthcoming book on

the natural history of West Indian amphibians and reptiles. I doubt that he would've been up to reading it, but I did want him to know that I had written it (with Bob Powell). Perhaps my ego (or insecurity) hoped he'd at least think, "Bob's done OK."

In the Field with Henry Fitch

David M. Hillis

Section of Integrative Biology, University of Texas
Austin, Texas 78712 (dhillis@mail.utexas.edu)

I received a phone call from Alice Fitch Echelle in the fall of my junior year at Baylor University. I knew Alice, Henry Fitch's daughter, through her husband Tony Echelle. Tony was teaching a graduate course in Systematics at Baylor, and had given me permission to enroll in his class as an undergraduate. That course opened my eyes to the exciting possibilities of phylogenetics. Tony and Alice often let me come along on their many field trips to collect fishes throughout Texas, so Alice knew that I was enthusiastic about fieldwork.

Over the phone, Alice described how her father had received a small grant to study the impact of human exploitation of iguanas for food, and was planning a semester-long field trip through Mexico and Central America. As Henry was nearing retirement, Alice was worried about him making the trip alone, and she knew that I had a passion for anything to do with herpetology. She wanted to know if I was interested in taking off a semester from school and accompanying Henry in the field. "I would love to do it, but I'll need to think about it," I said, as I considered how delaying my graduation by a semester might affect my future plans for graduate school. I hung up the phone and thought for about 30 seconds, then called Alice back. "I'll do it…when do we leave?" That was the extent of the background and the planning for what was to be my most educational semester as an undergraduate.

I was already quite familiar with Henry Fitch through his books and research articles. I had met him the previous summer as he visited Alice and Tony, when I asked him to sign my copy of his book, *Reproductive Cycles of Lizards and Snakes*. I remember that he was pleased to see that my copy of the book was worn and obviously heavily used. Henry had been embarrassed and modest, acting as if he felt honored to be asked by an over-eager undergraduate for his autograph. I couldn't believe that such a famous person could be so modest.

Henry drove down from Kansas and picked me up in Texas in early January, in an old International Harvester pickup with a well-worn camper in the bed, which was to be our home for the next four months. We crossed into Mexico the next day, and I learned very quickly that there was little justification for Henry's modest demeanor. I asked questions about everything we saw, and rarely did I manage to stump him. At every camping site, I caught practically every herp, fish, insect, spider, crustacean, and mammal that I could find, and Henry told me something about them all. He frequently also would explain fundamental concepts of geology, climate, ecology, and just about every other aspect of natural history as we slowly moved south through Mexico into Central America. His impromptu lectures stimulated me to write long entries in my field journal every evening.

The funded purpose of the trip was to study iguana exploitation, and we did that. But Henry was fascinated with anoles, and it became clear to me that Henry was much more interested in studying the systematics, ecology, and behavior of anoles than he was in studying iguanas. That was fine with me; I didn't care what we studied, as long as it was related to herpetology. We traveled fairly slowly, so that we had plenty of time to collect anoles and other herps at every campsite.

I had never before met an adult who was so completely immersed in the study of natural history, so we hit it off immediately. Henry was as enthusiastic about being in the field as I was, at least by day. I was surprised, however, that Henry did not accompany me on my nightly forays into the forests around our campsites after dark. His diabetes had affected his night vision, and so he did not see well at night. But he was always enthusiastic about all the herps I would find and bring back to him in the camper after dark, and we would often stay up late talking about our latest captures and what interesting research problems they might suggest. To Henry, every species provided new questions that were waiting to be answered. I couldn't imagine a more exciting life.

As much as I was enjoying myself, there were a few aspects of Henry's approach to fieldwork that caused me some aggravation. First, he insisted on doing all the driving, even though I'd been asked by Alice to accompany Henry on the basis that he would need some help. Given his poor night vision, his night-driving proved quite frightening to everyone on the road except Henry, and more than once I was convinced we would drive off one of the many precipitous roadsides in the mountains of Central America. Eventually, I insisted that he had to let me drive at night, or else I would only get in the truck with him by day. We drove only by day from then on; I was still not permitted to drive the old International Harvester pickup.

A second minor aggravation was what can generously be described as Henry's rather parsimonious nature. We bought and cooked all our own food, which was fine with me, except that Henry was a straight Midwestern meat-and-potatoes man, and we almost never had any meat. So we ate mostly potatoes. After the first few weeks of a steady potato diet, I was getting desperate for something I could taste. I started buying a few peppers and spices from the markets on the sly, and catching land crabs, freshwater prawns, and fish from the streams around our campsites. Soon I was cooking up two meals: boiled potatoes for Henry, and a spicy concoction of whatever I could catch around our campsites for me. Henry politely tried my attempts at culinary diversity a few times, but he always returned to potatoes for dinner. Sometimes, for excitement, he would put a little salt and pepper or butter on them, or even add a scrambled egg when he was feeling extravagant.

Other than gasoline (which cost about 30 cents a gallon in Mexico at the time), I think Henry was spending less than a dollar a day for all our other living expenses. So when we reached the Guatemala–El Salvador border on a Saturday in February, and Henry discovered that the weekend fee for crossing the border was 50 cents/person, but that the weekday rate was 25 cents, we of course had to turn around and camp out in Guatemala until Monday morning to save 50 cents. At our Guatemalan campsite near the border, I found synbranchid eels in a small stream, and I had a blast figuring out how to catch them (and I still have fond memories of *Synbranchus* stew). By Sunday I had to hang my clothes out to dry, and some locals who had been drinking decided to take advantage of the situation. They grabbed my clothes and ran, and I briefly gave chase, until one of them turned and pulled out a machete. I returned to camp and suggested to Henry that we might want to find a new camping spot. Henry did not seem very interested in doing so until rocks started raining down on us from the cliff above our campsite. We pulled out just as a large rock smashed our windshield. When I last saw that pickup many years later, that broken windshield had never been repaired.

On Monday morning after the windshield-smashing event, we arrived at the border at 8 AM, just when the weekend rate was supposed to change back to the weekday rate. But after the customary spraying of the truck with DDT (a ritual that was practiced on both sides of every Central American border), the border official charged us 50 cents a person. Henry objected, and pointed to the clock on the wall, which said 8:05 AM. The border official calmly went to the clock, changed the time to 7:55, and charged us the weekend rate. It was one of the few times in four months I saw Henry mad about anything. For the most part, he would roll with whatever life dished out, and make the best of every situation.

Our study of human exploitation of iguanas and ctenosaurs reached a peak during Lent, when the markets of Central America became well stocked with these large lizards. Lizard is not considered "meat" by many people who give up meat for Lent, so iguanas and ctenosaurs were sold and


DAVID HILLIS

Henry Fitch examining an iguana in a market in El Salvador, February 1979.

eaten by the thousands during this time. But after Lent, we were back into the mountains, looking for more species of anoles. By then, we had hatched a project to study intra- and interspecific variation of anole dewlaps, and were busy collecting series of as many species as we could locate.

One might think that it would have been a physical mismatch to pair a young strapping undergraduate with a professor nearing retirement on an extended field trip. It was…I had a hard time keeping up with Henry. He wasn't fast, but he never stopped. He could walk all day up steep mountainsides in pursuit of the next species of anole, and we did so just about every day. Some years later, as a graduate student at the University of Kansas, I would take public education classes of schoolchildren out to the KU Natural History Reservation where Henry and his wife Virginia lived. Even well into his "retirement" years, Henry took great pride in leaving kids in the dust. As he cruised through the Reservation, he would grab snakes as he walked, checking their ventral clips for individual identification. "Aha! It's female number 1675! I have captured this racer more than 300 times in her life…I am glad to see that she is still alive." The kids were always wide-eyed with amazement, as they stood there trying to catch their breath before Henry rushed off to the next snake.

As it turned out, Alice need not have worried about Henry's "advancing age" when we set off for our Central American field trip. Henry remained active in the field for another three decades after that trip … a full career for many people. Henry collected more data after he "retired" than most people collect in their lifetimes. I doubt anyone will ever be able to repeat the kind of long-term autecological studies that he perfected. But more than the specific knowledge that I learned from Henry, what I admired most about him was his child-like enthusiasm for nature and everything in it, and his unquenchable need to ask questions about everything he encountered. Several generations of herpetologists benefited from his wisdom, his kindness, and his passion. Mention his name to anyone who ever met him, and you will get a smile and a story. I can't think of a better legacy for a great naturalist who squeezed so much out of such a long and productive life. Henry, we will all miss you, but we will smile every time your name is mentioned.

Natural History Observations of Henry Fitch

Raymond B. Huey

Department of Biology (Box 351800), University of Washington
Seattle, Washington 98195-1800 (hueyrb@u.washington.edu)

The Second World Congress of Herpetology was held in Adelaide, Australia in 1994. One symposium was on the biology of snakes, and Henry Fitch was a presenter. For many in the audience, this was their first time to hear the legend in person. So as Henry walked to the podium, the audience's initial mood (or at least mine) was one of excitement, anticipation, and respect.

Henry gave an amazing talk. The theme was long-term (really long-term!) demographic trends of all of the snakes on the Kansas Natural History Reserve. The results were stunning but depressing: The density of essentially every species had declined over time.

The audience (largely snake buffs of the first order) quickly became somber. Adding to the poignancy of the moment, we all recognized that this grim result was being delivered by a kind and gentle man whose deep love for snakes and their natural history had inspired him to carry out a lifelong study of these snakes. But the clear conclusion emerging from all of his immense work was that his beloved subjects were declining to extinction. Sometimes, life doesn't seem fair.

Either in his talk, or in the question period afterwards, Henry noted that a primary cause was a policy of suppressing fires on the Reserve: as a result, succession was unchecked, such that habitats on the reserve were increasingly forested and increasingly unfavorable to snakes.

Someone asked, "Why don't you light a fire?" Henry thought for a moment, and then replied quietly, "I can't do that." My distinct impression at the time was that he really did want to do just that, but that he couldn't do so ethically, given his position at the Reserve.

But I also remember distinctly feeling at the time that Henry was sending a subliminal message to us in the audience: "If you want to start a fire..."

For me, Henry's talk was certainly among the most memorable ones of the entire Congress. Moreover, its central lesson still haunts my thoughts. We should do science because we love the process, not because we need to love the results. Henry Fitch could not have loved the results of his work, but there's no doubt he loved the process.

Memories of Henry Fitch

Michael V. Plummer

Department of Biology, Harding University
Searcy, Arkansas 72149 (plummer@harding.edu)

Henry Fitch was one of the most gracious, kind, and gentle men I have ever known. I greatly respected him for his long list of professional achievements, but I also respected him for the man he was and how he treated others. He was always the gentle encourager to me and I often think of his example when I get in an exasperating situation with my students or colleagues. I never heard a degrading word spoken against Henry the man

by anyone. Any and all who happened to come by the Natural History Reservation were heartily welcomed by Henry and his lovely wife Virginia, and that seemed to happen frequently.

My formal association with Henry began in July 1972 when I came to KU to begin a Ph.D. program. I found it difficult to believe I had the opportunity to work with such a professional giant. I remember standing in awe as we spoke about potential research projects and thinking that since Henry was 64 at the time, I just might be his last student before he retired (wrong! I only missed by about 30 years). Henry was THE man as far as snake ecology was concerned and I assumed my dissertation would become yet another monograph of a Reservation snake species. But then he suggested we go down on the "Kaw" (Kansas River) to look for softshell turtles. I was fascinated by the sandbars, the softshells, and Henry's nonstop fountain of knowledge about them – talk about information overload! But what I remember most about our inaugural softshell trip was this 27-yr-old kid in the prime of life trying desperately to keep up with an aging 64-yr-old walking (more like running) on the soft sand as he talked. I looked for a red "S" on his chest.

Henry once had a guest at the Reservation, a gentleman from the Bombay Natural History Society, and because India is near the center of softshell diversity, Henry asked me to take the gentleman out on the Kaw and show him our American softshells. By that time, I had captured hundreds of *Apalone mutica* and I assured Henry that it would be no problem seeing numerous softshells. Any field biologist could probably guess what happened. After working hard for a couple of hours, we saw maybe two or three juvenile softshells. I learned that day that one should never make such rash statements regardless of how confident he is about seeing animals in the field. Henry was apologetic to the gentleman and I was embarrassed, but Henry never said another word about it to me.

Henry frequently encouraged his students to do "interesting" side projects along with their thesis or dissertation work. He suggested a project on softshell glands in the summer of 1972 that would fit in "nicely" with my ecological Ph.D. work. Being a swamped and overwhelmed new grad student, I wasn't terribly interested in his suggestion at the time, but I never forgot it (probably because of who suggested it). Well Henry, you would be pleased to know that I finally did do the project and it was published in 2009 just before you left us. Sorry I'm so slow; it only took 37 years. Thanks for the treasured memories.

Henry Fitch as a Mentor and Teacher

Richard A. Seigel

Department of Biological Sciences, Towson University
Towson, Maryland 21252 (rseigel@towson.edu)

Most herpetologists today know Henry S. Fitch only as a name on his classic papers and monographs (e. g., *Autecology of the Copperhead*, *A Kansas Snake Community*). In this remembrance, I would like to give my perspective on Henry in the roles I knew him best, as a mentor and teacher.

In 1979, all I knew about Henry Fitch was his outstanding publication record. I had been accepted to the Ph.D. program at the University of Kansas for the fall 1979 semester, and, through a series of letters, Henry had tentatively agreed to accept me as his doctoral student. However, he had cautioned me that he was retiring in 1980 and that I might want to reconsider coming to KU as his final student. Thus, in June 1979, my wife Nadia and I drove to Kansas to meet Henry and his wife Virginia for the first time. Little did I know that this initial meeting would lead to a 30 year relationship with Henry and Virginia and that my appreciation and respect for them would go far beyond anything I might have expected.

As we drove on the unpaved entrance road leading to Henry's house on the KU Natural History Reservation (now the Fitch Natural History Reservation), I saw numerous metal coverboards ("shelters" in Henry's terminology) and drift fences scattered at what appeared to be random intervals along the road. As soon as we reached the small, incredibly modest house where the Fitches lived on the Reservation, Henry and Virginia were out the front door to greet us. Almost immediately, I gained an insight into Henry's character: Knowing what to call your presumptive major professor is always a delicate proposition for a new student ("Dr. Fitch?" "Professor Fitch?"), but Henry dealt with that by holding out his hand and introducing himself as "Henry Fitch," and we were on a first name basis from then on. Virginia went even further and gave Nadia and me a huge hug, inviting us in for lunch.

Feeling much more at ease, we only got to the Fitch's front porch when I saw that there were a large series of jars, cans, and snake bags, all holding various live herps. Asking Henry where these came from, he proceeded to tell us that was today's catch and then tell much more about the ecology and natural history of his "finds" than four years of field work and reading had provided me so far. I was struck especially by the detailed notes Henry took on each find and how much data he was extracting from each individual.

After lunch, Henry suggested that we do "a round" of his traps and shelters, and the two of us set off up the hillside by the house. Within minutes I discovered that this 69-year-old man was in better shape than most grad students, as he went up the hill on what felt like a trot. As we went, he began to tell me a detailed history of what felt like every tree and critter we saw. Phrases such as "I am hearing a Yellow-billed Cuckoo" were thrown out casually, leading to two thoughts I dared not express: "I thought this was a herpetologist" and "I am glad YOU are hearing this, since I surely don't!"

I was thrilled when we came to the first series of shelters at what was known as Quarry Field, since the pace finally slowed down and Henry said this was the best place to see Copperheads. Sure enough, there were two gorgeous Copperheads curled up under the first shelter we flipped and they were right in front of Henry. Problem was, there were also four Ringneck Snakes right in front of me, and, while I had eyes only for the Copperheads (and did

COURTESY OF ALICE F. ECHELLE

Henry Fitch used funnel traps and drift fences to capture many of the snakes on the Natural History Reservation.

not see the Ringnecks), Henry did exactly the opposite. Thus, I went for the Copperheads in front of Henry with my hook and Henry bent down to get the Ringnecks in front of me (thinking, I am sure, "who is this dummy who does not see snakes right in front of him?"). As we bounced off of each other, Henry stumbled forward, putting his foot right in front of the Copperheads, one of which immediately struck his boot! I could see the headline now: "Famed herpetologist killed by venomous snake; new grad student to blame."

Fortunately, the snake managed only to clip the front of Henry's boot, and we quickly captured both Copperheads and at least some of the Ringnecks. After flipping a few more shelters, we had a total of four Copperheads, three of which were marked individuals, one as long as nine years ago. I found this nothing short of amazing, having only recently read that high recapture rates were impossible for snakes, and said as much to Henry. He shook his head and said: "If I had just a few more fences and more shelters, I'd have a 100% recapture rate." I glanced at Henry, trying to decide if he was saying this in jest or if he was angling for a compliment. I quickly realized that neither of these was true; he genuinely felt that he had simply not worked hard enough and needed to do more to satisfy his own standards. What a great example for a new Ph.D. student!

A few years later, I got to see a second example of Henry's genuine humility regarding his fieldwork when the noted lizard ecologist Laurie Vitt visited the Reservation. Knowing that Laurie was especially interested in lizards, Henry made sure to check the shelters where he knew Slender Glass Lizards could be found, and we quickly got several of them. When Laurie said something to the effect of "are you going to publish anything on these?" Henry indicated that the sample size was still too small for a solid publication. Laurie asked: "How many of them have you found?" thinking (I am sure) that the answer would be a hundred or so. Henry's response floored us: "About 1,500 so far," he said rather casually. When we tried to convince Henry that 1,500 glass lizards was nothing short of phenomenal and far more than anyone else had, he just shook his head and said he needed more data! By the way, Henry did publish a monograph on these lizards in 1989; the sample size was 2,216 individuals captured 3,353 times! (Fitch 1989).

In addition to doing field research with Henry, I was also lucky enough to be his TA for the last two courses he taught at KU, Vertebrate Natural History and Animals of Kansas. Both courses were combined lecture/field trip formats and my main role was driving students to and from the field sites and helping in the field any way that I could. Although Henry's lectures were detailed and comprehensive, the fun part of both classes was the field trips. Students enjoyed trying to "challenge" Henry by bringing him whatever odd insect, snake skin, or mammal dropping they found, then having him act as a living version of Wikipedia and proceed to lecture them on everything that was known about the species under question. One of my favorite memories was when a student found a newly hatched Five-lined Skink and asked Henry how much the tiny lizard weighed. Henry held the lizard for a few seconds and then replied: "1.15 grams." The class immediately burst out laughing at the absurdly precise answer. So, the whole class walked over to the old, dilapidated building that Henry called his "lab" and we proceeded to weigh the skink on an old triple-beam balance. Sure enough: 1.15 grams! Somewhat awed, one of the students asked, "How could you possibly know that?" Henry's response was typically low-key: "When you have processed over 5,000 of something, you know their weights pretty well!"

Given Henry's low-key approach and humility, it would be easy to conclude that he was not competitive and that he would let his grad students get away with things. Neither conclusion would be true. I recall quite well the first time Henry came to my study site in northwestern Missouri where I was doing mark-recapture studies on snakes. After catching our first snake of the day, I marked it using scale-clipping (no PIT tags in those days) and proudly showed it to Henry. "Oh," he said, "I guess you don't want to be able to recognize this snake if you capture it again?" This was Henry's way of telling me I was not marking properly, and the message was delivered loud and clear. To this day when I scale clip snakes, I follow Henry's methods and can tell you, they work extremely well.

Henry's competitive nature may be illustrated by something only a select few got to experience, something called "Fitchian Basketball." Henry always had a grass/dirt basketball "court" set up outside his front door and during the spring of 1980, his current students got a taste of how competitive Henry Fitch could be at times. There were eight of us that day, three women (Nancy Zushlag [Henry's master's student], my wife Nadia, and Jim Knight's wife, Karin), and five men (Henry, myself, and three of Henry's other students: Larry Hunt, Luis Malaret, and Jim Knight). When the time came to play, Henry started explaining the "rules"; first, there were two hoops, one at 10 feet, the other at 8 feet. The 10-foot hoop was for the guys, the 8-foot hoop for the women. Next, there were odd but very specific rules about the men and women taking the ball out separately, whether the women could be guarded, and how the points were tallied. What we all found most amusing was how new rules suddenly appeared whenever someone scored against Henry's team. My personal favorite was "no jump shots from the corner," which just happened to be my best place to shoot from. Needless to say, we all spent more time laughing than we spent playing, as watching Henry morph into this competitive jock was something none of us had seen before.

Basketball finished, we then got to see a fine demonstration of Henry's character. Henry was due to retire that year and it fell to our group of graduate students to find an appropriate way to celebrate Henry's many achievements. With the help of Joseph Collins, Bill Duellman, and many others, we organized a symposium at the 1980 herp meetings in Milwaukee, with many of Henry's former students presenting papers. We also planned to publish a volume based on that symposium, which appeared in 1984. After lunch, we sprang all this on Henry, including a plaque made especially for the occasion. Henry was deeply moved (Virginia was in tears), but I could tell that while he was clearly touched, part of him was saying to himself: "I need to get out there and check the shelters…"

No discussion of Henry could possibly be complete without mentioning Virginia. Her pride in Henry's accomplishments and her irreplaceable role in his life cannot be overestimated. Watching her beam from ear to ear during our symposium honoring Henry in 1980 was a joy to watch. For me (and Nadia), Virginia was more like a grandmother than the wife of my major professor. From giving us furniture when we were starving grad students to giving our son his first tricycle, her warmth and devotion to Henry and his students was truly remarkable.

As I think of Henry now, I see him heading off to do another "round" at the Reservation. May he always have as many shelters to check as he could ever want, and may his traps always have many marked snakes. When his morning rounds are over, he'll be headed back home, where Virginia has lunch waiting.

Henry Fitch: The Twilight of an Incredible Career

George R. Pisani

Kansas Biological Survey, University of Kansas
2101 Constant Avenue, Lawrence, Kansas 66047 (gpisani@ku.edu)

I first met Henry Fitch in 1968, forty-one years ago, while visiting a friend in Lawrence. I'd read many of his papers in the course of my studies, and when I met him again in 1970, I was again impressed by two things beyond his vast store of knowledge. At age fifty-nine he could, while making a round in the field, walk the legs off many people far younger. And, for someone whose many papers had essentially established the field of snake ecology as we now know it, he was incredibly unassuming and reserved (except when playing the, ummm… *rules-modified*, basketball games that then were a Reservation feature event).

Many herpetologists accompanied this remarkable man into the field in the course of his long, distinguished career. It was my distinct privilege

SHARON HAGAN, COURTESY OF CHESTER FITCH

Henry Fitch at the entrance to the Fitch Natural History Reservation, 1997.

to be among them at various times, and to work with him during the final few years of that career. Our close professional relationship really began in the mid-1980s with our collaboration on Timber Rattlesnake telemetry. I built an effective (albeit awkwardly maneuverable) antenna. Using that and some transmitters (immense by current standards!) assembled by Dr. Tony Shirer, and which Henry pushed gently down the throats of large rattlers, we spent a summer gathering movement data that retrospectively turned out to be more a learning experience about the technique than about the snakes. Henry assimilated all this, and nearly 20 years later, when we had far better equipment and far more background knowledge on the subtleties of using it, we were able to initiate an ongoing study of this species in northeast Kansas.

In 1987 Henry and I received funding from Oklahoma Dept. of Natural Resources to study rattlesnake roundups and their effects on the populations of Western Diamondback Rattlesnakes. It was no secret that Henry's long-term enthusiasm for rattlesnake study wasn't shared by his wife Virginia, perhaps out of recognition that his reflexes were slowing, as do everyone's with time, hampering the avoidance response essential for such work. It's one thing to dodge the feint of a 2-foot Copperhead, but quite another to dodge the long strike of a 5-foot *Crotalus*. Virginia's reaction was subdued apprehension. But after some discussion we agreed to handle the captive snakes after cooling them, a reassuring model that Virginia accepted, and which proved effective for safely gathering the morphological data we sought.

Henry's enthusiasm for field work and for learning all there was to learn about snake ecology never diminished, though by 2002, time plainly was having its inexorable effect of limiting bone and muscle. In these later years of his career, I had retired and so was able to help him make rounds in the field using one of the field station's "Gator" ATVs. I drove while Henry's gaze was fixed firmly on our destination of the day, wherever it happened to be. By 2003, he was gamely trying to maneuver using crutches on a local ledge that served as a Timber Rattlesnake den. I emphasized to him that I didn't plan to be remembered as the guy who brought him back from the field with a severe envenomation or a broken leg, and so he agreed (perhaps acquiesced is a more accurate term!) with a change of model— I'd do the rough and tumble stuff and he'd wait in the 6-wheeler to share in the results, and we'd collaborate on papers that, of course, required his incredible store of knowledge. Or, if topography allowed, he'd hunt close to the 'Gator while I ventured further. That model worked well through the remainder of the time he was able to live independently on FNHR, and other persons, younger than either of us, pitched in to help Henry make productive rounds in the field safely. Notable among these are Scott Sharp (a high school teacher in a nearby district) and his family, and KU undergrads Mike Zerwekh and Joey Brown.

As late as 2006, the "Henry and George team" (which I once pointed out to him had an average age of 79, a realization he greatly enjoyed) still made joint rounds, these in my Smooth Earth Snake study area not far from FNHR. This was a species he'd barely seen, with just 3 FNHR records. He was fascinated by the fact that the species was so close, yet he'd seen so few. When on our first trip into that area I caught the first of several we subsequently found in tall grass habitat, his reaction was to look at it intently and softly remark, "Well, I'll be damned." I think it was the only time I heard him say that! I'm glad I sent him the final draft of the article summarizing that research. When I emailed it to his daughter Alice, his primary caregiver by then, I asked her to "tell Henry he has to stick around to see this in print." Planned publication was for December 2009. Alice read it to him and afterward told me how attentive he'd been and how he'd enjoyed learning about this elusive species.

On 8 September 2009, just a few months shy of his centennial birthday, Henry Sheldon Fitch passed away, leaving for science one of the most outstanding legacies of ecological study ever known. Best known for his extensive long-term study of the herpetofauna of what in 1948 was The University of Kansas Natural History Reservation (renamed in 1986 the Fitch Natural History Reservation [FNHR]), his published studies in animal ecology extending back to 1933 also include a wide range of birds, mammals, and invertebrates, as well as the local successional flora of their habitats. Harry Greene, interviewed by the *Lawrence Journal-World*, accurately reflected on Henry's legacy by stating, "It's not an exaggeration to say that Henry's the father of snake biology." His studies on the ecology and relations of these many species were refined through his extensive career to reflect his unique insights regarding the way they form communities of interacting organisms. All of us who continue to build on this legacy, and those who follow us and will do the same, owe a tremendous thanks to this modest man of great talent.

Literature Cited

Echelle, A.F. and M.M. Stewart. 2000. Historical perspective: Henry S. Fitch. *Copeia* 2000:891–900.

Fitch, H.S. 1989. A field study of the Slender Glass Lizard, *Ophisaurus attenuatus* in northeastern Kansas. *University of Kansas Museum of Natural History Occasional Paper* 125:1–50.

Note.—All of Henry Fitch's papers published by the University of Kansas are incorporated in the Biodiversity Heritage Library, where they can be downloaded at www.biodiversitylibrary.org. The family suggests donations to honor Professor Fitch be directed to the Henry and Virginia Fitch Memorial Fund at the KU Endowment Association: <www.kuendowment.org>.

COURTESY OF ALICE F. ECHELLE

Henry Fitch (right) in an ultralight plane in March 2004. His nephew flew him over the area where he had grown up near Medford. This is a good indication of Henry's spirit of adventure and love of travel — characteristics he never lost.

Diet Specialization by the Scarlet Kingsnake, *Lampropeltis elapsoides* (Colubridae)

Harry W. Greene[1], Edmund J. Zimmerer[2], William M. Palmer[3], and Michael F. Benard[4]

[1]Department of Ecology and Evolutionary Biology, Cornell University, Ithaca, NY 14853 (hwg5@cornell.edu)
[2]Department of Biological Sciences, Murray State University, Murray, KY 42071 (ed.zimmerer@murraystate.edu)
[3]North Carolina Museum of Natural Sciences, Raleigh, NC 27699
[4]Department of Biology, Case Western Reserve University, Cleveland, OH 44106 (michael.benard@case.edu)

Based on 34 natural prey items, *Lampropeltis elapsoides* eats primarily elongate squamates (97%), especially skinks (74%) and colubroid snakes (15%). No ontogenetic or geographic variation is evident; prey items are swallowed headfirst and average 19% of predator mass. The diet substantially overlaps that of juveniles of some other lampropeltines, including sympatric *L. triangulum*, but is unusually narrow compared to adults of most other species.

Scarlet Kingsnakes (*Lampropeltis elapsoides*), now recognized as distinct from the much more widespread Milksnake (*L. triangulum*), occur at low and moderate elevations from Virginia to Florida, thence west to Kentucky and Louisiana (Conant and Collins 1998). The two species are sympatric with little or no hybridization at several contact zones, the best studied of which are in western Kentucky and adjacent Tennessee (Armstrong et al. 2001) and North Carolina (Harper and Pfennig 2008). These secretive coral snake mimics (Greene and McDiarmid 2005, Harper and Pfennig 2008) range in total length (TL) from 130 mm at hatching to a maximum of 576 mm (Wright and Bishop 1915, Williams 1988), and, along with other lampropeltines, are of interest from diverse perspectives (e.g., Rodríguez-Robles and de Jésus Escobar 1999, Pyron and Burbrink 2009).

ALAN CRESSLER

Scarlet Kingsnakes (*Lampropeltis elapsoides*) occur at low and moderate elevations from Virginia to Florida and west to Kentucky and Louisiana. In contrast with published reports, these snakes are not dietary generalists.

SUZANNE L. COLLINS, CNAH

Red Milksnakes (*Lampropeltis triangulum syspila*) show a significant dietary shift with increasing size, shifting from reptiles to mammals as they get larger).

Herein, we: (i) Provide a first critical analysis of the feeding ecology of *L. elapsoides*; (ii) refute implications that it is a dietary generalist (e.g., "food includes small snakes and lizards, baby mice, small fish, insects, and earthworms"; Conant and Collins 1998:375); and (iii) assess its potential interactions with other sympatric snakes, especially Red Milksnakes (*L. t. syspila*) in the Kentucky-Tennessee contact zone. We are especially pleased that Henry Fitch provided unpublished data for this project and enjoyed reading our manuscript during the summer of his 100th year.

Materials and Methods

We examined stomach contents of preserved *L. elapsoides* (for methods see Greene and Rodríguez-Robles 2003) at Archbold Biological Station, Carnegie Museum of Natural History, and North Carolina State Museum of Natural Sciences, then integrated those data with EJZ.'s field observations from Kentucky; anecdotes provided by J.D. Groves (pers. comm.) and J.D. Wilson (Savanna River Ecology Lab files); and credible literature records (Carr 1940, based on Florida Museum of Natural History 1568; K.L. Krysko, pers. comm.; Mount 1963; Brown 1979; Palmer and Braswell 1995, excluding a Worm Snake, *Carphophis amoenus*, which field notes indicate was eaten after capture; Lee 2006). We omitted records cited by Williams (1988) that were based on captives or unsupported by explicit data (Brimley 1905, Ditmars 1907, Brode and Allison 1958); we excluded Wright and Bishop's (1915:167) report of "an angleworm and … two killifishes," because those prey are otherwise unknown in the diet of any lampropeltine (Rodríguez-Robles and de Jésus Escobar 1999) and more plausibly stomach contents from an ingested item (e.g., Eastern Gartersnake, *Thamnophis sirtalis*). We assessed dietary overlap with *L. t. syspila* based on five records from Kentucky and Tennessee obtained by EJZ and 22 records from Kansas (Fitch 1999, pers. comm.).

Results

Thirty-four prey items from 32 *L. elapsoides* (mean 1.1 items/snake) include 13 *Scincella lateralis* (Ground Skink, including 1 set of 5 eggs and 1 tail), 6 *Plestiodon inexpectatus* (Southeastern Five-lined Skink), 1 *P. egregius* (Mole Skink), 2 *Plestiodon* sp., 3 unidentified skinks, 1 set of 4 lizard eggs, 2 *Aspidoscelis sexlineata* (Six-lined Racerunner), 2 *Diadophis punctatus* (Ring-necked Snake), 1 *Tantilla coronata* (Southeastern Crowned Snake), 1 *Thamnophis* sp. (gartersnake), 1 *Virginia striatula* (Rough Earthsnake), and 1 nestling rodent. They encompass ≥9 prey species, including 33 (97%) somewhat to very elongate, mostly smooth-scaled squamate reptiles; 25 (74%) were skinks (mainly 2 species) and 5 (15%) were colubroid snakes. Only 2 ate multiple items, so we cannot evaluate whether individuals specialize on particular prey types.

LAURIE J. VITT (TOP)

Preying mainly on slender squamates, such as reclusive skinks and small snakes, the diet of Scarlet Kingsnakes appears to be constrained by a small gape. Southeastern Five-lined Skinks (*Plestiodon inexpectatus*; top) and Ground Skinks (*Scincella lateralis*; bottom) are prominently represented in stomach samples.

SUZANNE L. COLLINS, CNAH (FOR BOTH IMAGES)

Small snakes in the diet of Scarlet Kingsnakes include Ring-necked Snakes (*Diadophis punctatus*; top) and Rough Earthsnakes (*Virginia striatula*; bottom).

The 34 prey items are from Florida (8), Kentucky (7), Louisiana (1), Mississippi (2), North Carolina (12), and South Carolina (4), and lizards predominated throughout the range. Florida *L. elapsoides* ate 7 lizards and a mouse; North Carolina prey included 10 lizards and 2 snakes, and, although Kentucky snakes occupy distinctive habitat (Armstrong et al.

Table 1. Data for individual Scarlet Kingsnakes (*Lampropeltis elapsoides*) and their prey. MR = mass ratio.

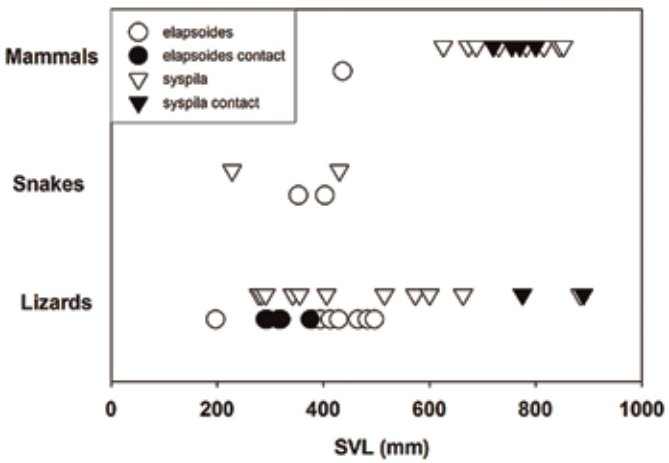
Locality	Size	Prey	MR	Direction	Date	Source
LA	353 mm, 9g	1 *Thamnophis* sp., 1 g	0.11	headfirst		CM 91903
FL	379 mm, 16 g	1 *Aspidoscelis sexlineata*, 6 g	0.38	headfirst		ABS
MI	403 mm, 18 g	*2 Diadophis punctatus*, 2 g, 3 g	0.11			Lee (2006)
			0.17			
FL	413 mm, NA	1 *Plestiodon inexpectatus*, NA				ABS
FL	429 mm, 13 g	1 skink, 2 g	0.15	headfirst	9/1936	CM 19840
FL	436 mm, 20 g	1 rodent, 4 g	0.20			ABS
GA		1 angleworm, 2 killifishes				CUMV 6242, W&B
FL	196 mm	1 *Scincella lateralis*			1/1937	Carr (1940) FMNH 1568
FL		1 *Scincella lateralis*				Carr (1940)
FL	~10 in	UID skink scales in feces				J.D.Groves (in litt.)
FL	300 mm	*Plestiodon egregius,* tail				Mount (1963)
SC		2 *Scincella lateralis*				Brown (1979)
SC		1 *Scincella lateralis*				Brown (1979)
SC	348 mm, 12.5 g	1 *Scincella lateralis*			4/17/07	J.D.Wilson (SREL)
NC, Moore	adult female	1 *Aspidocelis sexlineata*, juv.			9/1/2004	NCSM 04-2049
NC, Richmond	adult female	1 *Plestiodon inexpectatus*			4/13/2002	NCSM 02-364
NC, Craven	197 mm	1 *Scincella lateralis,* tail			9/12/1968	NCSM 33820
NC, Beaufort	483 mm	1 *Scincella lateralis* [5 eggs]			7/1/1968	NCSM/PB
NC, Craven	394 mm	1 *Plestiodon inexpectatus*			5/24/1968	NCSM 33819/PB
NC, Hyde	496 mm	1 *Plestiodon inexpectatus,* adult			4/30/1960	NCSM 972/PB
NC, Cateret	465 mm	1 *Plestiodon inexpectatus,* adult			4/25/1970	NCSM 9253/PB
NC, Bladen	294 mm	1 *Scincella lateralis,* adult				NCSM 15005/PB
NC, Brunswick		1 *Plestiodon inexpectatus*				P&B (1995)
NC, Brunswick		1 *Virginia striatula*				P&B (1995)
NC, Scotland		1 *Scincella lateralis*				P&B (1995)
NC, Scotland		1 *Tantilla coronata*				P&B (1995)
KY	370 mm	1 set of 4 reptile eggs (6–7 mm)			7/98	EMZ 1523
KY	375 mm	1 *Plestiodon* sp.		headfirst	6/98	EMZ 1525
KY	290 mm SV	1 *Scincella lateralis*, 4 cm SV		headfirst	7/98	EMZ 1527
	(est. 334 TL)					
KY	295 mm	1 *Plestiodon* sp., 4 cm SV			6/99	EMZ
KY	290 mm	1 skink			6/05	EMZ
KY	320 mm	1 *Scincella lateralis*			6/05	EMZ
KY	315 mm	1 *Scincella lateralis*, 4 cm SV			6/06	EMZ

2001), all of their prey were skinks. Snakes with prey were found in January (1), March (1), April (4), May (1), June (5), July (3), and September (3). They measured 196–496 mm in TL (mean 354 mm, n = 23), of which the two smallest ate *S. lateralis*, one of them (TL 197 mm) only a tail; the largest contained an adult *P. inexpectatus* and the only mammal was in a 436-mm adult. Prey/predator mass ratios were 0.11–0.38 (mean 0.19, n = 6), of which the largest was an *A. sexlineata* in a small adult snake (TL 379 mm), and all five items for which direction of ingestion was recorded were swallowed headfirst.

Scarlet Kingsnakes exhibit no ontogenetic change in diet; they thus completely overlap the diet of juvenile Red Milksnakes and partly that of adults. Eleven *L. t. syspila* within the size range of *L. elapsoides* (<576 mm TL) had eaten 8 skinks and 3 small snakes, whereas 17 larger adults (600–890 mm TL) had consumed 4 skinks (18%), a limbless lizard, and 17 mammals (77%) — a significant dietary shift with increasing size (reptiles versus mammals; Fisher's exact test, $p < 0.0001$).

Discussion

By preying mainly on slender squamates, *L. elapsoides* of all sizes resemble juveniles of *L. californiae* (K. Wiseman and H.W. Greene, unpubl. data), *L. triangulum* (Fitch 1999; M.F. Benard and H.W. Greene, unpubl. data), and *L. zonata* (Greene and Rodriguez-Robles 2003), as well as adults of



Prey types in relation to predator size for Scarlet Kingsnakes (*Lampropeltis elapsoides*) and Red Milksnakes (*L. triangulum syspila*), based on samples from a sympatric contact zone and elsewhere in the range of each species.

Table 2. Data for individual Red Milksnakes (*Lampropeltis triangulum syspila*) and prey.

Locality	Size	Prey	Direction	Date	Source
TN, Montgomery	720 mm	mammal hair		6/97	EMZ
KY, Lyon	755 mm	1 *Peromyscus* sp.		6/97	EMZ
KY, Trigg	770 mm	mammal hair		6/97	EMZ
KY, Marshall	775 mm	1 *Plestiodon* sp. 80 mm	headfirst	6/00	EMZ
TN, Lake	890 mm	1 *Plestiodon* sp. 70 mm		10/03	EMZ
TN, Lake	800 mm	1*Peromyscus* sp., young with hair		5/06	EMZ
KS	228 mm	1*Diadophis punctatus*		6/18/66	HSF
KS	278 mm	1*Plestiodon fasciatus*, 1st yr		4/86	HSF
KS	283 mm	1 *Plestiodon obsoletus*, tail only		9/21/66	HSF
KS	291 mm	1 *Plestiodon fasciatus*, juv.		4/30/66	HSF
KS	342 mm	1 *Plestiodon fasciatus*, adult		9/25/64	HSF
KS	355 mm	1 *Plestiodon fasciatus*, juv.		9/17/73	HSF
KS	406 mm	1 *Plestiodon fasciatus*, gravid ad.		6/14/66	HSF
KS	430 mm	1 *Carphophis amoenus*, adult		5/26/55	HSF
KS	430 mm	1 set 3 *Diadophis punctatus* eggs		7/16/78	HSF
KS	515 mm	1 *Plestiodon fasciatus*, ad. & 5 eggs		6/26/78	HSF
KS	573 mm	1 *Plestiodon fasciatus*, adult		5/22/66	HSF
KS	600 mm	1 *Plestiodon fasciatus*, 1st yr		5/18/60	HSF
KS	626 mm	2 *Microtus ochrogaster*, juveniles		6/7/93	HSF
KS	663 mm	1 *Plestiodon fasciatus*, adult		5/7/67	HSF
KS	673 mm, 90 g	4 *Microtus ochrogaster*, juv. @15 g		10/8/86	HSF
KS	688 mm	1 *Blarina hylophaga*		5/23/93	HSF
KS	730 mm	1 *Blarina hylophaga*		4/17/81	HSF
KS	782 mm	1 *Cryptotis parva*		10/10/90	HSF
KS	815 mm	1 *Microtus* sp.		8/18/67	HSF
KS	845 mm	2 *Microtus ochrogaster*, nestlings		7/23/92	HSF
KS	852 mm	1 *Microtus ochrogaster*, adult		5/26/90	HSF
KS	884 mm	1 *Ophisaurus attenuatus*, adult		8/1/61	HSF

some other small colubroid snakes (e.g., *Hypsiglena*, Rodríguez-Robles et al. 1999). Compared to other *Lampropeltis*, Scarlet Kingsnakes have pointed snouts and fused head scales suggestive of fossorial habits (Wright and Bishop 1915, Williams 1988), and they are typically found under cover objects, especially bark on old fallen logs and vertical stumps (Palmer and Braswell 1995, Reichling 2008). Accordingly, this species might simply be a habitat specialist, its narrow diet constrained by small gape and high encounter rates for reclusive skink and snake prey.

Additional lines of evidence imply Scarlet Kingsnakes are specialized predators (for general discussions see Rodríguez-Robles and Greene 1999, Brischoux et al. 2009). With 82% of its diet lizards and 89% of those items skinks, *L. elapsoides* has a narrower diet than another lampropeltine, *Rhinocheilus lecontei* (Long-nosed Snake), with a diet consisting of 65% lizards and 72% (48% of total items) teiids (*Aspidoscelis*); respective means for 55 other snake species in which lizards are modal prey are 75% and 47% (Rodríguez-Robles and Greene 1999). Moreover, *L. elapsoides* has the highest incidence of skinks in the adult diet of any North American serpent (Ernst and Ernst 2003) and its anterior teeth are enlarged like those of other skink specialists (Greene 1989). Finally, throughout its range, *L. elapsoides* co-occurs with *S. lateralis* and two to four species of *Plestiodon*, whereas, elsewhere in North America, no more than two species of skinks are typically sympatric (maps in Conant and Collins 1998, Jones and Lovich 2009).

In terms of prey taken by other sympatric snakes, *L. elapsoides* partly overlaps *Coluber constrictor* (Racer), *L. getula* (Common Kingsnake), *L. extenuata* (Short-tailed Snake), and *Micrurus fulvius* (Eastern Coralsnake), of which the first two have much broader diets and the others are moderately to exclusively specialized on snakes (Ernst and Ernst 2003). As MacArthur (1972) pointed out, one way to trump potential competitors is to eat them, and *M. fulvius* indeed preys on both *P. inexpectatus* (ABS field notes) and *L. elapsoides* (Krysko and Arbdelfattah 2002). None of those other snakes specializes on skinks, but we have demonstrated that juveniles of *L. t. syspila* do so, and adults of that species partially overlap the diet of sympatric *L. elapsoides*. Additional studies of Scarlet Kingsnakes in a community ecological context will likely provide further insights into specialization, speciation, mimicry, and other evolutionary processes.

Acknowledgments

We thank K.L. Krysko, J.N. Layne, and S.P. Rogers for access to and/or information on preserved specimens; H.S. Fitch, J.D. Groves, and J.D. Wilson for use of their observations; and J.D. Groves and L.J. Vitt for insightful feedback.

Literature Cited

Armstrong, M.P., D. Frymire, and EJ. Zimmerer. 2001. Analysis of sympatric populations of *Lampropeltis triangulum syspila* and *Lampropeltis triangulum elapsoides*, in western Kentucky and adjacent Tennessee with relation to the taxonomic status of the Scarlet Kingsnake. *Journal of Herpetology* 35:688–693.

Blanchard, F.N. 1921. A revision of the king snakes genus *Lampropeltis*. *Bulletin of the U.S. National Museum* 114:1–260.

Brimley, C.S. 1905. Notes on the food and feeding habits of some American reptiles. *Journal of the Elisha Mitchell Society* 21:149–155.

Brischoux, F., X. Bonnet, and R. Shine. 2009. Determinants of dietary specialization: A comparison of two sympatric species of sea snakes. *Oikos* 118:145–151.

Brode, W.E. and P. Allison. 1958. Burrowing snakes of the panhandle counties of Mississippi. *Herpetologica* 14:37–40.

Brown, E.E. 1979. Some snake food records from the Carolinas. *Brimleyana* 1:113–124.

Carr, A.F., Jr. 1940. A contribution to the herpetology of Florida. *University of Florida Publications, Biological Science Series* 3:1–118.

Conant, R. and J.T. Collins. 1998. *A Field Guide to Reptiles and Amphibians: Eastern and Central North America* (3rd ed.). Houghton Mifflin, Boston, Massachusetts.

Ditmars, R.L. 1907. *The Reptiles of North America.* Doubleday, Garden City, New York.

Ernst, C.H. and E.M. Ernst. 2003. *Snakes of the United States and Canada.* Smithsonian Books, Washington, D.C.

Fitch, H.S. 1999. *A Kansas Snake Community: Composition and Change over 50 Years.* Krieger Publishing Co., Malabar, Forida.

Greene, H.W. 1989. Defensive behavior and feeding biology of the Asian Mock Viper, *Psammodynastes pulverulentus* (Colubridae), a specialized predator on scincid lizards. *Chinese Herpetological Research* 2:21–32.

Greene, H.W. and R.W. McDiarmid. 2005. Wallace and Savage: Heroes, theories, and venomous snake mimicry, pp. 190–208. In: M.A. Donnelly, B.I. Crother, C.E. Guyer, M.H. Wake, and M.E. White (eds.), *Ecology and Evolution in the Tropics: A Herpetological Perspective.* University of Chicago Press, Chicago, Illinois.

Greene, H.W. and J.A. Rodríguez-Robles. 2003. Feeding ecology of the California Mountain Kingsnake, *Lampropeltis zonata* (Colubridae). *Copeia* 2003:308–314.

Harper, G.R. and D.W. Pfennig. 2008. Selection overrides gene flow to break down maladaptive mimicry. *Nature* 451:1103–1107.

Jones, L.L.C. and R.E. Lovich (eds.). 2009. *Lizards of the American Southwest: A Photographic Field Guide.* Rio Nuevo Press, Tucson, Arizona.

Krysko, K.L. and K.R. Arbdelfattah. 2002. *Micrurus fulvius* (Eastern Coral Snake). Predation. *Herpetological Review* 33:57–58.

Lee, J.R. 2006. *Lampropeltis triangulum elapsoides* (Scarlet Kingsnake). Ophiophagy. *Herpetological Review* 37:231.

MacArthur, R.H. 1972. *Geographical Ecology.* Harper and Row, New York.

Mount, R.H. 1963. The natural history of the Red-tailed Skink, *Eumeces egregius* Baird. *American Midland Naturalist* 70:356–385.

Palmer, W.M. and A.L. Braswell. 1995. *Reptiles of North Carolina.* University of North Carolina Press, Chapel Hill.

Pyron, R.A. and F.T. Burbrink. 2009. Neogene diversification and taxonomic stability in the snake tribe Lampropeltini (Serpentes: Colubridae). *Molecular Phylogenetics and Evolution* 52:524–529.

Reichling, S.B. 2008. *Reptiles and Amphibians of the Southern Pine Woods.* University Press of Florida, Gainesville.

Rodríguez-Robles, J.A. and H.W. Greene. 1999. Food habits of the Long-nosed Snake, *Rhinocheilus lecontei*, a "specialist" predator? *Journal of Zoology (London)* 248:489–499.

Rodríguez-Robles, J.A. and J.M. de Jésus Escobar. 1999. Molecular systematics of New World lampropeltine snakes (Colubridae): Implications for biogeography and evolution of food habits. *Biological Journal of the Linnean Society* 68:355–385.

Rodríguez-Robles, J.A., D.G. Mulcahy, and H.W. Greene. 1999. Feeding ecology of the Desert Nightsnake, *Hypsiglena torquata* (Colubridae). *Copeia* 1999:93–100.

Williams, K.L. 1988. *Systematics and Natural History of the American Milk Snake,* Lampropeltis triangulum (2nd rev. ed.). Milwaukee Public Museum, Milwaukee, Wisconsin.

Wright, A.H. and S.C. Bishop. 1915. A biological reconnaissance of the Okefinokee Swamp in Georgia. II. Snakes. *Proceedings of the Academy of Natural Sciences of Philadelphia* 67:139–192.

A Survey of Gravid Snakes at Several Sites in Southern Wisconsin

Joshua M. Kapfer

Department of Environmental Studies, Elon University, Elon, North Carolina 27244 (jkapfer@elon.edu)

Photographs by the author except where indicated.

Fitch (1987a) indicated that morphological measurements, particularly measures of snout-to-vent length (SVL), provide some of the most useful information that can be obtained from field-based research on snakes. Unfortunately, published research that focuses on natural history, which includes morphological data such as snake size, has declined sharply in recent years (Henderson and Powell 2009, McCallum and McCallum 2006). In some cases, natural history observations considered "anecdotal" are even treated with scorn by researchers. As Fitch (1987b) suggested, such reactions to life history studies are unfortunate, and information that may be considered anecdotal still has a valuable role in increasing the understanding of many species' ecological needs. Therefore, this information should be published.

Considerable data have been published on the ecology and life history of several natricine snake species, particularly the Common Garter Snakes (*Thamnophis sirtalis*; e.g., Fitch 1965, 1999, 2001). These include information on aspects of their morphology, such as size (SVL) and weight. However, certain small fossorial species, such as members of the genus *Storeria* have received less attention. In addition, although the size of "mature" females has been reported for several species at some locations in the upper midwestern United States (e.g., Ohio and Michigan), such information is rare from populations in Wisconsin. Furthermore, few if any data from Wisconsin have been published, with the possible exception of technical reports that are not easily obtained. Such information is valuable for determining numerous aspects of the biology of these species, such as size at sexual maturity and morphological characteristics of regional

An example of typical Eastern Garter Snake (*Thamnophis sirtalis sirtalis*) habitat in Wisconsin.

Grassland habitat is often preferred by Brown Snakes (*Storeria dekayi*) in Wisconsin.

SUZANNE L. COLLINS, CNAH

Brown Snakes (*Storeria dekayi*) were found at only one of the survey locations.

Table 1. Sample sizes, mean snout-vent-length (SVL) in mm for each species captured per survey location.

Species	Site Name	Wisconsin County	Sample Size	Mean SVL ± SD (range)
S. dekayi	Mud Lake	Dodge	21	264 ± 25 (241–295)
S. occipitomaculata	Westford	Dodge	2	231 ± 22 (215–248)
S. occipitomaculata	French Creek	Marquette	1	196
S. occipitomaculata	Horicon	Dodge	2	225 ± 16 (214–237)
T. sirtalis	Cedarburg	Ozaukee	11	471 ± 72 (356–620)
T. sirtalis	Horicon	Dodge	10	546 ± 53 (469–603)
T. sirtalis	Mud Lake	Dodge	5	562 ± 36 (524–609)
T. sirtalis	Westford	Dodge	4	492 ± 39 (450–533)

populations. Therefore, my objective was to survey for gravid natricines at several sites in southern Wisconsin, with particular interest in the understudied members of the genus *Storeria,* to determine if the sizes of gravid snakes encountered conformed to previously published reports of adult female size or size at maturity. In addition, the goal of these surveys was to provide baseline natural history data that may have current and future value to herpetologists, ecologists, and conservation biologists.

I conducted surveys for gravid females at five sites across three counties in southern Wisconsin during the late spring-summer of 2009. I chose this period to conduct my surveys because it is within the season during which Wisconsin species are gravid. Although sites varied in area, ratio of wetland to upland, and plant community complexity, all survey locations possessed open shallow marsh habitats with associated open upland habitats (primarily grassland or fallow grassland). Each site was surveyed via artificial cover objects (Fitch 1987a) in the form of ¾-inch plywood cut in 3 x 4-ft sheets. Boards were placed opportunistically in areas that appeared suitable for natricine snakes, with a particular focus on species of *Thamnophis*, *Storeria*, and *Nerodia*. Boards were checked after 1700 h only on days that had been partly sunny to sunny. This insured that the microclimate under each board would be warm enough to attract gravid females, but not so warm as to be unsuitable. Gravidity was determined by palpation of the lower third of the snake to check for the presence of formed embryos. I measured the SVL of gravid snakes by gently, but firmly, stretching them along a tape measure as described in Fitch (1999).

Due to resource limitations, the survey effort at each site varied. At some locations, cover objects were deployed several years prior to initiation of the study, whereas at other locations, boards were deployed in late spring 2009, immediately prior to initiation of surveys. In addition, each site was not surveyed the same number of times, and an equal number of cover objects was not implemented equally across sites. Mud Lake and Westford, for example, each had ten cover objects and were visited six times throughout the late spring and summer. Cedarburg, on the other hand, had 15 cover boards and was surveyed four times. French Creek had 10 boards and was surveyed four times, whereas Horicon had 20 boards divided among four locations and was surveyed nine times. However, because the objective of these studies (i.e., to sample gravid females on-site and measure their SVL) did not depend upon equitable survey efforts across sites, these variations were deemed acceptable.

Throughout the course of these surveys, I encountered adult gravid females of three natricine species: Northern Brown Snake (*Storeria dekayi dekayi*), Redbelly Snake (*Storeria occipitomaculata occipitomaculata*), and Eastern Garter Snake (*Thamnophis sirtalis sirtalis*; Table 1). However, I did not find all three species at every survey location. Gravid snakes also were found at all survey locations. For example, at the French Creek site, I found only one gravid Redbelly Snake and no gravid females of other species. Brown Snakes were encountered only at the Mud Lake site, whereas gravid Eastern Garter Snakes were found at all sites except French Creek (Table 1). Overall, gravid Eastern Garter Snakes were the most frequently encountered snakes across all sites (n = 30). These were followed by Northern Brown Snakes (n = 21) and Redbelly Snakes (n = 5). Because I did not mark individuals, I may have collected and measured the same snake on more than one occasion.

Table 2. Size comparisons of adult female snakes encountered during this study and past published reports. Measurements of snakes reported to be gravid are indicated with a single asterisk (*); publications reporting estimated size at sexual maturity are indicated with a double asterisk (**).

Species	Source	Location of Study	Sample Size	Average SVL (mm)
S. dekayi	This study	Wisconsin	21	264*
S. dekayi	Wilson and Dorcas (2004)	North Carolina	9	245
S. dekayi	Minton (2001)	Indiana	21	266
S. dekayi	Fitch (1999)	Kansas	22	256*
S. dekayi	King (1997)	Ontario/Ohio	NA	230**
S. dekayi	Kofron (1979)	Louisiana	30	170–175**
S. occipitomaculata	This study	Wisconsin	5	222*
S. occipitomaculata	Wilson & Dorcas (2004)	North Carolina	7	181
S. occipitomaculata	Minton (2001)	Indiana	10	198
S. occipitomaculata	Brodie & Ducey (1989)	New York	42	209*
S. occipitomaculata	Semlitsch & Moran (1984)	South Carolina	37	157
S. occipitomaculata	Blanchard (1937)	Michigan	71	194
T. sirtalis	This study	Wisconsin	30	514*
T. sirtalis	Minton (2001)	Indiana	30	531
T. sirtalis	Fitch (1999)	Kansas	1592	639
T. sirtalis	Rossman et al. (1996)	Various	NA	420–550**
T. sirtalis	Mitchell (1994)	Virginia	—	515
T. sirtalis	Larsen et al. (1993)	Canada	23	745*
T. sirtalis	King (1989)	Lake Erie Islands	345	683
T. sirtalis	Hebard (1950)	Washington	32	408

In general, the SVL of gravid females of all species encountered did not vary greatly from past reports (Table 2). On average, gravid Brown Snakes were 264 ± 25 mm in SVL with little variation in individual SVL. This species has been reported to show significant geographic variation in SVL (King 1997), which also has been noted for *Thamnophis sirtalis* (King 1989). Gravid Redbelly Snakes were slightly smaller than Brown Snakes on average, but sizes varied little (222 ± 20 mm). The average SVL of gravid Eastern Garter Snakes captured during my surveys was 514 mm, making them the largest snake encountered. Unlike the other two species, however, considerable variation in SVL was observed in this species (SD = 67 mm).

Although Redbelly Snake SVLs reported from past studies are smaller than the average I recorded for individuals in Wisconsin, my sample size was

Redbelly Snakes (*Storeria occipitomaculata*) were found in habitat such as this during surveys.

SUZANNE L. COLLINS, CNAH (ONLY FOR PHOTO OF SNAKE, NOT FOR SNAKE IN HAND)

Redbelly Snakes (*Storeria occipitomaculata*) were encountered at more sites than Brown Snakes (*S. dekayi*), but in lower densities.

The Eastern Garter Snake (*Thamnophis sirtalis sirtalis*) was the most frequently observed snake during surveys.

small (n = 5), and I recommend caution when interpreting this. However, to my knowledge, few published reports have large sample-sizes of this species. For example, Wilson and Dorcas (2004) reported capturing seven females over five years of surveys in North Carolina; Brodie and Ducey (1989) reported a sample of 42 gravid females captured over two years in New York; Semlitsch and Moran (1984) captured 37 females; and Blanchard (1937), who commented specifically on how infrequently they are encountered, analyzed 71 females for which he had acquired data over 12 years. In addition, although my samples were small, despite being spread across three sites in two counties, little variation was observed in SVL (SD = 20 mm).

Rossman et al. (1996) reported that female *Thamnophis sirtalis* mature at 420–550 mm and all of the average SVLs that I observed per site fit within this range (Table 2). At one location (Cedarburg), I examined two gravid individuals that were below this threshold (397 mm and 356 mm). Fitch (1999) reported that the smallest gravid female, among the hundreds that he analyzed over 50 years at a site in Kansas, measured 490 mm in SVL. At least ten gravid individuals that I encountered at all survey locations were shorter than this.

In summary, the gravid snakes of all species encountered during my surveys were similar in SVL to previously published reports. Unfortunately, the small sample sizes and relatively short survey period (i.e., one season) of this work limits comparisons with other studies. More data are necessary to make definitive conclusions about the sizes of gravid snakes in this region of North America.

Acknowledgements

I thank Natural Resources Consulting, Inc. and the Wisconsin Department of Natural Resources-Bureau of Endangered Resources for supplying cover boards that were used, in part, to obtain this information. I thank the U.S. Fish and Wildlife Service, the Wisconsin Department of Natural Resources, and the University of Wisconsin-Milwaukee Field Station for granting me access to their properties for survey work. Robert Henderson (Milwaukee Public Museum) graciously read and commented on an earlier draft of this manuscript.

Literature Cited

Blanchard, F. 1937. Data on the natural history of the Red-bellied Snake, *Storeria occipitomaculalta* (Storer), in northern Michigan. *Copeia* 1937:151–162.

Brodie, E.D. and P.K. Ducey. 1989. Allocation of reproductive investment in the Redbelly Snake, *Storeria occipitomaculata*. *American Midland Naturalist* 122:51–58.

Fitch, H.S. 1999. *A Kansas Snake Community: Composition and Changes over 50 Years*. Krieger Publishing, Malabar, Florida.

Fitch, H.S. 2001. Further study of the Garter Snake, *Thamnophis sirtalis*, in northeastern Kansas. *Scientific Papers, University of Kansas Museum of Natural History* 19:1–6.

Fitch, H.S. 1987a. Collecting and life history techniques, pp. 143–164. In: R.A. Seigel, J.T. Collins, and S.S. Novak (eds.), *Snakes: Ecology and Evolutionary Biology*. The Blackburn Press. Caldwell, New Jersey.

Fitch, H.S. 1987b. The sin of anecdotal writing. *Herpetological Review* 18:68.

Fitch, H.S. 1965. An ecological study of the Garter Snake, *Thamnophis sirtalis*. *University of Kansas Museum of Natural History* 15:493–564.

Hebard, W.B. 1950. Relationships and variation in the Garter Snake, genus *Thamnophis*, of the Puget Sound region of Washington state. *Herpetologica* 6:97–101.

Henderson, R.W. and R. Powell. 2009. The state of natural history: A perspective from the literature on West Indian Herpetology. *Herpetological Review* 40:273–275.

King, R.B. 1997. Variation in Brown Snake (*Storeria dekayi*) morphology and scalation: Sex, family, and microgeographic differences. *Journal of Herpetology* 31:335–346.

King, R.B. 1989. Body size variation among island and mainland snake populations near Lake Erie. *Herpetologica* 45:84–88.

Kofron, C.P. 1979. Female reproductive biology of the Brown Snake, *Storeria dekayi*, in Louisiana. *Copeia* 1979:463–466.

Larsen, K.W., P.T. Gregory, and R. Antoniak. 1993. Reproductive ecology of the Common Garter Snake *Thamnophis sirtalis* at the northern limit of its range. *American Midland Naturalist* 129:336–345.

McCallum, M.L. and J.L. McCallum. 2006. Publication trends of natural history and field studies in herpetology. *Herpetological Conservation and Biology* 1:62–67.

Minton, S.A. 2001. *Amphibians and Reptiles of Indiana*. Revised 2nd ed. Indiana Academy of Sciences, Indianapolis.

Mitchell, J.C. 1994. *The Reptiles of Virginia*. Smithsonian Institute Press, Washington, D.C.

Rossman, D.A., N.B. Ford, and R.A. Seigel. 1996. *The Garter Snake: Evolution and Ecology*. The University of Oklahoma Press, Norman.

Semlitsch, R.D. and G.B. Moran. 1984. Ecology of the Redbelly Snake (*Storeria occipitomaculata*) using mesic habitats in South Carolina. *American Midland Naturalist* 111:33–40.

Wilson, J.D. and M.E. Dorcas. 2004. Aspects of the ecology of small fossorial snakes in the western Piedmont of North Carolina. *Southeastern Naturalist* 3:1–12.

Daytime Amphibian Surveys in Three Protected Areas in the Western Great Lakes

Kenneth D. Bowen and Erik A. Beever

U.S. National Park Service, Great Lakes Inventory and Monitoring Network, Ashland, Wisconsin 54806 (kennethdbowen@gmail.com)

We performed pilot monitoring of amphibian populations at Apostle Islands National Lakeshore (APIS) in 2006, Pictured Rocks National Lakeshore (PIRO) in 2007, and Sleeping Bear Dunes National Lakeshore (SLBE) in both 2006 and 2007. We performed daytime surveys (using multiple methods) at numerous sites in each of the three parks. We detected 10 amphibian and two reptilian species at APIS, nine amphibian and four reptilian species at SLBE, and nine amphibian and one reptilian species at PIRO. No one daytime survey technique appeared to be superior to any other. Our work resulted in two new species records (Gray Treefrog and Green Frog) for Basswood Island at APIS.

The Great Lakes Inventory and Monitoring Network (hereafter GLKN or the Network) was formed by the U.S. National Park Service (NPS) in 1999 and is one of 32 networks of parks that share common geography and management priorities. The purpose of GLKN is to inventory and monitor natural resources within nine national park units in the northern Great Lakes ecoregion, including Indiana, Michigan, Minnesota, and Wisconsin (Route and Elias 2007). In 2000, GLKN began a biological inventory in Network parks (Route 2000), and, in 2002, the Network began planning a "Vital Signs" monitoring program. Vital Signs are defined as a select group of attributes that are particularly rich in information needed for understanding and managing NPS areas (Route 2004). Vital Signs were chosen in part based on how they reflect the health of park ecosystems and how they respond (or are hypothesized to respond) to natural or anthropogenic stressors. A prioritized list of Vital Signs was finalized in 2004 and amphibian populations were one of the Vital Signs chosen for early protocol development (Route and Elias 2007).

Amphibian populations were chosen as a GLKN Vital Sign for several reasons. Many species of amphibians need both aquatic and terrestrial habitats for life cycle completion, and therefore provide a biological link between land and water and the stressors of each (Stebbins and Cohen 1995, Semlitsch 2000). Concordantly, amphibians are important components of both forest and wetland ecosystems. Amphibians often occur at high density and therefore occupy an important position in food webs while potentially dominating energy transfer between terrestrial and aquatic habitats (Stebbins and Cohen 1995, Welsh and Droege 2001, Gibbons et al. 2006). Finally, amphibians are sensitive to a wide variety of natural and anthropogenic stressors (Alford and Richards 1999, Boone et al. 2007, Davidson and Knapp 2007), and the worldwide decline of amphibian species diversity and abundance is well-documented (Wake 1991, Green 1997, Lannoo 2005).

In 2006 and 2007, the GLKN performed pilot work surveying for amphibians within network management units. The portion of the pilot work reported on here had two primary objectives: (1) To gather information on species distribution and abundance for park inventories and as a baseline for future work, and (2) to test the efficiency and effectiveness of daytime survey and research methods.

Methods

Study Areas.—We performed pilot work at Apostle Islands National Lakeshore (APIS) in 2006, Pictured Rocks National Lakeshore (PIRO) in 2007, and Sleeping Bear Dunes National Lakeshore (SLBE) in both 2006 and 2007. Apostle Islands National Lakeshore is located near Bayfield, Wisconsin and consists of an archipelago of 21 islands and a narrow 12-mile segment along the mainland shore of Lake Superior. The park is primarily hemlock-hardwood forest (but contains elements of southern boreal forest), and has a wide diversity of coastal features. About 190,000 people visit the park annually. Pictured Rocks National Lakeshore is headquartered in Munising, Michigan and is located along the south-central shore of Lake Superior within a transition zone between the boreal and eastern deciduous forest. Wetlands are common throughout the park. About 450,000 people visit annually. Sleeping Bear Dunes National Lakeshore is headquartered

Fig. 1. Daytime survey points for 2006 at Apostle Islands National Lakeshore, Wisconsin. Green indicates parkland.

in Empire, Michigan along the northeastern shore of Lake Michigan. The Park includes two large islands in Lake Michigan as well as 65 miles of Lake Michigan shoreline, 26 inland lakes, and four streams. About 1.2 million people visit the park annually (Route and Elias 2007).

Site Selection.—Daytime survey sites were chosen by several methods, depending on the logistical difficulties present. At APIS, sampling of wetlands was constrained by numerous logistical factors. These included lake conditions and the availability of watercraft and qualified pilots. The resource-management staff at APIS communicated that only a limited number of permanent wetlands were present on the island group, and we sampled all of the sites that were identified (10 sites; Fig. 1).

Sampling of wetlands at SLBE was limited by several factors. The largest source of littoral habitats was Lake Michigan. However, much of this was unprotected, and thus exposed to too much wave action to be suitable as amphibian habitat. That action also created sandy bottoms without submerged or emergent vegetation along much of the coastline. Additionally, many bodies of water had private in-holdings within the Lakeshore boundaries, and thus were not available for sampling. Water bodies known to the resource managers that were not affected by the above constraints were selected for sampling (seven sites; Fig. 2).

Fig. 2. Daytime survey points for 2006 and 2007 at Sleeping Bear Dunes National Lakeshore, Michigan. Green indicates parkland.

Fig. 3. Daytime survey points for 2007 at Pictured Rocks National Lakeshore, Michigan. Dark Green indicates parkland; light green indicates the non-federal Inland Buffer Zone.

Site selection at PIRO was more probabilistic. All wetlands from the NHD (National Hydrography Dataset) database with areas of 0.02–2.0 ha were assigned random numbers, which we used to select the top 20 of 108 sites. The natural-resources staff at PIRO indicated which of these 20 sites they considered reasonable for sampling (i.e., relative accessibility of habitats within one day's time; Fig. 3).

Field Methods.—Methods for daytime surveys consisted of five components at each site: call survey, sampling of physical and chemical attributes of the wetland, visual encounter survey (Heyer et al. 1994) and dip-net sweep (Thoms et al. 1997), and perimeter search. We performed the surveys in that order if we arrived at the site in the morning; but to increase detectability in the call surveys, we performed those last if we arrived in the afternoon. Two observers performed one subsample of each type of survey at each site, or one observer performed two of each type of survey at each site if two observers were unavailable. Where possible, daytime survey sites were sampled once each during each of three seasons (Weir and Mossman 2005). The "early spring" season roughly corresponded to the period from early April–early May, the "late spring" season to mid-May–early June, and the "summer" season to mid-June–early July.

Call surveys consisted of standing in an open location on the periphery of the site and listening for calling anurans for a ten-minute period. General methodology for call surveys followed Weir and Mossman (2005). We recorded the species calling, the maximum calling index value for each species (Weir and Mossman 2005), and the time to first detection (TTFD) for each species.

For visual encounter and dip-net surveys, the observer walked a transect through the wetland. Transects were located arbitrarily (but far enough apart so that observers did not disturb each other) along the edge of open water and consisted of ten nodes, with each node being two minutes in duration. At the end of each two-minute node, the observer performed a dip-net sweep (~1 m in length). We recorded the species observed, the approximate number of individuals of each species, and the TTFD of each species during each two-minute node. We also recorded the species observed and the approximate number of each species for each dip-net sweep. Any ensnared animals were immediately released at the point of capture.

Perimeter surveys consisted of the observer walking along the land-water interface of the site or, alternatively, along the edge of the wetland basin if it was clearly defined. Starting points were located arbitrarily, but were far enough apart so that observers did not disturb each other while searching. Perimeter surveys were terminated after 20 minutes or (rarely) when the site had been thoroughly circumnavigated, whichever came first. We scrutinized the land/water interface for adult amphibians, larvae, and egg masses, and also looked under logs and other potential cover objects adjacent to the wetland. We recorded the species observed, the approximate number of individuals of each species, and the TTFD for each species.

Analytical Methods.—To analyze daytime survey data, we first organized species detections by year, park, site, method, and season. We combined visual encounter and dip-net survey results for the analysis. Detections were defined as an observation of a species at a given site, on a given day, using a given method. For example, if 20 Green Frogs (*Lithobates clamitans*) were detected by a dip-net survey at a given site on a given day, it was considered to be one detection of that species. If Green Frogs were also detected during the call survey at the same site on the same day, it was considered to be a separate detection. This approach allowed us to determine the species composition at each park and site, and to determine which species were most common (and most commonly detected) among sites without biasing our results toward species that are locally abundant or toward a particular survey technique. We calculated the percentage of survey sites at which each detected species was found (naïve occupancy; Mackenzie et al. 2002).

Occasionally, we observed species at sites outside of the proscribed survey periods; these species do not appear in the above analyses. We therefore

Table 1. Amphibian species detections by site, method, and season at Apostle Islands National Lakeshore (Wisconsin) in 2006. ES = early spring, LS = late spring, S = summer.

Species	Site	Method	Season
Anaxyrus americanus	Rocky Island South Swamp	Dip Net Survey	LS
	Michigan Lagoon	Dip Net Survey	S
	Outer Island Lagoon	Perimeter Survey	LS
Hyla versicolor	Little Sand Bay	Dip Net Survey	LS
Pseudacris crucifer	Little Sand Bay	Call Survey	ES
	Basswood Quarry	Call Survey	ES, LS
		Dip Net Survey	ES, S
	Stockton Lagoon South	Call Survey	ES, LS
		Dip Net Survey	LS
	Stockton Lagoon North	Call Survey	LS
	Rocky Island South Swamp	Call Survey	LS
	Sand River	Call Survey	LS
		Perimeter Survey	LS
	Michigan Lagoon	Call Survey	LS
		Dip Net Survey	LS, S
	Outer Island Lagoon	Perimeter Survey	LS
	Outer Island Beaver Pond	Call Survey	LS
		Dip Net	LS
		Perimeter Survey	LS
Lithobates clamitans	Little Sand Bay	Call Survey	S
		Dip Net Survey	LS, S
		Perimeter Survey	S
	Basswood Quarry	Call Survey	S
		Dip Net Survey	LS, S
		Perimeter Survey	S
	Stockton Lagoon North	Dip Net Survey	S
	Sand River	Dip Net Survey	LS, S
		Perimeter Survey	LS, S
	Michigan Lagoon	Dip Net Survey	LS, S
		Perimeter Survey	S
	Outer Island Beaver Pond	Dip Net Survey	LS
		Perimeter Survey	LS
	Outer Lagoon North	Dip Net Survey	S
		Perimeter Survey	S
Lithobates septentrionalis	Sand River	Dip Net Survey	LS
Lithobates sylvatica	Basswood Quarry	Dip Net Survey	LS, S
		Perimeter Survey	LS
	Rocky Island South Swamp	Dip Net Survey	LS
		Perimeter Survey	ES, LS
	Michigan Lagoon	Perimeter Survey	LS
Ambystoma maculatum	Basswood Quarry	Dip Net Survey	ES, LS
	Rocky Island South Swamp	Dip Net Survey	ES, LS
	Michigan Lagoon	Dip Net Survey	LS, S
	Stockton Lagoon South	Dip Net Survey	S
		Perimeter Survey	S
	Sand River	Dip Net Survey	S
	Outer Island Beaver Pond	Dip Net Survey	LS
		Perimeter Survey	LS
	Outer Lagoon North	Perimeter Survey	S
Notophthalmus viridescens	Michigan Lagoon	Dip Net Survey	LS
	Outer Island Beaver Pond	Dip Net Survey	LS
Ambystoma laterale	Rocky Island South Swamp	Perimeter Survey	LS
Hemidactylium scutatum	Rocky Island South Swamp	Perimeter Survey	LS


ERIK BEEVER

Fig. 4. A Northern Leopard Frog (*Lithobates pipiens*) at Long Island, Apostle Islands National Lakeshore, Wisconsin.


ERIC ELLIS

Fig. 5. Stockton Island Lagoon South, one of the sampling sites at Apostle Islands National Lakeshore, Wisconsin.

compiled a separate list of species found outside of the survey periods at each site in each park in order to provide a more complete accounting of the species present. We included any observed reptilian species in this list. For all analyses, common and scientific names of species follow Crother (2008).

Results

We were unable to determine the number of detections or the most-common species with regard to season because not all sites were visited in all three seasons, and some sites were visited multiple times in one season. Furthermore, we were unable to quantitatively determine the utility of various methods based on detections because we were unable to perform all surveys during every visit at all sites. For these same reasons, naïve occupancy estimates and species and detections per site should be viewed with caution. However, quantity or diversity of detections differed little among methods or seasons, with the possible exception of summer season surveys resulting in lower species diversity.

We detected a total of 10 amphibian species at APIS (Figs. 4 & 5). Outer Island and Michigan Island appeared to have the most diverse herpetofaunas, with five amphibian and two reptilian species and six amphibian and one reptilian species, respectively. With regard to individual sampling sites, Michigan Lagoon and Rocky Island South Swamp had the most amphibian species detections (six each). Basswood Quarry produced the largest number of amphibian detections (13), followed by Michigan Lagoon (11; Table 1). Naïve occupancy ranged from 90% of sites for the Spring Peeper (*Pseudacris crucifer*) to only one of ten sites for Gray Treefrogs (*Hyla versicolor*), Mink Frogs (*Lithobates septentrionalis*), Blue-spotted Salamanders (*Ambystoma laterale*), and Four-toed Salamanders (*Hemidactylium scutatum*; Table 2). We found Painted Turtles (*Chrysemys picta*) on Outer Island and Stockton Island, and Eastern Gartersnakes (*Thamnophis sirtalis*) on Outer Island and Michigan Island.

We detected a total of nine amphibian species and four reptilian species at SLBE over two years (Tables 3 & 4; Figs. 6–8). In 2006, Aral Lodge and Indian Trail West had the most amphibian species detections (five each). Aral Lodge produced the largest number of amphibian detections (seven), followed by Indian Trail West (six; Table 3). Naïve occupancy ranged from 85.7% of sites for the Green Frog to only one of seven sites for Gray Treefrogs and Central Newts (*Notophthalmus viridescens*; Table 2). Outside of the survey periods, we observed Green Frogs at Aral Lodge and Northern Leopard Frogs (*Lithobates pipiens*) at Indian Trail West. If combined with survey data, this results in a naive occupancy of 100% at daytime sites for Green Frogs in 2006. The only reptilian species that we observed in 2006 were the Eastern Gartersnake at Otter Creek and the Northern Ribbonsnake (*Thamnophis sauritus*) at Aral Lodge and Indian Trail East.

Table 2. Number of daytime sampling sites (in parentheses) at which amphibian species were detected and percent of sites occupied by amphibian species (naïve occupancy) for Apostle Islands National Lakeshore in 2006 (APIS, Wisconsin), Pictured Rocks National Lakeshore in 2007 (PIRO, Michigan), and Sleeping Bear Dunes National Lakeshore in 2006 and 2007 (SLBE, Michigan).

	Anaxyrus americanus	*Hyla versicolor*	*Pseudacris crucifer*	*Lithobates clamitans*	*Lithobates pipiens*	*Lithobates septentrionalis*
APIS 2006	(3) 30.0	(1) 10.0	(9) 90.0	(7) 70.0		(1) 10.0
SLBE 2006	(2) 28.6	(1) 14.3	(5) 71.4	(6) 85.7		
SLBE 2007	(1) 14.3	(5) 71.4	(5) 71.4	(6) 85.7	(2) 28.6	
PIRO 2007	(3) 42.9	(2) 28.6	(5) 71.4	(7) 100.0	(1) 14.3	(1) 14.3

	Lithobates sylvatica	*Notophthalmus viridescens*	*Plethodon cinereus*	*Hemidactylium scutatum*	*Ambystoma laterale*	*Ambystoma maculatum*
APIS 2006	(3) 30.0	(2) 20.0		(1) 10.0	(1) 10.0	(7) 70.0
SLBE 2006	(2) 28.6	(1) 14.3	(2) 28.6			
SLBE 2007	(2) 28.6	(1) 14.3	(3) 42.9			(1) 14.3
PIRO 2007	(2) 28.6	(1) 14.3	(1) 14.3			


ERIC ELLIS

Fig. 6. Indian Trail East, one of the sampling sites at Sleeping Bear Dunes National Lakeshore, Michigan.

In 2007, Indian Trail West had the most amphibian species detections (five), followed by Platte River, Kelderhouse, and Indian Trail East (four each). Martin Road produced the largest number of amphibian detections (14), followed by Indian Trail West and Platte River (12 each; Table 4). However, detections at Martin Road were dominated by Green Frogs and Spring Peepers. Naïve occupancy ranged from 85.7% of sites for the Green Frog to only one of seven sites for American Toads (*Anaxyrus americanus*), Spotted Salamanders (*Ambystoma maculatum*), and Central Newts


SUSAN MCMAHON

Fig. 7. An American Toad (*Anaxyrus americanus*) at Sleeping Bear Dunes National Lakeshore, Michigan.

Table 3. Amphibian species detections by site, method, and season at Sleeping Bear Dunes National Lakeshore (Michigan) in 2006. LS = late spring, S = summer.

Species	Site	Method	Season
Anaxyrus americanus	Aral Lodge	Call Survey	LS
		Dip Net Survey	S
	Indian Trail West	Dip Net Survey	S
Hyla versicolor	Aral Lodge	Call Survey	LS
		Dip Net Survey	LS
Pseudacris crucifer	Platte River	Call Survey	LS
	Aral Lodge	Dip Net Survey	S
	Indian Trail West	Dip Net Survey	S
	Indian Trail East	Dip Net Survey	S
	Kelderhouse	Dip Net Survey	S
Lithobates clamitans	Otter Creek	Call Survey	S
		Dip Net Survey	LS, S
		Perimeter Survey	LS, S
	Platte River	Dip Net Survey	LS, S
		Perimeter Survey	LS, S
	Indian Trail West	Call Survey	S
		Perimeter Survey	S
	Indian Trail East	Call Survey	S
		Perimeter Survey	S
	Kelderhouse	Call Survey	S
		Dip Net Survey	S
		Perimeter Survey	S
	Martin Road	Call Survey	S
		Perimeter Survey	S
Lithobates sylvatica	Aral Lodge	Dip Net Survey	S
	Indian Trail East	Dip Net Survey	S
Notophthalmus viridescens	Indian Trail West	Dip Net Survey	S
Plethodon cinereus	Aral Lodge	Perimeter Survey	LS
	Indian Trail West	Perimeter Survey	S

(Table 2). We observed Eastern Gartersnakes at Platte River, Indian Trail East, and Indian Trail West and Northern Ribbonsnakes at Aral Lodge, Indian Trail East, and Indian Trail West. We also observed Painted Turtles


SUSAN MCMAHON

Fig. 8. An abnormally pigmented Green Frog (*Lithobates clamitans*) larva found at Kelderhouse, Sleeping Bear Dunes National Lakeshore, Michigan.

Table 4. Amphibian species detections by site, method, and season at Sleeping Bear Dunes National Lakeshore (Michigan) in 2007. ES = early spring, LS = late spring, S = summer.

Species	Site	Method	Season
Anaxyrus americanus	Kelderhouse	Call Survey	LS
Hyla versicolor	Platte River	Call Survey	LS
		Perimeter Survey	LS
	Aral Lodge	Perimeter Survey	LS
	Indian Trail West	Call Survey	LS
		Dip Net Survey	LS
		Perimeter Survey	LS
	Indian Trail East	Call Survey	ES, LS
		Dip Net Survey	LS
		Perimeter Survey	LS
	Martin Road	Call Survey	LS
		Dip Net Survey	ES
		Perimeter Survey	LS
Pseudacris crucifer	Otter Creek	Call Survey	ES
	Aral Lodge	Call Survey	LS
		Dip Net Survey	LS
	Indian Trail West	Dip Net Survey	LS
	Kelderhouse	Call Survey	ES, LS
	Martin Road	Call Survey	ES, LS
		Dip Net Survey	LS
		Perimeter Survey	LS
Lithobates clamitans	Otter Creek	Dip Net Survey	ES, LS, S
		Perimeter Survey	ES, LS, S
	Platte River	Call Survey	S
		Dip Net Survey	ES, LS, S
		Perimeter Survey	ES, LS, S
	Indian Trail West	Call Survey	S
		Dip Net Survey	LS, S
		Perimeter Survey	LS, S
	Indian Trail East	Call Survey	LS, S
		Dip Net Survey	LS, S
	Kelderhouse	Call Survey	S
		Dip Net Survey	ES, LS, S
		Perimeter Survey	LS, S
	Martin Road	Call Survey	LS, S
		Dip Net Survey	ES, LS, S
		Perimeter Survey	LS
Lithobates pipiens	Platte River	Perimeter Survey	LS, S
	Indian Trail East	Call Survey	ES
Lithobates sylvatica	Platte River	Perimeter Survey	LS
	Kelderhouse	Perimeter Survey	ES
Ambystoma maculatum	Martin Road	Perimeter Survey	LS
Notophthalmus viridescens	Indian Trail West	Dip Net Survey	LS
Plethodon cinereus	Aral Lodge	Perimeter Survey	LS
	Indian Trail West	Perimeter Survey	ES, LS
	Indian Trail East	Perimeter Survey	LS

at Indian Trail East and Martin Road and Snapping Turtles (*Chelydra serpentina*) at Platte River, Indian Trail West, and Martin Road.

We detected a total of nine amphibian species and one reptilian species at PIRO (Table 5; Figs. 9–11). North Country Trail had the most

Table 5. Amphibian species detections by site, method, and season at Pictured Rocks National Lakeshore (Michigan) in 2007. ES = early spring, LS = late spring, S = summer.

Species	Site	Method	Season
Anaxyrus americanus	Chapel Road Stream	Perimeter Survey	LS
	Chapel Road Beaver Pond	Call Survey	ES
	North Country Trail	Call Survey	ES
		Dip Net Survey	ES
Hyla versicolor	North Country Trail	Call Survey	ES
		Dip Net Survey	LS
	Chapel Road Alders	Call Survey	ES
Pseudacris crucifer	7-Mile Creek	Call Survey	ES
	Chapel Road Stream	Call Survey	ES
	Chapel Road Beaver Pond	Call Survey	ES
	North Country Trail	Call Survey	ES
	Chapel Road Alders	Call Survey	ES
		Dip Net Survey	LS
		Perimeter Survey	ES
Lithobates clamitans	7-Mile Creek	Perimeter Survey	S
	Beaver Basin West	Call Survey	S
		Perimeter Survey	S
	Beaver Basin East	Dip Net Survey	S
		Perimeter Survey	S
	Chapel Road Stream	Call Survey	S
		Perimeter Survey	ES, LS
	Chapel Road Beaver Pond	Call Survey	LS
		Dip Net Survey	ES, LS
		Perimeter Survey	LS, S
	North Country Trail	Dip Net Survey	LS, S
		Perimeter Survey	LS
	Chapel Road Alders	Dip Net Survey	LS, S
Lithobates pipiens	North Country Trail	Dip Net Survey	LS
Lithobates septentrionalis	Chapel Road Beaver Pond	Call Survey	S
Lithobates sylvatica	North Country Trail	Dip Net Survey	ES
		Perimeter Survey	LS
	Chapel Road Alders	Call Survey	ES
Notophthalmus viridescens	Beaver Basin West	Perimeter Survey	S
Plethodon cinereus	Beaver Basin West	Perimeter Survey	S

SUSAN MCMAHON

Fig. 9. An Eastern Gartersnake (*Thamnophis sirtalis*) at Pictured Rocks National Lakeshore, Michigan.

EVA HORNE

The Eastern Collared Lizard (*Crotaphytus collaris*) was the subject of one of Dr. Fitch's many contributions to better understanding the natural history of the Kansas herpetofauna (Fitch, H.S. 1956. An ecological study of the Collared Lizard (*Crotaphytus collaris*). *University of Kansas Publications of the Museum of Natural History* (8):213–274).

amphibian species detections (six), followed by Chapel Road Alders and Chapel Road Beaver Pond (four each). North Country Trail produced the largest number of amphibian detections (11), followed by Chapel Road Beaver Pond (eight; Table 5). Naïve occupancy ranged from 100% of sites for the Green Frog to only one of seven sites for Northern Leopard Frogs, Mink Frogs, Central Newts, and Eastern Red-backed Salamanders (*Plethodon cinereus*; Table 2). Outside of the survey periods, we observed American Toads at Beaver Basin West and Chapel Road Alders. The only reptilian species that we observed at PIRO was the Eastern Gartersnake at North Country Trail.

Discussion

With regard to overall number of species detected, daytime surveys were an effective way to monitor amphibians. More species were detected using the different daytime survey methods than by using nighttime call surveys (data not shown). In particular, daytime surveys resulted in detections of species that do not call, such as salamanders. Daytime surveys also allowed us to determine if reproduction was actually occurring via detections of egg masses and larvae, whereas calling males do not necessarily equate with successful reproduction (Heyer et al. 1994). At this time, we cannot recommend one of the four daytime sampling methods over the others. Dip-net surveys tended to produce more detections, but call surveys and perimeter surveys allowed us to detect species that would not have been noted using dip-net surveys alone. Our data suggest that changing seasons does not change the effectiveness of visual encounter and dip-net surveys for detecting Green Frogs (the only species with enough detections for a comparison).

SLBE was the most diverse park in terms of reptilian and amphibian species detected, followed by APIS and PIRO. This is sensible given the fact that SLBE is the southernmost park that we sampled. However, more amphibian species were detected at APIS than at either of the other parks. A number of species at all three parks should have been present but were not detected, such as Fowler's Toads (*Anaxyrus fowleri*) at SLBE, Four-toed Salamanders at PIRO, and Eastern Red-backed Salamanders at APIS (Harding 1997; Casper 2001, 2005; Casper and Anton 2008). In some cases, we know that these species are present based on past surveys. Regardless, we cannot state with confidence that any species is absent without more surveying effort (Kéry 2002, Mackenzie 2005). Notable species detections included two new records for Basswood Island at APIS (Gray Treefrogs and Green Frogs; Casper 2001).

SUSAN MCMAHON

Fig. 10. A Green Frog (*Lithobates clamitans*) at Pictured Rocks National Lakeshore, Michigan.

KENNETH BOWEN

Fig. 11. Chapel Road Stream, one of the sampling sites at Pictured Rocks National Lakeshore, Michigan.

Acknowledgements

This pilot work would not have been possible without the advice of and logistical support from the natural resources staff of the three parks. In particular, we extend thanks to S. Yancho and K. Hyde at SLBE and to J. Belant, B. Leutscher, and L. Loope at PIRO. S. McMahon, E. Ellis, T. Van Zoeren, A. Van Zoeren, and M. Cochran provided assistance in the field. Additionally, logistical and programmatic support was provided by the U.S. National Park Service's Great Lakes Inventory and Monitoring Network; in particular, we are grateful to W. Route and T. Keniry for leadership and to U. Gafvert, who created the maps. Portions of this manuscript appear in a National Park Service technical report.

Literature Cited

Alford, R.A. and S.J. Richards. 1999. Global amphibian declines: A problem in applied ecology. *Annual Review of Ecology and Systematics* 30:133–165.

Boone, M.D., R.D. Semlitsch, E.E. Little, and M.C. Doyle. 2007. Multiple stressors in amphibian communities: Effects of chemical contamination, Bullfrogs, and fish. *Ecological Applications* 17:291–301.

Casper, G.S. 2001. Reptile surveys of Long, Michigan, and Stockton Islands, and Little Sand Bay, in the Apostle Islands National Lakeshore, with notes on amphibians. Technical Report to Apostle Islands National Lakeshore, Wisconsin.

Casper, G.S. 2005. An amphibian and reptile inventory of Pictured Rocks National Lakeshore. Great Lakes Inventory and Monitoring Network. Technical Report GLKN/2005/05. National Park Service, Ashland, Wisconsin.

Casper, G.S. and T.G. Anton. 2008. An amphibian and reptile inventory of Sleeping Bear Dunes National Lakeshore. Natural Resource Technical Report NPS/GLKN/NRTR—2008/147. National Park Service, Fort Collins, Colorado.

Crother, B.I. (ed.). 2008. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico*. Herpetological Circular 37. Society for the Study of Amphibians and Reptiles, Salt Lake City, Utah.

Davidson, C. and R.A. Knapp. 2007. Multiple stressors and amphibian declines: Dual impacts of pesticides and fish on Yellow-legged Frogs. *Ecological Applications* 17:587–597.

Gibbons, J.W., C.T. Winne, D.E. Scott, J.D. Willson, X. Glaudas, K.M. Andrews, B.D. Todd, L.A. Fedewa, L. Wilkinson, R.N. Tsaliagos, S.J. Harper, J.L. Greene, T.D. Tuberville, B.S. Metts, M.E. Dorcas, J.P. Nestor, C.A. Young, T. Akre, R.N. Reed, K.A. Buhlmann, J. Norman, D.A. Croshaw, C. Hagen, and B.B. Rothermel. 2006. Remarkable amphibian biomass and abundance in an isolated wetland: Implications for wetland conservation. *Conservation Biology* 20:1457–1465.

Green. D.M. 1997. Perspectives on amphibian population declines: Defining the problem and searching for answers, pp. 291–308. In: D.M. Green (ed.), *Amphibians in Decline: Canadian Studies of a Global Problem*. Society for the Study of Amphibians and Reptiles, St. Louis, Missouri.

Harding, J.H. 1997. *Amphibians and Reptiles of the Great Lakes Region*. University of Michigan Press, Ann Arbor.

Heyer, W.R., M.A. Donnelly, R.W. McDiarmid, L.C. Hayek, and M.S. Foster. 1994. *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians*. Smithsonian Institution Press, Washington, D.C.

Kéry, M. 2002. Inferring the absence of a species – a case study of snakes. *Journal of Wildlife Management* 66:330–338.

Lannoo, M.J. (ed.). 2005. *Amphibian Declines: The Conservation Status of United States Species*. University of California Press, Berkeley

MacKenzie, D.I. 2005. What are the issues with presence-absence data for wildlife managers? *Journal of Wildlife Management* 69:849–860.

MacKenzie, D.I., J.D. Nichols, G.B. Lachman, S. Droege, J.A. Royle, and C.A. Langtimm. 2002. Estimating site occupancy rates when detection probabilities are less than one. *Ecology* 83:2248–2255.

Route, B. 2000. Study plan for conducting biological inventories: 2001–2004. U.S. National Park Service. Great Lakes Inventory and Monitoring Network. Technical Report GLKN/2000/01. National Park Service, Ashland, Wisconsin.

Route, B. 2004. Process and results of selecting and prioritizing Vital Signs for the Great Lakes Network. Great Lakes Inventory and Monitoring Network. Technical Report GLKN/2004/05. National Park Service, Ashland, Wisconsin.

Route, B. and J. Elias. 2007. Chapter 1 – Background information, pp. 1–28. In: B. Route and J. Elias (eds.), Long-term ecological monitoring plan: Great Lakes Inventory and Monitoring Network. Natural Resource Report NPS/GLKN/NRR/2007/001. National Park Service, Fort Collins, Colorado.

Semlitsch, R.D. 2000. Principles for management of aquatic-breeding amphibians. *Journal of Wildlife Management* 64:615–631.

Stebbins, R.C. and N.W. Cohen. 1995. *A Natural History of Amphibians*. Princeton University Press, Princeton.

Thoms, C., C.C. Corkran, and D.H. Olson. 1997. Basic amphibian survey for inventory and monitoring in lentic habitats, pp. 35–46. In: D.H. Olson, W.P. Leonard, and R.B. Bury (eds.), *Sampling Amphibians in Lentic Habitats*. Society for Northwestern Vertebrate Biology, Olympia, Washington.

Wake, D.B. 1991. Declining amphibian populations. *Science* 253:860.

Weir, L.A. and M.J. Mossman. 2005. North American Amphibian Monitoring Program (NAAMP), pp. 307–313. In: M.J. Lannoo (ed.), *Amphibian Declines: The Conservation of United States Species*. University of California Press, Berkeley.

Welsh, H.H. and S. Droege. 2001. A case for using plethodontid salamanders for monitoring biodiversity and ecosystem integrity of North American forests. *Conservation Biology* 15:558–569.

Male Calling Sites in Two Species of Australian Toadlets (Anura: Myobatrachidae: *Uperoleia*) at Two Ponds in New South Wales

Francis L. Lemckert[1,2*], Georgina Lemckert[2], Campbell Lemckert[2], and Frances A. Lemckert[2]

[1]School of Environmental and Life Sciences, University of Newcastle, Callaghan, New South Wales, Australia (frankl@sf.nsw.gov.au)
[2]Berowra Heights, New South Wales, Australia

Introduction

"Toadlets" of the myobatrachid genus *Uperoleia* are commonly encountered calling around ponds located in southeastern Australia. Usually one species only is present at any given pond, but two species occasionally can be calling around the same site. The Smooth Toadlet (*Uperoleia laevigata*) and the Dusky Toadlet (*U. fusca*) call at the same time on the same nights around two ponds on the central coast of New South Wales, Australia, and observations suggest that the males call in relatively discrete groups that differ to at least some degree in location. The two species are closely related (Tyler et al. 1981), the advertisement calls of the two species are similar (Barker et al. 1995, Cogger 2000), and they possess similar calling seasons and preferred breeding sites (Barker et al. 1995, Cogger 2000, Anstis 2002). Under such circumstances the two species may be expected to show differences in their call site selection (Littlejohn and Martin 1969) that will assist in distinguishing the males of the two species by females moving to the pond to breed.

A calling male *Uperoleia fusca*.

We collected data on the calling positions of the males of each species to determine if the males were selecting different calling areas or types of calling sites. We compared locations of calling males relative to the ponds and also microhabitat information associated with the calling positions to determine what features the males of each species might be selecting for a calling site and how much they differ — if at all.

Methods

The study site consists of two adjacent ponds (within 5 m) that are located approximately 15 km northwest of Kulnura on the central coast of NSW, around 120 km north of Sydney (33° 07' 58.9" S, 151° 12' 22.6" E). Both ponds have been present since at least the late 1970s and are roughly circular in shape. The smaller pond is approximately 10 m in diameter and 0.3 m deep, and the larger 14 m in diameter and 0.9 m deep (depths vary with rainfall).

A calling male *Uperoleia laevigata.*

Native vegetation in the surrounding area consists of dry open woodland dominated by Smooth-barked Apple (*Angophora costata*), Red Bloodwood (*Corymbia gummifera*), and Stringybarks (*Eucalyptus oblonga*), with a sclerophyllous understory (Forestry Commission 1989). Approximately 25% of the surrounding land has been cleared for grazing by livestock.

We collected data on calling males on the night of 20 February 2006, locating males of both species by their calls from 2000–2300 h. Locations of males were marked with a bamboo skewer color-coded for each species. We returned to the pond during daylight hours and obtained a digital photograph from a height of one meter of each calling site, with the skewer in place. We recorded the following attributes of each calling site, either at the time of taking the photograph or from the photograph: (1) Distance from the edge of the water to the calling site (in meters), (2) percentage bare ground (rock or soil) within a 10-cm radius of the call site (as opposed to being covered with leaf litter or vegetation), and (3) percentage shading of the calling site within a 10-cm radius of the call site. This measure provides an indication of the level of cover afforded to the calling male.

Each category of data was inspected visually to determine if it was normally distributed. This was the case for distance from the pond. Percentage of bare ground and percentage of cover were arcsine transformed to meet test assumptions. We used t-tests in Microsoft Excel 2007 to compare the measurements made for the two species using $P < 0.05$ as the accepted level of significance.

Results

We collected data for 19 calling males of *U. fusca* and 16 calling males of *U. laevigata* (Table 1). Comparisons of the data from the call sites of the males indicated that the distance of the calling sites from the edge of a pond was significantly greater for *U. laevigata* than for *U. fusca* ($t = 7.39$; $df = 33$; $P < 0.001$). The percentage of bare ground was greater around the calling sites of *U. laevigata* than at those of *U. fusca* ($t = 4.14$; $P < 0.001$).

Table 1. Mean (± one standard deviation) and range of habitat variables at syntopic calling sites for males of *Uperoleia fusca* and *U. laevigata.*

	Species	
Variable	***Uperoleia fusca* (n = 19)** Mean (range)	***Uperoleia laevigata* (n = 16)** Mean (range)
Shading	18 ± 24.7% (0–90%)	9 ± 22.7% (0–100%)
Bare Ground	9 ± 16.1% (0–70%)	39 ± 26.4% (0–84%)
Distance to Pond	2.1 ± 2.9 m (0.0–8.9 m)	10.9 ± 4.1 m (1.9–18.2 m)

View of the study ponds (left). Males of *Uperoleia fusca* generally call in the vegetation around the edges of the ponds, whereas male *U. laevigata* tend to call on or next to the road on the left hand side of the image. On the right is the larger of the two adjacent ponds showing the areas of vegetation on the banks as well as areas of bare bank from which the males call.

The mean percentage of cover above the calling sites was greater for *U. fusca* males than *U. laevigata,* but the difference was not statistically significant ($t = 1.62$; $P > 0.10$), although this result might have been influenced by one male *U. laevigata* that called from under 100% cover. A number of *U. laevigata* males were observed calling on patches of bare sand, whereas *U. fusca* males almost always chose locations where they rested on leaf litter or vegetation. *Uperoleia fusca* males generally called from under some form of vegetation, but also called from positions partially concealed by rocks or deadfall.

Discussion

The males of the two species do appear to have slightly different preferences in calling site location. Male *U. fusca* call significantly closer to the edge of the pond than do male *U. laevigata.* They also prefer sites afforded protection by some cover above the calling site, whereas male *U. laevigata* often call from exposed positions.

The preferred calling distance from the pond may provide a simple means of separating the two species at a common calling site. Both species call consistently on the same nights of the year, often in combined choruses of more than 40 males and sometimes over 150 males (F.L. Lemckert, unpubl. data). At the time of maximum calling activity, a syntopic chorus is very complex and noisy, and a spatial separation of the males of the two species would likely be of considerable assistance to females attempting to locate conspecific males.

Uperoleia fusca males were more likely to call from positions that were at least partially obscured by vegetation. We noted that the densest vegetation cover was close to the pond and the most open areas were farther from the pond. Hence, the relative location of the habitats that provide the preferred calling sites for the males may be enough to allow for the observed separation of the two species.

The separation of sites might also be a response to calling competition, as predicted by Littlejohn and Martin (1969). They predicted that males, in the presence of acoustic competition, would change their calling sites or patterns to reduce this competition and avoid heterospecific matings. Determining the characteristics of chosen calling sites at ponds where males of only one of the two species call would indicate if the males have different preferred calling locations in the absence of the other species. If no change in behavior is evident, then data could be collected on the spatial structure of suitable ground cover to test if the difference in structural elements influences the choice of calling site or whether the selection of a calling site is simply a function of distance from the edge of the pond.

Acknowledgements

We thank Mike Mahony and Rachael Peak for their assistance in formulating this study and Murray Littlejohn for comments on a draft of this manuscript. This work was carried out with an appropriate animal research license obtained from the Department of Environment and Climate Change and an Animal Welfare License from the Animal Care and Ethics Committee.

Literature Cited

Anstis, M. 2002. *Tadpoles of South-eastern Australia: A Guide with Keys.* Reed-New Holland, Sydney.

Barker, J., G.C. Grigg, and M.J. Tyler. 1995. *A Field Guide to Australian Frogs.* Surrey Beatty & Sons, Sydney.

Cogger, H.G. 2000. *Reptiles and Amphibians of Australia.* 6th ed. Reed-New Holland, Sydney.

Forestry Commission. 1989. *Forest Types in New South Wales.* Research Note No. 17. Forestry Commission of New South Wales (now Forests NSW), Sydney.

Halliday, T. and M. Tejedo. Intrasexual selection and alternative mating behaviour, pp. 419–468. In: H. Heatwole and B.K. Sullivan (eds.), *Amphibian Biology. Volume 2. Social Behaviour.* Surrey Beatty and Sons Pty Ltd, Sydney.

Littlejohn, M.J. and A.A. Martin. 1969. Acoustic interactions between two species of leptodactylid frogs. *Animal Behaviour* 17:785–791.

Tyler, M.J., M. Davies, and A.A. Martin. 1981. Australian frogs of the leptodactylid genus *Uperoleia* Gray. *Australian Journal of Zoology Supplementary Series* 79:1–64.

Amplexus in *Uperoleia fusca.*

Hunting Tamacoré, *Uranoscodon superciliosus*

Zilca Campos[1] and William Magnusson[2]

[1]Embrapa Pantanal, CP 109 Corumbá, MS Brazil 79320-900, Brazil (zilca@cpap.embrapa.br)
[2]INPA, Coordenação de Pesquisas em Ecologia, CP 478, 69069-020 Manaus AM, Brazil (bill@inpa.gov.br)

Brown Tree Climbers (*Uranoscodon superciliosus* Linnaeus 1758), known locally as Tamacoré, occur throughout the Amazon Basin, and often are found along the edges of water courses perched on branches of tree and vines (Fig. 1; Vitt et al. 2008). These lizards also are called "Diving Lizards" because they dive into the water to escape danger. They are model sit-and-wait predators. The diet has been studied in Brazil by Hoowland et al. (1990), Vitt et al. (1991), and Gasnier et al. (1994) and in Surinam by Hoogmoed (1973). The species spends most of its time on tree-trunks, but feeds mainly on prey that occur exclusively or much more abundantly on the ground (Gasnier et al. 1994). The main prey items are orthopterans, cockroaches, earthworms, small frogs, and lepidopteran larvae. The higher consumption of larvae was coincident with or soon after oviposition in July–November (Gasnier et al. 1997).

LAURIE J. VITT

Fig. 1. Brown Tree Climbers (*Uranoscodon superciliosus*) occur throughout Amazonia, often along water courses perched on branches of trees and vines.

Here, we report illegal hunting of *U. superciliosus* in the Brazilian Amazon. On 13 August 2008, near Cururu Lake near the Solimões River (3° 34' 30.4" S, 60° 40' 03.3" W; datum: WGS84; elev. 80 m), State of Amazonas, a local resident captured and killed 18 individual juveniles and adult *U. superciliosus* (Fig. 2). Lizards on tree branches and vines in flooded forest (igapó) around Cururu Lake were captured by hand. A buyer had ordered 30 individuals. Each animal was eviscerated and stored in alcohol. The following day, the buyer went to the hunter's house and paid R$1.00 (about US $0.60) per lizard. He said that the lizards were to be used in an Umbanda (an Afro-Brazilian religion that blends African religions with Catholicism) ritual as part of a treatment for male sexual inadequacy.

The species also is commonly found in the market in the city of Belém, State of the Pará, and such rituals might be part of the popular culture in much of Amazonia. All wildlife has been protected in Brazil since 1967, except that taken for subsistence — and trade for aphrodisiacs is unlikely to be considered subsistence. Although the species has an enormous range, lizards are captured during the reproductive period, and collection could affect local populations, especially in areas where much of the riparian vegetation has been cleared.

Literature Cited

Gasnier, T.R., W.E. Magnusson, and A.P. Lima. 1994. Foraging activity and diet of four

ZILCA CAMPOS

Fig. 2. *Uranoscodon superciliosus* killed by a market hunter at Cururu Lake, Brazilian Amazon, August 2008.

sympatric lizard species in a tropical rainforest. *Journal of Herpetology* 28:187–192.

Gasnier, T.R., W.E. Magnusson, and A. Waichman. 1997. Growth curve shape and growth variation of the tropical lizard *Uranoscodon superciliosus* (Sauria: Tropiduridae). *Ecotropica* 3:101–107.

Hoogmoed, M.S. 1973. Notes on the herpetofauna of Surinam. IV. The lizards and amphisbaenians of Surinam. *Biogeographica* 4:1–419.

Howland, J.M., L.J. Vitt, and P.T. Lopez. 1990. Life at the edge: The ecology and life history of the tropidurine iguanid lizard *Uranoscodon superciliosum*. *Canadian Journal of Zoology* 68:1366–1373.

Vitt, L., W.E. Magnusson, T.C. Avila-Pires, and A.P. Lima. 2008. *Guide to the Lizards of Reserva Adolpho Ducke, Cntral Amazonia. Guia de Lagartos da Reserva Adolpho Ducke, Amazônia Central.* Áttema Design Editorial, Manaus, Brazil.

Alligator Snapper Stuck in the Mud: Evidence of Aestivation

Steven G. George

U.S. Army Corps of Engineers
Engineer Research and Development Center, Environmental Laboratory
Vicksburg, Mississippi 39180 (Steven.G.George@usace.army.mil)

The Alligator Snapping Turtle (*Macrochelys temminckii*) is the largest freshwater turtle in North America, capable of reaching a weight of 113 kg with a carapace length of 80.0 cm (Ernst et al. 1994). These turtles are confined to river systems of the lower Mississippi Basin and rivers that drain the northern Gulf of Mexico (Ernst et al. 1994, Trauth et al. 2004). The Alligator Snapping Turtle is highly aquatic, and only the female leaves the water to nest (Ernst et al. 1994, Pritchard 1989). Little is known of the behavior of this species under natural conditions, especially during low water when individuals might become stranded.

On 3 September 1993, while working on Panther Creek (Yazoo County, Mississippi) during low-water conditions, I observed an Alligator Snapping Turtle that appeared to be aestivating while buried deeply in mud. After encountering the turtle, my coworker and I returned the following day to take pictures and collect data. The sediment depth of the buried turtle was 35.6 cm, and the turtle had moved 17.8 cm since first observed 16 h earlier. The sediment surrounding the turtle was soft mud that contained seepage from a spring. The temperature of the seepage was 22 ºC. The maximum carapace length of the turtle was 66 cm. The individual was a male and weighed just over 45.3 kg.

On 24 October 2003, while sampling fishes in the Quiver River upstream from Hwy 3 in Sunflower County, Mississippi, a coworker and I observed a second Alligator Snapper stranded in mud. Only the upper half of the turtle's body was exposed. Apparently the turtle had been stranded during low-water conditions and was waiting for a rise in the river to initiate movement. Ernst et al. (http://nlbif.eti.uva.nl/bis/turtles.php) reported turtles aestivating in drying riverbeds to prevent desiccation. Although other colleagues also have observed Alligator Snapping Turtles stranded or aestivating during low water conditions (Bill Lancaster, retired turtle trapper, Sunflower County, Mississippi; Brent Harrel, USFWS, pers. comm.), this account appears to be the first published documentation of *Macrochelys temminckii* stranded or aestivating in natural habitat.

Acknowledgments

William T. Slack reviewed this manuscript and Bradley Lewis and Jay Collins provided field assistance. Work conducted in the Mississippi Delta was supported by the Vicksburg District, U.S. Army Corps of Engineers. Permission was granted by the Chief of Engineers to publish this information.

Literature Cited

Ernst, C.H., J.E. Lovich, and R.W. Barbour. 1994. *Turtles of the United States and Canada*. Smithsonian Institution Press, Washington, D.C.

Ernst, C.H., R.G.M. Altenburg and R.W. Barbour. Turtles of the World Online Data Source (http://nlbif.eti.uva.nl/bis/turtles.php).

Pritchard, P.C. 1989. *The Alligator Snapping Turtle: Biology and Conservation*. Milwaukee Public Museum, Milwaukee, Wisconsin.

Trauth S.E., H.W. Robison, and M.V. Plummer 2004. *The Amphibians and Reptiles of Arkansas*. The University of Arkansas Press, Fayetteville.

BRADLEY LEWIS

Excavating an Alligator Snapping Turtle from the mud during low-water conditions in Panther Creek, Yazoo County, Mississippi.

Timber Rattlesnake (*Crotalus horridus*) Swims the Mississippi River

Steven G. George

U.S. Army Corps of Engineers
Engineer Research and Development Center, Environmental Laboratory
Vicksburg, Mississippi 39180 (Steven.G.George@usace.army.mil)

The Timber Rattlesnake (*Crotalus horridus*) is widely but sporadically distributed throughout much of the southeastern United States (Trauth et al. 2004, Conant and Collins 1991). Numerous life history studies have been conducted on the species, addressing topics that include reproduction, migration, and movement (e.g., Palmer et al. 1995, Trauth et al. 2004); however, reports of swimming behavior are few. Walker (1963) observed an individual swimming across a lake in Jackson Parish, Louisiana. Viosca (1944) commented that the Mississippi River and its floodplain provide a potential barrier for east-west movement for various amphibians and reptiles; however, the Mississippi River itself might prove to be an excellent corridor for dispersal.

BRADLEY LEWIS

A Timber Rattlesnake swimming and floating with the currents of the Mississippi River approximately 300 m from land.

On 19 July 2002, while working on the Mississippi River just south of Vicksburg, Mississippi at River Kilometer 685.6 (RM 426), our field crew and I observed a Timber Rattlesnake swimming across the river presumably from Madison Parish, Louisiana to Warren County, Mississippi. The stream width where the swimming rattlesnake was observed was 750 m, and the water temperature was 29.5 ºC. The snake was over halfway across the river and approximately 300 m from the nearest shore. It looked to be in excellent condition and appeared quite capable of completing its journey across the river.

Interestingly, Dr. David Biedenharn (USACE Coastal and Hydraulics Laboratory, ERDC; pers. comm.) also observed a Timber Rattlesnake swimming the Mississippi River in the Vicksburg area during the summer, although the event took place several years ago. In addition, while working on the Alabama River during late summer 2004, I observed Timber Rattlesnakes on two separate occasions swimming the river near Camden, Alabama. These observations provide support for the contention that large rivers are not a major barrier to Timber Rattlesnake dispersal.

Acknowledgments

Special thanks to William Lancaster and Bradley Lewis for field assistance and photographs, and to William T. Slack for reviewing the manuscript. Work conducted on the Mississippi River was supported by the Mississippi Valley Division, U.S. Army Corps of Engineers. Permission to publish was granted by the Chief of Engineers.

Literature Cited

Conant, R. and J.T. Collins. 1991. *A Field Guide to Reptiles and Amphibians of Eastern and Central North America*. 3rd ed. Houghton Mifflin Co., Boston.

Palmer, W.M. and A.L. Braswell. 1995. *Reptiles of North Carolina*. University of North Carolina Press, Chapel Hill.

Trauth S.E., H.W. Robison, and M.V. Plummer. 2004. *The Amphibians and*

WILLIAM LANCASTER

The author and a Timber Rattlesnake that had been swimming across the Mississippi River from Madison Parish, Louisiana to Warren County, Mississippi.

BRADLEY LEWIS

A Timber Rattlesnake swimming the Alabama River, Camden County, Alabama in 2004.

Reptiles of Arkansas. The University of Arkansas Press, Fayetteville.

Viosca, P., Jr. 1944. Distribution of certain coldblooded animals in Louisiana in relationship to the geology and physiography of the state. *Proceedings of the Louisiana Academy of Sciences* 8:47–62.

Walker J.M. 1963. Amphibians and reptiles of Jackson Parish, Louisiana. *Proceedings of the Louisiana Academy of Sciences* 26:91–101.

A Defensive Display by a Smooth Earth Snake (*Virginia valeriae*)

Andrew M. Durso[1] and Kevin P. Durso[2]

[1]Odum School of Ecology, University of Georgia, Athens, Georgia 30602 (amdurso@gmail.com)
[2]College of Natural Resources, North Carolina State University, Raleigh, North Carolina 27607 (kpdurso@ncsu.edu)

The Smooth Earth Snake (*Virginia valeriae*) is a small (maximum size 393 mm) and ubiquitous natricine snake of the southeastern United States. Whereas many large natricine snakes will display defensively when unable to retreat, gaping, vibrating the tail, and striking at would-be predators, these behaviors are less commonly observed in small snakes, possibly due to their non-threatening and inconsequential effect on large predators. Both *Virginia valeriae* and Red-bellied Snakes (*Storeria occipitomaculata*) are known instead to exhibit "lip-curling," an unusual and elaborate exhibition of the maxillary teeth, which is hypothesized to constitute an agonistic display targeted at smaller predators and a delivery agent for Duvernoy's gland secretions (do Amaral 1999, Conant 1951).

At 1100 h on 24 July 2008, we observed a defensive display in an adult *V. valeriae* while photographing the animal in suburban deciduous woodlands near the site where it was captured at night two days earlier. The snake had been moving across the paved walkway of a private residence in Wake County, North Carolina at 0015 h after a light rain and was held for later photography due to poor light conditions during the intervening two days. Immediately upon being removed from its temporary container and placed under light restraint, the snake faced us and gaped in a striking position, but did not strike. This behavior continued for approximately 30 sec, after which the snake changed its behavior and instead attempted to escape for approximately 2 min. The initial escape behavior was then followed by approximately 2 min of gaping, slight neck-flaring, and actual striking before the snake resorted entirely to escape and burrowing behaviors, which it continued as we photographed it for almost 20 min despite being removed from hospitable burrowing habitat and placed on a firm, open surface.

This account of defensive behavior in *V. valeriae* is strikingly similar to that of Todd (2008) for an individual from Barnwell County, South Carolina. In both instances, the behavior might have been an atypical display by a highly agitated individual or it could be a trait that is more common than previously thought. Other defensive behaviors documented for *V. valeriae* include writhing violently, spraying musk, voiding feces, feigning death (Ernst and Ernst 2003), and loop-knotting the body to prevent ingestion (Yeatman 1983).

Literature Cited

Conant, R. 1951. *The Reptiles of Ohio.* 2nd ed. and revisionary addenda, University of Notre Dame Press, Notre Dame, Indiana.

do Amaral, J.P.S. 1999. Lip-curling in Redbelly Snakes (*Storeria occipitomaculata*): Functional morphology and ecological significance. *Journal of Zoology: Proceedings of the Zoological Society of London* 248:289–293.

Ernst, C.H. and E.M. Ernst. 2003. *Snakes of the United States and Canada.* Smithsonian Institution Press, Washington, D.C.

Todd, B.D. 2008. *Virginia valeriae* (Smooth Earth Snake). Threat display. *Herpetological Review* 39:475.

Yeatman, H.C. 1983. *Virginia v. valeriae* (Eastern Smooth Earth Snake). Defense. *Herpetological Review* 14:22.

A Smooth Earth Snake (*Virginia valeriae*) exhibiting a prolonged defensive display (see text).

Sharing the Resource: Six Species of Rattlesnakes in Joshua Tree National Park, California

Harold F. De Lisle

Joshua Tree National Park, Twentynine Palms, California 92277
(hdelisle@hughes.net)

Photographs by the author except where noted.

The competitive exclusion principle would seem to apply to six species of rattlesnakes in the genus *Crotalus*, all of which feed mostly on small mammals. In Joshua Tree National Park, California, however, six species occur in an area of just 400,000 ha. A pattern noted in ecology is that diversity at one level begets diversity at other levels. Almost 70 years of locality data combined with present field research was used as evidence for the hypothesis that these rattlesnake species mostly avoid competitive exclusion by microhabitat differences within the great diversity of ecological communities in the park. These long-term records might also indicate that the dynamics of the desert ecosystem could be changing, possibly the result of climate change and/or local urbanization.

Introduction

Ecological theory predicts that species in ecological communities can coexist only if they differ in their responses to limiting resources. This competitive exclusion principle would seem to apply to the six species of rattlesnakes in the single genus *Crotalus* in the area (400,000 ha) of Joshua Tree National Park (JTNP). Adult rattlesnakes feed almost exclusively on small mammals (Mackessy 1988, Beavers 1976), with the exception of Sidewinders (*C. cerastes*), for which mammals comprise about 50% of the diet (Funk 1965). In JTNP, the ubiquitous Merriam's Kangaroo Rat (*Dipodomys merriami*) probably makes up the bulk of the diet of all six species, as it does elsewhere in the desert (Reynolds and Scott 1982), whereas Side-blotched Lizards (*Uta stansburiana*) almost certainly serve the same role for hatchling rattlesnakes. How does this limited resource support so many closely related species without violating ecological theory?

Materials and Methods

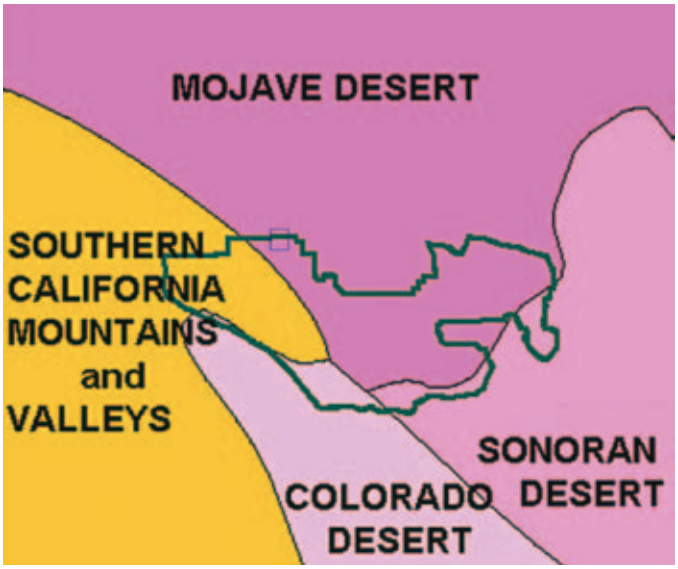
Joshua Tree National Park is an ideal place to study rattlesnake ecology. Its protected status has preserved natural habitats in fairly good condition for 70 years. The first herpetological survey of what was then a national monument was conducted by Robert C. Stebbins from 1945–1955. R.B. Loomis and his colleagues continued to inventory the reptiles during the 1960s. I began periodic herpetological visits to the Park in the 1970s, and conducted season-long (March–November) surveys in 1999–2005. In addition, observation records made by rangers and others have been accumulating for almost 50 years. The result (Table 1) is that we have accumulated some 400 locality data reports on Western Diamondback Rattlesnakes (*C. atrox*; 18), Southern Pacific Rattlesnakes (*C. helleri*; 60), Red Diamond Rattlesnakes (*C. ruber*; 15), Mojave Rattlesnakes (*C. scutulatus*; 21), Southwestern Speckled Rattlesnakes (*C. pyrrhus*; 155), and Sidewinders (*C. cerastes*; 133).

All locality data were plotted on a map of the park using ESRI ArcView. These species maps were then compared with maps showing vegetation patterns (Leary 1977). Extensive fieldwork was conducted in areas of sympatry to identify possible differences in microhabitats within Leary's habitat (vegetation association) types. These data were used to test the hypothesis that the rattlesnakes in the park avoid competitive exclusion primarily by partitioning microhabitats.

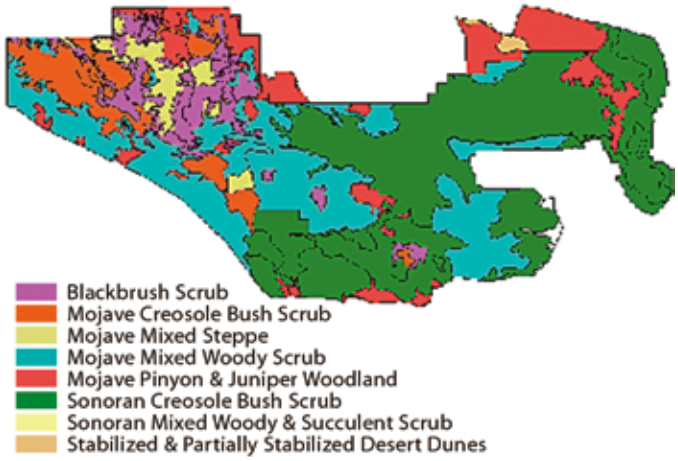
Multivariate analyses of habitats were not employed, but work elsewhere (Reinert 1984a, 1984b) indicated that habitat separation is probably the chief method for snakes that prey on small mammals to avoid niche competition. Because "habitat" is a very broad category that can include a

PHOTOGRAPH COURTESY OF NATIONAL PARK SERVICE.

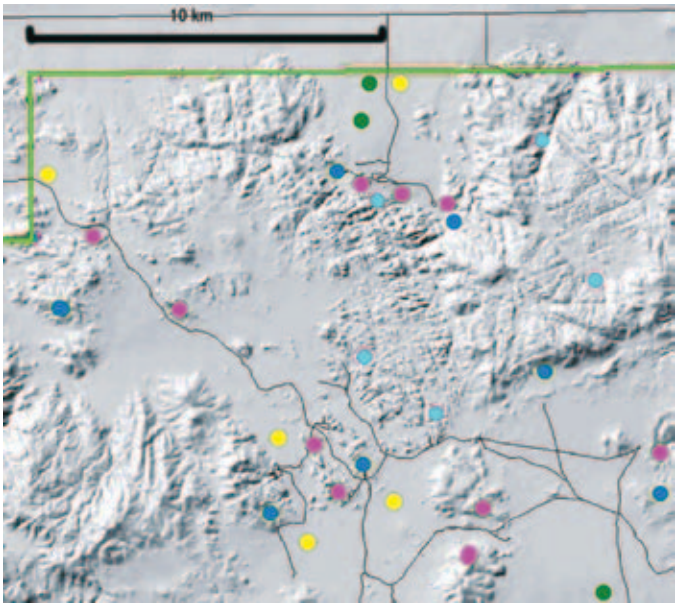
The ubiquitous Merriam's Kangaroo Rat (*Dipodomys merriami*) is taken by larger rattlesnakes of all species, whereas hatchlings feed largely on the phenomenally abundant Side-blotched Lizards (*Uta stansburiana*).



Location of Joshua Tree National Park and local ecoregions (the small square indicates the Indian Cove area).



The ecological communities in Joshua Tree National Park.



The Indian Cove area, with locality records for *Crotalus cerastes* (green), *C. helleri* (dark blue), *C. pyrrhus* (magenta), *C. ruber* (light blue), and *C. scutulatus* (yellow).

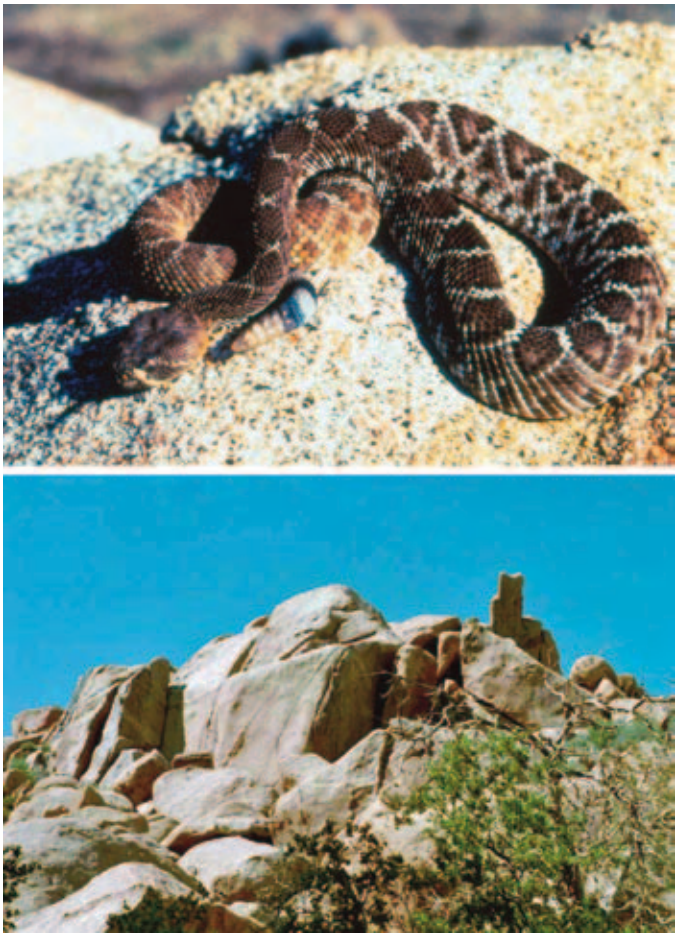
Western Diamondback Rattlesnakes (*Crotalus atrox*) are confined mostly to the Sonoran Desert ecoregion.

Sidewinders (*Crotalus cerastes*) appear to be limited to areas with sandy substrates.

Southern Pacific Rattlesnakes (*Crotalus helleri*) inhabit rocky areas within the Pinyon-Juniper community.

variety of dissimilar entities, approaching the concept from a snake's perspective, rather than our own, is important. Every individual has to: (1) Get to a place (or be born there), (2) be able to exploit all essential resources, and (3) avoid deleterious conditions, which might be episodic but can be severe. These factors are distributed on several scales, from <1m to many km^2.

Southwestern Speckled Rattlesnakes (*Crotalus pyrrhus*) occur in rocky canyons, hills, and ridges in the eastern half of the park, but appear to be limited to rocky canyons in the western half.



PHOTOGRAPH COURTESY OF NATIONAL PARK SERVICE

Red Diamond Rattlesnakes (*Crotalus ruber*) occur in the southwestern corner of the park and an isolated population is known from the Wonderland of Rocks.

Results

Crotalus atrox reaches the northern-most point of its distribution in California within JTNP. It is mostly confined to the Sonoran Desert ecoregion section. *Crotalus cerastes* seems strictly limited to areas of sand substrate. *Crotalus scutulatus* reaches the southern-most extent of its range in California in the northwestern part of JTNP. It appears limited in occurrence to Joshua Tree flats. *Crotalus helleri* inhabits rocky areas within the Pinyon-Juniper community. All locality records are within areas with California Junipers (*Juniperus californicus*). *Crotalus ruber* occurs in two apparently disjunct populations in JTNP. One, in the southwestern corner of the park, is probably the eastern terminus of the main population of the desert foothills (e.g., Whitewater Canyon). The second has long been considered an isolated population within the Wonderland of Rocks, where it is associated with large outcroppings of monzogranite in very rugged terrain. *Crotalus pyrrhus* is the most abundant species of rattlesnake in JTNP. In the eastern half of the park, it is the only species occurring in rocky canyons, hills, and ridges. In the western half of the park it seems to have a narrower niche, and appears to be limited to rocky canyons. It does occur to elevations as high as 1,525 m above sea level.

Most species were clearly associated with particular habitat types. However, the locality data revealed one area of the park in which five species of *Crotalus* (*cerastes, ruber, helleri, pyrrhus, scutulatus*) appear to be sympatric. This area centers around Indian Cove. Ground reconnaissance of the localities of sympatry revealed that the species are not syntopic.

Table 1. Basic habitat types and locality records by species.

Habitat Types	**Species of *Crotalus***					
	C. atrox	*C. cerastes*	*C. helleri*	*C. pyrrhus*	*C. ruber*	*C. scutulatus*
Rocky canyons W	20		19	45	10	14
Rocky canyons E	80			31		
Rocky ridges W (pinyon-juniper)				81	4	90
Rocky ridges E				1		
Joshua flats W				11		86
Creosote flats E				8		
Sandy washes/flats W		10				
Sandy washes/flats E		90				

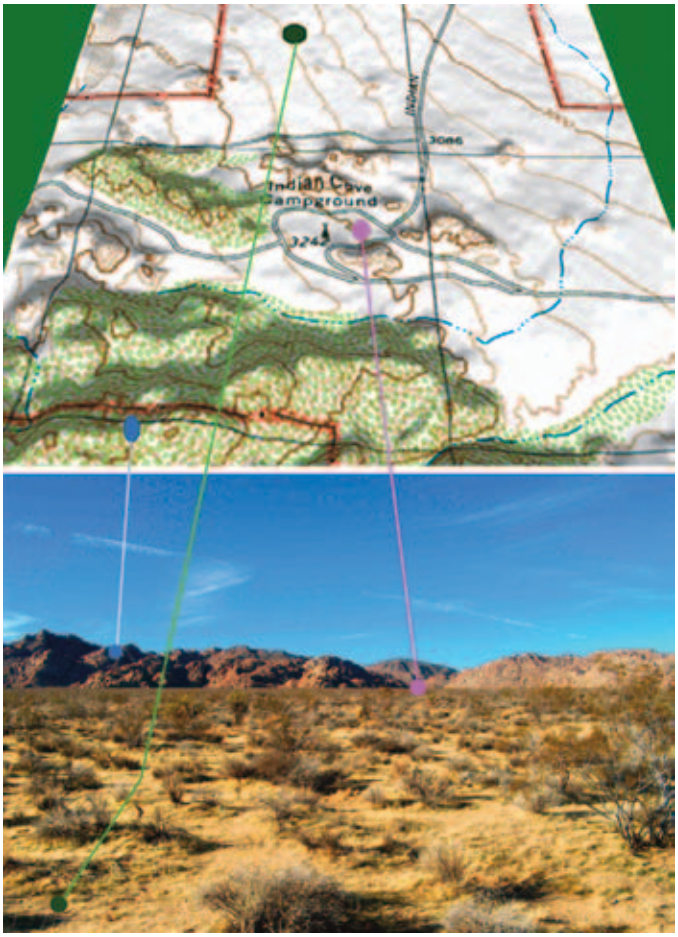
Mojave Rattlesnakes (*Crotalus scutulatus*) reach the southern-most extent of their range in California in the northwestern part of JTNP. The species appears to be limited in occurrence to Joshua Tree flats.

Discussion

Resources potentially subject to interspecific competition are food, place, and time. Locality records and field studies seem to support the hypothesis that niches are distinct at the microhabitat level. For the rattlesnakes of JTNP, shelter is probably in more than adequate supply, with holes and crevices essentially everywhere. Nocturnal-diurnal behavior is dictated by seasonal temperatures and appears to be the same for all species at the same altitude. Very few quantitative studies of the diets of rattlesnakes have been conducted. The few existing dietary data for these species were determined elsewhere in their range. That they are essentially the same in JTNP may or may not be a valid assumption, as dietary shifts are known to occur in wide-ranging species.

The rattlesnake distribution in the park may be changing along with ecosystem changes. The last verified sighting in the park of *C. scutulatus* was in 1991 (Keys Ranch). The two flatland corridors that lead from the north (main range of the Mojave Rattlesnake) are now largely blocked by urbanization. If the park was formerly a "sink" for movements of this species, the corridors are now mostly blocked, and the species may have become extirpated from the park, although it remains abundant 25 km to the north, on the other side of the urban development.

In the last two decades exotic grasses (mostly Cheat Grasses, *Bromus* spp.) have invaded much of the Juniper and Joshua Tree woodlands. These exotics have provided fuel for recurring wildfires in plant communities not adapted to fire. An intensive survey after the May 1999 fire showed that most reptiles survived the fire, but a subsequent survey during the following spring indicated a near total absence of all species in the burned area.



The Indian Cove area, with the topographic map (top) and photograph showing the same view. Blue dots indicate habitat of *Crotalus helleri*, green dots that of *C. cerastes*, and magenta dots that of *C. pyrrhus*.

Acknowledgements

I thank Henry McCutcheon, Chief of Resource Management, JTNP, for his encouragement and the necessary permits to do research in the park, and especially Todd Hoggan, San Bernardino County Museum, for his help with fieldwork. The Lee Family Foundation and the Joshua Tree National Park Association provided funding.

Literature Cited

Beavers, R.A. 1976. Food habits of the Western Diamondback Rattlesnake, *Crotalus atrox* (Viperidae) in Texas. *Southwestern Naturalist* 20:503–515.

De Lisle, H.F. 2003. Amphibians and reptiles of Joshua Tree National Park: Annotated checklist. Unpubl. Report for the National Park Service, Joshua Tree National Park, California.

Funk, R.S. 1965. Food of *Crotalus cerastes laterorepens* in Yuma County, Arizona. *Herpetologica* 21:15–17.

Geest, J.C. 1971. Studies of a population of Sidewinder Rattlesnakes, *Crotalus cerastes* Hallowell, from the suggested area of intergradation. Unpubl. Report for the National Park Service, Joshua Tree National Park, California.

Leary, P.J. 1977. *Investigation of the Vegetation Communities of Joshua Tree National Monument.* Technical Report 2. National Park Service and the University of Nevada, Las Vegas.

Loomis, R.B. and R.C. Stephens. 1962. Records of snakes from Joshua Tree National Monument, California. *Bulletin of the Southern California Academy of Sciences* 61:29–36.

Loomis, R.B. and R.C. Stephens. 1967. Additional notes on snakes taken in and near Joshua Tree National Monument, California. *Bulletin of the Southern California Academy of Sciences* 66:1–21.

Mackessy, S.P. 1988. Venom ontogeny in the Pacific rattlesnakes, *Crotalus viridis helleri* and *C. v. oreganus. Copeia* 1988:92–101.

Miller, A.H. and R.C Stebbins. 1964. *The Lives of Desert Animals.* University of California Press, Berkeley.

Rainey, D. 1962. Amphibians and reptiles of Covington Flat, Joshua Tree National Monument. Unpubl. Report for the National Park Service, Joshua Tree National Park, California.

Rainey, D. 1965. The distribution of amphibians, reptiles, and mammals of Joshua Tree National Monument. Unpubl. Report for the National Park Service, Joshua Tree National Park, California.

Reinert, H.K. 1984a. Habitat separation between sympatric snake populations. *Ecology* 65:678–486.

Reinert, H.K. 1984b. Habitat variation within sympatric snake populations. *Ecology* 65:1673–1682.

Reynolds, R.P. and N.J. Scott, Jr. 1982. Use of a mammalian resource by a Chihuahuan snake community, pp. 99–118. In: N.J. Scott, Jr. (ed.), *Herpetological Communities*. United States Department of the Interior Fish and Wildlife Service Research Report 13, Washington, D.C.

Observations of Amplexus and Oviposition in *Ollotis* [*Bufo*] *occidentalis* in the Río Salado, Puebla, Mexico

Geoffrey R. Smith[1] and Julio A. Lemos-Espinal[2]

[1]Department of Biology, Denison University, Granville, OH 43023, USA (smithg@denison.edu)
[2]Laboratorio de Ecología, Unidad de Biología, Tecnología y Prototipos (FES-Iztacala, UNAM), Av. de los Barrios S/N, Los Reyes Iztacala, Tlalnepantla, Estado de México, México 54090

The Río Salado runs through El Valle de Zapotitlán Salinas in southeastern Puebla, Mexico. Pools along the Río Salado are seasonal, forming during the dry season as the water level in the Río Salado falls. During a monthly survey of a section of the Río Salado for tadpoles (Woolrich-Peña et al., unpubl. data), we observed an amplectant pair of *Ollotis* [*Bufo*] *occidentalis* and their egg mass. The only previously published reports on reproduction in *O. occidentalis* are an observation by Duellman (1961) of tadpoles collected on "May 3 in a quiet section of a fast stream near Barranca Seca" in Michoacán, Mexico, and an observation of an amplectant pair in El Valle de Zapotitlán Salinas on 27 October 1998 that produced an egg mass with >10,000 eggs (Oliver-Lopez et al. 2000).

We observed the amplectant pair on 24 November 2007 at 0745 h. Indications that it had rained the previous night were abundant. The egg mass was deposited in a shallow pool along the main channel of the river. The depth of the water was 2 cm. The conductivity of the water was 1,966 mS cm^{-1}, the salinity was 1.2 ppt, the dissolved oxygen content was 6.49 mg L^{-1}, and the temperature was 17.0 °C (measured using a YSI Model 85 Handheld DO/conductivity meter). A survey of several other pools along a

JULIO A. LEMOS-ESPINAL

Amplectant pair of *Ollotis* [*Bufo*] *occidentalis* and egg mass in a pool along the Río Salado in Puebla, Mexico on 24 November 2007. Note the shallowness of the water.

2-km section of the river revealed no other egg masses, amplectant toads, or any other adult toads, although we encountered several tadpoles of varying sizes throughout this section of the river.

Our observation suggests that, in the Río Salado, these toads lay their eggs in relatively shallow pools. During the period when tadpoles are present in the Río Salado (November–February), pools remain relatively shallow; however, tadpoles are more frequently found in deeper and larger pools, and are found only in pools along the main channel of the Río Salado (Woolrich-Piña et al., unpubl. data). Given the relatively shallow nature of the pool in which we observed the amplectant pair, choices of oviposition sites by the adults might be limited beyond laying eggs in the main channel of the river, and tadpoles likely move among pools until the river dries thereby isolating many of the pools. However, further study that more systematically examines the oviposition site selection of these toads would be informative and might provide valuable information to guide any assessment of conservation or management plans of the Río Salado, which is potentially affected by human-alterations, including the use of water from the river for the production of salt in "salineras."

Acknowledgements

This research was supported by funds from the Dirección General de Asuntos de Personal Académico through project PAPIIT-IN221707, "Factores que determinan la distribución de los anfibios en las pozas asociadas al Río Salado, Puebla, México"; and by the Facultad de Estudios Superiores Iztacala through the Programa de Apoyo a los Profesores de Carrera (PAPCA) 2007–2008 for the project "Caracterización de las pozas asociadas al Río Salado (Puebla) y su influencia en la distribución de los anfibios: aspectos ecológicos y geográficos." The research was approved by the Denison University Institutional Animal Care and Use Committee (Protocol 07-004).

Literature Cited

Duellman, W.E. 1961. The amphibians and reptiles of Michoacán, México. *University of Kansas Publications, Museum of Natural History* 15:1–148.

Oliver-Lopez, L., A. Ramirez-Bautista, and J.A. Lemos-Espinal. 2000. *Bufo occidentalis*. Fecundity. *Herpetological Review* 31:39–40.

Discovery of *Goniurosaurus* Geckos (Squamata: Eublepharidae) in Northwestern Guangdong, China

Zu-Sheng Yi[1], Zhen-Chang Li[2], Wei-Liang Wen[3], Mian Hou[4], Wen-Hua Lu[5], and James Lazell[5]

[1]College of Life Sciences, Guangzhou University, Panyu, Guangdong 510006, China
[2]College of Life Sciences, South China Normal University, Guangzhou, Guangdong 510063, China
[3]Forestry Bureau of Qingyuan Prefecture, Guangdong 511500, China
[4]Center for Chinese Endemic Herp-Breeding and Conservation Research, Shenyang Normal University, Liaoning 110034, China
[5]The Conservation Agency, Jamestown, Rhode Island 02835, USA

Photographs by Mian Hou, except where indicated otherwise.

Leopard Geckos of the genus *Goniurosaurus* (Squamata: Eublepharidae) typically inhabit caves and cliffs in forested areas in the Ryu-Kyu Archipelago of Japan and southeastern Asia (Blair et al. 2009). Ten to twelve species have been described, most recently *G. catbaensis* (Ziegler et al. 2008) and *G. huuliensis* (Orlov et al. 2008), both from northern Vietnam. In China, the first Leopard Gecko was reported from Hainan Island in 1908 as *G.* "*lichtenfelderi*" (Zhao and Adler 1993). This insular form was previously thought to be a Vietnamese species but is now separated as *G. hainanensis* (Grismer et al. 2002, Blair et al. 2009). *Goniurosaurus lichtenfelderi* is confined to granitic substrates in northwestern Vietnam and

Table 1. Comparison of *Goniurosaurus* indet. with species of the *G. luii* group (*G. araneus*, *G. bawanglingensis*, *G. catbaensis*, *G. huuliensis*, and *G. luii*) on scale counts and morphometric characters in mm (from our data, Grismer et al. 1999, Orlov et al. 2008). SL = supralabials; IL = infralabials; PM = postmentals; PO = preorbitals; EF = eyelid fringe scales; PVT = paravertebral tubercles between limb insertions; BS = scales around midbody; GST = granular scales surrounding dorsal tubercles; LT4 = basal and distal subdigital lamellae under fourth toe (hind limb); PP = precloacal pores, SVL = snout vent length; HL = head length from snout to posterior of external ear; HW = head width at the widest area of head.

	SL	IL	PM	PO	EF	PVT	BS	GST	LT4	PP	SVL	HL	HW
G. indet. (male)	8	7	2	16	50–51	34	106	9–10	17–21	12	80	23	14
G. indet. (female)	8	7–8	4	14–16	51–55	33	107	10-11	17–21	—	86	23	15
G. araneus	8–11	8–10	4–6	13–18	61–69	32–38	129–149	10–14	23–24	18–23	111–130	30–33	19-25
G. bawanglingensis	8–10	7–11	2–3	12–18	56–67	32–36	104–133	9–13	18–22	37–46	104	—	—
G. catbaensis	8–9	6–8	2–3	—	52–56	33–34	112–127	8–11	22–24	16–21	84–113	23–32	16-23
G. huuliensis	10–11	9–11	2–3	—	41–44	34–36	118–129	12–13	18–20	25–28	108–117	29–33	18-23
G. luii	9–12	8–11	2–6	14–17	52–63	33–35	119–148	9–14	20–24	21–29	106–120	30–33	19-23

offshore islands in the Gulf of Tongkin (Orlov et al. 2008). Today, three species are known in China: *G. hainanensis* and *G. bawanglingensis* are confined to Hainan Island, whereas the presence of *G. luii* on Hainan Island (Grismer et al. 1999) is discredited (L.L. Grismer, pers. comm., 2 March 2010); it does occur in Guangxi Province (Grismer et al. 1999) and northern Vietnam (Vu et al. 2006). Another *Goniurosaurus* has been found in Guangdong Province, and herein we report this new record. This population of *Goniurosaurus* (currently identified as "*G.* indet.") probably represents a new species in the *G. luii* group, which also includes *G. araneus*, *G. bawanglingensis*, *G. catbaensis*, and *G. huuliensis* (Table 1), all of which have five pairs of black transverse dorsal bands beginning just behind the head (the "nuchal loop" of Grismer 1988) and extending to the base of the tail.

The first individual of *Goniurosaurus* indet., collected on 16 July 2007 in a karst cave approximately 160–170 km NW Guangzhou, Guangdong Province, at approximately 250 m in elevation, was an adult male, 80 mm SVL (South China Normal University [SCNU] 26115). Details of the locality, including GPS coordinates, are withheld because of the dire consequences of over-collecting — which has led to the extirpation of entire populations of this genus (e.g., Stuart et al. 2006).

After several failed attempts to collect more animals in June 2008, we returned to the site on 9 February 2010 and secured two additional specimens: an adult female, 86 mm SVL (SCNU 26116) and a juvenile, 48 mm SVL (SCNU 26117). All three specimens have regenerated tails. The cave system in which these geckos were found is small, with two chambers and three openings. The lowest opening is level with the valley floor and about 10 m from the edge of a cultivated paddy; one cannot enter the cave system through this opening. Each of the two upper openings has a chamber that is connected with the other (we could hear each other); they are ~30 m apart in upslope distance. The middle entrance is ~5 m vertically above the valley floor and the upper entrance is ~15 m above the lowest opening. A small stream courses through the lower reaches of both cave chambers and flows out the lowest opening. Stalactites and stalagmites are developed in both chambers, which are well used by humans. We saw pots and pans, feathers of chickens and other birds, ashes, and charcoal. We observed cave crickets and spiders. The slope is cutover and dominated by shrub vegetation, with only a few scattered, mature trees about 50 cm in trunk diameter. The slope and cave entrances face west. SCNU 26115 was found on the cave wall dur-

Adult female (top) and immature of *Goniurosaurus* indet. from Guangdong Province, China.

L.L. GRISMER

The other three species of *Goniurosaurus* that have been recorded from China: *G. hainanensis* (top) and *G. bawanglingensis* (middle) are confined to Hainan Island, whereas *G. luii* (bottom) occurs in Guangxi Province and in northern Vietnam.

ing summer at night; SCNU 26116 and SCNU 26117 were caught among rubble on the cave floor in winter during daytime (we returned later at night but failed to find more geckos). Although the sample size is very small, these data might be suggestive of seasonal behavior.

The two adults are among the dullest in color of all known *Goniurosaurus*. In life, our female (SCNU 26116) had a gray-brown dorsal ground color with dull yellow tints; the five transverse dorsal bands are sooty to near black, bold, and in pairs; each pair has a pale gray-brown band with a dull yellow tint at center; these light center bands are immaculate. The dorsal zones between the bands and the top of the head were spotted and marbled with near-black. The venter was pale, immaculate, lavender to gray-brown. The iris was brick-red. The male (SCNU 26115) is a drab version of the female when preserved and was similar to her in life; its stomach contained fragments of a cave cricket's femur and tibia. Sexual size dimorphism in *Goniurosaurus* typically is female-biased (females are larger), probably because males do not engage in combat behavior, which would favor large male size (Kratochvíl and Frynta 2002).

Immature *Goniurosaurus* typically have brighter coloration than adults (Grismer et al. 1994, 1999). Our juvenile (SCNU 26117) was strongly contrasting red and yellow, and, except for its smaller size, resembles the most colorful adults of *G. bawanglingensis* and *G. luii*, as figured by Blair et al. (2009) and as described by Grismer et al. (1999, 2002) and Vu et al. (2006). The dorsal ground color was light red; the venter was pale yellow; the transverse dorsal bands were bright yellow edged by the near-black paired dorsal bands. The iris was bright red. Dark spotting on the head and in the dorsal ground color was sparse, indicating that increased spotting is a function of age. The two adults differ most notably from members of the *G. luii* group in duller coloration and pattern, smaller size, and fewer precloacal pores (Table 1). Because the taxonomic status of *Goniurosaurus* indet. might require a genetic assessment, our specimens have been preserved in ethanol to facilitate DNA extraction for such comparisons.

Literature Cited

Blair, C., N.L. Orlov, H.-T. Shi, and R.W. Murphy. 2009. A taxonomic re-evaluation of *Goniurosaurus hainanensis* (Squamata: Eublepharidae) from Hainan Island, China. *Russian Journal of Herpetology* 16:35–40.

Grismer, L.L. 1988. Phylogeny, taxonomy, classification, and biogeography of eublepharid geckos, pp. 369–469. In: R. Estes and J. Pregill (eds.), *Phylogenetic Relationships of the Lizard Families*. Stanford University Press, Stanford, California.

Grismer, L.L., H. Ota, and S. Tanaka. 1994. Phylogeny, classification, and biogeography of *Goniurosaurus kuroiwae* (Squamata: Eublepharidae) from the Ryu-Kyu Archipelago, Japan, with description of a new subspecies. *Zoological Science* 11:319–335.

Grismer, L.L., B.E. Viets, and L.J. Boyle. 1999. Two new continental species of *Goniurosaurus* (Squamata: Eublepharidae) with a phylogeny and evolutionary classification of the genus. *Journal of Herpetology* 33:382–393.

Grismer, L.L., H. Shi, N.L. Orlov, and N.B. Ananjeva. 2002. A new species of *Goniurosaurus* (Squamata: Eublepharidae) from Hainan Island, China. *Journal of Herpetology* 36:217–224.

Kratochvíl, L.S. and D. Frynta. 2002. Body size, male combat and the evolution of sexual dimorphism in eublepharid geckos (Squamata: Eublepharidae). *Biological Journal of the Linnean Society* 76:303–314.

Orlov, N.L., S.A. Ryabov, N.T. Tao, N.Q. Truong, and H.T. Cuc. 2008. A new species of *Goniurosaurus* (Sauria: Gekkota: Eublepharidae) from North Vietnam. *Russian Journal of Herpetology* 15:229–244.

Stuart, B.L., A.G.J. Rhodin, L.L. Grismer, and T. Hansell. 2006. Scientific description can imperil species. *Science* 312:1137.

Vu, N.T., Q.T. Nguyen, L.L. Grismer, and T. Ziegler. 2006. First record of the Chinese Leopard Gecko, *Goniurosaurus luii* (Reptilia: Eublepharidae) from Vietnam. *Current Herpetology* 25:93–95.

Ziegler, T., Q.T. Nguyen, A. Schmitz, R. Stenke, and H. Rösler. 2008. A new species of *Goniurosaurus* from Cat Ba Island, Hai Phong, northern Vietnam (Squamata: Eublepharidae). *Zootaxa* 1771:16–30.

Zhao, E. and K. Adler. 1993. *Herpetology of China*. Contributions to Herpetology 10. Society for the Study of Amphibians and Reptiles, Ithaca, New York, USA.

Snakes Using Stumpholes and Windfall Tree-associated Subterranean Structures in Longleaf Pine Forests

David A. Steen[1,2], Amanda D. Steen[1], Scott Pokswinski[1], Sean P. Graham[2], and Lora L. Smith[1]

[1]Joseph W. Jones Ecological Research Center, Newton, Georgia 39870, USA (DavidASteen@gmail.com)
[2]Department of Biological Sciences, Auburn University, Auburn, Alabama 36849, USA

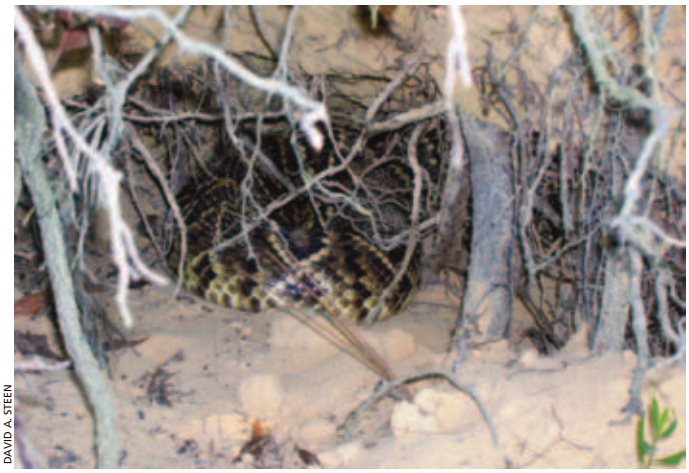
Stumpholes are a common habitat feature of fire-maintained Longleaf Pine ecosystems in the southeastern United States. These stumpholes and associated subterranean tunnels that form as stumps decay or are consumed by fire have been identified as important refugia for numerous vertebrate species (Means 2005; Steen et al., in press). Trees downed by wind, such as those seen after major storm events (Gresham et al. 1991), may create subterranean depressions or cavities near their bases as roots are exposed. These represent potential microhabitats for animals that do not construct their own burrows. Herein we report on five observations of snakes using refugia associated with stumphole tunnels or root cavities of downed trees in Longleaf Pine forests.

On 26 May 2009 at 1300 h, we observed an adult Pigmy Rattlesnake (*Sistrurus miliarius)* alongside a burnt stump; the rattlesnake retreated into a tunnel within the stumphole shortly after being observed. On 13 July 2009 at 0640 h, we observed an adult Coral Snake (*Micrurus fulvius*) on the forest floor. After ~30 sec of observation, the snake was disturbed and made its way to a stump approximately 70 cm from its original location. The snake retreated into a tunnel associated with the stump. Both observations occurred in Okaloosa County, Florida. To our knowledge, they represent the first accounts of these species using this type of refuge. On 8 April 2005 in Upson County, Georgia, we observed a large adult Eastern Kingsnake (*Lampropeltis getula getula*) coiled and partially visible at about 1400 h within the leaf litter of a Longleaf Pine stump.

On 16 June 2009 at 0730 h, we observed an adult Eastern Diamondback Rattlesnake (*Crotalus adamanteus)* within a cavity under the root system of a large downed Sand Live Oak Tree. On 23 July 2009 at 1950 h, we observed an adult Cottonmouth (*Agkistrodon piscivorus*) within a cavity associated with the base of a downed tree on the bank of a small clear-water stream. Both observations occurred in Okaloosa County, Florida.

DAVID A. STEEN

The sunrise illuminates the understory of a Longleaf Pine forest in Okaloosa County, Florida. Although herpetologists typically are not active at dawn, avian sampling obligations in the spring of 2009 enabled me to take advantage of the morning light — and to find the Coral Snake and Eastern Diamondback Rattlesnake described in the text.



DAVID A. STEEN

The Eastern Diamondback Rattlesnake (*Crotalus adamanteus*) uses subterranean refuges associated with downed trees. However, one may have to fruitlessly examine scores of such structures before a snake is encountered. The observation of this individual is described in the text.

These observations indicate that many species of southeastern snakes may be influenced by forest management strategies that affect the presence of stumpholes and cavities associated with windfall trees within Longleaf Pine forests. These refugia may be especially important in areas of low Gopher Tortoise (*Gopherus polyphemus*) burrow densities, such as in Okaloosa County, Florida, where four of these observations occurred, as tortoise burrows are documented shelters for all aforementioned snake species (Jackson and Milstrey 1989). Forest management practices including the harvesting of stumps and fire suppression have reduced stumphole habitat in many southeastern forests (Means 2006). In addition, harvesting trees downed by wind may reduce available subterranean shelter for forest-associated wildlife species, although large-scale experimental manipulations of coarse woody debris in the southeastern Coastal Plain did not document compelling trends that suggest that amphibians and reptiles generally responded on a population level (Owens et al. 2008).

Literature Cited

Gresham, C.A., T.M. Williams, and D.J. Lipscomb. 1991. Hurricane Hugo wind damage to southeastern U.S. coastal forest tree species. *Biotropica* 23:420–426.

Jackson, D.R. and E.G. Milstrey. 1989. The fauna of Gopher Tortoise burrows, pp. 86–98. In: J.E. Diemer, D.R. Jackson, J.L. Landers, J.N. Layne, and D.A. Wood (eds.), *Gopher Tortoise Relocation Symposium Proceedings*. Florida Game and Fresh Water Fish Commission Nongame Wildlife Program Technical Report No. 5, Tallahassee.

Means, D.B. 2005. The value of dead tree bases and stumpholes as habitat for wildlife, pp. 74–78. In: W.E. Meshaka and K. Babbitt (eds.), *Status and Conservation of Florida Amphibians and Reptiles*. University Press of Florida, Gainesville.

Means, D.B. 2006. Vertebrate faunal diversity in Longleaf Pine savannas, pp. 155–213. In: S. Jose, E. Jokela, and D. Miller, (eds.), *Longleaf Pine Ecosystems: Ecology, Management, and Restoration*. Springer, New York.

Owens, A.K., K.R. Moseley, T.S. McCay, S.B. Castleberry, J.C. Kilgo, and W.M. Ford. 2008. Amphibian and reptile community response to coarse woody debris manipulations in upland Loblolly Pine (*Pinus taeda*) forests. *Forest Ecology and Management* 256:2078–2083.

Steen, D.A., J.M. Linehan, and L.L. Smith. Multiscale habitat selection and refuge use of Common Kingsnakes, *Lampropeltis getula*, in southwestern Georgia. *Copeia*: In press.

GREG SIEVERT

By the time Dr. Fitch's study of the Ringneck Snake (*Diadophis punctatus*) was published in 1975, he had already established himself as the "father of snake ecology" (Fitch, H.S. 1975. A demographic study of the Ring-neck Snake (*Diadophis punctatus*) in Kansas. *University of Kansas Museum of Natural History Miscellaneous Publication* (62):1–53). This was the single most frequently encountered species of snake in his 50-year study of reptiles on the University of Kansas (now Fitch) Natural History Reservation (Fitch, H.S. 1999. *A Kansas Snake Community: Composition and Changes Over 50 Years*. Krieger Publishing Co., Malabar, Florida).

SUZANNE L. COLLINS, CNAH

Many of the same techniques used to study snakes applied as well to another reptilian species native to northeastern Kansas. The Slender Glass Lizard (*Ophisaurus attenuatus*), although very snake-like in many ways, is quite lizard-like in its insectivorous diet (Fitch, H.S. 1989. A field Study of the Slender Glass Lizard, *Ophisaurus attenuatus*, in northeastern Kansas. *Occasional Papers of the Museum of Natural History, The University of Kansas* (125):1–50).

INVASIVE SPECIES

Is the Northern African Python (*Python sebae*) Established in Southern Florida?

Robert N. Reed[1*], Kenneth L. Krysko[2], Ray W. Snow[3], and Gordon H. Rodda[1]

[1]U.S. Geological Survey, Fort Collins Science Center, 2150 Centre Ave, Bldg C, Fort Collins, Colorado 80526
[2]Florida Museum of Natural History, Division of Herpetology, University of Florida, Gainesville, Florida 32611
[3] National Park Service, Everglades National Park, 40001 State Road 9336, Homestead, Florida 33034
*Corresponding author: reedr@usgs.gov, 970-226-9464

More than 45 species of nonindigenous amphibians and reptiles are currently established in Florida, largely as a consequence of international trade in live animals as pets (Meshaka et al. 2004, Kraus 2009, K. Krysko, unpubl. data). Among these, the Burmese Python (*Python molurus bivittatus* Kuhl 1820) has expanded its range through several thousand square kilometers of the southern Everglades and adjacent areas (Snow et al. 2007). The Boa Constrictor (*Boa constrictor* Linnaeus 1758) also is established in a forested county park in southeastern Miami, Miami-Dade County (Snow et al. 2007), but delineating the geographic distribution of this population is difficult because boas found nearby could be either dispersers from the known population or recently released or escaped animals from captivity. Free-ranging individuals of several additional species of large constrictors (e.g., Green Anaconda, *Eunectes murinus* Linnaeus 1758; Yellow Anaconda, *E. notaeus* Cope 1862; Reticulated Python, *Broghammerus reticulatus* Schneider 1801; and White-lipped Python, *Leiopython albertisii* Peters and Doria 1878) have been found in various parts of Florida, but evidence of reproduction for these species is presently lacking. Herein, we provide evidence suggesting the possibility of a reproducing population of a third species of giant constrictor in Florida, the Northern African Python (*Python sebae* Gmelin 1788; Fig. 1).

In 2002, a large (ca. 4.9 m total length) *Python sebae* was found at the intersection of SW 26th Street and SW 147th Avenue, Miami, Miami-Dade County (25.74298°N, -80.43221°W; datum WGS84; Fig. 2A), and recovered, but not retained, by the Miami-Dade Venom Response Unit (A. Cruz, pers. comm.; Internet Broadcasting Systems 2005). A snake of this size would almost certainly be female, as this species exhibits female-biased sexual size dimorphism, and males are not known to attain such sizes in its native range (Reed and Rodda 2009).

L. OBERHOFER, NATIONAL PARK SERVICE

Fig. 1. Northern African Python (*Python sebae*) captured by Anthony Flanagan on 19 December 2009.

Fig. 2. Specimens and observations of the Northern African Python (*Python sebae*) in Miami, Miami-Dade County, Florida. Localities (see text) include: A = 2002, B = 11 October 2005, C = November 2008, D = 30 May 2009, E = 5 August 2009, F = 16 August 2009, G = 19 December 2009.

On 11 October 2005, an adult (ca. 3 m total length) *Python sebae* (photographic voucher UF 153699) was found in a plant nursery just north of the same intersection (Fig. 2B). The snake had entered an outdoor enclosure for raising fowl, and had consumed a domestic turkey (A. Cruz, pers. comm.; Internet Broadcasting Systems 2005).

In November 2008, an experienced snake collector observed a large (3.5–4.0 m total length) adult python along a canal bank (25.72739°N, -80.46548°W), 3.7 km southwest of the intersection cited above (Fig. 2C; A. Flanagan, pers. comm. 2009). He attempted to capture the snake, but it escaped from his grasp after a brief struggle. This observer has captured 100 *P. molurus* in southern Florida, and was confident of his identification of this snake as *P. sebae*, including the observation that the individual bore an aberrant middorsal dark stripe.

On 30 May 2009, an approximately 2.75 m-long *Python sebae* was struck by a motor vehicle at the same intersection cited above (Fig. 2D), and recovered by the Miami-Dade Venom Response Unit (A. Cruz, pers. comm.). This snake subsequently died from its injuries, and dissection revealed that it was an adult female with 37 "undeveloped ova" (unknown whether these were ovarian follicles or oviductal eggs, as they were discarded prior to preservation). This specimen, along with photographic images, was transferred to the Florida Museum of Natural History (UF 155725) for preservation and documentation.

On 5 August 2009, a neonate (59 cm SVL) *Python sebae* (UF 155500) was found dead on US 41, 0.09 km west of 160th Avenue (25.76089ºN, -80.45596ºW; Fig. 2E), which is 3.0 km northwest of the intersection cited above. On 16 August 2009, another juvenile *P. sebae* (110 g, UF 155726) was collected at 15527 SW 18th Street, Miami (25.74984ºN, -80.44637ºW; Fig. 2F), and recovered by the Miami-Dade Venom Response Unit (L. Woods, pers. comm.). Dissection revealed a 72-g Boat-tailed Grackle (*Quiscalus major*) in the stomach of the python. See Table 1 for body lengths and disposition of specimens.

Most recently, on 19 December 2009, an adult male *P. sebae* (UF 157193, 249 cm SVL, 281 cm total length, 10.374 kg) was collected from a *Melaleuca* slash pile (Fig. 3) just west of 157th Avenue south of US 41 (25.75245°N, -80.45079W; specimen not yet accessioned into FLMNH). The snake was basking on top of dead logs and appeared reproductively competent; its testes were swollen and mildly turgid, sperm ducts were convoluted, and microscopic examination of fluid expressed from the ducts revealed multiple spermatozoa.

The above specimens and observations are presently confined to a small (~10 km^2) area of Miami, just 1.6 km east of Everglades National Park (Fig. 2). All seven pythons were found southeast of the intersection of US 41 and SR 997, an area often referred to as Bird Drive Basin. Taken as a whole, these seven observations over a seven-year period, including multiple adults, a gravid female, and young-of-year hatchlings suggest the possibility of a reproducing population of *Python sebae*. Recovery of adults over several years followed by recently hatched juveniles argues against the notion that all of these individuals were the result of a single release of multiple individuals, leaving multiple releases or a reproducing population as the most likely explanations. These observations do not represent definitive evidence of a reproducing population, and some would argue that only the discovery of a female brooding eggs would qualify as definitive evidence. By the time such discoveries are typically made, of course, a species is often well established. Indeed, the observations of *Python sebae* in Miami highlight the difficulty of declaring when a population of extremely cryptic reptiles has become established.

Three of the five adult pythons were from a small area just south of Tree Island Park, which is south of US 41 and bounded on the east and west by SW 146th Street and SW 149th Street, respectively. The two hatchlings were found farther to the west and north, and could conceivably represent dispersing individuals. Habitats in this area include high-density single-family housing developments, undeveloped but highly disturbed habitats with a preponderance of invasive *Melaleuca* trees, small man-made canals and lakes, agricultural areas (primarily to the southwest), and seasonally flooded wetlands. Land ownership in the area is complex, with various parcels belonging to homeowners, housing developers, plant nursery and agricultural interests, Miami-Dade County, South Florida Water Management District, Miccosukee Tribe of Indians, State of Florida, and others.


R.N. REED, U.S. GEOLOGICAL SURVEY

Fig. 3. Scott Goetz (U.S. Geological Survey) precariously makes his way through a large pile of dead *Melaleuca* logs while searching for pythons in Bird Drive Basin. The python pictured in Fig. 1 had been captured from this pile.

The area described above is within or adjacent to the eastern edge of the known distribution of invasive Burmese Pythons (*Python molurus bivittatus*; Snow et al. 2007). Distinguishing between *P. molurus* and *P. sebae* can be challenging, and often hinges on color pattern; although meristic characters (e.g., scale counts) are sufficient to distinguish many individuals, moderate overlap exists among these species in many of those characters. *Python molurus* and *P. sebae* are known to hybridize in captivity (Branch and Erasmus 1984 and references therein), which could further complicate the identification of a python recovered from this area. Fertility and fitness of hybrids is unknown, as are the potential implications of adding *P. sebae* genes to the existing population of *P. molurus*. The potential difficulty of accurately identifying free-ranging individuals of different species of exotic pythons is exemplified by two *P. sebae* recovered from southwestern Florida (east of Sarasota) in 2006 and 2009. Both of these specimens were originally reported as a different species (one identified as *P. molurus* and one as a Reticulated Python, *Broghammerus* [formerly *Python*] *reticulatus*). As the population of Burmese Pythons continues to expand within Florida, accurate identification of large snakes will be crucial to identifying incipient populations of other species before their populations become too widespread for effective eradication programs.

Efforts are currently underway to develop education and outreach materials that will allow discrimination among these and other giant constrictor species by citizens and resource managers lacking herpetological

Table 1. Specimen information for seven *P. sebae* recovered from the western boundaries of greater Miami, FL from 2002 to 2009. When available, specimens were accessioned into the Florida Museum of Natural History in Gainesville, FL.

Date	Specimen No.	Specimen Type	Approx. Total Length
19 December 2009	157193	Whole body	2.81 m
16 August 2009	155726	Whole body	0.71 m
05 August 2009	155500	Whole body	0.67 m
30 May 2009	155725	Whole body	2.75 m
November 2008	N/A	Credible sighting	~3.7 m
11 October 2005	153699	Media account	3.05 m
2002	N/A	Credible sighting	4.9 m

expertise. Stakeholders from various federal, state, tribal, and local agencies also plan to partner with non-governmental cooperators to conduct intensive surveys for *Python sebae* in the Bird Drive Basin area in 2010 (D. Giardina, Florida Fish and Wildlife Conservation Commission, pers. comm. 2009). Such surveys will aim to delineate the size and geographic extent of the incipient population and attempt eradication of remaining individuals.

Acknowledgments

We thank A. Cruz, M. Easter, A. Flanagan, C. Gillette, and L. Woods for providing information and/or specimens, M. Granatosky for assisting with specimen preparation, and C. Dove for identification of avian prey remains. K. Hart, W. Meshaka, M. Rochford, and an anonymous reviewer provided helpful comments on earlier versions of this manuscript.

Literature Cited

Branch, W.R. and H. Erasmus. 1984. Captive breeding of pythons in South Africa, including details of an interspecific hybrid (*Python sebae natalensis* x *Python molurus bivittatus*). *Journal of the Herpetological Association of Africa* 1984:1–10.

Internet Broadcasting Systems. 2005. Rare 10-foot python attacks farmer's poultry. <http://www.clickorlando.com/news/5087908/detail.html> (accessed 31 August 2009).

Kraus, F. 2009. *Alien Reptiles and Amphibians: A Scientific Compendium and Analysis.* Invading Nature — Springer Series in Invasion Ecology, volume 4. Springer, New York.

Meshaka, W.E., Jr., B.P. Butterfield, and J.B. Hauge. 2004. *Exotic Amphibians and Reptiles of Florida.* Krieger Publishing Co., Melbourne.

Reed, R.N. and G.H. Rodda. 2009. Giant constrictors: Biological and management profiles and an establishment risk assessment for nine large species of pythons, anacondas, and the Boa Constrictor. U.S. Geological Survey Open File Report 2009-1202. Fort Collins, Colorado.

Snow, R.W., K.L. Krysko, K.M. Enge, L. Oberhofer, A. Warren-Bradley, and L. Wilkins. 2007. Introduced populations of *Boa constrictor* (Boidae) and *Python molurus bivittatus* (Pythonidae) in southern Florida, pp. 416–438. In: R.W. Henderson and R. Powell (eds.), *Biology of the Boas and Pythons.* Eagle Mountain Publishing LC, Eagle Mountain, Utah.

CONSERVATION RESEARCH REPORTS

Conserving Mexican Amphibians

Traditionally, biodiversity conservation gap analyses have been focused on governmental protected areas (PAs). However, an increasing number of social initiatives in conservation (SICs) are promoting a new perspective for analysis. SICs include all of the efforts that society implements to conserve biodiversity, such as land protection, from private reserves to community zoning plans, some of which have generated community-protected areas. This is the first attempt to analyze the status of conservation in Latin America in which some of these social initiatives are included. The analyses were focused on amphibians because they are one of the most threatened groups worldwide. **OCHOA-OCHOA ET AL.** (2009. *PLoS ONE* 4:1–9) used a niche model approach to map the potential and real geographical distribution (extracting the transformed areas) of endemic Mexican amphibians. All species have suffered some degree of loss, but 36 species have lost more than 50% of their potential distribution. For 50 micro-endemic species, the authors could not model their potential distribution range due to the small number of records per species; therefore, the analyses were performed using these records directly. The authors then evaluated the efficiency of the existing set of governmental PAs and established the contribution of SICs (private and community) for land protection for amphibian conservation. They found that most of the species have some portion of their potential ecological niche distribution protected, but 20% are not protected at all within governmental PAs. 73% of endemic and 26% of micro-endemic amphibians are represented within SICs. However, 30 micro-endemic species are not represented in either governmental PAs or SICs. This study shows how the role of land conservation through SICs is becoming an increasingly crucial element for an important number of species not protected by governmental PAs.

Artificial Refuges Facilitate Reptilian Recovery

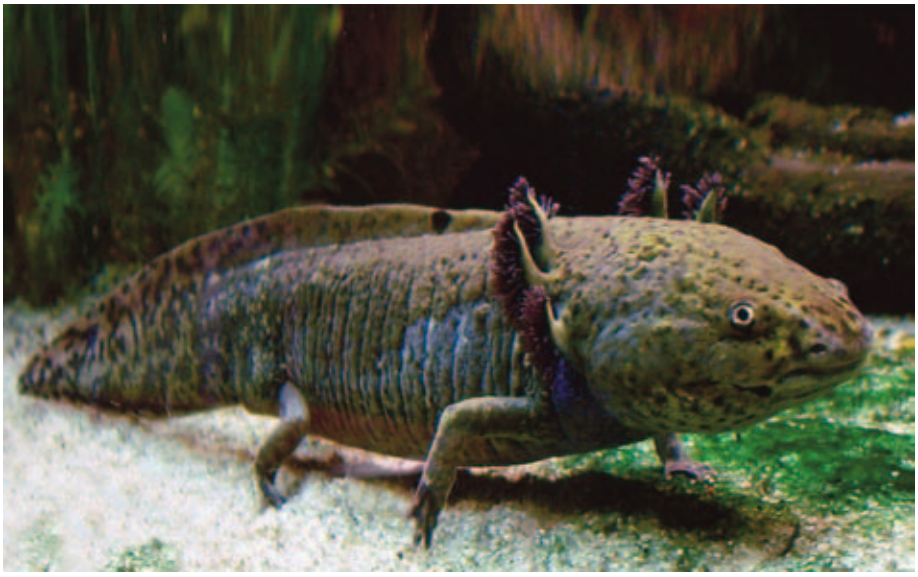
Ecosystem restoration requires that habitat requirements of all species be considered. In 1998, a massive quantity of tailings broke out of the holding pond of the Aznalcollar Mine in southwestern Spain and polluted the Guadiamar River valley. After the accident, a soil and vegetation restoration program began, and the Guadiamar Green Corridor was created to connect two large natural areas, a national park and the Sierra Morena. The mine-tailing spill polluted a large area, giving rise to an interesting case study involving soil and vegetation restoration and recovery of the terrestrial reptilian community in the contaminated area. The 5-year study by **MARQUEZ-FERRANDO ET AL.** (*Restoration Ecology* 17:660–667) evaluated whether the reptilian community in the polluted area remained dramatically impoverished because of the elimination of all natural refuges. The area managed with artificial refuges exhibited a better and faster recovery of the reptilian community than the control area with no refuges.

LUIS FERNÁNDEZ GARCÍA

Horseshoe Whip Snakes (*Hemorrhois hippocrepis*) were found significantly more frequently in plots with artificial refuges than in control plots without refuges.

Power Boating and Northern Map Turtles

Recreational power boating is growing in popularity in North America. This activity is known to have lethal and sub-lethal effects on aquatic wildlife, and freshwater turtles may be particularly sensitive to this activity. **BULTÉ ET AL.** (2009. *Aquatic Conservation: Marine and Freshwater Ecosystems*, early view published online 26 October 2009) reported on patterns of traumatic injuries inflicted by powerboat propellers to Common Map Turtles (*Graptemys geographica*) from two sites differing in boat traffic intensity in Ontario, Canada. The relative vulnerability of turtles was assessed in light of seasonal patterns in boat traffic, as a function of sex- and age-specific movement patterns, habitat use, and basking behavior obtained by radio-telemetry. The authors conducted population viability analyses (PVA) to evaluate the potential demographic consequences of mortality induced by powerboats. The prevalence of propeller injuries was two to nine times higher in adult females than in adult males and juvenile females. Patterns of movement, habitat use, and aquatic basking indicated that adult females are more exposed to collisions with boats. PVA showed that boat-induced mortality in adult females could lead to rapid population extinction if the risk of mortality when hit by a boat is greater than 10%. The results of this study showed that recreational power boating is a serious threat to Northern Map Turtles, even under



The critically endangered Axolotl (*Ambystoma mexicanum*) is one of many Mexican amphibians with declining distributions.

SUZANNE L. COLLINS, CNAH

Adult female Common Map Turtles (*Graptemys geographica*) are more vulnerable to collisions with boats than are adult males and juveniles (illustrated).

moderate boat traffic, which speaks to the need to adopt measures restricting boat traffic in areas important to turtles.

The Trade in Vertebrates Promotes Extinctions and Introductions

The process of taxonomic homogenization occurs through two mechanisms, extinctions and introductions, and leads to a reduction of global biodiversity. **Romagosa et al.** (2009. *Conservation Biology* 23:1001–1007) used available U.S. trade data as a proxy for global trade in live vertebrates to assess the contribution of trade to the process of taxonomic homogenization. Data included all available U.S. importation and exportation records, estimation of extinction risk, and reports of establishment outside the native range for species within six vertebrate groups. Based on Monte Carlo sampling (a class of computational algorithms that rely on repeated random sampling to compute their results), the number of species traded, established outside of the native range, and threatened with extinction was not randomly distributed among vertebrate families. Twenty-eight percent of vertebrate families that were traded preferentially were also established or threatened with extinction, an unusually high percentage compared with the 7% of families that were not traded preferentially but that became established or threatened with extinction. The importance of trade in homogenization of vertebrates suggests that additional efforts should be made to prevent introductions and extinctions through this medium.

TOM WIEWANDT, WILDHORIZONS.COM

Species in the family Iguanidae were traded significantly more than expected based on randomization procedures — despite the fact that some species, such as this San Esteban Island Chuckwalla (*Sauromalus varius*), rarely appear in the trade for pets, skins, or meat.

Road-kill Hotspots

Roads with wetlands on both sides are considered hotspots because of the high mortality rates of amphibians and reptiles that live near the roads. **Langen et al.** (2009. *Journal of Wildlife Management* 73:104–114) studied a 219-mile highway network in New York, where they discovered both amphibian and reptilian road mortality to be spatially clustered, and causeways were more likely to have road-kills than points with one adjacent wetland or with no wetland present. Road crossing occurs when the animals migrate during seasonal migrations to and from hibernation or breeding sites. The authors stated that planners could identify valid predictors of hotspots when designing or restoring roads to avoid as much harm as possible to amphibian and reptilian populations.

SUZANNE L. COLLINS, CNAH

Northern Leopard Frogs (*Lithobates pipiens*) were among nine species of anuran roadkills found more frequently on causeways than on roads with one adjacent wetland or no wetland.

Australian Snakes Vulnerable to Climate Change

The Broad-headed Snake (*Hoplocephalus bungaroides*), Australia's most endangered snake, will find areas of higher elevation most suitable for surviving climate change. **Penman et al.** (*Diversity and Distributions* 2010:109–118) analyzed the Sydney Basin Bioregion and predicted the distribution of this species under low and high climate change scenarios for 2030 and 2070. Populations will be lost under both climate-warming scenarios. The species has highly specialized habitat requirements and exhibits delayed maturation and a low reproductive rate. These factors reduce the species' ability to recover from population reductions. Populations have declined dramatically throughout the range in the 200 years since European settlement because of anthropogenic reasons, particularly urbanization. The authors concluded that many areas that are currently occupied will become too hot and dry for this species, and only cooler areas at higher elevations will remain suitable.

If the Broad-headed Snake (*Hoplocephalus bungaroides*), Australia's most endangered snake, will survive climate change, it will most likely be restricted to cooler areas at higher elevations.

NATURAL HISTORY RESEARCH REPORTS

Turtles and Wetlands

Seasonal differences in wetland use by Spotted Turtles (*Clemmys guttata*) and Blanding's Turtles (*Emydoidea blandingii*) are complex and require a dynamic landscape to sustain these rare turtles. **Beaundry et al.** (2009. *Journal of Herpetology* 43:636–645) examined these factors in southern Maine, where wetlands are abundant and diverse. The study concluded that the characteristic of the wetlands used by the turtles varies between the species. In the spring, Spotted Turtles used wetlands with abundant Wood Frog egg masses and showed a negative association with forested swamps. In the summer and fall, they used wetlands with high sun exposure. Blanding's Turtles used wetlands within deciduous forests and with a high cover of sphagnum in the spring. During late summer and fall, these turtles were associated with deep-water wetlands. Seasonally, Blanding's Turtles were active earlier than Spotted Turtles.

SUZANNE L. COLLINS, CNAH

Spotted Turtles (*Clemmys guttata*; top) and Blanding's Turtles (*Emydoidea blandingii*) differ in seasonal wetland use in southern Maine.

Horned Lizards and Climate

The prediction that variation in species morphology is related to environmental features has long been of interest to ecologists and evolutionary biologists. **Luxbacher and Knouft** (2009. *Journal of Evolutionary Biology* 22:1669–1678) used morphological, environmental, and phylogenetic data compiled from studies of Horned Lizards (*Phrynosoma*) to examine morphological and climatic variation across the geographic ranges of these species in an evolutionary context. In the first study, patterns of environmental niche and morphological trait variation among Horned Lizards were examined in a phylogenetic context. The results indicated that closely related species of *Phrynosoma* occupy more similar environmental niches than distantly related species, which was suggestive of niche conservatism. In the second study, morphological characters of 14 Horned Lizard species were measured. The results suggested no discernable pattern in the evolution of body size or form among Horned Lizards. The lack of a phylogenetic signal in body size may seem surprising, but phylogenetic signals are responsive to sample sizes, and this analysis was limited to 14 species. The final study looked at associations between environmental niches and morphological traits. Although the study could not determine if morphological characters were responding directly to climate or to, for example, vegetative communities that are affected by climate, the results showed that morphological traits (excluding body size) are correlated with climatic features among Horned Lizards. Species of *Phrynosoma* with long limbs occur in dry lowland habitats with relatively high temperatures and species with large heads occur in wet environments with high temperature seasonality (i.e., wide annual fluctuations in temperature). This pattern is also supported by empirical data.

SUZANNE L. COLLINS, CNAH

Morphological traits (excluding body size) are correlated with climatic features among Horned Lizards. For example, short-limbed Mountain Short-horned Lizards (*Phrynosoma hernandesi*) occur at high elevations and cooler temperatures across the western United States and into Sonora, Chihuahua, and Durango, Mexico.

Bird and Crocodilian Lungs are Similar

When it breathes, the American Alligator (*Alligator mississippiensis*), a semi-aquatic ectotherm without air sacs, possesses the same unidirectional airflow in the lungs as birds. During inhalation and exhalation, airflow in the avian lung moves gases in the same direction through small tubes called the parabronchi. Crocodilian lungs are distinctly different than those of birds, but the topography of the intrapulmonary bronchi is similar in both. **Farmers and Sanders** (2010. *Science* 327:338–340) tested the hypothesis that airflow in alligator lungs is unidirectional and concluded that it was extremely bird-like. The mechanisms for unidirectional airflow in alligator lungs remain unknown, but crocodilians and birds both belong to the crown-group Archosauria, which includes crocodiles, dinosaurs, and pterosaurs of the Triassic Period (251–199 million years ago), suggesting that the unidirectional airflow in alligators and birds could have evolved before these groups diverged.

Unidirectional airflow through the lungs of American Alligators (*Alligator mississippiensis*) is essentially similar to that in birds, suggesting that airflow mechanisms evolved before crocodilians and birds diverged.

NEWSBRIEFS

Amphibian Reserve Launched in Colombia

An exciting new partnership between the IUCN/SSC Amphibian Specialist Group, IUCN Netherlands, Dendrobatidae Nederland, Conservation International-Colombia, and Fundación ProAves has led to the launch of a new amphibian reserve to protect spectacular poison frogs in Colombia. Colombia has more threatened amphibians than any other country, largely restricted to highly fragmented subtropical and montane forests which are unprotected and at threat of agricultural expansion. Within Colombia, the hotspot for threatened amphibians is the Central Cordillera, which also has the greatest concentration of coffee production in South America and is almost denuded of natural forests.

MAURICIO RIVERA

A new amphibian reserve in Colombia is home to many threatened species, including the previously undescribed Little Golden Poison Frog (*Ranitomeya tolimense*).

After extensive searches of the Central Cordillera for amphibians, herpetologist and Fundación ProAves President, Alonso Quevedo, with ecologist Oscar Gallego, discovered one of the largest surviving forest fragments, a mere 200 acres of forest on its eastern flank. Not only did Alonso discover that the 200 acres contained many threatened amphibians, but that it held many previously undescribed species including two spectacular poison frogs, recently named as the Swainson's Poison Frog (*Ranitomeya doriswainsonae*) and Little Golden Poison Frog (*Ranitomeya tolimense*).

Sadly, these last 200 acres were in the process of being cleared for avocado and coffee plantations and that would almost certainly seal the fate of countless amphibians and other unique biodiversity. "In an urgent bid to save this unique island of amphibian diversity," said Alonso Quevedo, "I negotiated with different land owners of the 200-acre forest to stop clearing forest and sell the land to the national conservation NGO, Fundación ProAves. The owners agreed, so I immediately approached the IUCN/SSC Amphibian Specialist Group and IUCN Netherlands for emergency support."

The two groups promptly provided the support necessary to purchase the land and resources for the long-term protection and management of the area. In early December, the newly named "Ranita Dorada Amphibian Reserve," named after the Little Golden Poison Frog, was launched. This action comes at a crucial moment when conservation measures are urgently needed for this highly sensitive group.

Robin Moore
Amphibian Specialist Group
Species, Magazine of the Species Survival Commission
(IUCN) 50:15

Tracking the Illegal Capture of Marine Turtles

Critically Endangered marine turtles from southeastern Asia are being targeted by foreign vessels originating in Hainan, China, and (to a lesser degree) Vietnam. These boats leave port with the express purpose of catching marine turtles, a practice which is illegal both in their home countries and in the waters of countries in which they fish. The last half decade has seen such a noteworthy increase that there is a need to determine the severity of this practice. How much poaching goes unrecorded or undetected? How severe are the impacts to turtle populations? What drives this trade, and how can it be curtailed?

Significant and urgent inroads need to be made into curbing this illegal trade and further research is needed to fully understand the market forces at play in illegal wildlife trade in order to design economic deterrents to it. In June 2009 members of the IUCN Marine Turtle Specialist Group coorganized a workshop along with the Terengganu State Government, University Malaysia Terengganu, the Marine Research Foundation, Conservation International (Philippines), and the IUCN Marine Turtle Specialist Group. The purpose of the workshop was to document the apprehensions of foreign vessels and fishermen involved in the illegal direct capture, to present information on the declining trend of marine turtles in the region and the efforts undertaken to arrest the decline, and to demonstrate that direct capture of adult and sub-adult marine turtles will rapidly cause a collapse of turtle populations in the Southeast Asian Region.

Solutions to the direct capture of sea turtles were discussed, and there are plans to address the problem through a partnership with Chinese authorities and scientists, analyzing market forces, raising awareness within the fishery, training of customs staff in turtle meat and parts identification, tracking consignments through DNA evaluation, translation and provision of conservation materials into Mandarin, and continued dialogue and information exchange sessions.

Nicolas J. Pilcher, Chan Eng Heng, and Kevin Hiew
Marine Turtle Specialist Group

The State of the World's Sea Turtles (SWOT) report is produced by the Marine Turtle Specialist Group in partnership with Conservation International and Duke University. The fourth volume, released in 2009, features the first-ever map of global Flatback Turtle (*Natator depressus*) nesting data, genetic stocks, and inwater distribution. Other highlights include articles about why Leatherback Turtle populations vary globally, how retail sales help communities and sea turtles in Brazil, and how fishermen are aiding conservation efforts in Canada. The full report can be downloaded at www.seaturtlestatus.org.

Roderic Mast and Nicolas J. Pilcher
Co-Chairs, Marine Turtle Specialist Group
Species, Magazine of the Species Survival Commission
(IUCN) 50:24–25

NICOLE MOLLETT, SEATURTLE.ORG

Critically Endangered marine turtles, such as this Australian Flatback Turtle (*Natator depressus*), are being targeted by foreign vessels originating in Hainan, China, and Vietnam.

Dog Hunts Invasive Turtles

If the turtles in Blackburn Lake don't smell right, Angus will sniff them out. The pure-bred Labrador Retriever has been trained specifically to track and hunt down the illegally introduced Red-eared Slider (*Trachemys scripta elegans*). The invasive pest has been seen in Blackburn Lake Sanctuary, Elsternwick Park Lake, and Ruffey Lake Park in Whitehorse, Australia.

A turtle was captured in Blackburn Lake in January of this year, but authorities believe up to three turtles and possibly a nest remain. Gary Jackson, Angus' trainer, said the five-year-old was the only dog in the world trained specifically to catch Red-eared Sliders. "We have trained him to ignore native turtles and eggs," Mr. Jackson said. "He loves finding the slider turtle's nests; when he sniffs one he starts digging for it and unless we pull him off, he would dig all the way through to the nest and probably eat the eggs."

Angus is on loan from the Queensland Government for the next week and will be hunting for the elusive turtle in Blackburn.

Agriculture Minister Joe Helper said the World Conservation Union listed the Red-eared Slider as one of the world's 100 most-invasive species. Females lay up to 70 eggs and, if unchecked, the species can destroy native habitats and food supply. Red-eared Sliders have a distinctive red stripe behind each eye and a dome-shaped shell. Mr. Helper urged the public to report any sightings to the Department of Primary Industries.

James Dowling
Whitehorse (Australia) *Leader*
27 October 2009

BRENT MELTON

A Labrador Retriever has been trained to track illegally introduced Red-eared Sliders (*Trachemys scripta elegans*) in Whitehorse, Australia.

African Dwarf Frogs Implicated in *Salmonella* Outbreak

Amphibians and reptiles are carriers of *Salmonella.* This type of bacteria is a health hazard most frequently contracted by touching raw foods (e.g., meats, eggs), but also can be acquired by touching animals that carry *Salmonella.* Thoroughly washing hands after any potential contact is important if infections are to be avoided. African Dwarf Frogs (*Hymenochirus boettgeri*) have been implicated in 85 cases of patients with *Salmonella typhimurin* infections in 2009. This was the first reported multistate outbreak of *Salmonella* infections associated with amphibians. The investigation conducted by the Center for Disease Control and Prevention found the infection in 31 states, extending from Massachusetts to California, and the age range of patients was 3 weeks to 54 years. The multistate investigation revealed that all patients were exposed to frogs, which were traced back to the same breeder in California. African Dwarf Frogs are aquatic animals sold as ornamental aquarium pets. The most likely source of transmission in this outbreak was contact with water from the frogs' aquaria.

KARLIK SZPONIASTY

African Dwarf Frogs (*Hymenochirus boettgeri*) have been implicated in a multistate outbreak of *Salmonella* infections.

National Center for Zoonotic, Vector-borne, and Enteric Diseases (ZVED)
7 January 2010

Florida Wildlife (Native and Non-native) Affected by Protracted Cold Spell

As January daytime temperatures hovered in the 50s and dropped below 30 at night for several days in a row, Florida's crops, as well as native and non-native flora and fauna felt the chill. Wildlife officials reported at least 70 dead crocodiles, more than 60 manatee carcasses, and perhaps the biggest fish kill in modern Florida history. Florida sea-turtle rehabilitators organized a massive rescue of more than 2,000 turtles suffering cold-stun syndrome. The cold water paralyzes them, making them unable to swim or feed.

"What we witnessed was a major ecological disturbance event equal to a fire or a hurricane," said Frank Mazzotti, a wildlife ecologist and associate professor at the University of Florida. "A lot of things have happened that nobody has seen before in Florida."

The cold temperatures also affected many of the marquee names in the state's invasive species zoo. "Anecdotally, we might have lost maybe half of the pythons out there to the cold," said Scott Hardin, the Florida Fish and Wildlife Conservation Commission's exotic species coordinator. "Iguanas definitely. From a collection of observations from people, more than 50 percent fatality on Green Iguanas." Catatonic iguanas were reported falling from trees and littering walkways and canals in a state of suspended animation.

The cold snap played into a highly politicized debate over how to prevent non-native species from colonizing the United States. Reptile dealers and hobbyists strongly oppose a proposal by the U.S. Fish and Wildlife Service to ban the import of and interstate trade in Burmese Pythons and several other large snakes. They say southern Florida's cold snap shows that these species don't threaten to spread north, as some claim, and a federal crackdown is unnecessary.

"Pythons are tropical animals," said Andrew Wyatt, president of the United States Association of Reptile Keepers. "When temperatures fall below a certain level, they are unable to survive. It reinforces the idea that the pythons can't exist more than a short period of time north of Lake Okeechobee. Even the pythons in the Everglades are dying during the cold snap." Wyatt said that scientists are downplaying the effect of cold weather on the pythons because that would undermine their ability to win grants to study a problem that has received international publicity.

No one knows how many Burmese Pythons live in the Everglades, where they were released as unwanted pets or where they found refuge after hurricanes destroyed their breeding facilities — but what's certain is that a lot fewer are there today than a month ago.

Greg Graziani, a police officer who owns a reptile breeding facility, is one of several licensed python hunters who stalks the snakes in the Everglades. In cold weather, Graziani said, pythons go into a catatonic state, and if they don't make it to a safe place to ride out the weather, freeze to death. "We're finding the smaller pythons are handling it better than the large ones — the smaller ones can get into different cracks and crevices to maintain the temperatures they need."

Adapted from articles in the
Fort Lauderdale Sun-Sentinel, *The Miami Herald*,
and *The Orlando Sentinel*

CAROLE SAUCIER

Green Iguanas (*Iguana iguana*) were literally falling from the trees in southern Florida. Unable to revive after the sustained cold temperatures, they made their contribution to the workload of the state's "clean-up" crew of vultures and other scavengers.

OBITUARY

John Thorbjarnarson
(1957–2010)[1]

The conservation community sustained a great loss on 14 February 2009. John Thorbjarnarson died tragically in New Delhi, India of advanced falciparum malaria likely contracted in Uganda while working to save the animals he loved. John served as Senior Conservation Officer of the Wildlife Conservation Society since 1993. He also was an Adjunct Assistant Professor at Columbia University.

John T., as he was better known to friends and colleagues, was primarily known and respected as one of the world's premier crocodilian biologists; his research encompassed reproductive ecology, diet, feeding behavior, movement patterns, habitat use, social behavior, and population dynamics. However, research for him was not purely an academic endeavor. He utilized his findings to help develop conservation programs for endangered species. His approach, based on the sustainable use of reptiles through community-based programs, was both innovative and effective.

"What a real tragedy this is," says Grahame Webb, chair of the IUCN Crocodile Specialist Group. "At a personal level, JT was truly admired and a friend of so many. At a professional level, you just cannot replace people like JT... I do not believe the world will ever again allow individuals to learn so much about crocodiles in the field and then craft that knowledge over years so it becomes effective at the front line... He was one of the most careful of scientists, who through WCS was doing more on crocodile conservation around the world than any other individual has done in the past — or will do in the future."

John also will be mourned by his colleagues in chelonian conservation. He was a major contributor to the book *Turtle Conservation* by Michael Klemens, but he will be remembered best for spearheading the organization of a workshop in China to begin development of a strategic plan for saving *Rafetus*. This workshop — and the resulting China Softshell Turtle guide — ultimately led to the discovery of the Changsha Zoo female and involvement of the Turtle Survival Alliance (TSA). John also co-authored a seminal 2003 paper in *Chelonian Conservation and Biology* that provided a thoughtful analysis ranking Asian countries in order of their importance for turtle conservation. That paper essentially became the organizing principle behind the TSA's Asian field program.

Anders Rhodin, chair of the IUCN Tortoise and Freshwater Turtle Specialist Group, eloquently reflected on John's passing: "I echo the sentiments of others as I stop to reflect on the dedication to conservation, crocodiles, and turtles that John had, and how he was always traveling to the ends of the earth and into wilderness regions to pursue his passion and work. His energy and devotion will indeed be sorely missed… John loved his work and I'm sure he would not have changed what he did."

John is perhaps best described in the words of his nephew, writer Andri Magnason: "He was a scientist, specialized in cold-blooded animals but himself full of warmth with a strong human touch — he could act as a peacekeeper between people and the creatures they feared the most, he could eliminate prejudice and create understanding for the graceful but unpopular creatures in the crocodile family. He could get people to understand that a crocodile is a healthy sign in an ecosystem — not some kind of a pest to be exterminated. By destroying the habitat of the crocodile, the wetlands, swamps, and rivers, people would eventually harm their own existence. He was realistic and understood that people needed a source of living — and by promoting sustainable hunting, the long term benefit of a species could be secured."

John's passing leaves a tremendous void in the lives of those with whom he worked and in the projects he spearheaded. He was a passionate advocate for conservation and is simply irreplaceable. His legacy will be the remarkable number of young and aspiring biologists that he trained and mentored. His work truly spanned the globe with projects in South America (most notably Brazil), Asia (including pioneering work in Burma, China, and Cambodia), Africa, and the Caribbean (especially Cuba). A special session paying tribute to the life of John T. is being planned for the upcoming TSA conference in Orlando.

[1] Adapted from obituaries and remembrances by Rick Hudson, Chuck Shaffer, and Andri Magnason.

Editors' Remarks

The response to our call-for-papers for this special tribute to Dr. Henry S. Fitch, which will extend into portions of the next two issues of *Reptiles & Amphibians*, was overwhelming. It speaks eloquently to the influence Dr. Fitch had on the herpetological community and to the high esteem in which he was held by his students, colleagues, acquaintances who frequently called upon him for advice, and those who merely read his many seminal publications.

Robert W. Henderson, who studied under Dr. Fitch, and Gad Perry, who stepped up from his usual role as associate editor, served as co-editors for this tribute. They reviewed or facilitated the review of all contributions, solicited content and images, and provided valuable insights throughout the process.

We thank Alice Fitch Echelle for her support and help in providing photographs. Dwight Platt, one of Dr. Fitch's earliest students, shared comments he presented at the 36th Annual Meeting of the Kansas Herpetological Society in November 2009. Joe and Suzanne L. Collins, Center for North American Herpetology, publicized the call-for-papers and donated a number of images. Scott A. Schaefer (*Copeia*), Robert Hansen (*Herpetological Review*), and the authors gave permission to reprint content originally published in those journals. Mostly, however, we were gratified by the response to our tribute to Dr. Fitch and his legacy — and take this opportunity to thank all of the contributors, including those whose work will appear in later issues.

The Editors of *Reptiles & Amphibians*

STATEMENT OF PURPOSE

The International Reptile Conservation Foundation works to conserve reptiles and amphibians and the natural habitats and ecosystems that support them.

The International Reptile Conservation Foundation, Inc. is a non-profit 501 (c)(3) California corporation.

MEMBERSHIP INFORMATION

IRCF, REPTILES & AMPHIBIANS, CONSERVATION AND NATURAL HISTORY, the Journal of The International Reptile Conservation Foundation, is distributed quarterly.

Annual Rates:

Individual U.S. Membership	$25.00
Individual Membership, Digital (Adobe PDF)*	$25.00
Institutional U.S. Subscription	$30.00
International Membership (including Canada)	$55.00
International Institutional Subscription	$60.00

Additional copies are available upon request at $6.00 each plus postage.

*The Adobe PDF is optimized for web publishing and does not provide the quality and resolution of the archival printed version, especially noticeable in photographs and complex graphics.

JOIN ONLINE: **www.IRCF.org**

MEMBERSHIP QUESTIONS

info@IRCF.org, or Toll free 1-877-472-3674 (U.S. Only), or write to: IRCF, 3010 Magnum Drive, San Jose, CA 95135

SOLICITATIONS

The IRCF encourages contribution of articles, letters to the Editor, news items, and announcements for publication in *REPTILES & AMPHIBIANS*. General articles can deal with any aspect of reptilian or amphibian biology, including conservation, behavior, ecology, physiology, systematics, or husbandry. Submission of photographs to accompany articles is encouraged. Guidelines for submissions and figures are at www.ircf.org/about/submissions. Manuscripts may be submitted via e-mail (send to AJ@IRCF.org). Authors of one page or more of print will receive a free copy of the journal in which their contribution appears, and will receive a PDF file of their article for distribution.

DONATIONS

For any donations, please include your name, address, phone number, and e-mail address.

ADVERTISING POLICY

We advertise only non-living products (except feeder insects). For advertising rates and options contact Sandy Binns, Advertising Director, at SB@IRCF.org or 3010 Magnum Drive, San Jose, CA 95135.

 IRCF, Reptiles & Amphibians, Conservation and Natural History (ISSN 1098-6324) is published quarterly by the International Reptile Conservation Foundation, a nonprofit, tax-exempt organization, 3010 Magnum Drive, San Jose, CA. Periodical postage paid at San Jose, CA.

FOCUS ON CONSERVATION

Rescue Darwin's Frogs

While on his famous voyage around the world, Charles Darwin collected the first specimens of what later became known as Darwin`s Frog (*Rhinoderma darwinii*)(see the article in *Reptiles & Amphibians* 16(4):246–255). These little frogs have a unique reproductive biology, in which tadpoles develop in the vocal sac of the male until metamorphosis. The genus contains a second species (*R. rufum*), in which the males keep the tadpoles for a shorter period before releasing them into small streams.

Rhinoderma rufum has not been seen for more than two decades and might be extinct. The habitat of *R. darwinii,* the cool Valdivian rainforests of Eastern Patagonia, is vanishing quickly as a consequence of deforestation and dam construction. The chytrid fungus, which is known to cause extinction in many amphibian species, has been found in wild populations. The outlook for these spectacular frogs is dire.

In 2002, European zoos, private keepers, scientists, and conservation organizations and agencies in Chile and Europe initiated a collaborative conservation project for *Rhinoderma*. The project, led by the German herpetological magazine *Reptilia*, the Museum Alexander Koenig in Bonn, and the Zoological Society for the Protection of Species and Populations (ZGAP), instigated efforts to protect these frogs: (1) Surveys to search for *R. rufum*, (2) a 6-year field study of selected populations of *R. darwinii*, (3) *in-situ* and *ex-situ* husbandry and breeding of *R. darwinii*, (4) status surveys of wild populations of *R. darwinii* and screening for the presence of the chytrid fungus, (5) construction of a lab and breeding station by Zoo Leipzig at the University of Concepción in Chile, and (6) support for other projects regarding *Rhinoderma*.

To support this difficult and expensive work, please contact: Heiko Werning, Redaktion REPTILIA, Seestr. 101, 13353 Berlin, Germany (e-mail: redaktion-reptilia@ms-verlag.de).

ALEXANDRA DRAGHICI

Although Dr. Fitch is probably best known for his five decades of work on the herpetofauna of northeastern Kansas, he spent considerable time in the Neotropics, where one focus of his work was the exploitation of Black Iguanas (*Ctenosaura similis*; illustrated) and Green Iguanas (*Iguana iguana*) in Central America (see also the photograph on p. 14).