



Volume 28, Number 3, Fall 2008

THE QUARTERLY NEWSLETTER OF THE NEW YORK STATE WILDLIFE REHABILITATION COUNCIL, INC.

### Important Dates:

**NYSWRC Board Meetings**-open to all  
Oct 25, Nov. 23, Dec. 14, 2008  
E-mail Kelly (kmartink@midtel.net) for information about how to join us.

**NYSWRC Annual Seminar**, October 24-26, 2008  
Grand Island, (Niagara Falls area) N.Y.

**IWRC Conference**, CA Nov. 5-9, 2008  
visit [www.iwrc-online.org](http://www.iwrc-online.org)

### 28th Annual Fall Seminar

We are all looking forward to a terrific seminar this fall. There is still time to register and attend. It would be a shame to miss this event. The hotel has kept the price it gave us three years ago, a bargain even then, which turns out to be such a savings that any additional gas costs will be outweighed. We hope you will make plans to attend. Treat yourself to a mini working vacation, where you relax with friends yet learn all the current rehabilitation techniques from the experts. You worked for wildlife all year long, so now it is time to take care of something special for yourself.

The registration forms are found on our website: [www.NYSWRC.org](http://www.NYSWRC.org), and you can call Amy or Steve with any questions: (518) 582-3655.

This Seminar features:

- \* over 60 lectures and specialty labs
- \* taught by rehabilitators and veterinarians
- \* Auction & Raffle
- \* Vendors & Exhibitors
- \* Field Trips
- \* Fall color in Niagara Falls
- \* Halloween Costume Party



### Our NYSWRC Mission:

NYSWRC, Inc. is a not for profit membership organization dedicated to the education of wildlife rehabilitators, improvement of the field of wildlife rehabilitation, and the protection and preservation of the environment.

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**NYSWRC WEBSITE:** [www.NYSWRC.org](http://www.NYSWRC.org)

### Editor's note:

I welcome your articles, poems, information, questions and artwork. We are pleased to print articles from our members, but caution each reader that NYSWRC is not responsible for the accuracy of the content or information provided, and does not necessarily endorse the policies proposed. Submissions should be sent to: nisseq@aol.com or to PO Box 62, Newcomb, NY 12852. Thank you to artists: Arleen Santonas and George West!

**Congratulations!**  
**2008 Veterinarian of the Year**  
**Dr. Karen Moran**

Dr. Moran is the recipient of the 2008 award, sponsored by NYSWRC and Bill Brothers of ACES.



*Excerpts from the nomination letter:*

Dr. Karen's enthusiasm for aiding distressed wildlife was sparked years ago. Doing yard work one afternoon, she saw her neighbor knock a bird's nest from a down spout, toss the nest away and leave two tiny, featherless birds on the ground to die. Dr. Karen retrieved the nest, returned it to its previous location and placed the baby birds back inside. She then convinced the neighbor to keep the nest in place until the birds were old enough to fledge. Dr. Karen spent the next two weeks monitoring the nest and watching the parents tend to their babies inside. Dr. Karen's passion for wildlife rehabilitation began as she watched the young Robins leave the nest on their own.

Dr. Karen earned her undergraduate degree in Animal Science from Cornell University in 1991. She graduated from Cornell Veterinary College in 1995. While attending Veterinary school, she was actively involved with the Cornell Raccoon Rabies Oral Vaccination Project.

Following graduation from Vet school, Dr. Karen worked for many years at a small animal practice in Wheatfield, New York. Three years ago, Dr. Karen joined the staff of the SPCA Serving Erie County, to provide relief veterinarian services on a part-time basis. In addition, she signed on as a volunteer in the Wildlife Department. Since then she has left the Wheatfield practice, to focus on her work at the shelter. Her increased presence has allowed her to spend more time treating wildlife.

**Veterinarian of the Year  
Award Recipients:**

- 1997 Dr. Michael Bonda**
- 1998 Dr. Alison Hazel**
- 1999 Dr. Carl Tomascke**
- 2000 Dr. Basil Tangredi**
- 2001 Dr. Wendi Westrom**
- 2002 Dr. Carl Eisenhard**
- 2003 Dr. James Robinson**
- 2004 Dr. Laura Wade**
- 2005 Dr. Victor J. Dasaro**
- 2006 Dr. Brian Landenberger**
- 2007 Dr. Brian Hall**
- 2008 Dr. Karen Moran**

Dr. Karen has been an invaluable addition to the SPCA's Wildlife Department. She has helped grow the department through her surgical and medical expertise. Although Dr. Karen enjoys working with all species of wildlife, she is particularly fond of reptiles. To that end, she has established a critical care ward for reptiles at her home.

Dr. Karen is a licensed wildlife rehabilitator who is very giving of her time and knowledge. For the past three years, Dr. Karen has assisted NYSWRC by sharing her artwork for conference programs and by instructing several seminar workshops.

Dr. Karen lives in Wheatfield with her husband Allen, her son Spencer, four cats and many aquariums of fish, snakes and turtles. She still volunteers several hours to the Wildlife Department, and has become a permanent member of the SPCA Veterinary staff.

Congratulations!

**George Kollias, NYSWRC Advisory Board member, joins international conservation organization - Congratulations!**

George Kollias, DVM, PhD, was invited to become a full member of the International Union for the Conservation of Nature. Specifically, he has been appointed to the Species Survival Commission Otter Specialist Group and the Otters in Captivity Task Force. The appointment recognizes his major and ongoing contributions to the conservation of otters. Kollias has been involved nationally and internationally in wildlife health and conservation for more than 30 years. As a member of the New York State River Otter Project, Kollias was instrumental in reintroducing the Nearctic river otter to its historic range in western NY. As a member of the international organization, Kollias will monitor the status of species, identify threats to these species, and prioritize and promote the necessary conservation actions at all levels. In addition, he will provide scientific advice to conservation organizations and government agencies. Kollias was also named a fellow with the Wildlife Conservation Society. In this position, he will have more formal involvement with international conservation research and serve as an advisor on projects that support wildlife health and conservation. At Cornell, Kollias is the Jay Hyman Professor of Wildlife Medicine.



**THE BEARS AND I, by Tom Sears**  
(sent to NYSWRC by Lainie Angel)

Black bears typically have two cubs, rarely one or three. In 2007, in northern New Hampshire, a black bear sow gave birth to five healthy young. There were two or three reports of sows with as many as four cubs but five was, and is, extraordinary. I learned of them shortly after they emerged from their den and set myself a goal of photographing all five cubs with their mom, no matter how much time and effort was involved. I knew the trail they followed on a fairly regular basis, usually shortly before dark. After spending nearly four hours a day, seven days a week, for six weeks I had that once in a lifetime opportunity and photographed them in the shadows and dull lighting of the evening. Due to these conditions the photograph is a bit noisy as I had to use the equivalent of a very fast film speed on my digital camera. The print is properly focused and well exposed with all six bears posing as if they were in a studio for a family portrait.



I stayed in touch with other people who saw the bears during the summer and into the fall hunting season. All six bears continued to thrive. As time for hibernation approached, I found still more folks who had seen them and everything remained OK. I stayed away from the bears as I was concerned that they might become habituated to me, or to people in general, as approachable friends. This could be dangerous for both man and animal. After Halloween I received no further reports and could only hope the bears survived until they hibernated.

This spring, before the snow disappeared, all six bears came out of their den and wandered the same familiar territory they trekked in the spring of 2007. I saw them before mid April and dreamed nightly of taking another family portrait, an improbable second once in a lifetime photograph. On April 25, 2008 I achieved my dream.



When something as magical as this happens between man and animal Native Americans say, "We have walked together in the shadow of a rainbow."

And so it is with humility and great pleasure that I share these photos with you.  
*Sincerely, Tom Sears*

## Why Wind Turbines Can Mean Death For Bats

ScienceDaily (Aug. 26, 2008)

Power-generating wind turbines have long been recognized as a potentially life-threatening hazard for birds. But at most wind facilities, bats actually die in much greater numbers. Now, researchers reporting in *Current Biology*, a Cell Press journal, on August 26th think they know why.

Ninety percent of the bats they examined after death showed signs of internal hemorrhaging consistent with trauma from the sudden drop in air pressure (a condition known as barotrauma) at turbine blades. Only about half of the bats showed any evidence of direct contact with the blades.

“Because bats can detect objects with echolocation, they seldom collide with man-made structures,” said Erin Baerwald of the University of Calgary in Canada. “An atmospheric-pressure drop at wind-turbine blades is an undetectable—and potentially unforeseeable—hazard for bats, thus partially explaining the large number of bat fatalities at these specific structures.

“Given that bats are more susceptible to barotrauma than birds, and that bat fatalities at wind turbines far outnumber bird fatalities at most sites, wildlife fatalities at wind turbines are now a bat issue, not a bird issue.”

The respiratory systems of bats and birds differ in important ways, in terms of both their structure and their function. Bats’ lungs, like those of other mammals, are balloon-like, with two-way airflow ending in thin flexible sacs surrounded by capillaries, the researchers explained. When outside pressure drops, those sacs can over-expand, bursting the capillaries around them. Bird lungs, on the other hand, are more rigid and tube-like, with one-way circular airflow passing over and around capillaries. That rigid system can more easily withstand sudden drops in air pressure.

The majority of bats killed at wind turbines are migratory bats that roost in trees, including hoary bats, eastern red bats, and silver-haired bats. While little is known about their population sizes, the researchers said, those deaths could have far-reaching consequences.

Bats typically live for many years, in some cases reaching ages of 30 or more. Most also have just one or two pups at a time, and not necessarily every year. “Slow reproductive rates can limit a population’s ability to recover from crashes and thereby increase the risk of endangerment or extinction,” said Robert Barclay, also at the University of Calgary, noting that migrating animals tend to be more vulnerable as it is.

All three species of migratory bats killed by wind turbines fly at night, eating thousands of insects—including many crop pests—per day as they go. Therefore, bat losses in one area could have very real effects on ecosystems miles away, along the bats’ migration routes.

Baerwald said there is no obvious way to reduce the pressure drop at wind turbines without severely limiting their use. Because bats are more active when wind speeds are low, one strategy may be to increase the speed at which turbine blades begin to rotate during the bats’ fall migration period.

The researchers include Erin F. Baerwald, Genevieve H. D’Amours, Brandon J. Klug and Robert M.R. Barclay of the University of Calgary in Calgary, AB Canada.

Journal reference: Erin F. Baerwald, Genevieve H. D’Amours, Brandon J. Klug and Robert M.R. Barclay. **Barotrauma is a significant cause of bat fatalities at wind turbines.** *Current Biology*, 2008; Vol 18, R695-R696



## Insurance

Do Wildlife Rehabilitators Need Additional Insurance? This topic often comes up at our conferences. We all find unique answers to the problem. NYSWRC is not promoting anyone, but thought you might like to know:

The National Wildlife Rehabilitators Association is helping to make insurance available to rehabilitators by working with the following company. There are several links to Christian Baker on the NWRA website, [www.nrawildlife.org](http://www.nrawildlife.org). You can call Jim Pace at (717) 761-4712, or email us at [info@buybestins.com](mailto:info@buybestins.com). Christian Baker’s site is [www.wildlifeinsurance.com](http://www.wildlifeinsurance.com).

### **SALMONELLA ENTERICA Isolated From Wildlife At Two Ohio Rehabilitation Centers**

Steffani Jijón, Amy Wetzell, B.S., Ph.D., and Jeffrey LeJeune, D.V.M., Ph.D., Dipl. A.C.V.M.

*Journal of Zoo and Wildlife Medicine* 38(3): 409–413, 2007 Copyright 2007 by American Association of Zoo Veterinarians

**Abstract:** Between May and September 2004, fecal samples from various wildlife species admitted to two rehabilitation centers in Ohio were cultured for *Salmonella enterica* and *Escherichia coli* O157:H7. Eight of 71 (11%) samples, including specimens from three opossums (*Didelphis virginiana*), two gray squirrels (*Sciurus carolinensis*), a woodchuck (*Marmota monax*), a Harris hawk (*Parabuteo unicinctus*), and a screech owl (*Otus asio*) tested positive for *Salmonella* serovars Braenderup, Senftenberg, Oranienburg, and Kentucky. The *Salmonella* Oranienburg isolates were indistinguishable by pulsed-field gel electrophoresis. Most isolates were susceptible to commonly used antibiotics; however, the *Salmonella* Kentucky isolate was resistant to multiple beta-lactam antibiotics (amoxicillin/clavulanic acid and ampicillin), cefoxitin, and ceftiofur, a third-generation cephalosporin. *Escherichia coli* O157:H7 was not isolated from any sample. Transmission of *Salmonella* from wildlife may occur between animals at rehabilitation centers.

#### **Conclusion:**

Efforts should be made to increase the public and rehabilitator awareness of the zoonotic hazards associated with wildlife contact. Specifically, wildlife contact should be considered in cases of human salmonellosis.

Furthermore, we emphasize the need for increased education among individuals who have contact with wildlife. Individuals working with wildlife should know and practice appropriate measures of environmental and personal hygiene to prevent nosocomial infections among animal patients, as well as to reduce the potential of zoonotic infections among animal handlers, rehabilitators, veterinarians, and other people who might have contact with these animals.



@ George West

### **Bat Formula**

We've made a few adjustments to the formula based on feedback we've received from several rehabbers across the US over the past week: [http://www.batworld.org/worldbatline/bat\\_milk\\_recipe.html](http://www.batworld.org/worldbatline/bat_milk_recipe.html)

#### **Foliage-roosting bats:**

They seem very prone to bloat on this recipe. By a process of elimination it actually appears to be Similac causing the problems. If you have foliage pups that are bloating, feed them a small meal of the blended meal worm recipe [http://www.batworld.org/worldbatline/pdf\\_files/tartar%20control%20diet.pdf](http://www.batworld.org/worldbatline/pdf_files/tartar%20control%20diet.pdf) to help push the bloat through - do not add milk. At the following meal, feed them a mixture of 9 parts goats milk and 1 part blended meal worms. Several of us have had reds bats on the goats milk & blended meal worms formula for five days and the bats are doing very well with minimal bloat. At some point oil will need to be re-added (and we are currently looking at a different source of oil). I'll keep everyone posted on the results.

#### **Crevice-roosting bats:**

Free-tails and evening bats absolutely thrive on the recipe. However, I have cut the amount of oil in half and also added flax oil and have had even better results (see the updated recipe page, link above). So far I'm up to 33 pups with no deaths caused by the formula. Big browns may experience some bloat and if this occurs, follow the directions for foliage-roosting bats until the bloat is gone then go back to the recipe using only flax oil in the measurement provided.

Thank you for your feedback in making this work for everyone. Amanda Lollar, Founder/President  
Bat World Sanctuary [www.batworld.org](http://www.batworld.org)

#### **From the Web:**

Opossum rehabilitators will be pleased to have a new resource for information.

Go to [http://web.missouri.edu/~krausew/Histology/Home\\_files/opossum.pdf](http://web.missouri.edu/~krausew/Histology/Home_files/opossum.pdf) for a downloadable opossum book that is filled with wonderful and useful information. It comes from William J. Krause, Ph.D., Professor of Anatomy at the University of Missouri. His home page is found at: <http://web.missouri.edu/~krausew/Histology/Home.html> This will provide links to several excellent videos about opossums natural history and care.

## Appreciation, by Anne Rockmore

Through an ad in the paper and some prodding from a friend, I attended a training session for volunteers, to rehabilitate wildlife at a Wildlife Rehabilitation Center that was a mere 20 minutes from where I lived. After years of forsaking my passion to work with animals (in favor of making money and paying my bills), I was finally getting the opportunity. And wasn't it great! Two or three, four-hour shifts a week at the center, Cornell educated wildlife care supervisor to compute the K calcs and answer any questions, periodic workshops with wonderful speakers and handouts, education director to teach raptor care and handling, and many opportunities to assist with education programs and train others. There was a nice prep kitchen and even a washing machine. Cages (indoor and out) were plentiful and donations of several incubators completed the housing. The network was extensive, with transport volunteers, phone volunteers and veterinarians who donated their time. Wildlife rehabilitation nirvana.... For eight years I carried on in this setting before moving too far away to make the commute to the center. I networked a little and did some turtle rehab in my small condo and volunteered at a local nature center, working mostly with their raptors. It wasn't the same.

Two years ago at the NYSWRC conference, by chance, I sat at a table with fellow Northern Westchester rehabbers and met Maggie Ciarcia.

Born and raised in Mt Vernon, NY, a stone's throw from the "big City," Maggie always loved animals. It was in her blood. Her parents had pets and continued the trend after Maggie came along. But that wasn't enough. As a kid, living in the "wilds" of this Southern Westchester city, Maggie brought everything home—turtles, frogs, etc.

At 16, she began working for a veterinarian and credits him for inspiring her and her initial training. He was the vet for the Central Park Zoo in the late 1960's and sparked her interest in wildlife. He pioneered major diet studies with carnivores (ocelots, margays), and Maggie was in on the research. Years passed and Maggie earned a Bachelor's degree in psychology and education.

An interest in ferrets developed and through her first ferret adoption she met wildlife rehabilitator Joanne Dreeban. This veteran rehabber took Maggie under her "wing" and soon they developed education programs and began recruiting others into the world of wildlife rehabilitation, networking among the vast area that is New York City, Westchester and Putnam County. They developed educational programs and began presenting them around the County.

Look at Maggie's house from the outside, and you see a nice raised ranch in the middle of the woods. Some

might think it odd to see several ducks in a fenced back yard by the raised pool. Most probably would not notice the aviaries in the back of the house, as they are hidden well in the woods. You have to go around to the side entrance and enter the basement to get the full impact. The basement is a wildlife hospital: cages on the floor, on tables, caged room in back, washer/dryer to the side. If you call her house and get the answering machine (Did I say that Maggie also works?) there is a terrific and concise message for those with injured or suspected orphaned wildlife. This is the wildlife rehabilitation facility of one person! Not a center where people take shifts and others volunteer to man the phones and transport animals back and forth, but one person's effort to help the local wildlife. And what a job she is doing! She has set up veterinary connections. She presents several training programs she has developed with her mentor, Joanne Dreeban, and she manages to keep current on wildlife rehab policies and procedures by attending training programs herself.

With her husband, Frank, (a medical ethics professor who probably never knew what wildlife rehabilitation was before they married) Maggie has developed "wildlife case studies" to illustrate wildlife rescue and rehabilitation issues. Their articles in *Release* have sparked many an interesting discussion across the state! She is always looking to improve her skills and educate others.

So from a part-time volunteer rehabilitator to all those full-time "home rehabbers" like Maggie, I salute you and commend your effort, time, and dedication.

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"Dear State Bird Rehab Centers,  
My colleague and I are working with Stackpole books to produce a field guide to bird feather identification for North America. When finished, the guide will contain color photographs and measurements of flight and body feathers from over 400 North American Bird Species. In order to tackle the enormous task of specimen collection we are requesting help from rehabilitation centers across the continent. On our web site ([www.featherguide.com](http://www.featherguide.com)) you will find an up to date list of species we are still seeking for inclusion in the guide. We are asking willing rehabilitation centers to save whole dead specimens from our list for later shipment to us. For your convenience we have UPS and FedEx account numbers available. If you are interested in helping with this important project please contact us at: email **dscottmp@yahoo.com** or (425) 319-3685

This project is working under U.S. Federal Permit #MB181249-0 and WA State Permit #08-225

Sincerely,  
Dave Scott and Casey McFarland"

**BIG SUR****Endangered condors survive fire****The birds found fresh air and food - after the blaze swept through, many flew home**

Tracie Cone, Associated Press  
Friday, July 18, 2008

**(07-18) 04:00 PDT Big Sur** — As wildfire whipped toward a remote sanctuary of the endangered California condor last month, the rare birds got their biggest test in survival after years of pampering by biologists: They had to live completely on their own.

Forced away by flames, their scientist handlers could only hope the birds' animal instincts would kick in. To their delight, they did. The birds found fresh air and food: a beached whale and decaying California sea lion at the edge of Big Sur's cliffs. After the blaze swept through the area, many even returned home. "It's incredible. They did just what they're supposed to do," said Kelly Sorenson, executive director of the Ventana Wildlife Society, which runs the sanctuary. "I was honestly thinking we'd lose four to six birds. You can rebuild pens, but we only have a limited amount of time to restore a species."

The Ventana Wildlife Society near Big Sur is the only nonprofit in California to prepare captive-bred condors for life in the wild, making it an integral part of conservation efforts to save the condor from extinction.

Flames from the 188-square-mile fire in the Los Padres National Forest last month destroyed the society's aviary and release pen and thousands of dollars worth of equipment. The fire also displaced the 43 free-flying birds the society monitors and forced a hasty Coast Guard rescue of seven year-old chicks and their adult mentor.

For 17 days, biologists were cut off from the sanctuary, monitoring the wild birds by electronic transmitters. "We felt so helpless," Sorenson said.

The vulture was declared an endangered species in 1967, when its population - estimated to be 50 to 60 birds at the time - was in sharp decline because of poaching, habitat destruction and lead poisoning. In the 1980s, the U.S. government approved an ambitious and costly conservation plan that brought the last of the nearly two dozen surviving California condors into captivity for a captive-breeding program. After teaching the newborns with puppets and other tools how to survive in the wild, reintroduction into forests started in the 1990s. While there have been some setbacks (power lines have proved a difficult obstacle to navigate), there are now 332 condors, half of which are living supervised in the wild in Arizona, California and Baja California.

The wildfires near the sanctuary started the night of June 21 with a burst of lightning storms that ignited fires all over Northern and Central California. The blaze near Big Sur was particularly complicated to attack because of the steep terrain.

At the remote sanctuary that night, entertaining donors, Sorenson saw a black cloud blow in over the coast. "I had an eerie feeling," Sorenson said. "We know it's dangerous. I told my donors we needed to get out of there." By the time Sorenson and his group reached the highway, he could see four plumes of smoke rising from the mountains behind him.

The next day, the Ventana Wildlife staff sought to rescue the seven year-old juveniles and one adult mentor from the sanctuary. They were not ready to be released into the wild to fend for themselves. The birds had to be taken to a sanctuary the group operates with federal biologists from Pinnacles National Monument. With roads impassable, the U.S. Coast Guard airlifted the birds out in two trips through thick smoke and approaching flames. "The clock was ticking," said senior biologist Joe Burnett.

All told, biologists have tentatively accounted for all but two birds: a chick that had been in a nest high in a redwood tree and another older condor that was released into the wild two years ago.

Last week, Sorenson and Burnett returned to the burned-out sanctuary and hiked to the edge of the feeding site. At the top of a charred Ponderosa pine, the alpha male of the group surveyed his blackened canyon. Burnett pumped his fist. "They survived on their own without us," Sorenson said. "It shows us they can do it."

Editor's Note: This article appeared on page B - 6 of the San Francisco Chronicle and is reprinted here as a reminder that it can happen to any of us.

**Is your disaster plan in place?**

## **Clinical Implications of Reptile Physiology**

By Jeff Baier, MS, DVM

Baier Veterinary Services, Golden, Colorado

jeffbaier6@msn.com

### **Introduction**

Reptiles possess many unique physiological adaptations. Two adaptations that play a major role in their success are anaerobic glycolysis and a low metabolic rate. These adaptations allow them to compete with other species that are generally considered more active. When aspects of reptilian physiology are considered separately we can be misled into thinking of them as sluggish lifeless creatures. The relative efficiency of a given organ system or systems, does not necessarily create an inefficient organism. We must look at the whole organism, before we can make such judgments. This paper will address many aspects of reptile physiology. However, time will not allow a complete investigation of all systems. The major areas that will be covered include the cardiovascular system, the renal portal system and the effects of temperature. This paper will also look at UV light sources, as this form of radiation has such a profound impact on the health of so many reptiles in a captive situation.

### **Anaerobic Glycolysis**

Anaerobic glycolysis has been described as the Smith and Wesson of heterotherms. Based on aerobic metabolism a 70-kilogram human is five times stronger than a 700-kilogram crocodile. If threatened, the crocodile can utilize anaerobic glycolysis to become approximately twenty times stronger than a human. This burst of anaerobic activity will lead to the production of lactic acid, but no carbon dioxide is produced. This lactic acid can be converted by the liver back to glucose. Glycogen stores when utilized for short bursts of energy through anaerobic glycolysis can be replenished in short order. Utilization of the full amount of glycogen stores is generally reserved combat for or matters survival. Complete replenishment of these stores will require a great deal of time.

As a clinician, we must consider this unique metabolism and physiology when we perform procedures on reptilian patients. The manipulations involved in physically examination and obtaining samples may induce the types of responses that will induce anaerobic glycolysis in the patient. After the procedures have been completed, the patient should be allowed to rest and regenerate glycogen stores. The lactic acid build up that accompanies manual restraint should also be a consideration in fluid therapy. Since the reptilian patient is likely to already have a considerable lactic acid level, many clinicians prefer solutions that do not contain lactate. Solutions that works very well for in reptiles include 0.45% Saline with 2.5% Dextrose or a mixture of equal parts 5% Dextrose with a solution such as normosol. Slightly hypotonic solutions have been suggested for fluid replacement in reptiles. This has been suggested because reptiles have relatively lower plasma volumes and higher intracellular fluid volumes

than mammals. Based on this fact, replenishment of intracellular volume may be as important as restoration of circulating plasma volume.

### **Metabolic Rate and Environmental Temperature**

As a group, the metabolic rate of reptiles is lower than that of mammals. It must be pointed out that metabolic rate is not a constant for all reptiles. The metabolic rates of reptiles follows the same trends exhibited by mammals. As size of the animals in a given species increases metabolic rate decreases. Also metabolic rate decreases as the animal matures. Coulson demonstrated that if oxygen consumption is calculated with weight as a constant, the metabolic rate of an anole (500 L/day) is similar to that of a human (400 L/day), but both are more than twice that of an alligator (174 L/day).

The difference in metabolic rate between mammals and reptiles lies in the maintenance of body temperature. Reptiles do not maintain their body temperature at a constant set point. They are capable of functioning over a wide range of body temperatures. They also maintain a normal body temperature a few degrees lower than that maintained by mammals. The major difference that allows reptiles to operate at a lower metabolic rate lies in the mechanism of body temperature maintenance. Reptiles rely on their environment to maintain their body temperature. The heat of metabolism does play a role in this process, but cannot completely maintain body temperature. Reptiles accomplish this process by interacting with their environment over a range of temperatures referred to as the activity temperature range. Within this range the animal can maintain normal physiologic functions. At or above the upper end of this temperature range, the animal must seek out cooler area of environment, or it will die. At or below the lower end of this temperature range the animal will either seek warmth or begin the normal over wintering process. Interactions with their environment allow them to maintain their preferred body temperature. When given access to an environmental temperature range similar to that in which they would be active in the wild, captive reptiles can thrive. Presentation of a range of temperatures in the captive environment allows the animal to maintain its preferred body temperature. Unfortunately, in a captive situation this can be quite difficult. When reptiles cannot adequately maintain body temperatures within their normal range, they cannot maintain all physiological processes necessary to remain healthy.

Reptiles have also been noted to prefer somewhat different temperatures during illness. In the acute stages of disease they often seek out warmer areas in their environment. This alteration in normal behavior may allow them to increase body temperature, possibly stimulating immune function. Some have referred to this change as a behavioral fever. Conversely, reptiles in the chronic stages of disease have been noted to seek out cooler areas in their environment. It has been theorized that this change not only slows body processes, but also slows the disease process, allowing the immune system

to work on a less active disease process. Changing body temperature in either direction may change the susceptibility of the pathogen to host immune responses.

Metabolic rate may also influence anesthetic induction, especially when using inhalant anesthetics. Induction of anesthesia in reptiles using inhalant anesthetics is a slow process at best. These animals have the ability to hold their breath for long periods. One possibility in this situation is that they are reluctant to inhale due to the odor of the anesthetic. The other factor may be the use of 100% oxygen to carry the anesthetic agent. Because of the high levels of oxygen, the animals may simply be breathing at the rate necessary to meet their oxygen needs. The rate may be further affected if anaerobic glycolysis is being utilized, as carbon dioxide production will be minimal. Custer and Bush noted that induction time of Gopher Snakes was shortened when Halothane was administered in a 3:1 combination of nitrous oxide and oxygen. Metabolic rate and the use of 100% oxygen are likely to be part of the reason that reptiles exhibit low respiratory rates during surgery and immediately post surgery when volatile anesthetics are used. This is likely because of the aforementioned mechanism.

### Temperature

Body temperature will have effects on many body processes. Acid-Base balance is one of these processes. Blood pH decreases to near 7.0 pH as body temperature increases. As body temperature decreases the pH will increase. Normally, this change is of little consequence as the goal of acid-base balance in reptiles is to maintain a constant ratio of hydroxyl to hydrogen ions. At least this is true of animals that utilize alpha-imidazole in acid-base balance. Heart rate and respiratory rate generally increase as body temperature rises and decrease and the temperature falls. Oxygen consumption follows the same trend. The plasma volume of turtles is decreased as temperature is decreased. The stroke volume of iguanas has been shown to decrease as temperature increases. In this situation, the increased need for oxygen transport is met by an increase in heart rate and more efficient delivery of oxygen to the tissues.

Organ perfusion is also affected by temperature. Perfusion of the lungs and kidneys increases as body temperature increases. Lung perfusion likely increases to meet the increase in oxygen demands. Kidney perfusion probably increases to aid in the maintenance of acid-base balance. Once the temperature exceeds the upper limit of the activity temperature range, perfusion of these organs decreases. This may be due to shunting of blood to the periphery to aid reduction of body temperature. It may have other protective benefits as well. It has been shown that snakes at the upper limit of the activity temperature range have higher arterial oxygen concentration than alveolar oxygen concentration. If this gradient were to persist the animal would eventually lose oxygen from circulation back into the lung. Partial bypass of pulmonary circulation at this time would reduce this potential loss. Perfusion of the liver and brain appear to remain relatively constant over a range of temperatures.

Body temperature has been shown to have effects on pharmacokinetics. Increasing ambient temperature to increase body temperature has been shown to be beneficial to sick reptiles. Mader demonstrated that increased ambient temperature increased the volume of distribution of Amikacin. The same study also indicated that the higher temperature increased the susceptibility of bacteria to Amikacin.

### Cardiovascular System

The reptilian heart is uniquely adapted to the function it must serve. It should not be considered an intermediate step in the evolution of the four chambered heart possessed by higher vertebrates. The heart consists of a single common ventricle, two atria, two aortas and a single pulmonary artery. The ventricle consists of three distinct sub-chambers, the cavum arteriosum, cavum pulmonale and the cavum venosum. The cavum arteriosum is similar to the left ventricle in that it generally supplies the systemic circulation. The cavum pulmonale is similar to the right ventricle, as it generally supplies the pulmonary circulation. The cavum venosum potentially allows for admixture of the two circuits, but appears to function in directing flow to the appropriate circuit.

The flow of blood in the pulmonary and systemic circuits can either be in series, as in mammals or in parallel. This arrangement allows for partial bypass of blood flow in one of the two circuits. The presence of controlled left to right and right to left shunting is a major advantage for reptiles. Right to left shunting occurs during diving and basking. Near complete bypass of the pulmonary circuit during a dive is advantageous, as the amount of oxygen present in the lung is not sufficient to support a dive. Short term, partial reversals of this right to left shunt occur allowing for elimination of carbon dioxide from the blood. There is also an anticipatory left to right shunt that precedes surfacing. This shunt will continue for a few minutes post diving to repay the oxygen debt accumulated during the dive. Right to left shunting occurs during basking as well.

Bypassing the pulmonary circuit in this situation allows more blood to be sent to the skin surface, allowing the animal to warm more quickly. The direction of shunting is controlled by changes in the resistance within the two circuits. For example, increased resistance in the pulmonary circuit will lead to right to left shunting.

The unique adaptations of the circulatory system have allowed snakes to become a highly successful group of animals. Snakes utilize terrestrial, arboreal and aquatic habitats. This diversity is due in part to their unique circulatory system, which they possess. Arboreal snakes must overcome gravitational effects on their blood vessels when vertical to maintain adequate blood pressure to their brain and prevent blood pooling in dependant areas. Sea snakes live in an environment of near neutral buoyancy, so are not affected by these changes. Sea snakes are incapable of making the

## Clinical Implications of Reptile Physiology, *cont.*

adjustments necessary to compensate for gravitational pressures when removed from an aquatic environment. Some terrestrial snakes appear to lack this ability as well. Terrestrial and semi-aquatic snakes are the intermediate between these two groups in all other matters discussed. To overcome the effects of gravity on their circulatory system arboreal snakes have higher blood pressure and better control over blood pressure than the other two groups. This may be a consequence of better muscle tone and tightly adhering skin, since both factors increase venous return to the heart by resisting blood pooling in dependant areas. Arboreal snakes tend to have hearts that are cranially located, which helps ensure adequate blood flow to the brain. The heart of sea snakes tends to be located near mid-body, minimizing the work done by the heart. This functions well for them as gravity has little effect on their blood flow. Size and location of the vascular portion of the lung also varies among these three groups. To minimize the effect of gravitational pressures the vascular portion of the lung of arboreal snakes is generally short. This portion of the lung is located mainly cranial to the heart. Conversely, the vascular lung tissue of sea snakes may extend nearly the entire length of the body.

### Renal Portal System

Reptiles possess kidneys that are of metanephric origin. The kidney cannot form urine of concentration higher than that of plasma, presumably due to the absence of the loop of Henle. Glomerular filtration rate is determined by the number of nephrons receiving perfusion at a given time. A renal portal system exists to supply blood to the proximal and distal convoluted tubules of the nephrons during periods of dehydration when glomerular perfusion is decreased. The renal portal system receives blood from the caudal portion of the body to supply the tubules.

Controversy exists surrounding the clinical effects of the renal portal system. Some feel that because of the presence of the renal portal system, injections should not be made into the caudal portions of the body of reptiles. There are two reasons that this has been suggested. First, since injections made in the caudal portion of the body will enter the kidney first, the possibility exists that the injected substance may be partially eliminated by the kidney before it can reach systemic circulation. The second involves the use of potentially nephrotoxic drugs. It may be possible to increase the potential of nephrotoxicity by administering the drug into an area that drains directly to the kidney. On the surface these points appear to have validity, but it is the authors opinion that the renal portal system is of little clinical significance. Holz has demonstrated that not all of the blood in the renal portal system must enter the kidneys. There appears to be a mechanism for bypassing the kidney in most species studied. Holz has also shown that injection site has no clinically significant effect on pharmacokinetics. The author has utilized nuclear

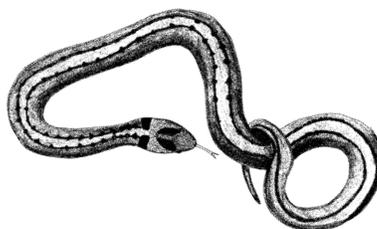
scintigraphy to evaluate the renal portal system in snakes (unpublished data). There appears to be no elimination of technetium-99m upon first pass through the kidneys. Technetium-99m also does not accumulate in the kidneys. Further research is necessary but the preliminary work is compelling.

### Ultraviolet Lighting

Ultraviolet light of the UVB portion of the spectrum is necessary for animals to synthesize vitamin D. A lack of vitamin D production by the animal or a lack of useable vitamin D in the diet will lead to poor calcium and phosphorus absorption from the gastrointestinal tract. If calcium and phosphorus are not absorbed in proper amounts the bones will be profoundly affected. Calcium will be removed from the bones to maintain adequate serum calcium levels. If this situation continues long enough osteodystrophy will result. Research into the nutrient requirements of reptiles is currently lacking. Consequently, commercially available complete rations are not available. Since diet cannot be relied upon to meet the vitamin D requirements of reptiles, herpetoculturists have relied on UV light exposure to meet the needs of their animals. There are several companies now that are marketing lights for use with reptiles that emit light in the UVB portion of the spectrum.

Gehrmann and Ferguson have evaluated some but not all of the commercially available UV light sources. At the Denver Zoo the reptile care staff has also evaluated several other commercially available UV light sources for use with animals in the collection. These evaluations were made using a UVX Radiometer (Davis Instruments). This instrument measures UVB in microwatts/cm<sup>2</sup>. The fluorescent bulbs that were utilized were new, except for one used sunlamp. The tubes were all twenty-four inch, twenty-watt models. The Westron bulbs evaluated are incandescent bulbs. Measurements were made in a dark room, used for developing radiographs. The following lights were evaluated.

1. Duro-Test Vita-Lite, power twist
2. Phillips F20T12/BL, Blacklite
3. General Electric Cool White F20T12-CW
4. Ultraviolet Resources Inc., Experimental C
5. ZooMed, Reptisun F20T12/Rept.R135 5.0UVB
6. Energy Savers Reptile Daylight
7. Light Sources UVB FS20T12 RO39, Sunlamp (New) Ultraviolet Resources Inc.
8. Light Sources UVB FS20T12 RO39, Sunlamp (Used)
9. Wonder Light 160 watt, Westron Inc.
10. Wonder Light 300 watt, Westron Inc.



*continues p. 11*

**UVB Irradiance:**

Measurements are in microwatts/cm<sup>2</sup>

Light Source	Distance from Light Source		
	6 in.	12 in.	24 in.
Vitalight	4.7	2.0	0.9
Blacklight	5.2	2.0	0.4
Cool White	5.6	0.9	0.0
Experimental Lamp	69.9	27.3	8.3
Reptisun	109.7	43.0	14.4
Reptile Daylight	35.9	14.0	4.0
Sun Lamp (New)	460.0	175.2	55.0
Sun Lamp (Used)	249.0	100.4	33.7
Wonder Light (160)	N/A	211.0	72.0
Wonder Light (300)	N/A	400.0	130.0

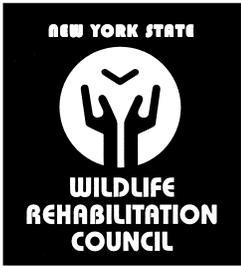
The exact length of time that the used sunlamp had been in service could not be determined, but the lamp had been in place for at least six months. When sunlamps are used as a UVB source, they are used for only two fifteen-minute periods per day. Use for longer periods has led to corneal damage. Measurements of the Westron bulbs were not done at six inches because these bulbs produce a great deal of heat. Use of these bulbs at this distance will cause thermal injury. Measurements were taken on these two bulbs at a distance of thirty-six inches. The 160-watt bulb produced thirty-four microwatts/cm<sup>2</sup>. The 300-watt bulb produced sixty-three microwatts/cm<sup>2</sup>.

There are some other important facts about UV lighting that should be noted. Ultraviolet light does not penetrate transparent materials well. Glass blocks approximately ninety six percent of the UVB emitted by a light source. Even the screen tops commonly placed over aquariums used to house small reptiles can block a significant portion of the UVB emitted. The intensity of the UV light produced decreases as the distance from the source is increased. The amount of decrease can be calculated using the equation that describes the inverse square law. Fluorescent UVB light sources do not emit UVB along the entire length of the tube. The highest levels of irradiation are produced by the center of the tube. UVB is produced only by fifty percent of the tube. This UVB production is highest at the mid-point of the tube, and extends for twenty-five percent of the tube's length on either side of the center. For example, a twenty-four inch tube emits UVB for only twelve inches. These twelve inches will be located six inches either side of the middle of the tube. There will be six inches of tube at each end that may be producing visible light, but no UVB. Fluorescent tubes lose their ability to emit UVB over time. It is suggested that most fluorescent tubes be replaced every six months.

This paper has been a quick and cursory overview of many subjects. The information is intended to be useful to the clinician. The veterinary care of reptiles can be a rewarding experience. There are many aspects of reptile medicine that are not yet covered in veterinary basic education, but new resources are continually becoming available. Continuing education programs can be a valuable resource, allowing the clinician to fill in the gaps in their knowledge base.

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