2014 Year of the Salamander

Salamander News

No. 12 December 2014

www.yearofthesalamander.org

A Focus on Salamanders at the Toledo Zoo

Article and photos by Timothy A. Herman, Toledo Zoo

In the year 2000, the Toledo Zoo opened the award-winning "Frogtown, USA" exhibit, showcasing amphibians native to Ohio, including one display housing a variety of plethodontid salamanders. Captive husbandry of lungless salamanders of the family Plethodontidae had previously been extremely rudimentary, and few people had maintained these amphibians in zoos. In this exhibit in 2007, the first captive reproduction of the Northern Slimy Salamander (*Plethodon glutinosus*) was achieved in a zoo setting, followed shortly thereafter by the Four-toed Salamander (*Hemidactylium scutatum*) in an off-display holding area.

A sample of the photogenic salamander diversity encountered during MUSHNAT/Toledo Zoo fieldwork in Guatemala, clockwise from top left: *Oedipina elongata*, *Bolitoglossa eremia*, *Bolitoglossa salvinii*, *Nyctanolis pernix*.

This exhibit was taken down and overhauled for Year of the Frog in 2008, giving us the opportunity to design, from the ground up, a facility incorporating the lessons learned from the first iteration. Major components of this new Amazing Amphibians exhibit included a renovated plethodontid salamander display, holding space to develop techniques for the captive reproduction of plethodontid salamanders, and four biosecure rooms to work with imperiled amphibians with the potential for release back into the wild. One of these rooms was constructed with the capacity to maintain environmental conditions for high-elevation tropical salamanders.

In 2009 a collaborative project was launched between the Museo de Historia Natural (MUSHNAT), at the Universidad de San Carlos de

continued on p. 4

Inside:

sponsored by PARC - Partners in Amphibian and Reptile Conservation

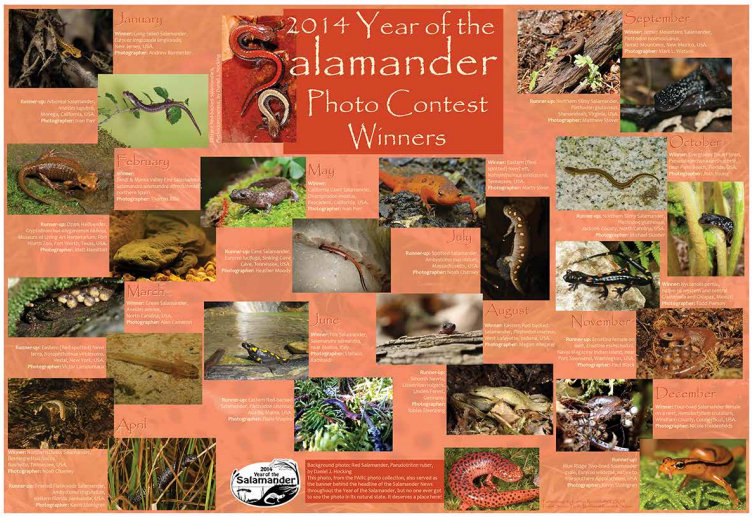
Photo Contest Winners Poster - now available!

If you missed some of our monthly calendars, or just want to have a poster that you can continue to display in your office or classroom that shows some of the wonderful variety of salamanders, download the free Year of the Salamander Photo Contest Winners poster. Thanks to all who submitted such a fantastic collection of photos! If only we'd had more months!

Download the poster at www.yearofthesalamander.org

Get Your December Photo Contest Calendar - Free!

Nests of terrestrial-breeding salamanders can be very difficult to find. That's one of the things that makes **Nicole Freidenfelds'** winning photo of a female **Four-toed Salamander (*Hemidactylium scutatum*)** so extraordinary. To see it full-size, and see our striking runner-up, go to **http://www.parcplace.org/images/stories/YOSal/YoSalCalendarDecember.pdf.**



Get your Year of the Salamander 2014 Gear!

Go online to the PARCStore (**http://www.cafepress.com/parcstore**).

Ready to gear up for Year of the Salamander? We've got you covered!

At the Café Press PARCStore, you can find just about any style of t-shirt, sweatshirt, or hoodie, for men, women, or children. But don't stop there - you'll find a messenger bag, field bag, aluminum water bottle, even a beach towel (in case you want to join the salamanders crawling out of that primeval sea).

And take a look at the beautiful **Year of the Salamander Wall Calendar**, full of fantastic salamander photos for every month of your year!

Proceeds from sales go to the Year of the Salamander Conservation grant, managed by Amphibian and Reptile Conservancy, a not-for-profit organization that helps support PARC activities, such as public education, publications, and research.

December Newsletter Content Coordinator: Valorie Titus, Green Mountain College
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Year of the Salamander Committee Chair: Mary Beth Kolozsvary, Siena College

Year of the Salamander Collaborating Partners

The Year of the Salamander Planning Team is pleased to welcome the following organizations to our growing list of collaborating partners:

Columbus Zoo www.colszoo.org

Home to more than 10,000 animals representing over 575 species from around the globe, the Columbus Zoo and Aquarium leads and inspires by connecting people and wildlife. The Zoo complex is a recreational and education destination that includes the 22-acre Zoombezi Bay water park and 18-hole Safari Golf Course. The Columbus Zoo and Aquarium also operates the Wilds, a 10,000-acre conservation center and safari park located in southeastern Ohio. It is a regional attraction with global impact; contributing more than $1 million annually to support over 70 conservation projects worldwide. A 501(c)(3) nonprofit organization, the Columbus Zoo has earned Charity Navigator's prestigious 4-star rating.

Riverbanks Zoo and Garden www.riverbanks.org

For nearly 40 years, Riverbanks Zoo and Garden has connected individuals, families and groups with the world's wildlife and wild places. Riverbanks is a special purpose district governed by the Riverbanks Park Commission, which consists of seven members, two appointed by Richland County Council, two by Lexington County Council, two by the City of Columbia, and one jointly by the three entities. It is the mission of Riverbanks Zoo and Garden to foster appreciation and concern for all living things.

Carolina Box Turtles www.carolinaboxturtles.com

Carolina Box Turtles is a non-profit Box Turtle rescue, rehabilitation, education, research, and conservation group that is located in the Western Piedmont of North Carolina. We promote awareness and interest in the Eastern Box Turtle, we promote the helping of box turtles cross roadways, and we promote leaving them wild and not collecting them for pets. We participate in different educational events, providing hands-on experiences with Box Turtles and disseminating information.

The *rare* Charitable Research Reserve www.raresites.org

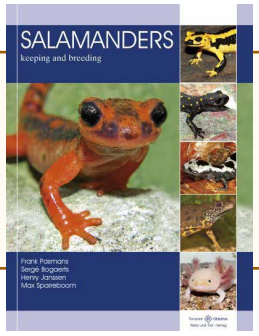
Founded in 2001, the *rare* Charitable Research Reserve is a 900+acre land reserve situated in southern Ontario, Canada. The reserve is not only a beautiful and culturally significant landscape, but includes trees more than 240 years old and provides a diversity of habitats that supports rich biodiversity. This pristine landscape is home to an incredible array of flora and fauna, some of which are ranked significant regionally, provincially, nationally, even globally. The lands at *rare* and their proximity to urban development make them important sites for conducting ecological monitoring. As an important indicator species, salamanders have been monitored at *rare* since 2006 and have provided invaluable information on the health of the forest ecosystem in the face of agriculture and development pressures.

New Book!

Salamanders: Keeping and Breeding

By Frank Pasmans, Sergé Bogaerts, Henry Janssens, Max Sparreboom

October 2014, 248 pages, Ntv Natur und Tier - Verlag



Focus on Salamanders at Toledo Zoo, *cont. from p. 1*

Guatemala (Carlos Vásquez Almazán), and the Toledo Zoo (Tim Herman) to investigate the natural history, distribution, and conservation status of salamander species in Guatemala. Eight genera of plethodontid salamanders, comprising 63 known species, are found in this Central American country the size of Ohio. Many of these species are threatened with extinction, and little useful information was available pertinent to their environmental requirements should a captive assurance population be necessary. Temperature data loggers were deployed in the microhabitats of species across the country, targeting a broad sampling of taxonomic diversity and elevational variation exploited by salamanders. Twice-yearly trips to download information from these loggers have been organized through 2014 to concordantly survey the spectacular diversity of habitats in Guatemala for amphibians, and to distribute educational materials about the biology and importance of amphibians to schools and community leaders in the surrounding rural areas. Basic surveys and voucher collections across poorly sampled areas in Guatemala are among the most urgent priorities for amphibian conservation, and these few trips have yielded several major distributional extensions and potential new species. Information from these trips and collaborators at the University of California-Berkeley is already being implemented to develop a network of amphibian reserves spanning the country.

Back in Toledo, successful reproduction of plethodontid salamanders has advanced rapidly in the new facility. As of November 2014, twelve species from seven plethodontid genera have bred at the zoo, most on multiple occasions. Among these are two Guatemalan species, *Bolitoglossa nympha* and *Bolitoglossa conanti*, that were brought to the zoo in 2009 as part of our collaborative project. Many of these salamanders reproduce underground or in caves, and accounts of eggs or young juveniles are rare or totally unknown from the wild. Most recently, a Pigeon Mountain Salamander, *Plethodon petraeus*, laid

Plethodontid salamander reproduction at the Toledo Zoo, clockwise from top left: hatching *Desmognathus welteri*; *Pseudotriton montanus diastictus* undergoing metamorphosis; *Eurycea longicauda* eggs; female *Plethodon glutinosus* attending eggs; hatchling *Bolitoglossa nympha* on a fingertip; hatchling *Bolitoglossa conanti*; hatching *Aneides aeneus*; juvenile *Pseudotriton r. ruber*; female *Plethodon petraeus* with recently laid eggs.

eggs in our off-display facility. This impressive species is known from only the eastern slope of Pigeon Mountain in northwestern Georgia, and was not described until 1988. A group of these salamanders was collected in 2009 in cooperation with Georgia DNR herpetologist John Jensen. Until now, nothing was known of its reproductive biology in spite of repeated efforts to document it in the field.

Last but not least, the Toledo Zoo is also currently an active partner in the Ohio Hellbender Partnership, headstarting juveniles from wild egg masses for eventual reintroduction to rehabilitated streams where the species had previously been extirpated. These larvae are reared in biosecure facilities at the zoo, and a new facility expanding our capacity is under construction, to come online in 2015. This effort is just the next phase in our commitment to study and conserve salamanders at the Toledo Zoo.

Developing husbandry and breeding protocols for the critically endangered Reticulated Flatwoods Salamander, *Ambystoma bishopi*

By Danté Fenolio, Ph.D., and Jennifer Stabile, San Antonio Zoo, and Thomas Gorman, Kelly Jones, and Carola Haas, Virginia Tech

The Reticulated Flatwoods Salamander, *Ambystoma bishopi*, once ranged in North America across sites in three states including Georgia, Florida, and Alabama. The species is a specialist of Longleaf Pine Flatwoods and breeds in ephemeral wetlands that typically fill with water in the winter. While there may be other negative forces helping to drive the decline, habitat loss has significantly reduced the range of this species. Only a few remaining breeding populations exist, with the most robust populations occurring on Eglin Air Force Base, Florida. While there may be some unknown remaining populations, the species has suffered a catastrophic decline across its range and now ranks among the world's most critically endangered salamander species.

Danté Fenolio holding a small divot of soil and vegetation containing eggs of Reticulated Flatwoods Salamander, *Ambystoma bishopi*, from Eglin Air Force Base, Okaloosa County, Florida. (Photographed by Kelly Jones)

In light of the dire circumstances, a consortium of biologists from academia, federal agencies, and a zoo have stepped in to try and prevent the species' extinction. Much thought has gone into how the consortium might positively affect the plight of this salamander. For example, the group recently met at a U.S. Fish and Wildlife Service conference on structured decision making and spent a week developing a strategy to try and slow the decline of the species, ultimately looking to bolster wild populations. The advantages of the process are tremendous, as all goals are outlined, stakeholder interests are taken into account, steps for achieving goals are developed, and transparency throughout the process is maintained. One thing was clear, dating back to the first discussions of a conservation initiative in 2010: developing an assurance colony was in order. Development of captive assurance colonies for critically endangered species helps to mitigate the loss of amphibian biodiversity and is a concept supported by Amphibian Ark, the IUCN, and the Amphibian Conservation Action Plan (Gascon et al. 2007).

Larval Reticulated Flatwoods Salamander, *Ambystoma bishopi*, from Eglin Air Force Base, Okaloosa County, Florida. (Photographed by Danté Fenolio)

Biologists from Virginia Tech, United States Fish and Wildlife Service, United States Geological Survey, University of Missouri, Eglin Air Force Base, and San Antonio Zoo have been working to develop a captive assurance colony for *A. bishopi* and the closely related *A. cingulatum* (the Frosted Flatwoods Salamander). One of the challenges with these

species is neither has been bred in captivity, nor were there published records of anyone having reared them in captivity through metamorphosis, or documented attempts to hatch eggs in the lab. We began developing protocols for egg collection, transport, and captive hatching in 2011, with initial success in both 2011 and 2012. We created a protocol for hatching the eggs and for rearing the salamander larvae through metamorphosis (see Fenolio et al. 2014).

Challenges with developing a captive assurance colony remain. Shortly after metamorphosis, it is not uncommon for individuals to stop feeding. This problem surfaced with the individuals that were collected in 2011 and 2012. While diversifying the food items being offered has largely mitigated this issue, a small number of individuals still refused to eat. Learning the dietary preferences of juvenile salamanders has been complicated by the fact that there are no diet data available for postmetamorphic individuals. The addition of white worms, *Enchytraeus albidus*, to the diet of juvenile salamanders has both improved their interest in food and has enabled keepers to increase the weight of salamanders in a short period of time. White worm cultures should be a mainstay for any organization developing a colony of Flatwoods Salamanders, as both the larvae and the adults readily eat the worms. The culture of the worms is basic and production can be scaled depending on the number of salamanders being maintained.

Kelly Jones holding a small divot of soil and vegetation containing eggs of Reticulated Flatwoods Salamander, *Ambystoma bishopi*, from Eglin Air Force Base, Okaloosa County, Florida. (Photographed by Kelly Jones) (Photographed by Danté Fenolio)

In a conservation landscape where "in the wild is always better" simply does not hold up to the realities of habitat loss and other issues, our consortium has decided to intervene and develop captive assurance colonies of the Reticulated Flatwoods Salamander. As the project continues, we will continue to publish our protocols and results so that others can follow if we have success. In 2015, salamanders currently at the San Antonio Zoo will be old enough to attempt captive reproduction. We are excited about the prospects of producing animals that might someday be released into the wild at sites that have long-term conservation goals in place.

Acknowledgements: Early work with these salamanders was carried out at the Atlanta Botanical Garden. Special thanks to Mark Mandica, Leslie Phillips and Lauren Melde for their assistance. We thank Eglin Air Force Base, especially Kathy Gault, Jeremy Preston, and Bruce Hagedorn, for logistical support, and the assistance of Harold Mitchell, Brandon Rincon, Steve Goodman, John Himes, and Annamarie Saenger with detection and collection of eggs in the field. Conservation Fisheries Inc. (Knoxville, Tennessee) kindly supplied cultured freshwater amphipods to use as food with early-stage salamander larvae.

Literature Cited:

Fenolio DB, Gorman TA, Jones KC, Mandica M, Phillips L, Melde L, Mitchell H, Haas C. 2014. Rearing the federally endangered Reticulated Flatwoods Salamander, *Ambystoma bishopi*, from eggs through metamorphosis. Herpetological Review 45(1): 62–65.

Gascon C, Collins JP, Moore RD, Church DR, McKay JE, Mendelson JR III (eds.). 2007. Amphibian Conservation Action Plan. IUCN/SSC Amphibian Specialist Group, Gland, Switzerland, and Cambridge, United Kingdom.

Upcoming Meetings & Events

Amphibian Decline & Conservation Webinar - Northern California, December 10, 10:30-11:30 am PST (1:30-2:30 pm EST). Michael Adams and Brian Halstead talk about the conservation and population trends of N. Cal. amphibians. To Join: **http://mat.adobeconnect.com/reptiledec10/** and call (712) 432-1212 with code 275423690# for audio.

Northwest PARC annual meeting, February 24, 2015, Embassy Suites Hotel, Portland, OR. **www.nwparc.org**

Western Clade Striped Newts at the Jacksonville Zoo and Gardens

By Mark Beshel, Senior Herpetology Keeper at the Jacksonville Zoo and Gardens

Striped Newts (*Notophthalmus perstriatus*) are a small salamander historically found throughout much of the southeastern United States. Like many other newts, they have a complicated life cycle. Adults congregate in seasonal wetlands in the winter to breed and lay eggs. Eggs hatch into aquatic larvae which metamorphose into a terrestrial "eft" stage. These juvenile newts remain terrestrial for 1-2 years before reaching maturity and then renew the cycle. Striped Newts are listed as Near-Threatened by the IUCN; however the western clade (which shows significant genetic variance and may be a separate species/subspecies) appears to show a more rapid decline.

A western clade Striped Newt, *Notophthalmus perstriatus*.

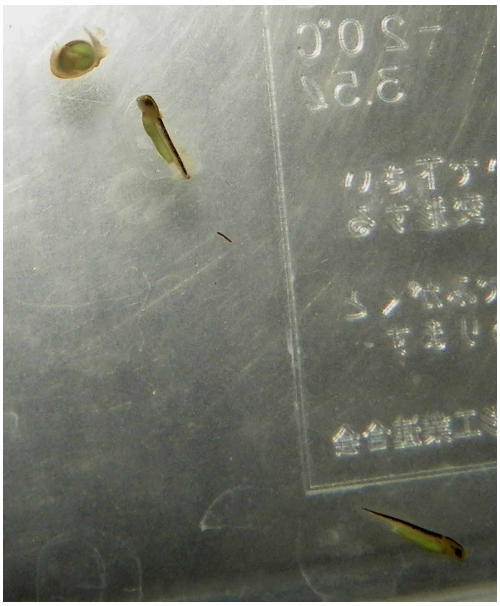
Western clade Striped Newts were once found in abundance in the Munson Sandhills region of the Apalachicola National Forest. Persistent trapping and surveying methods were employed over the past decade, which revealed a complete loss of this population. Decline is linked to several factors; most notably habitat loss, a long period of drought, increased demand on the water supply for the nearby city of Tallahassee, and improper fire suppression/prescribed burning. Fires which normally occur in the summer after lightning strikes would burn to the center of the dry wetlands. These summer fires are suppressed; instead prescribed burning usually takes place during the winter months when Striped Newts and other seasonal breeding amphibians are on the move to use these wetlands. Fire only reaches the edges of the water, which doesn't kill smaller trees and shrubs in the center. Over time, these wetlands become drier and are wet for shorter durations, thus altering the habitat and making it less suitable for these and other species.

A breeding colony of western clade Striped Newts at Jacksonville Zoo and Gardens.

The Jacksonville Zoo and Gardens first started working with Striped Newts (eastern clade) in 2007, and began breeding them in the winter of 2008. We bred this species extensively until early 2012, at which time we switched our focus to the more imperiled western clade Striped Newt. We obtained 2 wild-caught specimens from USGS, and an additional 2 from Memphis Zoo. These newts began to reproduce in the winter of 2012-2013. With the help of Dino Ferri (curator of herpetology at JZG) and Dr. Steve Reichling (Curator at Memphis Zoo), we struck a partnership with the Coastal Plains Institute (coastalplains.org) to begin a release program for captive-bred striped newts.

Ryan Means (Conservation Biologist and co-founder of Coastal Plains Institute) has been working in the Munson Sandhills region on short-term wetland augmentation as part of a five-year grant. Synthetic wetland liners were installed under several ponds (at a depth of approximately 18 inches) to prevent total water loss. In 2013 we released our first batch of western clade Striped Newt larvae, totaling 58 animals. Using drift fences, a total of 3 Striped Newts were observed leaving the wetland. We overwintered 114 larvae in their enclosures and released them as metamorphosed efts and young adults in February 2014. We released an additional 266 through May 2014. Memphis Zoo also released 53 larvae this year for a total of 433 larvae in 2014 and a grand total of 491 released to date. The Jacksonville Zoo and Gardens is currently holding over 100 juveniles and larvae for release in early 2015 and we are expecting egg production to start back up in January.

2014 proved to be one of the wettest years in recent history, and we were unable to successfully measure the number of metamorphosed newts leaving the wetlands as the rain inundated the drift fences and made typical pitfall trap observations impossible. One wetland that did recede below the level of the drift fences yielded an almost 20% success rate; 19 efts were captured of the 102 that were originally released at that site, with no way of knowing how many others evaded capture when the pond was at its highest.



Hatchling western clade Striped Newt larvae.

Repatriation is highly dependent on season; captive newts will often produce long after they would in the wild due to a more controlled environment. Temperatures, rainfall, water level in the wetlands are all considerations for deciding when to release animals. Releases to the Apalachicola National Forest are often postponed after May as temperatures begin to rise and wetlands recede. Remaining offspring are housed in their respective institutions for release at a later date or the following year. Weather is a potential problem; Florida weather is unpredictable at best, and if winter rains don't come we cannot release animals. Sudden temperature changes can also influence release efforts.

Currently, 2015 is the final year for the grant-provided funding for this study. With increased efforts, as well as interest from additional local institutions, we are hopeful that this project can continue into the future, and are (cautiously) optimistic for its success!

The Bridge between Mother Nature and Vivariums—Mesocosms

By Matt Charnock, ASG and ASA Journalist

One could easily become engrossed with the shock-and-awe of our sensationalized zoological facilities. Between the pseudo-dominating acts over Mother Nature and the ever-present anthropomorphic allusions, it's a catalyst for delusional ideas. But these hubs of faunal diversity aren't just for show—they're first-and-foremost centers of preservation and suitability. And it's the practices and dedication of the "behind the scenes" conservation efforts that should be kept in the limelight—that's if that established mesocosm allows for a diurnal variable.

Mesocosms– housing units that allow natural environmental conditions to remain under controlled observation – have become essential in both Japanese and Chinese Giant Salamander conservation work.Photo courtesy of **Takashi Yamaoku**.

The literal, cold definition of a mesocosm is a practice that brings otherwise natural conditions—i.e., pond habitats and river-system niches—to a captive setting, focusing on key variables placed under a said experiment or practice—a mouthful, isn't it? But the utilization of such controlled practices has played a vital role in sustainability's ever-shrinking theatrical production. And with the continual implementation of this conservation

Because wild populations are notoriously over-harvested, Chinese Giant Salamanders are now commonly farmed in mesocosms, yielding viable offspring for later reintroduction into their endemic ecosystems. Photo credit: **Takashi Yamaoku**.

tool, we'll collectively keep the curtain from closing.

While mesocosms have been used in both the vertebrate and non-vertebrate realms of conservation, amphibians—primarily aquatic anurans, newts, and salamanders—seem to be the most pronounced beneficiaries from this form of insurance. By micro-managing some of Mother Nature's more temporal variables—temperature changes, fungal and algae growth factors in relation to seasonal changes, etc.—biologists and like-minded ecocetnric individuals can grasp a firmer handle on conservation's heavily-lubricated pull-up bar.

Giant salamanders belonging to the genus *Andrias*, a personal favorite of mine, are a picture-perfect example of how these mesocosms can impact population increases and how they can establish a captive breeding program for reintroduction. Chinese Giant Salamanders (*Andrias davidianus*) are an endemic, endangered salamanders species found in-and-around mainland China—there's ironically been an introduced population to the Katsugara river system in Japan, facilitated by the culinary practice. And because of China's carbon-heavy practices, the country's acidic rain is affecting the pH balance of their aquatic dwellings, scarring their semi-permeable skin and killing off their fertilized eggs. Couple their affinity toward contracting chytridmycosis into that dreary equation, and you're presented with a strongly-hued conservation red flag, enveloped by a thin film of coal-burnt ash—that's where mesocosms begin to dust-off that otherwise dilapidated textile.

China has now successfully established captive breeding and rearing programs for the salamander, cementing its existence for some time. And even better so, these human-facilitated ecosystems are shedding light onto their otherwise shadowed lifestyles—and the timing couldn't be better. In recent years, an iridovirus—the deadly anuran ranaviurs is in the same family of pathogens—has been recently introduced into the wild population, killing-off almost ninety-five-percent of all symptomatic animals via intense hemogroging. Even worse—it's present at all developmental stages in Chinese Giant Salamanders.

As we cap-off the Year of the Salamander with this newsletter, we hope our outreach efforts have left an ever-present, conservation-echoing ring in your ears. Never before in the history of man's existence have we experienced such declines our biosphere's amphibious life. And to allude to our sensationalized, "who's to blame" cultural customs, why is this happening—may I introduce you to the reflection shining back at you from that algae-heavy, stagnated pond. But that realization shouldn't come as a source for listful thinking—it should be a place to draw empowement from. Every action, decision, and thought that bounces-off your synapses is an opportunity to change, an opportunity to make a greener future. For one, I think that's incredibly inspiring, don't you think? You don't need to be a biologist, zoologist, environmentalist, or college educated individual to make a difference. All one needs is a change in perception, a willingness to make every day a sustainable, "greener" day for the one to follow.

And on that cheerfully chromatic note, I'll leave you with this: "Staring tempered glass, encaging a vulnerable amphibian—salamander or otherwise—allow yourself to become empathetic toward that creature. You, glaring through your incandescent-aid reflection, are biotic life. That amphibian, peering out from its moist dwellings, is biotic life. We encompass life itself—and we, the human race, need to share this biosphere harmoniously with our amphibious neighbors … especially the ones present in our heavily-monitored mesocosms."

Follow all of the Year of the Salamander news and happenings on Facebook (https://www.facebook.com/YearOfTheSalamander2014) and Twitter (@YOSal2014).

Developing husbandry and breeding protocols for the imperiled Georgia Blind Salamander, *Eurycea wallacei*

By Danté Fenolio, Ph.D., Manager of Conservation and Research, San Antonio Zoo;
Matthew Niemiller, Ph.D., Postdoctoral Research Associate, Illinois Natural History Survey;
Jennifer Stabile, Supervisor of Conservation and Research, San Antonio Zoo

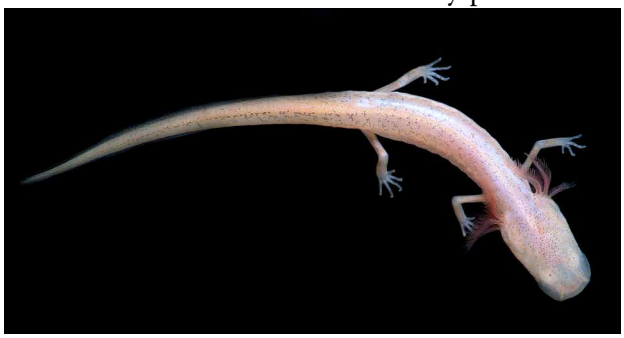
Groundwater salamanders are examples of highly adapted organisms, well suited for life in extreme habitats. Life below ground poses challenges owing to the lack of light and low food availability. Many groundwater-inhabiting species rely on heightened senses other than vision that help them find food, mates, and detect their environment in perpetual darkness. For example, sensitivity to chemical cues and hyper-developed structures that detect vibrations and movement in the water serve in the place of vision for these amphibians. Groundwater salamanders can also go long periods of time between meals, living life with a slow metabolism. The Georgia Blind Salamander, *Eurycea wallacei*, inhabits the Floridan Aquifer below southwestern Georgia and adjacent Florida. This species has little pigment and only vestiges of eyes, characteristics common to salamanders permanently living in subterranean habitats. Little is known of its biology and ecology owing to the difficulty of direct study. However, we do know that there are a multitude of threats facing the species.

Georgia Blind Salamander, *Eurycea wallacei*, in situ. (Photographed by Danté Fenolio)

Georgia Blind Salamanders are at risk from several anthropogenic threats, the most serious of which are over-harvesting of groundwater and groundwater pollution (Means 1977, 1992, 2005; Fenolio et al. 2012, 2013). The species is listed as "Vulnerable" by the IUCN (Hammerson 2004) and "Imperiled" (G2) by NatureServe (Natureserve 2013) because of few known occurrences, limited geographic distribution, potential range-wide threats, and declines in range and population size. The Georgia Blind Salamander is also designated as "Threatened" in both Florida and Georgia (Means 2005; Jensen et al. 2008). The Floridan Aquifer is designated as an at-risk aquifer for fertilizer contamination by the United States Geological Survey (Nolan et al. 1998); however, no regular monitoring protocols have been initiated to monitor changes in the populations of endemic groundwater fauna within the aquifer.

Georgia Blind Salamander, *Eurycea wallacei*, in situ. (Photographed by Danté Fenolio)

A project was conceived in 2008 to develop a better understanding of the threats that Georgia Blind Salamanders face and to develop a protocol for their captive husbandry and reproduction. Should the habitat for this species continue to deteriorate, the development of captive assurance colonies will become necessary. This project jump-starts development of these captive assurance colonies and husbandry protocols. Further, development of captive assurance colonies for critically endangered species helps to mitigate the loss of amphibian biodiversity and is a concept supported by Amphibian Ark, the IUCN, and the Amphibian Conservation Action Plan (Gascon et al. 2007).



Georgia Blind Salamander, *Eurycea wallacei*. (Photographed by Danté Fenolio)

Our program takes several approaches to better understand both the contemporary distribution of the salamander and in clarifying risks to extant populations. First, we have partnered with several cave divers who survey flooded cave systems, reporting the numbers of salamanders observed and bringing

Georgia Blind Salamander, *Eurycea wallacei*. (Photographed by Danté Fenolio)

samples to the surface. Salamanders that are brought to the surface are tested for emergent infectious amphibian diseases (e.g., chytrid fungus). Some of these animals have then been included in the development of small captive groups, wherein the captive husbandry and reproduction protocols will be determined. The remaining salamanders are returned to the point of capture. Second, we are using traps specially designed to fit down well-water monitoring pipes in hopes of identifying new localities and to better define the distribution of the species. Partnering with the Georgia Department of Natural Resources and the United States Geological Survey, we are deploying the traps in water-monitoring wells in southwestern Georgia.

Georgia Blind Salamanders face a complicated future. Overharvest and contamination of groundwater challenge the only habitat in which this species can survive. The absence of monitoring programs for known populations leaves the current status of the species in question. Establishment of husbandry and breeding protocols, before they are critically necessary, allow for the rapid development of assurance colonies should they be required in the future. Trapping across the expanse of the Floridan Aquifer allows for a better determination of the species range. Testing individuals for emergent infectious amphibian disease keeps biologists apprised of potential threats. With time, these various approaches will provide some protection from further decline or extinction of this miraculous groundwater salamander.

Acknowledgements: We thank Tree Walkers International (Grant no. 001) and Lee Moran for financial support. Ben Martinez, Jim Clark, Kelly Jessop, Mike Stine, and Bonnie Stine provided cave-diving support. Paul Moler and K. Denise Kendall assisted in the field. The San Antonio Zoo and the Atlanta Botanical Garden provided logistical support. Mark Mandica, Leslie Phillips, Lauren Melde, and the Atlanta Botanical Garden assisted with live animal care. Live specimens were collected from Florida under FFWCC permit No. LSSC-09-0288 and from Georgia under GADNR permit No. 29-WBH-09-190.

Jim Clark, holding captured Georgia Blind Salamanders, *Eurycea wallacei*. (Photographed by Danté Fenolio)

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Chopsticks for Salamanders

"To increase awareness about deforestation for the production of disposable chopsticks, disseminate information about the diversity of salamanders within the United States and raise money to support salamander conservation, education, and research."

The global demand for disposable chopsticks is causing staggering deforestation. China alone consumes as many as 80 million pairs of chopsticks each year, costing an estimated 20 millions trees annually. This overwhelming demand has led to the deforestation of some of the world's most pristine forests. Fortunately, Asian initiatives like Bring Your Own Chopsticks (BYOC) have pushed for social change, with the goal of reducing the use of disposable chopsticks. Such programs have even led some provinces in China to ban the production of disposable chopsticks and heavily tax their use. Despite these victories, global demand for disposable wooden chopsticks is still on the rise.

Chopsticks for Salamanders was founded late in 2011 to fundraise for salamander research and conservation, promote awareness about global deforestation caused by the manufacture of disposable chopsticks, and promote the use of reusable chopsticks here in the United States. To this end, CFS sells reusable, stainless steel chopsticks in a branded pouch for easy transport and includes educational information with each pair of chopsticks sold. Initial funding was generated through a social media campaign that raised over $2,000 to purchase the first chopsticks and generate the accompanying educational trifolds. Three American Association of Zoo Keeper Chapters (AAZK), the National Zoo AAZK chapter, the Greater Baltimore AAZK and the New York City AAZK chapters accepted the first chopsticks and began promoting the program locally. The initiative has subsequently expanded to 12 supporting organizations, most of which are AAZK chapters.

Chopsticks for Salamanders began offering its yearly research, conservation and education grant of $1,500 in January 2013. Thus far, CFS has funded two salamander research projects, two travel grants, and a third zoo-based salamander monitoring & habitat enhancement initiative, totaling just under $10,000. Due to successful fundraising efforts, CFS has incrementally increased its research grant award to $5,000, which will be awarded during its current grant cycle.

Chopsticks for Salamanders is a zookeeper initiative; in addition to selling chopsticks, AAZK members across the country have thrown successful fundraising events which have allowed the program to increase grant awards to their current amount. From its founding, Chopsticks for Salamanders has had the significant goal of giving back to this community by working to empower other zookeepers to participate in amphibian conservation. With hopes of connecting field biologists and zookeepers, many of whom are educated and highly enthusiastic, the CFS grant committee encourages zookeepers as well as conservation biologists to apply for each funding opportunity.

Although the majority of funds have been raised via the sale of chopsticks in bulk to AAZK chapters for distribution, significant funds have been raised through internet sales and person-to-person sales at conferences. Chopsticks for Salamanders hopes to further increase its chopstick sales by selling in retail locations, including zoo gift shops, specialty businesses and universities. CFS chopsticks are currently sold in two retail locations, and it is actively seeking further partners for chopstick distribution. Having sold over 2,300 pairs of chopsticks in its first three years, Chopsticks for Salamanders is confident that expanding our outreach will have a significant impact on public awareness of deforestation and will allow us to generate significant funds for salamander conservation.

For further information on Chopsticks for Salamanders, upcoming fundraising events or to apply for a grant, please visit **www.chopsticksforsalamanders.org** or "like" us on Facebook at **www.facebook.com/ChopsticksForSalamanders**. If you are interested in getting involved, selling chopsticks, or would like a CFS representative to present at a conference or event, please email us at reusechopsticks@gmail.com.

Red Hills Salamanders and the Collaborative Efforts to Save Them

J.J. Apodaca, Warren Wilson College

"Hidden in the glorious wildness like unmined gold." – John Muir

Perhaps the greatest legal protection that an imperiled species can be afforded is to be listed as "endangered" or "threatened" under the Endangered Species Act (ESA). The Red Hills Salamander (*Phaeognathus hubrichti*) is one of the relatively few salamander species that has been afforded such protection. In fact, of the 1351 animal species covered by the ESA, only a mere 19 are salamanders (or slightly less than 1.5%). Of these 19 species, the rare Red Hills Salamander was the first to receive the "threatened" designation (officially listed in 1976) under the then relatively new ESA. There is a common misconception most people hold regarding the listing of species under the ESA, and that is that once a species is listed, the protections afforded to it naturally lead to recovery. This fallacy has been buoyed in the last few decades with the recovery of a few very charismatic species, such as the American Alligator (*Alligator mississippiensis*) and the Bald Eagle (*Haliaeetus leucocephalus*). However, the truth is that a relatively small percentage of federally listed amphibians see marked improvements in population declines and even fewer are ever removed from protected status. In fact, none of the salamander species that have been afforded protection under the ESA have ever been delisted (a proxy for recovery). The natural response to these trends is to blame the piece of legislation itself as ineffective and inefficient, and a quick Internet search will reveal no shortage of sharp criticisms derived from a variety of authors and organizations. In fact, there are so many criticisms out there that it is easy to begin to wonder if they are right, as some in congress have done just this year. Yet, an in-depth reading of most of these condemnations will reveal shortsighted views that ignore the intrinsic fact that species recovery is not a simple undertaking, and we cannot reasonably expect that any single action will have an impact unless we fully commit to species recovery. An example of this necessary paradigm shift has been playing out as part of the ongoing conservation efforts surrounding the Red Hills Salamander, where a team of diverse conservationists is fighting to make this species the first salamander to be delisted. The collaborative nature and hard work across state and federal agencies, conservation organizations, academic institutions, and private landholders has demonstrated that perhaps it is not the ESA we should be evaluating, but rather the way we as a society and conservation community interact with endangered species and the legislation that protects them.

A close-up of the mighty Red Hills Salamander (*Phaeognathus hubrichti*). (Photographed by Danté Fenolio)

To behold a Red Hills Salamander is a unique experience to say the least. Everything about this rare species evokes astonishment, starting with the land from which they hail. Most people have probably never heard of the Red Hills of Alabama even though this very small area of south Alabama has provided us with two of the United States' most celebrated 20th century authors in Harper Lee and Truman Capote and one of the most influential American musicians in Hank Williams, Sr. In parts of the Red Hills you would swear you were in the mountains of North Carolina despite being no more than 80 or 90 miles from the Gulf of Mexico. One minute you are driving through flat lands and then next you are crossing through deep ravines that rival the beauty of many mountain coves, but if you blink you have missed it. These deep rifts in a tiny geologic sliver of south Alabama are where the Red Hills Salamander makes its home, on steep slopes and surrounded by a plant community more often associated with high-elevation Appalachian mountaintops than the pinelands of south Alabama.

Unlike most salamander species, you will not find *Phaeognathus hubrichti* roaming the forest floor on a rainy night, or even underneath rotting logs. Instead, if you are lucky, you will see them observing the world through tiny

A large male Red Hills Salamander (*Phaeognathus hubrichti*) awaits his next meal at the entrance to his burrow. (Photographed by Kenneth Wray)

burrow openings that obscure their incredibly large size (for a lungless salamander that is) of around 11 inches long. It is precisely this trait of living almost entirely within intricate burrow systems and feeding only at the burrow entrances that confines this unique creature to the Red Hills and their distinctive geology. Without the claystone formations found in this geologic band, the salamander would not be able to make and maintain the trademark homes for which they are perfectly adapted. In fact, life in these burrows has shaped this species so much that they have an entire suite of adaptations for subterranean life. Traits include an elongate body with reduced limbs, a rock-hard spade-like skull, and even a prehensile tail that they can use to sling themselves deep into their burrows if they are threatened. Like "unmined gold", when you can coax this rare species out of their underground retreats, it is nearly impossible not to be awed by these uncanny creatures.

With the help of their specialized burrows, the Red Hills Salamander can withstand nearly all of the slings and arrows that nature sends its way, from brutal south Alabama summer heat and drought to scores of predators. Yet, it is their reliance on their burrows that has also caused them to be susceptible to the acts of humans. By altering and fragmenting their habitat we have, over several decades, eliminated or greatly reduced a large number of populations. Many species would simply be able to migrate out of a habitat patch that was no longer perfectly suitable (various species of birds being the perfect example of this). Yet, when you are adapted to a specific habitat type and on top of that you are a burrower (remember that whole reduced limbs thing) moving out of the neighborhood is not really an option. So instead, we have seen many populations precipitously decline, even under the umbrella of the ESA.

Much of the blame for these declines has been cast upon timber harvesting practices. While the timber industry has certainly had a negative impact on the Red Hills Salamander, most of the damage was done before anyone realized P. hubrichti existed in the area or just how detrimental certain management practices can be to the species, demonstrating just how vital applicable conservation research is to a species recovery. Moreover, there is no denying that without the involvement of those who manage their land for timber production, there is no chance of long-term survival for the species. In fact, it has been the willingness of some of the largest landholders in the region (all of whom manage for timber) to enter into Habitat Conservation Plans (HCPs), a legally binding agreement with the USFWS, which has served to stabilize this species and has laid the groundwork for ongoing and future conservation opportunities.

Along with the establishment of the HCPs, which afford protection for the species for a limited amount of time (generally 30 years), there have been other signs of improvement for the species within the last decade. These developments include the discovery of several new populations, increasing the total known range of the species by about 15%, and a great deal of research that has increased our knowledge of how to properly manage for the species. However, the most vital step forward has been in the establishment of a permanently protected area for the species by the Alabama Forever Wild Land Trust, which has secured more than 4,000 acres in the heart of Red Hills Salamander habitat. Perhaps the most encouraging aspect of all of these conservation advances is that they demonstrate a multipronged approach to the conservation of this remarkable species. Rather than relying solely on the ESA, an alliance of government agencies, landowners, timber companies, conservation organizations, and academic institutions are achieving real, on-the-ground conservation through a proactive approach that is slowly protecting one of the world's rarest salamanders. While the Red Hills Salamander is far from secure, these groups are helping to conserve the species burrow by burrow so that the generation to come can appreciate this astounding species, and who knows, one day maybe it can be the first delisted salamander.

An Interview with Ray Semlitsch

By Dede Olson, U.S. Forest Service, Pacific Northwest Research Station


Dr. Ray Semlitsch

Dr. Ray Semlitsch received a Ph.D. at the University of Georgia in 1984. He was a post-doctoral Research Associate at Duke University and is currently a Curators' Professor of Biological Sciences at the University of Missouri. He has been a leader in amphibian ecology and the conservation of wetlands for >30 years. He has published several books, including Amphibian Conservation by Smithsonian Press, 25 book chapters and newsletter articles, and >200 scientific journal papers on the ecology of amphibians and other semi-aquatic species. His current research is focused on understanding the dispersal behavior of juveniles, habitat resistance and connectivity, and source-sink dynamics of pond-breeding species. In 1999, he was presented the Chancellor's Award for Outstanding Research and Creative Activity from the University of Missouri, the National Wetlands Award for Science Research from The Environmental Law Institute in Washington, D.C in 2008, and the Henry Fitch Award for Excellence in Herpetology in 2011.

How did you become interested in salamanders, and at what age?

I was a Junior in college and Jim Spotila gave me a paper he had published on water loss in plethodontid salamanders. When I read about them being lungless and living on land, I was hooked. I thought, wow, is this animal cool or what!!

What is your current role in salamander research and conservation?

I believe I have two roles currently. First, to direct research aimed at understanding the mechanisms responsible for a species' growth or decline. I strongly believe that critical problems in conservation can only be solved by understanding the mechanisms, i.e. ecological, behavioral, and genetic, rather than simply describing the patterns of change or effect. Patterns always beg the question, why? My second role is to train a new generation of salamander biologists to be leaders in research and as state and federal managers for the future. I love working with my graduate students on projects.

Do you have a favorite salamander or group of salamanders?

Well, I love them all! I think the small Plethodons are very special and beautiful. But, currently I think the Ringed Salamander, *Ambystoma annulatum*, is my favorite.

How would you describe a defining moment or favorite memory of working with salamanders?

I think one of the most amazing experiences I have had was at the Savannah River Site working in Carolina bay wetlands. I don't think I really understood the productivity and growth potential of species until I personally experienced 1000s of breeding adult Mole Salamanders (*Ambystoma talpoideum*) moving into wetlands to breed year after year, and then one year I personally counted 11,000 metamorphosing juveniles of the Mole Salamander leaving one site in a two-day period. That was a memory I will never forget!

What do you believe is the biggest threat facing salamanders in the 21st century?

I think there are two issues. One is getting people to work together to solve problems facing salamanders, both research collaborations and groups of managers and stakeholders. People seem to be standing back and waiting for someone else to take the lead. We need to plunge forward to save species! The other is a lack of understanding about what drives species persistence, metapopulation dynamics at larger spatial scales, source-sink dynamics, and connectivity and rescue among

*The views and opinions of interviewees are not necessarily shared by all members of PARC or other Year of the Salamander Partners

isolated populations. I think we are focusing too much on local population and small scale issues.

What are some of the ways that the public help in the conservation of salamanders?

The public needs to be educated about salamanders, what they are or are not, and that just because they live underground and are less visible, doesn't mean they are less important. I think we as biologists need to find ways to incorporate citizens into our research and make it real for them, just as biologists do with other taxa.

A Ringed Salamander, *Ambystoma annulatum*. Photo by Daniel J. Hocking.

What guidance would you give to natural resource managers and policy makers regarding salamander conservation?

I guess several things. First, less visible does not mean less important. I believe salamanders will end up being very important in ecosystem processes and therefore their loss will be very significant. Further, work with adjoining states and all stakeholders to manage species across boundaries that include the entire range of a species, don't just worry about them in your state and forget about what's happening across the boundary. Also, consider management at larger scales and how or if populations are connected to insure long-term persistence. Last, time is critical to make decisions and take actions, we need to expedite policies to save them, many species can't wait, they need action now or many will go extinct in our lifetime.

What advice would you give to young people (or adults) who love salamanders and want to work with them?

We need passionate people to help in all aspects of salamander conservation. Find your passion and then pursue it with all your heart. If you want to work in this field, then get a solid education in the basic concepts in ecology, behavior, genetics, and evolution, then combine that with education and working knowledge of management, economics, policy, social science, and lots of quantitative skills such as statistical and mathematical modeling. Lots of the future issues and solutions will be interdisciplinary and require model simulations to visualize results and then make decisions.

Just out by Ray Semlitsch: Abundance, biomass production, nutrient content, and the possible role of terrestrial salamanders in Missouri Ozark forest ecosystems. R.D. Semlitsch, K.M. O'Donnell, and F.R. Thompson III. Canadian Journal of Zoology 92: 997–1004 (2014) dx.doi.org/10.1139/cjz-2014-0141. **Ray talks about the study:** **http://biology.missouri.edu/news/semlitsch-talks-about-his-study-on-salamander-abundance/**

The Last Dragons: Protecting Appalachia's Hellbenders

Freshwaters Illustrated has just released a short film, **The Last Dragons - Protecting Appalachia's Hellbenders**, about North America's largest salamander and its conservation need. Produced in Partnership with the US Forest Service, this film aims to raise awareness and appreciation for these rare and little-known stream-dwellers, and to help viewers understand how sensitive their streambed habitats can be in the biologically diverse rivers of Appalachia. The film features fantastic underwater footage of Hellbenders in their increasingly rare habitat: clean, cool streams with rocky bottoms.

Watch **The Last Dragons** now on Vimeo!
http://vimeo.com/wemayfly/thelastdragons

Salamanders and Surface Mining in the Appalachian Mountains

Jen Williams - PARC, NPS; Steven Price - Department of Forestry, University of Kentucky; Petra Wood - USGS WV Cooperative Research Unit at West Virginia University

The Appalachian region boasts 10% of the world's salamander species. The rich, moist soil; numerous streams, seeps and wetlands; and cool conditions of the eastern deciduous forest are ideal for terrestrial and semi-aquatic salamanders whose physiological constraints require their skin to remain moist.

Long-tailed Salamander (*Eurycea longicauda*) – a streamside species that is common in the eastern coalfields of central Appalachia. Photo: Steven Price, University of Kentucky.

The Appalachian region is also well known for plentiful natural resources, including extensive coal deposits. Mountaintop removal mining (MRM), a form of surface mining that involves the removal of mountaintops to expose coal seams, is the primary mining method in parts of West Virginia, Kentucky, Virginia and Tennessee. This type of mining results in loss of thousands of hectares of mature forest and creates significant amounts of excess rock, or overburden, which is often disposed of into nearby valleys, creating a valley fill.

While MRM is a fast and efficient way to mine for coal, it is altering habitat across this region at an unprecedented rate. Just how many streams have been buried from valley fills? Experts estimate >2,000 kilometers in Kentucky alone! Streams that once flowed freely are now filled with sediment, boulders, and other rock debris. How has MRM altered terrestrial habitat? Mountaintop removal mines are reclaimed by planting mostly exotic grasses, legumes, and shrubs. As such, this historically rugged and forested landscape is changing to rolling grasslands. Over 1 million hectares of forests have been altered by surface mining in the central Appalachian Mountains.

So what does this mean for salamander populations? Recent studies from researchers at West Virginia University and University of Kentucky found that streams below valley fills had greatly reduced species' occupancy rates and relative abundances and half the species richness of streams unaffected by valley fills. Terrestrial salamanders are also greatly impacted by MRM; reclaimed grassland and shrub habitat in West Virginia had significantly fewer individual salamanders and reduced species richness compared to nearby forests. Abundance of salamanders increased with increasing distance from mine edges.

Valley fills can be hundreds of hectares in size. Riprap channels along the sides of valley fills and in streams below the fills channel surface water to reduce erosion. Creation of valley fills buries valuable streamside habitat for semi-aquatic salamanders. Photo: John Edwards, West Virginia University.

What mechanisms are responsible for salamander declines on mined land? Streams impacted by valley fills have higher levels of silt, which may coat salamander eggs and gills as well as fill in spaces between rocks and other cover items, ultimately reducing quality of habitat. Water chemistry is also greatly altered by MRM and valley fills, which may affect salamander physiology. Specific conductance (the degree to which water can conduct electricity), sulfate levels, and total dissolved solids levels were 10-70 times greater in streams below valley fills compared to forest streams in both states. These changes in water chemistry have been linked to declines in both abundance and diversity of stream macroinvertebrates, a key food source for many salamanders.

The hot, dry conditions are obvious contributors to decreased terrestrial salamander abundances on reclaimed grasslands. However, during the reclamation

process and as required under the Surface Mining Control and Reclamation Act (SMCRA), mine soils are compacted to decrease erosion. This compaction, in combination with high rock content, hinders tree growth and may inhibit the ability of salamanders to construct burrows. Most reclaimed habitats show no signs of succession to the forested habitats preferred by salamanders.

Current reclamation approaches have been largely unsuccessful at improving stream water quality and restoring forests. The Forestry Reclamation Approach, which advocates adding organic matter, planting native tree species, and not compacting soils, may help forests to develop after reclamation, thereby benefitting both terrestrial and semi-aquatic salamanders on lands influenced by MRM.

Reclaimed grasslands on a mountaintop removal mine are often planted with exotic grasses. These grasslands have compacted soil and are hot and dry; they contrast sharply with the surrounding native forested landscape. Photo: Scott Bosworth, West Virginia University.

For further information, see:
1. Muncy, BL, SJ Price, SJ Bonner and CD Barton. 2014. Mountaintop removal mining reduces stream salamander occupancy and richness in southeastern Kentucky (USA). Biological Conservation 180: 115-121.
2. Wood, PB and JM Williams. 2013. Impact of valley fills on streamside salamanders in southern West Virginia. Journal of Herpetology 47: 119-125.
3. Wood, PB and JM Williams. 2013. Terrestrial salamander abundance on reclaimed mountaintop removal mines. Wildlife Society Bulletin 37:815-823.

Oklahoma Salamanders at the Tulsa Zoo

by Barry Downer, Animal Curator - Herpetology/Aquatics, Tulsa Zoo

The Tulsa Zoo is currently working on a project in cooperation with Oklahoma Department of Wildlife Conservation (ODWC) and The Nature Conservancy in Oklahoma looking at 3 species of native salamander, *Plethodon kiamichi*, *Ambystoma annulatum*, and *Eurycea tynerensis*. The main focus is to set up a small captive breeding group of all 3 species, which were chosen due to their different lifecycles and see if we can establish successful breeding groups without the use of hormones.

In addition, we are also testing myriad native amphibians from within the ranges of these 3 species in Eastern Oklahoma to identify amphibian chytrid fungus and ranavirus in the ecosystem. We have already had 2 positive chytrid tests from last year and will be focusing more on the *A. annulatum* population and their range this year at the urging of ODWC. Many amphibian species in Oklahoma are listed as being Data Deficient, so we are hoping to gain some insight on how the populations of these 3 species are doing currently and hope to establish some baseline numbers in the state in which to compare future surveys with to determine population health and hopefully range stability.

Be a Salamander (and Newt) Hero!

The newly discovered fungus *Batrachochytrium salamandrivorans* is overwhelmingly lethal to many species of salamanders and newts. Find out more about the **Amphibian Survival Alliance's** campaign to stop the spread of this disease and the related *B. dendrobatidis*, and sign up for one of the 500 free kits to get your pet salamander or newt tested. For more information, see **http://us6.campaign-archive1.com/?u=b58881e4e4c1aa2aea044f998&id=44061321df&e=c160354686**. Be a hero to your amphibian friends!