



**International Symposium on Urban Wildlife and the Environment**  
**Murray D. Lincoln Campus Center**  
**University of Massachusetts-Amherst**  
**Amherst, MA 01003**

**Logo by Bruce Wilson, Moss Brook Arts**

## Welcome to the International Symposium on Urban Wildlife and the Environment

The Urban Wildlife Working Group of The Wildlife Society (TWS), together with the Massachusetts Division of Fisheries and Wildlife, Massachusetts Department of Conservation and Recreation, University of Massachusetts Amherst, USGS Massachusetts Cooperative Fish and Wildlife Research Unit, and the USDA Forest Service Northern Research Station, is sponsoring this International Symposium on Urban Wildlife Ecology and Management. The conference is being held at the Murray D. Lincoln Campus Center on the University of Massachusetts campus in Amherst, Massachusetts, June 21-24, 2009.

The last conference of this type sponsored by the Urban Wildlife Working Group of TWS was held in Tucson, Arizona in 1999. In the 10 years since that conference, interest, concern, research, and conservation in all matters related to urban wildlife has grown astronomically. The topic of urban wildlife continues to expand to include urban planners, landscape architects, policy makers, developers and builders, and ecologists of all backgrounds from countries around the world. This conference brings together all of these disciplines to showcase and discuss the latest topics and advancements related to the ecology of urban environments.

There are well over 100 oral and poster presentations at the conference from all over North America and from several other countries, representing a wide range of taxa and topics. We hope that you find the conference a worthwhile experience and that you enjoy your stay on the UMass-Amherst campus and in the Pioneer Valley of central Massachusetts.

We would like to extend our thanks to everyone who helped make this conference happen: our sponsors, the members of the planning and program committees, the many people who took on various tasks to make the conference work, the speakers, poster authors, and session moderators, the wonderful folks with UMass. Conference Services, and everyone else who contributed.

Thanks for coming and for participating,

Steve DeStefano, Planning Chair  
Seth Riley, Program Chair

## Events

**Sunday evening social and icebreaker** – in the Amherst Room on the 10th floor of the Campus Center with food and a cash bar, Sunday evening, June 21, 4:30-7:00 p.m.

**Sunday evening registration and uploading of PowerPoint talks** – available on the 10<sup>th</sup> floor of the Campus Center, Sunday evening, June 21, from 4:00-6:00 p.m.

**Monday morning registration and uploading of PowerPoint talks** – available on the first floor (lower level) of the Campus Center, Monday morning, June 21, from 7:00-8:30 p.m.

**Monday morning plenary session** – in the Campus Center Auditorium on the first floor (lower level) of the Campus Center, Monday morning, June 22, 8:30-11:50 a.m.

**Concurrent sessions, oral presentations** – in various conference rooms on the first floor (lower level) of the Campus Center, Monday (June 22) afternoon, Tuesday (June 23) morning and afternoon, and Wednesday (June 24) morning and afternoon.

**Poster presentations** – in the lobby area of the first floor (lower level) of the Campus Center, Tuesday, June 22. Poster authors will be available for questions and discussion at their posters during the Tuesday morning and afternoon breaks.

**Tuesday evening banquet** – in the Marriott Room on the 11<sup>th</sup> floor of the Campus Center, Tuesday evening, June 22; cash bar opens at 6:00 p.m., buffet-style food served at 7:00 p.m.

**Conference adjourns** – the conference ends on Wednesday, June 23, at 5:00 p.m. Enjoy the rest of your stay and safe travels home.

## Schedule of Plenary and Concurrent Sessions

### Plenary Session

#### **Monday, June 22, Morning, Campus Center Auditorium.**

- 08:30-08:45      **Welcome and introductions.** Stephen DeStefano, USGS Cooperative Research Units, and Seth Riley, National Park Service.
- 08:45-09:35      **Cities, human well-being, and the future of biodiversity.** James Miller, Department of Natural Resources and Environmental Sciences, University of Illinois, Urbana, IL.
- 09:35-10:25      **Gotham is wilder than you think.** Michael Feller, Chief Naturalist, Natural Resources Group, City of New York.
- 10:25-11:00      BREAK
- 11:00-11:50      **City and ring-around-the-city for wildlife in an urbanizing world.** Richard T. T. Forman, Professor, Graduate School of Design, Harvard University, Cambridge, MA.
- 11:50-1:30        BREAK FOR LUNCH

### Concurrent Sessions

Institution is listed for the first author only; it is not necessarily the institution for co-authors.

#### **Monday, June 22, Afternoon**

##### **Session 1. Roads and urban wildlife: maximizing connectivity, minimizing mortality – moderator Dave Paulson. Room 163C.**

- 1:30-1:50        **Urban region perspective on wildlife, roadsides, and road ecology.** Richard T. T. Forman; Harvard University.
- 1:50-2:10        **History and analysis of wildlife road passage structures in Massachusetts.** David J. Paulson and Paul R. Sievert; University of Massachusetts Amherst.
- 2:10-2:30        **Community cooperation and a mixed conservation strategy to reduce amphibian road mortality during the spring migration in Tompkins County, New York.** L. Leann Kanda, John Confer, and Kit Straley; Ithaca College.
- 2:30-2:50        **Combining science, planning, and design to reduce roadway impacts on wildlife in southern California.** Raymond M. Sauvajot, Amy Pettler, Jeff A. Sikich, and Seth P. D. Riley; Santa Monica Mountains National Recreation Area.
- 2:50-3:30        BREAK

- 3:30-3:50 **Movements of the endangered black ratsnake on current and proposed roadways on a college campus in western Massachusetts.** Tom Tynning and Anne Stengle; Berkshire Community College.
- 3:50-4:10 **Monitoring and enhancing wildlife movement across freeways in urban southern California.** Catherine M. Schoonmaker, Jeff A. Sikich, Seth P.D. Riley, and Raymond M. Sauvajot; Santa Monica Mountains National Recreation Area.
- 4:10-4:30 **Behavioral responses of captive deer to physical and visual barriers designed to minimize deer-vehicle collisions.** Daniel W. Stull, David A. Osborn, William D. Gulsby, David M. Jared, Gino J. D'Angelo, Shane B. Roberts, George R. Gallagher, Robert J. Warren, Karl V. Miller; University of Georgia.
- 4:30-4:50 **Integrating transportation planning and wildlife connectivity in California.** Amy Pettler; California Department of Transportation.

## **Session 2. Ecology and conservation of birds in urban areas – moderator Chris Moorman. Room 162-175.**

- 1:30-1:50 **Altered predator-prey relationship in urban landscapes: the coyote and the goose.** Justin Brown and Stanley D. Gehrt; Max McGraw Wildlife Foundation, Dundee, Illinois.
- 1:50-2:10 **Habitat fragmentation and forest bird diversity in an urban matrix.** Lowell W. Adams, Juliet M. Healy, Fred W. Fallon, Fred K. Pierce, and Gerald R. Tarbell; University of Maryland.
- 2:10-2:30 **Can urban parks provide suitable stopover habitat for migratory landbirds? A call for additional research.** Chad L. Seewagen and Christopher G. Guglielmo; Wildlife Conservation Society and University of Western Ontario.
- 2:30-2:50 **Breeding bird communities and nest survival on Montreal-area golf courses and green spaces.** Marie-Anne R. Hudson and David M. Bird; McGill University.
- 2:50-3:30 BREAK
- 3:30-3:50 **The socio-ecology of dying trees: cavity nesting birds, hazard trees, and declining urban forest canopies.** Paige S. Warren, Brian C. P. Kane, and Charles Nilon; University of Massachusetts, Amherst.
- 3:50-4:10 **Park mallards (revisited).** H. W. Heusmann; Massachusetts Division of Fisheries and Wildlife.

## **Session 3. Managing highly successful urban wildlife species – moderator Stephen DeStefano. Room 165-169.**

- 1:30-1:50 **Highly successful urban and suburban wildlife: the science of overabundance revisited.** Stephen DeStefano; U.S.G.S. Massachusetts Cooperative Fish and Wildlife Research Unit.
- 1:50-2:10 **The relationship of human density and spatial distribution to human-wildlife conflicts in Massachusetts.** Michael A. Huguenin, Laura Hajduk, and Stephen DeStefano; Massachusetts Division of Fisheries and Wildlife.

- 2:10-2:30 **Regional movements, food resources, and use of water supply reservoirs by ring-billed and herring gulls in central Massachusetts.** Daniel E. Clark, Kiana Koenen, Ken MacKenzie, and Jillian Pereira; Massachusetts Department of Conservation and Recreation.
- 2:30-2:50 **Anthropogenic resources used by Atlantic coast striped skunks inhabiting coastal waterbird nesting areas.** Luanne Johnson, Stephen DeStefano, and Scott Melvin; Antioch College of New England.
- 2:50-3:30 BREAK
- 3:30-3:50 **Temporal patterns of raccoon predation on breeding black-crowned night herons and double crested cormorants at an urban park in Lake Ontario.** Gail S. Fraser; York University, Canada.
- 3:50-4:10 **Raccoon ecology in western Pennsylvania as related to an oral rabies vaccination program.** Justin A. Compton, Gary San Julian, and Richard Yahner; Pennsylvania State University, University Park.
- 4:10-4:30 **Deterrent or dinner bell? Can ultrasonic and water jet deterrents control badger activity?** Alastair I. Ward, Stéphane Pietravalle, David P. Cowan, Richard J. Delahay; The Food and Environment Research Agency, Sand Hutton, York, YO41 1LZ, UK.
- 4:30-5:20 **Recent changes and projected trends in management of the "overabundant": beavers in transition from resource to pest.** Jennifer E. Strules, Laura Hajduk, Robert D. Deblinger, Kiana Koenen, and Stephen DeStefano; University of Massachusetts, Amherst.

#### **Session 4. Ungulate management and conservation issues in urban areas – moderator David Wattles. Room 101.**

- 1:30-1:50 **Elk behavioral response to varying levels of human predation risk: implications for wildland-urban interface elk management.** Shawn M. Cleveland and Mark Hebblewhite; University of Montana.
- 1:50-2:10 **Non-invasive genetic population monitoring of the southern mule deer in San Diego County.** Anna Mitelberg; San Diego State University.
- 2:10-2:30 **Relocation of moose as a means of resolving human-wildlife conflicts in urban areas.** David W. Wattles and Stephen DeStefano; U.S.G.S. Massachusetts Cooperative Fish and Wildlife Research Unit.
- 2:30-2:50 **First evaluation of 4-posters, passive acaricide applicators, on a non-target animal.** Arthur M. Abrams, John Carroll, and Lowell W. Adams; USDA, ARS, Beltsville Agricultural Research Center.

### **Tuesday, June 23, Morning**

#### **Session 5. Coyotes in urban landscapes: challenges and opportunities – moderator Camilla Fox. Room 163C.**

- 08:30-08:50 **The coy coyote: can we learn to coexist?** Camilla H. Fox; Project Coyote, Animal Welfare Institute.

- 08:50-09:10 **Movement patterns, toxicant exposure, and disease exposure in coyotes in urban southern California.** Seth P. D. Riley, Cathy M. Schoonmaker, Jeff A. Sikich, Joanne G. Moriarty, Cassity Bromley, Eric C. York, and Raymond M. Sauvajot; Santa Monica Mountains National Recreation Area.
- 09:10-09:30 **Ecology of coyotes in the Chicago region: implications for management.** Stanley D. Gehrt; Ohio State University.
- 09:30-09:50 **Coyote resource use in a human-dominated, suburban landscape.** Daniel A. Bogan and Paul D. Curtis; Department of Natural Resources, Cornell University.
- 09:50-10:30 BREAK
- 10:30-10:50 **Territory boundary changes in adjacent coyote packs: implications for management.** Numi Mitchell, Ralph Pratt, Meagan Griffin; The Conservation Agency, Rhode Island.
- 10:50-11:10 **Eastern coyote movement patterns: lessons learned in urbanized ecosystems** Jonathan G. Way and Eric G. Strauss; Barnstable High School, Hyannis, MA.
- 11:10-11:30 **Analysis of coyote behavior in relation to land use type on Cape Cod, Massachusetts.** Maili Page and John Finn; University of Massachusetts.
- 11:30-11:50 **Coyote populations in urban ecosystems: ecosystem services and trophic considerations.** Eric G. Strauss and Jonathan G. Way; Boston College.
- 11:50-1:30 BREAK FOR LUNCH
- 1:30-1:50 **Coyotes, conflicts, and animal control officers in Massachusetts: a study of attitudes, values, and perceptions of animal control officers in Massachusetts with respect to human-coyote conflicts.** Nadine Pellegrini; Tufts University.
- 1:50-2:10 **Human-coyote relationships in suburban New York: exploring people's attitudes and experiences.** Heather Wieczorek Hudenko, Daniel J. Decker, and William F. Siemer; Cornell University.
- 2:10-2:30 **Attitudes toward coyotes in urban landscapes: management and public outreach implications.** Megan M. Draheim, Larry L. Rockwood, E.C.M. Parsons, and Gregory Guagnano; George Mason University, Project Coyote.
- 2:30-2:50 **Cosmopolitan coyotes: practical ethics in a mixed community of humans and coyotes.** William S. Lynn; Williams College.

## **Session 6. Managing residential landscapes for wildlife – moderator Susannah Lerman. Room 165-169.**

- 08:30-08:50 **Multifunctional green corridors in suburban landscapes: spatial concepts and design strategies.** Jack Ahern; Landscape Architecture and Regional Planning, University of Massachusetts, Amherst, MA.
- 08:50-09:10 **Human drivers of management practices and ecological structure in Phoenix, Arizona.** Kelli L. Larson, Sharon J. Hall, Elizabeth M. Cook, Ben Funke, Colleen Strawhacker, and V. Kelly Turner; Arizona State University.



- 09:10-09:30 **Comparing arthropod diversity and trophic dynamics between residential landscapes and desert patches in Phoenix – Long term monitoring and experimental studies.** Christofer Bang, John L. Sabo, and Stanley H. Faeth; Arizona State University.
- 09:30-09:50 **Birds, habitat, an urban gradient, and socioeconomic factors: exploring the relationships in a residential landscape.** Susannah B. Lerman and Paige S. Warren; University of Massachusetts, Amherst.
- 09:50-10:30 BREAK
- 10:30-10:50 **BES bird monitoring project: bird species composition, abundance, and distribution in everyday Baltimore.** Charles Nilon, Paige Warren, Scott Holan and Chris Wikle; University of Missouri, Columbia.
- 10:50-11:10 **The impact of non-native landscape plants on local food webs.** Douglas W. Tallamy, Karin T. Burghardt, Erin Reed, and W. Gregory Shriver; University of Delaware.
- 11:10-11:30 **Reconciling conflicting requirements for greenways in residential landscapes.** Christopher E. Moorman and George R. Hess; North Carolina State University.
- 11:30-11:50 **Do the preferences of the New Creative Class induce residential development of wildlife friendly neighborhoods?** Mark. C. Wallace, Michael Farmer, Charlie Klein, and Michael Shiroya; Texas Tech University.

## **Session 7. Urban wildlife education – moderator David Drake. Room 101.**

- 08:30-08:50 **The evaluation of the ability of a wildlife education program to enhance the perceptions of wildlife by inner-city youths.** Brandon K. Pope; University of Missouri, Columbia.
- 08:50-09:10 **Opportunities for urban wildlife contact for children in urban childcare centers.** Camilla Rice; University of Nebraska-Lincoln.
- 09:10-09:30 **Evaluation of an urban wildlife education program in high schools across the U. S.** Jessica Tegt and Ben West; Mississippi State University.
- 09:30-09:50 **Public education programs in Georgia for dealing with nuisance wildlife issues.** Michael T. Mengak; Warnell School of Forestry & Natural Resources, U. of Georgia.
- 09:50-10:30 BREAK
- 10:30-10:50 **Urban wildlife education at North American colleges and universities: a 20-year follow-up study.** David Drake and Mark C. Wallace; University of Wisconsin.
- 10:50-11:10 **A training needs assessment for wildlife professionals.** Jessica Tegt, Ben C. West, and Phil Jones; Mississippi State University.
- 11:10-11:30 **Changing roles: re-tooling staff for increasingly urban work.** John M. Davis and Angela Soldinger; Texas Parks and Wildlife Department.
- 11:30-11:50 **Urban wildlife management is not a technique.** Clark E. Adams; Texas A&M Univ.

Tuesday, June 23, Afternoon

**Session 8. Carnivore ecology in urban landscapes – moderator Erin Boydston. Room 163C.**

- 3:30-3:50      **Interactions between San Joaquin kit foxes, red foxes, striped skunks, and feral cats in urban environments: implications for conservation of kit foxes.** Brian L. Cypher, Stephen W. R. Harrison, Christine Van Horn Job, and Samantha Bremner-Harrison; California State University-Stanislaus, Endangered Species Recovery Program.
- 3:50-4:10      **Snow tracking red foxes and eastern coyotes along an urban-to-rural gradient in the Adirondack Park of upstate New York.** Matthew Walter, Peter Palmiotto, and Jon Atwood; Antioch University.
- 4:10-4:30      **Space use and movement patterns of bobcats in Orange County, California.** Erin E. Boydston, Lisa M. Lyren, Robert N. Fisher, and Kevin R. Crooks; USGS Western Ecological Research Center.
- 4:30-4:50      **Toxicant exposure in carnivores: small mammals as a source and the role it plays in a synergistic disease epidemic.** Joanne G. Moriarty, Seth P. D. Riley, Cathy M. Schoonmaker, and Raymond M. Sauvajot; Santa Monica Mountains National Recreation Area.

**Session 9. Studies in contrasts: urban vs. rural and urbanization gradients – moderator Rodney van der Ree. Room 165-169.**

- 1:30-1:50      **Varying effects of vegetation and buildings on the distribution of breeding riparian birds within an urban environment across spatial scales.** Derric N. Pennington and Robert B. Blair; University of Minnesota.
- 1:50-2:10      **Effects of urbanization on scrub-shrub bird abundance in Massachusetts.** David I. King and Scott Schlossberg; Northern Research Station, USDA Forest Service, University of Massachusetts.
- 2:10-2:30      **No apparent benefit to early breeding by northern cardinals in urban and rural forests.** Daniel P. Shustack and Amanda D. Rodewald; Massachusetts College of Liberal Arts.
- 2:30-2:50      **The glucocorticoid stress response in urban and rural populations of the clay-colored thrush in Nicaragua.** Brian G. Walker, Jonathan W. Haskins and Frank A. Spizzoucco; Fairfield University.
- 2:50-3:30      BREAK
- 3:30-3:50      **Effects of anthropogenic disturbance on home range size of eastern box turtles and wood turtles in central and western Massachusetts.** Lisabeth L. Willey, Michael T. Jones, and Paul R. Sievert; University of Massachusetts.
- 3:50-4:10      **Patterns of emerging dragonfly communities at small wetlands on the urbanizing New England landscape.** Maria A. Aliberti Lubertazzi; University of Rhode Island.

- 4:10-4:30 **A non-linear response of marsh bird communities to urbanization in Massachusetts landscapes.** Brian G. Tavernia and J. Michael Reed; Tufts University.
- 4:30-4:50 **Combining different taxa to assess space and environmental determinants of species distributions in Switzerland's urban environment.** Marco Moretti, Thomas Sattler, Peter Duelli, Martin K. Obrist, Fabio Bontadina, and Pierre Legendre; Swiss Federal Research Institute, University of Bern.

## **Session 10. Wildlife management in urban open spaces – moderator Lowell Adams. Room 101.**

- 1:30-1:50 **More than just White House raccoons or cherry tree beavers: managing for wildlife in the national parks of the National Capital Region.** Scott Bates; Center for Urban Ecology, National Park Service.
- 1:50-2:10 **Ecological restoration in urban parks: the use of “poor” sandy soils to encourage native communities.** Mike Feller; City of New York Parks & Recreation.
- 2:10-2:30 **Wildlife management in a heavily urbanized region – Cook County, Illinois.** Chris Anchor; Forest Preserve District of Cook County, Illinois.
- 2:30-2:50 **Between a rock and a hard place: urban wildlife decisions in Fort Worth, Texas.** Robert Denkhaus; Fort Worth Nature Center & Refuge.
- 2:50-3:30 BREAK
- 3:30-3:50 **Recreation impacts on wildlife in and adjacent to public open space in Pitkin County, Colorado.** Gary Tennenbaum; Pitkin County Open Space and Trails.
- 3:50-4:10 **Wildlife conservation and management in an urban national park.** Tania N. Pollak; Presidio Trust, San Francisco.
- 4:10-4:30 **Planning riparian corridors as refuge areas for urban wildlife in metropolitan Detroit.** Sam B. Lovall, Kent H. Anderson, Kelly A. Cave, and John H. Hartig; Hamilton Anderson Associates.
- 4:30-4:50 **Green and Wild Planning: meeting the Needs of Local Planners.** Jessica Wilkinson; Senior Policy Analyst, Environmental Law Institute.

## **Poster session. Posters will be displayed all day Tuesday, and poster presenters will attend their posters during the morning and afternoon breaks.**

**Role of urban forests and homesteads in realizing the targets of the forest and wildlife conservation policies in India.** M. M. Animon; Kerala Agricultural University, Kerala, India.

**Food for thought: anthropogenic food sources and their impact on avian diversity.** Jason D. Fischer and James R. Miller; University of Illinois- Urbana/Champaign.

**Simple modifications to transportation infrastructure to reduce impacts on wildlife.** Jack H. Hecht; HDR, Inc. Pearl River, NY.

**An international research agenda for the urban green space.** Philip James, Kostantinos Tzoulas, Mags D. Adams, Alan Barber, John Box, Jürgen Breuste, Thomas Elmqvist, Matthew Frith, Chris Gordon, Kim Greening, Stephen Haworth, Aleksandra E. Kazmierczak, Mark Johnston, Kalevi Korpela, Marco Moretti, Jari Niemelä, Stephan Pauleit, Maggie H. Roe, Jon P. Sadler, and Catharine Ward Thompson.

**Southeastern coyote activity patterns across an urban to rural gradient.** Holly E. Jantz, James Armstrong, and Wendy Arjo; Auburn University.

**Toxicant exposure and disease susceptibility in bobcat populations in an urban, fragmented landscape.** Laurel E. Klein, Seth P.D. Riley, Ray Sauvajot, and Robert Wayne; University of California, Los Angeles.

**Estimating a re-colonizing moose population on an urban-suburban watershed in Massachusetts.** Kiana Koenen, Stephen DeStefano, Dan Clark, Ken MacKenzie, Jillian Pereira, David Wattles, and Justin Compton; Massachusetts Department of Conservation and Recreation.

**An assessment of competing priorities in wildlife habitat management by residential owners.** Rachel Samara Levine; University of Massachusetts Amherst.

**Environmental factors as predictors for amphibian movements and occurrence on the Province Lands Road, Cape Cod National Seashore.** Megan McLean, Rachel K. Thiet, Robert P. Cook, Brad C. Timm; Antioch University New England.

**Landscape features influencing residential rodent control behavior and animal movement in two urban areas of California.** Anita T. Morzillo, Seth P. D. Riley, Brian Cypher, and Denise A. Kamradt; US Environmental Protection Agency.

**Reptile monitoring in an urban national park: effects of fragmentation on diversity.** Seth P. D. Riley, Gary T. Busted, Cathy M. Schoonmaker, Lena F. S. Lee; Santa Monica Mountains National Recreation Area.

**Wildlife passage structures facilitate wildlife movement through urban/suburban environments.** Lydia Rogers and Dan Stimson.

**Nighthawk Patrol: Community-based research on an endangered urban bird species in southwest New Hampshire.** Brett Amy Thelen, Ken Klapper, and Rebecca Suomala; Ashuelot Valley Environmental Observatory, Keene, NH.

**An evaluation of the benefit gained through a spatially explicit approach to conserving pool-breeding amphibian habitat.** Daniel R. Zeh, Robert Baldwin, and Jonathan Atwood; Antioch University New England.

**Is suburbanization a mechanism for geographic range expansion in the red-bellied woodpecker?** Janice Zepko and Paige Warren; University of Massachusetts, Amherst.

Wednesday, June 24, Morning

**Session 11. Ecology of urban reptiles and amphibians – moderator Robert Fisher. Room 163C.**

08:30-08:50 **Urban herpetology: diverse opportunities and new horizons.** Joseph C. Mitchell; Mitchell Ecological Research Service, Florida.

08:50-09:10 **Frogs and salamanders in a fragmented landscape: defining relevant scales.** Noah D. Charney and Paige S. Warren; University of Massachusetts Amherst.

- 09:10-09:30 **Characterization of freshwater turtle nesting beaches in an urban environment: implications for management through the proposed use of artificial nesting beaches.** Nicole Richards and Bob Johnson; York University.
- 09:30-09:50 **Impacts of habitat loss, fragmentation, and the introduction of non-native species as a result of urbanization on the western pond turtle in southern California.** Sara L. Schuster and Robert N. Fisher; United States Geological Survey.
- 09:50-10:30 BREAK
- 10:30-10:50 **The road that leads to urbanization: an overview of ecological effects of roads on herpetofauna.** Kimberley M. Andrews, J. Whitfield Gibbons, and Denim M. Jochimsen; Savannah River Ecology Laboratory, University of Georgia.
- 10:50-11:10 **Habitat use and spatial biology of northern watersnakes living along an urban stream.** Abigail M. Pattishall & David Cundall; Wildlands Conservancy, Emmaus PA.
- 11:10-11:30 **Impacts of urbanization on four species of snakes in Southern California.** Jay Diffendorfer, Robert Fisher, Milan Mitrovich, and Michael Anguiano; U.S.G.S., Rocky Mountain Geographic Science Center.

## **Session 12. The human side: human attitudes and policy towards wildlife in urban areas – moderator Michael Mengak. Room 165-169.**

- 08:30-08:50 **Evaluation of euthanasia and trap–neuter–return (TNR) programs in managing free-roaming cat populations.** Paige M. Schmidt, Todd M. Swannack, Robert A. McCleery, and Roel R. Lopez; Texas A&M University.
- 08:50-09:10 **Shaping hunter preferences: how attitudes, motivations, and demographics help determine typologies and landscape choice of urban archery deer hunters and how they influence participation, harvest, and satisfaction.** Nathan Weber and Charles H. Nilon; University of Missouri, Columbia.
- 09:10-09:30 **Assessment of the urban public’s knowledge of white-tailed deer management in two Texas communities.** Jessica Alderson & Clark Adams; Texas Parks & Wildlife Department.
- 09:30-09:50 **How does the public process impact the selection of a nuisance wildlife management plan?** Julianne S. Siegel; Massachusetts Institute of Technology.
- 09:50-10:30 BREAK
- 10:30-10:50 **Feral cats as sacred cows: trap-neuter-return of feral cats and the future of urban conservation.** Travis Longcore and Catherine Rich; The Urban Wildlands Group.
- 10:50-11:10 **Urban wildlife management and free-roaming cats in an urban neighborhood of Olympia, Washington: human perspectives, knowledge, and attitudes.** Lisa Macki; The Evergreen State College, WA.
- 11:10-11:30 **Suggested protocol for the responsible management of wildlife affected by land clearing and the modification of wildlife habitats.** Kevin D. Clark and Michael J. Dwyer; Critter Control, Inc., MI.
- 11:30-11:50 **The role of green building in protecting urban wildlife: planning for sustainable habitats.** Simi Hoque and David Damery; University of Massachusetts, Amherst.

### **Session 13. Wildlife conflicts in urban areas – moderator John Hadidian. Room 101.**

- 08:30-08:50      **Recent progress in porcine zona pellucida (PZP) immunocontraception of white-tailed deer.** Allen T. Rutberg, Ricky E. Naugle, and John W. Turner, Jr.; Tufts University.
- 08:50-09:10      **European badgers: resolving damage problems in English urban environments.** Alastair I. Ward, Richard J. Delahay, David P. Cowan; The Food and Environment Research Agency, United Kingdom.
- 09:10-09:30      **A regional approach to resolving conflicts with Canada geese.** David Feld; GeesePeace.
- 09:30-09:50      **The best management practices for resolving beaver - human conflicts: the use of innovative flow device technologies, scope and limits.** Michael W. Callahan, Beaver Solutions.
- 09:50-10:30      BREAK
- 10:30-10:50      **Coyote space use and human interactions in a suburban landscape.** Daniel A. Bogan, Paul D. Curtis, and Gordon R. Batcheller; Cornell University.
- 10:50-11:10      **An interactive website to help people with wildlife conflicts.** Linda Huebner; Massachusetts Society for the Prevention of Cruelty to Animals.
- 11:10-11:30      **Wildlife conflicts in urban areas: an animal welfare perspective.** John Hadidian; Humane Society of the United States.

### **Collaborative research symposium – moderator Tommy Parker. Room 162-175.**

Special session held Wednesday morning, 8:30-12:00.

Other presenters welcome and encouraged! Inquire at the Conference Office, Room 178, or contact Tommy Parker: [tommy.parker@louisville.edu](mailto:tommy.parker@louisville.edu); Tel: 573.356.8667.

**Urban ecology's next top model: reproductive strategies and success of opossums in response to urbanization.** Dylan Allen and Charles H. Nilon; University of Missouri, Columbia.

**The effects of matrix composition on mammalian resource use in urban patches.** Judith Metcalf and Tommy Parker; University of Louisville.

**Urban landscape attributes correlated with resource use and behavior in urban wildlife.** Tommy Parker; University of Louisville.

Wednesday, June 24, Afternoon

**Session 14. Large carnivores in urban areas – moderator Jeff Sikich. Room 163C.**

- 1:30-1:50        **Carnivores, redistribution and humans: patterns and process.** Jon P. Beckmann; Wildlife Conservation Society.
- 1:50-2:10        **Retrofitting dumpsters with bear resistant lids to reduce human-bear interactions in New Jersey.** Amanda M. Makkay, Kelcey Burgess, Andrew S Zellner, and Jane E. Huffman; East Stroudsburg University.
- 2:10-2:30        **Evaluation of aversive conditioning on nuisance activity levels of black bear using low cost GPS telemetry collars.** Nancy A. Comeau, Catherine Callahan, and Andrew A. Timmins; Plymouth State University, NH.
- 2:30-2:50        **Mountain lion movements and kill sites relative to development, roads, and trails in a fragmented, urban landscape.** Jeff A. Sikich, Seth P.D. Riley, Eric C. York, and Raymond M. Sauvajot; Santa Monica Mountains National Recreation Area.
- 2:50-3:30        BREAK
- 3:30-3:50        **Public attitudes towards black bears in Missoula, Montana.** Jerod A. Merkle, Paul R. Krausman, and Melinda M. Booth; University of Montana.
- 3:50-4:10        **The use of GPS/satellite collars to evaluate aversive conditioning on black bears in New Jersey.** Michael Madonia, Andrew Zellner, Jane Huffman, Eugenia Skirta, and Kelcey Burgess; East Stroudsburg University, New Jersey Division of Fish and Wildlife.
- 4:10-4:30        **Where mountain lions roam in Arizona.** Kerry L. Nicholson; University of Arizona.

**Session 15. Wildlife conservation challenges in urban areas: rare and indicator species – moderator Travis Longcore. Room 101.**

- 1:30-1:50        **San Joaquin kit foxes in urban environments: conservation opportunity.** Brian L. Cypher, Christine Van Horn Job, Stephen W. R. Harrison, Samantha Bremner-Harrison, Curtis D. Bjurlin, and Carie M. Wingert; California State University-Stanislaus, Endangered Species Recovery Program.
- 1:50-2:10        **Excluding mammalian predators from diamondback terrapin nesting beaches with an electric fence.** Curtis H. Bennett, Sona Chaudhry, Marjorie P. Clemens, Lacy A. Gilmer, Samantha Y. Lee, Thomas A. Parker, Emily Peterson, Jessica E. Rajkowski, Karen Shih, Sasika Subramaniam, Rachel E. Wells, Jessica C. White, Willem M. Roosenburg, and Lowell W. Adams; University of Maryland.
- 2:10-2:30        **Northern cricket frog: current knowledge, research needs, and potential threats and mitigation in an urban area.** Jack H. Hecht; HDR, Inc. Pearl River, NY.
- 2:30-2:50        **Progress and prospects for recovery of the Palos Verdes blue butterfly, an urban conservation success.** Travis Longcore; The Urban Wildlands Group, CA.
- 2:50-3:30        BREAK

- 3:30-3:50 **Persistence and management of a Blanding's turtle population in a suburban landscape.** Bryan Windmiller and John Berkholtz; Hyla Ecological Services, Inc.
- 3:50-4:10 **Responses of eastern red-backed salamanders to exotic flora and fauna and forest restoration in Inwood Hill Park, Manhattan, New York City, USA.** Ellen Pehek and Susan Stanley; New York City Department of Parks & Recreation.
- 4:10-4:30 **Charismatic animal species and indicators for ecosystem quality: first results from the interdisciplinary BiodiverCity project in Switzerland.** Marco Moretti, Thomas Sattler, Robert Home, Martin K. Obrist, Fabio Bontadina, Nicole Bauer, and Marcel Hunziker; Swiss Federal Research Institute, University of Bern.
- 4:30-4:50 **Promoting pollinator conservation in New York City Parks: a collaborative approach using traditional and unorthodox resources to greatly expand pollinator resources in the urban context.** Edward Toth, Elizabeth Johnson, and Kevin Matteson; NYC Parks & Recreation.

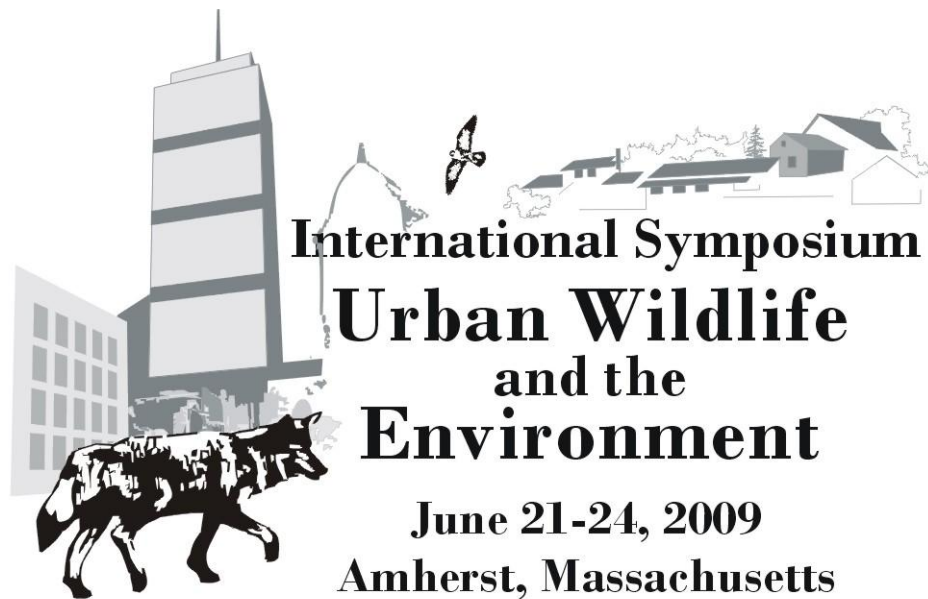
## **Session 16. Urban-adapted species – moderator Justin Compton. Room 165-169.**

- 1:30-1:50 **Do big brains count?** Philip Baker, Stephen Harris, and Richard Sibly; University of Reading, United Kingdom.
- 1:50-2:10 **The roles of food and nest predation in shaping urban bird communities: a study with the northern mockingbird, an urban adapter.** Christine M. Stracey and Scott K. Robinson; Florida Museum of Natural History, University of Florida.
- 2:10-2:30 **Antipredator alarm behavior in gray squirrels studied by means of observation and a mechanical robot.** Sarah Partan, Andrew Fulmer, Maya Gounard, Dana Morrison, and Jake Redmond; Hampshire College.
- 2:30-2:50 **A prickly problem? Movement patterns of urban hedgehogs in the UK.** Claire Dowding, Stephen Harris, and Philip Baker; University of Bristol, United Kingdom.
- 2:50-3:30 BREAK
- 3:30-3:50 **The invasive Cuban treefrog: an emerging urban pest in the southeast.** Steve A. Johnson and Monica E. McGarrity; University of Florida.
- 3:50-4:10 **Historical changes in the bee fauna of New York City.** Kevin C. Matteson and John S. Ascher; Fordham University.
- 4:10-4:30 **The urban and suburban matrix: an important resource for wildlife in a rapidly urbanising world.** Rodney van der Ree, Fiona Caryl, Katrina Thompson, Amy Hahs, Nicholas Williams, Mark McDonnell, Kelly Holland; Australian Research Centre for Urban Ecology, Royal Botanic Gardens Melbourne.



# **Abstracts of Oral Presentations**

**Alphabetically by Lead Author**



**International Symposium**  
**Urban Wildlife**  
**and the**  
**Environment**

**June 21-24, 2009**  
**Amherst, Massachusetts**

### **First evaluation of 4-posters, passive acaricide applicators, on a non-target animal**

Arthur M. Abrams<sup>1</sup>, John Carroll<sup>1</sup>, and Lowell W. Adams<sup>2</sup>; <sup>1</sup>USDA, ARS, Beltsville Agricultural Research Center, Beltsville, MD, <sup>2</sup>University of Maryland, College Park, MD. Contact: [art.abrams@ars.usda.gov](mailto:art.abrams@ars.usda.gov); 301-504-8588.

The increase in white-tailed deer (*Odocoileus virginianus*) in suburban environments of the mid-Atlantic and Northeast states has facilitated a rapid expansion of Lyme disease. To exploit the feeding relationship of the female adult black-legged deer tick (*Ixodes scapularis*) upon deer, researchers of the USDA, Agricultural Research Service devised a strategy of treating deer with acaricides using 4-posters, topical acaricide applicators that passively medicate deer as the animals feed on corn provided as bait. The success of this strategy was predicated upon a subsequent reduction in the abundance of nymphs, the life stage most commonly implicated in the transmission of *Borrelia burgdorferi*, the causative agent of Lyme disease, to humans. Treatment of deer with acaricides may also reduce populations of lone star ticks (*Amblyomma americanum*) for which white-tailed deer are the principle host. Lone star ticks bite humans, transmit zoonotic diseases, and decrease public enjoyment of the outdoors. The corn provided by 4-posters also attracts small and medium-sized animals that are hosts of deer ticks and lone star ticks, including gray squirrels (*Sciurus carolinensis*), a putative reservoir of *Borrelia*. To determine the efficacy of 4-posters in controlling ticks on squirrels, we sampled distinct populations: those that visited 4-posters and those that were isolated from 4-posters by distance or anthropogenic barriers. In the spring and summer of 2001 squirrels were trapped, anesthetized, and examined for ticks. Significantly fewer ticks were found on squirrels that visited 4-posters than on squirrels that were not in contact with 4-posters. These results support the hypothesis that 4-posters may be useful in reducing tick infestations on animals other than deer, which may aid in reducing the local abundance of deer ticks and lone star ticks.

### **Urban wildlife management is not a technique**

Clark E. Adams, Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, TX. Contact: [ce-adams@tamu.edu](mailto:ce-adams@tamu.edu); 979-845-8824. Kieran J. Lindsey, College of Natural Resources, Virginia Polytechnic Institute and State University, Blacksburg, VA. Contact: [klindsey@vt.edu](mailto:klindsey@vt.edu).

One of the common problems associated with introducing urban wildlife management (UWM) as part of the curriculum in the wildlife sciences has been the simplistic notions our colleagues, students, and others have regarding its conceptual framework. For example, the “raccoon in a garbage can” always seems to become the summative explanation of urban wildlife management. Other reductionist definitions include animal damage control, or that UWM is a particular suite of techniques peculiar only to urban areas. The latter problem is of our own making given the inclusion of UWM in the *Wildlife Management Techniques Manual* published by The Wildlife Society. Truth be known, wildlife management techniques primarily consist of catching, identifying, marking, and counting wild animals flavored with a healthy dose of formulae and statistics to add scientific rigor to the first four activities. UWM is another expression of the depth and breadth of human involvement with wild things. This presentation will explore an extensive range of concepts that are required to provide a more complete and accurate presentation of UWM to colleagues, students, and the general public. This will be done by examining the many similarities and differences between wildlife management in urban vs. rural habitats. This presentation is going to articulate and summarize the critical curriculum components for courses on UWM. Finally, this exercise will provide a unique identity to the UWM profession which goes far beyond raccoons and techniques.

### **Habitat fragmentation and forest bird diversity in an urban matrix**

Lowell W. Adams, Juliet M. Healy, Fred W. Fallon, Fred K. Pierce, and Gerald R. Tarbell, Department of Environmental Science and Technology, University of Maryland, College Park, MD 20742. Contact: [Ladams4@umd.edu](mailto:Ladams4@umd.edu); 301-405-1178.

The effects of forest fragmentation on songbirds have been studied since the mid-1950s. Researchers have noted that many species are dependent on relatively large forest tracts during the breeding season. Island biogeography theory has provided researchers a framework for explaining these observations. Since 1967, biologists have studied relevance of island biogeography theory for explaining numbers of species on “terrestrial habitat islands.” We studied applicability of the theory on a small, urban scale. Our study was conducted on the 343-ha NASA Goddard Space Flight Center in Greenbelt, Maryland. During June of 2002, breeding birds were surveyed with point counts and transect counts during the early morning hours (sunrise to 9 am). A separate owl survey was conducted March – May 2002 by playing tape recordings of owl calls to elicit responses of breeding owls. Seventy species of birds were recorded during the breeding bird survey. Small forest fragments (average size = 0.4 ha) contained roughly half the number of species in large (average size = 15.8 ha) and medium (average size = 2.8 ha) fragments. Small fragments did not provide habitat for “area sensitive” species in need of conservation. Three species of owls were recorded and all were located in large forest tracts. Any additional fragmentation of remaining forests at NASA Goddard will further impact forest bird species most in need of conservation. Species most likely to be lost with further fragmentation are summer tanager, black-and-white warbler, and worm-eating warbler; populations of others will decline. Any loss or modification of the larger forested fragments at NASA Goddard will likely be detrimental to the 3 owl species as well.

### **Multifunctional green corridors in suburban landscapes: spatial concepts and design strategies**

Jack Ahern, Landscape Architecture and Regional Planning, University of Massachusetts, Amherst, MA 01003. Contact: [jfa@larp.umass.edu](mailto:jfa@larp.umass.edu).

Suburban landscapes often contribute to habitat fragmentation and reduced connectivity for wildlife habitat and movement due to the spatial configuration of the built environment (buildings and roads) and the lack of ecologically-informed landscape design practices. Suburban landscape plantings are generally limited in species, age, size, diversity, and structural complexity. Alternative spatial concepts are proposed for multifunctional green corridors in suburban landscapes that can address the typical ecological limitations of suburban landscape plantings. The spatial concepts are organized by scale, available space, and alternative establishment and management practices and strategies.

### **Assessment of the urban public’s knowledge of white-tailed deer management in two Texas communities**

Jessica Alderson, Texas Parks and Wildlife Department, and Clark Adams, Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, TX. Contact: [jessica.alderson@tpwd.state.tx.us](mailto:jessica.alderson@tpwd.state.tx.us); 979-777-3033.

Previous studies have addressed the public’s attitudes concerning the most acceptable white-tailed deer management techniques in urban areas. This study examined the degree to which urban residents’ deer management preferences were grounded in an adequate knowledge base, an understanding and acceptance of available and appropriate management strategies, personal involvement in deer management, and selected demographic characteristics. Two Texas communities, Lakeway and Hollywood Park, were chosen for this study. Since the 1990s, urban deer herds have negatively impacted these communities through increased deer-vehicle collisions, defined browse lines throughout the community, and human-deer encounters. An internet survey was developed that asked residents a series of questions about the deer herd in their community which included: perceptions of numbers, personal interactions, personal economic losses, acceptable and actual management methods and personal involvement, management responsibility,

expected management results, knowledge about urban deer, and best methods of disseminating information and educational materials to urban residents. Postcard invitations were sent to a random sample of Lakeway (N = 4,090, n = 704) and Hollywood Park (N = 1,547, n = 616) residents. The study revealed that many Hollywood Park and Lakeway residents lacked the basic knowledge about deer ecology and management. They were unfamiliar with deer biology and the consequences of not managing urban deer herds. This information can be used to assist communities, as well as Texas Parks and Wildlife, to develop appropriate educational materials that will provide relevant, current, and accurate information about urban deer population ecology and management for the urban resident. The methods of this study serve as a useful tool for others to develop pro-active management strategies for controlling over-abundant urban white-tailed deer populations and aid in reducing the conflict between urban deer managers and the public.

### **Reproductive strategies of opossums in an urbanized environment.**

Dylan Allen and Charles H. Nilon. University of Missouri, Department of Fisheries and Wildlife Sciences, 302 ABNR, Columbia, MO 50201.

Urbanization is increasing at a faster rate than ever before, with the majority of Americans now living in urban environments. This has resulted in a need to better understand urban ecosystems for both conservation and human-wildlife conflict prevention efforts. It is understood that wildlife populations occurring in cities must cope with different environmental forces than those living in more traditional systems. These different forces result in different behaviors and strategies among urban wildlife populations when compared to their rural counterparts. Reproductive strategy has been one of the aspects of life history to shift due to the pressures of living in an urban environment, with longer life spans, higher population densities, and high resource availability being cited as the probable causes. There has been little work done examining the details of the reproductive strategies of medium-sized mammals in urban areas to date. This study seeks to remedy this gap in the literature by determining the reproductive strategies used by opossums (*Didelphis virginiana*) in various environments within Baltimore, MD. This study will result in a better understanding of the environmental factors that influence reproductive strategy of medium-sized mammals living in urban habitats.

### **Wildlife management in a heavily urbanized region: Cook County, Illinois**

Chris Anchor, Forest Preserve District of Cook County, Illinois, 536 North Harlem Ave., River Forest, IL 60305. Contact: [crizzo299@hotmail.com](mailto:crizzo299@hotmail.com); 847-798-0354.

Chicago is one of the largest cities in the nation and lies within the Cook County metropolitan area. Cook County is also one of the most highly urbanized counties in the country. Even with all the urbanization, forest preserves make up about 11% or 68,000 acres in the county. The types of habitat on these 68,000 acres consist of marshes, forests, prairies, and recreational lands, such as turf and ball fields. Many of the lands have been impacted by urbanization. Wildlands have been managed to regain their presettlement condition. Our mission to "...restore, restock, protect and preserve... said lands together with their flora and fauna... for the education, pleasure, and recreation of the public" is fulfilled by our Department of Resource Management through a wide variety of educational programs, wildlife management, and restoration. The Wildlife Division is responsible for maintaining records of flora and fauna, collaborating with others, and coordinating research projects. This type of environment provides opportunity for research relating to urbanization, fragmentation, and human/animal interactions. Some of the past and ongoing projects focus on the coyote, Canada goose, gray fox, white-tailed deer, raccoon, opossum, skunk, eastern massasauga rattlesnake, bats, and wetland birds. The Wildlife Division is also responsible for management of white-tailed deer and the use of wildlife as zoonotic disease biomonitors.

### **The road that leads to urbanization: an overview of ecological effects of roads on herpetofauna**

Kimberly M. Andrews<sup>1</sup>, J. Whitfield Gibbons<sup>1</sup>, and Denim M. Jochimsen<sup>2</sup>; <sup>1</sup>Savannah River Ecology Laboratory, University of Georgia, Aiken, South Carolina, 29802, USA; <sup>2</sup>Department of Biological Sciences, Idaho State University, Pocatello, Idaho, 83209, USA.

Roads are the ultimate manifestation of urbanization, providing an essential connectivity within and between rural and heavily populated areas. The ecological impacts roads have on herpetofauna across temporal and spatial scales are profound, beginning during the early stages of construction and progressing through to completion and daily use. We provide examples of physiological, ecological, and behavioral traits inherent among herpetofauna that enhance their susceptibility to habitat alterations and environmental changes that can result from the development as well as the use of roads. We emphasize areas in which impacts on herpetofauna have not yet been documented, but are likely. We also identify potential threats to amphibians and reptiles by noting and discussing previous research in road ecology that is applicable. The most obvious impacts of roads are direct effects, which result in injury or death as a consequence of road construction followed by on-road mortality (roadkills) from contact with vehicles. In addition to the more measurable direct effects, road impacts are compounded further by a variety of indirect effects of roads on herpetofauna that can be pervasive through habitat fragmentation and alteration that extend to population and community level impacts. By identifying herpetofaunal susceptibilities and providing concrete examples of road impacts, we offer an ecological framework that can serve to suggest research questions and encourage investigators to pursue goals that relate to both direct and indirect effects of road development and subsequent urbanization on herpetofauna. Lastly, we present current and possible approaches for resolving and preventing conflicts between wildlife and roads.

### **Do big brains count?**

Philip Baker, University of Reading, UK; Stephen Harris, University of Bristol, UK; and Richard Sibly; University of Reading, UK.

In evolutionary terms, urban habitats are a very novel environment and are widely assumed to be associated with a range of factors that could negatively affect urban wildlife. These factors include, for example, the destruction and fragmentation of natural and semi-natural habitats, roads and traffic, an abundance of non-native plants, changes to key nutrient cycles, the increased abundance of some predators, and widespread disturbance by humans and companion animals. Consequently, we may expect urban dwelling wildlife species to exhibit traits that enable them to survive and thrive in the presence of such potentially negative factors. Phylogenetic analyses of birds have suggested that relative brain size (a proxy measure for intelligence and/or adaptability) significantly affects a species' ability to invade novel habitats where it has been introduced by humans and to adapt to changes in agricultural landscapes. In this presentation, we will (i) examine the possible influence of relative brain size in birds and mammals as a factor affecting the presence/absence of species in urban areas, and (ii) discuss the roles of species' traits versus behavioral plasticity in the context of adaptability to urban life.

### **Comparing arthropod diversity and trophic dynamics between residential landscapes and desert patches in Phoenix: long-term monitoring and experimental studies**

Christofer Bang<sup>1</sup>, John L. Sabo<sup>1</sup>, and Stanley H. Faeth<sup>2</sup>; <sup>1</sup>School of Life Sciences, POB 874501, Arizona State University, Tempe, AZ 85287-4501; <sup>2</sup>Biology Department, The University of North Carolina at Greensboro, 312 Eberhart Building, Greensboro, NC 27402-6170. Contact: [christofer.bang@asu.edu](mailto:christofer.bang@asu.edu); 480-274-5781.

Two widely held notions about urbanization are: 1) diversity decreases in urban areas and 2) remnant or restored habitats will have or re-gain the same diversity as natural areas. More recent research has shown contradicting results for both ideas. For over ten years we have monitored arthropod communities with pitfall traps in the Central Arizona Phoenix area in residential areas and compared them to desert and desert

remnant sites. We found that diversity in mesic yards varied similar to desert sites, albeit with a different community composition, while xeric yards and desert remnants experienced a dramatic decline in diversity over the 10-year period. Our results stress the complexity and seemingly unpredictable effects of urbanization on arthropod diversity superimposed on seasonal and regional climatic patterns. To explore underlying mechanisms for community composition, a large scale field experiment was initiated to study potential differences in trophic dynamics. We manipulated limiting resources to a common shrub, and surveyed the associated arthropod communities. The results revealed different dynamic patterns in trophic organization, indicating resource limiting processes in natural desert areas, and top-down forces dominating in urban residential areas. The strength of these processes and how they may be altered has yet to be determined, but our combined results call for new landscape management practices.

### **More than just White House raccoons or cherry tree beavers: managing for wildlife in the national parks of the National Capital Region**

Scott Bates, Center for Urban Ecology, National Park Service, 4598 McArthur Blvd, NW, Washington, D.C. Contact: [scott\\_bates@nps.gov](mailto:scott_bates@nps.gov); 202-342-1443-226.

Open spaces make up 15% of the National Park Service's National Capital Region. Within the last 20 years there has been a shift towards enhancing and maintaining open areas to directly or indirectly benefit wildlife. These areas include grasslands, wetlands, and agricultural leases. The shift in management practices benefits small mammals and grassland birds. Manassas National Battlefield established 600 acres of warm season grasses between 1998 and 2003. In 2005, a pair of Henslow's Sparrows (*Ammodramus henslowii*, a state-threatened species) was seen in the park during the breeding season. The park was included as part of the National Audubon Society's Important Bird Areas in 2005. Two additional small mammal species were caught during post-fire monitoring at Antietam National Battlefield in 2008. Monocacy National Battlefield has been monitoring small mammals for 3 years prior to the planned establishment of warm season grasses in a section of the park. A wetland management plan is expected to be implemented at Anacostia Park in 2011 to manage resident Canada geese (*Branta canadensis*) and restore historic wetland habitat.

### **Carnivores, redistribution and humans: patterns and process**

Jon P. Beckmann, Wildlife Conservation Society, North America Program, 301 N. Willson, Bozeman, MT 59715. Contact: [jbeckmann@wcs.org](mailto:jbeckmann@wcs.org).

The disappearance or removal of carnivores from systems across the globe has resulted in degraded or simplified ecosystems. However, the more subtle impacts of redistributions of carnivores at more localized scales on ecological functionality have received scant attention. At the interface of the Great Basin Desert and Sierra-Nevada Range, including the Lake Tahoe Basin, black bears (*Ursus americanus*) have historically been ecologically restricted, but they have recently experienced a rapid non-equilibrium response to increasing humans. To assess possible effects at contact zones, I tested predictions of resource-based models, first by contrasting biological features of individual bears between urban (experimental areas) and wildland areas (control areas), and second by considering temporal changes in life-histories and ecology that span almost 20 years. Among documented changes for bears from 1990 to 2009 were: (i) declines of mean home range size for urban males and females relative to wildland bears; (ii) increases in mean body mass for urban bears relative to wildland animals; (iii) alterations of denning chronology for urban bears; (iv) shifts in the pattern and amount of daily activity for bears in urban areas relative to wildland conspecifics; (v) alterations of fecundity levels for urban females; (vi) bear densities which increased 3+ fold in urban areas compared to baseline, historical densities; and (vii) the creation of sink habitats in urban areas ( $\lambda = 0.75$ ). I address the question of whether an increase in the prevalence of individuals in a geographical region reflects a population increase or a landscape-level redistribution. The results indicate that expanding but clumped urban foods facilitated a rapid redistribution of bears across this arid landscape. I will discuss the impacts of this redistribution on ecological functionality of bears in this

system. The careless provisioning of food, whether deliberate or unintended, may be operating at scales substantially larger than those I describe.

### **Excluding mammalian predators from diamondback terrapin nesting beaches with an electric fence**

Curtis H. Bennett, Sona Chaudhry, Marjorie P. Clemens, Lacy A. Gilmer, Samantha Y. Lee, Thomas A. Parker, Emily Peterson, Jessica E. Rajkowski, Karen Shih, Sasika Subramaniam, Rachel E. Wells, Jessica C. White, Gemstone Program, 0100 Ellicott Hall, University of Maryland, College Park, MD 20742; Willem M. Roosenburg, Department of Biological Sciences, Ohio University, Athens, OH 45701; and Lowell W. Adams, Department of Environmental Science and Technology, University of Maryland, College Park, MD 20742. Contact: [Ladams4@umd.edu](mailto:Ladams4@umd.edu); 301-405-1178.

Diamondback terrapin (*Malaclemys terrapin*) populations in the Chesapeake Bay region of the United States have declined from their historic abundance because of multiple factors, including commercial harvesting, habitat loss due to human development and erosion, drowning in crab and eel pots, and accessibility of nests to predators. In areas with high raccoon (*Procyon lotor*) and red fox (*Vulpes vulpes*) populations, predation on diamondback terrapin nests by these mammals can be substantial. This has been particularly true in metropolitan areas where densities of raccoons and foxes may be higher than in rural areas. We studied the use of electric fences on terrapin nesting beaches to reduce mammalian predation of terrapin nests. During the summers of 2007 and 2008, we set up treatment (fenced) and control (unfenced) plots on two nesting beaches of the lower Patuxent River near Mechanicsville, Maryland. Our objective was to design and test a system that would allow access to nesting areas for female terrapins and simultaneously exclude mammalian predators. We monitored the plots daily or several times per week throughout the nesting season and recorded the number of intact and depredated nests. Over the 2-year study, the predation rate within treatment plots was 40% (4 of 10 nests) compared to 69% (20 of 29 nests) in control plots. We believe that electric fences have potential as a conservation technique for reducing mammalian predation on diamondback terrapin nests.

### **Coyote resource use in a human-dominated, suburban landscape**

Daniel A. Bogan and Paul D. Curtis, Department of Natural Resources, Cornell University, Ithaca, NY. Contact: [dab93@cornel.edu](mailto:dab93@cornel.edu); 914-815-0317.

The coyote (*Canis latrans*) is now common across nearly all landscapes of the northeastern United States. Detailed ecological studies are important to understand the behavioral ecology of coyotes inhabiting urban locales and their interactions with humans. We studied resource use of coyotes living in Westchester County, N.Y., along the urban-suburban gradient north of New York City. We examined the spatial ecology of coyotes using both VHF- and GPS-based telemetry to identify use of residential areas. Concurrently, we investigated coyote diets using trail-based fecal collections, and identified anthropogenic foods that could lead to negative human-coyote interactions. Preliminary results from the spatial study revealed that 71% of coyote locations (n = 1,987) were in natural lands, and 28% were in residential, recreational, and agricultural areas. Preliminary results from the diet analysis indicated that >50% of the scats (n = 491) collected contained white-tailed deer (*Odocoileus virginianus*) remains, while other natural food items accounted for the remaining food items. Domestic dog remains were not detected in scats, and only 4 scats have contained domestic cat remains (3 of which were collected along one trail during the same sampling period). Based on diet analyses, the risk for negative interactions with coyotes was low. However, a potential does remain for conflicts to occur given the heterogeneous suburban landscape. Overall, territorial coyotes appear to take wild prey items, and remain predominately embedded in natural processes, while avoiding most conflicts with humans in developed landscapes.

### **Coyote space use and human interactions in a suburban landscape**

Daniel A. Bogan, Paul D. Curtis, Department of Natural Resources, Cornell University, Ithaca, NY, and Gordon R. Batcheller, NYS Department of Environmental Conservation, Albany, NY. Contact: [dab93@cornel.edu](mailto:dab93@cornel.edu); 914-815-0317.

The coyote (*Canis latrans*) now inhabits nearly all landscapes in the northeastern United States. However, the management of this mid-sized carnivore in residential areas has been difficult. Urban coyote behavior is poorly understood, and may create uncertainty for residents and wildlife managers. Detailed field studies and accurate records of human-coyote interactions are necessary to understand the ecology of coyotes inhabiting urbanized landscapes. We are studying the spatial ecology of coyotes in Westchester County, N.Y., directly north of New York City. We are using both VHF- and GPS-based telemetry to measure home range and land cover use. Preliminary results of the spatial ecology study indicated that coyote home ranges ( $n = 26$ ) averaged  $5.53 \text{ km}^2 \pm 3.18 \text{ S.D.}$ , and ranged from  $1.16 - 12.02 \text{ km}^2$ . The majority of coyote locations ( $n = 1,987$ ) were located in natural lands (71%), and 28% were in residential, recreational, and agricultural areas. In addition to the field study, we are monitoring a statewide, systematic database of coyote incident reports recorded by New York State Department of Environmental Conservation (NYSDEC). During May 2005 - May 2007, NYSDEC recorded 269 incident reports. Interactions with pets accounted for 35.3% of the reports, and 53.6% included novel to occasional sightings of coyotes in residential areas. While our findings from telemetry indicate the risk for negative interactions was relatively low, the reported conflicts were broad in nature and often involved pets. Overall, resident coyotes appear to live in natural areas and remain embedded in natural processes, while avoiding human interactions in developed landscapes. Because of frequent coyote sightings near residential areas, there is a need for public education so that landowners can live with coyotes, and respond appropriately to high-risk situations.

### **Space use and movement patterns of bobcats in Orange County, California.**

Erin E. Boydston<sup>1</sup>, Lisa M. Lyren<sup>1</sup>, Robert N. Fisher<sup>1</sup>, and Kevin R. Crooks<sup>2</sup>; <sup>1</sup>USGS Western Ecological Research Center; <sup>2</sup>Colorado State University Department of Fish, Wildlife, and Conservation Biology. Contact: [eboydston@usgs.gov](mailto:eboydston@usgs.gov); 714-508-4704.

We examined space utilization patterns among bobcats across a network of nature reserves of varying sizes in the most densely human-populated county in Southern California. Using GPS-telemetry collars during 2002-2007, we tracked 18 male and 14 female bobcats up to 6 months each. To study movements, we scheduled collars to collect GPS locations every 15 min during time bouts lasting 2 to 4 hours. We obtained an average of  $527 \pm 167$  (SEM) high-quality GPS locations per individual, and found that  $93 \pm 3\%$  of each bobcat's GPS-locations were within natural areas and the distance of locations to the nearest urban edge averaged  $432 \pm 67$  m. Overall, males had larger home ranges than females, but this typical bobcat sex difference was less apparent in the more fragmented portions of the landscape where bobcats were closer to or more often in developed areas. GPS data indicated that most collared males ranged across roads, at least on occasion. Collared females living in more highly fragmented areas crossed roads as frequently as males, while females in areas of relatively intact contiguous habitat did not encounter roadways. Although we generally could not determine whether collared animals crossed over or underneath roads, males and females appeared to face similar mortality risks from vehicles. Of bobcats found dead on roads during 2005-2007, 16 were male and 15 were female.

### **A roof for the birds: creating bird habitat on the Portland Mausoleum roof**

Kelly Brenner, Landscape Architecture Student, University of Oregon. Contact: [kellybrenner@gmail.com](mailto:kellybrenner@gmail.com); 971-404-7617.

Loss of habitat is a serious threat to the avian world, so if you could easily place a habitat patch the size of a city block right in the middle of the city why wouldn't you? Eco-roofs incorporate habitat into urban locations on existing buildings and infrastructure. Roofs offer a safe location for foraging or nesting away



from ground predators. As a landscape architecture student at the University of Oregon, I proposed creating habitat for local bird species on a roof for my final comprehensive project. The Portland Mausoleum sits in view of downtown Portland, Oregon, alongside the Willamette River, overlooking Oaks Bottom Wildlife Refuge and surrounded by a residential neighborhood. The building's roof is over an acre in size and consists of many different levels. The focal species for my proposal is the common nighthawk. Four habitat types were incorporated into the expansive roof including prairie, rocky outcrop, brownfield and sedum along with habitat elements to attract insects and birds to perch, forage or roost. These habitat types have the potential to be tested and replicated on other city buildings in the Pacific Northwest. Because it was all designed as a light-weight, extensive green roof, it could be easily replicated. Recognizing the urban composition is not going to change dramatically to add or improve habitat, green roofs offer creative ways to incorporate valuable habitat into the existing urban fabric.

### **Altered predator-prey relationship in urban landscapes: the coyote and the goose**

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It is generally accepted that urbanization has the potential to alter predator-prey relationships; however, alterations in this relationship resulting in top-down effects for a top carnivore have rarely been demonstrated. Coyotes (*Canis latrans*) have recently become top predators in many North American metropolitan landscapes, but their ecological role in such landscapes is poorly understood. We assessed whether coyotes can exert top-down control on Canada geese (*Branta canadensis*) in the Chicago area. Within this system, nest predation appears to be a limiting factor. Thus, our objectives were to: 1) identify the relative importance of coyotes on goose nesting success, and other population dynamics and 2) use our data to model the effects of coyotes on the growth rate of the goose population to determine what degree top-down pressure is affecting the goose population. To identify the relative role predators have on Canada goose population dynamics, we monitored 286 nests in 2005 using time-lapse infrared video cameras, plasticine eggs and/or sign collected at depredated nests. All 3 techniques only identified raccoons and coyotes as nest predators. Raccoons and coyotes were responsible for 22-25% and 75-78% of all Canada goose nest depredation, respectively. To determine the potential influence of coyotes on the Canada goose population, we created a Canada goose matrix population model that includes variables such as coyote predation on adults and nests as well as coyote influence on nest desertion. Using the base population model we calculated the Canada goose population to be increasing with  $\lambda=1.055$ . The removal of all coyote influence on the goose population increased  $\lambda$  to 1.214. Model elasticity suggested nest predation was the most important coyote related factor; the removal of coyote nest predation from the model resulted in a  $\lambda = 1.157$ . Our modeling results suggest coyotes were serving as a limiting factor for the Chicago areas Canada goose population.

### **The best management practices for resolving beaver-human conflicts: the use of innovative flow device technologies, scope and limits**

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The return of the North American beaver (*Castor canadensis*) to its native range across the continent has resulted in land use conflicts with humans. In the absence of beavers, roads, homes, businesses, railroads, and utilities were often built in historic beaver wetland habitat. Often human developments are threatened by flooding when beavers dam streams to create their ponds. In recent years due to habitat scarcity, beaver conflicts have become increasingly common in highly developed settings. Traditionally, the primary beaver management tool had been nuisance trapping to remove the offending beavers and recreational trapping to control the population. However, with the decline of interest in recreational trapping, beaver populations steadily increased even where trapping was not restricted. Beavers are a North American keystone species, which makes maximizing their presence on the landscape of vital ecological importance. Trapping to

control beaver problems is invariably a reactive management approach and one that results in the loss of numerous beaver-created wetland functions, as well as biodiversity. Over the past 10-15 years innovative, nonlethal methods of resolving beaver conflicts with water control devices (flow devices) have been developed and thoroughly field tested. They have been proven to be the most cost-effective, long-term, environmentally friendly, and humane method for resolving most beaver conflicts. The presenter, Michael Callahan, owner of Beaver Solutions™ has personally installed successful flow devices at over 700 beaver conflict sites since 1998. Most of these installations have been in Massachusetts, which is the 4<sup>th</sup> most densely populated state in the U.S. He will share his wealth of knowledge and experiences resolving beaver conflicts in urban settings, discussing the pros and cons of both flow devices and beaver trapping.

### **Frogs and salamanders in a fragmented landscape: defining relevant scales**

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Studying and conserving wildlife impacted by urbanization requires us to select appropriate spatial scales over which to measure and preserve habitat. Given an organism sensitive to forest fragmentation, such as a pond breeding amphibian, how large of an area must be preserved in order to maintain a viable population? If the breeding pond is the population center, at what distance from the pond does deforestation impact the amphibians? Wetland protection regulations mandate buffer zones around ponds, but are the sizes of these buffers ecologically relevant? We used data from 387 vernal ponds in western Massachusetts to determine the appropriate scale for protecting populations of vernal pool breeding amphibians. The study sites included urbanized, agricultural, and fully forested areas. Using GIS, we evaluated the distance from ponds at which the amount of deforestation best predicts the presence or absence of amphibian breeding activity within the focal pond. We calculated percent forested area within 2 types of buffers each with 15 different radii ranging from 50 m to 1500 m. We also constructed models for presence as predicted by both distance to nearest forest patch (for ponds in fields) and distance to nearest non-forest patch (for ponds in forest). The ideal buffer radius for the models ranged from 600 m to 1200 m. Although wood frogs (*Rana sylvatica*) bred in vernal pools much farther from forest than spotted salamanders (*Ambystoma maculatum*), presence of both species was best predicted by percent forest within similar sized buffers. These data suggest that both published migration distances and current wetland regulations offer a much smaller scale than is relevant for preserving populations of pond breeding amphibians.

### **Suggested protocol for the responsible management of wildlife affected by land clearing and the modification of wildlife habitats**

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The suggested protocol for land clearing provides guidelines to ensure that fair, reasonable, and appropriate measures are available to those involved in the destruction or modification of wildlife habitats: the overall purpose being to minimize the adverse effects on wild animal welfare and conservation. The principles set out in this protocol are for the guidance of land management and real estate developers, municipal planners, plant and machinery operators, lumber companies, farmers, and any other person, entity, or agency involved in activities that are likely to cause the displacement or death of wild animals, either directly or indirectly, as a result of destruction, modification, or disruption of wildlife habitats. The protocol emphasizes the responsibilities of all relevant parties to: take all reasonable steps necessary to prevent cruelty and/or suffering to animals; minimize the loss of wildlife caused directly or indirectly by development or land clearing; and to conserve, as much as possible, the ecological values of development sites and their surrounding natural environment. The protocol will help in reducing conflicts between people and wildlife, including but not limited to animal/vehicle accidents, destruction and damage to homes/structures and property, crop damage, and aircraft strikes. It was adapted from Steve Irwin's Wildlife Warriors sponsored Code of Practice used in Australia.

### **Regional movements, food resources, and use of water supply reservoirs by ring-billed and herring gulls in central Massachusetts**

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Quabbin and Wachusett reservoirs are located in central Massachusetts and serve as the unfiltered drinking water supply to over 2 million people in metropolitan Boston. High concentrations of nightly roosting gulls on each water body during the fall and winter have necessitated a daily bird harassment program to maintain water quality standards. While the bird harassment programs have successfully moved and kept birds away from water intake structures, they have allowed roosting in other areas of the reservoirs. Although harassment programs have been conducted at each reservoir for several years, very little basic information was known about the birds being harassed. In February 2008, a study was initiated to capture and mark ring-billed (*Larus delawarensis*), herring (*L. argentatus*), and great black-back gulls (*L. marinus*) with either colored wing-tags or satellite transmitters. To date, over 300 birds have been wing-tagged and 17 birds (7 ring-billed, 9 herring, 1 black-back) have been fitted with satellite transmitters. Information from marked birds will be used to determine movement patterns within Massachusetts and regionally, to identify food resources, and to determine the relative importance of Quabbin and Wachusett reservoirs as nightly roosts.

### **Elk behavioral response to varying levels of human predation risk: implications for wildland-urban interface elk management**

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Elk (*Cervus elaphus*) have been an increasing ungulate species throughout the west, especially in the wildland-urban interface (WUI). The ability of wildlife managers to use public hunting as a management tool for these elk populations has been limited given the resistance WUI homeowners have to hunting near their homes. As an example of this problem, the intrinsic growth rate of the North Hills Elk Herd, in Missoula, has been about 11% since the early 1980s, and the herd now numbers over 300 animals. North Hills landownership is a complex matrix of public and private lands that range from partial to complete exclusion of hunting, thus elk harvest is low and provides little population level regulatory ability. Additionally, anti-predator response of elk towards humans has diminished, increasing habituation. Little research has been done assessing the effects human hunting has on elk anti-predator behaviors of vigilance, flight response, and avoidance in the WUI. Behavioral responses of elk were measured at low, medium, and high levels of human predation risk during and following hunting season to determine temporal variation in anti-predator behaviors of elk towards humans. Preliminary results suggested a decreasing trend in anti-predator response to humans following hunting season. Knowledge of elk anti-predator behavior will allow managers to better understand the degree of hunting necessary to reduce elk habituation while providing needed information on the efficacy of current hunting seasons for managing WUI elk.

### **Evaluation of aversive conditioning on nuisance activity levels of black bear using low cost GPS telemetry collars**

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Human-wildlife conflicts caused by black bears (*Ursus americanus*) utilizing anthropogenic food sources have been an increasing challenge for wildlife managers. Food-conditioned bears become habituated to and frequent human-occupied areas raising concern for both the communities and wildlife managers. Complaints of nuisance activity by black bears in New Hampshire have increased 57% since the mid-

1990s. We tested 2 commonly used non-lethal deterrents (i.e., rubber projectiles, trained bear hounds) by measuring changes in nuisance activity levels of bears before and after treatment. During 2007 and 2008, 10 bears in 5 northern New Hampshire communities were fitted with radiotelemetry collars equipped with low-cost GPS data loggers. Capture sites included areas containing dumpsters/garbage (8) and backyard birdfeeders (2). Eleven treatment attempts were made on bears in 3 communities including 8 rubber projectiles and 3 with trained hounds. The ability to execute hazing attempts was disproportionately higher with trained hounds (100%) as compared to rubber projectiles (12.5%). Preliminary results suggest that neither method was successful in deterring long-term repetitive nuisance activity as treated bears did return to the communities in which treatments were administered. Subsequent objectives included quantifying spatial and temporal habitat use within or adjacent to human-occupied areas and experimenting with a low-cost technique of collecting fine-scale spatial data utilizing small GPS data loggers. Technology costs have decreased significantly making short-term deployments of GPS collars a cost effective method of collecting data. This information is essential to predicting patterns of nuisance bear activity, applying targeted management, and identifying features that serve as travel corridors and influence dispersal.

### **Ecology of common raccoon in western Pennsylvania as related to an oral rabies vaccination program**

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Over the past 25 years, raccoon (*Procyon lotor*) rabies has become one of the most important and economically devastating wildlife diseases in the eastern United States. Although current methods of combating rabies infections have slowed the spread of this disease westward, raccoon rabies continues to advance towards the heavily fragmented landscapes of the Midwestern United States. Raccoon movements and densities are landscape dependent; thus future rabies management protocols, designed to eliminate the westward spread of rabies, must take into account the effects that altered landscape compositions and configurations of the Midwestern states have upon raccoon movement behavior. Unfortunately, data critical to the design and implementation of rabies vaccination programs, specifically the influence of landscape attributes on the demographic and movement parameters of raccoons on the leading edge of the rabies enzootic, are lacking. Research on the western front of the current rabies outbreak in western Pennsylvania provides an opportunity to investigate raccoon ecology and landscape fragmentation for the purpose of developing rabies management strategies, particularly for the fragmented landscapes of the Midwest.

### **San Joaquin kit foxes in urban environments: conservation opportunity**

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San Joaquin kit foxes (*Vulpes macrotis mutica*) are federally endangered and California threatened, primarily due to profound habitat loss and degradation throughout their range. Although urban development is one of the main causes of these habitat impacts, kit foxes have persisted in or colonized some urban areas. These urban kit fox populations exhibit higher survival probabilities than those observed in non-urban populations. Whereas larger predators are the primary cause of mortality for non-urban kit foxes, vehicles are the primary cause in urban areas with other causes including poisons, dogs, and accidents (e.g., entanglement in soccer goal nets). Reproductive success also is higher among urban kit foxes compared to non-urban kit foxes. Kit foxes are obligate den users and appear able to locate sufficient denning opportunities in urban areas. In non-urban areas, kangaroo rats (*Dipodomys* spp.) and insects (grasshoppers and beetles) comprise the primary food items consumed by kit foxes, whereas pocket gophers (*Thomomys bottae*), California ground squirrels (*Spermophilus beechyi*), insects (primarily beetles) and anthropogenic items (e.g., trash, pet food) are the primary foods in urban areas. Additionally, food availability likely is more consistent in urban areas, whereas availability in non-urban areas can fluctuate markedly with annual environmental conditions, particularly precipitation. With regards to human attitudes,

kit foxes do not pose a threat to people, do not cause damage, and rarely constitute a nuisance, and therefore urban residents favor conservation of kit foxes in urban areas. With these positive demographics, ecological attributes, and human attitudes, conservation of urban kit fox populations appears quite feasible. Such populations could contribute to the range-wide recovery of San Joaquin kit foxes by increasing overall abundance and number of populations, preserving genetic diversity, buffering against catastrophic events in natural lands, serving as a source of reintroduction stock, and increasing public awareness.

### **Interactions between San Joaquin kit foxes, red foxes, striped skunks, and feral cats in urban environments: implications for conservation of kit foxes**

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Endangered San Joaquin kit foxes (*Vulpes macrotis mutica*) occur in several urban areas and these urban populations potentially could contribute to range-wide conservation and recovery efforts. In these urban areas, kit foxes encounter other carnivores that they rarely encounter in their natural habitat. These species include non-native red foxes (*Vulpes vulpes*), striped skunks (*Mephitis mephitis*), and feral cats (*Felis catus*). These species pose potential threats to kit foxes through interference and exploitative competition and disease transmission. Of 156 kit foxes found dead in Bakersfield, none appeared to have been killed by any of these species. Spatially, all 4 species appear to overlap, although temporal segregation may be employed at times to facilitate such sympatry. All 4 species have been observed using common feeding sites (e.g., feeding stations for feral cats) with occasional simultaneous use, particularly by cats and kit foxes. Red foxes food habits overlap extensively with those of kit foxes, but food availability does not appear to be a limiting factor in urban areas. Red foxes, skunks, and cats all have been observed using dens formerly used by kit foxes, but dens do not appear to be a limiting factor for kit foxes. On 4 occasions, radio-collared kit foxes and skunks were found sharing a common den. Interference competition was not evident between kit foxes and any of the other species. Some exploitative competition may be occurring, but such competition may be ameliorated by an abundance of food and denning sites in urban areas. Thus, competition from red foxes, skunks, and cats does not appear to be a limiting factor for kit foxes. However, the overlapping space use, including occasional den sharing and contact at feeding sites, results in a high potential for transmission of pathogens from these other species to kit foxes. Therefore, strategies to mitigate epidemiological threats to kit foxes in urban areas may be warranted.

### **Changing roles: re-tooling staff for increasingly urban work**

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Natural resource agencies are being called upon to provide solutions to increasingly complex challenges at the wildland-urban interface (WUI). Communities are growing rapidly and landowners' management goals often conflict. Residents may not understand the benefits of resource management, and the resulting risks to environmental quality and human quality of life are becoming more apparent. To help meet these needs, the Southern Group of State Foresters led a partnership with the USDA Forest Service, Southern Center for Wildland-Urban Interface Research and Information (SCWUIRI), the University of Florida, and the U.S. Fish and Wildlife Service to develop this WUI professional development program called Changing Roles. This program provides state and federal natural resource agencies with a set of flexible resources to conduct their own training programs aimed toward building skills and tools to successfully tackle WUI issues. The Texas Forest Service and the Texas Parks and Wildlife Department have joined forces to train existing staff using the Changing Roles curriculum. This effort has already produced fruit in new partnerships and better equipped field staff. In April, 2009, Texas completed its first train-the-trainer workshop to reproduce additional training sessions across the state.

### **Between a rock and a hard place: urban wildlife decisions in Fort Worth, Texas**

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Given Fort Worth, Texas' history as "Cow Town," one would think that residents would understand and appreciate the city's connection to the land. As the fastest growing large city in the United States, the city's relationship with the land has been fading into the collective unconscious. While traditional Texans may still value the native landscape and its wildlife as a part of their natural heritage and culture, neo-Texans, including most urbanites and many inhabiting the urban fringe, prefer to keep natural Texas at arm's length. The "not-in-my-backyard" mentality predominates when wildlife issues are discussed. Media reports of free-ranging wildlife often breed concern for public safety. City officials are frequently faced with vocal residents' demands for wildlife control and elimination of habitat. The Fort Worth Nature Center and Refuge is a 1,450+ ha urban green space located in, and owned by, the City of Fort Worth and managed by the Parks and Community Services Department as a natural, native landscape complete with a diverse fauna. The nature center and refuge often finds itself caught between dissenting opinions, especially regarding controversial species such as feral hogs (*Sus scrofa*), coyotes (*Canis latrans*) and American alligators (*Alligator mississippiensis*), when attempting to manage for native wildlife and its habitat. Proactive management, education, and public involvement are used to allay fears and change attitudes among residents and city leaders, allowing the nature center and refuge to engage in active management of wildlife species and their habitats using traditional and standard rural wildlife management methods.

### **Highly successful urban and suburban wildlife: the science of overabundance revisited**

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Successful species can be defined in numerous ways. In evolutionary terms, success can be marked by a species' longevity or persistence in geologic time. In ecological measures, success is equivalent to fitness, which is the ability for an individual to reproduce successfully and pass its genetic material on to succeeding generations. Demographic measures of success in wildlife populations can be manifested by high survival rates (and conversely low mortality). In urban-suburban ecology, high densities and widespread distribution are usually the mark of success: the more common a species is, the more successful it is thought to be. Further, those species that are highly successful are often identified as "overabundant" -- a term that basically means humans think there are too many. A comprehensive review of the science of overabundance was published in a book by that name in 1997 (W. J. McShea et al., Smithsonian Institution Press). The focus of that book was entirely on white-tailed deer (*Odocoileus virginianus*). The term overabundant has since been applied to numerous other species, particularly when those species occur in urban or suburban environments. This talk introduces the session on successful urban and suburban wildlife. I discuss various measures that define successful species in urban and suburban environments and propose ways in which research in this arena can benefit both science and conservation.

### **Impacts of urbanization on four species of snakes in southern California**

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From 1999 to 2006 we performed a series of studies on California kingsnakes (*Lampropeltis getula*), coachwhips (*Masticophis flagellum*), rosy boas (*Charina (Lichanura) trivirgata*), and striped racers (*Masticophis lateralis*) in the urbanized landscapes of southern California. The studies were motivated by different questions yet all included telemetry, 2 included genetic data, and all species were collected during herpetofauna monitoring studies throughout the region. What do these studies tell us about snake responses

to urbanization? First, snakes show a rich and diverse spatial ecology, the causes of which also result in varying responses to urbanization. For example, coachwhips decreased their home range size an order of magnitude in small fragments and may have avoided urbanized areas, while kingsnakes actually spent considerable time in backyards along the wildland-urban interface and showed few changes in home range size in small fragments. Second, from a patch occupancy framework, snakes generally declined with fragmentation but some species were more tolerant than others. Factors affecting occupancy included the type and amount of habitat remaining in fragments, connectivity, and the levels of urban edge. Third, results from movement and patch occupancy studies indicated a diverse suite of deterministic and stochastic processes likely affected snake declines in urban systems. Species-specific life histories altered the impact of edges and roads, lack of connectivity, absence of suitable habitat within a patch, and perhaps increased predation. Fourth, large-scale urbanization, such as the coastal development from the US-Mexico border to Los Angeles, impacts historic patterns of phylogeographic variation. Our history in the southern California landscape leads us to recommend combining phylogeographic studies, large-scale capture-recapture surveys and historical data, and radiotelemetry when studying urbanization. Though time consuming, these methods generate information at different spatial scales and link patterns of occupancy in urban areas to both snake spatial ecology and historic patterns of spatial variation.

### **A prickly problem? Movement patterns of urban hedgehogs in the UK**

Claire Dowding, University of Bristol; Stephen Harris, University of Bristol; and Philip Baker, University of Reading.

Foraging animals typically face the dual problems of locating and acquiring food while simultaneously avoiding predators. Consequently, selection would favor those individuals that are able to adjust the duration and timing of foraging bouts and the course of foraging trajectories in order to optimize net energy gain in relation to food availability and predation risk. For hibernators, such processes are especially important as they must consistently ingest more energy than they expend over many foraging bouts in order that they accumulate sufficient fat reserves to survive the period of torpor. In rural habitats in the UK, Western European hedgehogs (*Erinaceus europaeus*) are thought to be in decline. Yet in suburban areas they can attain relatively high densities, such that this habitat is potentially becoming more important for this species at a national level. In this presentation, we examine the movement patterns of hedgehogs in the city of Bristol in relation to i) habitat availability, ii) the distribution of roads and iii) rainfall and temperature: these results are discussed in the context of the future conservation of hedgehogs in the UK.

### **Attitudes toward coyotes in urban landscapes: management and public outreach implications**

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Understanding and assessing the public's attitudes towards species that live in urban areas is a vital step in creating management plans, increasing knowledge and awareness about wildlife, and fostering coexistence between people and wildlife. Coyotes, as a predatory species, can prompt extreme attitudes, both positive and negative, necessitating that we understand them better. This presentation will explore one such study in the Washington, D.C. metropolitan area, where coyotes are a recent addition to the local fauna, and the resulting implications for management policies. The presentation will highlight differences between groups in the study population (gender and pet owners), as well as attitudes towards specific management tools. Attitudinal research can also help inform the development of effective outreach materials designed to educate the public about living with coyotes in urban areas. Specific messages in the Washington, D.C. metropolitan area study seemed to initiate both positive and negative feelings towards coyotes. For example, focusing on ecological messages such as coyote behavior that parallels ideal human behavior (i.e., monogamous relationships, social behavior, etc.) and messages that express a potential benefit to humans (i.e., coyotes prey on rodents) influenced attitudes in a positive direction ( $p < 0.05$ ). Alternatively, images of coyotes howling and attempts to eradicate the species were viewed negatively ( $p < 0.05$ ). Information

like this can help not only in creating outreach materials and campaigns, but can also provide valuable insight into the attitudes of a community.

### **Urban wildlife education at North American colleges and universities: a 20-year follow-up study**

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The American landscape continues to be urbanized for human needs, resulting in wildlife adapting to human-dominated landscapes and increasing wildlife-human interactions. Many wildlife principles taught in traditional (i.e., rural) wildlife management programs at the college and university level apply to urban wildlife management, but urban and suburban environments pose unique challenges to managing wildlife (and human) populations that require new thinking, research, and training. Adams et al. (1987) surveyed North American colleges and universities offering a wildlife degree program to gauge the extent of urban wildlife research and education being conducted. Among their findings, Adams et al. (1987) discovered that only 5% of all research projects were devoted to urban wildlife, only 8% of surveyed colleges had an urban wildlife program, and urban wildlife courses were offered at only 9% of surveyed institutions. We conducted a 20-year follow-up survey and found that not much had changed. Only 9% of colleges/universities offering a degree in wildlife focused research on urban wildlife, 6% offered an urban wildlife program, and 16% offered a course dedicated to managing urban wildlife. We examine existing urban wildlife courses, identifying common themes and diversity of foci and approaches. Based on the data, we offer a strategy for implementing an urban wildlife curriculum for colleges and universities offering a wildlife degree program in order to adequately educate and train the next generation of wildlife biologists.

### **Ecological restoration in urban parks: the use of “poor” sandy soils to encourage native communities**

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Many of our native plant communities are adapted to nutrient- and moisture-limited soils with low pH. Conversely, many highly invasive, non-native plants that natural resources managers struggle with favor nutrient subsidized, mesic soils with higher pH. To many ecological restoration practitioners with horticultural biases, using low nutrient soils with little or no organic matter as planting media is counter-intuitive. This presentation will examine case studies in which the city of NY Parks & Recreation Natural Resources Group has successfully used sand as a planting substrate for forest, wetland, and grassland restoration projects. Implicit in our approach to ecological restoration is that sustainable ecosystems provide improved habitat for the entire wildlife community. Although some of our restoration projects target colonial wading bird nesting habitat, and 2 of our grassland restoration/creation projects target breeding habitat for area-sensitive grassland nesting birds (e.g., grasshopper sparrow, upland sandpiper, savannah sparrow), in general we are not performing wildlife management in a single-species approach. We perform pre- and post-restoration monitoring that can include fish, benthic invertebrates, breeding birds, heron feeding success, horseshoe crab nesting, winter waterfowl, and other relevant indicators of success.



### **Gotham is wilder than you think**

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The popular perception of New York City rests on its role as a world cultural and financial center with multi-ethnic immigrant communities, iconic bridges, and a landscape of concrete canyons below soaring skyscrapers. What is often overlooked is the city's gargantuan built-scale, economic vitality, and cultural capital are the result of its natural endowment. New York is situated in the Hudson Raritan Estuary, the only east coast estuary to retain its full compliment of historic breeding fish. At the juncture of northern and southern hardiness zones with mountain, coastal plain, and piedmont physiographic and biotic provinces, the city has an abundant and diverse flora and fauna. The City of New York Parks & Recreation's Natural Resources Group has, for the past 25 years, been performing natural resources inventories and assessments of the 12,000 acres of natural area in its portfolio. It formulates management plans and performs wetland, forest, and grassland restoration projects in parklands. These parklands have some of the highest concentrations of Natural Heritage Program-listed plants in New York State and the largest colonial wading bird rookeries in the region. Additionally, these managed areas are surrounded by the densest occurrence of urban peregrine falcon nests in the world. This talk will give an overview of the Natural Resources Group's 25 years of work.

### **City and ring-around-the-city for wildlife in an urbanizing world**

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Wildlife live and move where people are concentrated, and where change is the main theme . . . population growth, urban infill, urban expansion, squatters arriving, heat island increasing, sea level rising, transportation expanding, water-systems increasingly inadequate, commercial development, industrialization, residential spread, and more. The urban species, a mix of natives, non-natives, invasives, naturalized, and the newly adapted, "need" habitat for home and routes for movement. An urban region, composed of all-built metro area (city embedded within) and inner and outer urban-region rings, appears to be the optimum scale and space for understanding, planning and managing. Even worldwide in eco-regions with significant urbanization present, and expected, rare vertebrates are in noticeable decline. Parks, corridors, and other greenspaces in a city support considerable biodiversity, though often not where design and management are greater. Basic options exist to increase habitat, routes, or both for different types of urban wildlife. The inner urban-region ring, subject to the greatest diurnal-to-semipermanent changes, represents the triage zone for wildlife, where big differences in short-term outcome can be accomplished.

In the outer ring, large natural or semi-natural areas with circular connecting corridors offer longer-term stability for wildlife, and radial green corridors to the metro area offer useful linkages for city wildlife, human recreationists, and ecosystem services. Several other designs with flexibility, adaptability, and resilience offer promise for urban change worldwide. In the face of the conspicuous swiftly and powerfully moving urban tsunami, tomorrow's wildlife will differ from today's...and we can mold that future.

### **Urban region perspective on wildlife, roadsides, and road ecology**

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Road ecology principles address three broad objectives: (1) environmentally improve strips alongside the entire road system; (2) create a compatible road network and surrounding emerald network of large natural patches and major wildlife corridors; and (3) reestablish surrounding near-natural water flows and aquatic ecosystems compatible with the road system. Wildlife and roadsides are considered here relative to distinctive spatial patterns in the ring-around-the-city. Priority locations for wildlife underpasses/overpasses should strengthen the ring of large semi-natural areas in the outer portion of an urban region, and then radially connect these outer areas to, for example, green wedges or a ring of large parks close to the city.

Closing at least one strategically located road in every town/county would benefit the region's wildlife and biodiversity. Roads and traffic normally interrupt finer-scale green corridors here used by mostly common species, pests, and some much-appreciated animals; mitigation may be a local, not regional, priority. A major increase in strategically located culverts would produce manifold benefits, including hydrologic flows, wetlands, and amphibian/fish movements. Roadside soil berms or planter structures for noise abatement are useful where busy highways pass close to large natural areas and key wildlife crossings. Indeed, many societal goals can be addressed in the extensive urban-region roadside area, creating attractive, productive variegation for the next generation of America's roadsides. A Massachusetts roadside-design case study for diverse agricultural products close to markets is illustrated with goals, principles, pros/cons, and solutions. Six other societal goals, including different wildlife considerations and a safer highway, are integrated into the example. For most of the issues presented here, studies are scarce; research and pilot projects should have high impact in urban regions, with associated transportation funding and public support.

### **The coy coyote: can we learn to coexist?**

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The extirpation of large carnivores, coupled with the destruction and fragmentation of their habitat, has led to increases in coyote numbers and range throughout North and Central America. As an adaptable, resilient, and intelligent carnivore, coyotes have colonized even the most urbanized cities in the U.S. from Los Angeles to New York City and Austin to Chicago. The abundance of food, water, and shelter found in such humanized landscapes has worked to the coyote's advantage. Intentional and unintentional feeding of coyotes has led to increasing encounters and conflicts. How communities address such conflicts lies at the center of public debate with passionate viewpoints on both ends of the political spectrum. However, many state wildlife agencies and local municipalities lack the resources to effectively implement proactive strategies before sightings and encounters escalate to conflicts, and the lack of agency coordination, combined with a largely uninformed populace, hinder effective conflict resolutions. Moreover, Animal Control Officers at the municipal level are often the first responders to human-wildlife conflicts and lack formal training in human-wildlife conflict mitigation, wildlife ecology, and human dimensions even though all three comprise an increasingly greater portion of their work. All of these factors combined can lead to reactive community responses to coyote-human-pet conflicts that ultimately fail to address the root of many conflicts: a constant and readily available food source and an uninformed populace. The failure to address such issues proactively can lead to a vicious cycle of trapping and killing coyotes and increased political strife over how to address such conflicts. This presentation discusses the challenges and opportunities of living with coyotes in urban landscapes, strategies for reducing coyote conflicts, and suggestions for how communities can implement proactive measures that address the root of conflicts.

### **Temporal patterns of raccoon predation on breeding black-crowned night-herons and double-crested cormorants at an urban park in Lake Ontario**

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Predators can have a significant impact on colonial waterbird reproductive success as well as negatively affect site tenacity. We studied the activity patterns of raccoons (*Procyon lotor*) in a mixed species colony of tree nesting black-crowned night-herons (*Nycticorax nycticorax*) and double-crested cormorants (*Phalacrocorax auritus*) in Tommy Thompson Park, an "urban wilderness" adjacent to Toronto, Canada. In 2007 and 2008, we compared relative tree visitations by raccoons by placing heavy duty foil on trunks of nesting trees (2007: n = 20 heron trees; n = 10 cormorant trees; 2008: n = 20 heron trees; n = 15 cormorant trees). Claw marks, the index of activity, were clearly visible in the foil. In 2007, all the raccoon activity was limited to black-crowned night-heron nesting trees. In 2008, the pattern of tree visitations was more variable (total number of foiled trees with claw marks from May 5 to Aug 7: heron = 35, mixed species =

22, cormorants = 17). In 2008, raccoon activity on heron trees peaked 3 times: mid-May, end of June and the end of July, while activity on the cormorant trees increased in mid-July and peaked at the beginning of August. For all trees monitored, there appeared to be a lull in raccoon activity in mid-June. This colony of black-crowned night-herons is one of the larger colonies in Ontario and provides a partial basis of the Important Bird Areas designation for this site. We recommend installation of predator guards to reduce predation on nesting night herons and further study on citizens which capture raccoons in their neighborhoods and illegally release raccoons at this urban park.

### **Ecology of coyotes in the Chicago region: implications for management**

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Coyotes are found living in most large metropolitan areas across North America, often resulting in conflicts or raising concerns among the public. Unfortunately the public's perception of coyotes is often influenced by media accounts or publications that focus exclusively on conflicts, with little information on the ecology of coyotes in urban landscapes. My objective is to describe some aspects of coyote ecology from a major metropolitan area and discuss how these findings have potential management implications, particularly with regard to the causation and frequency of nuisance coyotes. During 2000-2008, over 300 coyotes were livetrapped and a subsample radio-tracked in the Chicago metropolitan area. Multiple lines of evidence including activity and movement patterns, land use, and diet, indicate that most coyotes avoided people and pets when possible. Consequently, frequency of nuisance coyotes in the population was relatively low, although media accounts would suggest otherwise. Our data suggest that modifying human behavior through education programs or enforced regulations may be an important element of management programs, and may increase the success of targeted removal of problem coyotes at the local level.

### **Urban wildlife conflicts**

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From raccoons parading across the back lawn of the White House to deer denuding the understory of urban forests, conflicts with wildlife in cities and towns continue to increase in number, scope, and complexity. The term "urban wildlife," until only recently considered an oxymoron, all too often now conjures up images of raccoons in chimneys, geese on golf courses, beaver flooding back yards, or coyotes killing cats. This session samples the variety of concepts and issues associated with human-wildlife conflicts in urban environments. Topics range from species-specific problems and their practical, technical solutions to broader social concepts as well as the more theoretical issues associated with urban wildlife conflicts and their resolution. Urban wildlife research and education may be driven by many of the social and economic dimensions of wildlife conflict resolution. The programs, concepts, and codes of practice that make up our efforts to address wildlife conflicts issues will comprise a bridge between the social and ecological components of urban wildlife research and management, and greatly influence the field in its broadest context.

### **Northern cricket frog: current knowledge, research needs, and potential threats and mitigation in an urban area**

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Less than 2.5 cm long, under a gram in weight, and displaying several color phases, the endangered northern cricket frog (*Acris crepitans*) is the smallest and most colorful frog in New York. Its small size and cryptic color patterns make it a difficult species to observe in aquatic habitats where males calling from sites just above the surface of the water are more conspicuous than females. In its terrestrial habitat, the

cricket frog is active during the spring and fall on warm, sunny days. On close approach, cricket frogs are easily stimulated into making 50- to 100-cm hops often resulting in an audible landing. Cricket frogs utilize upland habitats and have been found as far as 450 m from the nearest known calling and breeding sites. Observed movements in the fall are generally away from breeding sites, whereas movements in the spring are generally towards these same habitats, suggesting that some cricket frogs overwinter well outside their breeding sites. In upland areas, cricket frogs are often found in association with ephemeral pools, rock outcrops, stumps, intermittent streams, and seeps. Northern cricket frogs and their habitats have been impacted by development projects and other activities outside the 100 foot mandatory state regulated wetland buffer surrounding confirmed breeding sites. Additional research on upland movements and habitat requirements is critically needed to determine potential direct and/or indirect impacts to cricket frog populations. An educated public and well regulated citizen scientists have become increasingly important in providing information on status, distribution and habitat usage; identifying threats; critically evaluating the contents, statements, conclusions and qualifications of consultants preparing habitat assessments and environmental impact statements; and working with agencies to protect cricket frogs and their habitats.

### **The role of green building in protecting urban wildlife: planning for sustainable habitats**

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Building activities have a profound effect on the natural environment and the habitats of wildlife. Buildings alter the ecology, biodiversity, fecundity of wildlife, and hydrology of the site. This paper addresses some of the issues associated with the construction and development of urban buildings and how these may be mitigated by proactive sustainable design and construction practices. Sustainable planning techniques provide an ethical and practical response to minimize environmental impact and resource consumption. Sustainable land use is based upon the principle that undeveloped, natural, or agricultural land is a finite resource and its development should be minimized. It involves integrating the building with the local ecosystem, considering the geology, topography, solar radiation, and hydrology of the site, while minimizing light pollution and heat islands, and controlling construction operations. These factors have an enormous impact on the environment and arguably promote the survival and recovery of wildlife species that inhabit the landscape. Sustainable site planning offers the greatest opportunity for the integration of the urban and natural environment, and in doing so, the continued existence of urban wildlife. Using a series of green building case studies, this paper will describe new strategies and innovations in sustainable design that have been utilized to preserve and protect wildlife habitats. Key topics will include grayfield remediation, construction activity staging, living roofs, vertical landscaping, stormwater and erosion management, heat island mitigation, and light trespass and pollution reduction.

### **Human-coyote relationships in suburban New York: exploring people's attitudes and experiences**

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Despite urbanization of natural areas, many carnivore species, such as the coyote (*Canis latrans*), persist in suburban landscapes. The close proximity of humans and coyotes in these areas increases opportunity for interactions. Managing human-coyote interactions to reduce negative impacts is of growing interest among wildlife managers and communities. To improve understanding of human-coyote relationships and inform communication initiatives, we conducted a situation analysis. Our inquiry included semi-structured, in-depth interviews with key informants and telephone surveys of residents in 2 suburban areas of New York State. Analysis revealed that awareness of coyote presence and sightings of coyotes were relatively high in the study communities, but problematic interactions with coyotes were uncommon. While problem occurrence was low and about half of the residents surveyed reported enjoying coyotes, concern about coyotes in suburban areas was rather high and tolerance for their presence in most suburban spaces was low. We also evaluated the relation between experience with coyotes and people's attitudes and risk perceptions. Neutral experience (e.g., seeing a coyote) generally was associated with positive attitudes, and

negative experience (e.g., having a problem with a coyote) was associated with negative attitudes and elevated risk perceptions. People living in an area with a longer history of coyote presence tended to express more positive attitudes and less concern than those living with coyotes for a shorter period of time. In sum, our results imply that people may adjust to living with coyotes if negative impacts occur at low and tolerable levels, and that managers and organizations wishing to engage in communication efforts about coyotes may want to target the high concern associated with coyote presence. These conditions may lead to increased tolerance for coyotes and help promote human-coyote coexistence in suburban landscapes.

### **Breeding bird communities and nest survival on Montreal-area golf courses and green spaces**

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It has been suggested that golf courses can serve as wildlife habitat, provided key landscape features are present. Breeding bird communities were characterized on 6 golf courses and 6 green spaces in the Montreal area, Quebec, Canada. Six of these sites were also intensively searched for nests, which were monitored until fledging or failure. Landscape variables were measured to see which ones were the best correlates of avian species richness within and across sites. While there was no difference in the mean number of bird species (golf:  $31 \pm 2.4$  SE; green:  $33 \pm 4.5$  SE), golf courses supported fewer total species (golf: 55; green: 66). However, most of the species contributing to the green spaces' higher cumulative total were found at one site. Species composition differed between golf courses and green spaces, and was most correlated with site size, housing density surrounding the site, and extent of coniferous tree, grass, and vegetated water cover. Over 3 field seasons, 865 nests of 19 species were located and monitored. Our results support the work of others, and suggest that golf course architects can improve habitat quality by: 1) increasing deciduous and coniferous tree cover; 2) increasing native vegetation within and surrounding all water bodies; 3) reducing the amount of highly managed grass area; 4) ensuring large, undeveloped buffers are maintained to prevent a shift in avian community composition with increasing urban sprawl; and 5) ensuring sites are planned as large as possible. Additional analyses concerning possible pesticide contamination and nest survival will further our understanding of urban golf courses' role in avian conservation.

### **Park mallards (revisited)**

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The mallards (*Anas platyrhynchos*) that nest in Massachusetts are the descendants of birds once kept in captivity. Most of these birds do not migrate south but overwinter in the state, primarily at sites where they are artificially fed. Parks and other sites where waterfowl are fed have been important wintering habitat for mallards. We have tracked wintering park waterfowl populations in Massachusetts every 5 years since 1973. We achieved state-wide coverage by the 1988 survey when 12,389 mallards were counted on 153 sites. Mallard numbers peaked in 1993 at 20,110 on 218 sites and declined steadily thereafter (1998 - 16,610 on 247 sites; 2003 - 14,329 on 187 sites; 2008 - 11,596 on 148 sites). The decline appears related to an increase in wintering Canada goose (*Branta canadensis*) populations, which were so few that they were not even counted until the 1983 survey when 1,976 were recorded. Since that survey, Canada geese on "park" sites increased rapidly reaching 4,987 in 1993 and 5,296 in 1998 before declining to 3,335 in 2003 and 1,718 in 2008. Canada geese increased from occurring on 18.3% of the feeding sites in 1988 to 49.7% of the sites by 2003 before declining back to 37.8% of sites by 2008. Like mallards, Canada geese are not indigenous nesting waterfowl in Massachusetts, having originated from flocks once kept as live decoys; their numbers have increased several-fold since the 1970s. As they have done so, there has been a resulting backlash of "No feeding waterfowl" ordinances due to the disgust for fecal matter deposited by the geese. A decline in the number of sites where people feed waterfowl, less feeding at remaining sites, and direct competition between mallards and Canada geese for handouts all appear involved in the decline in wintering mallards at park sites. With a reduction in winter feeding, it is questionable if mallards will be

able to maintain their niche as welfare waterfowl. One bright note may be that the number of mallards counted on the annual aerial coastal Midwinter Waterfowl Survey, often on natural sites, has increased from 425 in 1973 to 5,113 by 2008.

### **The relationship of human density and spatial distribution to human-wildlife conflicts in Massachusetts**

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Massachusetts is the third most densely populated state in the country, with 6 million people spread over 2 million ha. About 280 species of breeding birds and land mammals can be found in Massachusetts. The state is diverse in landscapes, including large cities and expanding suburban areas as well as rural communities and a wide array of natural areas and wildlife habitats. Given the dense human population, mixture of landscapes, and ability of some species to be successful in urban-suburban environments, it is not surprising that conflicts between humans and wildlife occur throughout the state. We compiled and summarized information on human-wildlife interactions collected by the Massachusetts Division of Fisheries and Wildlife from 2001–2007 and compared these to human densities in various communities and regions of Massachusetts. We focused on 3 species (coyotes [*Canis latrans*], white-tailed deer [*Odocoileus virginianus*], and turkeys [*Meleagris gallopavo*]) because they represent a wide spectrum of interactions with humans, including positive and negative observations, depredation, and vehicle collisions. We examined 750 coyote, 2,010 deer, and 192 turkey reports from the public. These records were incorporated into a Geographic Information System (GIS) to compare the percentage of conflicts by species that occurred in urban, suburban, and rural areas, based on human density. We also compared these reports to harvest data to illustrate disparities in conflict locations and harvest locations. By examining these relationships, managers can determine if current management regimes (e.g., education and regulated harvest) have been effective in mitigating human-wildlife conflicts at specific localities.

### **Anthropogenic resources used by Atlantic Coast striped skunks inhabiting coastal waterbird nesting areas**

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Striped skunks (*Mephitis mephitis*) are a well-studied meso-carnivore in North America. However, little is known about their habits in coastal areas that have experienced rapid development. Skunk populations have responded positively to coastal development and urbanization and are an egg predator for rare and threatened plovers, terns, and oystercatchers. During 2004-2007, we captured and radio-collared 50 skunks on coastal waterbird nesting beaches on the island of Martha's Vineyard, Massachusetts and tracked them throughout the year. Skunks foraged on an abundance of invertebrate food available in the intertidal zone, wrackline, and primary and backdune areas of beaches, but they were also drawn to food scraps or camp fires left by humans in the berm area above the high tide line and other resources away from the beach. Of 1,375 observations of active skunks,  $\geq 15\%$  were associated with anthropogenic resources over the course of the study. Through tracking skunks captured on beaches during all seasons, we documented their movements inland for the winter months and identified increased use of anthropogenic resources. Anthropogenic objects or structures provided 8% (88/1096) of resting sites used by skunks between 1 April and 30 September and 27% (52/196) of resting sites used by skunks between 1 October and 30 March. As part of an integrated predator management strategy, we have identified resources that could be removed or limited through public outreach, education, and beach management to reduce subsidies for these adaptable generalists near priority beaches.

### **The invasive Cuban treefrog: an emerging urban pest in the Southeast**

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The Cuban treefrog (*Osteopilus septentrionalis*) is an established, invasive amphibian in Florida, with the earliest confirmed records in the state dating to the late 1920s from the Florida Keys. To date, breeding populations of this species have been found as far north as Cedar Key on Florida's Gulf Coast, Jacksonville on the Atlantic Coast, and Gainesville in North-central Florida. Cuban treefrogs continue to expand their range and individuals have been documented recently in coastal Georgia, South Carolina, Alabama, and Texas, as well as in the panhandle of Florida. Cuban treefrogs thrive in human-modified habitats and appear to be the most common species of treefrog in suburban and urban settings in central and southern Florida. They also are able to invade a variety of native habitats, and there is mounting evidence that Cuban treefrogs may be negatively affecting populations of native treefrogs. Cuban treefrogs are generalist predators, consuming a great diversity of invertebrate prey; as such, competition with native vertebrates in Florida is possible. Cuban treefrogs are also a nuisance and are having impacts on the quality of life of Floridians. They enter homes through plumbing systems and are known to clog sinks and turn up in toilets. Their feces is unsightly and may accumulate on windows and doors of homes. During the spring and summer breeding season their calls can be annoying, and they will breed in unmaintained ornamental fish ponds and swimming pools. These invasive frogs have noxious skin secretions that can irritate the mucous membranes of people who handle them. Cuban treefrogs also have negative economic impacts. They invade electrical utility equipment, causing short circuits and interruption of power to customers. We summarize problems that Cuban treefrogs cause in urban settings and offer potential solutions.

### **Community cooperation and a mixed conservation strategy to reduce amphibian road mortality during the spring migration in Tompkins County, New York**

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Many amphibians are suffering high mortality rates from vehicles because roads separate the amphibian wintering grounds from breeding grounds. In Tompkins County, New York, there is a concentrated population of amphibians that use the vernal and permanent ponds that lie between 2 parallel roads. More amphibians cross east to the ponds over Thomas Road, but in 2008 we discovered that the amphibians crossing west over Ellis Hollow Road included the Jefferson salamander (*Ambystoma jeffersonianum*), a New York Species of Special Concern. Conservation efforts in this area have been complicated by the roads falling in 3 separate highway department jurisdictions (the Town of Caroline, the Town of Dryden, and Tompkins County). Here we report on the successes and difficulties in coordinating a conservation effort for this area. The 2009 season is slated to use a mixed strategy, with road closures on Thomas Road coordinated with volunteer effort on Ellis Hollow Road to move amphibians across the road during high-traffic migration times.

### **Effects of urbanization on scrub-shrub bird abundance in Massachusetts**

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Although historically considered “edge” or “weedy” species, recent research shows scrub-shrub birds are habitat specialists whose populations closely track local changes in habitat structure. Scrub-shrub birds are exhibiting dramatic population declines as the result of changes in land management practices combined with the disruption of natural disturbance regimes. As a result of these declines, scrub-shrub birds have become the focus of widespread habitat restoration efforts, which include the establishment and

maintenance of early-seral habitat in the form of “wildlife openings.” The effect of treatment regime on scrub-shrub birds in wildlife openings is reasonably well understood, however some birds are reported to be affected by landscape context as well. Massachusetts is the third most densely populated state in the US, and thus urbanization is a potentially important and growing influence on bird populations here. The negative effects of urbanization on mature forest birds are well documented, however there are few studies of the effects of urbanization on scrub-shrub birds. We studied scrub-shrub birds in wildlife openings from 2003-2006 in 4 rural and 4 urban landscapes in Massachusetts to determine if their abundance was influenced by urbanization at the landscape scale. Of the 13 scrub-shrub bird species abundant enough for analyses, 5 differed between rural and urban sites. Chestnut-sided warblers, field sparrows and prairie warblers were more abundant in rural areas. In contrast, song sparrows and yellow warblers were more abundant in urban areas. All of these species except yellow warblers have declined significantly in eastern North America since 1966, and chestnut-sided warblers and prairie warblers are considered At-Risk Species in Massachusetts. Our results suggest that the negative influence of urbanization documented in forest birds also affects scrub-shrub birds, and furthermore, that the notion of locating wildlife openings in urban areas to minimize effects on mature forest birds should be critically examined.

### **Human drivers of management practices and ecological structure in Phoenix, Arizona**

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As the fastest growing land use in urban areas of the United States, residential landscapes have increasingly garnered the attention of scholars interested in coupled human-environment systems. They are subject to intensive human management that alters biodiversity and imposes water and chemical inputs. In the fall of 2008, a group of students and faculty at Arizona State University collaborated in an interdisciplinary workshop to explore the multi-scalar social drivers of residential landscaping decisions and their impacts on management and ecosystem structure in Phoenix, Arizona. At the individual household scale, human cognitive factors, such as homeowner values, were investigated as a driver of landscaping preferences and management choices. Across neighborhoods, individuals exhibited similar core values and environmental orientations and these values did not necessarily predict landscaping preferences. Individual household decisions are made within the context of landscape legacies and constrained by the rules and regulations of formal and informal social institutions operating at multiple scales. The group explored such regional and neighborhood legacy effects through interviews with members of the development industry who identified a broad collection of decision-drivers including structural elements of urban form and abstract forces such as underlying worldviews. Finally, we examined the set of constraints introduced by homeowners associations through covenants, codes, and restrictions to address the impact of social institutions on individual residential landscape management choices. We propose that individual household values and the constraints of social institutions and legacy effects are components of a larger framework: human drivers of ecological patterns and processes at hierarchical geographic scales.

### **Birds, habitat, an urban gradient, and socioeconomic factors: exploring the relationships in a residential landscape**

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Residential landscapes represent a large percentage of urban land cover. Managing these landscapes for native birds and other wildlife could potentially reduce the negative impacts of urbanization on biodiversity by providing mini refugia within urban areas. Residential landscape design in Phoenix, Arizona is dominated by mesic (turf, water-dependent plants), and xeric (gravel, drought-tolerant plants) yards. These landscapes vary in design, vegetation composition, and configuration. Previous urban bird studies have



shown that birds demonstrate a strong association with vegetation composition. In urban landscapes, humans have modified plant conditions and have created entirely novel plant communities. Therefore, to fully understand how birds respond to residential landscapes, we propose a conceptual model that integrates socioeconomic factors that influence landscaping decisions and thus drive urban bird community patterns. We propose social drivers (e.g., income and education) as processes driving the urban bird community structure. These social drivers have a large influence on landscaping decisions (habitat for birds) and correlate with urban gradient measures (distance from urban center; i.e., ability for native birds to colonize urban landscapes). We explore these relationships at 39 of the bird monitoring locations at the Central Arizona – Phoenix Long Term Ecological Research (CAP LTER) site. Preliminary results suggest native bird species align closely with xeric landscaping, and areas closer to remnant desert patches. Although not significant, the census variables suggest a trend towards native birds aligning with higher income neighborhoods, college educated and owner occupied residents. Our results also suggest racial and economic inequalities in regards to biodiversity where Hispanic and poor neighborhoods have fewer native birds. By including socioeconomic variables in the analysis, we gain a greater understanding of the driving factors behind the urban bird community, and thus, provide necessary information for urban planners who aim to create residential landscapes desirable for both birds and people.

### **Progress and prospects for recovery of the Palos Verdes blue butterfly, an urban conservation success**

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The Palos Verdes blue butterfly is arguably one of the rarest butterflies on the planet, with the subspecies having been deemed extinct for 10 years before its discovery on a military fuel depot near the port of Los Angeles in 1994. Since that time, research and conservation actions for the species have resulted in establishment of new populations within its historic range, using captive-reared butterflies. This paper reports on the knowledge gained from an urban conservation project and its applicability to other invertebrates. In particular, captive breeding techniques have been perfected allowing the release of butterflies into new habitats. Annual surveys of the wild population yield insights about survey techniques for rare butterflies and have now been conducted for a sufficient time to support analysis. A comparison of multiple plausible models to explain adult population size indicated that rainfall during the year of larval development best explains adult population size while temperature during flight season explained apparent mortality rate but not overall population size. This indicates risk to the species in the event of a warming and drying local climate. Surveys also confirmed a high correlation between total population and distribution within and between total population and the apparent phenology (e.g., the date the first butterfly is observed). Mitigating the risk of climate change will require protection and restoration of habitat that represents a range of topoclimatic conditions. Regulatory obstacles to obtain permission to reintroduce the butterfly at new locations have now been overcome and future work will monitor the success of releases at restored habitats. Lessons learned from this experience are being applied to conservation efforts for butterflies at other urban or industrial sites, including for El Segundo blue butterfly (Los Angeles) and Lange's metalmark (Antioch, California).

### **Feral cats as sacred cows: trap-neuter-return of feral cats and the future of urban conservation**

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Trap-neuter-return is an approach to feral cat management in which cats are trapped, sterilized, and returned to the location of capture. Those supporting this approach have increasing political power and achieved success in the adoption of TNR policies by a number of jurisdictions. We argue that TNR is not an effective method to reduce feral cat populations under prevailing circumstances and that feral and free-roaming cats harm native species and ecosystems and present hazards to wildlife and humans. We illustrate with an example from the City of Los Angeles that TNR policies tend to originate as animal welfare

initiatives (e.g., to reduce euthanasia) and consequently do not receive the proper environmental review that should accompany actions that have adverse impacts on the environment. We review many of the assertions that are made by advocates in support of TNR and find that they conflict with the peer-reviewed literature. We find that advocates either deny that feral and free-roaming cats have any impact on native species or that impacts to native species should be considered at the population level, while cats are afforded importance as individuals.

### **Planning riparian corridors as refuge areas for urban wildlife in metropolitan Detroit**

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The economy of southeast Michigan is transitioning from heavy manufacturing to a diverse mix of higher education, health care, alternative energy, and ecotourism. Formerly used exclusively to support heavy industry and the convenient release of combined sewer overflows, the Rouge and Detroit Rivers are now being reclaimed as wildlife sanctuaries and recreational amenities. Hamilton Anderson Associates recently assisted Wayne County and the US Fish and Wildlife Service in developing master plans for the Rouge River gateway corridor and opportunities for wildlife habitat enhancement on the Detroit River. The Rouge Gateway Master Plan encompasses the river's lowest 8 miles and its neighboring communities. The plan threads a variety of habitat restoration projects along an urban trail fostering relationships between the river and its natural and social systems. The resurgence of bald eagles, peregrine falcons, sturgeon and coyote has been symbolic of the healing ecosystem. Efforts on the Detroit River include planning for the Detroit River International Wildlife Refuge (DRIWR) – the first “international” refuge in North America. This “urban” refuge has received national acclaim for its use of public-private partnerships. In the first 5 years, the refuge has grown from 304 acres to 4,982 acres. Unlike many refuges, the DRIWR is located near a major metropolitan area offering access to large numbers of people for recreational and educational purposes. The refuge, which includes islands, coastal wetlands, marshes, shoals, and riverfront lands along 48 miles of the Detroit River and western Lake Erie, will protect and restore habitat for 29 species of waterfowl, 65 kinds of fish, and 300 species of migratory birds in Michigan and Ontario. The collective vision of these projects is to restore habitats within a metropolitan area and to create successful ways for people to interact positively with the natural environment.

### **Patterns of emerging dragonfly communities at small wetlands on the urbanizing New England landscape**

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Small wetlands play many roles in our urbanizing coastal landscape. The faunas using these wetlands are, in turn, influenced by factors related to the urbanization of the site. The emerging dragonfly faunas of 18 small Rhode Island wetlands were surveyed over 2 field seasons (2004 and 2005) by standardized, timed collections of exuviae. These 18 sites are located along an urbanization gradient, indicated by water quality (chloride concentration) and percent forest cover in a 100-m buffer zone. No relationship was found between diversity measurements (species richness, Shannon-Wiener Index, evenness measures) and urbanization level. However, very different species assemblages predominated in urban vs. rural sites. Species assemblages also shifted with regard to distance from the coast, and presence of fish. We constructed a model of predicted dragonfly distribution patterns based on these results. Twenty-three new sites were surveyed in 2006 to test this model. Overall patterns of species diversity at the test sites were compatible with predictions. However, individual species patterns varied and were not always consistent with the faunistic patterns. We discuss the potential reasons for the unique diversity patterns, based on dragonfly ecology and life history.

### **Cosmopolitan coyotes: practical ethics in a mixed community of humans and coyotes**

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Ethics is indispensable in managing people's relationship to animals and nature. As an expression of those moral values that ought to guide our individual and collective lives, this insight is generating a moral turn in wildlife policy and practice. It is one that is particularly relevant to urban, suburban, and rural spaces where coyotes, humans, and other creatures co-reside in shared landscapes. The theoretical outlines of this turn are as follows. First, ethics complements science and politics in the making of public policy. Second, non-human animals have an intrinsic moral value that deserves our respect. Third, wildlife management has consequences for the well-being of people and animals, and is therefore unavoidably a matter of ethics. Fourth, the most important questions of wildlife management, environmental protection, and land-use planning are rooted in conflicting values and visions of how we ought to live with other people and animals. Finding our moral bearings to put theory into practice is another matter. The usual method is that of applied ethics, where abstract moral certainties are deductively 'applied' to an issue. This is a valuable intellectual exercise for mapping out the implications of one's beliefs. Yet it is a poor moral compass as it fails to account for the contextual dynamics of real-world problems. Practical ethics is an alternative moral compass for the troubled relationship between people and coyotes. Practical ethics avoids moral certainties, and instead matches a diverse reservoir of ethical concepts with the characteristics of concrete sites and situations. It does this not by applying ideas in a top-down manner, but by bringing the theoretical and empirical into mutual dialogue. Practical ethics helps us distinguish better from worse ways of thinking and living. It provides guidance into what the ethical issues are, the moral and other values at stake, and how we might best act in the interest of the entire mixed community of people, coyotes, and the rest of nature.

### **Urban wildlife management: free-roaming cats in an urban neighborhood of Olympia, WA--human perspectives, knowledge, and attitudes**

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A major issue within urban wildlife management is how companion animals or pets impact wildlife populations. *Felis catus*, or more commonly, house cats, were domesticated in Egypt around 4,000 years ago. Since that time, they have traveled the world as both pet and feral animals. In 2007, it was estimated there were 82 million pet cats and at least an equal number of feral cats in the United States. Cats prey on a wide variety of animals including: small mammals, birds, amphibians, reptiles, and invertebrates. Research has shown even well fed free-roaming cats prey on wildlife. In urban areas, the high density and predation rates of free-roaming cats combine with lower habitat quality and quantity to put tremendous stress on wildlife populations. Cat predation is of particular concern in areas containing endangered species of small mammals and ground-nesting birds. Management of free-roaming cats is complicated by their relationship with humans. This relationship often affords them priority consideration over wildlife, as is evident by the social acceptability of cats' unrestricted access to the outdoors and the rise of programs to feed and care for feral cats. In an attempt to further understand cats' relationship with humans, a survey will be administered to residents of an urban neighborhood in Olympia, WA. This survey will look for trends in residents' perspectives, knowledge, and attitudes toward free-roaming cats based on factors such as age, education, and experience. Specifically, it is hypothesized that education and issue knowledge levels will have little or no impact on cats' access to the outdoors, but that past experience will. It is also hypothesized that residents' perception of a human health threat will be a stronger indicator of which methods of control are considered acceptable than perceived impact on wildlife. It is the goal of this survey to provide valuable information for management, educational programs, and to serve as a tool for future research.

### **The use of GPS satellite collars to evaluate aversive conditioning on black bears in New Jersey**

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Increased conflict and interactions among residents and the American black bear (*Ursus americanus*) continue to escalate throughout New Jersey. This is the result of increased bear populations, encroachment of development, tolerance of human activity, and accessibility of human derived food items. As a result of these increased interactions, we evaluated the effectiveness and economic feasibility of aversively conditioning bears. We determined if avoidance of human activity was demonstrated after aversive conditioning was implemented. During the months of May and June in 2008, 9 nuisance adult female bears were captured in Hardyston, Vernon, and West Milford Townships. An experimental group of 4 bears was released and aversively conditioned at the capture site utilizing rubber buckshot and dogs. Five control animals received no aversive conditioning. Each bear was outfitted with a GPS/satellite collar programmed to record GPS coordinates at a frequency of twenty-four transmissions per day for approximately 5.5 months. A total of 18,938 GPS points was compiled from all 9 animals throughout the entire study period. Landscape analysis was performed at capture locations and fixed kernel home range sites were established to determine correlation between landscape use and nuisance activity. Preliminary data suggest home range movement remained unchanged for both groups with minimal to no change in behavior of avoiding human activity in residential areas. Bears that displayed short-term avoidance of the conditioning location established similar nuisance behavior at adjacent locations signifying aversive conditioning may move nuisance activity to other locations.

### **Retrofitting dumpsters with bear resistant lids to reduce human-bear interactions in New Jersey**

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Black bear populations are increasing throughout North America. When areas of black bear population expansion overlap regions of substantial human use, conflict can ensue. Human-bear conflicts can have negative economic, health/safety, and social impacts. Attraction to human foods brings bears into more frequent contact with people, resulting in a higher probability of negative human-bear encounters. In order to achieve successful management of human-bear conflicts, the use of bear-resistant lids outfitted on dumpsters can be one management tool. We evaluated the efficacy of modified Interagency Grizzly Bear Approved (IGBA) lids that were installed on dumpsters in a community in northwestern New Jersey. Black bear sows exhibiting nuisance behavior were trapped in the community at dumpster sites, outfitted with either radiotelemetry or GPS satellite collars, and their movements were tracked for the year prior to the installation of the retrofitted bear-resistant dumpster lids. After the lids were installed, movement patterns were monitored to determine the extent at which bears alter their behavior and leave the area when dumpster access is no longer available.

### **Historical changes in the bee fauna of New York City**

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Although urbanization is considered one of the leading causes of species endangerment, resulting in exclusion of entire species guilds, some species groups may exhibit neutral or even positive responses to urbanization. Bees, in particular, may utilize small habitat patches consisting of nesting sites and/or floral resources scattered throughout cities, allowing numerous species to persist even in heavily urbanized

landscapes. To assess the impact of extensive, long-term urbanization on the diversity of bees, we compared over 5,000 bee specimens collected in the New York City metropolitan area from 1990 to 2009 with those collected from 1890 to 1910 (prior to major urbanization of the outer boroughs). We found that over 100 bee species known historically have persisted in New York City during this time period, despite a near tripling of the human population and associated habitat losses. Many additional native species present only in the recent sample may have been overlooked before, as most historic data is from a few sites in Brooklyn and the Bronx and a single collector. Some losses of species from the New York City region (and elsewhere) are evident, notably loss of three species of *Macropis* oil bees, and their *Epeoloides pilosula* cleptoparasite, attributable to loss of *Lysimachia*, the host plant of *Macropis*. Certain bumble bees also have disappeared from the New York City metropolitan area, including *Bombus affinis*, its parasite *Bombus ashtoni*, and *Bombus pensylvanicus*, reflecting region-wide problems (the former due to parasites across its ranges, the last due to other causes in the northern portion of its range). Several bumble bees remain abundant in the city. Exotic bee species have become ever more prevalent in New York City and now comprise a significant portion of species encountered in surveys, including some of the most abundant species. These results suggest that urbanization may be compatible with persistence of many but not all, bee species. More extensive monitoring and research is required to ensure their preservation.

### **Public education programs in Georgia for dealing with nuisance wildlife issues**

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The wildlife outreach program at the Warnell School of Forestry and Natural Resources is tasked with meeting the needs of Georgia citizens for scientific based education products on the broad topic of nuisance wildlife management. Since 2003, the Georgia Master Naturalist program has trained over 300 adults on topics such as ecology, forestry, wildlife management, natural resource conservation, and agriculture. In addition, the Georgia Master Gardener program includes education material on wildlife management. Additional training is provided to county agents and county agent-led programs at the individual community level. Print and on-line products include a wildlife management and natural history publication series that provides topic specific information. Common wildlife species generating most calls for information include deer, armadillo, and moles. Surveys have found that urban dwellers commonly request information on these and other species and there has been little change in this species list from previous surveys. The outreach program teaches a simple model that seeks to educate homeowners on methods of coping with nuisance wildlife. The model acronym – HERL – relies on habitat modification, exclusion, repellents or removal, and lethal control as methods available to homeowners for dealing with nuisance issues. Citizens receive instruction in methods available to them under each action in the HERL model. This presentation will review the HERL model, discussing methods for dealing with nuisance wildlife issues in urban settings.

### **Public attitudes towards black bears in Missoula, Montana**

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Successful wildlife management actions and policies depend on public acceptance. Management actions minimizing human-black bear (*Ursus americanus*) conflicts are controversial, and research that articulates public attitudes in a diversity of situations is often lacking. Our objectives were to examine public attitudes towards black bear management of residents in the Wildland-Urban Interface (WUI; where bears and humans coexist) and the city core (i.e., where no bears are present). We also examined the effects of education and information (EI) efforts to minimize human-bear conflicts. Two questionnaires were distributed to residents living in Missoula, Montana before (2004) and after (2008) EI efforts were implemented. Residents living in the city core and the WUI both attracted bears with bird feeders, BBQ grills, and gardens but had significantly different frequencies of available vegetation and garbage. In the

WUI, the frequency of available native and non-native vegetative bear food was significantly higher, whereas the frequency of outdoor garbage storage was significantly lower. In 2008, attitudes were not significantly different between residents in the WUI and the city core. The 4 years of EI efforts did not alter resident behaviors that produce attractants in the WUI. However, the EI efforts in the WUI did increase support for management actions used to minimize conflicts. Managers may be able to use EI efforts to gain support for black bear management actions, but must realize that behaviors producing attractants may be spatially ubiquitous and difficult to modify.

### **The effects of matrix composition on mammalian resource use in urban patches.**

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The process of urbanization usually results in a mosaic of fragmented patches that may potentially provide habitat for numerous species of wildlife. These patches are often surrounded by a matrix of diverse land use patterns that vary in composition. In general, the urban matrix has features that can be grouped into two broad categories, pervious or impervious surfaces, both of which can be situated immediately adjacent to urban patches, and consequently, may have some effect on the patch's edge. The purpose of this study is to investigate the influence of matrix composition on resource use and behavior of small and medium sized mammals that utilize the edges of urban patches. Study areas will include urban parks located in Baltimore, MD, a NSF funded long term ecological research area for urban ecology, and Louisville, KY. Matrix composition will be determined through the use of geographical information systems and classified as high, medium, or low concentrations of urbanization. Radio telemetry, digital video recording and remote sensing techniques will be utilized to collect data on resource use and behavior.

### **Cities, human well-being, and the future of biodiversity**

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Four of five people in the United States live in cities or suburbs. For most Americans, the nature they experience on a day-to-day basis is urban 'nature', which thus plays a crucial role in the preservation of biodiversity throughout the nation and beyond. Still, the dominant paradigms in conservation science and natural resource management are out of sync with this reality. Recognizing that biodiversity is threatened by urbanization, yet also contributes to the quality of life in cities, we must place greater emphasis on designing the places where we live and work in ways that accommodate the needs of other species and highlight the interdependence between people and the natural world. This will require careful consideration of what constitutes 'habitat' and what 'habitat restoration' means (or should mean) in the metropolitan environment. It will also require a re-evaluation of the role of urban and suburban nature reserves in conserving native species, and creative ways to extend the influence of these places, blurring the distinction between reserved lands and the neighborhoods that surround them. Because biodiversity conservation is ultimately a grassroots effort, the relevance of this endeavor to the well-being of city-dwellers must be made obvious, and a logical starting point is focusing on benefits accruing to our children – the next generation of environmental stewards. Ultimately, the measure of success we achieve will hinge on effective collaborations involving not only natural resource managers and conservation ecologists, but also designers, social scientists, medical professionals, planners, and most importantly, stakeholders representing diverse interests in the places we wish to affect.

### **Urban herpetology: diverse opportunities and new horizons**

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Urban areas cover about 4% of the earth's surface yet support half of the global human population. Patterns of amphibian and reptile occurrence vary dramatically across rural-urban gradients regionally and globally. One theme persists however: herpetofaunal population decline and extirpation in these areas are directly related to habitat loss, fragmentation, and isolation, as well as environmental degradation. A general pattern as urbanization intensifies is lower species richness, species homogenization, and high turnover of amphibians and reptiles, although these results depend on the intensity of urbanization, presence of source populations, and occurrence of introduced species. Numerous publications have documented the effects of habitat loss and alteration due to urbanization. Fewer documents have examined the effects of light and chemical pollution, and fewer still evaluate the effects of infrastructure (e.g., stormwater retention ponds) and recreational activities (e.g., swimming pools, golf courses). Introduced species often have negative effects on amphibian and reptile populations but the effects are not well elucidated. Despite the growing body of literature on the negative effects of urbanization on herpetofaunal populations and communities, management and conservation of populations and habitats is seldom practiced, and the regulatory community lacks the support to enact laws and ordinances that would enhance local diversity. Thus it is imperative for herpetologists and conservation biologists to educate the public and get citizens involved with local conservation projects. Responses of amphibians and reptiles to the many stresses in urban systems will vary depending on the context at different environmental, geographic, and spatial scales. The many and varied contexts in which these animals occur along rural-urban gradients globally offer a wealth of opportunities for research and conservation. Amphibians and reptiles could serve as model organisms to answer questions about the effects of urbanization and to test theories on environmental stress. The new book on Urban Herpetology (SSAR, 2008) contains reviews and research reports on all of these topics and serves as a guidebook for future conservation, management, and research into this field of inquiry.

### **Territory boundary changes in adjacent coyote packs: implications for management**

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Fixed kernel home ranges of resident GPS-collared coyotes on two Narragansett Bay islands averaged smaller than previously reported in the literature: 5.5 km<sup>2</sup> (range 0.74 – 13.56 km<sup>2</sup>). Low incidence of trespassing led us to believe that most of the home range was defended (territory). Only 5% of point locations of resident coyotes were within another pack's 99% fixed volume contour. By the 70% contour, there was essentially no trespassing (0.19% of point locations) by members of adjacent packs. The 70% contour appeared to be biologically significant: "core territory" was frequently marked by lines of scats deposited on entry trails by resident coyotes. Our data indicate that coyotes are extensively subsidized by anthropogenic sources. Food subsidies found within the territory of established coyotes seemed to influence movements. In two cases it appeared that presence or absence of reliable food sources might have explained pack boundary changes between immediate neighbors. Initial data indicated that an abundance of food resources, many anthropogenic, might explain the small home range/territory size. If food does influence territory size, it could ultimately influence coyote density in two ways: 1) the pack lives at higher densities in a smaller area, 2) space is freed for other coyote packs to colonize, increasing the overall population density. We have drafted a 10 point management plan to reduce direct and indirect anthropogenic subsidies to coyotes. Management recommendations include educating the public, developing town ordinances regarding the intentional feeding of wild animals, and disposal of livestock carcasses and large road-killed animals in fenced composting facilities. We are presenting the management plan to city and town governments on Conanicut and Aquidneck Islands and hoping to implement the plan in 2009. We expect subsequent tracking to reveal larger average territory sizes once subsidies are removed.

### **Non-invasive genetic population monitoring of the southern mule deer in San Diego County**

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San Diego County was among the first to implement a large-scale adaptive management plan under California's NCCP program. A diligent monitoring program is critical to any species protection plan, particularly one focused on multiple species in a large region with substantial urban development. Although monitoring efforts under these plans tend to focus on rare and sensitive species, analyses of population dynamics in common species can also improve adaptive management decisions. This study explores the prospect of monitoring population dynamics of the relatively widespread southern mule deer, *Odocoileus hemionus fuliginatus*, across the urban canyons of northern San Diego. Over 500 scat samples were collected, yielding 267 reliable genotypes, representing 186 unique individuals. Recapture rates outside the initial capture date were low, and in all but two cases occurred at the same site where they were originally sampled. Individuals within a site were often highly related, and this was especially true for females. Within the study area, we found low genetic diversity and moderate to high levels of gene flow, despite the relatively fractured nature of the habitat these animals occupy.

### **Reconciling conflicting requirements for greenways in residential landscapes**

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Greenways have become popular worldwide as a means of conserving green space in sub/urbanizing areas, and are expected to provide services ranging from human transportation and recreation to floodplain protection and wildlife habitat. Through a series of "Greenways for Wildlife" research projects, we have investigated how the width of the forest corridor containing the greenway, the adjacent land use, and greenway composition and vegetation structure affect breeding bird, migrating bird, avian nest predator communities, and the abundance of two-lined salamanders in Raleigh and Cary, North Carolina, USA. A variety of wildlife used greenways, including 53 species of birds during the breeding season, 94 bird species during spring and fall migration, and 9 mammal species. In general, our findings suggest that greenways for wildlife – particularly species that are sensitive to sub/urban development – should be designed with wide (>100 m) forested corridors, narrow trails and associated maintained shoulders, and complex vegetative structure. This contrasts with preferences for human use that include wide trails and managed shoulders to allow universal access by cyclists, joggers, and walkers; broad sight lines to address perceived safety concerns; and minimal root intrusion under the paved path. Our results also suggest that greenways be located in areas of low-density development with low amounts of impervious surface and bare earth. However, sub/urban greenways most often are narrow and located in areas of intense development where user demand is high and land is expensive. Our challenge going forward is to seek design solutions for greenways that allow use by diverse, native wildlife and satisfy requirements for human recreation. One approach would be to place wide trails near the edge of the greenway, rather than down the center, to avoid fragmenting the forest canopy. This and other design solutions, however, often require more land and money than people are willing to allocate to greenways.

### **Combining different taxa to assess space and environmental determinants of species distributions in Switzerland's urban environment**

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Current knowledge on species distributions in urban environment is often based on studies dealing with single taxa of particular trophic guilds. This limits our understanding in how environmental and spatial factors interact and affect community composition at different spatial scales. We analyzed the relationship



between arthropod and bird biodiversity and urban environmental factors at 96 sites in three Swiss cities. We chose a two-step approach: First we analyzed the influence of sealed area, age of settlement, human management (by mowing) and habitat heterogeneity (composition and configuration) on species richness of 29 taxonomic invertebrate groups. We found little local variation in species number along the 3 urban environmental gradients. While the effect sizes of the variables age (positive effect with increasing age) and configuration (positive) were noticeable, the effect sizes of sealed area (negative), human management (negative) and composition (positive) were minor within the observed gradient ranges.

In the second analysis we selected 5 different taxa with distinct mobility attributes ranging from low mobile spiders and carabids, to mid mobile weevils and bees, and high mobile birds. Environmental variables were considered at different radii ranging from 10 m to 2000 m. Despite city-specific influences, there was a clear pattern that spider and carabid communities were influenced on local scales (maximum influence 100 m) while bee and birds communities were influenced on larger scales (from 50-100 m and above). At all spatial scales, the spatial component of the urban landscape had little influence on community composition. This suggests that even though total species richness is quite resistant to man-made environmental changes in the urban area, species compositions are heavily affected by human planning and management in complex urban habitats. Urban environments are dominated by a fine scaled mosaic structure with multiple effects acting on several scales.

### **Charismatic animal species and indicators for ecosystem quality: first results from the interdisciplinary BiodiverCity project in Switzerland**

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In urban ecology it is generally assumed that a high urban biodiversity is esteemed by the citizens and improves their quality of life in the urban area. This appreciation has recently been questioned and was never investigated for different types of urban areas in the required detail. Yet, it has been shown that thorough knowledge of people's relationship with nature is necessary, if they should be motivated to accept or actively support nature conservation measures. Two fundamental conditions need to be fulfilled if conservation research is to make a practical difference in the world: Firstly, sufficient knowledge of the state of the environment in question is required so that strategies to improve its quality can be developed. Secondly, sufficient knowledge of the motivations of those expected to implement the strategies, or tolerate the interventions, is required so the developed strategies have a chance of success. An interdisciplinary project called 'BiodiverCity' <http://www.biodivercity.ch/> adopts an approach of parallel social and ecological studies to the question of how to develop and implement strategies to enhance biodiversity in Swiss cities. This presentation outlines the project and describes the research into the identification of indicator and charismatic (flagship) species. We conclude that complex questions in conservation research, such as those exploring the interface between human and natural environments, are best addressed by collaborative efforts from the relevant disciplines.

### **Small mammals as a source of secondary toxicant exposure in carnivores and the role it plays in a synergistic disease epidemic**

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A 12-year study of carnivores in a fragmented urban landscape in southern California has revealed a high incident morbidity and mortality in felid species from Notoedric mange disease. Mange first appeared in bobcats in 2002 and has led to a dramatic reduction of bobcat densities along the urban edge, a reduction that has persisted through the current year. Concurrently we have also detected a high rate of exposure in urban felids to the anticoagulant toxicants commonly used in rodenticides. Ninety percent of bobcats and 8

out of 9 mountain lions that have been tested post-mortem were positive for one or more anticoagulant compounds. Further analyses of mortality data show a high correlation between nonlethal exposure to anticoagulant toxicants and severe mange disease in bobcats. Small mammals, chiefly rabbits (*Silvilagus spp.*), woodrats (*Neotoma spp.*), and ground squirrels (*Otospermophilus beecheyi*), make up the largest portion of bobcat diets in our study area and are also often considered pest animals in the urban areas. Secondary exposure of carnivores to anticoagulants is likely occurring from the ingestion of small mammals previously exposed to rodenticides used in developed areas. Recently we have expanded our research to investigate the exposure of common carnivore prey species to anticoagulant toxicants in an attempt to determine the species being exposed, the prevalence of exposure, and the distance exposed animals are found from the urban edge. Along urban edges and in adjacent core natural areas, we are measuring prothrombin (clotting) times in live animals and anticoagulant levels in the livers of small mammals found dead. Better understanding small mammal exposure will help us determine where across the landscape carnivores are at a higher risk for secondary exposure and potential deleterious effects on individuals or populations.

### **Where mountain lions roam in Arizona**

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One challenge for wildlife biologists in the 21<sup>st</sup> century is to maintain a balance for wildlife and human use of the landscape. Using an aggregation of fine-scaled movement patterns to describe broad-scale distributions can provide a mechanistic link to many ecological processes and provide an understanding of anthropogenic influences on wildlife. Because mountain lion (*Puma concolor*) habitat is adjacent to urbanization in Arizona, lions are ideal models to examine how human alteration of their habitats influences their life history characteristics and their ability to adapt to a variety of environments. We calculated 95% and 50% fixed kernel home ranges for 8 female and 21 male mountain lions that were radio-collared in Payson, Prescott, and Tucson, Arizona from August 2005 through August 2008. Using compositional analysis, we assessed use of vegetation associations and urban areas at second order selection. Home range sizes for resident males ranged from 5,286 ha to 83,859 ha and transient males covered up to 409,195 ha. Home ranges for females ranged from 2,860 ha to 21,772 ha. In Tucson, lions avoided agriculture and selected for chaparral and woodland habitats. Lions adjacent to Payson and Prescott avoided agriculture and shrub lands and were also found more often in chaparral and woodlands. All lions avoided urban areas. Intensive development and conversion of large open spaces to small properties and subdivisions has led to increased habitat loss and encroachment. Preserving habitat for movement of species between fragments is important for maintaining landscape connectivity and viable populations adjacent to urbanization. Protection of habitat mosaics that include critical habitat for lions will maintain the conservation of these populations.

### **BES bird monitoring project: bird species composition, abundance, and distribution in everyday Baltimore**

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As co-investigators on a long-term urban ecology research project in Baltimore, Maryland USA, we want to understand how changes in residential neighborhoods influence bird species composition, distribution, and abundance. We are particularly interested in changes that occur at the residential lot scale that may be initiated by residents, at the block scale that may be initiated by groups of residents and local officials, and at the neighborhood scale that may be initiated by local officials. The Baltimore Ecosystem Study (BES) Bird Monitoring Project collects data on bird composition and abundance at 132 points in Baltimore

neighborhoods. Our goal is to develop models that predict bird species distribution and abundance for selected species using lot-level variables collected as part of the U.S. Forest Service UFORE project, block-level variables collected as part of a study of neighborhood change, and neighborhood-level variables that are readily available to local governments and planners. We are developing bird community models using ordination and multivariate techniques, and spatial models that can be used to predict species composition and abundance at different locations in the city. The findings from our study are being applied to management efforts in Baltimore neighborhoods that seek to involve local residents in neighborhood-based conservation projects.

### **Analysis of coyote behavior in relation to land use type on Cape Cod, Massachusetts**

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The residents and visitors of Cape Cod, Massachusetts have experienced an increase in coyote (*Canis latrans*) human interactions and conflicts. Coyotes have become a concern to the public since they are the first large carnivore to be able to tolerate anthropogenic environments with altered landscapes and fragmented habitats. Through the use of radiotelemetry collars, Jonathan Way collected over 12,000 locations on 32 coyotes on Cape Cod since 1997. We have used these data to determine that the overall average coyote home range size is 32,596m<sup>2</sup> (8 acres) using 95% minimum convex polygons. On average, forest comprises 42% of the home ranges, followed by residential at 34% and commercial at 12%. However, in using an equation to determine preference, this sample of coyotes appears to prefer wetlands as their primary land use type followed by residential, and then water. Understanding the correlation between land use type and coyote behavior can aid wildlife managers in understanding the correlation between human behavior and coyote behavior.

### **Antipredator alarm behavior in gray squirrels studied by means of observation and a mechanical robot**

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Despite the ubiquity of eastern gray squirrels in the urban environment, there is little empirical data about their communication behavior, particularly their antipredator alarm behavior. We will present data from two studies: first, some basic observational data on the incidence of alarm calling, and reactions to alarm calls, in a population of gray squirrels in Massachusetts. Second, we present data from an experimental study in which we presented a mechanical model of an alarm calling squirrel to wild conspecifics. The alarm behavior of the “robotic” model elicited alarm from the squirrels, showing the contagion of alarm behavior among these animals. Further, we separated the audio and the visual components of alarm behavior in our robot, presenting alarm calls and tail flagging motions separately as well as together, and found that the two components of alarm sent redundant messages. This is important for an understanding of how multiple signal components work together in natural communication behavior. The use of a “robotic” animal to elicit reactions from squirrels may prove to be a useful tool in other behavioral and management studies.

### **Habitat use and spatial biology of northern watersnakes living along an urban stream**

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For 3 years we radio-tracked 50 northern watersnakes (*Nerodia sipedon*) living along a city stream in northern Pennsylvania, USA. Based on structural habitat, we characterized half the stream length as urbanized (municipal park and an active industrial area) and half as relatively natural (conservation area).

Habitats selected by the snakes in the 2 areas differed. In the natural half, snakes occupied areas with a wide riparian zone and dense canopy cover. In the urban half, snakes frequently used man-made substrates and were in close proximity to people. Urban and natural areas had similar numbers of snake-selected sites, but snakes were located more often in urban areas, and urban sites were used by more snakes. Specific sites selected by large numbers of snakes were man-made, suggesting that man-made structures provide better conditions than naturally-occurring habitat features. Snakes in urban areas exhibited reduced movement patterns compared to those in natural areas. Snakes in the urban half moved less often and exhibited greater site fidelity than those in the natural half. These results suggest watersnakes survive in this urban environment by reducing their movements and by capitalizing on man-made habitat features.

### **Urban landscape attributes correlated with resource use and behavior in urban wildlife.**

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A species must meet its requirements for food, water, shelter, and reproduction to persist in any habitat. The factors that influence the population characteristics and behavior of wildlife are correlated with the ability of individuals in the population to locate and secure resources. The goal of this project is to ascertain how characteristics of urban landscapes influence the ability of wildlife to obtain the necessary resources for survival. In this project, I ask the question, "How does the habitat and landscape characteristics of urban areas influence resource use by wildlife?" Radio telemetry, digital video recordings, and other remote sensing techniques will be utilized to collect data on resource use and behavior. Patch and urban landscape attributes will be determined by the use of geographical information systems. Study areas will include urban parks located in Baltimore, MD, a NSF funded long term ecological research area for urban ecology, and Louisville, KY.

### **History and analysis of wildlife road passage structures in Massachusetts**

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There are currently 28 road passage systems for wildlife in Massachusetts, of which 14 were specifically built for turtles, and the remainder for amphibians (3) and general wildlife (11). Some structures were installed as early as the 1960s, however, the majority have been constructed in the last 10 years. Strong state environmental laws, along with support from local communities and conservation organizations, have led to the incorporation of passage systems in road design. Maintenance of habitat connectivity has also played a role in development of state stream crossing standards as well as open space planning. In this study, we identified all known crossing structures in Massachusetts and collected site and structural design information for each. Passage design in Massachusetts has changed in concert with our understanding of road ecology, but little research has been conducted in order to inform this field. As a result, many planning decisions are left up to the judgment of professionals. In addition, design is often constrained by site characteristics, the surrounding landscape, and the size of the area affected by the roadway. Due to the high cost of installation and maintenance of road passage systems, it is critical to monitor the success of passages in order to inform future passage design.

### **Responses of eastern red-backed salamanders to exotic flora and fauna and forest restoration in Inwood Hill Park, Manhattan, New York City, USA**

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Park systems throughout North America are restoring forests in an attempt to return them to a state closer to that which existed before European settlement. Intensive forest restoration since 1985, and the new

Million Trees program, make it essential that NYC Parks develops indicators for evaluating success. Exotic plants that are targets of restoration have negative effects on native plants and soil chemistry, but effects on soil fauna are just beginning to be understood. We studied the responses of eastern red-backed salamander (*Plethodon cinereus*) abundance, length, and morph ratio (striped vs. unstriped) to habitat restoration, vegetation, coarse woody debris, and soil chemistry, structure and fauna in an urban park. We were particularly interested in whether garlic mustard (*Alliaria petiolata*), black locust (*Robinia pseudoacacia*) or exotic earthworms have negative relationships with salamanders. As predicted, salamander abundance was lower where garlic mustard was most frequent, but increased garlic mustard cover was associated with higher salamander abundance. Black locust had no effect on any salamander variable, but white mulberry (*Morus alba*), another exotic invasive tree, was associated with decreased salamander length. The percent native ground layer vegetation was associated with increased abundance and larger salamanders. Earthworm abundance was not related to salamander abundance or length, but there were more salamanders of the striped morph where earthworms were more numerous. Salamander abundance did not differ between restored and unrestored areas, but salamanders were smaller, and fewer were striped, in restored areas. Salamander length in restored areas dropped steeply 3 years after restoration, but rose steadily thereafter. Five years after restoration, salamanders in restored and unrestored areas were of similar lengths. Eastern red-backed salamanders may be good indicators of recovery of forests post-restoration, and may be useful in assessing the severity of invasion by exotic plants and animals in forests.

### **Coyotes, conflicts, and animal control officers in Massachusetts: a study of attitudes, values, and perceptions of animal control officers in Massachusetts with respect to human-coyote conflicts**

Nadine Pellegrini, Tufts Cummings School, Center for Animals and Public Policy

Town and city employed animal control officers (ACOs) are now frequently called upon to resolve human-wildlife conflicts, specifically involving coyotes, even though this type of duty was not traditionally within the realm of an ACO. Previously, how an ACO responded to a conflict involving coyotes, and why an officer resolved a conflict in a particular manner, had not been studied. This study sought to determine the attitudes, values, and perceptions of ACOs in Massachusetts with respect to wildlife generally and human-coyote conflicts specifically. The study incorporated a qualitative interpretative analysis based upon the data collected from personal in-depth interviews conducted with ACOs who were randomly selected from several counties throughout Massachusetts. The method of interpretive analysis was used to identify the values, attitudes, and perceptions surrounding wildlife conflicts with coyotes from the interviews of the ACOs. This presentation will include both the research findings and the researcher's interpretations about the challenges ACO's face in addressing human-coyote encounters and the needs of the ACO community to better address this issue.

### **Varying effects of vegetation and buildings on the distribution of breeding riparian birds within an urban environment across spatial scales**

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Urban areas can harbor a diversity of breeding birds, but the factors that influence their distribution in a city are poorly understood. We examined breeding riparian bird species and the influences of 2 important biophysical features of the urban environment – vegetation and buildings. To better understand the relative importance of landscape features at different spatial scales within an urban landscape, we surveyed breeding songbirds and a number of vegetation characteristics on 71 sites along an urban gradient within Cincinnati, Ohio, U.S.A. Landscape features at larger scales were quantified using GIS. Using an information-theoretic approach, we modeled relative density for 48 bird species in relation to local woody vegetation and to tree cover, grass cover, and building density within 50-1000 m of each site. At the most proximate scale, native tree and understory stem frequency were the most important vegetation variables; native tree frequency had a positive influence on 35 species and a negative influence on 13 of the 48 species and native understory frequency had a positive influence on 27 species and a negative influence on

21 species. At the landscape scale, both tree cover and grass cover were the most important variables, and were included in competitive models across all species: tree cover positively influenced 15 species and negatively influenced 5 species, and grass cover positively influenced 22 species and negatively influenced 5 species. Building density was an important variable for 13 species, 6 of which were positively associated with buildings. We compared the importance of features across different scales, and found that models combining proximate vegetation and landscape scales were best at describing bird distributions, while models considering only local vegetation fared poorly. Overall, native breeding birds in urban areas would be served well by management practices that maintain a wide buffer of native vegetation around urban streams.

### **Integrating transportation planning and wildlife connectivity in California**

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Although connectivity analysis has been done in California at several scales, modeling of wildlife connectivity statewide has not been completed. Successful modeling of wildlife corridors has been conducted in more localized areas of the state, however, different methods were used in areas that could not be effectively applied or integrated statewide or built upon by additional stakeholders. The question of “how can the state of California model essential habitat connectivity areas that is repeatable and coordinated with major land managers and regulatory agencies?” became a reoccurring issue. California successfully passed Assembly Bill 2785, which requires the state to identify essential wildlife corridors and habitat linkages. SAFETEA-LU section 6001 (Metropolitan Transportation Planning) is more specifically referred to as Title 23 CFR 450.316 and 450.322. CFR section 450.316 addresses consultation and cooperation requirements between State and regional Metropolitan Transportation Planning organizations (MPOs) and CFR section 450.322 requires discussion of potential environmental mitigation activities in the Regional Transportation Plan. Upon review, it has been identified that appropriate data were needed to help inform transportation planners, MPOs, resource agencies, and land use planners. Caltrans and CA Department of Fish and Game have formed a partnership to evaluate the issue collectively and engage a broad range of stakeholders. The two Departments evaluated existing modeling methods, and developed the scope for a statewide essential habitat connectivity project and sought funding through the State Planning and Research special projects. The project was developed with the following steps outlined: 1) Establish a multidisciplinary team of agencies including land management agencies, infrastructure agencies, and wildlife or regulatory agencies; 2) construct a statewide wildlife habitat connectivity map using a geographic (GIS) based modeling approach; 3) identify criteria and priorities for connectivity analyses; and 4) develop a strategic plan that will outline the framework necessary to complete connectivity analyses. The coordination with implementers and planners influenced the way in which the products were developed and considered land use and transportation modeling practices as well.

### **Wildlife conservation and management in an urban national park**

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The Presidio of San Francisco, a former military base, encompasses about 1,490 acres in the northern tip of San Francisco. The Presidio is primarily managed by the Presidio Trust, a federal agency created by Congress in 1996, but is part of the larger Golden Gate National Recreation Area, administered by the National Park Service. The Presidio is also designated as a National Historic Landmark. The Trust’s mandates require preservation, and where appropriate, enhancement of the historical, cultural, natural, recreational, and scenic resources and sustaining the Presidio indefinitely as a “great national park in an urban setting.” Although highly developed, the Presidio provides one of the few large open space areas in San Francisco and supports a diversity of wildlife species not typically associated with urban areas. While different areas of the Presidio have differing management objectives (recreation focus, preservation of culturally significant landscapes, building redevelopment and reuse, and native plant habitat restoration), the park’s wildlife makes use of all areas of the park. The challenges and opportunities for the Trust are in

balancing its diverse goals, including supporting the long-term sustainability of wildlife. Native habitat restoration forms a basis for wildlife conservation and management. However, opportunities for habitat restoration are limited to specific areas and may conflict with preservation of historic landscapes. In addition, many other factors affect the viability of wildlife in the park, particularly as the park continues to develop and increase in human activity. This presentation will explore some of the many issues and opportunities related to wildlife conservation in an urban park, including: protecting birds under the Migratory Bird Treaty Act, addressing the effects of night lighting on wildlife, wildlife enhancement within cultural landscapes, inventorying and monitoring wildlife populations, addressing public safety concerns, and the potential for species reintroductions to the park.

### **Evaluation of the ability of a wildlife education program to enhance the perceptions of wildlife by inner-city youths**

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There is limited research regarding how effective wildlife educational programs are at fostering an appreciation of wildlife in inner-city children. Often, these are youth with limited exposure to wildlife and opinions of wildlife that can be described as indifferent or negative. An understanding of the perceptions of wildlife by these children and the factors that influenced their perceptions can lead to development of a wildlife educational program better suited for inner-city children. The goal of this study was to ascertain if a wildlife education program is effective at cultivating an appreciation for wildlife in inner-city children. It is an ongoing study being conducted in two schools in the state of Missouri, with ages of the children between 10 and 16, with an end-date of May 31, 2009. The study involves interviews of the children before the wildlife educational program and will include interviews after participation in the program. The interviews will be compared to ascertain any change in the children's perception of wildlife. The questions within each interview were open-ended in nature with the objective of determining the youths' opinion of wildlife and discovering what experiences they have had prior to the wildlife education program. Interviews have shown that inner-city children have a wide array of perceptions of wildlife. Those children with positive perceptions usually have had positive encounters with wildlife at an early age. Conversely, children with negative perceptions of wildlife also had early, but negative encounters with wildlife. In the context of the local school, wildlife programs that address the specific needs of inner-city children can encourage children to appreciate the wildlife around their homes. On a larger scale, this awareness can lead to increase the diverse makeup of future natural resource managers.

### **Opportunities for urban wildlife contact for children in urban childcare centers**

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This study seeks to broaden the understanding of the benefits of providing urban wildlife habitat through design of outdoor areas for preschool children in urban contexts. This presentation examines data collected from urban child care centers to determine the link between outdoor classroom design, urban wildlife, and the development of affinity with nature in preschool children. Interviews of preschool aged children were conducted in two urban contexts. Within each context responses from children who were enrolled in programs with outdoor nature classrooms with wildlife habitat were compared to those enrolled in programs without nature classrooms or wildlife habitat. Two different assessment strategies were used with each child. The first assessment was a "puppet interview" designed to measure biophilia. The child was presented with two identical puppets and was told something about each puppet's thoughts and feelings toward nature, including wildlife, and then the child was asked, "Which one is more like you?" For example, one item reads: "This boy/girl likes to find bugs and look at them. This boy/girl likes to find bugs and stomp on them and kill them." The questions are then summed to create a total biophilia score. The second assessment strategy involved presenting the child with photographs from the outdoor area of the

child care program and asking the child to choose the places where they like to play the most. The child was then asked a series of open-ended questions about each place, what wildlife they find in the outdoor classroom, what they like and dislike about the places with wildlife, and how they feel when they are in the wildlife place. Data analysis will focus on comparing biophilic responses of children from programs with nature classrooms (n = 8) and without (n = 6) and the types of wildlife preschool children are comfortable with.

### **Characterization of freshwater turtle nesting beaches in an urban environment: implications for management through the proposed use of artificial nesting beaches**

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With approximately 5.5 million people living in the Greater Toronto Area, and nearly 2.5 million living within the city itself, Toronto is a highly urbanized centre. Southern Ontario in general has seen a drastic decrease in wetland habitat, with 80% lost since European settlement. Habitat loss is one of many challenges impacting turtles in urban landscapes.

Nesting habitat is of prime importance to turtles, and urban development can both directly and indirectly destroy nesting habitat. Turtles generally have high nest-site affinity and may attempt to find historic locations even in an altered landscape. In situations where nesting beaches no longer exist, or the paths to nest-sites include hazards such as roads, the option of constructing artificial nesting beaches could be considered. The creation of artificial turtle nesting beaches requires knowledge of native nesting habitat to ensure effectiveness and reduce the risk of creating population sinks. This study compares the characteristics of snapping turtle nesting beaches (n=5) to non-nesting beaches (n=10) along a section of the Rouge River with the aim to collect beach characteristics for future artificial nesting beaches. Snapping turtles in the river choose nest beaches comprised of substrate with a greater proportion of large grain sizes and comparatively less sand and clay than beaches that are not chosen. There is also a trend toward drier nest beaches with less subsurface organic matter, with significance at  $\alpha=0.05$  but not at a Bonferroni-corrected  $\alpha$  level. Other characteristics, including substrate temperature, albedo, aspect, and slope are apparently not important factors in nest beach selection in this area. Thus, if future nest-habitat creation is to be considered for the snapping turtles in this area, the riverine nest beaches may serve as a model. In this case, grain size, moisture, and organic matter are factors that must be considered to mitigate habitat loss.

### **Movement patterns, toxicant exposure, and disease exposure in coyotes in urban southern California**

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National parks in urban areas face significant challenges in preserving wildlife populations, particularly populations of wide-ranging species such as mammalian carnivores. Since 1996, we have been studying the behavior, ecology, and conservation of carnivores at Santa Monica Mountains National Recreation Area north of Los Angeles. From 1996-2004, we captured 130 and radio-tracked 110 coyotes. Overall, coyotes predominantly used natural habitat, although there was considerable variation between individuals. On average, coyote home ranges consisted of 67% natural habitat, and 77% of coyote radiotelemetry locations were in natural areas. Some coyotes made use of small habitat fragments, as small as 80 ha, moving through developed areas between fragments of natural habitat. For example, one adult female coyote lived and raised young in the San Fernando Valley, a highly developed area north of Los Angeles. Although 75% of her home range was developed, only 7.5% of her locations were in developed areas – she was generally located in vegetated areas on a community college campus or in landscaped (golf course, parkland) and natural areas along the LA River. The second-leading cause of mortality for coyotes in our study was poisoning from anticoagulant rodenticides. Of 45 known mortalities, 23 were from vehicles, and 12 were from anticoagulant poisoning (death from uncontrolled internal bleeding). Overall, 20 of 24 coyotes (83%) tested were positive for anticoagulants, and 9 of these 20 were exposed to multiple compounds. Coyotes



were exposed to (seropositive for) a number of canid diseases such as canine distemper (52%), canine parvovirus (79%), and canine herpesvirus (64%), although no cases of these diseases were documented. Seropositivity was not significantly related to use of development. Although coyote-human conflict in southern California has been widely publicized, of 110 radio-collared coyotes in our study, to our knowledge none ever exhibited aggression towards humans or became nuisance animals.

### **Recent progress in porcine zona pellucida (PZP) immunocontraception of white-tailed deer**

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Research into immunocontraception as a technique for reducing urban deer populations and mitigating conflicts with urban deer has been pursued for nearly 2 decades. Immunocontraception is perceived as advantageous because, unlike steroid contraceptive technologies first pursued in the 1960s, immunocontraceptives do not pass through the food chain and can be delivered remotely in the field. The porcine zona pellucida vaccine (PZP), in particular, has been widely tested on white-tailed deer in the field, as well as wild horses, African elephants, and other species. In early field trials, a PZP vaccine preparation requiring 2 initial shots and annual boosters reduced fawning rates in individual female deer by 80-90%, showing minimal side effects. More recent work addressed concerns about the practicality of multiple-shot vaccines and vaccine effectiveness at the population level. Beginning in 2005, we hand-injected female white-tailed deer in late winter on Fripp Island, SC, with 100 µg PZP emulsified in modified Freund's Complete Adjuvant plus PZP incorporated into lactide-glycolide pellets engineered to release PZP at 1, 3 and 12 months. These treatments reduced pregnancy rates relative to untreated controls by approximately 80% in year 1 and 75% in year 2. From 2005-2008, winter distance sampling at Fripp showed a 35% decline in deer population density; densities at the neighboring Hunting Island control site remained stable over that period. The Fripp Island population trends supplement those previously reported at PZP study sites at Fire Island National Seashore, NY, and the National Institute of Standards and Technology, MD. Thus, most of the obstacles remaining to the widespread use of contraception for stabilizing and reducing urban deer populations are regulatory and political.

### **Combining science, planning, and design to reduce roadway impacts on wildlife in southern California**

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Beginning in 1996, the National Park Service, Caltrans, and other agencies and organizations have worked to collect, analyze, and share data about regional wildlife movement corridors within the Santa Susana Mountains, Simi Hills, and Santa Monica Mountains, near Los Angeles, California. This region is characterized by intense urban development, several major multi-lane highways, and large expanses of protected open space supporting abundant wildlife. Research has included radiotelemetry of coyotes, bobcats, and mountain lions, monitoring of undercrossings and culverts to evaluate wildlife utilization, assessment of wildlife mortality along roads, and genetic investigations of the effects of roads on wildlife. Results demonstrated that regional wildlife viability will depend on identifying and protecting habitat linkages and wildlife movement corridors across highways that bisect remaining open space. For example, genetic results confirm that multi-lane highways restrict gene flow for bobcats and coyotes. At the same time, opportunities do exist to retain landscape connectivity with many species using a variety of roadway crossing structures. By applying science to transportation planning, collaborators are integrating conservation actions with needed transportation improvement projects and regional transportation plans. Recent successes include multi-agency and local participant groups identifying and prioritizing regional wildlife movement corridors, and creating plans for implementing enhancements. Overall, we demonstrated

that by sharing expertise and experiences, and by linking science and planning, regional wildlife habitat connectivity can be enhanced in combination with needed transportation projects. This model of partnership and collaboration can be applied to other urban interface areas facing similar wildlife conservation and transportation challenges.

### **Evaluation of euthanasia and trap–neuter–return (TNR) programs in managing free-roaming cat populations**

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Global estimates of the number of domestic cats (*Felis catus*) are >400 million. Issues associated with free roaming cats are of global importance because of animal-welfare and public-health concerns and impacts on native wildlife through predation, competition and disease transmission. In the United States, proposed control solutions for managing urban free-roaming cat populations include euthanasia and trap–neuter–return (TNR) programs. We evaluated control methods using a demographic population model for a 25-year period, with parameters estimated from an unmanaged, free-roaming cat population in Texas. We modeled euthanasia and TNR at 25%, 50% and 75% implementation rates and a 50:50 combination of euthanasia and TNR at 25%, 50%, 75% and 100% implementation rates for 0%, 25% and 50% maximum immigration rates. We compared final population size, total number of cats treated and treatment effort relative to population reduction. Population decreases were comparable among euthanasia, TNR and a 50:50 combination for all treatment rates when the immigration rate was 0%; however, they were higher for euthanasia at 25% and 50% maximum immigration rates. Euthanasia required higher treatment effort than TNR. Our results indicate that immigration must be prevented and high (>50%) treatment rates must be implemented to reduce free-roaming cat populations.

### **Monitoring and enhancing wildlife movement across freeways in urban southern California**

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In southern California, numerous busy and wide freeways can act as barriers to wildlife movement and can cause wildlife mortality due to vehicle collisions. Since 2002, National Park Service and California Department of Transportation biologists have been collaborating to monitor wildlife connectivity across 2 freeways and investigate the potential benefits of mitigation to reduce wildlife mortality and increase wildlife use of crossing structures. In Ventura County along State Route 23 before the construction of 2 additional lanes, we conducted wildlife mortality surveys along a 3.2 km stretch of freeway, for 34 months. We used remote digital cameras to simultaneously monitor wildlife use of 3 underpasses along the same stretch of freeway, 2 of which were significantly obstructed by debris. We documented 222 wildlife mortalities and extensive wildlife use of the open culvert, but the 2 blocked culverts received significantly less use. During construction the 2 blocked culverts were cleared and an entirely new right-of-way fence was built along the freeway, including 12 one-way gates that are designed to allow animals caught on the freeway to exit but not allow animals to enter. We are beginning to monitor post-construction wildlife road mortality, underpass use, and the use of the one-way gates. Along Highway 405 in Los Angeles, one of the busiest freeways in the U.S., we are using digital cameras to monitor wildlife use of 3 crossing points (2 underpasses and 1 road bridge) and wildlife activity in open space near these crossing points. Here we will monitor wildlife movement and activity before construction, during the construction phase, and post-construction, to determine the impacts of widening the freeway on wildlife movement and the potential benefits of enhancing the road bridge for wildlife crossing. These long-term road studies will help us gather valuable information about mitigation efforts along busy freeways and wildlife movement in challenging urban landscapes.

### **Impacts of habitat loss, fragmentation, and the introduction of non-native species as a result of urbanization on the western pond turtle in southern California**

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More than 90% of southern California's riparian and aquatic habitats have been destroyed or modified by agriculture and urbanization. This has had profound effects on species dependant on these habitats including the western pond turtle (*Actinemys marmorata*), the only freshwater aquatic turtle native to southern California. We have been monitoring the southern California pond turtle populations since 2001 and have documented their decline. This decline has been a result of the direct and indirect effects of urbanization including habitat loss, habitat alteration, habitat fragmentation, the introduction of non-native species, and recreation activities. Our trapping efforts have detected a minimum of 15 species of non-native turtles in southern California with red-eared sliders and spiny softshell the most common. At sites occupied by non-native turtles, non-native turtles have outnumbered the native turtles. We have also documented a negative correlation between pond turtle presence and sites with recreational use, while non-native turtles are positively correlated with recreational use. Finally, pond turtle presence is positively correlated with the naturalness of a site while non-natives were more likely to occur at modified or artificial sites. Only a few viable pond turtle populations remain in southern California, most populations are male-biased with little to no recruitment. Currently, we are developing programs such as long-term monitoring, genetics microsatellite analysis, habitat suitability assessment, habitat restoration and creation, translocation, head starting, and captive breeding to be used as tools to promote the recovery of the pond turtles in southern California.

### **Can urban parks provide suitable stopover habitat for migratory landbirds? A call for additional research**

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The major migration pathways of Neotropical-Nearctic migratory landbirds overlap with some of the most urbanized regions of North America. As a result, migrants in need of stopover sites to replenish energy stores sometimes utilize city parks where they can occur at very high densities. This phenomenon has long been recognized and exploited by birdwatchers, who delight in large numbers of migratory birds concentrated in small spaces. The very conditions that make city parks wonderful birdwatching locations may, however, be detrimental to birds. High densities of migrants likely increases intra- and inter-specific competition for resources in these habitats where resources may be limited by non-native plants and animals, pollution, or other forms of degradation. It remains largely unknown whether urban habitats can in fact provide suitable refueling conditions for landbird migrants. Given that meeting the habitat requirements of migration has been repeatedly listed as a priority in migratory bird conservation strategies, and worldwide urbanization is proceeding rapidly, we argue that this issue is in need of greater attention. Although birds have historically been studied in urban areas perhaps more than any other taxon, nearly all of the work has focused on breeding birds. In this talk we will review the limited urban stopover biology research conducted to-date, identify the largest outstanding questions in need of study, and suggest priorities for future research. We will also discuss some of the unique challenges to studying stopover biology in an urban setting of which researchers should be aware of and address before initiating research.

### **No apparent benefit to early breeding by northern cardinals in urban and rural forests**

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While the patterns of advanced reproductive phenology in urban versus rural populations of birds are generally well described, the causes and consequences of altered reproductive phenology associated with

urbanization remain poorly understood. We studied the patterns, causes, and consequences of altered reproductive timing of northern cardinals (*Cardinalis cardinalis*) nesting in urban and rural forests in central Ohio, USA between 2004-2007. The earliest dates for both nesting activity and clutch initiation were seven to ten days earlier in urban versus rural forests. However, after accounting for differences in northern cardinal density across sites, the timing of nest initiation was not significantly related to urbanization. Using an information-theoretic approach, we evaluated several potential mechanisms explaining variation in nesting phenology. Temperature accumulations in March were the best predictor variables explaining breeding phenology, though January temperatures, amount of urbanization within the surrounding landscape, and conspecific density also received some support. In contrast, vegetation phenology (i.e., bud break, leaf elongation), site-level survival rates of adults, and the availability of nest sites failed to explain variation in breeding phenology of northern cardinals. Contrary to findings from other studies, breeding earlier in the season was not significantly related to the number of fledglings produced over the season. Rather, the expected number of fledglings produced per successful nest remained constant over the course of the season at ~1.7 fledglings per successful nest. The absence of a benefit to early breeding may be the consequence of high rates of nest predation early in the breeding season.

### **How does the public process impact the selection of a nuisance wildlife management plan?**

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Since the 1950s, the human relationship with wildlife in the United States has shifted dramatically; from primarily consumptive to primarily recreational. Over the same time period, a trend of humans moving into suburban communities farther from the urban core developed. These people inadvertently enhanced their new suburban environment to be more appealing to certain generalist species known as nuisance wildlife. Policy decisions for nuisance wildlife species are made at a national or state level; however, municipalities manage most nuisance wildlife-human conflicts. An individual town or city is responsible for controlling populations of nuisance species both financially and tactically. Given that a municipality must select a wildlife management tactic when conflict occurs, do different decision-making processes yield different outcomes? This study identifies the link between public process and management outcomes; a connection that informs municipalities of the decision-making methods that lead to the most effective wildlife management. Through an examination of resident Canada goose management in four small Massachusetts cities and towns, this study demonstrates the processes used to select nuisance wildlife management plans and the success or failure of those plans. Through the trials of the municipalities examined, it is clear that management plans selected in the most straightforward and transparent manner and those that engage the public experienced the greatest success. I contend that open decision-making significantly reduced the risk of public conflict or controversy, and ensured the longevity of the selected management plan.

### **Mountain lion movements and kill sites relative to development, roads, and trails in a fragmented, urban landscape**

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Habitat loss and fragmentation due to urbanization can have substantial impacts on wildlife movement and survival. Large carnivores, such as mountain lions (*Puma concolor*), are especially vulnerable to the effects of urbanization because of their extensive spatial requirements, low densities, and potential for conflicts with humans. Since 2002, we have been using GPS collars to study the behavior, ecology, and conservation of mountain lions in and around Santa Monica Mountains National Recreation Area, a national park west of Los Angeles. We measured the degree to which mountain lions used developed areas, altered open lands, and natural areas with varying distances from urbanization. On average, mountain lion home ranges included less developed area or habitat close to development and more area > 1 km from development than available on the study area. However, 3 mountain lions utilized urban and altered areas significantly more

than other animals, with home ranges consisting of more than 10% developed area. Mountain lions regularly crossed all of the major 2-lane paved roads through the Santa Monica Mountains. Consecutive GPS locations and tracking showed that mountain lions moved along recreational roads and trails frequented by people, but that they did so mostly at night when human activity was low. Generally, most mountain lion kills were located away from development, roads, and trails. Only 2% of mountain lion kills were within 100 m of development, while 70% of all kills were located > 1 km from urban areas. Only 2% of kills were located < 10 m from a trail, and in all of these cases mountain lions primarily visited the kills at night and spent most of the days at a rest site farther from the trail. Even though mountain lions utilized habitat near urban areas with many roads and trails and recreating humans, there have been minimal encounters and conflicts with people.

### **The roles of food and nest predation in shaping urban bird communities: a study with the northern mockingbird, an urban adapter**

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Before we can exploit the conservation potential of urban ecosystems, we must understand the mechanisms structuring urban communities. Although many native species have been extirpated from urban areas, some have adapted well. We tested 2 hypotheses for why the northern mockingbird (*Mimus polyglottos*), an urban adapter, has higher population densities in urban habitats in Florida, USA: reduced rates of nest predation and increased food resources. There was no evidence for increased food resources on a per capita basis in urban habitats (parking lots and residential areas) relative to non-urban habitats (pastures and natural areas). Food quality appeared to be slightly higher in non-urban areas. Nest predation rates, however, were significantly lower in the urban habitats in 2 of 4 years, despite 3 times as many avian predators censused in urban habitats. Infrared cameras showed that the nest predator communities differed in both their identity and timing of predation. Overall, more fledglings were produced per pair in urban habitats in the 2 years with low predation rates and there were no differences in the other 2 years. We conclude that urban habitats offer a refuge from nest predation in some years, which outweighs any slight reductions in per-capita food availability. Urban ecosystems provide conservation opportunities for some species, depending on their life history traits related to predator avoidance.

### **Coyote populations in urban ecosystems: ecosystem services and trophic considerations**

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Studies of eastern coyotes have contributed considerably to our understanding of canid natural history, behavioral ecology, genetics, and adaptation. In this presentation, we propose that the expanding range of longitudinal studies of coyotes across North America, especially those in urbanized areas, can provide a platform for considering coyotes as a model system for investigating general questions in ecology, open space management, and public health. Emerging patterns of ecological dynamics in urbanized areas have driven the development of new models for the collection and interpretation of ecological data. The National Science Foundation's *Integrated Science for Society and the Environment* Model considers the biogeophysical and human socioeconomic drivers as integrated forces of change within ecosystems. Some preliminary data suggest that coyotes, as top order predators, may play an important role in the trophic dynamics of urban ecosystems. As a result, this impact may alter the population of other consumer guilds, which in turn, may impact key aspects of human health in urban areas. Our hope is that this presentation will serve as a catalyst for future collaborative model building, hypothesis testing, and the study of coyotes in additional geographic areas.

### **Recent changes and projected trends in management of the "overabundant": beavers in transition from resource to pest**

Jennifer E. Strules, Massachusetts Cooperative Fish and Wildlife Research Unit, University of Massachusetts, Amherst, MA; Laura Hajduk and Robert D. Deblinger, Massachusetts Division of Fisheries and Wildlife, Westborough, MA; Kiana Koenen, Massachusetts Department of Conservation and Recreation, Belchertown, MA; and Stephen DeStefano, U. S. Geological Survey, Massachusetts Cooperative Fish and Wildlife Research Unit, Amherst, MA. Contact: [jestrule@nrc.umass.edu](mailto:jestrule@nrc.umass.edu).

The beaver (*Castor canadensis*) has played a major role in the history and evolution of human-wildlife relationships in North America. By virtue of its ability to alter and create ecosystems, numerous labels have underscored the beaver's ecological importance: keystone species, environmental engineer, indicator species, and umbrella species. However, in many parts of the United States, and especially in urbanized states, another term is now firmly affixed to the beaver: pest. Changes in harvest regulations and consequently in the management of beaver populations have not only altered patterns of survival and mortality, but have impacted the collection of data and influenced the perception of the public towards this species. We trace the history and consequences of those changes in Massachusetts over the past decade, since the passing of a referendum that prohibited the use of body-gripping traps. As a consequence, beaver populations grew exponentially, qualifying the species as "overabundant," as did complaints by the public. With the changes in management regulations, record keeping and data gathering have been problematic and information has been lost. Other consequences, although difficult to document, include the heightened potential for killing of beavers and the destruction of dams without legal permit. Public sentiment in urban and suburban areas may indeed lean away from traditional use of wildlife species, but the consequences of that choice for beavers and other species should be examined and discussed.

### **Behavioral responses of captive deer to physical and visual barriers designed to minimize deer-vehicle collisions**

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Collisions with white-tailed deer (*Odocoileus virginianus*) present a significant hazard to motorists. Dense deer populations, coupled with a growing human population and expansion of the nation's roadway system, have increased the risk of deer-vehicle collisions. Our previous research revealed that deer whistles and roadside reflectors were ineffective at sufficiently altering roadside behavior of deer to prevent deer-vehicle collisions. To assess which types of barriers might prevent deer from gaining access to the roadways, we evaluated the ability of captive deer to cross fences and other barriers, and examined the effects of the barriers on their behavior. We tested 3 fence designs of various heights, and a barrier constructed of rip-rap rock. Deer were placed into groups of 2 and behaviors were recorded as they were approaching and attempting to cross the fences. All deer (n=12) crossed 4-5 ft-tall woven wire fences. Nine (75%), 5 (42%), and 0 deer jumped 6 ft, 7 ft, and 8 ft fences, respectively. When retrofitted with opaque coverings, 9 of 10 deer jumped the 4-5 ft fences and 8 (80%) crossed 6 ft fences. When 4 ft fencing was retrofitted with a 2 ft opaque 45° outward-facing outrigger, 7 (70%) deer successfully crossed. However, when we replaced experienced deer with 6 naïve deer, 0 jumped this modified fence. The naïve deer trials revealed the implications of using a deer's perception of various barriers to prevent crossings even when deer have the physical ability to jump the barriers. The barrier constructed of rip-rap rock was unsuccessful in restricting deer movement as all deer (n=12) crossed a 20 ft wide swath. Recorded behaviors and actions will be further studied and compiled for a decision tree analysis.

### **The impact of non-native landscape plants on local food webs**

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Managed landscapes in which non-native ornamental plants are favored over native vegetation now dominate the United States, particularly east of the Mississippi River. We measured how landscaping with native plants affects the avian and lepidopteran communities on 6 pairs of suburban properties in southeastern Pennsylvania. One property in each pair was landscaped primarily with natives and the other exhibited a more conventional suburban mix of a native canopy and alien groundcover and shrubs. Vegetation sampling confirmed that total cover did not differ between treatments, but alien plant cover was greater on the conventional sites and native plant cover was greater on the native sites. Several avian (abundance, species richness, biomass, breeding bird abundance) and larval lepidopteran community parameters (abundance, species richness, biomass) were measured from June 2006-August 2006. Native properties supported a three times greater caterpillar abundance and species richness, and a significantly greater avian abundance, diversity, species richness, and biomass as well as more breeding pairs of native bird species. In addition, native properties supported over eight times greater abundance and richness of bird species of regional conservation concern. Thus, native landscaping positively influences the avian and lepidopteran carrying capacity of suburbia, and provides a mechanism for reducing biodiversity losses in human-dominated ecosystems.

### **A non-linear response of marsh bird communities to urbanization in Massachusetts landscapes**

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Effective conservation of marsh birds imperiled by habitat loss requires an accurate understanding of the relationships between habitat features at multiple spatial scales and species' distributions. Urbanization of adjacent landscapes has the potential to negatively impact marsh bird communities via several top-down and bottom-up mechanisms. Despite this, conflicting patterns have been reported in the literature. While some researchers report the expected negative effect upon marsh adapted species richness, others report a positive effect. Conservation of state-listed marsh bird species in Massachusetts will require a clear understanding of the impact of urbanization on their distributions. To investigate this issue, we conducted marsh bird community surveys in 34 Massachusetts wetlands varying in the degree of surrounding urbanization. Degree of urbanization was defined by road density in the surrounding landscape. Roads have the potential to impact wetland hydrology and water quality, resulting in reduced habitat quality for breeding marsh birds. Our results suggest that urbanization has a threshold effect upon marsh bird communities, such that long distance migrants and marsh specialists are less likely to occur in urban settings. Consequently, efforts to conserve marsh specialists may need to take a landscape approach, restricting the development of landscapes surrounding critical habitat for these species.

### **Evaluation of an urban wildlife education program in high schools across the U.S.**

Jessica Tegt and Ben West, Department of Wildlife and Fisheries, Mississippi State University, Mailstop 9690, Mississippi State, MS 39762

Research indicates that high school aged adolescents are the least informed about urban wildlife issues. Numerous programs have been created as a supplement to existing science programs informing students about urban wildlife, but have fallen short in increasing knowledge or assessing student attitudes. We evaluated a different style of urban wildlife education program in classrooms across the eastern and mid-western United States where white-tailed deer are prevalent. The program entitled, "Living with White-tailed Deer" allows students to become stakeholder groups and conduct research regarding a hypothetical town overpopulated with deer. The students conduct a mock-town meeting following the research to reach consensus on deer management. In addition to meeting national academic correlations for science, the

program also meets correlations for social studies, civics, and environmental education. Our research also assessed the knowledge and attitudes of the students before and after the program, as well as certain demographic characteristics. We also surveyed the teachers to evaluate the academic soundness of the program. Preliminary first-year results indicated that students in rural areas have more favorable attitudes toward deer and higher knowledge overall. Additionally, teachers reported that this type of cross-disciplinary educational program allows students to become invested in not only the research, but also the town meeting forum.

### **A training needs assessment for wildlife professionals**

Jessica Tegt, Ben C. West, and Phil Jones, Department of Wildlife and Fisheries, Mississippi State University, Mailstop 9690, Mississippi State, MS 39762

Customarily, wildlife biologists have not entered their discipline with the desire to interpose managerial and public conflicts, nor has adequate training provided for them to do so. Lack of preparation can often be disastrous when wildlife agencies propose management plans that contradict the opinions of the community. Worldwide, the need for education and training tools is recognized. The problem remains, however, in understanding exactly what those needs are and how to best deliver the tools to fill training gaps. To assess this problem, we conducted a needs assessment for wildlife professionals within USDA Wildlife Services that identified training needs within the field of wildlife management. This needs assessment specifically addressed where educational gaps lie, where the limits on both knowledge and equipment reside, and the availability of effective training programs. Overwhelmingly, our results indicated that human dimensions type training was the most needed and least available training to wildlife professionals. In addition, the needs assessment showed that training programs were often constrained by budget and travel restrictions. Managers also expressed concern that many human dimensions training courses were not designed for wildlife professionals and applicability affected the dispatch of employees to certain programs. Our results offer a foundation for providing training programs to wildlife professionals in the future. Our findings also allow us to better understand what wildlife employees need to reach maximum job performance potential and to communicate effectively with the public.

### **Recreation impacts on wildlife in and adjacent to public open space in Pitkin County, Colorado**

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Pitkin County voters approved a property tax mill levy to purchase open space and build trails in 1990. The county has protected over 3000 acres of open space and built over 40 miles of trails. As open space programs mature and lands are acquired, taxpayers demand access to some of the lands purchased with tax dollars. Balancing this demand for recreation with wildlife protection is a management dilemma. The mission of the Open Space and Trails Department is to acquire, preserve, maintain, and manage open space properties for multiple purposes including, but not limited to, recreational, wildlife, agricultural, scenic, and access purposes; and to acquire, preserve, develop, maintain, and manage trails for similar purposes. This mission leads to conflicts between humans and wildlife when human access is considered on open space lands. Pitkin County has developed many tools for managing properties with diverse wildlife populations and incorporated them into management plans that strive to fulfill the department's mission. The story of one of the most recent management plans created by Pitkin County illustrates the struggle of fulfilling the mission of the department while providing the best protection for wildlife next to a small community near Redstone, Colorado. The management plan took 5 years to complete and had both the public access and wildlife protection camps at war. The adopted plan has everything from long seasonal closures to travel management corridors to try to protect critical habitat. Pitkin County also requires all trail projects to go through a land use review to assess environmental impacts and develop ways to mitigate. Projects will be reviewed to show some of the successes and pitfalls associated with public open space on urban borders.



**Promoting pollinator conservation in New York City parks: a collaborative approach using traditional and unorthodox resources to greatly expand pollinator resources in the urban context**

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Surveys have revealed 225 extant species of native and introduced bees from the five boroughs of New York City (NYC). This number would surprise many given extreme and prolonged habitat fragmentation leading to a presumed severe reduction in pollinator resources, especially native plant species. Starting in 2007, under the general umbrella of *The Great Pollinator Project (GPP)*, the NYC Department of Parks and the American Museum of Natural History have collaborated on efforts to improve pollinator conservation in the city. The first effort has been a citizen-science program called *Bee Watchers*. *Bee Watchers* has focused on educating the public to pollinator conservation and the importance of native plants (native species grown by the department are distributed to participants) and establishing a rough metric of the relative occurrence of pollinator services throughout the city. The goals of the *GPP* collaboration also include the intent to influence policy and implement management practices within the major land managing agencies of the city. In 2009 the first steps in meeting those goals are being implemented through various outreaches targeting the city's land managers and horticulturists. A symposium, field workshop, and intensive pilot projects will all lead to development of a best management practices (BMP) protocol for managing pollinators in the urban context. In addition, the collaboration has revealed hidden opportunities to utilize non-traditional resources, such as *Greenstreets*- Parks Department traffic island beautification sites, neighborhood backyards, high rise terraces, and community gardens. These sites are being used to increase pollinator resources directly and, in some instances, as functional linkages for pollinators to the city's larger habitat resources.

**Movements of the endangered black ratsnake on current and proposed roadways on a college campus in western Massachusetts**

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As urbanization continues to change the natural landscape, the impact it has on native species is an important issue to question. Wildlife habitat can be fragmented, leading to reduced populations and less genetic mixing between populations. The black ratsnake (*Pantherophis alleghaniensis*) is widespread across the country geographically, and Massachusetts is part of the northern tip of its range, which is an area subject to frequent change from urbanization. Beginning in the summer of 2007 through to the present, thirteen adult black ratsnakes have been followed using radiotelemetry at a nearby site in western Massachusetts. The study site is adjacent to a college campus of about 9000 students along the Holyoke Mountain Range. The study was initiated in response to a proposed new road construction project connecting the college campus to a state highway. Nine of the thirteen snakes followed or crossed the proposed roadway, two crossed roads on campus multiple times, and four spent significant time on or near roadside edges. There were no known road mortalities of the monitored snakes. A major attraction seems to be several compost piles located in an open field next to the proposed roadway. The town's highway department established these compost piles more than 20 years ago. Data on habitat selection, home ranges, population, and natural history are the primary focus areas of this study. Estimating long-term survival of this population will require careful analysis of movement data over several years to determine what habitat elements are especially important to individuals in this endangered species population.

### **The urban and suburban matrix: an important resource for wildlife in a rapidly urbanizing world**

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Wildlife species typically respond to urbanization by either increasing (i.e., urban adapters) or decreasing (i.e., urban avoiders) their abundance or range. Our ability to quantitatively document the decline (or expansion) of a species is often limited by a lack of quality before-urbanization data. This in turn may hinder our ability to appropriately manage urbanizing landscapes for wildlife conservation. In our study, we used atlas databases to infer the persistence of all vertebrate wildlife taxa across Melbourne, the second largest city in Australia. The results for mammals indicated that < 50% of species had a > 95% probability (i.e., remaining extant) across the city. Recognizing that streets and residential properties potentially provide significant amounts of habitat for wildlife, we further studied two species of mammal to explore their response to urbanization and their reliance on resources within the urban and suburban matrix. The wide-ranging grey-headed flying-fox (*Pteropus poliocephalus*) recently established a permanent camp in Melbourne and now up to 30,000 bats call Melbourne home. Our evaluation of the vegetation along streets and in backyards demonstrates a wider temporal and spatial availability of food for flying-foxes than occurred prior to urbanization. In contrast, the sugar glider (*Petaurus breviceps*) is relatively sedentary and reliant on patches of native eucalypt forest for survival. Our radio-tracking study demonstrated that the sugar glider also used vegetation within the privately-owned properties adjacent to bushland and appropriate management of this resource can benefit an otherwise urban-avoiding species. Conservation effort typically (and necessarily) focuses on patches of relatively intact native vegetation within and outside city limits. However, our work clearly demonstrates that some species utilize, and in some cases rely heavily on, the urban and suburban matrix for survival. Management efforts are required across the urban-rural gradient to maximize species conservation.

### **The glucocorticoid stress response in urban and rural populations of the clay-colored thrush in Nicaragua**

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Myriad studies have examined and documented lists of species that appear to be tolerant to living and breeding in urban environments. The ability of these species to adapt their life histories to successful urban living is likely driven by changes in the internal physiological mechanisms that drive behavioral and reproductive choices. Thus, quantifying physiological differences between urban and rural populations may allow for a better understanding of why some species do well in urban environments and some do not. Here we present data collected in the summer of 2008 on the glucocorticoid stress response in two populations of the clay-colored thrush (*Turdus grayii*): one population in the middle of the urban center of Managua, Nicaragua, and a second population in the high-mountain rural (i.e., less disturbed) north-central department of Jinotega, Nicaragua. It is hypothesized that highly disturbed populations likely show a blunting of the glucocorticoid stress response in order to avoid the negative consequences of having chronically elevated levels of these stress hormones. We subjected thrushes in both habitats to the classic capture-restraint protocol to determine their ability to respond to severe acute stress. During the restraint period, we collected blood samples to measure the circulating level of corticosterone, the glucocorticoid hormone secreted in response to stressors in birds. By comparing both the pre-disturbance levels of circulating corticosterone as well as the acute stress-induced responses in these two populations, we will show what, if any, differences in stress hormone secretion are present in these two populations with very different levels of human disturbance.

### **Do the preferences of the New Creative Class induce residential development of wildlife friendly neighborhoods?**

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The city of Lubbock, TX is an urban forest island in the southern High Plains of Texas. Native short-grass prairie in this region has been replaced with intensive agriculture (primarily cotton), with some 20% in CRP land since 1986 in danger of being recultivated. The next best available viable growing habitat is urban and, for short periods, abandoned cotton fields readied for new sub-division development. A key economic development objective for these new neighborhoods is to serve an emerging bio-tech industry by leveraging a progressing private–university partnership in agriculture and the health sectors. The demographic then is the so-called ‘New Creative Class,’ who show a strong preference for an amenity-rich environment. We want to determine home features, landscapes, and local amenities most valued by these professionals reflected in home purchase decisions. Incidental evidence suggests these consumers might prefer environmental amenities like trees and faunal communities, or generally landscapes friendly to more progressed wildlife assemblages. We selected a representative sample of purchasers of homes in middle and upper-middle income neighborhoods during 2008 from MLS Realtor listings. We surveyed over 200 of these homeowners who had recently purchased homes in the city of Lubbock, TX, asking them to select which housing features were most critical in their particular house purchase and neighborhood attribute variables considered. Concurrently, we surveyed resident wildlife (primarily avifauna) in selected neighborhoods and completed a landscape characteristic typology for individual homes and their immediate neighborhoods (meaning ‘green’ space is classified by landscaping style). We present a preliminary analysis of the variables, both cultural and environmental, that affect location and purchase prices by professional home owners. Results provide opportunities for the more entrepreneurial developers in this region to capture these opportunities and design neighborhoods strategically to provide economically valued wildlife friendly developments.

### **Snow tracking red foxes and eastern coyotes along a suburban-to-rural gradient in the Adirondack Park of upstate New York**

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Before the early 20<sup>th</sup> century, coyotes (*Canis latrans*) were absent from the eastern half of the United States, their range restricted to the great plains states and southern regions of the prairie provinces of Canada. In the face of anthropogenic landscape alteration and the extirpation of wolves (*Canis lupus*) and cougars (*Felis concolor*), coyotes have expanded their range, becoming nearly ubiquitous in the northeastern U. S. since their detection in 1925. Given the rapid nature of this expansion, many questions remain regarding the ecological effects coyotes may exert within regions they have colonized. For example, it has been suggested that red foxes inhabit areas closer to humans when coyotes are present. Given that red foxes are a known reservoir-vector of rabies, *Trichinella* spp., and cyclophyllid cestodes including *Echinococcus multilocularis*, an increased presence of red foxes within developed areas may raise the risk of zoonotic disease transmission. Using snow tracking, field interpretation of wildlife sign, and DNA-supported scat identification, we conducted plot-based surveys to document the presence-absence of canids along the development gradient within and on the periphery of the Village of Saranac Lake in Upstate New York. Snow depth, snow pack structure, mean sinking depth of canids, and land cover were recorded to further define the locations of red foxes and coyotes. Red foxes inhabit developed areas while coyotes are more active in undeveloped regions. However, red foxes are able to exploit resources in less developed areas where coyotes are present when snowpack characteristics may inhibit coyote movement. We aim to provide data on the movements of sympatric canids that may assist wildlife officials, urban planners, and health practitioners in assessing associated zoonoses transmission risk.

### **European badgers: resolving damage problems in English urban environments**

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The European badger (*Meles meles*) is widespread and abundant within the UK. It enjoys a high degree of protection by way of the Protection of Badgers Act 1992, which prohibits interference with a badger or its sett (burrow) without a licence granted by the appropriate licensing authority. Natural England (the licensing authority in England) annually receives approximately 600 applications for licences to take action against badgers because of the damage they can cause, mainly due to sett excavation, but also foraging activities. In recent years an increasing proportion of licence applications have originated from urban and suburban areas. Action against badgers to prevent damage in urban areas only rarely involves lethal control or translocation. The most common action is to exclude badgers from their setts using one-way gates, but this has a variable success rate. In order to develop a sustainable and humane strategy to resolve urban damage problems, we have been carrying out field investigations into urban badger behavior and ecology for the past 5 years. We will demonstrate how many of the features of badger social organization, sett use, and movement patterns in urban areas differ from rural populations. For example, home ranges are typically smaller, and territories can be non-contiguous and apparently undefended in urban populations. Such observations may help explain why it is sometimes very difficult to successfully exclude badgers from their setts. In such cases, alternative strategies may be required. One approach is to use fertility control to stabilize, reduce and/or eliminate local problems. Over the past year, we have been monitoring urban badger movement patterns using GPS tags, and modelling their population dynamics to explore the feasibility of using a GnRH vaccine to reduce fertility in females.

### **Deterrent or dinner bell? Can ultrasonic and water jet repellents control urban badger activity?**

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The increasing incidence of reports of damage caused by Eurasian badgers (*Meles meles*) in UK urban environments requires the development of effective, humane, non-lethal solutions. Ultrasonic deterrents are widely available to the public and are sold as a humane solution to the presence of unwanted animals in urban gardens. The reported failure of some ultrasonic devices may be caused by habituation of the target animals to the devices and the lack of association with a negative, physical stimulus. We tested the ability of a commercially available, motion sensor triggered ultrasonic device and a motion sensor triggered water jet device, in isolation and in combination, to alter badger activity and feeding at baited plots. We will discuss the somewhat surprising results in relation to the development of cost-effective solutions to the growing problem of badger damage in urban areas.

### **The socio-ecology of dying trees: cavity nesting birds, hazard trees, and declining urban forest canopies**

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Precipitous losses of urban trees have raised concerns in cities around the United States over effects on climate, water quality, and neighborhood vitality. Less attention has been paid to implications for biodiversity. At both broad and local scales, the decline of urban forests has clear impacts on wildlife. For species dependent on dead wood, such as cavity nesting birds, the effects may be complex. We suggest that at broad scales, cavity nesting birds are associated with greater tree canopy cover, with evidence from a variety of field studies including our own research in Baltimore, MD. At the scale of individual trees,

however, cavity nesters may benefit from the acceleration of decay in urban trees caused by stresses of urban life. Standard arboricultural practice typically removes deadwood from places that could impact people or property. Using standardized hazard ratings by certified arborists, we assessed the degree of overlap between tree hazards for people and deadwood habitat for birds in locations spanning a wildland-urban gradient in Massachusetts. Trees used by cavity nesting birds exhibited higher hazard ratings than nearby randomly chosen trees of the same size and species, particularly in the category of “probability of failure” (probability of falling). In addition, the wildland location retained proportionally greater numbers of trees with both high hazard ratings and suitable nesting habitat than trees in suburban and urban residential plots. Management for habitat for cavity nesting birds and other deadwood dependent species requires attention to both broad scales (restoration of declining urban tree canopies) and local scales (maintenance and care of individual trees). At the local scale in particular, best management practices must be derived with reference to both wildlife ecology and legitimate human concerns over risk.

### **Relocation of moose as a means of resolving human-wildlife conflicts in urban areas**

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Moose (*Alces alces*) have been re-colonizing southern New England for the past 2-3 decades. This range expansion is taking place in one of the most densely populated regions of the country. Introduction of this large and wide-ranging animal into a human-dominated landscape has led to conflicts. When moose wander into urban areas or onto roadways they become a public safety hazard. The state of Massachusetts has formed a large animal response team to deal with these situations. Early on the policy was to euthanize moose in problem situations to eliminate the threat of public harm. Public outcry after a well-publicized incident led to a change in policy. There is now a 3-stage plan to resolve conflicts. Whenever possible, animals are herded out of the area. If that fails and there is no immediate threat to public safety the moose is tranquilized and relocated. If neither of these approaches is possible or there is an immediate threat to public safety, the animal can be euthanized. We examined 22 moose relocations to compare survival rates of relocated moose to free-ranging moose captured as part of a research project. Our objective was to determine if relocating moose is a viable option to euthanasia. Thirteen of the 22 moose that were relocated survived  $\geq 6$  months following capture; 6 animals died and the fate of 3 was unknown. Of 14 free-ranging moose, 100% survived  $\geq 6$  months. In 5 of 6 instances of mortality, poor body condition, circumstances of capture, or prior injuries were likely the cause of death. At least 8 of the relocated animals lived for  $\geq 2$  years following relocation. We believe that moose relocation is a viable option to euthanasia in resolving human-wildlife conflicts in urban areas and will continue to play a role in maintaining healthy moose populations in urbanizing environments.

### **Eastern coyote movement patterns: lessons learned in urbanized ecosystems**

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Activity and movement patterns represent a fundamental aspect of a species' natural history. Twenty-four-hour movements of coyotes ranged up to 31.9 linear km and averaged  $23.5 \pm 7.3$  (SD) km from 5-14 radiotelemetry locations during each 24-hr monitoring period. Coyotes moved mostly at night and through altered open areas (e.g., powerlines, dumps) more than expected when compared to residential and natural areas. Coyotes inhabiting urbanized areas generally used residential areas for traveling and/or foraging. With large daily movement patterns, resident coyotes can potentially be located anywhere within their home range and at any given time. Our data revealed that one pack of coyotes (3-4 individuals) can cover a combined 75-100 km per night, in a territory averaging 30 km<sup>2</sup>. Transient movements from capture location to end location varied from 23.0-100.5 km and averaged  $63.8 \pm 52.0$  km for 2 females and  $38.7 \pm 17.2$  km for 3 males. Coyotes travel long distances even in human-dominated areas, allowing transients to find vacant territories. Because of the ability of coyotes to colonize and recolonize areas, we recommend that

coyote management efforts focus more on educating the public about coyote behavior and their life history needs than on killing them.

**Shaping hunter preferences: how attitudes, motivations, and demographics help determine typologies and landscape choice of urban archery deer hunters and how they influence participation, harvest, and satisfaction**

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The objectives of this research project are to determine what demographic variables influence urban hunter typologies and how specific typologies influence motivations, participation, satisfaction, and harvest. Additionally, hunter landscape preferences will be determined to identify relationships between habitat selection and harvest success. Two self-administered mail surveys will be performed. Initial surveys mailed in October, 2008 focus on demographic variables, perceptions, and motivations that lead to participation in the Columbia, Missouri Urban Archery Deer Hunting Program. Two methods of determining hunter motivations and typologies will be employed. First, we will use the major groups of motivations linking hunters to the sport that were described by Decker and Connelly, 1989. In addition to these motivations, typologies derived from Boulanger's study of South Dakota muzzleloader hunters in 2005 will be linked to demographic backgrounds, experience levels, and hunting commitment variables. The post-hunt survey conducted in January, 2009, will provide insight into landscape preferences, harvest, hunting participation, and satisfaction. Using public property inside urban areas to manage white-tailed deer has spawned a great amount of research related to the costs and methods of such strategies in their ability to reduce deer densities. However, little has been developed concerning what type of hunters participate in urban hunts and how their demographic characteristics relate to hunter behavior, participation, satisfaction, and harvest. Since August 16, 2004, the city of Columbia, Missouri has opened 3 city parks, portions of the city landfill, and 3 sewer utility properties to Missouri's general archery season, which occurs from September 15 through January 15. This management program provides a foundation to determine what hunter types and which demographic segments are more likely to participate and harvest deer within the confines of Columbia, Missouri.

**Green and wild planning: meeting the needs of local planners**

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For most threatened or endangered species, habitat loss and fragmentation are the major causes of their imperilment and the most significant threats to their conservation. The number of imperiled species will continue to grow as more habitat is converted and fragmented by human development and use. Community planning and development decisions made at the local, county, and state levels have a substantial and cumulative effect on the conservation of natural communities. While many planners and decision-makers express interest in using their tools to conserve habitat and wildlife, most land use decisions are made in the context of competing political interests and without the information necessary to make conservation-minded, science-based decisions. Although we know a lot about *what* to protect to conserve biodiversity and *how* to identify conservation priorities, conservation planning is not yet well implemented. Determining how to move from the theoretical underpinnings of conservation principles to effective and biologically sound land use planning is a considerable challenge. The Environmental Law Institute's (ELI) Conservation Thresholds Project seeks to support the integration of conservation principles into land use planning. To support this goal, ELI has hired an experienced communications consulting firm to determine what kind of information planning professionals, elected officials, planning board members, and conservation biologists most need to support their efforts to integrate conservation into local planning, how the information should be packaged, and how it can be delivered most effectively. I will give an overview of the findings of this research and discuss model approaches being undertaken around the country.

### **Effects of anthropogenic disturbance on home range size of eastern box turtles and wood turtles in central and western Massachusetts**

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We examined movements of 2 turtle species across a gradient of urbanization in central and western Massachusetts. Using radiotelemetry, we calculated 6 measures of home range size for 89 eastern box (*Terrapene c. carolina*) and 126 wood (*Glyptemys insculpta*) turtles. We evaluated the effects of urban development (using impervious surface cover and road density as surrogates), landscape disturbance level (using invasive species abundance), and availability of early-successional habitat on home range size using multiple linear regression. We also evaluated the effects of sex, age, and body size on movement patterns. Over the range of disturbance examined, we found a negative relationship between disturbance and home range size, but we suggest that once disturbance levels reach an unknown threshold, the site is so heavily modified that neither turtle species can survive. As a result, severely disturbed sites were not well represented in our sample. For species that require both early-successional and forested communities, such as wood and box turtles, home range size may be reduced where disparate resources are located in close proximity to one another. We also observed high mortality rates in wood turtles due to agricultural activities, which indicate that while Massachusetts box and wood turtles may prefer early-successional habitats, mechanically maintaining those habitats may create ecological traps. Male and female box and female wood turtles moved less in disturbed areas, but male wood turtle movements were unaffected by landscape, and instead changed with body size. In addition, female wood turtle movements increased with age, suggesting that sex, age, and body size may be important to isolate the effects of landscape on movement patterns. The relationship between movements and disturbance was more evident for some home range metrics than others, suggesting that multiple species-relevant home range measures may be necessary to detect differences across sites.

### **Persistence and management of a Blanding's turtle population in a suburban landscape.**

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Blanding's turtles (*Emys blandingii*) are rare throughout most of their range, critically so in New England. The conservation status of Blanding's turtles is further weakened by the fact that this species is known to wander long distances overland between wetlands in search of nesting sites, exposing the turtles to road-kill and other anthropogenic sources of mortality. Furthermore, the largest populations of this species in New England occur in predominately suburban landscapes. Since 2003, we have been studying the Great Meadows Blanding's turtle population in Concord, Massachusetts. These same turtles were studied and marked in the 1970s, and we have documented a decline by more than 50% in adult population size in the intervening decades. Surprisingly, however, given the proximity of large roads, adult mortality is now low among Great Meadows Blanding's turtles. These suburban turtles are unusually sedentary, often using only 1 wetland complex throughout the year. In contrast, there was evidence of high mortality among eggs and perhaps hatchlings in past years and recruitment has been very low. Most of the breeding females we handled were marked as adults 25 – 35 years ago. In recent years, we have instituted a nest protection and head-start program to boost future recruitment of adults into this population, and we are gathering data on the fate and habitat use of young head-started juveniles. This program not only provides the potential to reverse the decline in this, one of the largest remaining Blanding's turtle populations in New England, but also serves as a model for using active wildlife intervention techniques as a means of educating and garnering support for wildlife conservation from human suburbanites.

# **Abstracts of Poster Presentations**

**Alphabetically by Lead Author**



**International Symposium**

**Urban Wildlife**

**and the**

**Environment**

**June 21-24, 2009**

**Amherst, Massachusetts**



### **Role of urban forests and homesteads in realizing the targets of the forest and wildlife conservation policies in India**

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India has experienced fast economic growth in recent times. However, in terms of natural resources management, many targets of forest policies, especially to have 33% of the land under forest cover, remain unrealized. Additionally, steps taken to save endangered species have not succeeded as expected. Economic growth has barely made a contribution to the enhancement of wildlife populations or forest resources in the country. On the other hand, many habitats, such as wetlands, have dwindled in the recent past. Urbanization continues unabated in critical habitats. Currently, India has a network of 99 national parks, 515 wildlife sanctuaries, 43 conservation reserves, and 4 community reserves. However, fragmentation of natural habitats has resulted in little connectivity between them. Perhaps homesteads and farmlands might provide connectivity in a large landscape context, at least to some wildlife. This paper discusses the relevance of homesteads and urban wildlife in India and their role in achieving the targets specified by forest policies. It also describes the relevance of the Wildlife Protection Act (1972) and the implications of wildlife conservation outside conventional protected areas in India. Understanding and promoting wildlife conservation in the homesteads and urban areas has a great role to play in this rapidly developing economy.

### **Food for thought: anthropogenic food sources and their impact on avian diversity**

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Alterations in food availability are frequently cited as one of the drivers of avian diversity along gradients of urbanization. Some functional groups decline as their food sources decrease in abundance with increasing development. For example, the exotic tree species that dominate most urban environments support lower abundances of arthropods and by extension fewer tree-gleaning insectivores. Conversely, other groups grow in abundance as food sources such as refuse, provisioned food, and fruiting ornamentals increase with greater human population densities. The success of crows and cardinals in urban environments has been attributed to greater availability of these food sources. A thorough understanding of the interaction between changes in food availability and avian diversity will be essential in managing avian populations to minimize conflicts with humans and maximize biodiversity. Here we review the available literature on anthropogenic food sources and summarize knowledge on their distributions, the factors that produce these distributions, and their impact on avian diversity. We identify fruitful areas for future research, and describe proposed doctoral work to investigate the influence of bird feeders on avian diversity at different scales.

### **Simple modifications to transportation infrastructure to reduce impacts on wildlife**

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Transportation infrastructure, such as concrete median barriers and rails, can be an impediment to movement and pose threats to amphibian, reptile, and other small animal populations adjacent to transportation rights-of-way (ROWs). Small animals attempting to cross roadways with solid concrete median barriers are subjected to increased time on the roadway and therefore are at greater risk of collision, predation, or dying of dehydration and/or exhaustion. During rain events, curbing and median barriers channeling runoff from the road surface may result in swift currents. Small animals (primarily salamanders and turtles) may be entrained into channeled runoff and transported to drains and catchments where they may be trapped or discharged into other conduits. In addition, rail lines also create partial barriers to the movements of some small animals between habitats bisected by railways. Turtles are generally unable to cross over rails and unlike other small animals, they cannot squeeze under them. Turtles may become trapped between rails by entering at road crossings or by crossing under one rail in areas with uneven

ballast. Modifications such as cut-outs near the base of median barriers may allow some terrestrial animals to cross roadways and pass through temporary work area barriers. Modified drains and curbing may allow some small animals to exit the roadway rather than falling into road drains. Reinforced preformed channels with ramps securely placed between two ties provide under rail crossings-escape channels for small animals (primarily turtles). These simple modifications are not in general use; however, under specific conditions (primarily the presence of species and suitable habitats on both sides of the ROW or developments adjacent to suitable habitats) their use could be valuable in reducing impacts to wildlife. These and other modifications are recommended and described for potential future use and evaluation.

### **An international research agenda for urban green space**

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As urban populations continue to grow, the requirement for more residential and commercial buildings and transport infrastructure puts increasing pressures on green open space within cities. However, green open spaces are increasingly seen as an integral part of cities because of the ecological and cultural benefits they provide. The needs for development and maintenance of open green space can create tension among departmental personnel in city management, are multi-faceted, and operate at different social and ecological scales. To address this complexity, a multidisciplinary group of 40 academics, practitioners and consultants from across Europe, under the auspices of Urban Nature (an international multidisciplinary community of interests focussing on urban and urban influenced environments), came together to develop a research agenda for green open spaces in cities. Based on the Delphi technique, an iterative process was employed to address this task. This iterative process consisted of email-mediated discussions and a 2-day symposium. One output was an integrated framework for transdisciplinary, multidisciplinary and interdisciplinary research. This framework identified four research areas (i.e., ecosystem services, drivers of change, pressures on urban green space, and human processes and goals of provision of urban green space) and five emergent research themes in urban green space studies (i.e. physicality, experience, valuation, management, and governance). Further, the framework provides an international research agenda within which detailed, locally relevant research questions can be placed. A key factor, demonstrated by this agenda, is that a traditional approach based on a single discipline is insufficient to address the complexity and interrelationships of issues. Trans-, inter- and multidisciplinary research will be required to address this agenda.

### **Southeastern coyote activity patterns across an urban to rural gradient**

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Recent increases in both human and coyote populations, along with the rising number of human-coyote interactions in the southeastern U.S., have brought the issue of coyote populations in urban areas to the forefront. Studies have shown that coyotes living in rural areas or areas without many humans in the western U.S., tend to be more crepuscular, while urban coyotes adjust their activity schedules to be more active during the night. There is currently no information on spatial and temporal behavior of urban coyotes in the Southeast. As human-coyote interactions increase, there will be a greater need for information on behavioral adaptations of the southeastern coyote so that appropriate management plans may be developed. Studying activity patterns of coyotes in urban areas will be helpful in determining how much the southeastern coyote has adapted to urban areas. If we do find that urban southeastern coyotes are changing their activity patterns to avoid humans, we will know that they are adapting to the area, which has important management implications because it shows behavioral adaptations by landscape. We expect that coyotes in urban areas will be more active during the night to avoid human contact, while coyotes in rural areas will be most active during dawn and dusk. We radio-collared and are tracking 15 coyotes living in

urban, suburban, and rural areas of the county, at random times through 24-hour periods from May 2008-May 2009. Preliminary data show that urban coyotes are more active at night than rural coyotes. This suggests that urban coyotes may be changing their hours of activity to avoid humans.

### **Hematological characteristics of bobcats in an urban, fragmented landscape**

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Hematological characteristics can serve as important indicators of nutritional status, disease, environmental stress, and habitat quality. This study aims to evaluate the effects of urban development on populations of bobcats near and within an urban, fragmented landscape. Hematological characteristics were evaluated in individuals from populations found in two different habitat types: 1) urban, fragmented and 2) continuous, core habitat. Core individuals were found to have normal hematological values, while animals greater than one-year old found in urban areas had elevated counts of certain white blood cells. These data suggest a physiological response is occurring as a result of proximity to urban development. Increased exposure to disease, stress, or toxicants may be responsible for these increased cell counts.

### **Estimating a re-colonizing moose population on an urban-suburban watershed in Massachusetts**

Kiana Koenen<sup>1</sup>, Stephen DeStefano<sup>2</sup>, Dan Clark<sup>1</sup>, Ken MacKenzie<sup>1</sup>, Jillian Pereira<sup>1</sup>, David Wattles<sup>2</sup>, and Justin Compton<sup>2</sup>; <sup>1</sup>Department of Conservation and Recreation, Division of Water Supply Protection, Belchertown, Massachusetts; <sup>2</sup>U. S. Geological Survey, Massachusetts Cooperative Fish and Wildlife Research Unit, University of Massachusetts, Amherst, Massachusetts. Contact: [kiana.koenen@state.ma.us](mailto:kiana.koenen@state.ma.us); 413-323-6921 x163.

After being extirpated from southern New England for over a century, moose (*Alces alces*) have been re-colonizing Massachusetts from areas farther north for the past 3-4 decades. To date, no one is sure how many moose are in Massachusetts, but best guesses range from 800-2,000 or more individuals. Reproduction is occurring, with twin calves often reported. The Quabbin Watershed and Reservoir Reservation is a 484-km<sup>2</sup> managed watershed and reservoir in central Massachusetts that supplies much of metropolitan Boston and the surrounding suburbs with domestic water. Each fall, a carefully managed deer hunt takes place to help control the deer population and the potential negative impacts too many deer can have on the vegetation and the watershed. During 2006-2008, we enlisted the help of deer hunters to count moose on the Quabbin. Each hunter was provided instructions and a report card during check in. We asked hunters to report all moose sightings, including the number, age, sex, time, and location, and to turn in their card at the end of the day whether they had seen moose or not. At check out, cards were collected and any moose locations were recorded on topographic maps. We then used the information provided to eliminate multiple sightings of the same moose and to count total number seen. Based on this technique, we estimated that the moose population could be as high as 100 individuals, or 0.2 moose per km<sup>2</sup> on the Quabbin Reservation. The dynamics of moose-vegetation interactions are being studied with exclosures set up on various parts of the watershed.

### **An assessment of competing priorities in wildlife habitat management by residential owners**

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The earth is experiencing rapid climate change and resource depletion due to human activities. Since humans both impact and are impacted by the changing environment, it is important to consider the human dimensions of wildlife management, including the motivations behind environmentally relevant decisions. Leaving standing dead wood on one's property can provide habitat for many wildlife species. Maintaining

habitat and attracting wildlife in urban and suburban areas can have emotional, social, health, and economic benefits for humans. However, landowners must also weigh the possibility that a standing dead tree may fall, causing damage to property or human injury. Aesthetics, property value, social norms, and liability may also come into play when making decisions about maintaining dead wood. I will outline the design and implementation of a survey instrument, grounded in the theory of planned behavior, to assess how landowners rank competing priorities when making environmentally relevant decisions and whether knowledge of the environmental value of an action can affect a landowner's decision to act in a pro-environmental way. In addition, I will review other previously researched environmentally relevant decisions, such as recycling and public transportation use, and attempt to categorize these decision-types based on a cost-benefit analysis. I will compare these decisions with the choice to remove standing dead wood from one's property and discuss how this decision-type fits within a cost-benefit categorization. This study will provide a model for addressing similar kinds of trade-offs in residential land management decisions, such as maintaining shrubbery in fire-prone areas and promoting wildlife that may be a vector for human diseases.

### **Environmental factors as predictors for amphibian movements and occurrence on the Province Lands Road, Cape Cod National Seashore**

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Roads present many challenges to wildlife including direct road mortality. Amphibians are particularly vulnerable to road mortality as a result of their high vagility and unique life histories that necessitate large migration events. Eco-tunnels and road closures have been enacted to mitigate amphibian mortality on roads. However, the effectiveness of these techniques is understudied. Cape Cod National Seashore (CACO) developed a protocol for road closures on Province Lands Road, an area of high amphibian activity, which was based largely on subjective decision making. The goal of this study was to identify environmental factors that predicted timing and magnitude of amphibian occurrence on Province Lands Road. A 1,300-m section of the road was surveyed on warm, rainy evenings in addition to a fixed sampling strategy 3 nights a week in the spring and summer of 2007-08. Amphibian species were recorded and microclimate road conditions were collected during each sampling event. Macroclimate environmental factors were obtained from the Provincetown weather station. Identifying specific environmental variables that correlate with activity on roads including large breeding migration and juvenile dispersal events ensures effective road closures both in the park and regionally. Results and management recommendations will be discussed during the presentation.

### **Landscape features influencing residential rodent control behavior and animal movement in two urban areas of California**

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Residential "pest" control of both native (e.g., gophers, rabbits) and exotic (e.g., black and Norway rats, house mice) species may impact populations of non-target species inadvertently. We evaluated relationships between animal movement, rodent control, and landscape features in two urban locations in California. Southwestern Bakersfield consists of high- and medium-density development and is home to an urban population of San Joaquin kit foxes. Southeastern Ventura County (including part of western Los Angeles County; hereafter SMMNRA) contains low- and medium-density development interspersed with natural areas and is home to several large carnivores (bobcats, coyotes, mountain lions). We collected

rodent control data via a survey of local residents and compared results to animal movement data from radio-tracking studies. Across both areas, exotic species were the most targeted for control. Controlling for native species occurred at a greater rate among respondents in SMMNRA. In Bakersfield, kit foxes used altered open areas (sumps, golf courses, schoolyards) for denning and foraging, commercial areas for foraging, and occasionally used residential areas. Rodent control did not vary with distance from open space. In SMMNRA, bobcats, coyotes, and mountain lions used natural areas most intensively. Bobcats and coyotes used altered open and low-density residential areas extensively and high-density residential and commercial areas occasionally. Rodent control was widespread, but more common in near natural areas. In both locations, rodent control was more prevalent among relatively low density development. Areas of overlap between wildlife use and rodent control increases potential for adverse impacts to wildlife and may be important target locations for mitigation measures.

### **Reptile monitoring in an urban national park: effects of fragmentation on diversity**

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Long-term monitoring can provide valuable information about change in ecological communities relative to broad ecosystem-level changes, such as landscape alteration or climate change. At Santa Monica Mountains National Recreation Area, outside Los Angeles, we monitor reptiles and amphibians (herpetofauna) as a diverse and sensitive group of wildlife. Habitat loss and fragmentation from urbanization are dominant forces. We use arrays of pitfalls traps, drift fencing, and snake funnel traps to measure abundance and diversity of terrestrial herpetofauna. Arrays have been placed in different habitats and in different sections of the park that vary in degree of urbanization and fragmentation. In the Simi Hills area, the most urbanized portion of the park, we sampled the 2 most common habitats (coastal sage scrub and exotic grassland) across the landscape in small fragments (8-45 ha, n=7), large fragments (328-445 ha, n=3), and continuous core habitat areas (n=2). Species richness was positively associated with fragment size, with more species detected in large fragments (avg=14.0) and core areas (avg=14.5) than in small fragments (avg=7.4). Larger snakes such as striped racers (*Masticophis lateralis*), coachwhips (*Masticophis flagellum*) and western rattlesnakes (*Crotalus viridis*) were largely or entirely absent from small patches, likely because of extensive movements and persecution by humans. However, even though individual small patches were less diverse, as a group, the small patches contained 14 species, including some relatively rare ones, in an area of only 174 ha. In the western end of the Santa Monica Mountains, the least developed and fragmented part of the park, we detected 4 species that had not been found previously. We detected the rare mountain king snake (*Lampropeltis zonata*), and found wider distribution of sensitive coast horned lizards (*Phrynosoma coronatum*). Overall, in more than 8 years of sampling across 3 regions, we have detected 24 of 25 potential species of terrestrial herpetofauna. Urbanization is affecting species distribution and abundance, but habitat fragments may still have significant conservation value for reptiles and amphibians.

### **Wildlife passage structures facilitate wildlife movement through urban/suburban environments**

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Successful wildlife use of passage structures has been documented in many rural locations but not in urban settings. Route 2 is a four-lane artery in Concord, MA with an average daily volume of about 50,000 vehicles. It divides some of the few remaining areas of open space and presents a major barrier to wildlife movement. In 2003, MassHighway installed 4 concrete box culverts to mitigate habitat fragmentation exacerbated by Jersey barriers and road improvement projects. The Wildlife Passages Task Force (WPTF) was formed to study how wildlife responded. The 4 concrete box tunnels are 82 ft or 96 ft long, 6 ft high by 9 ft wide (2 tunnels), 5 ft by 8 ft, and 3 ft by 5 ft with a 2-inch layer of dirt substrate. Wildlife activity was determined by 2 complementary methods: a tracking bed from sifted substrate in one tunnel (the only one

sufficiently dry) and remote photography. Passive infrared-triggered Reconyx digital cameras were installed intermittently in the center of each tunnel. We recorded over 30 species that used the tunnels, some intensively. The tracking bed documented species missed by cameras, such as most small mammals (mice, voles) and herptiles (frogs, salamanders, snakes). We calculated the estimated annual passage rate for each species, which varied widely by species and also by location and method of capture. For example, the annual passage rates from remote photography for the 4 tunnels were 496 raccoons, 203 fisher, 4 mink, 1 otter, 17 cottontail rabbits, 141 deer, 193 red fox, 5 coyotes (including in the 3 ft by 5 ft tunnel), and 113 humans. We were also afforded a glimpse at wildlife behaviors, such as fisher carrying prey and deer swimming through the flooded tunnel. These results suggest that wildlife underpasses function as part of movement corridors even in areas severely impacted by human activity.

### **Nighthawk patrol: community-based research on an endangered urban bird species in southwest New Hampshire**

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Breeding Bird Survey and statewide atlas data indicate that common nighthawks (*Chordeiles minor*) are declining throughout their range, and especially in the eastern United States. Nighthawks were once common in cities and towns throughout the Northeast, where they nested on flat, peastone gravel roofs and fed on insects attracted to city lights. In recent years, rubber and PVC have largely replaced peastone roofing, and nesting nighthawks have disappeared from many New Hampshire towns; in the two cities where they remain (Concord and Keene), their numbers have declined dramatically. In collaboration with New Hampshire Audubon's Project Nighthawk initiative, Ashuelot Valley Environmental Observatory (AVEO) installed 15 experimental gravel "nest patches" on flat rooftops throughout Keene in 2007 and 2008 to serve as potential nighthawk nesting substrate. AVEO also trained over 50 Nighthawk Patrol volunteers to conduct coordinated weekly monitoring of nighthawks in Keene during the summers of 2007 and 2008, and searched for nighthawk nests in places where the birds displayed courtship and territoriality behavior. Volunteers detected four nighthawks in Keene during the breeding season. Nest patches have not yet been utilized by breeding birds, but volunteers observed courtship behavior in the vicinity of several nest patches in 2008. Although the efficacy of nest patches is still to be determined, the sustained enthusiasm and participation of volunteers, building owners, and businesses indicate that community-based research carries strong potential for generating meaningful localized support for urban wildlife conservation.

### **An evaluation of the benefit gained through a spatially explicit approach to conserving pool-breeding amphibian habitat**

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Conservation planning for pool-breeding amphibians on private lands is constrained by the high cost of land in developable areas, a situation worsening as development pressure rapidly increases over much of New England. Until now, the dominant conservation paradigm has been uniform radial buffer zones that are not only inadequate in size but also focus upon individual breeding pools as opposed to landscapes. Uniform buffer zones lack the spatial specificity to address multiple habitat needs, yet they potentially require more habitat than is affordable given competing demands for conservation funds. To address these problems, we developed a spatial model to expand the planning focus to include the important adjacent non-breeding habitat where amphibians spend most of their lives. We created 6 spatially explicit GIS models that focused on both the breeding and non-breeding habitats and included 95% of a hypothetical population fitted to a normal distribution developed from published average minimum and maximum seasonal migration distances of pool-breeding amphibians. We compared the size of area required to

conserve these habitats, which allowed for movements outside published buffers, with a large uniform radial buffer zone of 368 m. Results showed that areas representing 48.4% to 82.7% of radial buffers may capture required habitats even when movements outside the buffers are considered. We conclude that by concentrating on spatially explicit non-breeding habitat, a larger portion of the important non-breeding habitat could be conserved in an area totaling less than the area of the radial buffer zone, implying lower cost to conserve. We then offer suggestions on how this model can be supported by local conservation efforts.

### **Is suburbanization a mechanism for geographic range expansion in the red-bellied woodpecker?**

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Suburbanization and the changes in natural areas surrounding urban centers have allowed some wildlife populations to thrive. Red-bellied woodpeckers are one such species. They favor the mix of wooded and semi-wooded habitat that often results from suburban development. Over the last 40 years, the red-bellied woodpecker has expanded the northern limit of its eastern range from Maryland into central New York and southern New England and continues to move northward. Christmas Bird Counts and Breeding Bird Surveys have documented this range expansion, and a pilot study using data from Pennsylvania and Massachusetts showed a higher rate of expansion into suburban areas than into rural settings. We propose a more thorough examination using data sets from Maryland up through New England to analyze the timing and intensity of the northward expansion, and using ArcGIS to map and analyze the habitat characteristics, land use, and degree of urbanization at each location. The analysis should shed light on what is driving the expansion of the red-bellied woodpecker. While many studies look at the detrimental effects of urbanization on wildlife, few are aimed at understanding the wildlife preferences that could help refine development planning and land management regulations to promote healthy, diverse populations.

## Notes