The Conservation Behaviorist

Animal Behavior Society **ABS Conservation Committee**

The Conservation Behaviorist, an electronic news-update, informs ABS members about the Conservation Committee's activities, research trends in behavior and conservation, and relevant scientific news in conservation research where behavior plays an important role. www.animalbehavior.org/Committees/Conservation

The Conservation Behaviorist

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Social behavior and Conservation...

"This is the first evidence that a predator training regime, which incorporates the target species social environment, can mimic experiences in the wild and improve long term survival post-release…" says **Debra M. Shier** in our Feature Article: ***"Social influences on predator training for conservation"***

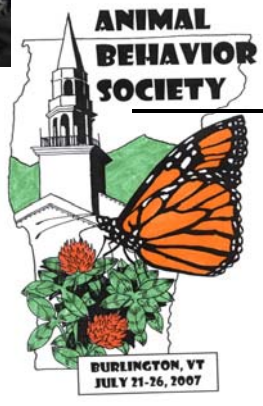
(see page 6)

In this issue

The ABS Conservation Committee

Created in 1997, the Conservation Committee aims to encourage ABS members to participate in research programs addressing the interface between animal behavior and conservation science. By identifying and evaluating the areas in which behavioral research has contributed to conservation, as well as the fields that need development, the Committee seeks to generate discussion and promote studies in behavior and conservation.

ABS Conservation Committee Members



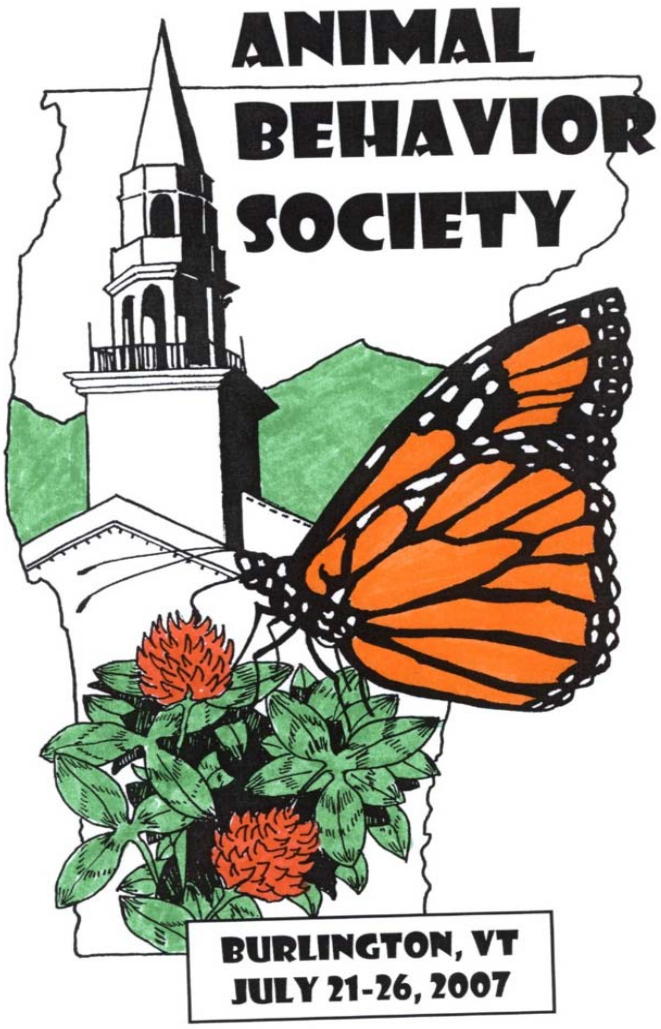
annual meetings of the Animal Behavior Society will take place in Burlington, VT, July 21-26

Interact with the Conservation Committee

Send letters, announcements, comments and contributions to The Conservation Behaviorist *dshier@sandiegozoo.org*
Deadlines for articles are the 15th of the month preceding the next news update. The next deadline is **October 15th**. Contributions submitted by members of the Animal Behavior Society and judged by the Conservation Committee to be appropriate will be published in The Conservation Behaviorist. The publication of such material does not imply ABS or Conservation Committee endorsement of the opinions expressed by contributors.

Editor Guillermo Paz-y-Miño C.
Associate Editor Debra M. Shier

Behavior and Conservation at the 2007 ABS Meeting 21-26 July 2007



Conservation Behavior: From implications to applications

Symposium organized by **Colleen Cassady St. Clair** on behalf of the ABS-Conservation Committee

Conservation Behavior is a burgeoning field at the interface between Conservation Biology and Animal Behavior. Dozens of papers and four edited collections have been published in conservation behavior, yet the field remains the sum of two parts. All four books have titles that suggest additive, rather than multiplicative interactions between the two disciplines, and most contributions focus mainly on the *potential* for knowledge of animal behavior to contribute to conservation policy or practice. Some behaviorists have suggested that the actual relevance of behavior to conservation is limited (e.g. ***Tim Caro*** 2006 ISBE meeting, France), while others see conservation biology as tangential to their main interests, and unsuitable as a vehicle for making general theoretical contributions to animal behavior. These pessimistic views have been reinforced by different disciplinary traditions, non-overlapping professional circles, and the inherent logistical challenges of conservation research. The objective of our symposium is to challenge these reservations. We do that by highlighting (i) situations in which general principles in animal behavior have improved conservation programs, (ii) cases in which problems faced by conservation biologists have suggested innovative avenues of research in basic animal behavior, and (iii) ways that a holistic approach to conservation behavior can lead to advances in both disciplines.

To set the stage for the symposium, ***Colleen Cassady St. Clair*** will provide a historical overview of situations in which basic principles of animal behavior have expanded to conservation application, and identify some challenges and opportunities for the future. ***Ron Swaisgood*** will explore the ways that manipulating social behavior can aid management of *in* and *ex situ* small populations. ***John Eadie*** will follow by exploring the links between behavioral ecology and harvested wildlife with an emphasis on waterfowl. ***Bruce Shulte*** will examine behavioral solutions for human-wildlife conflict with an emphasis on elephants. ***Dan Blumstein*** will outline a Darwinian approach to adaptive management. Finally, ***Jan Komdeur*** will illustrate some of the behavioral adaptations that animals exhibit to avoid inbreeding in small, isolated populations.

A second session will emphasize the other direction of the synergy: how conservation problems can contribute to basic behavioral theory. ***Judy Stamps*** will examine this reciprocity by testing behavioral assumptions about habitat selection in conservation contexts. ***Debra Shier*** will explore reciprocal contributions of behavior and conservation with reintroduction programs. ***Scott Creel*** will finish the session by describing the

stress responses of animals to human and non-human predators to demonstrate the advances in stress physiology research brought about by conservation and management questions. Colleen Cassady St. Clair will wrap up the symposium by synthesizing its contributions, compare them to the earlier potential, and suggest some profitable lines of future research. A final discussion period will give other symposium participants and members of the audience opportunities for similar synthesis, critique, and prediction.

With this symposium, we hope to inspire colleagues and students to devote more attention to conservation behavior not only as a means of contributing to conservation solutions, but also as a mechanism of making new and important contributions to behavioral research. Ultimately, our aim is to integrate conservation behavior more holistically with the disciplines of both Animal Behavior and Conservation Biology ■.

For additional information contact *cstclair@ualberta.ca*

Symposium Topics and Participants

Chair Esteban Fernández-Jiricic

Part I: From behavioral implications to conservation applications

Colleen Cassady St. Clair (University of Alberta), *Conservation Behavior: From implications to applications*

Ron Swaisgood (Zoological Society of San Diego), *Manipulating social behavior for small population management*

John Eadie (UC Davis), *Behavioral ecology of harvested populations*

Bruce A. Schulte (Georgia Southern University), *Reducing human-elephant conflict through an understanding of elephant behaviour*

Dan Blumstein (UCLA), *Improving adaptive management with Darwinian decision making*

Jan Komdeur, Lyanne Brouwer, (University of Groningen, The Netherlands), and David S. Richardson (University of Sheffield, UK), *Behavioral adaptations for inbreeding avoidance in restricted populations*

Part II: From conservation applications to behavioral theory

Judy Stamps (UC Davis), *What can conservation biology teach behaviorists? Using applied research to identify shortfalls in habitat selection theory*

Debra Shier (Zoological Society of San Diego), *Using behavior to inform reintroductions and reintroductions to study behaviour*

Scott Creel (Montana State University), *Behavioral responses of elk to wolves, their costs, and their effects on demography and population dynamics*

The E. O. Wilson Award

The Edward O. Wilson ABS Student Research Grant for Conservation seeks to encourage graduate students of animal behavior to participate in meaningful conservation-related research. The award is part of the **ABS Student Research Grant Program** and it supports a ***proposal*** considered meritorious for its science and conservation component.

E. O. Wilson, professor at Harvard University, who in 2002 received the ABS Distinguished Animal Behaviorist Award, is one of the world's most eminent scientists and pioneers in biodiversity conservation.

Recipients of the E. O. Wilson Award

2004: **Jason Munshi-South**, University of Maryland College Park, *"Behavioral responses of treeshrews to selective logging on Borneo."*

2005: **Heidi Fisher**, Boston University, *"Communication breakdown and hybridization in Xiphophorus fishes."*

2006: **Alysa Remsburg**, University of Wisconsin, *"Effects of lakeshore vegetation on dragonfly oviposition site-selection behavior."*

2007: **Jordan A. Thomson**, Simon Fraser University, "*Predation-sensitive behaviour by marine turtles: The effects of tiger shark predation risk on diving and habitat use*."

For additional information on this award see the website www.animalbehavior.org/ABS/Grants/ or contact the **Conservation Committee** cstclair@ualberta.ca

Conservation Tips By Dan Blumstein

Is there anything a behaviorist can do to help conservation?

"Comment on a conservation plan. The US Fish and Wildlife Service, as well as many state, local, and international agencies, make conservation plans available for public comment. Most of these species survival or habitat conservation plans were not written by behavioral biologists. Lack of behavioral knowledge should not be seen as a short-coming as much as it should be seen as an opportunity for us to share our knowledge and intellectual toolkit with others. Most of these plans are now easily accessible on agency websites."

Perspectives

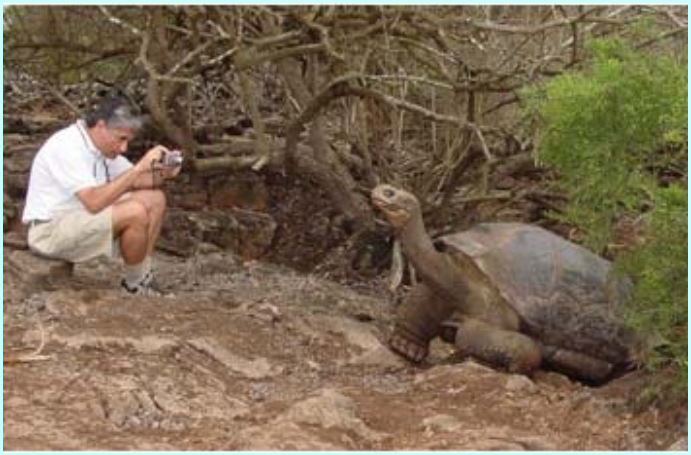
Behavior and Conservation in the Galapagos

By Guillermo Paz-y-Miño C.

"I will… [give] an account of the extreme tameness of the [Galapagos] birds. This disposition is common to all the terrestrial species; namely, to the mocking-thrushes, the finches, wrens, tyrant-flycatchers, the dove, and carrion-buzzard. All of them often approached sufficiently near to be killed with a switch, and sometimes, as I myself tried, with a cap or hat. A gun is here almost superfluous; for with the muzzle I pushed a hawk off the branch of a tree. One day, whilst lying down, a mocking-thrush alighted on the edge of a pitcher, made of the shell of a tortoise, which I held in my hand, and began very quietly to sip the water; it allowed me to lift it from the ground whilst seated on the vessel: I often tried, and very nearly, succeeded, in catching these birds by their legs… It is surprising that they have not become wilder; for these islands during the last hundred and fifty years have been frequently visited by bucaniers and whalers; and the sailors, wandering through the woods in search of tortoises, always take cruel delight in knocking down the little birds…" **Charles Darwin, The Voyage of the Beagle, 1839.**

A great adaptation animals have is the ability to spot predators and avoid them; predators, in response, have to keep up with prey evolution. Elusive, poisonous, deceiving, confusing and difficult-to-capture prey trigger countering responses in their predators, which have become, over millions of years, even more secretive, tolerant to noxious chemicals, smart and able to catch the fastest, most camouflaged and unpalatable prey. This "evolutionary arms race" is responsible for the enormous variety of prey and predatory traits existing in nature. But if predators are absent or rare, species mainly evolve behavioral repertoires to cope with the immediate struggle for life at the expense of behaviors that, if the environment changes by, for example, the arrival of unfamiliar enemies, could be essential for survival. "Maladaptive behavioral responses" or lack of appropriate action in presence of novel danger can drive animals into extinction, which nowadays is a concern in the Galapagos National Park, a protected volcanic archipelago located 600 miles of the coast of Ecuador (see Box on page 5).

Three to five million years of isolation have generated unique characteristics among the Galapagos endemic and resident species: cormorants have lost their ability to fly and now dive searching for fish in a turbulent ocean, marine iguanas feed on algae in the bottom of the sea shore, three-hundred pound giant tortoises digest cactus which spines cause no damage in their guts, lava lizards jump and tumble while capturing flies over the huge bellies of resting sea lions, blue-footed boobies and albatrosses saturate the ground with their nests and courtship displays, and various species of Darwin finches coexist by sharing seeds, insects and occupying distinct habitats near and above the ground. Although these tame fascinating creatures are fit for the Galapagos rocky landscape, human impact is threatening their survival. Introduced goats, cats, dogs, pigs, donkeys, and other animals, are destroying these fragile islands.



A curious giant tortoise approaches a photographer (G. Paz-y-Miño C. © photo).

Settlers released domestic animals in the Galapagos five centuries ago. Feral goats now feed on the natural vegetation and stump on re-growths of the endemic flora, transforming the landscape from shrubby-dense plant cover to desert-like and eroded terrains. Cats and dogs prey on birds and reptiles, while pigs dig into nests and crash and eat the eggs of giant tortoises, marine and terrestrial iguanas. Because the Galapagos vertebrates are nonpoisonous or unpalatable and have had no phylogenetic exposure to mammalian enemies, predator avoidance behaviors develop very slowly. After years of exotic animal invasions and other related human impacts on the islands (deforestation and farming), the Galapagos fauna seems to be losing this battle unless conservation plans are implemented. Captive breeding programs at the Charles Darwin Research Station (CDRS), in Santa Cruz Island, are giving positive results for the giant tortoises and terrestrial iguanas. Understanding their reproductive behavior and social organization together with research on feeding habits and dispersal patterns are helping biologists to reintroduce these species into the wild. But restoration requires entire habitat rehabilitation to secure viable populations. In Galapagos the solution is clear: feral nasty animals, such as goats, cats, dogs, pigs and donkeys must go! Who should go first? Goats, the nastiest; they are thriving in the Galapagos and overpowering tortoises and iguanas.

Sea lions resting while ignoring visitors; people quickly get used to wander among the uniquely tame Galapagos animals (G. Paz-y-Miño C. © photo).

Creative hunting campaigns aimed at eradicating goats have been in practice over half a century. Most recently, goats have been trapped and released with radio tracking devices, which allow hunters to locate herds and gun them down from helicopters. Goats, however, do learn quickly to elude predators coming from the sky in flying vessels and soon turn erratically nocturnal and crepuscular, spread while being chased to congregate again and continue with their own survival. Confusion, dilution, odd prey effects, and other behavioral phenomena are taken into consideration by the CDRS to exterminate goats efficiently, yet the outcome is ambiguous. Hunting from aircrafts selects for fast, smart, even more opportunistic animals, plus is very expensive. The islands of Isabela, Santiago and Santa Cruz still have large populations of feral goats.

Galapagos mockingbirds boldly interact with people (G. Paz-y-Miño C. © photo).

Galapagos -sanctuary of wildlife and United Nations World Heritage- faces its most challenging times ever. The archipelago is an example of both proper ecotourism/scientific management and acute human conflicts with nature. One hundred thousand visitors arrive in the National Park and Marine Reserve every year and follow strict rules and organized procedures to explore the islands. Scientists and students engage in research and environmental education programs (geology, biology, anthropology) sponsored by universities and non-profit organizations. At the same time, the human population in Isabela, Santa Cruz and San Cristobal grows and enormous environmental pressure is imposed by farmers, fisheries and developers. Conservation problems continue and some worsen: fire ants, quinine trees, bees and rats invade the islands at an alarming rate, illegal sea cucumber harvesting and shark and tuna fishing propagate in protected waters, while powerful cruise corporations find their way into bringing entertainment ships to replace the local ecotourism enterprises. It is hard not to agree with Darwin and his disenchantment with the visitors of the nineteenth century who while "… *wandering through the woods in search of tortoises, always [took] cruel delight in knocking down the little [Galapagos] birds…"* Today's "wanderers" either driven by poverty or equipped with technology, credit and political influence are knocking down an entire World Heritage ■.

The Galapagos Archipelago

There is no place on Earth like the Galapagos Islands (declared World Heritage *and* Biosphere Reserve *by UNESCO). Their unique natural history makes these islands ideal scenarios for scientific research in biology, biogeography, environmental sciences, human ecology and the history of evolutionary biology. Darwin's visit to the Galapagos in 1835 was crucial for the development of the theory of evolution.*

History

1535 *Galapagos officially 'discovered' by the Bishop of Panama, Fray Tomás de Berlanga*

1574 *the Ortelius' map calls the archipelago 'insulae de los galapegos'*

1500-1700s *pirates, whalers and buccaneers control the islands*

1832 *Ecuador assumes jurisdiction of the 'Archipiélago del Ecuador'*

1835 *Charles Darwin visit the Galapagos Islands*

1959 *Ecuador creates de Galapagos National Park*

1964 *the Charles Darwin Research Station opens*

1979 *UNESCO declares Galapagos a* World Heritage

1985 *UNESCO declares Galapagos a* Biosphere Reserve

2000s *100,000 visitors arrive in Galapagos every year*

Feature Article

Social influences on predator training for conservation

By Debra Shier & Donald Owings*

Predator training has become an integral part of captive-breeding reintroduction programs for many species. Although there is little rigorous experimental research, a few studies have shown how the type, intensity and context of pre-release training may affect post release survival. Here we demonstrate that social transmission of anti-predator behavior during training can improve long-term survival following release and that, as long as a social training regime is used, predator avoidance training can mimic experience gained in the wild.

Social learning is important in the ontogeny of behavior in many taxa (*1-3*). Interactions with experienced conspecifics can allow inexperienced young to learn about their environment without incurring the time, energy and fitness costs associated with learning survival skills alone. For example, animals that see a conspecific responding to a stimulus may adapt their behavior (observational conditioning)(*4*). Alternatively, an experienced conspecific can indirectly bring the attention of a naïve animal to a particular stimulus or event in the local environment (local enhancement)(*5*).

Social influences on development

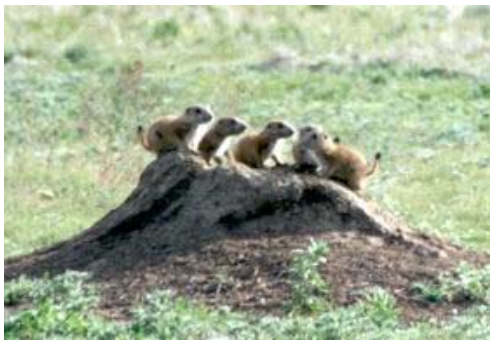
For many species, social factors may strongly influence how experience shapes development. For example, in some songbirds, the presence of a live tutor can extend the developmental period during which young learn a species-specific song (*6*) and even the presence of nonvocal social companions can affect song rate and potency (*7*). Social factors may have similar influences on the ontogeny of antipredator behavior. Young animals may first face predators or predator-related stimuli in the company of their parents, siblings, or other conspecifics. Thus, there are many opportunities for juveniles to learn antipredator skills from experienced group members.

Predator training and conservation

Information on the role of social experience in the ontogeny of antipredator behavior is of practical as well as theoretical importance when the subject species is the target of efforts to reintroduce captive-bred individuals into the wild. Captive environments may not provide the predator-related experiences necessary to ensure survival on release into native habitat, and even the skills of wild-caught individuals may erode during captivity (*8*). Several recent studies have examined how animals learn to recognize and avoid predators (reviews in *9, 10*), and predator training is becoming part of many captive breeding programs (*10-17*). But the success of such predator- training programs depends on our understanding of the developmental processes supporting antipredator behavior, and that understanding is limited. To be most effective, antipredator training should mimic the critical features of ontogenetic processes in the wild: the experimental treatments used, the developmental timing of the training, and the social and physical context in which it occurs may all be crucial.

The primary goal of the our study was to find out whether juvenile black-tailed prairie dogs *(Cynomys ludovicianus)* trained in the presence of an experienced demonstrator acquire more effective antipredator responses and thus higher survival post-release than those trained without one. Black-tailed prairie dogs are prey to various predators, including black-footed ferrets, raptors, snakes, coyotes, weasels and bobcats. Prairie dogs are colonial and live in large social groups. When adult prairie dogs see predatory mammals or raptors, they bark repetitiously, warning offspring and nondescendant kin of impending danger (*18*). When prairie dogs hear a bark alarm call, they scan for predators and if one is detected, run to a burrow mound and either enter or begin calling (*18*). Interactions with snakes are quite different. Adult prairie dogs typically confront snakes, approaching them in an extended posture, sniffing, jumping away and giving distinct jump-yips calls and sometimes footdrumming (*19, 20*). By contrast, newly emergent juveniles remain close to burrows, are vigilant, and forage little (*21*).

Ferrigenous hawk flying over prairie dog colony. Debra M. Shier © photo



Newly emergent pups on burrow entrance. Debra M. Shier © photo.

It is likely that social experience is essential for the ontogeny of effective antipredator behavior in prairie dogs. Mothers call more often after first juveniles emerge than males or nonmaternal females (*18*). However, newly emergent juveniles may benefit equally from all maternal females in their coterie since several females in a coterie may be reproductive at the same time and allonurse (*18*).

Experimental Manipulation of Predator Experience

We trapped wild juvenile prairie dogs at emergence and transferred them to field enclosures with their mothers. We tested each focal juvenile before training to determine baseline behavior. For pretraining tests, we measured each focal juvenile's response to each of the following stimulus animals: (1) a black-footed ferret (*Mustela nigripes*), (2) a prairie rattlesnake, 3) a red-tailed hawk, and 4) a desert cottontail as a nonpredator control. Following the pretraining tests, we placed

juveniles from each litter into one of the following developmental treatments: (a) Experienced Adult (EA), in which the focal juveniles were trained over a five-week period with an experienced adult female demonstrator, or (b) Without Experienced Adults (WEA) where juveniles were trained without an experienced adult present. We then measured any change in behavior due to predator exposure by retesting each juvenile after the five-week treatment period with each stimulus animal.

Comparison to Wild-reared Counterparts

Once post-tests were complete, we trapped all remaining coterie members in the wild and brought them into the enclosures. We then tested a subset of these wild-reared juveniles with each stimulus animal following the same procedures for the pretraining tests and compared their behavior with that of EA trained juveniles.

Measuring training success

At the end of the experiment we released all prairie dogs into a newly established prairie dog colony to measure survival and reproductive success. We used "soft release" protocol which allowed animals to habituate to the new site and remain protected from predators while digging new burrow systems. We kept coterie units together to decrease stress and dampen post-release dispersal.

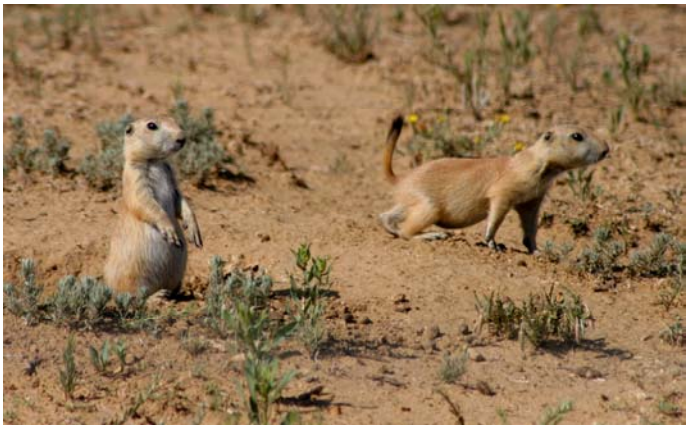
We compared the frequency of survival of juveniles captive-reared, trained and reintroduced to those wild-reared and translocated the following spring to find out if the survival rate of animals brought into captivity and trained differed from the survival rate of translocated animals from the same coteries.

Effect of social context on training

We found that juveniles trained with experienced demonstrators were much more wary following training with all three predator stimulus animals than juveniles trained without an experienced demonstrator. Following training, experienced-adult trained animals alarm called, were vigilant, showed reduced activity, and spent time in shelter in the presence of all four stimulus animals. In contrast, juveniles trained without experienced adults rarely alarm called, displayed reduced vigilance and increased activity, and spent less time in shelter following training with the predators and the control animal. Further, levels of vigilance and alarm vocalizations in demonstrators during training were correlated with juvenile prairie dog behavior during the post-training tests. This pattern of results suggests that juvenile prairie dogs attended to the behavior of the demonstrator, if present, and that this altered their subsequent responses to the predators and cottontail.

Captive-trained vs. Wild-experienced Juveniles

Does training young prairie dogs in captivity elicit antipredator behavior similar to that of animals that have had experience in the wild? The results suggest it does not. Before release, trained captive-reared juveniles spent less time vigilant and alarm calling and more time in shelter than wild-reared juveniles of the same age. These differences are most likely because of different environments during development. Disparity in time juveniles spent in shelter may be because of differential exposure to the enclosure itself. However, differential acclimation to the enclosure cannot fully explain the higher rates of alarm calling or vigilance displayed by the wild-reared juveniles because these behaviors varied by predator type and therefore do not represent an overall heightened reactivity. Rather, these differences were likely due to critical features of the juvenile's social and physical environments during development. For example, wild-reared juveniles had the opportunity for aboveground experience with predators in the presence of multiple group members.



Prairie dog pups in alert postures. Debra M. Shier © photo

For individuals that live in stable groups, such as prairie dogs, a social group, rather than the individual or a single added social partner, form the backdrop for social learning (*3*), and social training regimes are likely to be more effective because they mimic natural processes. Not surprisingly, research has begun to reveal the various influences of social context (number of demonstrators; *22, 23*); (demonstrator status; *24, 25*), and housing environment on learning (*26, 27*) and suggests that what an individual learns will depend on the context in which it is presented. In this study, we exposed naïve juveniles to predators with only one demonstrator present. It is possible the behavioral differences between captive and wild-reared individuals were simply because of the number of demonstrators present during interactions with predator stimuli. Alternatively or in addition, the complex interactions between multiple individuals and their environment may be required for the development of effective skills. It seems reasonable to assert that watching or hearing fearful behavior or smelling pheromones released during interactions of nearby individuals have contagious properties (see *28*). We did not faithfully replicate these types of interactions in this captive setting. Further studies examining the effectiveness of predator training in the presence of intact social groups may elucidate this dynamic process.

Training Success

Finally, prerelease behavior after training appears to translate to post-release survival. Previously, we showed that training juvenile prairie dogs with predators increased survival following release compared with naïve juveniles (*29*). The present study provides the first evidence that social transmission of antipredator behavior during training can improve long-term survival following release. Juveniles trained with experienced demonstrators while in captivity were more likely to survive one year post-release than those exposed to predators

without experienced demonstrators. Perhaps more importantly, the results further suggest that predator avoidance training can replicate experience gained in the wild, as long as a social learning regime is used. Wild-reared juveniles translocated to the same site were more likely to survive than trained captive-reared juveniles. However, there was no difference in the survival of juveniles brought into captivity at emergence and trained with experienced adult demonstrators and those wild-reared and translocated. These results encourage further investigation into the application of social experience and/or learning in predator training, particularly for species in which captive-breeding is the only alternative ■.

Black-tailed prairie dog mother and pup. Debra M. Shier © photo

*For the full article by these authors see D.M. Shier, D.H. Owings, *Animal Behaviour* 73, 567 (2007).

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Excerpts from back issues

To access back issues of The Conservation Behaviorist, visit *www.animalbehavior.org/Committees/Conservation/ConservationBehaviorist*

2006 Volume 4 Number 1

Richard Buchholz, **Should Animal Behaviorists Teach Conservation?**

"The neglect shown ethology in conservation-biology textbooks was an impetus for the formal development of conservation behavior. Now that scholarly texts are available for conservation behaviorists, it is time to address the absence of conservation in animal behavior textbooks and in our classes. First, I ask whether conservation belongs in the undergraduate animal behavior course. Next, I review the conservation content of a recent sample of ethology textbooks. Finally, I suggest ways in which conservation could be incorporated into both the lecture and laboratory work in animal behavior, behavioral ecology, comparative psychology and ethology."

Elizabeth V. Lonsdorf, **The Role of Studying Behavior in the Conservation of Chimpanzees and Gorillas**

"Chimpanzees and gorillas are among our closest living relatives, sharing most of our genetic code and many similarities in anatomy, physiology and behavior. These apes have the capacity to make and use tools, have strong family bonds and some even have population-specific behaviors similar to human cultures. But populations of chimpanzees and gorillas are in dramatic decline due to hunting for bushmeat, loss of habitat, and the varied risks of small, isolated populations. Recognizing and understanding the complexities of these threats is the first step in conserving the world's wild ape populations. Mitigating these risks takes a deeper understanding of ape behavior. In this article, I provide examples of how the study of gorilla and chimpanzee behaviors intersects with and should be considered critical to conservation efforts."

Mark L. Wildhaber, **The Role of Reproductive Behavior in the Conservation of Fishes: Examples from the Great Plains Riverine Fishes**

"Recovery efforts for threatened and endangered fish species are hampered by lack of knowledge on their reproductive ecology. Habitat requirements and environmental stimuli necessary for reproduction are unknown and vary widely among species. For Great Plains riverine fishes, this is often complicated by the high turbidity of the system where the species occur, which precludes direct visual observation of behavior. Innovative methods for collecting behavioral data are required to better understand the conditions necessary for successful reproduction. To this goal, I will discuss four fish species on which I have worked in collaboration with university and agency researchers, graduate students, state and federal resource managers, and private landowners."