Conservation Behavior

Applying Behavioral Ecology to Wildlife Conservation and Management

Conservation behavior assists the investigation of species endangerment associated with managing animals impacted by anthropogenic activities. It employs a theoretical framework that examines the mechanisms, development, function and phylogeny of behavior variation in order to develop practical tools for preventing biodiversity loss and extinction.

Developed from a symposium held at the International Congress for Conservation Biology in 2011, this is the first book to offer an in-depth, logical framework that identifies three vital areas for understanding conservation behavior: anthropogenic threats to wildlife, conservation and management protocols, and indicators of anthropogenic threats. Bridging the gap between behavioral ecology and conservation biology, this volume ascertains key links between the fields, explores the theoretical foundations of these linkages, and connects them to practical wildlife management tools and concise applicable advice.

Adopting a clear and structured approach throughout, this book is a vital resource for graduate students, academic researchers, and wildlife managers.

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Conservation Biology

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Edited by

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This book is dedicated to my parents, Noa and Arieh, for their inexhaustible love and support.

OBT

To the young conservation biology undergraduate and graduate students around the world to whom I leave the burden of repairing all the damage my generation has so skillfully inflicted on this planet.

DS

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Prologue – don't feed the bear!

Like A. A. Milne's Winnie-the-Pooh, real bears love rich food, and just like Pooh, real bears strive to minimize the costs and maximize the benefits of obtaining that food. Like Pooh, real bears also don't realize the possible consequences. In Pooh's case, his attempts to get free food result in him becoming stuck in one of the entrances to Rabbit's den, after consuming all of Rabbit's honey, and becoming too fat to go back out the way he came in. In the real world, bears learn very quickly that humans can provide easy access to food resources that will increase their net energetic return, and start seeking out human activity and steal or beg for food.

"Don't feed the bears!" is a line commonly appearing on roadside notices in many US National Parks. It encompasses the realization that our actions may alter the behavior of the species around us; a realization that took many years to materialize.

Initially, the begging behavior of bears was considered amusing and the US Park Service actually encouraged this, so called, habituation. It was not long before problems concerning human safety began surfacing. Bears began actively seeking human contact and occasionally would become aggressive towards visitors who would not "share their lunch". In 1902, the Park Service outlawed the hand feeding of bears, but did not enforce it and the practice continued. The situation became increasingly dangerous for both humans and bears. Fatal attacks on humans became common and problem bears were shot. Finally, in 1970, the Park Service began enforcing the law and devised various methods to prevent bear access to anthropogenic food sources. These include raising awareness in humans, preventing the bears from accessing food (e.g. introducing bear-proof containers), and using bear deterrents and aversive behavioral conditioning to keep bears away. Behavioral conditioning relies on our understanding of how bears learn and how they react to novel stimuli, and behavioral ecologists continue to devise better and more effective methods that will allow wildlife

managers to resolve human-bear conflicts in an efficient, non-lethal manner.

Avoiding the consequences that may follow human-wildlife contacts is but one example of how looking at the world from the animal's point of view can improve the way we conserve and manage wildlife. "Thinking like a mountain" is what conservation behavior is all about.

Preface – the role of behavior in conservation biology

Conservation biology is an applied multidisciplinary science that often deals with crisis situations. Of the many sciences from which conservation biology draws, it relies most heavily on ecology and its various sub-disciplines (population biology and genetics, community ecology, landscape ecology, etc.). One of these sub-disciplines, behavioral ecology, began in the past two decades receiving particular attention regarding its role in conservation biology. Specifically, several books (e.g. Clemmons & Buchholz 1997, Caro 1998, Festa-Bianchet & Apollonio 2003, Blumstein & Fernández-Juricic E. 2010) and papers (e.g. Sutherland 1998, Caro 1999, Linklater 2004, Angeloni *et al.* 2008, Greggor *et al.* 2014) began focusing on the interface between conservation biology and behavioral ecology, arguing that the discipline of behavioral ecology is an important component of conservation theory and practice, but has not yet received the attention it deserves. Further published opinions claimed that, in contrast to other ecology sub-disciplines, behavioral ecology has little bearing on conservation (Caro 2007), while others argued that behavioral ecology is, and always was, an important component of conservation biology (Harcourt 1999 and Buchholz 2007, respectively). A survey of the literature by Angeloni *et al.* (2008) indicated that only ~5% of papers published in leading conservation journals included the term behavior (or its derivatives) in their title, and that there is no evidence of an increasing trend. Angeloni *et al.* (2008) concluded, based on these findings, that a gap exists between the two disciplines and that the importance of behavioral ecology to conservation has yet to be fully realized. More recently, Nelson (2014) made a similar analysis and reached the same conclusions. When one considers that similar debates never took place with regard to the role of other ecology sub-disciplines in conservation, this debate is somewhat intriguing. It is especially interesting since all the aforementioned papers appear to pose legitimate arguments backed by logic and data that underpin two basic

points of contention: (1) is behavioral ecology an important factor in conservation thinking and decision-making? And (2) is conservation behavior (i.e. the application of animal behavior in conservation) a young discipline not yet receiving the attention it deserves?

Biodiversity is a pivotal issue in conservation biology. The logic is straightforward: Diversity is the engine that drives evolution and enables species to change as the world changes. If ecosystems are to continue to provide the services man needs, diversity must be maintained to enable adaptation to a rapidly changing globe. The study of the linkage between biodiversity and ecosystem functioning is considered a top priority in future conservation research (Sutherland *et al.* 2009). Thus, conservation biology focuses on preventing the loss of diversity (of all types) stemming from anthropogenic influences. The behavior of an animal is the outcome of the interaction between its genes and the environment (GXE) and fulfills the role of a mediator between these two elements. Thus, it is almost axiomatic that animal behavior is a component of biodiversity and should be considered in conservation biology. The ability of animals to respond to anthropogenic activity depends on their learning capabilities and their behavioral diversity. An inability to respond behaviorally may contribute to, and even be a direct cause of, extinction. Because behavior is the result of GXE interactions, changes in behavior can be used to assess anthropogenic impacts on the environment, and any conservation or development planning should consider the impact of such actions on the behavior of organisms. Thus, the importance of animal behavior in conservation is, for the most part, self-evident.

The realization that behavior is an important component of managing wild populations stems back to the earliest studies of threatened species long before conservation biology was a realm of science. In the first issue of the first scientific journal devoted to applied ecology – *The Journal of Wildlife Management* – two of the twelve (>15%) papers published: "Winter and spring studies of the sharp-tailed grouse in Utah" (Marshall & Jensen 1937) and "Goose nesting studies on Bear River migratory waterfowl refuge" (Williams & Marshal 1937), focused on behavior and its role in managing wild population. In his book *A Sand County Almanac*, first published in 1949, Aldo Leopold states (page 81) "Science knows little about home range: how big it is, at various seasons, what food and cover it must include, when and how it is defended against trespass, and whether ownership is an individual, family, or group affair. These are fundamentals of animal economics or ecology." So Leopold too realized that the behavior of wildlife is a fundamental part of their economy. Undergraduate

programs in Wildlife Management dating back 40 years (Humboldt State University, California 1977 yearly catalog) typically offered two upper-division courses in wildlife ethology or behavioral ecology that focused on the relationship between animal behavior and management. Thus, the realization of the importance of behavioral ecology in managing wild populations dates back many years before conservation biology became an academic field. That said, the question remains as to whether it is receiving the attention it deserves?

Angeloni *et al.* (2008)-surveyed the conservation literature, focusing on three leading journals (*Conservation Biology*, *Biological Conservation* and *Ecological Applications*) over a one decade period (1996–2005) looking for the prevalence of the term "behav*" in the title or abstract of all papers published. They found behavioral issues occupy only 2–6% of the volume of published papers in leading conservation journals. Based on a similar survey we carried out (limited to one journal, *Conservation Biology*), this trend continues through 2009 and increases somewhat thereafter to ca. 8%. Although, at first glance, this seems low, one must consider that conservation biology is a multidisciplinary science covering many disciplines including: conservation genetics, population dynamics, community structure, ecosystem management, ecotoxicology – to name a few that are in essence ecological, and other non-ecological fields. There are several ways to evaluate this: First, one can check the prevalence of other sub-disciplines in the conservation literature – for example the occurrence of the term "genetic(s)." We checked its prevalence in *Conservation Biology* and found that from 1988 to 2003 "genetic*" was twice as prevalent in the titles and abstracts as "behav*" (on average 10.8 vs. 4.4%, respectively), but declined in the following decade, 2004–2013, to 8.5 versus 8.0%, respectively. Thus, an undoubtedly important sub-discipline such as genetics is no more prevalent in the conservation literature than behavior. We found a similar trend in the journal *Animal Conservation*,with considerably greater difference in the first decade the journal was published (1998–2008; 27.5 vs. 10.8%, respectively) but becoming closer between the years 2009–2013 (17.3 vs. 13.7%, respectively). The overall higher percentages in both these topics in an animal-oriented conservation journal is not surprising as it will not cover all realms a general conservation journal would (e.g. plant diversity and community structure). Another option is to compare animal-oriented journals in ecology to animal-oriented journals in conservation ecology – e.g. *Journal of Animal Ecology* versus *Animal Conservation*. In the 1998–2008 period, the percentage of papers in *Journal of Animal Ecology* with "genetic*" in the title or abstract was considerably lower than those with the term

"behav*" (4.4 vs. 28.2%, respectively) but the gap shrank between the years 2009 and 2013 due to an increase in the prevalence of genetic studies (9.7 vs. 31.8%). The prevalence of behavior-oriented papers in this journal is just over twice as high as in *Animal Conservation*, reflecting a true difference in focus stemming from the inherent multidisciplinary character of conservation.

These numbers suggest that the volume of behavioral ecology papers within the realm of conservation biology is similar to that of other subdisciplines (e.g. genetics), and cannot be expected to increase substantially (if at all) in a multidisciplinary field like conservation biology. If that is the case, then what spawned the debate regarding the prevalence of behavioral considerations in conservation in the first place? In his 2007 paper, Tim Caro (2007) claims that behavioral ecology *theory* and *paradigms* have little bearing on conservation. A recent survey of the literature suggested that conservation topics such as invasive species and climate change studies often consider foraging and dispersal behaviors. However, related behavior ecology theories – i.e. optimal foraging and ideal free distribution – are mentioned in only a small fraction (<<1%) of the papers (unpublished data). By contrast, genetic studies in conservation commonly refer to, and are driven by underlying theory (e.g. Hardy-Weinberg theorem, founder effects and genetic drift). Thus, the problem appears to be not the consideration of behavior in conservation, but rather placing conservation behavior studies within the theoretical behavioral ecology framework and paradigms.

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Frameworks are essential for the progression of science as they lend structure and layering, provide a linkage to theory and channel work in certain directions, spawning hypotheses and, later on, generalizations and paradigms. Without these, ad hoc explanations are provided to explain research findings and no rules evolve. Some realms of conservation behavior where key paradigms may evolve in the near future are, for example, the linkage of habituation and the landscape of fear, and the role of social structure in small/declining populations. Structure is not only vital for the progression of science; it also facilitates learning, as comprehension requires the organization of ideas relative to each other and to existing knowledge (Kintsch 1988). Frameworks are especially important in applied sciences dealing with crisis situations (such as conservation biology and medicine), because these sciences are goal oriented and involve frequent and vital decision-making processes. The frameworks provide focus and point to potential issues that need to be considered.

In 2011 we suggested a conceptual theoretical framework for the field of conservation behavior (Berger-Tal *et al.* 2011). The framework focuses on three main realms in which the role of behavior must be considered: anthropogenic threats to wildlife, conservation and management protocols, and indicators of anthropogenic threats or management success. These three elements form the backbone of the conservation behavior conceptual model and dictate the structure of this book.

This book is made up of four parts. The first part serves as an introduction to conservation behavior. In Chapter 1 we give a brief overview of the fields of conservation biology and behavioral ecology and introduce the conservation behavior framework. In Chapter 2 John Swaddle expands on the basic process through which animal behaviors and consequential responses to environmental changes are shaped – evolution. In Chapter 3 Schakner and Blumstein discuss another fundamental process that is vital to understanding how animals respond to human activity – the process of learning. The rest of the book closely follows the three themes of the conservation behavior framework.

Part II looks at how anthropogenic activities impact animal behavior and how these impacts are linked to demographic changes. In Chapter 4 we look at the consequences of not changing one's behavior in the face of a rapidly changing environment. In Chapter 5 Daniel Rubenstein provides the complementary view point and describes the possible consequences of altering one's behavior in response to a changing environment.

Part III considers the various uses of behavioral ecology in conservation and management planning. Esteban Fernández-Juricic provides an overview of the role of sensory ecology in behavioral-based management (Chapter 6). In Chapters 7 and 8 St. Clair *et al.* and Ben Bell discuss the use of behavioral knowledge for reserve design and management and for reintroductions, respectively. Bessa-Gomez and Sarrazin give a brief introduction to the use of behavior ecology in wildlife population modeling (Chapter 9). Lastly, in Chapter 10 Debra Shier considers how manipulating animal behavior can increase the success of captive breeding programs.

Part IV of the book deals with the use of behavior as a leading indicator either of anthropogenic threats to wildlife or of the success of management programs. In Chapter 11 Kotler *et al.* give a detailed overview and guidelines of how to use foraging behavior as a leading indicator for assessing populations' state. In Chapter 12 we look at how behavioral indicators can be used to gauge shifts in the community structure, assess ecosystem health and predict global changes.

The book is aimed at behavioral ecologists of all levels, especially those looking for ways to help with conservation of species, and at conservation practitioners and wildlife managers. Each non-introductory chapter ends with a section that focuses on giving concise and practical advice regarding the uses of behavioral theory and knowledge in management. The structured nature of the book also makes it an excellent basis for a conservation behavior course or for behavioral-oriented classes within a conservation biology course.

Behavior acts as a mediator between the animal and its environment. As such it rapidly varies over time and space and is a function of past experience and the genetic limits resulting from past selection. Behavior is therefore an important component of biodiversity, and like all other components of biodiversity should be regularly addressed when managing animal populations. We hope this book will help implement this concept and will serve as a basis for future development and improvements of the conservation behavior framework.

David Saltz and Oded Berger-Tal

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