# Problem-Solving in Conservation Biology and Wildlife Management

# Problem-Solving in Conservation Biology and Wildlife Management

## Exercises for Class, Field, and Laboratory

James P. Gibbs
Malcolm L. Hunter, Jr.
Eleanor J. Sterling

Blackwell Publishing

BLACKWELL PUBLISHING
350 Main Street, Malden, MA 02148-5020, USA
9600 Garsington Road, Oxford OX4 2DQ, UK
550 Swanston Street, Carlton, Victoria 3053, Australia



First edition published 1998 by Blackwell Publishing
Second edition published 2008

1 2008

*Library of Congress Cataloging-in-Publication Data*

Gibbs, James P.
Problem-solving in conservation biology : exercises for class, field, and laboratory / James P. Gibbs, Malcolm L. Hunter, Jr., Eleanor J. Sterling. – 2nd ed.
p. cm.
Includes bibliographical references and index.
ISBN 978-1-4051-5287-7 (pbk. : alk. paper) 1. Conservation biology. 2. Wildlife management. 3. Conservation biology–Problems, exercises, etc. 4. Wildlife management–Problems, exercises, etc. I. Hunter, Malcolm L. II. Sterling, Eleanor J. III. Title.
QH75.G53 2008
577–dc22
2007016279

A catalogue record for this title is available from the British Library.

Set in 10.5/13pt Janson
by SPi Publisher Services, Pondicherry, India
Printed and bound in [Country of Printing]
by [Name and Address of Printer]

The publisher's policy is to use permanent paper from mills that operate a sustainable forestry policy, and which has been manufactured from pulp processed using acid-free and elementary chlorine-free practices. Furthermore, the publisher ensures that the text paper and cover board used have met acceptable environmental accreditation standards.

For further information on
Blackwell Publishing, visit our website:
www.blackwellpublishing.com

# Contents

# Preface

If you are a student today you have an opportunity to play a significant role in how the biodiversity crisis plays out. Although the long-term trajectory of the human population is unclear, during the next few decades the level at which it might eventually stabilize will become increasingly clear. Of course, enormous expanses of the environment have been fundamentally transformed by our activities, yet much is left that merits conserving. How we conserve that which remains, and how we choose to live upon and in some cases restore the rest, will determine the fates of millions of wild species. Much of this will transpire during your career.

While you can learn a good deal from attending class lectures, what will be most useful to you are practical experiences. This is because conservation biology and wildlife management are, more than anything, about the application of ideas to the solving of problems. One can go to great effort to discuss all the dimensions of the biodiversity crisis, carefully enumerate the individuals in an endangered population, or methodically poll the public on its attitudes toward wild life. Ultimately what matters most is putting this information into action. This is the biggest challenge that any practicing conservationist faces.

We have generated this book expressly for the students and teachers of conservation biology and wildlife management who want to have an impact beyond the classroom. The book originated from our collective sense that "learning by doing" is the most effective, fun, and durable way to develop into a professional. A so-called problem-based learning approach worked best for us when we were students. Now we wish to share this engaging learning approach with you.

We have created a set of exercises that addresses problems spanning a wide range of conservation issues: genetic analysis, population biology, ecosystem management, the public policy process, and more. Some can be used as simple homework exercises for individuals working alone. Others are lengthy, group exercises. All carry a message about "making it happen," that is, how to take what you have learned in an exercise and have an impact in the larger world.

The first edition of this book was published in 1998. In the interim, the book has been purchased and used by many around the world, enough to warrant a second edition. We now have more experience in developing exercises that "work." Approximately two-thirds of the material in this second edition is new or dramatically revised from the first.

Our target audience is upper-level college undergraduates, early-stage graduate students, and possibly some practicing professionals. While the book might best complement an existing conservation biology or wildlife management lecture course, it can contribute to a variety of courses, and has, for example, been adopted for a re-training course for secondary school teachers and a field-based natural history course.

We view conservation biology and wildlife management as complementary fields, and have therefore included exercises applicable to both. The two fields contrast mostly in terms of emphasis. Conservation biology views all of nature's diversity as important and having inherent value, whereas traditional wildlife management operates from a somewhat more utilitarian perspective with a primary objective of providing recreational resources for people, including sustained yields of harvested species, especially birds and mammals. Both fields recognize the need to integrate the contributions of non-biologists (economists, sociologists, political scientists) to conserve wild species. This commonality distinguishes both fields from the pure sciences. Because of the blurred distinctions between these fields we have intentionally not tried to identify which exercises are more suitable to a conservation biology class versus a wildlife management class.

The book has been designed to accompany any of the main-stream conservation biology and wildlife management texts. Instructors should be aware that they need a copy of the accompanying instructors' manual to make certain exercises succeed. To secure a copy, see "Important note about the instructor's manual" below.

## Copying

We are well aware that the cost of textbooks often leads both students and faculty to copy portions of textbooks illegally. The temptation to do this is particularly great with lab texts in which not all of the exercises will be used. We have tried to minimize this temptation by keeping the price of the book low. We are also aware that many scanned, electronic copies of exercises from the first edition of the book are posted on course websites on the internet. This is flattering yet frustrating as it undercuts not only our efforts but also any publisher's interest in books such as this. Perhaps it will help some people to avoid the temptation of photocopying to know that all of the royalties from this book have been dedicated to conservation: two fellowship funds for natural resource and biology students from developing countries.

## Important Note About the Instructor's Manual

Instructors should be aware that they need a copy of an accompanying instructor's manual to make many exercises succeed. While developing this book we compiled a companion electronic document with the answers to all the exercises as well as many tips and suggestions. We wish to manage the distribution of this manual to instructors of classes. To receive an electronic copy, please send an email message to James Gibbs at jpgibbs@esf.edu indicating:

- your institution and position
- the course name and number, and
- approximate number of students in the class.

With this information we will arrange a web download or email transmission of the manual.

As we regard this as an evolving project please also send along suggestions and criticisms. We would especially like to hear about ways to improve these exercises. We know that many teachers of conservation biology and wildlife management courses have put together similar exercises for their classes. For possible inclusion in a future edition of the book, please send them along to us.

## The Book's Website

This book has an accompanying website with the data sets and other resources to support many of the exercises presented herein: www.blackwellpublishing.com/gibbs

# Acknowledgments

We are most grateful to the students who worked through earlier, less polished versions of these exercises. Most of the exercises have been "field-tested" and greatly improved by students at the State University of New York's College of Environmental Science and Forestry, Columbia University, the University of Maine, and Yale University. Also, Erin McCreless and Brian Weeks kindly assisted with exercise preparation.

A number of people have either authored Exercises or written them with us. We are extremely pleased to include their excellent contributions here:

Margret C. Domroese, American Museum of Natural History, New York, USA
Jennifer Griffiths, American Museum of Natural History, New York, USA
Luigi Guarino, Secretariat of the Pacific Community, Suva, Fiji
Ian J. Harrison, American Museum of Natural History, New York, USA
Robert J. Hijmans, International Rice Research Institute, Los Baños, Philippines
Andy Jarvis, Bioversity International and International Centre for Tropical Agriculture (CIAT), Cali, Colombia
Thane Joyal, Law Offices of Joseph J. Heath, Syracuse, New York, USA
Michael E. Meredith, Wildlife Conservation Society, Kuching, Malaysia
Viorel Popescu, State University of New York College of Environmental Science and Forestry, Syracuse, New York, USA
Richard B. Primack and Brian Drayton, Boston University, Boston, USA
Pablo Ramirez de Arellano, Bioforest S.A., Concepción, Chile
Robert S. Seymour, University of Maine, Orono, Maine, USA
Krishnan Sudharsan, Michigan State University, East Lansing, Michigan, USA

We would also like to highlight the direct and indirect contributions to this effort by the staff of the Network of Conservation Educators and Practicioners (NCEP), particularly Nora Bynum and Ian Harrison of the American Museum of Natural History. NCEP is a global project to improve the practice of biodiversity conservation by improving training in biodiversity conservation. Some of the exercises herein are adapted directly from NCEP materials and you are encouraged to consult the NCEP website to access many related materials, including class presentation materials, topic syntheses, and even more exercises: http://ncep.amnh.org/

Drawings were produced by Debbie Maizels and the staff of Emantras.

Last, but certainly not least, at Blackwell Publishing Rosie Hayden patiently guided us through an extended publication process and Janey Fisher did an extraordinary job scrutinizing the manuscript during the copy-editing process for this 2nd edition.

## Images at chapter and part openings: credits

*Front (p ii):* Green turtle at Monkey Mia, Western Australia. Image: Malcolm L. Hunter, Jr.

*Introduction:* Kihansi Gorge, Udzungwa Mountains, Eastern Arc, Tanzania. Image: James P. Gibbs.

1 *What is Biodiversity?* Araneidae. Image: Berland (1955).
2 *What is Conservation Biology?* Mountain ash (a species of *Eucalyptus*), Victoria, Australia. Image: Malcolm L. Hunter, Jr.
3 *Why is Biodiversity Important?* Giant anteater, Roraima, Brazil. Image: James P. Gibbs.

*Genes:* PCR amplicons for representatives of 94 fish families. Image: Ivanova, N. V., *et al*. Molecular Ecology Notes **7:**544–548.

4 *Population Genetics:* Orchid, unknown spp., Roraima, Brazil. Image: J. P. Gibbs.
5 *Genetic Drift:* Eastern barred bandicoot. Image: Hunter and Gibbs (2007).
6 *Pedigree Management:* Triple nose-leaf bat. Image: Blanford (1888).
7 *Landscape Genetics:* American toad, New York State, USA. Image: James P. Gibbs.

*Populations:* Leopard frogs, New York State, USA. Image: Nancy Karraker

8 *Life Table Analysis:* Albatross, Antarctic Ocean. Image: Malcolm L. Hunter, Jr.
9 *Population Viability Analysis:* Galapagos Penguins, Galapagos Islands, Ecuador. Image: James P. Gibbs.
10 *Habitat Loss and Fragmentation:* White trillium, New York State, USA. Image: Donald J. Leopold.
11 *Diagnosing Declining Populations: Opuntia* spp. Image: James P. Gibbs.
12 *Estimating Population Size with DISTANCE:* Orang utan, Sepilok Rehabilitation Center, Sabah. Image: Michael E. Meredith.
13 *Analyzing Camera Trap Data:* Golden cat. Image: Zoo Heidelberg/Ales Toman.
14 *Estimating Population Size with MARK:* Karanth and Nichols (2002). © Center for Wildlife Studies.

*Species:* Atlantic puffin. Image: Malcolm L. Hunter, Jr.

15 *Estimating "Biodiversity":* Various Coleoptera. Image: W. S. Blatchley, The Nature Publishing Company, Indianapolis, Indiana (1910).
16 *Designing a Zoo:* Candidate species. Image: Hunter and Gibbs (2007).
17 *Plant Reintroductions:* Blue lupine ready for outplanting. Image: James P. Gibbs.
18 *Edge Effects:* Artificial nest with hen's egg. Image: James P. Gibbs.

*Ecosystems and Landscapes:* Acadia National Park, Maine, USA. Image: Malcolm L. Hunter.

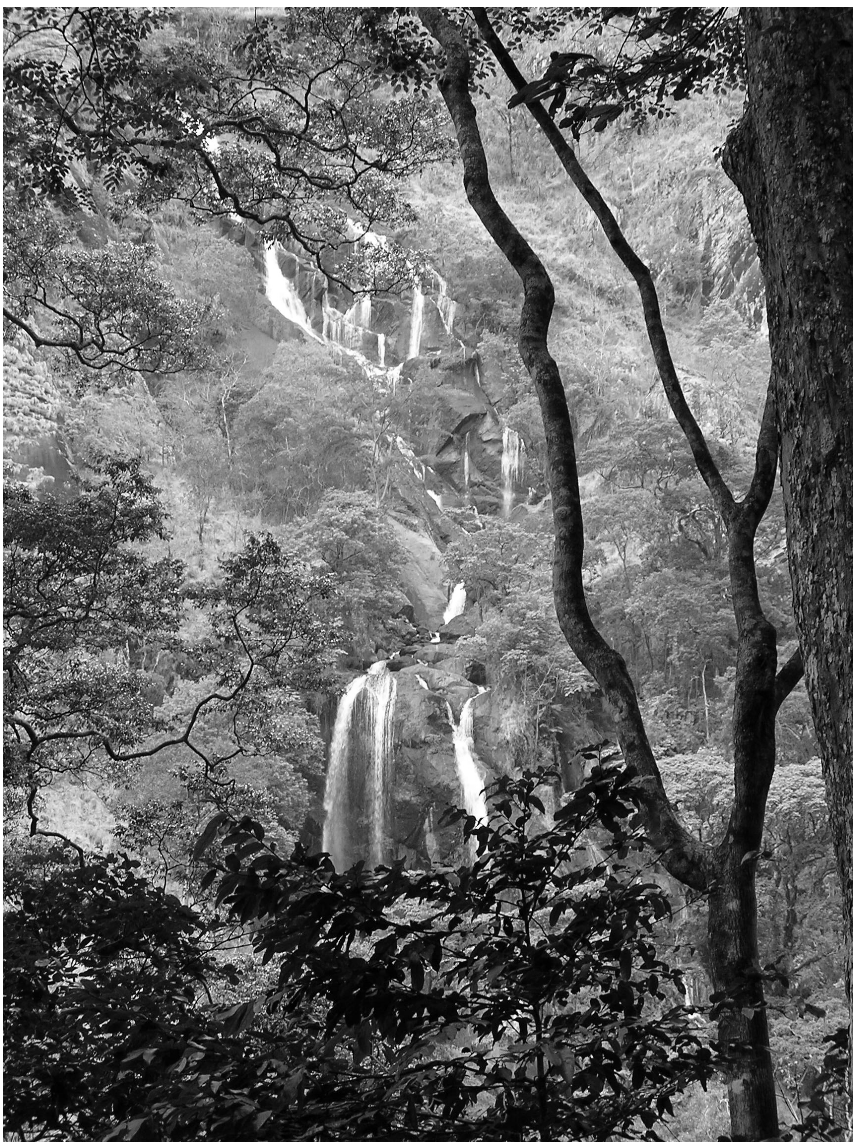
19 *Ecosystem Fragmentation:* Fragmentation stage. Image: Hunter and Gibbs (2007).
20 *Forest Harvesting:* Macaw, Roraima, Brazil. Image: James P. Gibbs.
21 *Protected Areas:* Working landscape. Image: Hunter and Gibbs (2007).
22 *Island Biogeography:* Species-area relationships. Image: Hunter and Gibbs (2007).
23 *GIS for Conservation:* Wild potato (*Solanum megistacrolobum* subsp. *toralapanum*), Toralapa, Cochabamba, Bolivia. Image: Robert Hijmans.
24 *Global Change:* Mink frog, Adirondack Mountains, New York, USA. Image: James P. Gibbs.
25 *Climate Envelope Modeling:* Wild peanut (*Arachis nitida*). Image: Karen Williams, U.S. Department of Agriculture.

*Policy and Organization:* Bottle-nosed dolphin, Monkey Mia, Western Australia. Image: Malcolm L. Hunter, Jr.

26 *Population, Consumption, or Governance:* Syracuse, New York, USA. Image: James P. Gibbs.
27 *Overconsumption:* SUNY-ESF, Syracuse, New York, USA. Image: James P. Gibbs.
28 *Conservation Values:* Opinion survey. Image: James P. Gibbs.
29 *Priority Setting:* Shavla River, Argut Nature Park, Altai, Russia. Image: James P. Gibbs.
30 *Commercial fishing in Galapagos National Park:* Pinzon Island, Galapagos National Park, Galapagos, Ecuador. Image: James P. Gibbs.
31 *Conservation Law:* Polar bears, Svalbard Islands. Image: Malcolm L. Hunter, Jr.
32 *Conservation Policy:* Formal letter. Image: James P. Gibbs.

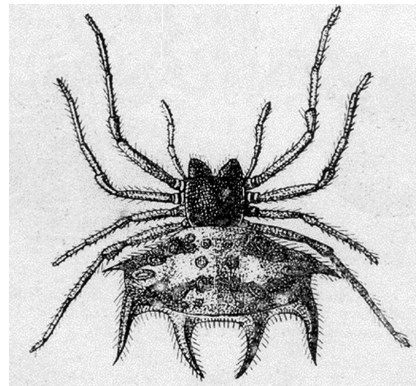
PART 1

# Introduction



# CHAPTER 1

# What is Biodiversity? Spiders as Exemplars of the Biodiversity Concept



*James P. Gibbs, Ian J. Harrison, and Jennifer Griffiths*

What is biodiversity? Ask anybody on the street if they have heard of the word "biodiversity" and you will usually get an affirmative answer. This is because the term has become very widely known – competing with some of the most popular terms from the media on the Internet. Popularly, the term resonates with the general public by conjuring up images of "tropical forest ringing with a cacophony of unseen frogs, insects, and birds; a coral reef seething with schools of myriad iridescent fishes; a vast tawny carpet of grass punctuated by herds of wildebeest and other antelope" (Hunter & Gibbs 2006). But then ask them to define it. Answers will range widely because the term is surprisingly misunderstood.

In practice "biodiversity" typically refers to the number and variety of distinct organisms (species) living on the Earth even though individual species are just one level of organization in living nature. Even with a focus simply on species diversity the concept of biodiversity and the practice of studying it can be overwhelming. The job of sorting out the many millions of species on Earth is the foundation of taxonomy, a subdiscipline within the larger discipline of systematics. The job of the taxonomist is to find an organized way for humans to make distinctions that parallel the distinctions that various organisms make themselves. Such distinctions are fundamental to conservation biology because if we are to maintain biodiversity we must understand how it is organized. In particular, we often need to identify which organisms will be affected by a particular conservation action. Moreover, we often need to focus on not just which species are different from one another but also consider *how* different they are.

## Objective

- To explore the concept of biological diversity as it occurs at various taxonomic levels through the classification of life forms.

## Procedures

Spiders are a highly species-rich group of invertebrates that exploit a wide variety of niches in virtually all the earth's biomes. Some species of spiders build elaborate webs that passively trap their prey whereas others are active predators that ambush or pursue their prey. Spiders represent useful indicators of environmental change and community level diversity because they are taxonomically diverse, with species inhabiting a variety of ecological niches, and they are easy to catch.

*Sorting and Classifying a Spider Sample Collection*

Spider collections have been assembled for you from 5 forest patches (sites 1 through 5) depicted on a map (Figure 1.1). Our first focus is on the spider sample collection for site 1 (Figure 1.2). The spiders were captured by a biologist traveling along transects through the forest patch, striking with a stick a random series of 100 tree branches. All spiders that were dislodged and fell onto an outstretched sheet were collected and preserved in alcohol. They have since been spread out on a tray for you to examine. The illustrations of the spiders collected are aligned in rows and columns so that it is easy to cut them out with scissors (if you wish) for subsequent examination, grouping, and identification.

The next task is to sort and identify the spiders. Look for external characters that all members of a particular group of spiders have in common but that are not shared by other groups of spiders. For example, look for characteristics such as leg length, hairiness, relative size of body segments, or abdomen patterning and abdomen shape. Describe briefly the set of characters unique to each group of morphologically indistinguishable spiders. These "operational taxonomic units" that you define will be considered separate species.

Assign each species a working name, preferably something descriptive. For example, you might call a particular species "spotted abdomen, very hairy" or

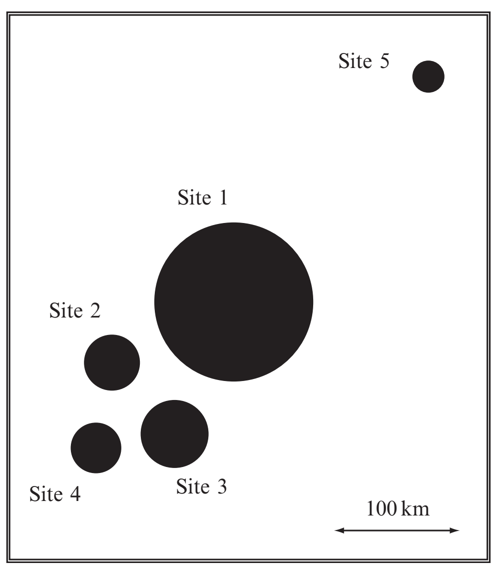



**Fig. 1.1** Locations of the 5 forest patches ("sites") where spider collections were made.

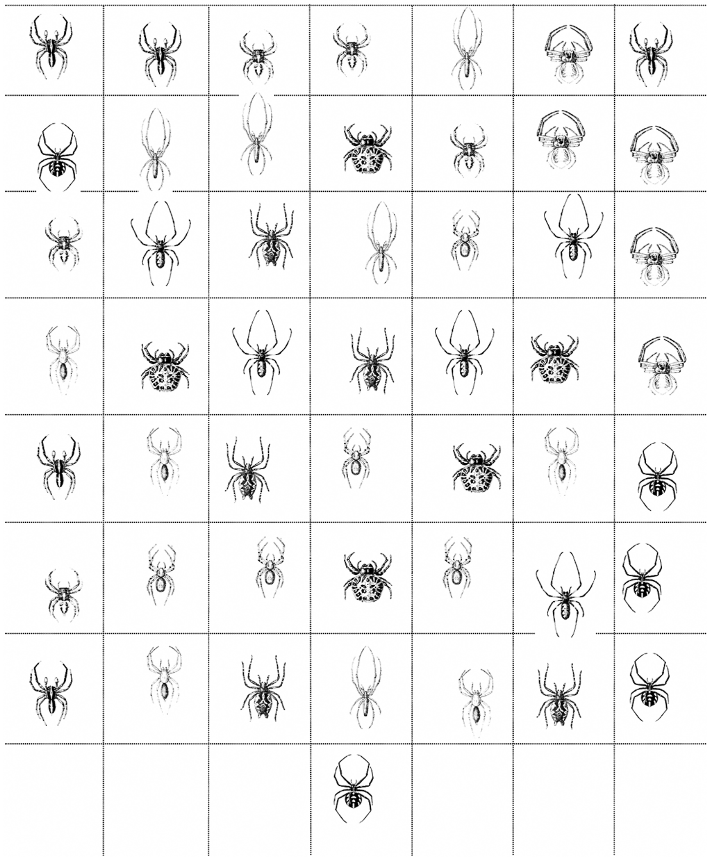



**Fig. 1.2** Specimens collected from forest patch ("site") 1.

"short legs, spiky abdomen." Just remember that names that signify something unique about the species will be more useful to you. Construct a table listing each species, its distinguishing characteristics, the name you have applied to it, and the number of occurrences of the species in the collection.

*Has Sampling at Site 1 been Adequate to Characterize the Spider Community?*

Next ask whether this collection adequately represents the true diversity of spiders in the forest patch at the time of collection. Were most of the species present sampled or were some likely missed? This is always an important question to ask to ensure that the sample was adequate and hence legitimately characterizes the assemblage of spiders at a site.

You can address this question by performing a simple but informative analysis that is standard practice for conservation biologists who do biodiversity surveys. This analysis involves constructing a simple, so-called "collector's curve" (Colwell & Coddington 1994). These plot the cumulative number of species observed ($y$-axis) against the cumulative number of individuals classified ($x$-axis). The collector's curve is an increasing function with a slope that will decrease as more individuals are classified and as fewer species remain to be identified (Figure 1.3). If sampling stops while the collector's curve is still rapidly increasing, sampling is incomplete and many species likely remain undetected. Alternatively, if the slope of the collector's

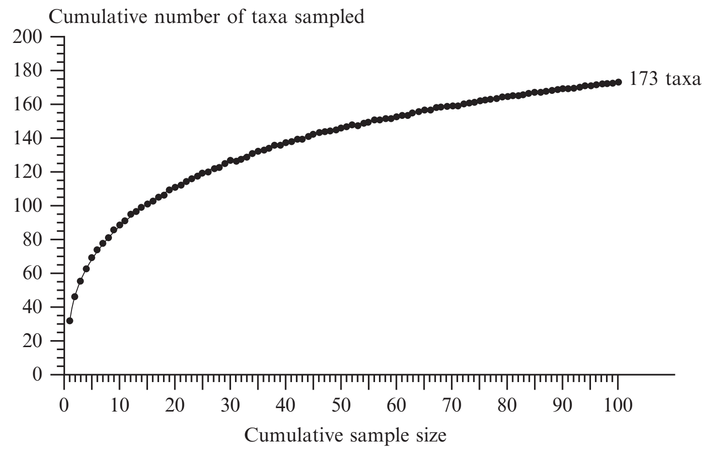



**Fig. 1.3** An example of a collectors' curve. Cumulative sample size represents the number of individuals classified. The cumulative number of taxa sampled refers to the number of new species detected.

curve reaches zero (flattens out), sampling is likely more than adequate as few to no new species remain undetected.

To construct the collectors' curve for this spider collection, choose any specimen within the collection at random (if you cut up the spider collections with scissors put them in a hat or bag and shake them up). This will be your first data point, such that $x = 1$ and $y = 1$, because after examining the first individual you have also identified one new species. Next move in any direction (but consistently so) to a new specimen and record whether it is a member of a new species. In this next step, $x = 2$, but $y$ may remain as 1 if the next individual is not of a new species or it may change to 2 if the individual represents a new species (different from specimen 1). Repeat this process until you have proceeded through all 50 specimens and construct the collector's curve from the data obtained (just plot $y$ versus $x$). Does the curve flatten out? If so, after how many individual spiders have been collected? If not, is the curve still increasing? What can you conclude from the shape of your collector's curve for site 1 as to whether the sample is an adequate characterization of spider diversity at the site?

### *Contrasting Spider Diversity among Sites to Provide a Basis for Prioritizing Conservation Efforts*

Now you are provided with spider collections from 4 other forest patches. The forest patches have resulted from fragmentation of a once much larger, continuous forest; a stylized map of the fragmented forest patches, showing their size and proximity to each other, is given in Figure 1.1. You will use the spider diversity information to prioritize efforts for the five different forest patches (including the data from the first patch which you have already classified). The additional spider collections are provided in Figures 1.4, 1.5, 1.6, and 1.7.

Again, tally how many individuals belonging to each species occur in each site's collection (use your classification of spiders completed for Site 1 during Level 1 of the exercise as a starting point with the caveat that you will "discover" some new species at the new sites). Data are most easily handled by constructing a table of species (rows) by site (columns). In the table's cells put the number of individuals of each species you found in the collection from each site. You can then analyze these data to generate different measures of community characteristics to help you to

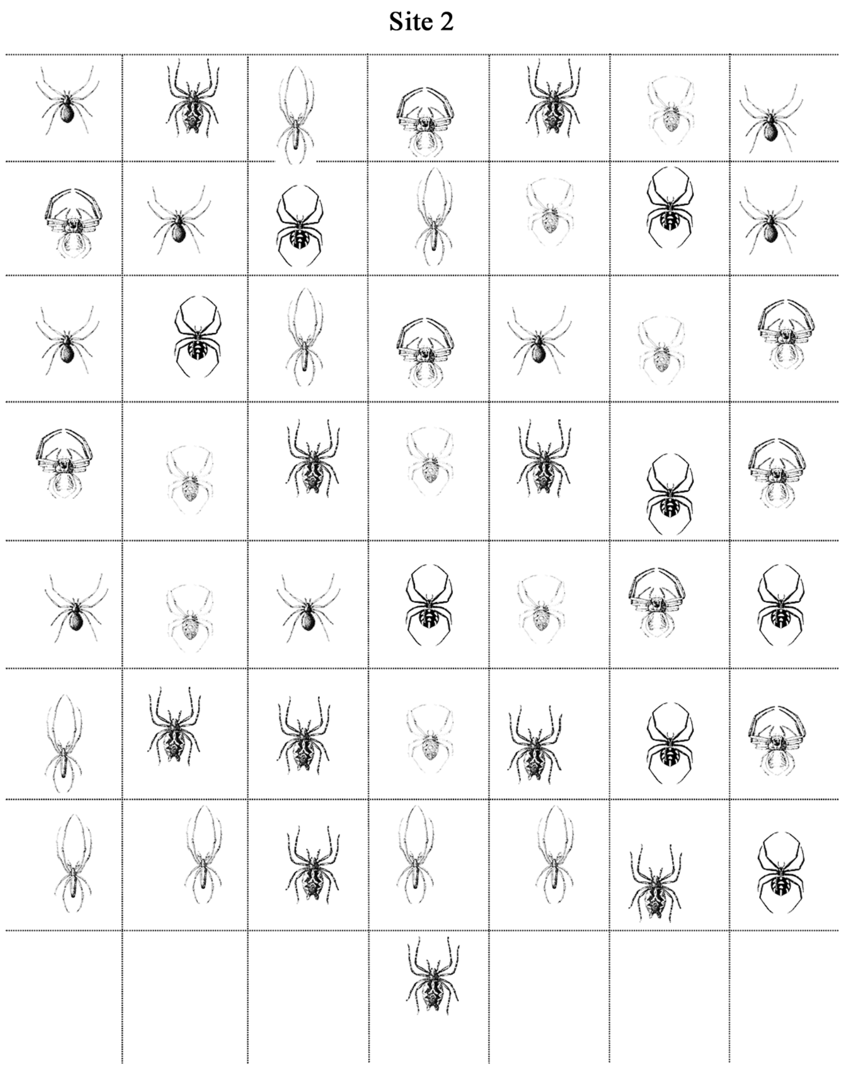



**Fig. 1.4** Specimens collected from forest patch ("site") 2.

decide how to prioritize protection of the forest patches. Recall that you need to rank the patches in terms of where protection efforts should be applied, and you need to provide a rationale for your ranking.

*Analyzing Community Diversity*

You will find it most useful to base your decisions about how to prioritize these sites for protection on three community characteristics:

- species richness within each forest patch
- species diversity within each forest patch
- the similarity of spider communities between patches.

Species richness is simply the tally of different spider species that were collected in a forest patch. Species diversity is a more complex concept. We will use a standard index called Simpson Reciprocal Index, 1/D where D is calculated as follows:

$$D = \sum p_i^2$$

**Site 3**

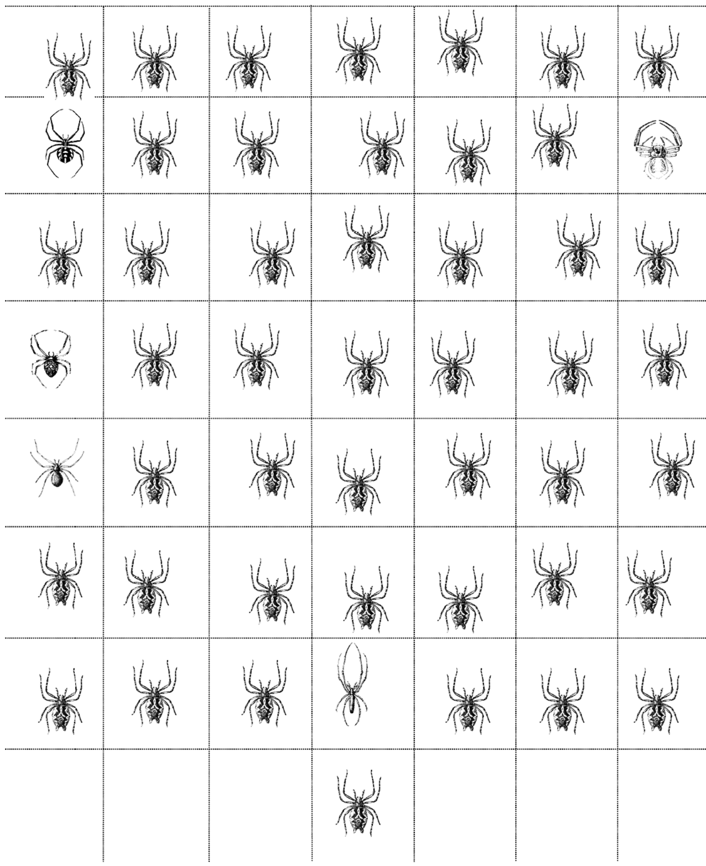


**Fig. 1.5** Specimens collected from forest patch ("site") 3.

where $p_i$ = the fractional abundance of the *i*th species on an site. For example, if you had a sample of 2 species with 5 individuals each, Simpson Reciprocal Index = 1 / ((0.5)2 + (0.5)2) = 1/2 or 0.5. The higher the value, the greater the diversity. The maximum value is the number of species in the sample, which occurs when all species contain an equal number of individuals. Because this index not only reflects the number of species present but also the relative distribution of individuals among species within a community it can reflect how "balanced" communities are in terms of how individuals are distributed across species. Textbooks usually discuss this concept in terms of "evenness." As a result, two communities may have an identical complement of species, and hence species richness, but substantially different diversity measures if individuals in one community are skewed toward a few of the species whereas individuals are distributed more evenly in the other community.

*Analyzing Community Distinctiveness*

Diversity is one thing, distinctiveness is quite another. Thus another important perspective in ranking sites is how different the communities are from one another. We will use the simplest available measure of community similarity, that is, the Jaccard coefficient of community similarity ($CC_J$), to contrast community distinctiveness between all possible pairs of sites:

$$CC_J = c/S$$

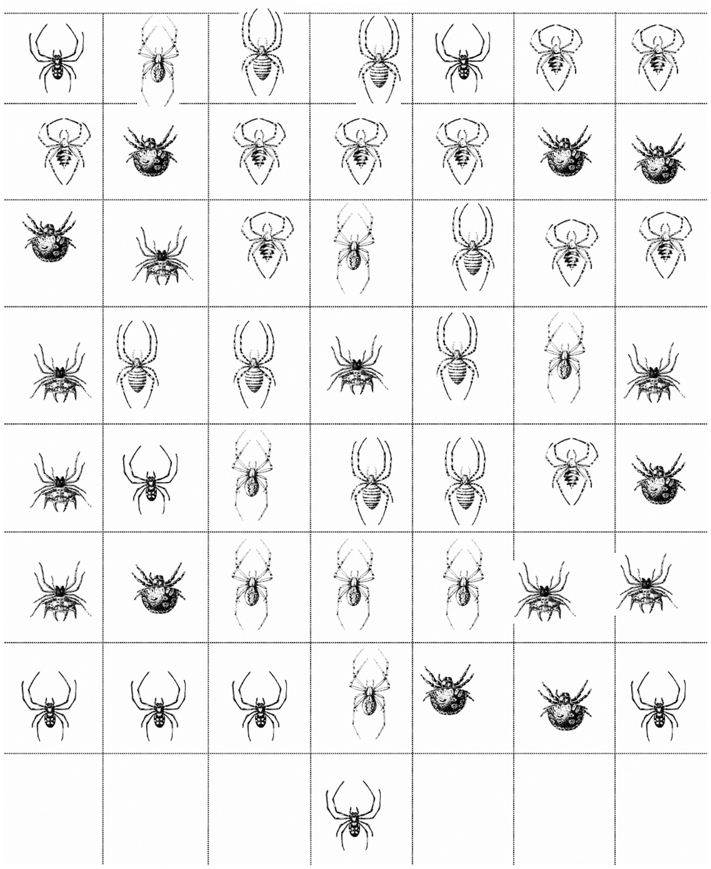



**Fig. 1.6** Specimens collected from forest patch ("site") 4.

where *c* is the number of species common to both communities and *S* is the total number of species present in the two communities. For example, if one site contains only 2 species and the other site 2 species, one of which is held in common by both sites, the total number of species present is 3 and the number shared is 1, so $1/3 = 33\%$. This index ranges from 0 (when no species are found in common between communities) to 1 (when all species are found in both communities). Calculate this index to compare each pair of sites separately, that is, compare Site 1 with Site 2, Site 1 with Site 3, . . . , Site 4 with Site 5 for a total of 10 comparisons. You might find it useful to determine the average similarity of one community to all the others, by averaging the $CC_J$ values across each comparison in which a particular site is included.

Once you have made these calculations of diversity (species richness and Simpson's Reciprocal Index) and distinctiveness ($CC_J$), you can tackle the primary question of the exercise:

- How should you rank these sites for protection and why?
- Making an informed decision requires reconciling your analysis with concepts of biological diversity as it pertains to diversity and distinctiveness.

Your decisions can be based principally on your estimates of species richness, diversity, endemicity (species found at only one site), and community similarity. However, once you have made those decisions you might also want to look at the spatial arrangement of the forest patches and compare that to the species

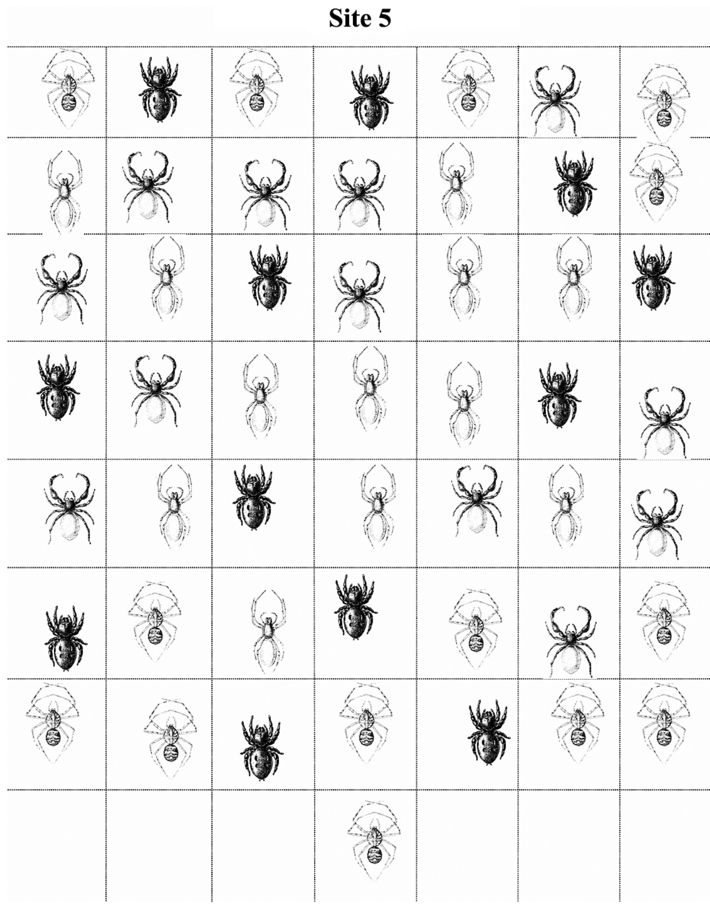



**Fig. 1.7** Specimens collected from forest patch ("site") 5.

distributions. This might help you in your interpretation of the species distributions, and might give useful additional information for ranking the sites for protection.

*Considering Evolutionary Distinctiveness*

When contrasting patterns of species diversity and community distinctiveness, we typically treat each species as equally important, yet are they? What if a species-poor area actually is quite evolutionarily distinct from others? Similarly, what if your most species-rich site is comprised of a swarm of species that have only recently diverged from one another and are quite similar to species present at another site? These questions allude to issues of biological diversity at higher taxonomic levels. Only by looking at the underlying evolutionary relationships among species can we gain this additional perspective. We have provided below a phylogeny of the spider families that occur in your collections (a genuine phylogeny for these families based in large part on Coddington & Levi, 1991). In brief, the more closely related families (and species therein) are located on more proximal branches within the phylogeny.

First, you need to match your species to the ones shown for the different families in the tree of phylogenetic relationships (Figure 1.8). Do you see any patterns of distributions across the forest patches for related species (that is, species that belong to the same family)?

Next, look for any interesting patterns of distributions of the families across the forest patches. Based on the evolutionary relationships among these families, and

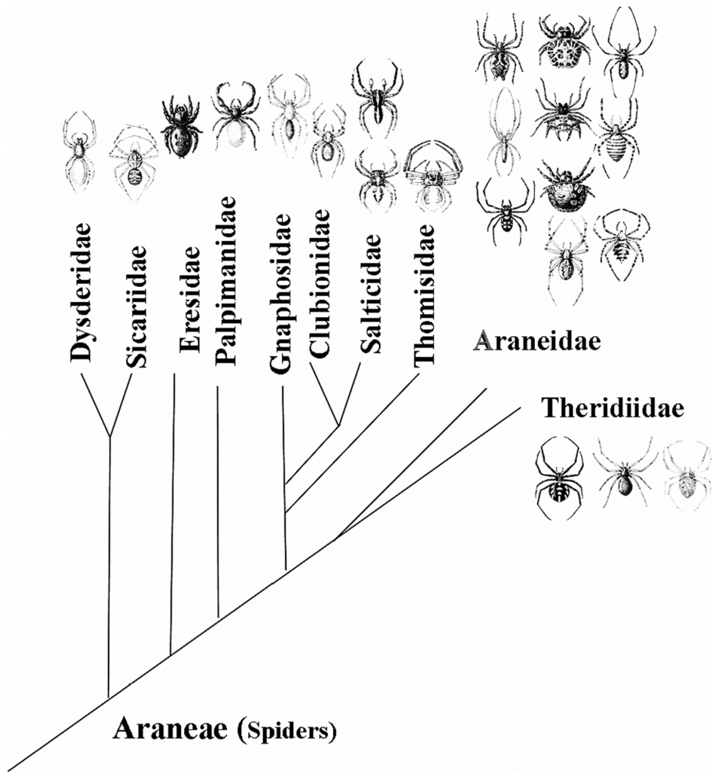



**Fig. 1.8** Phylogenetic relationships among the spider taxa encountered on sites 1–5. From Coddington & Levi 1991.

their distribution in the forest patches, do you find any additional information that might help inform your decisions on prioritizing forest patches?

## Expected Products

- A key to the species of spider identified (descriptive names and diagnostic characteristics, all ordered by family)
- A table of number of individuals tallied by species (rows) by site (columns)
- A table of the same format as the preceding one but with the proportion of total individuals at a site represented by each species at the site
- A table of the same format as the preceding one but with the proportions squared and then summed by site at the bottom of each site column. The reciprocal of the sums (the diversity measure) can then be easily calculated from these data
- A table (or matrix) of the average $CC_J$ values of each site compared to the other four sites
- A "collectors curve" for site 1 and its interpretation in terms of the adequacy of sampling to characterize spider diversity at the site
- A summary (in a format outlined by your instructor) of key findings and a description of how you will go about prioritizing the sites for protection based on the information gathered, including a consideration of the phylogenetic perspectives that may or may not change your conclusion based solely on the community composition data.
- Responses in a form indicated by your instructor to the Discussion questions below.

## Discussion

1 How would you rank the sites for protection and why?
2 Why would some conservation biologists make decisions emphasizing species endemism over species diversity?
3 Why does it matter if there are more species in one area than in another?
4 For the most part, conservation decisions as fundamental as where to put a reserve or which areas to restore should not be made on the basis of one taxon. What are the advantages and disadvantages of using an indicator taxon such as spiders as a proxy for comprehensive biodiversity surveys?
5 This exercise focuses on fully recognized species. If the site that you prioritized last for protection had a wide variety of subspecies present for each of the species it hosted, whereas on all the other islands each species was represented by a single taxon, would you change your recommendations?
6 What other site-level information would you find useful to assist the prioritization process beyond that related to species present and their evolutionary relationships?

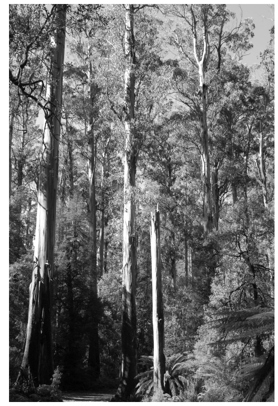
## Making It Happen

The work you have just completed is not simply an academic exercise. It used approaches very similar to those used currently all over the world to assess site-level biological diversity as a basis for making decisions about which areas to prioritize for protection. For example, investigate Conservation International's Rapid Assessment Program (RAP) website (information below) and scan through some of the trip reports. You will see many similarities to what you did here. You might find an opportunity one day to participate in such efforts. In the meantime, just look around your region — you will undoubtedly find conservation groups that need this kind of information for planning purposes. Moreover, there are likely other groups that devote a few days a month to going out in the field and observing and identifying various taxa – joining these groups is a fine way to build your skills as taxonomist. Bird watching is the most common activity, but mushroom forays, wildflower walks, and amphibian and reptile explorations also are often organized. Experienced members of these groups know that to persist they must recruit new members, and are often eager to instruct young people on the "ins" and "outs" of identifying a certain group of organisms. Because many amateur taxonomists are also avid conservationists, participating in these groups also permits one to make important contacts within the conservation community.

## Further Resources

Some useful discussions of the importance of phylogenetic analyses in biodiversity conservation are provided by Stiassny (1992), Stiassny & de Pinna (1994), and Benstead et al. (2003). For more on the issue of taxonomy and systematics in the biodiversity crisis, see Vane-Wright et al. (1991). To see real-world examples of what you just did, consult Conservation International's Rapid Assessment Program (RAP) website: www.conservation.org/xp/CIWEB/programs/rap/

# What is Conservation Biology? An Analysis of the Critical Ecosystem Partnership Fund's Strategies and Funding Priorities



*James P. Gibbs*

Attend a meeting of the Society for Conservation Biology and you are likely to meet economists and ecologists, geneticists and geographers, philosophers, foresters, and fisheries managers. People can wear many different hats and still say, "I am a conservation biologist." Conservation biology is a remarkably diverse discipline that sits squarely at the intersection of many other fields. Of course, one cannot define a discipline solely in terms of other intersecting disciplines. Conservation biology is best defined by its overarching goal, maintaining the planet's biological diversity. This focus creates a unique niche for conservation biologists, nestled within the larger arena of environmental management, applied ecology, and natural resources management. More and more people are finding a home in that niche as we become increasingly sensitive to the plight facing most of the earth's species and ecosystems.

But just what is Conservation Biology? Conservation biology is a crisis mission focused on saving life on earth. Despite this noble cause, the discipline still fails to "ring a bell" with much of the general public. One of the reasons is that conservation biology is indeed a mish-mash of many disciplines. Science in general and biology in particular play a big role in conservation biology yet the field extends into many other disciplines. These include finance, law, sociology, organization management, communications, and education; in other words, the "human dimensions" of conservation biology (Jacobson 1990, Soulé 1985). Expertise in these latter fields is what gives conservation biologists traction in the real world. It's been often said that conservation biology is as much about changing people's habits as it is about saving nature.

So what is the precise mix of disciplines? What do conservation biologists actually do? If you are preparing for a career in conservation biology, what skills should you develop? A schematic model developed by Susan Jacobson (1990) has frequently been used to depict the interacting fields that constitute conservation biology (Figure 2.1),

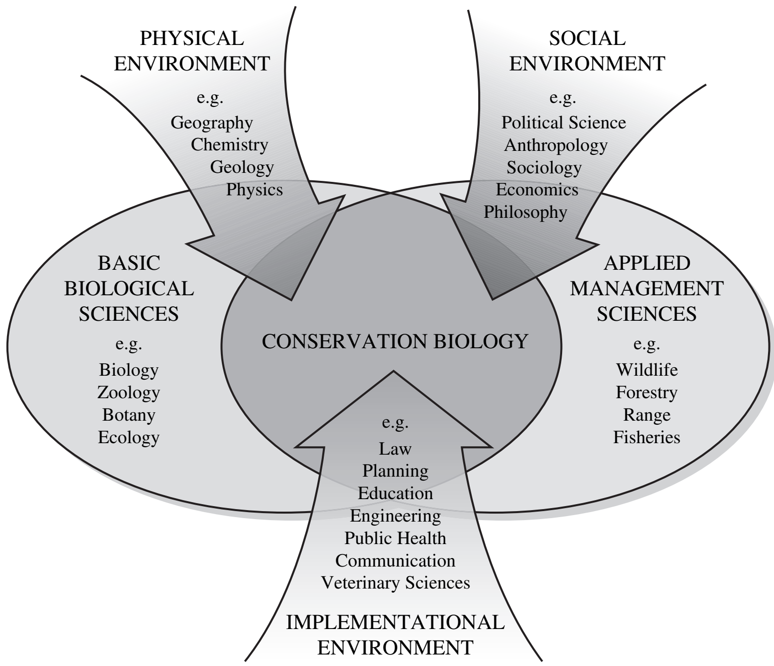



**Fig. 2.1** Schematic depicting the interaction of disciplines that together represent the field of conservation biology (redrawn after Jacobson 1990).

and gives us a starting point for analyzing just what conservation biologists do. This model indicates that students seeking a career in conservation biology need to develop an unusually broad outlook, marrying a focus on basic biological sciences and its application via the natural resources to a human-centered focus on economics, politics, law, and communication, which together represent the political arena in which all conservation efforts must operate. Conceptual models are useful but perhaps most useful is breaking down what conservation biologists are doing right now to stem the loss of biological diversity. In this exercise you will evaluate current strategies used by one of the largest and most ambitious conservation programs operating around the world. In analyzing the strategic emphases of this program, we hope to provide you with a timely view of what conservation biology is all about.

## Objectives

- To learn what conservation biologists do
- To generate an appreciation of the complexities that underlie most conservation issues
- To identify the diverse skills required for a career in conservation.

## Procedures

In this exercise we focus on the Critical Ecosystem Partnership Fund (CEPF). The CEPF advances biodiversity conservation at the global scale. Its main goal is to catalyze interactions among diverse groups working in the conservation and thereby develop a comprehensive, coordinated approach to conservation problems. Because the CEPF seeks to achieve the highest returns on conservation investments it focuses primarily on regions that are considered biodiversity "hotspots." These are the 25 or so regions that cover just 1.4 percent of the Earth's land surface yet host more than 60 percent of the planet's terrestrial species diversity. To be eligible for funds projects must be (i) within a biodiversity hotspot, (ii) within a developing country that has ratified the Convention on Biological Diversity, and (3) undertaken by applicants that represent nongovernmental organizations, community groups, or private-sector partners.

CEPF is a joint initiative of Conservation International, the Global Environment Facility, the Government of Japan, the John D. and Catherine T. MacArthur Foundation, and the World Bank, with some $125 million committed to date. Funds are administered by the non-profit conservation group Conservation International. Funds are provided in the form of grants to individual recipient organizations consistent with overall CEPF strategy. An immense amount of thought has gone into setting priorities and strategy to ensure that the many millions of dollars allocated to the effort produce tangible benefits for biodiversity and the local people associated with it. Because the CEPF represents a direct manifestation of the field of conservation biology it can be illuminating to focus on what strategies it has devised.

As a tool to organize your thinking, Jacobson's (1990) schemata shows graphically the relationship between conservation biology and other disciplines (Figure 2.1). To see how this model plays out in reality we will use it as the starting basis for an analysis of the CEPF strategies. The procedure is straightforward. We will crosswalk Jacobson's figure (and any variations of it that you can come up with) with the conservation directions and investment priorities established by the CEPF for five recognized global biodiversity hotspots: Eastern Arc Mountains and Coastal Forests of Tanzania and Kenya (Box 2.1), Cape Floristic Region (Box 2.2), Caucasus (Box 2.3), Southern Mesoamerica (Box 2.4), and the Mountains of Southwest China (Box 2.5).

**Box 2.1 CEPF strategic funding directions and investment priorities in the Eastern Arc Mountains and Coastal Forests of Tanzania and Kenya (2003–2008)**

1. Evaluate community-based forest management initiatives in the hotspot to determine best practices.
2. Promote nature-based, sustainable businesses that benefit local populations in the hotspot.
3. Explore possibilities for direct payments and easements (Conservation Concessions) for biodiversity conservation in the hotspot and support where appropriate.
4. Build the capacity of community-based organizations in the hotspot for advocacy in support of biodiversity conservation at all levels.
5. Support cultural practices that benefit biodiversity in the hotspot.
6. Research and promote eco-agricultural options for the local populations of the hotspot.

(*Continued*)

**Box 2.1 (*Continued*)**

7. Assess potential sites in the hotspot for connectivity interventions.
8. Support initiatives that maintain or restore connectivity in the hotspot.
9. Monitor and evaluate initiatives that maintain or restore connectivity in the hotspot.
10. Support best practices for restoring connectivity in ways that also benefit people.
11. Refine and implement a standardized monitoring program across the 160 eligible sites.
12. Support research in the less studied of the 160 eligible sites in the hotspot.
13. Monitor populations of Critically Endangered and Endangered Species in the hotspot.
14. Support research in the hotspot to facilitate Red List assessments and re-assessments for plants, reptiles, invertebrates and other taxa.
15. Compile and document indigenous knowledge on hotspot sites and species.
16. Support awareness programs that increase public knowledge of biodiversity values of the hotspot.
17. Support targeted efforts to increase connectivity of biologically important habitat patches.
18. Support efforts to increase biological knowledge of the sites and to conserve critically endangered species.
19. Establish a professional resource mobilization unit, within an appropriate local partner institution, for raising long-term funds and resources for the hotspot.
20. Utilize high-level corporate contacts to secure funding from the private sector for the hotspot.
21. Train local NGOs and community-based organizations in fundraising and proposal writing.

**Box 2.2 CEPF strategic funding directions and investment priorities in the Cape Floristic Region (2003–2008)**

1. Identify and design innovative mechanisms and strategies for conservation of private, corporate, or communal landholdings within biodiversity corridors.
2. Support private sector and local community participation in the development and implementation of management plans for biodiversity corridors.
3. Especially within the Gouritz and Cederberg corridors, identify priority landholdings requiring immediate conservation action.
4. Promote civil society efforts to establish and support biodiversity-based businesses among disadvantaged groups, in particular in areas surrounding the Gouritz and Baviaanskloof corridors.
5. Implement best practices within industries affecting biodiversity in the CFR, e.g. the wine and flower industries.

(*Continued*)

**Box 2.2 (*Continued*)**

6. Support civil society efforts to consolidate data to support appropriate land use and policy decisions.
7. Integrate biodiversity concerns into policy and local government procedures in priority municipalities.
8. Improve coordination among institutions involved in conservation of CFR biodiversity corridors through targeted civil society interventions.
9. Support internships and training programs to raise capacity for conservation, particularly targeting previously disadvantaged groups.
10. Support initiatives to increase technical capacity of organizations involved in CFR conservation, particularly in relation to the priority geographic areas.

**Box 2.3 CEPF strategic funding directions and investment priorities in the Caucasus (2003–2008)**

1. Promote transboundary cooperation by carrying out joint initiatives and harmonizing existing projects to conserve border ecosystems and species and site outcomes.
2. Support existing efforts to create new protected areas and wildlife corridors through planning processes and co-financing efforts.
3. Develop and implement management plans for model protected areas with broad participation of stakeholders.
4. Provide funding for research and implementation of the Caucasus Red List re-assessments, particularly for poorly represented taxas such as plants, invertebrates, reptiles, and fish.
5. Focus small grant efforts on supporting efforts to conserve 50 globally threatened species in the hotspot.
6. Provide support to conservation agencies specifically to improve implementation of international conventions such as the Convention on Biological Diversity, the Convention on International Trade in Endangered Species and the Ramsar Convention on Wetlands.
7. Evaluate and implement models for sustainable forestry, water use and range management.
8. Focus small grant efforts on supporting existing NGOs to undertake projects focused on developing alternative livelihoods, such as ecotourism, collection of non-timber forest products and sustainable hunting and fishing.
9. Support civil society efforts to mitigate, participate in, and monitor development projects.
10. Develop local capacity to train environmental journalists and develop incentives to write on environmental issues, targeting decisionmakers in particular.
11. Develop a communications campaign to increase environmental awareness.

**Box 2.4 CEPF strategic funding directions and investment priorities in Southern Mesoamerica (2003–2008)**

1. Create a coordinating group, led by the NGO community, that will guide conservation actions in the Cerro Silva-Indio Maiz-La Selva Corridor.
2. Support NGO efforts to evaluate modalities for establishing additional private conservation areas to integrate connectivity among key areas.
3. Support civil society efforts and community efforts to establish best practices in coffee, cocoa, and tourism in areas of potential connectivity.
4. Implement awareness programs focused on flagship species in order to improve public understanding of the value of biodiversity.
5. Establish an emergency fund to support projects that will help protect critically endangered species.
6. Create participatory management plans in target areas and provide opportunities for civil society to participate in government led planning processes.
7. Establish the Maquenque National Park in northern Costa Rica.
8. Support civil society efforts to establish protected areas within the Ngobe-Bugle indigenous territory.
9. Support efforts by the NGO and private sector community to provide financial incentives for private reserves and conservation set-asides.
10. Support targeted civil society efforts to implement discreet elements of existing management plans.

**Box 2.5 CEPF strategic funding directions and investment priorities in the Mountains of Southwest China (2003–2008)**

1. Define 5- and 10-year map-based conservation outcomes for the hotspot through a collaborative, participatory approach.
2. Support projects that utilize scientific tools to evaluate changes in land cover, spatial relationships, and ecosystem health.
3. Establish a mechanism to monitor and evaluate the effectiveness of the site-specific projects and ensure adaptive management and sharing of lessons learned.
4. Provide resources to track human-induced environmental trends and high-resolution monitoring to report on site-specific impacts.
5. Conduct scientific research and socioeconomic analysis to better understand biodiversity and conservation issues and threats in the region.
6. Improve the credibility and scientific methodology used for biodiversity conservation research in this hotspot.
7. Enact effective nature reserve and community resource management.
8. Develop ecotourism and environmental education as a tool to support biodiversity conservation.
9. Undertake ecosystem restoration, especially filling in the gaps in existing governmental programs.
10. Projects to reduce illegal and other unsustainable wild animals and plants trade.

(*Continued*)