Chapter 8
An Experiment in Managing the Human Animal: The PHVA Process and Its Role in Conservation Decision-Making

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1. Introduction

An alarming proportion of the world's catalog of biological diversity appears to be in decline (Wilson, 1992; Purvis and Hector, 2000), and the steady losses of species may have serious or even catastrophic impacts on the stability and functioning of ecosystems (Tilman and Downing, 1994; McGrady-Steed *et al*., 1997; Naeem and Li, 1997; McCann, 2000). Consequently, many of the services and benefits that humans derive from the natural world may be dangerously diminished (Chapin *et al*., 2000; Tilman, 2000). The primary causes of the decline of nearly all endangered species can be directly related to the activities of human populations, both urban and rural (Caughley, 1994): wildlife populations are over-harvested; landscapes are polluted with the infusion of toxins into the air, water, and soil through industrial activity; exotic competitors, predators, parasites, and diseases are introduced into naïve communities that lack the proper defenses to combat these new invaders; wild habitat is converted to agricultural land; and recent evidence suggests that local and now even global climates are substantially modified by the actions of humans (e.g., Walthier *et al*., 2002). Sadly, we have likely reached a point in time for much our world's biodiversity where these agents of decline will be difficult to reverse. Even if the original forces are relaxed, a remnant isolated wildlife population becomes vulnerable to other forces, intrinsic to the dynamics of small populations, which may drive the population to extinction despite our best attempts at scientifically based species and habitat management (Shaffer, 1981; Soulé, 1987).

It should be clear, then, that the responsibility for this global biodiversity crisis should be shared by all humanity. Stated another way, achieving meaningful and practical solutions to the problem should not be perceived as solely within the domain of the traditional biological sciences. In practical terms, implementing any strategy for biodiversity conservation demands an integration of both biological science and social science, expert and local knowledge, and even economic and conservation imperatives. This desperately needed synergy has been extremely difficult to achieve, but progress is being made.

This chapter describes a workshop process developed by the IUCN's Conservation Breeding Specialist Group (CBSG) that has been remarkably successful in leading the way towards this integration—the Population and Habitat Viability Assessment, or PHVA. Following a general discussion of the process and its key elements, we describe the PHVA workshop conducted for the mountain gorilla in Kampala, Uganda, in December 1997 and explain how this workshop represented a true landmark in our group's way of thinking about organizing and conducting these interactive and dynamic collaborative processes.

2. A Brief History of the PHVA Workshop

One of the cornerstones of applied conservation biology is the technique of population viability analysis, or PVA. PVA is a tool used to estimate the probabilities of wildlife population decline or extinction by analyses that integrate basic demographic and ecological data for a given species with identifiable threats to population survival. This integration is typically achieved through the use of computer simulation models that project the fate of a given population under a defined set of biological and environmental conditions (Burgman *et al*., 1993; Beissinger and McCullough, 2002; Miller and Lacy, 2003a). Simulation models are very adept at incorporating a large number of processes that can threaten the persistence of wildlife populations and, even more importantly, the interactions that can arise between them (e.g., inbreeding depression and resistance to disease). Since the first formal PVA on grizzly bears in western North America was completed in the late 1970s, a dizzying number of papers demonstrating the use of this tool—on everything from Minnesota moonworts to Wyoming toads to Sumatran tigers—have been published in conservation biology and ecology journals around the world (see Miller and Lacy, 2003b). To use the words of Michael Soulé, PVA has become conservation biology's "flagship industry."

Despite the general acceptance of PVA as a tool to assist conservation planning, this purely analytical process suffers from some fundamental flaws in its design. In short, most population viability analyses are conducted by mathematical ecologists and are typically intended to be read by other mathematical ecologists. The analyses focus very tightly on the biological issues surrounding population endangerment and recovery, with little to no recognition of the human social context within which the population became

endangered in the first place. Sophisticated models are constructed, output data are often subjected to rigorous statistical tests, and (sometimes) recommendations for optimal biological management of the population are made to the relevant authorities. However, in a traditional PVA, those human groups responsible for both the causes of endangerment and implementation of the optimal management scenarios are almost never involved in the collection and/or synthesis of biological data or the development of meaningful and achievable management strategies that stem from the analyses. This disconnect between the practitioners of PVA and those who are most acutely impacted by its results often leads to a considerable degree of apathy or even mistrust among the latter domain toward the PVA process. If certain stakeholder domains are to be held responsible for a species' decline toward extinction, then those same stakeholders must be involved in the analysis of relevant biological and social information and the generation of solutions that all parties can live with. To date, PVA has not achieved this level of integration, now often referred to as "transdisciplinarity" (Westley, 2003).

In order to bridge this daunting gap, the late Ulysses Seal, Chairman of the IUCN's Conservation Breeding Specialist Group (CBSG), developed in the late 1980s a workshop process that quickly came to be known as a Population and Habitat Viability Assessment, or PHVA. The PHVA workshop is a highly participatory and dynamic species risk assessment process involving participation by all interested parties showing a stake in the development of management plans for the species or population in question. The workshop balances integrating the biological information required to evaluate the probability of species persistence with integrating, or at least connecting, the individuals from different disciplines and sectors who are centrally concerned with the conservation of the species. The objective is to create a realignment of priorities among individual stakeholder groups to take into account the needs, views, and initiatives of other groups. In this way, the PHVA workshop represents a broadening of the traditional PVA methodology to incorporate as much information as possible on the focal species, its habitat, and the ways in which local human populations impact this focal species and its surroundings (Miller and Lacy, 2003a).

Central to this workshop process is the use of a PVA simulation modeling approach. Our most common software of choice is VORTEX, a package written by Bob Lacy of the Chicago Zoological Society and JP Pollak of Cornell University (Miller and Lacy, 2003b). VORTEX serves as an exceptionally valuable tool to help stimulate discussion around population data collection and the assumptions built into that process, to integrate diverse biological and even social science-based data sets, and to evaluate—without judgment or bias—a set of proposed management alternatives. In this way, the software unites PHVA workshop participants in a common activity, leading to a greater degree of buy-in to the process among participating stakeholders and, consequently, a greater likelihood for positive action following the meeting.

VORTEX effectively simulates the "extinction vortex" of Gilpin and Soulé (1986), in which random events affecting external environmental conditions

(e.g., weather, predator/competitor densities) or internal species biological processes (e.g., birth and death rates, offspring sex ratios) can dramatically influence the stability of small, isolated wildlife populations. The population simulation—consisting of mate selection, reproduction, mortality, increment of age by one time step (usually a year), dispersal among subpopulations, removal (harvest) of individuals, supplementation, and population limitation due to finite habitat availability (ecological "carrying capacity") as appropriate to the situation of interest—is repeated many times to generate the distribution of fates that the population might experience. The software is described in detail in Lacy (2000) and Miller and Lacy (2003b) and is available at http://www.cbsg.org.

PHVAs, however, are more than VORTEX-based scientific analysis—more than just a PVA. Over the past decade, considerable thought and experimentation has gone into the process design component of PHVA workshops: the design of the flow of human and task interactions that makes such interdisciplinary collaboration possible. As developed by CBSG, PHVA workshops are highly participatory processes, deliberately designed to combine optimal sophistication with optimal deliberation. Workshops are always conducted in the species' range country, at the direct invitation of the local wildlife management authority. The overall design allows for groups of 20 to 60 people to explore the implication of population dynamics, genetics, and a variety of threats to habitat and species persistence. Many of these people are wildlife management and academic professionals, but a considerable proportion of the total body of workshop participants lie far outside this sector of employment: social scientists, local and national government figures, and even private landowners are part of a typical mix of PHVA workshop attendees. For example, more than 60 people attended a PHVA workshop on the Houston toad (*Bufo houstonensis*) in Texas (USA) in 1994, but less than 20 of these people were biologists with expertise in the species or its conservation; the remainder included cattle ranchers, city mayors, real estate executives, and other concerned citizens (Seal, 1994). This seemingly chaotic mix of expertise and scientific experience was vitally important to the success of the workshop, since more than 95% of land in the state of Texas is privately owned. Management of this highly endangered species requires the direct participation of citizens across a wide range of sectors, so organization and implementation of the PHVA workshop must recognize this.

Participants work in small groups to identify and analyze risks and, ideally, to provide specific measures of such processes as habitat destruction and fragmentation or, if applicable, direct exploitation of the focal species. From the perspective of workshop design and facilitation, a PHVA workshop must provide encouragement for open and divergent expression of ideas as well as the tools necessary for convergence of these ideas and views in the interest of generating achievable action (Figure 8.1). The divergence phase allows for inclusion of a full range of data, views, and stakeholder needs, while the convergence phase allows for precision of analysis, risk assessment, and focused recommendations. Periods of small group work alternate with plenary

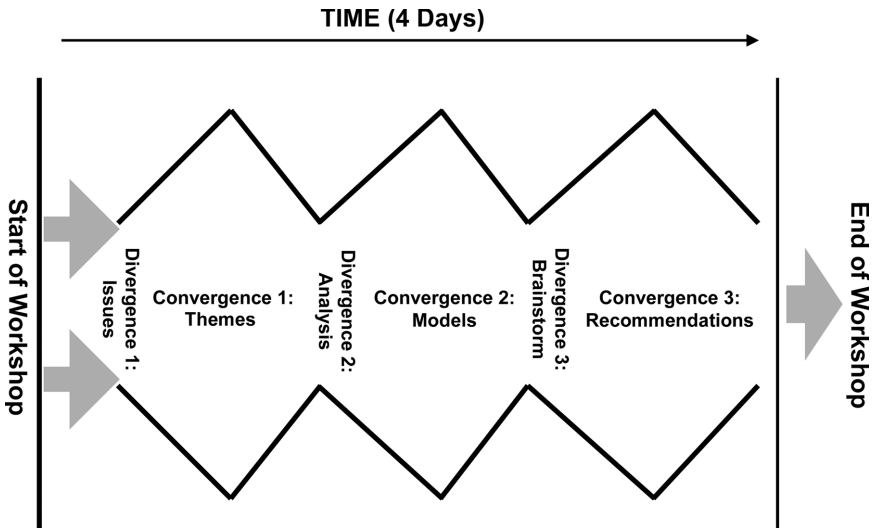

FIGURE 8.1. **Diagrammatic representation of the flow of small-group work in a typical PHVA workshop**. Adapted from Byers *et al*. (2003).

presentations, which allows all groups to comment on each other's analysis and recommendations. As more data are introduced and the complexity is increased, some level of acceptable consensus on recommended actions becomes more difficult to achieve. Some of the tools required to build consensus are the VORTEX model and the continual emphasis on prioritization and ultimately translation of analysis into specific plans to be implemented.

CBSG has conducted more than 100 PHVA workshops in nearly 50 countries, and the process has been recognized as an extremely effective vehicle for achieving meaningful decision-making for endangered species conservation (e.g., Conway, 1995; Westley and Miller, 2003). Even with this level of success, we continue to work to improve the process. Critical to this evolution has been the creation of a diverse group of experts devoted to the practical application of E.O. Wilson's concept of "consilience": the unity of knowledge between social and natural sciences as a means of addressing global environmental concerns (Wilson, 1998).

3. Expanding the PHVA Process: The Biodiversity Research Network

With funding from the Social Science and Humanities Research Council of Canada, a research network was formed in early 1997 to build interdisciplinary connections and facilitate exchange of information between specialists directly or indirectly involved with natural resource management. The work

of this Biodiversity Research Network has focused on two primary avenues of research (Westley, 2003):

- *Expanding stakeholder inclusion and integrating expertise*—Can we find more effective ways to link social scientists with expertise in such fields as industrial geography, agricultural economics, human demography, and political science with conservation biologists? We must develop a better understanding of the dynamics of the human social system that, in part, defines species endangerment in order to engage those people with the proper expertise and bring them into conservation planning workshops like PHVAs more frequently.
- *Integrating tools for better risk assessment*—Many of the disciplines listed above have their own quantitative tools for data analysis and scenario evaluation. We postulate that output from these tools can be used as critical variables in tools like VORTEX to assess endangered population extinction risk. The task is to develop the appropriate interface to facilitate two or more models to successfully "talk" with one another so that a richer risk assessment can emerge (Figure 8.2).

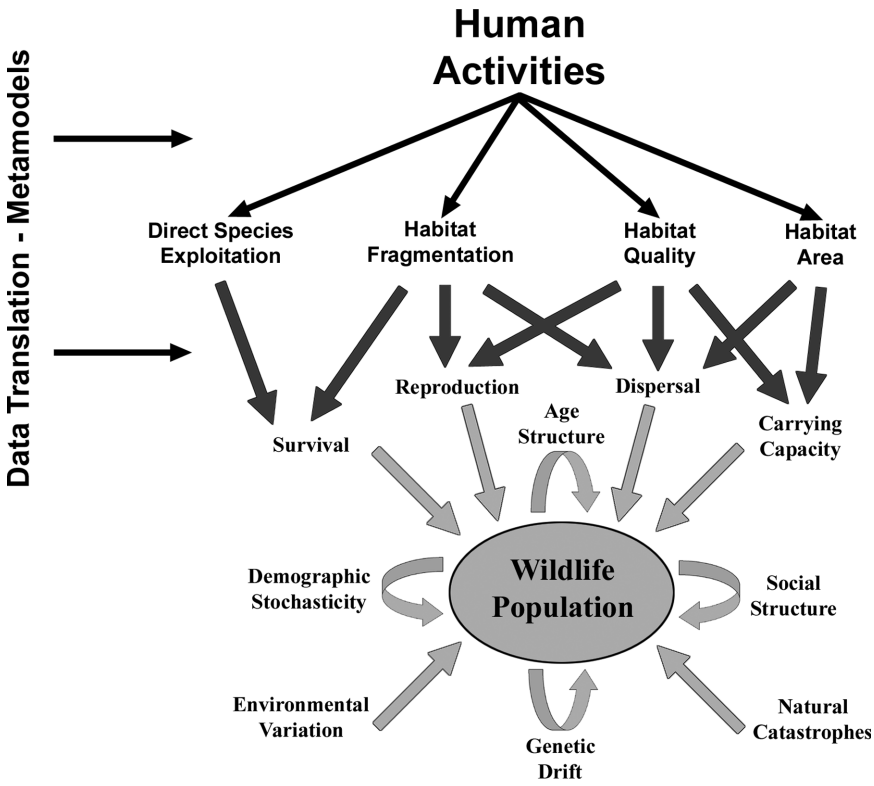

FIGURE 8.2. **Major factors influencing the viability of threatened wildlife populations that need to be addressed in the development and application of expanded PVA models as envisioned by the Biodiversity Research Network**. Adapted from Miller and Lacy (2003a).

Network members gathered at least twice each year in order to share expertise and to devise experiments around new and innovative approaches for expanding the traditional PHVA approach to stakeholder inclusion and analysis of diverse data sets. This type of transdisciplinary network is not always easy to manage: one of the first hurdles Network members faced was to develop a working understanding of the basic concepts underlying the represented disciplines: conservation biology, wildlife management, population genetics, interorganizational collaboration, human demography, political science, and business. Once it became a functional research unit, the Network quickly began to apply their diverse knowledge to the task of stretching the PHVA process beyond its traditional limits. Members immediately recognized that as the diversity of stakeholders invited to a PHVA is widened, the degree of divergence of ideas and viewpoints is likewise expanded and the task of subsequent convergence to action is made much more complicated. This was to be a major issue in the design and conduct of a revised workshop process.

Once the Network was confident in its conceptual foundation and had designed a revised PHVA workshop process to their satisfaction, it was time to "field test" the concept. In mid-1997, Network members defined the ideal characteristics of a workshop situation in which we could conduct this test: a diversity of available human demographic scenarios (defined primarily in terms of household-based fertility); dependency of local villages on local natural resources; and a well-defined distribution of the focal wildlife species. A workshop already scheduled for December 1997 appeared to be ideally suited for the Network's first case study: a Population and Habitat Viability Assessment for the mountain gorillas of eastern Africa.

4. The Mountain Gorilla PHVA Workshop

The Conservation Breeding Specialist Group, in collaboration with the IUCN Primate Specialist Group, was invited by the Director of the Uganda Wildlife Authority, the Office Rwandais de Tourisme et Parcs Nationaux, and the Institut Congolais pour la Conservation de la Nature to conduct a PHVA workshop for the mountain gorilla in December 1997 in Kampala, Uganda. Gorilla biologists saw considerable cause for optimism for the species' future based on the increase in the number of mountain gorillas over the previous two decades. However, the civil unrest and subsequent armed conflict in Rwanda and the Democratic Republic of Congo produced massive numbers of refugees seeking safety in protected areas such as the Parc des Volcans and Parc des Virunga regions. The potentially rapid rate of habitat destruction in the National Parks resulting from this crisis situation could result in a decline in mountain gorilla population size and a long-term reduction in the viability of the taxon. Local and international management agencies recognized the need for a systematic evaluation of species viability and the development of a regional management plan incorporating the needs of all relevant

governmental and nongovernmental agencies as well as public and private stakeholders.

The Biodiversity Research Network saw this PHVA workshop as a critical opportunity to test three hypotheses that formed the foundation of their study (Byers *et al.*, 2003):

- Increased stakeholder participation would result in a richer result and a greater sense of ownership of both process and product;
- Incorporation of local human demographic data into the VORTEX-based modeling process would lead to a more informative picture of mountain gorilla population viability and, consequently, a more effective set of population management recommendations; and
- A firm institutional context including political stability, general social well-being, and the presence of effective government policy could influence the success of conservation initiatives.

In advance of the workshop, Network members collected information on the social, political, and demographic circumstances in the area surrounding the two mountain gorilla populations (Bwindi Impenetrable National Park and the Virunga Volcanoes region). For example, we obtained several articles on the ecological impact of refugee activities and the role of various non-governmental organizations and other agencies in reducing that impact (Biswas and Tortajada-Quiroz, 1996; Pearce, 1996; UNHCR, 1996). A major challenge for the Network experiment was then to determine the best way in which these data could be successfully translated into input data for VORTEX through avenues such as reduction in habitat availability (carrying capacity) or indirect mortality. Additionally, Network members constructed a series of slide presentations designed to assist workshop participants understand the need to see species extinction risk in the context of definable and—more importantly from the standpoint of PVA—quantifiable consequences of human population growth.

Approximately 80 people, including biologists, researchers, governmental representatives and wildlife park managers, were in attendance on the workshop's first day, December 8, 1997. Although some individuals were unable to participate in the entire five-day event, the majority of these experts were committed to the intense discussions that became the defining element of the workshop. Twenty-six participants were from the three range states, and nearly 50 people had extensive expertise in working in these countries. Workshop sponsorship was generously provided by the Columbus Zoo (USA), International Gorilla Conservation Program, Dian Fossey Gorilla Funds Europe and International, Wildlife Conservation Society, Durrell Wildlife Conservation Trust, and Abercrombie and Kent. This diverse set of sponsors, including both *in situ* and *ex situ* conservation organizations, is a defining theme in PHVA workshop financial support.

The PHVA workshop began with overview presentations from mountain gorilla experts on the species' biology and past and present conservation

activities, and from CBSG / Network members on general workshop process. In addition, two Network members gave detailed presentations on the intent of the expanded workshop "experiment" and the enhanced simulation modeling process with a focus on discussion of human demographic data from Uganda. Following this, and as a technique for surfacing issues around which the remainder of the workshop would proceed, the workshop facilitator led the participants through a problem-generation brainstorming exercise. More than 130 statements were recorded on flip charts and thereafter lumped into six categories: population biology and simulation modeling, local human population issues, park and protected area ecology and management, veterinary and health issues, revenue and economics, and political governance. These topics became the titles of six working groups that would stay together for the remainder of the workshop. Each working group was asked to examine their issues in the context of research, education and communication, building of local conservation capacity, and interorganizational collaboration.

As the workshop's first day drew to a close, we Network members readily saw that a major element of our experiment—increased diversity of stakeholder participation—was unsatisfactory. Despite discussions with local and international workshop organizers about the need to broaden the scope of participation, there was a glaring paucity of social science expertise in the room. We knew from the beginning, however, that this was not the fault of the organizers; the difficulty lay in our own ability to adequately explain to them and to other potential participants the vital role that experts outside the realm of traditional biological sciences can play in endangered species risk assessment. We quickly understood that, in order to secure their support and participation, we needed to more effectively speak their professional language and, more importantly, promote their own interests as stakeholders in the larger picture. Unfortunately, our failure to properly secure this broader participation suggested that some potentially critical human population information would not be available for analysis. Nevertheless, we had the world's experts on mountain gorilla conservation biology together for five days and we were very excited about the prospects for a successful workshop outcome.

Data for the PVA component of the workshop was based on nearly three decades of field data collected by a variety of researchers at the Karisoke Research Center and by those studying habituated groups visited by tourists (summarized in Gerald-Steklis, 1995; Steklis and Steklis, Chapter 6, this volume). This vast dataset allowed the modeling group to develop excellent estimates of long-term average demographic rates and, more importantly, the levels of annual variation in these parameters due to both demographic and environmental stochasticity (see Miller and Lacy, 2003b). The working group on local human population issues was tasked during the PHVA with providing the human demographic and land-use information to the simulation modeling group for incorporation into an expanded VORTEX-based PVA model for each of the two mountain gorilla populations. Despite a number of complexities revolving around working group dynamics, data availability, and working

group structure (see Byers *et al*., 2003 for a more detailed discussion), the participants made important progress in collecting and synthesizing a data set on the projected impacts of severe human civil unrest and war on mountain gorilla populations and their habitat. Specifically, in close collaboration with the population biology and simulation modeling working group, they proposed detailed scenarios in which a major event such as the Rwandan genocide of 1994 would occur on average every 30 years and have an average duration of 10 years. During the event, fewer adult females would produce offspring and mortality rates among adults and infants would increase (Figure 8.3). In addition, selected scenarios were extended to include a gradual and cumulative decrease in ecological carrying capacity of mountain gorilla habitat through the direct destruction of the habitat as well as indirectly through the encroachment of refugees and combatants into this habitat. These assumptions were based in part on direct observations of population demographic processes

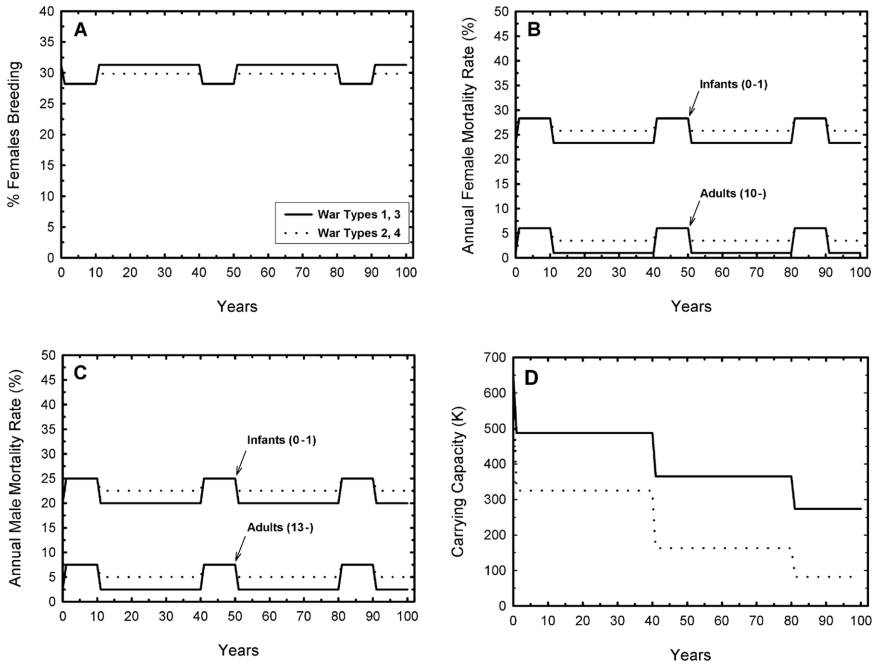

FIGURE 8.3. **Simulated impacts of a war scenario in the Virunga Volcanoes region on local mountain gorilla population demographics and habitat ecology**. Specific variables affected are (*A*) proportion of adult females breeding in a given year; (*B*) annual female mortality rate; (*C*) annual male mortality rate; and (*D*) habitat carrying capacity. War types 1 and 2 show full and partial return to normal demographic rates, respectively, in the time intervals between major civil unrest, while types 3 and 4 add either moderate or severe cumulative reductions in ecological carrying capacity on a schedule identical to the changes in population demographics. Adapted from Werikhe *et al*. (1998).

before and during the 1994 event, and also in part on expert judgment of the workshop participants. Unfortunately, the data needed to precisely quantify the demographic effects of major civil unrest on local mountain gorilla populations simply do not exist. Consequently, our computer simulations of gorilla population viability did not reach the level of sophistication to which Network members originally aspired. Despite this limitation, this is one of the first attempts to our knowledge at directly quantifying the anticipated population-level impacts of specific human activities on wildlife populations in the context of PVA. While some PVA "purists" may see this level of speculation as unproductive or perhaps even counterproductive, we feel strongly that ignoring such important human processes for the sake of scientific precision is even more unpalatable.

Our modeling efforts demonstrated the significant demographic impacts that periodic war could have on mountain gorilla populations (Figure 8.4).

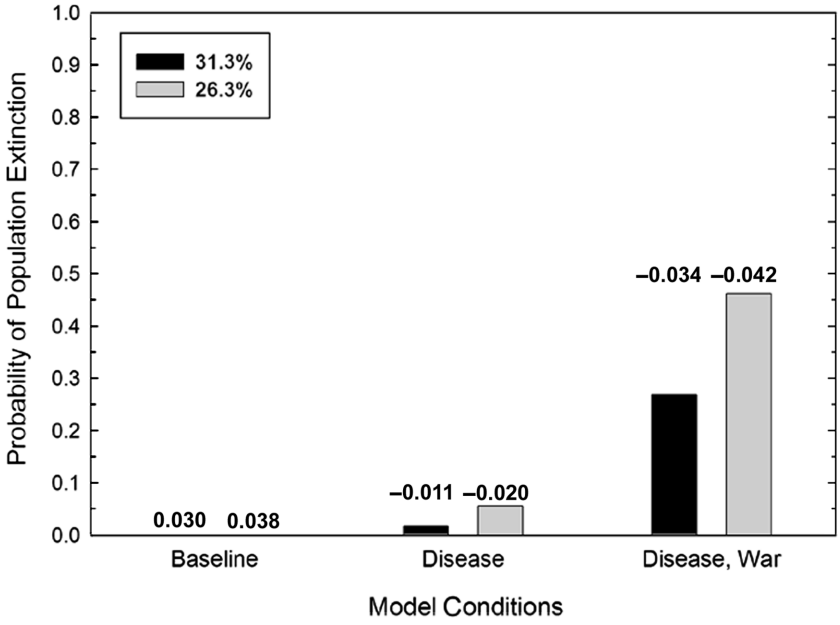

FIGURE 8.4. **Extinction risk estimates for simulated mountain gorilla populations derived from VORTEX analyses conducted at the PHVA workshop**. The baseline model incorporates the full set of demographic data collected over nearly three decades, while additional models include demographic impacts of possible disease epidemics and periodic civil unrest among the local human populations surrounding mountain gorilla habitat. Each pair of models shows projections for alternative levels of 31.3% or 26.3% adult female breeding success as part of a larger demographic sensitivity analysis conducted during the workshop. Numbers above each bar show the stochastic population growth rate calculated directly from the simulation. Adapted from Werikhe *et al.* (1998).

In addition to the inclusion of war in our models, we were able to work very closely with a group of gorilla veterinarians and health experts on the identification of a set of current and potential future disease threats and incorporate this potential for catastrophic outbreaks as simulation model elements. Under the combined effects of disease and severe human conflict, mountain gorilla populations in the Virunga Volcanoes region could face a major threat to their survival. It is important to note that while the extinction risk may not appear to be particularly high, especially in the disease scenarios, the negative population growth rates identified in Figure 8.4 indicate the simulated Virunga population is in decline and extinction risk will increase dramatically over a longer time period. Even though these sobering results may seem for some to be little more than plainly intuitive and, therefore, of little interest or value, an explicit and graphical depiction of the sometimes dramatic ways in which humans and wildlife interact on the landscape helps us to understand the nature of these relationships much more clearly and facilitates the successful communication of this understanding to decision makers. In this case, the enhanced PVA analysis and expanded PHVA workshop process helped stimulate new efforts among national and international conservation agencies to more carefully assess the impacts of the recent conflicts on local gorilla populations and their habitat.

As was discussed earlier in this chapter, a PHVA workshop is defined by a series of parallel discussions on many different topics that may or may not directly feed into a VORTEX–based PVA analysis. Lively discussions filled the full five days of the workshop on issues of gorilla management, research, institutional governance, revenue generation schemes, and regional and institutional collaboration. Based on the results of both the extended PVA modeling of war's impacts and the detailed discussions that define our expanded PHVA workshop process, a set of important workshop recommendations were created that included the following (for a full listing, see Werikhe *et al.*, 1998):

- Work should be conducted with humanitarian agencies to ensure that their emergency plans fully address environmental conservation concerns. In addition, conservation agencies must prepare their own emergency plans that address identified critical interactions of humans with gorillas and their habitat.
- When human-gorilla population conflicts are slight or absent, it is important to recognize the potential for resilient growth of mountain gorilla populations. However, our PVA efforts clearly indicate that human population pressures resulting in severe loss of gorilla habitat and a reduction in gorilla survival require an even greater appreciation of the acute risks facing gorillas in order to minimize the risk of population or even subspecies extinction.
- Based on explicit disease risk assessments conducted at the PHVA, the existence of effective and sustainable national veterinary units, responsible for implementation of gorilla veterinary services, is critical to the conservation of the mountain gorilla (MGVP/WCS, Chapter 2, this volume).

- Lead conservation agencies must encourage range country ministers to meet and discuss legal issues relevant to mountain gorilla conservation.
- All relevant stakeholders should meet to discuss and develop appropriate revenue sources and revenue sourcing mechanisms based on an extensive list of alternatives developed at the workshop.
- Standardized park ranger–based monitoring should be developed and implemented throughout the Virunga Volcanoes and Bwindi regions to ensure more effective ecological data collection and analysis procedures (Lanjouw, Chapter 13, this volume).

Mountain gorilla conservation has been largely dominated by the work of international conservation nongovernmental organizations. A primary focus of the PHVA workshop was to develop improvements in the ways these organizations could more effectively collaborate. Following the completion of the workshop, the Mountain Gorilla Foundation (MOGOF) was formed in an attempt to bring together top management representatives annually to develop new cooperative mechanisms for implementing the many and varied action steps outlined in the workshop report. Considered by some to be the most significant outcome of the workshop, MOGOF had its first meeting in January 1999 in Rwanda. In addition, biological research priorities are being prioritized based on the recommendations produced at this workshop, tourist activities have been restructured so that guides adhere to the specified maximum number of visitors and that visitors maintain a required minimum distance from the animals, and broader ranger-based monitoring programs were implemented. All in all, the PHVA workshop had the desired outcome: to stimulate new ways of thinking about the difficult conservation problems facing the mountain gorilla in eastern Africa, and to spur people to action from different countries and different fields of expertise.

5. The Future of the Expanded PHVA Process

Members of the Biodiversity Research Network traveled to Uganda with the intent of conducting a species conservation workshop that builds upon the already respected PHVA process and pushes it further outside of the "box." While being rather pleased with the success of the workshop as a whole, we also realized that our Network experiment's first field test left ample room for improvement. As an example, we came to develop an even greater appreciation of the difficulties involved in integrating different quantitative datasets for use in a PVA. Achieving a successful synthesis requires careful and lengthy preparation in advance of the workshop. Additionally, we must put the same kinds of effort into generating a broader base of stakeholders among the pool of workshop invitees. This often involves extending our own network of contacts to local organizations with the required stakeholder-based expertise. For example, names of appropriate social scientists and

academic researchers could perhaps be obtained through the IUCN's local Social Policy Program offices. Finally, we also learned extremely valuable lessons in Kampala about the complexities of designing and facilitating these kinds of diverse transdisciplinary processes. For example, we found that our own particular interests in implementing our experimental workshop designs may not be shared by other participants. If not handled very carefully, this can lead to rapid disaffection among skilled experts and their subsequent withdrawal from the discussions.

Learning these lessons proved invaluable in later implementations of similar field tests in PHVA workshops in Brazil, Papua New Guinea, and Canada (Westley and Miller, 2003). Knowledge gained from this experiment has since been applied in such diverse regions as Indonesia, Mexico, Bangladesh, and Colombia. For this reason, the mountain gorilla PHVA holds a very special place in the minds of those of us in the Network who strive to bring Wilson's notion of consilience to a more tangible reality.

Our Biodiversity Research Network continues to work toward achieving this goal. Specifically, our experiences have convinced us of the need to increase our understanding of both process and content in the field of biocomplexity. Without an appreciation of the mechanisms by which models—and modelers—can effectively communicate, how we can work across diverse disciplines, and how we can engage a wide range of stakeholder domains in complex discussions, we cannot adequately assist natural resource managers and decision makers dealing with difficult environmental problems. Toward this end, we are researching methods by which individual models can be physically linked together into "open-data metamodels" that are capable of passing data back and forth in a common data structure. Additionally, we are adapting techniques of scenario development and testing (Ringland, 1998; Gallopin, 2002) to our own workshop process as a mechanism to allow PHVA participants to use their judgment of likelihoods and their inherent sense of system structure to make predictions of particular events, which can then be translated into inputs to PVA tools like VORTEX. Through research like this, we hope to build upon the solid foundation provided to us by the late Chairman of CBSG, Ulysses Seal, in his persistent drive to get people talking and solving problems. Only by probing the ways we humans analyze and share knowledge will we be able to properly utilize the wisdom of those dedicated to preserving our wild species and spaces.

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