Population and Habitat Viability Assessment (PHVA)
Workshop Process Reference Packet

September 2010

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About CBSG

The Conservation Breeding Specialist Group (CBSG) (www.cbsg.org) is a global volunteer network of over 500 conservation professionals, coordinated by a headquarters staff of six and assisted by nine Regional and National Networks on six continents. This network is dedicated to saving threatened species by increasing the effectiveness of conservation efforts worldwide. CBSG is recognized and respected for its use of innovative, scientifically sound, collaborative processes that bring together people with diverse perspectives and knowledge to catalyze positive conservation change. CBSG is a part of the Species Survival Commission (SSC) of the International Union for Conservation of Nature (IUCN), and is supported by a non-profit organization incorporated under the name Global Conservation Network.

Since its inception in 1979, CBSG has assisted in the development of conservation plans involving over 190 species through more than 340 workshops held in 67 countries. CBSG has collaborated with more than 180 zoos and aquariums, 150 conservation non-governmental organizations (NGOs), 60 universities, 45 government agencies, and 30 corporations. By applying unique conservation tools, and training others in their use, CBSG contributes to the long-term sustainability of endangered species and ecosystems around the globe.

Our Approach to Conservation

CBSG promotes effective and comprehensive conservation action by emphasizing the exchange of information across diverse groups to reach agreement on the important challenges facing humans and wildlife. Our interactive, participatory workshops provide an objective environment, expert knowledge, and thoughtful group facilitation designed to systematically analyze problems and develop focused solutions using sound scientific principles. This process enables workshop participants to produce meaningful and practical management recommendations that generate political and social support for conservation action at all levels – from local communities to national political authorities. Rapid dissemination of these recommendations allows them to be used almost immediately to influence stakeholders and decision-makers, and maintains the momentum generated at the workshop.

CBSG Regional Networks

Regional Networks take CBSG tools and principles deep into the local institutions of a region or country, allowing stakeholders to work with our basic conservation techniques and adapt them to meet their own needs. This level of freedom to shape a Network according to the needs of the culture, society, and services of the individual country or region is a requirement for success. Regional and National Networks of CBSG are not just desirable but necessary due to the sheer magnitude of the problem of biodiversity loss on this planet, as

IUCN

The International Union for Conservation of Nature (IUCN) (www.iucn.org) brings together states, government agencies, and a diverse range of nongovernmental organizations in a unique world partnership that seeks to influence, encourage and assist societies throughout the world in conserving the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable.

SSC

The Species Survival Commission (www.iucn.org/about/work/programmes/species) is the largest of IUCN's six volunteer Commissions, with a global membership of 8,000 experts. SSC advises IUCN and its members on the wide range of technical and scientific aspects of species conservation and is dedicated to securing a future for biodiversity.

well as to address the diversity in environment, culture, economic conditions, governance, and philosophies encountered in different countries and regions.

Species Conservation Planning: Our Philosophical Approach

Traditional approaches to endangered species conservation planning have tended to emphasize our lack of information and the need for additional research. This has been coupled with a hesitancy to make explicit risk assessments of species status, and a reluctance to specify immediate or non-traditional management recommendations. The result has been long delays in preparing action plans, loss of momentum, and dependency on crisis-driven actions or broad recommendations that do not provide useful guidance to management authorities. Furthermore, there is a lack of generally accepted tools to evaluate the interaction of biological, physical, and social factors affecting the population dynamics of threatened species and populations. Consequently, we recognize an urgent need for tools and processes to characterize such things as: the risk of species and habitat extinction; the possible impacts of future events on populations; the predicted effects of management interventions on future population stability; and how to develop and sustain learning-based cross-institutional management programs.

Effective conservation action is best built upon a synthesis of available biological information, but is dependent on actions of humans living within the range of the threatened species, as well as established national and international interests. In this context, we also observe deficiencies in conservation planning methods when we view the system through the lens of sociological dynamics. Local management agencies, external consultants, or local experts will often identify endangered species management actions that have a heavy emphasis on traditional principles of wildlife biology and ecology. However, these isolated and narrow professional approaches seem to have little effect on the political and social changes required for effective collaborative management of threatened species and their habitat. This focused, disciplinary approach is a natural consequence of our specialist academic training, but usually fails to produce truly integrated solutions that will appeal to a broad domain of stakeholders and – more importantly – achieve more effective conservation of biodiversity.

Recognizing these complex issues and needs related to endangered species conservation planning, CBSG has nearly 20 years of experience in developing, testing and applying a series of scientifically based tools and processes to facilitate and improve risk characterization and species management decision-making. These tools are rooted in the more traditional conservation scientific disciplines of population biology, genetics, and ecology, but are also explicitly linked to methods based in the dynamics of social learning. Information is analyzed and recommendations are made in intensive, problem-solving workshops to produce realistic and achievable recommendations for both *in situ* and *ex situ* population management.

Our workshop processes provide an objective environment, expert knowledge, and neutral facilitation that support the sharing of information across institutions and stakeholder groups, fostering agreement on the issues and information, and enabling stakeholder groups to make useful and practical management recommendations for the taxon and habitat system under consideration. This approach has been quite successful in unearthing and integrating previously unpublished information that is frequently of great value to the decision making process. The constant refinement, expansion, and heuristic value of the CBSG workshop processes have made them imaginative and productive tools for species conservation planning (Conway 1995; Byers and Seal 2003; Westley and Miller 2003).

There are characteristic patterns of human behavior that are cross-disciplinary and cross-cultural which affect the processes of communication, problem-solving, and collaboration. Some of these characteristic behavior patterns show themselves in:

- the acquisition, sharing, and analysis of information pertinent to the conservation needs of the situation;
- the perception and characterization of risk to the species in question resulting from human activities;
- the development of trust among individuals (stakeholders) tasked with conservation planning; and
- 'territoriality' (personal, institutional, local, national) that impedes effective collaboration.

Each of these patterns has strong emotional components that shape our interactions. CBSG's recognition of these patterns has been essential in the development of processes to assist people in working groups to reach agreement on needed conservation actions, to identify collaborative structures required to implement those actions, and to establish new working relationships.

CBSG workshops are organized to bring together the full range of stakeholders who share a strong interest in the conservation and management (or the consequence of such management) of a species in its habitat. One goal in all workshops is to reach a common understanding of the scientific knowledge available and its possible application to the decision-making process and to needed management actions. We have found that a workshop process driven by practical decision-making – replete with risk characterization methods, stochastic simulation modeling, management scenario testing, and deliberation among stakeholders – can be a powerful tool for extracting, assembling, and exploring information. This workshop process encourages the development of a shared understanding across a broad spectrum of training and expertise. These tools also support the creation of working agreements and instilling local ownership of the conservation problems at hand and the management decisions and actions required to mitigate those problems. As participants work as a group to appreciate the complexity of the conservation problems at hand, they take ownership of the process and of the ultimate management recommendations that emerge. This is essential if the management recommendations generated by the workshops are to succeed.

CBSG's interactive and participatory workshop approach supports and promotes effective conservation by fostering the creation of species management plans and the political and social support of the local people needed to implement these plans. In addition, simulation modeling is an important tool in this process, and provides a platform for testing assumptions, data quality, and alternative management scenarios. Workshop participants recognize that the present science is imperfect, and that management policies and actions need to be designed as part of a biological and social learning process. The CBSG workshop process provides a means for designing and implementing management plans and programs on the basis of sound science, while allowing new information and unexpected events to be used for learning and to adjust management practices.

The PHVA Workshop Process: An Introduction

Probably the most widely recognized workshop process conducted by CBSG is the Population and Habitat Viability Assessment, or PHVA. At its most basic level, the PHVA workshop process is based upon an explicit integration of biological and sociological science. Its closest intellectual relative – and the methodology from which its own name is derived – is the process of population viability analysis, or PVA. Population viability analysis describes a suite of quantitative methods used for evaluating extinction risk and informing strategic management planning for species threatened by human activities. PVA has been widely recognized as an important tool in the arsenal of the conservation biologist and natural resource manager. However, the methodology is often limited in its practical application because of its use within a narrow biological context, largely ignoring important information from other disciplines and perspectives that can enhance the input to the PVA as well as expand the utility of the recommendations that come from detailed analysis of the output.

The PHVA workshop process designed by CBSG directly addresses this important issue. The PHVA combines traditional PVA methodologies – most notably, the use of computer simulation models of the extinction process in small populations of threatened species – with structured tools for issue formulation and problem solving among a group of engaged workshop participants from a broad range of disciplines. Through this integrative process, stakeholders develop more effective recommendations for species conservation action, including the identification of personal responsibilities and timelines for action to ensure that the recommendations agreed upon by the participants become reality.

In general, each 3-4 day PHVA workshop process is defined by the following five elements:

- A <u>pre-workshop planning phase</u>, where broad workshop goals are identified, the workshop venue is chosen, critical participants (stakeholders) are identified and invited, and briefing materials are collected and distributed. More recently, this phase often includes the construction and interpretation of preliminary PVA simulation models that will form the basis of a comparative risk assessment conducted at the workshop itself.
- A <u>workshop phase I – opening session</u>, where local officials open the workshop, experts give short presentations on biological and sociological aspects of conservation of the focal species, and CBSG facilitators provide background material on workshop structure and process.
- A <u>workshop phase II – working session</u>, where participants typically function within small working groups defined by specific problems/topics. Working group activity focuses on problem analysis, information assembly, and formulating detailed recommendations. Interactions among groups, including those experts conducting the quantitative risk assessment using data and alternative management scenarios assembled by the other groups, is enhanced by periodic report-back in full plenary sessions. Each group creates a detailed report of their discussions and recommendations, which become the main components of the workshop report to be produced later (see below).
- A <u>workshop phase III – closing session</u>, where final recommendations are presented by each working group for acceptance by the full body of participants. Specific steps to be taken after the workshop are discussed and outlined by all in attendance.
- A <u>post-workshop report production phase</u>, where workshop organizers (in close consultation with CBSG staff) produce a draft report that is then sent to key participants for review and revision. The final report is then produced and distributed to all workshop participants and other interested parties.

To date, CBSG has conducted more than 180 PHVA workshops in nearly 40 countries. This statistic points to the robust nature of the process outlined above, which can be adapted to the specific cultural, linguistic, and sociopolitical environment within which the focal species is located. Reports from many of these workshops can be obtained online at www.cbsg.org.

Each of the two primary elements of a PHVA workshop – quantitative population viability analysis and participatory decision-making in a structured and facilitated environment – will be discussed in more detail in the following sections.

The PHVA Workshop Process: Quantitative Risk Assessment

Introduction

Thousands of species and populations of animals and plants around the world are threatened with extinction within the coming decades. For the vast majority of these taxa, this threat is the direct result of human activity. The particular types of activity, and the ways in which they impact wildlife populations, are often complex in both cause and consequence; as a result, the techniques we must use to analyze their effects often seem to be complex as well. But scientists in the field of conservation biology have developed extremely useful tools for this purpose, dramatically improving our ability to conserve the planet's biodiversity.

Conservation biologists involved in recovery planning for a given threatened species usually try to develop a detailed understanding of the processes that put the species at risk, and will then identify the most effective methods to reduce that risk through active management of the species itself and/or the habitat in which it lives. In order to design such a program, we must engage in some sort of predictive process: we must gather information on the detailed characteristics of proposed alternative management strategies and somehow predict how the threatened species will respond in the future. A strategy that is predicted to reduce the risk by the greatest amount – and typically does so with the least amount of financial and/or sociological burden – is chosen as a central feature of the recovery plan.

But how does one predict the future? Is it realistically possible to perform such a feat in our fast-paced world of incredibly rapid and often unpredictable technological, cultural, and biological growth? How are such predictions best used in wildlife conservation? The answers to these questions emerge from an understanding of what has been called "the flagship industry" of conservation biology: population viability analysis, or PVA. Most methods for conducting PVA are merely extensions of tools we all use in our everyday lives.

The Basics of PVA

To appreciate the science and application of PVA to wildlife conservation, we first must learn a little bit about population biology. Biologists will usually describe the performance of a population by describing its demography, or simply the numerical depiction of the rates of birth and death in a group of animals or plants from one year to the next. Simply speaking, if the birth rate exceeds the death rate, a population is expected to increase in size over time. If the reverse is true, our population will decline. The overall rate of population growth is therefore a rather good descriptor of its relative security: positive population growth suggests some level of demographic health, while negative growth indicates that some external process is interfering with the normal population function and pushing it into an unstable state.

This relatively simple picture is, however, made a lot more complicated by an inescapable fact: wildlife population demographic rates fluctuate unpredictably over time. For example, if we declare that, after some numbers of years of direct field study, an average of 50% of our total population of adult females are expected to produce offspring annually, it is quite likely that the number of adult females breeding in any one particular year **will not** be exactly 50%. The same can be said for most all other demographic rates: survival of offspring and adults, the numbers of offspring born, and the offspring sex ratio will almost always change from one year to the next in a way that usually defies precise prediction. These variable rates then conspire to make a population's growth rate also change unpredictably from year to year. When wildlife populations are very large – if we consider seemingly endless herds of wildebeest on the savannahs of Africa, for example – this random annual fluctuation in population growth is of little to no consequence for the future health and stability of the population. However, theoretical and practical study of population biology has taught us that populations that are already small in size (often defined in terms of tens to a few hundred individuals) are affected by these fluctuations to a much greater extent – and the long-term impact of these fluctuations is always negative. Therefore, a wildlife population that has been reduced in numbers will become even smaller through this fundamental principle of wildlife biology. Furthermore, our understanding of this process provides an important backdrop to considerations of the impact of human activities that may, on the surface, appear relatively benign to larger and more stable wildlife populations. This self-reinforcing feedback loop, first coined the "extinction vortex" in the mid-1980's, is the cornerstone principle underlying our understanding of the dynamics of wildlife population extinction.

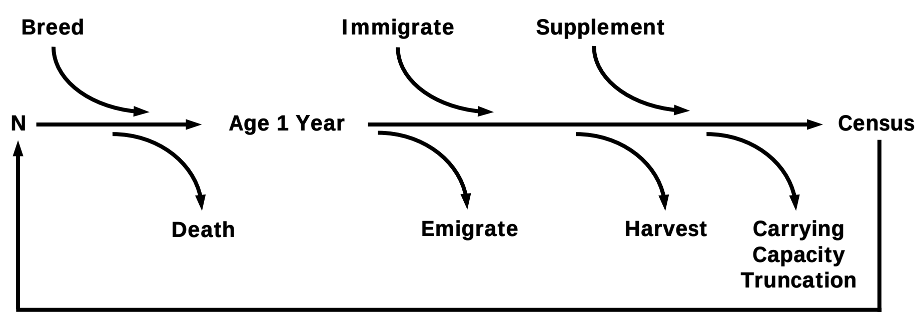
Once wildlife biologists have gone out into the field and collected data on a population's demography and used these data to calculate its current rate of growth (and how this rate may change over time), we now have at our disposal an extremely valuable source of information that can be used to predict the *future* rates of population growth or decline under conditions that may not be so favorable to the wildlife population of interest. For example, consider a population of primates living in a section of largely undisturbed Amazon rain forest that is now opened up to development by logging interests. If this development is to go ahead as planned, what will be the impact of this activity on the animals themselves, and the trees on which they depend for food and shelter? And what kinds of alternative development strategies might reduce the risk of primate population decline and extinction? To try to answer this question, we need two additional sets of information: 1) a comprehensive description of the proposed forest development plan (how will it occur, where will it be most intense, for what period of time, etc.) and 2) a detailed understanding of how the proposed activity will impact the primate population's demography (which animals will be most affected, how strongly will they be affected, will animals die outright more frequently or simply fail to reproduce as often, etc.). With this information in hand, we have a vital component in place to begin our PVA.

Next, we need a predictive tool – a sort of crystal ball, if you will, that helps us look into the future. After intensive study over nearly three decades, conservation biologists have settled on the use of computer simulation models as their preferred PVA tool. In general, models are any simplified representation of a real system. We use models in all aspects of our lives; for example, road maps are in fact relatively simple (and hopefully very accurate!) 2-dimensional representations of complex 3-dimensional landscapes we use to get us where we need to go. In addition to making predictions about the future, models are very helpful for us to: i) extract important trends from complex processes, ii) allow comparisons among different types of systems, and iii) facilitate analysis of processes acting on a system.

Recent advances in computer technology have allowed us to create very complex models of the demographic processes that define wildlife population growth. But at their core, these models attempt to replicate simple biological functions shared by most all wildlife species: individuals are born, some grow to adulthood, most of those that survive mate with individuals of the opposite sex and then give birth to one or more offspring, and they die from any of a wide variety of causes. Each species may have its own special set of circumstances – sea turtles may live to be 150 years old and lay 600 eggs in a single event, while a chimpanzee may give birth to just a single offspring every 4-5 years until the age of 45 – but the fundamental biology is the same. These essential elements of a species' biology can be incorporated into a computer program, and when combined with the basic rules for living and the general characteristics of the population's surrounding habitat, a model is created that can project the demographic behavior of our real observed population for a specified period of time into the future. What's more, these models can explicitly incorporate the random fluctuations in rates of birth and death discussed earlier in this section. As a result, the models can be much more realistic in their treatment of the forces that influence population dynamics, and in particular how human activities can interact with these intrinsic forces to put otherwise relatively stable wildlife populations at risk.

Many different software packages exist for the purposes of conducting a PVA. Perhaps the most widely-used of these packages is *VORTEX*, developed by CBSG for use in both applied and educational environments. *VORTEX* has been used by CBSG and other conservation biologists for more than 15 years and has proved to be a very useful tool for helping make more informed decisions in the field of wildlife population management.

VORTEX Simulation Model Timeline



Events listed above the timeline increase N, while events listed below the timeline decrease N.

Figure 1. Simple timeline of components that make up a typical one-year timestep in the PVA package *VORTEX*. Population size N is calculated based on additions of individuals through births, immigration and supplementation from an outside source, and removals through mortality, emigration, harvest, and truncation to below ecological carrying capacity.

The *VORTEX* Population Viability Analysis Model

VORTEX models demographic stochasticity (the randomness of reproduction and deaths among individuals in a population), environmental variation in the annual birth and death rates, the impacts of sporadic catastrophes, and the effects of inbreeding in small populations. *VORTEX* also allows analysis of the effects of losses or gains in habitat, harvest or supplementation of populations, and movement of individuals among local populations (Figure 1).

Density dependence in mortality is modeled by specifying a carrying capacity of the habitat. When the population size exceeds the carrying capacity, additional morality is imposed across all age classes to bring the population back down to the carrying capacity. The carrying capacity can be specified to change linearly over time, to model losses or gains in the amount or quality of habitat. Density dependence in reproduction is modeled by specifying the proportion of adult females breeding each year as a function of the population size.

VORTEX models loss of genetic variation in populations by simulating the transmission of alleles from parents to offspring at a hypothetical genetic locus. Each animal at the start of the simulation is assigned two unique alleles at the locus. During the simulation, *VORTEX* monitors how many of the original alleles remain within the population, and the average heterozygosity and gene diversity (or "expected heterozygosity") relative to the starting levels. *VORTEX* also monitors the inbreeding coefficients of each animal, and can reduce the juvenile survival of inbred animals to model the effects of inbreeding depression.

VORTEX is an *individual-based* model. That is, *VORTEX* creates a representation of each animal in its memory and follows the fate of the animal through each year of its lifetime. *VORTEX* keeps track of the sex, age, and parentage of each animal. Demographic events (birth, sex determination, mating, dispersal, and death) are modeled by determining for each animal in each year of the simulation whether any of these events occur. Events occur according to the specified age and sex-specific probabilities. Demographic stochasticity is therefore a consequence of the uncertainty regarding whether each demographic event occurs for any given animal.

VORTEX requires a lot of population-specific data. For example, the user must specify the amount of annual variation in each demographic rate caused by fluctuations in the environment. In addition, the frequency of each type of catastrophe (drought, flood, epidemic disease) and the effects of the catastrophes on survival and reproduction must be specified. Rates of migration (dispersal) between each pair of local populations must be specified. Because *VORTEX* requires specification of many biological parameters, it is not necessarily a good model for the examination of population dynamics that would result from some generalized life history. It is most usefully applied to the analysis of a specific population in a specific environment.

Further information on *VORTEX* is available in Lacy (2000) and Miller and Lacy (2005).

Strengths and Limitations of the PVA Approach

When considering the applicability of PVA to a specific issue, it is vitally important to understand those tasks to which PVA is well-suited as well as to understand what the technique is not well-designed to deliver. With this enhanced understanding will also come a more informed public that is better prepared to critically evaluate the results of a PVA and how they are applied to the practical conservation measures proposed for a given species or population.

The dynamics of population extinction are often quite complicated, with numerous processes impacting the dynamics in complex and interacting ways. Moreover, we have already come to appreciate the ways in which demographic rates fluctuate unpredictably in wildlife populations, and the data needed to provide estimates of these rates and their annual variability are themselves often uncertain, i.e., subject to observational bias or simple lack of detailed study over relatively longer periods of time. As a result, the elegant mental models or the detailed mathematical equations of even the most gifted conservation biologist are inadequate for capturing the detailed nuances of interacting factors that determine the fate of a wildlife population threatened by human activity. In contrast, simulation models can include as many factors that influence population dynamics as the modeler and the end-user of the model wish to assess. Detailed interactions between processes can also be modeled, if the nature of those interactions can be specified. Probabilistic events can be easily simulated by computer programs, providing output that gives both the mean expected result and the range or distribution of possible outcomes.

PVA models have also been shown to stimulate meaningful discussion among field biologists in the subjects of species biology, methods of data collection and analysis, and the assumptions that underlie the analysis of these data in preparation for their use in model construction. By making the models and their underlying data, algorithms, and assumptions explicit to all who learn from them, these discussions become a critical component in the social process of achieving a shared understanding of a threatened species' current status and the biological justification for identifying a particular management strategy as the most effective for species conservation. This additional benefit is most easily recognized when PVA is used in an interactive workshop-type setting, such as the Population and Habitat Viability Assessment (PHVA) workshop designed and implemented by CBSG.

Perhaps the greatest strength of the PVA approach to conservation decision-making is related to what many of its detractors see as its greatest weakness. Because of the inherent uncertainty now known to exist in the long-term demography of wildlife populations (particularly those that are small in size), and because of the difficulties in obtaining precise estimates of demographic rates through extended periods of time collecting data in the field, accurate predictions of the future performance of a threatened wildlife population are effectively impossible to make. Even the most respected PVA practitioner must honestly admit that an accurate prediction of the number of mountain gorillas that will roam the forests on the slopes of the eastern Africa's Virunga Volcanoes in the year 2075, or the number of polar bears that will swim the warming waters above the Arctic Circle when our great-grandchildren grow old, is beyond their reach. But this type of difficulty, recognized across diverse fields of study from climatology to gambling, is nothing new: in fact, the Nobel Prize-winning physicist Niels Bohr once said "Prediction is very difficult, especially when it's about the future." Instead of lamenting this inevitable quirk of the physical world as a fatal flaw in the practice of PVA, we must embrace it and instead use our very cloudy crystal ball for another purpose: to make **relative**, rather than **absolute**, predictions of wildlife population viability in the face of human pressure.

The process of generating relative predictions using the PVA approach is often referred to as <u>sensitivity analysis</u>. In this manner, we can make much more robust predictions about the relative response of a simulated wildlife population to alternate perturbations to its demography. For example, a PVA practitioner may not be able to make accurate predictions about how many individuals of a given species may persist in 50 years in the presence of intense human hunting pressure, but that practitioner can speak with considerably greater confidence about the relative merits of a male-biased hunting strategy compared to the much more severe demographic impact typically imposed by a female-biased hunting strategy. This type of comparative approach was used very effectively in a PVA for highly threatened populations of tree kangaroos (*Dendrolagus* sp.) living in Papua New Guinea, where adult females are hunted preferentially over their male counterparts. Comparative models showing the strong impacts of such a hunting strategy were part of an important process of conservation planning that led, within a few short weeks after a participatory workshop including a number of local hunters (Bonaccorso et al., 1999), to the signing of a long-term hunting moratorium for the most critically endangered species in the country, the tenkile or Scott's tree kangaroo (*Dendrolagus scottae*).

PVA models are necessarily incomplete. We can model only those factors which we understand and for which we can specify the parameters. Therefore, it is important to realize that the models often underestimate the threats facing the population, or the total risk these threats collectively impose on the population of interest. To address this limitation, conservation biologists must try to engage a diverse body of experts with knowledge spanning many different fields in an attempt to broaden our understanding of the consequences of interaction between humans and wildlife.

Additionally, models are used to predict the long-term effects of the processes presently acting on the population. Many aspects of the situation could change radically within the time span that is modeled. Therefore, it is important to reassess the data and model results periodically, with changes made to the conservation programs as needed (see Lacy and Miller (2002), Nyhus et al. (2002) and Westley and Miller (2003) for more details).

Finally, it is also important to understand that a PVA model by itself does not define the goals of conservation planning of a given species. Goals, in terms of population growth, probability of persistence, number of extant populations, genetic diversity, or other measures of population performance, must be defined by the management authorities before the results of population modeling can be used.

PVA and PHVA

While sounding quite similar in their acronyms, the generalized technique of population viability analysis and CBSG's workshop process known as Population and Habitat Viability Assessment (PHVA) have important differences that help us understand how each of them can be best used in conserving threatened biodiversity. A PVA is an analytical technique that is typically used to assess the current risk of decline or extinction of a given plant or animal population, and to investigate the most likely response of the population to changes in its rates of reproduction or survival from one year to the next. This investigation is conducted most effectively through the use of computer simulation models, and uses information gathered over many years by field researchers on the biological characteristics of the populations under study. These analyses can become quite complex and, therefore, they often remain in the confines of the conservation science community.

CBSG's Population and Habitat Viability Assessment, or PHVA, represents a significant extension of the more traditional PVA approach into the realm of practical conservation decision-making. Where a PVA is conducted with the expertise of population ecologists and geneticists and focuses intensively on the dynamics of population extinction, a typical PHVA workshop includes representatives and perspectives from a much more diverse body of interested parties, or stakeholders. These stakeholders utilize the results from a PVA analysis – performed during or immediately before the PVHA workshop – to improve the rigor and utility of very practical recommendations designed to effectively conserve the species or population that is the focus of the workshop. An outstanding example of effectively using a diversity of information to inform a PVA came in 1998 when local village chieftains and hunters were among those participating in the Papua New Guinea tree kangaroo PHVA workshop (Bonaccorso et al. 1999). Participatory Rural Appraisal (PRA) methods were used to determine the specifics of how these villagers hunted local tree kangaroos for food, with a special focus on the most endangered species known as the tenkile, or Scott's tree kangaroo. This information was not available from the standard scientific/academic community, instead residing as traditional knowledge in the communities that lived with the species. When incorporated into PVA models of tree kangaroo population dynamics, participants concluded that the hunting practices were unsustainable, and extinction of the tenkile was imminent unless drastic conservation measures were taken. Just weeks after the workshop, local village representatives signed a moratorium on tenkile hunting, and an Australian organization began working with the villages to adopt domestic animal farming as an alternative – and sustainable – protein source for the region. The moratorium is in effect to this day, and preliminary data indicate that the tenkile population is beginning to show signs of recovery. Without the input provided by those outside of the scientific community, the value of the analysis would have been greatly diminished.

In addition to the focused discussions on population dynamics, other discussions focusing on vital aspects of species conservation, such as legal issues, social acceptance, and human-wildlife interactions, form the basis of facilitated interactions between participants to a PHVA. So, the PVA forms the analytical "core" of the PHVA workshop, with expert participants from various disciplines encouraged to guide the use of the PVA models and adapt the results of the risk assessment to fit their own situations and needs as they develop species and habitat conservation strategies.

Perhaps the most visible difference between a PVA and a PHVA is in the number of experts needed to conduct one. A PVA can and often is completed by a single population biologist working with data gleaned from published sources. CBSG members and staff sometimes provide PVA consultant services, as do many other population biologists skilled in the modeling techniques. In contrast, a PHVA cannot be conducted by a single scientist, because by definition it involves the synthesis of concerns, ideas, data, and proposed conservation solutions from not only a range of population biologists, but also wildlife and land managers, social scientists, and others with knowledge needed for crafting a successful conservation plan for the species.

The PHVA Workshop Process: Design and Facilitation

Introduction

As discussed in the preceding section, a PHVA workshop is not defined merely by the presence of a stochastic simulation model of wildlife population dynamics. A broad diversity of stakeholders must be present to discuss a wide array of important topics affecting the future of the species, and the flow of information and ideas emanating from those experts must be assembled and managed in such a way that the group's productivity is maximized. These elements of successful collaboration can only be achieved through proper attention to workshop design and process facilitation. Westley and Byers (2003) refer to this process as "getting the right science and getting the science right". For our purposes here, we define *workshop design* as the construction of a chain of interactional tasks or elements that, when completed in their entirety, will help the participants achieve a predetermined workshop outcome that, in the case of a PHVA workshop, is the production of a species conservation management plan. Similarly, we define *facilitation* as the active management of the workshop process by trained individuals so that the participants can realize the workshop's objectives.

Workshop Design: Stakeholders

Once the workshop objectives and outcome have been clearly defined and understood by all involved in its organization, a critical first step in workshop design is the identification of key participants. A stakeholder is often defined by three primary characteristics:

- Concern – somebody with interest in the discussions around management of the focal species and the outcome of the PHVA workshop;
- Expertise – somebody with information or resources available to contribute to the workshop; and
- Power – somebody with the authority to support or block recommendations resulting from the workshop.

Ignoring any one of these characteristics will result in an erosion of collaborative spirit, a weak risk assessment of projected human impacts, or a degraded base of support for implementing important species conservation actions. Each one of these failures can seriously compromise the success of a PHVA workshop. Including a large diversity of stakeholders offers the greatest opportunity for creative collaboration – but also can mean a stiff challenge for a facilitator who is responsible for keeping all interested parties moving intellectually in the same direction. To do this, it is vitally important for all stakeholders to seek common ground in their deliberations around species conservation management issues.

Workshop Facilitation: The Divergent – Convergent Thinking Cycle

A basic principle of the PHVA workshop process is to encourage creative thinking around identification of alternative management options and the many ways in which they may be carried out. At the same time, the participants must use specific tools that assist them in choosing the best options in the spirit of action-based planning. The ideal workshop design explicitly includes at least three cycles of this type of convergent – divergent thinking (Figure 2). A variety of specific tools are introduced during a PHVA by the facilitator to help guide the participants through the appropriate element of the workshop design. A typical broad workshop design is described below. [It is important to recognize that each workshop will have its own needs that may require some degree of change from this basic format.]

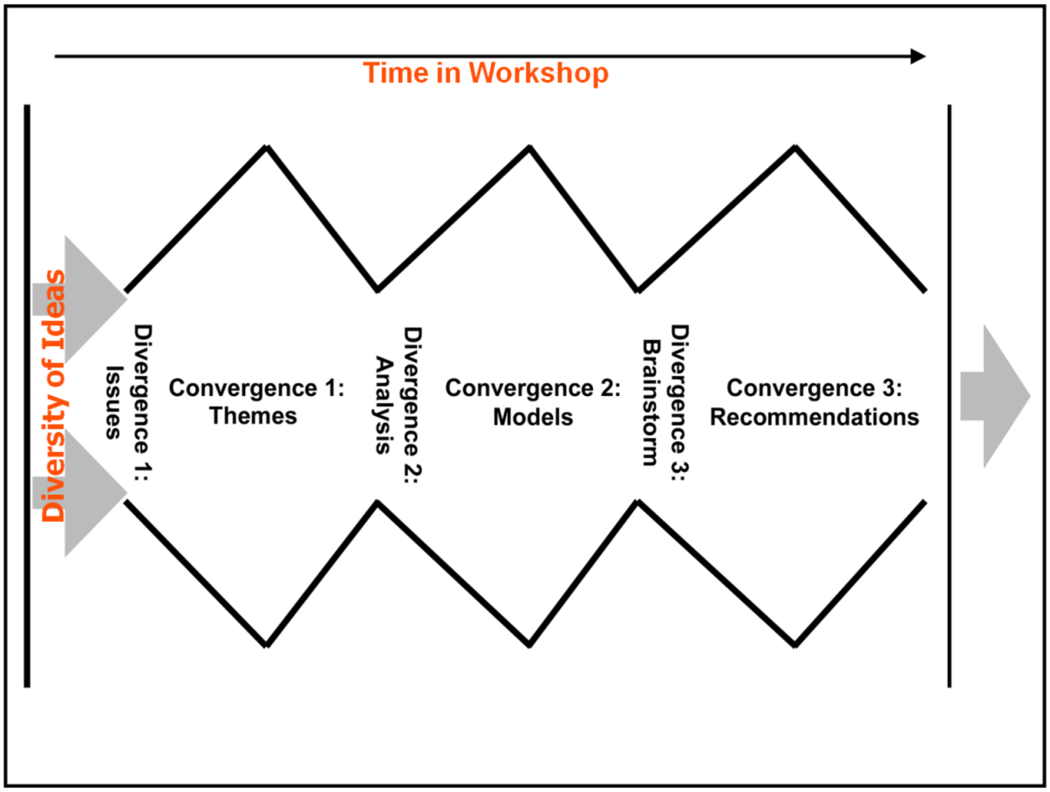


Figure 2. Generalized graphical depiction of process flow in working groups in a typical PHVA workshop. Adapted from Westley and Byers (2003).

<u>Cycle 1: Issue identification and theme generation</u>

Each participant comes to a PHVA workshop with their own experiences and issues, as well as concerns regarding how management of the species will impact their world. It is critical that they are able to express their opinions on the real problems surrounding conservation of the species – not only so that information is made available to the full group for discussion, but also so that each person feels involved in the workshop process from the beginning. This is accomplished by a brainstorming session where each person introduces himself or herself to the group and directly states their opinion about the most pressing issue facing conservation of the species in question. An important outcome of this process is the recognition that people from seemingly very different perspectives will often identify conservation of the species as a desirable outcome, thereby immediately defusing at least some level of tension between historically antagonistic stakeholders.

Once the full breadth of issues is identified, the facilitator must help the group cluster this list into a smaller collection of themed issues for discussion and analysis by smaller working groups. Human sociological research has determined that productive problem solving works best in groups of about six to eight people, with a focused set of issues to address. These themes typically are based on biological and sociological topics – habitat, genetics, disease, human/wildlife interactions, etc. – pertinent to the specific workshop at hand. Themes can also be based on taxonomy or geography in multi-species workshops. It is important that workshop participants are comfortable with the resulting consolidation of issues into themes, once again emphasizing stakeholder engagement throughout the process.

Workshop participants select the working group in which they wish to participate; the facilitator monitors this process so that one group does not become too large (say, > 15 people) at the expense of one or more other groups that become too small or even nonexistent. If this happens, the group revisits the choice of working group themes and adjusts as necessary to balance the distribution of participants among the groups. As a first task, each group expands upon their collection of brainstormed issues and produces a prioritized list of problem statements that form the basis of their upcoming deliberations.

Cycle 2: Data assembly and analysis

The next phase of divergence concentrates on another brainstorming process: the identification and assembly of information on the species and its conservation, in the specific context of each working group's theme. For those tasked with using the PVA simulation model, this phase consists of refining the basic demographic and genetic dataset used to create the preliminary risk assessment models. Other groups have the freedom to explore all relevant data, from population genetic data to information on the legislative environment for conservation in a given state, region or country. At this point in the workshop, it is critical to separate fact from assumption and to identify competing datasets so that information can be more effectively organized and interpreted.

During this phase of the workshop, working group participants often realize that other stakeholder have different perspectives on associated data (or more ambiguous assumptions), leading to difficulties in interpretation and agreement. Alternatively, a group may find there are very little hard data on their topic of interest, making if equally difficult to provide clear justification for conclusions that will form the basis of later recommendations. These complexities often make this the most difficult phase of the workshop – a period of maximum divergence sometimes referred to as the "groan zone" (Kaner 1996). The facilitator must be sensitive to this possibility and provide tools that can help groups make sense of the information at hand. These tools can include simple matrix templates or causal flow (influence) diagramming (see Appendix X for examples of products from these tools).

An especially valuable tool for data analysis is population viability simulation modeling. The use of such models, most commonly but not exclusively involving the *VORTEX* simulation, provides an environment within which alternative scenarios of human population activities and population/habitat management options can be constructed and tested. Where appropriate, each working group is encouraged to develop management scenarios that can be quantified for evaluation in *VORTEX*. This process thereby promotes interaction between working groups, enhancing the collaborative and participatory nature of the workshop process. Furthermore, the subsequent plenary report-back of results from the simulation modeling allows quick feedback to the various groups and provides them the information they need to proceed to the next step: conservation action planning.

Cycle 3: Developing recommendations and reaching consensus

As the working groups complete their analysis, they are once again asked to enter a divergent thinking phase and to brainstorm alternative solutions to the problems they have identified and analyzed. The workshop facilitator strives to keep the groups thinking first at a more strategic level, typically at the level of short- and long-term goals, before moving to the final step of constructing detailed action items. The identified goals are discussed, streamlined, and prioritized using techniques such as paired ranking, before moving to the final phase of action planning.

Working groups are asked to develop detailed action items for each of their goals, in order of priority. They are asked to apply the SMART criteria – Specific, Measurable, Achievable, Results-Oriented, Timely – to each action item so that they are fully characterized for later implementation. While this is the last element of the PHVA workshop process, it is the most critical as this is "where the rubber hits the road": this is the core of a long-term species conservation strategy. The facilitator must carefully monitor the presentation of these working group recommendations in the final workshop plenary, ensuring that full consensus is reached on the recommendations coming from the various groups. This consensus process is vital, as it enhances the sense of ownership among participants of the workshop product. This ownership will serve to promote timely and committed implementation of workshop recommendations.

CBSG has produced a set of task sheets that explain the various working group activities described above. These tasks are then typically assembled in a customized order – relevant to the specific workshop process required for a given project – to form a Workshop Handbook (see Appendix Y). This Handbook is distributed to all participants at the beginning of the workshop and serves as the main instrument for instructing them on the various tasks to be completed during the workshop. Throughout this divergent – convergent cycle of working group activity, PHVA workshop facilitators stress the importance of working group facilitation as a mechanism for productive discussion and effective development of recommendations. Before this cycle even begins, the facilitator explains the working group process and identifies various roles that working group participants must assume, perhaps on a rotating basis, in each working group session. These roles include working group *facilitator / discussion leader*; the *recorder*, who captures the core elements of the discussions on flip charts (this person could also be the facilitator); the *reporter*, who will present a summary of working group activity and output in plenary sessions; and the *timekeeper*, who will manage the amount of time spent on a given group activity and keep the group apprised of the time remaining for each task.

In conclusion, while we stress the importance of sound scientific logic and analysis as a core element of a PHVA workshop, the workshop will not succeed without equal attention given to sound process. Derivation of an effective process is predicated on the philosophy that stakeholders that participate in a complex species conservation planning project must be allowed to express their views and – more importantly – synthesize their views with those of others to collectively craft a set of conservation recommendations that will achieve endangered species stability while not excessively impacting the set of stakeholders who must live with the consequences of these recommendations. CBSG staff constantly work to refine the general process elements described here, and learn from others in the broad strategic planning community in order to bring the PHVA workshop process to an ever wider audience and, ultimately, to increase its effectiveness worldwide.

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Appendix I:
Input Data Required for *Vortex*

The following dataform is commonly distributed to selected PHVA workshop participants well in advance of the workshop as a way to collect and synthesize demographic and genetic information of value to the PVA process.

Vortex Population Viability Analysis Software
Input Data Required for Analysis

Note: *Vortex* has the capability to model complex demographic rates, if a user thinks that greater specificity is needed. For example, breeding or survival rates could be specified as functions of adult age, population density, environmental conditions, etc. In addition, infectious disease can be modeled in more detail with the *Outbreak* software package that can be linked to *Vortex*, thereby creating a more realistic simulation of the impacts of disease on population dynamics. Contact CBSG if you would like to learn more about this additional flexibility.

Throughout the process of completing this form, it is critical to cite the appropriate data sources as justification for a given parameter value. Cite peer-reviewed articles wherever possible, and state the source of the data if such articles do not exist.

1. Species and geographic range

2. Breeding system

Monogamous or Polygynous? ________ Long-term?______ Short-term?______

3. At what age do females begin breeding? ________

4. At what age do males begin breeding? ________

For each sex, we need to specify the age at which the typical animal produces its first litter. The age at which they "begin breeding" refers to their age when the offspring are actually born, and not when the parents mate.

5. Maximum breeding age? ________

When do they become reproductively senescent? *Vortex* will allow them to breed (if they happen to live this long) up to this maximum age.

6. What is the sex ratio of offspring at birth? ________

What proportion of the year's offspring are males?

7. What is the maximum litter/clutch size? ________

8. In the average year, and at optimal densities (see below), what proportion of adult females produces a litter/clutch? ________

9. **How much does the proportion of females that breed vary across years? ________**
Ideally, we need this value specified as a standard deviation (SD) of the proportion breeding. If long-term quantitative data are lacking, we can estimate this variation in several ways. At the simplest intuitive level, in about 67% of the years the proportion of adult females breeding would fall within 1 SD of the mean, so (mean value) + SD might represent the breeding rate in a typically “good” year, and (mean value) – SD might be the breeding rate in a typically “bad” year.

10. **Is reproduction density – dependent?** Yes or No ______
In many species, reproduction (defined here as the proportion of adult females that successfully breed in a given year) may be a function of density. Resource competition may lead to lower success at high densities, and difficulty in finding mates (Allee effect) may reduce success at low densities.
Describe the form of density dependence for this species below, either graphically or numerically. How does reproductive success change at high and/or low densities? What is the rate of change in reproductive success as density increases or decreases?

11. **Of litters that are born in a given year, what percentage have litters/clutches of …**
1 offspring? ________
2 offspring? ________
3 offspring? ________
4 offspring? ________
(and so on to the maximum litter size).

12. **What is the percent survival of females …**
from birth to 1 year of age (i.e., juveniles)? ________
from age 1 to age 2? ________
from age 2 to age 3? ________ (no need to answer this if they begin breeding at age 2)
from age *x* to age *x*+1, for adults? ________

13. **What is the percent survival of males …**
from birth to 1 year of age (i.e., juveniles)? ________
from age 1 to age 2? ________
from age 2 to age 3? ________ (no need to answer this if they begin breeding at age 2)
from age *x* to age *x*+1, for adults? ________

14. **For each of the survival rates listed above, enter the variation across years as a standard deviation:**
For females, what is the standard deviation in the survival rate
from birth to 1 year of age (i.e., juveniles)? ________
from age 1 to age 2? ________
from age 2 to age 3? ________ (no need to answer this if they begin breeding at age 2)
from age *x* to age *x*+1, for adults? ________

For males, what is the standard deviation in the survival rate
from birth to 1 year of age (i.e., juveniles)? ________
from age 1 to age 2? ________
from age 2 to age 3? ________ (no need to answer this if they begin breeding at age 2)
from age *x* to age *x*+1, for adults? ________

15. Do you want to incorporate inbreeding depression? Yes or No **__________**
Yes, if you think inbreeding might cause a reduction in fertility or survival
No, if you think inbreeding would not cause any negative impact

If you answered "Yes" to Question 15, then we need to specify the severity of the impacts of inbreeding by answering the following two questions:

15A. How many lethal equivalents exist in your population? ________
"Lethal equivalents" is a measure of the severity of effects of inbreeding on juvenile survival. The median value reported by Ralls et al. (1988) for 40 mammal populations was 3.14. The range for mammals reported in the literature is from 0.0 (no effect of inbreeding on survival) to about 15 (most inbred progeny die).

15B. What proportion of the total lethal equivalents is due to recessive lethal alleles? _______
This question relates to how easily natural selection would remove deleterious genes if inbreeding persisted for many generations (and the population did not become extinct). In other words, how well does the population adapt to inbreeding? The question is really asking this: what fraction of the genes responsible for inbreeding depression would be removed by selection over many generations? Unfortunately, little data exist for mammals regarding this question; data on fruit flies and rodents, however, suggest that about 50% of the total suite of inbreeding effects are, on average, due to lethal alleles.

16. Do you want environmental variation in reproduction to be correlated with environmental variation in survival? Yes or No ________
Answering "Yes" would indicate that good years for breeding are also good years for survival, and bad years for breeding are also bad years for survival. "No" would indicate that annual fluctuations in breeding and survival are independent.

17. How many types of catastrophes should be included in the models? ________
You can model disease epidemics, or any other type of disaster, which might kill many individuals or cause major breeding failure in sporadic years.

18. For each type of catastrophe considered in Question 17,
What is the probability of occurrence? ________
(i.e., how often does the catastrophe occur in a given time period, say, 100 years?)
What is the reproductive rate in a catastrophe year relative to reproduction in normal years? ________
(i.e., 1.00 = no reduction in breeding; 0.75 = 25% reduction; 0.00 = no breeding)
What is the survival rate in a catastrophe year relative to survival in normal years? ________
(i.e., 1.00 = no reduction in survival; 0.75 = 25% reduction; 0.00 = no survival: population extinction)

19. Are all adult males in the "pool" of potential breeders each year? Yes or No **________**
(Are there some males that are excluded from the group of available breeders because they are socially prevented from holding territories, are sterile, or otherwise prevented from having access to mates?)

20. If you answered "No" to Question 19, then answer at least one of the following:
What percentage of adult males is available for breeding each year? ________
or
What percentage of adult males typically sires a litter each year? ________
or
How many litters are sired by the average breeding male (of those siring at least one litter)? ____

21. What is the current population size? ________
(In most cases, we assume that the population starts at a "stable age distribution", rather than specifying ages of individual animals in the current population. If other information exists that allows us to specify the age distribution of the starting population, we can enter these data directly.)

22. What is the habitat carrying capacity? ________
How many animals could be supported in the existing habitat?
(We will assume that the habitat is not fluctuating randomly in quality over time.)

23. Will habitat be lost or gained over time? Yes or No ________

23A. If you answered "Yes" to Question 23, then over how many years will habitat be lost or gained? ________

23B. What percentage of habitat will be lost or gained each year? ________

24. Will animals be removed from the population (to captive stocks, for translocation, etc.)?
Yes or No ________
If "Yes", then,
At what annual interval? ________
For how many years? ________
How many female juveniles? _______ 1-2 year old females? _______ 2-3 year old females? _______ adult females? ________ will be removed each time.
How many male juveniles? _______ 1-2 year old males? _______ 2-3 year old males? _______ adult males? ________
will be removed each time.

25. Will animals be added to the population (from captive stocks, through translocation, etc.)?
Yes or No ________
If "Yes", then,
At what annual interval? ________
For how many years? ________
How many female juveniles? _______ Subadult females? _______ Adult females? ________ will be added each time.
How many male juveniles? _______ Subadult males? _______ Adult males? ________
will be added each time.

Appendix II:
Sample PHVA Workshop Agenda

RIO GRANDE SILVERY MINNOW
Population and Habitat Viability Assessment Workshop

WORKSHOP AGENDA

DAY 1

9:00 – 9:15	Opening of Workshop
9:15 – 10:15	Participant introductions; preliminary issue generation
10:15 – 10:30	Coffee Break
10:30 – 11:30	Background presentations on species biology and conservation
11:30 – 12:00	Introduction to CBSG Workshop process
12:00 – 1:00	Lunch
1:00 – 2:30	Introduction to population viability analysis; discussion
2:30 – 2:45	Coffee Break
2:45 – 3:15	Working Group formation
3:15 – 4:45	Working Group Session I: Issue generation and prioritization

DAY 2

8:30 – 9:30	Plenary Session I: Presentation of prioritized issues
9:30 – 12:00	Working Group Session II: Data assembly and analysis
10:00 – 10:15	Break
12:00 – 1:00	Lunch
1:00 – 2:00	Working Group Session III: Data assembly and analysis (cont'd)
2:00 – 3:00	Plenary Session II: Presentation of assembled data
3:00 – 3:15	Break
3:15 – 4:30	Working Group Session IV: Development of conservation goals

DAY 3

8:30 – 10:00	Working Group Session V: Development of conservation goals (cont'd)
10:00 – 10:15	Break
10:15 – 11:15	Plenary Session III: Presentation of conservation goals
11:15 – 12:30	Plenary Session IIIa: Group prioritization of conservation goals
12:30 – 1:30	Lunch
1:30 – 4:30	Working Group Session VI: Development of conservation actions

DAY 4

8:30 – 10:00	Working Group Session VII: Development of conservation actions (cont'd)
10:00 – 10:15	Break
10:15 – 11:30	Plenary Session IV: Presentation of conservation actions
11:30 – 12:00	Workshop closing; administration of workshop survey

Appendix III:
Sample PHVA Workshop Handbook

In many situations where a species conservation planning workshop such as a PHVA is required, CBSG will create a Workshop Handbook that is given to each participant. The Handbook explains the steps that working groups engage in to generate recommendations for species management. An example of such a document is presented below. It is important to remember that each workshop is unique, often requiring modifications to the general structure outlined here.

Scimitar – Horned Oryx (*Oryx dammah*) Conservation and Reintroduction Workshop

16 – 19 November, 2009
Al Ain Wildlife Park and Resort
Al Ain, United Arab Emirates

WORKSHOP HANDBOOK

Scimitar – Horned Oryx (*Oryx dammah*) Conservation and Reintroduction Workshop

16 – 19 November, 2009
Al Ain Wildlife Park and Resort
Al Ain, United Arab Emirates

Participants Information and Questions

Question 1: Please provide your name and a brief identification of organization, area of expertise, and area of primary interest.

Question 2: What is your personal goal for this workshop? What do you wish to see accomplished in the workshop?

Question 3: What, in your view, is the primary challenge for successful reintroduction of scimitar-horned oryx into its historic range over the next 25 years?

Question 4: What do you wish to contribute to this workshop?

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Al Ain Wildlife Park and Resort
Al Ain, United Arab Emirates

WORKING AGREEMENT

Workshop Facilitator: Philip Miller – Conservation Breeding Specialist Group
Caroline Lees – Conservation Breeding Specialist Group Australasia

Primary Roles

Facilitator: Sets time and tasks
Facilitates plenary discussions
Maintains focus on overall workshop theme
Maintains the integrity of the workshop design

Participants: Manage their own working group discussions
Provide information and determine issues of concern
Create future visions and propose goals

Ground Rules

- Leave all personal and institutional agendas at the door to focus on the task at hand
- All ideas are valid
- Everything is recorded on flip charts
- Everyone participates; no one dominates
- Listen to each other
- Treat each other with respect
- Seek common ground
- Personal differences and problems are acknowledged - not "worked"
- Observe time frames
- Complete draft report by end of meeting

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HUMAN FACTORS INFLUENCING OUR THINKING AND PROBLEM SOLVING PROCESS

- We all have biases and assumptions
- Unconscious assumptions and thinking
- We seek patterns in events
- We choose a pattern or interpretation with limited analysis
- We select data that support our preference
- We ignore data that disagree with our preference
- We start our analyses with conclusions – rather than defining our problems and needs
- It is difficult for people to make objective estimates of risks and probabilities. We ignore base rates.
- Difficult to evaluate in our heads all of the interactions in complex problems such as biological systems. Thinking tools can help.

TO AVOID THESE TRAPS WE NEED TO STRUCTURE OUR ANALYSIS.
Use thinking tools to assist in a systematic explicit objective process of problem definition, assumption identification, and seeking solutions. Groups of people are more productive of ideas and more inclusive of options than individuals working alone.

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16 – 19 November, 2009
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SELF-MANAGEMENT LEADERSHIP ROLES

Each small working group manages its own discussions, data gathering, time, and report production. Here are brief descriptions of the various roles to be played by different people in the group so that you can function as a group during the workshop. Leadership roles can be rotated; divide the work as you wish. **Remember, however, to assign these roles at the beginning of each working group session**.

Discussion leader – Assures that each person wanting to speak is heard within the time available. Keeps track of discussion using flip charts. Keeps the group task front and center at all times.

Flip Chart Recorder – May be another person than discussion leader. Records ideas using brief phrases to provide group memory and visible record of issues, ideas, and discussions. Checks with person that the phrase is an accurate representation of their contribution.

Computer Recorder – Keeps track of group discussion using a computer. This should not simply be a verbatim recording of the flip chart contents, but should also include a synthesis of the discussions accompanying the salient points written on the flip charts. It is important for this person to ask participants to briefly restate long ideas so that they can be accurately captured. This computer record will be the basis of the report from this workshop.

Timekeeper – Keeps the group aware of the time remaining for each working group session.

Reporter – Delivers the working group report in plenary. It is very important that this role be assigned at the beginning of each session so that the person can prepare a report accordingly

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Overview of Working Group Process

TASK 1a. **Brainstorm Problems/Issues** for your group's topic (see attached description of the process). This is not the time to develop solutions or actions or research projects for the problems. This will be done in later steps in the process.

TASK 1b. **Consolidate** the ideas and problems generated in the first step into a smaller number of topics – usually less than 10 items. Write a one or two sentence 'problem statement' for each problem (see attached description of the process). Retain a listing of the individual 'brainstorm' problems under the consolidated topics.

TASK 1c. **Prioritize the problem statements**. This process helps careful examination of each statement and possible further consolidation or better definition. It also assists making choices for the next step if time is limited.

TASK 2. **Data assembly and analysis.** Begin an exhaustive process to determine the facts and assumptions that are pertinent to your group's issues. What do we *know*? What do we *assume* we know? How do we justify our assumptions? What do we *need* to know?

TASK 3a. **Prepare short (1 year) and long-term (5 years) goals** (maximum and minimum) for each problem. Goals are intended to guide actions to help solve the problem. There will likely be more one goal needed. You also may develop sub-goals for a complex goal.

TASK 3b. **Prioritize each of the goals across each problem within your own working group**.

TASK 3c. **High-priority working group goals are brought to plenary and the entire set of goals is prioritized by the full body of workshop participants under a single set of criteria.**

TASK 4. **Develop and prioritize Action Steps for each of the high priority goals identified by the full body of workshop participants.** These priority actions will form the body of the recommendations from the workshop. Use the attached example information on the **characteristics** of action steps and **information** to be included with each action.

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Al Ain Wildlife Park and Resort
Al Ain, United Arab Emirates

Task 1: Problem Statements

Purpose: To focus the analysis by further defining your group's priority issues and identifying the root causes of the problems

Steps:

1. Discuss the issues that fall within your group's topic. Add any other issues you feel are missing.
2. Try to separate "problems" from "needs" in your analysis
3. Group the issues into categories or themes.
4. Prioritize the issues or groups of issues using paired ranking (see handout)
5. Using the "rule of 5 whys', attempt to get at the root cause of the problem.
6. Prepare a written problem statement of 2-3 sentences for each issue or group of issues.

Things to consider in preparing the written problem statement:

- Is the problem stated objectively?
- Is the problem within the scope of the program and the people involved?
- Does everyone have a common understanding of the problem?
- Does the statement include the whys?
- Avoid including any 'implied solution' in the problem statement. (Solutions come later).

Prioritizing Identified Issues

Steps:

- Create a simple list of the identified issues on a flip chart page.
- Use a technique such as paired ranking to prioritize the identified issues. Your group may wish to develop and rank a list of criteria against which the identified issues can be evaluated, and then proceed with a paired-ranking process using a matrix. Facilitators can assist you with this process.
- Number the issues on the flip chart page according to priority.

Scimitar – Horned Oryx (*Oryx dammah*) Conservation and Reintroduction Workshop

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Al Ain Wildlife Park and Resort
Al Ain, United Arab Emirates

PROBLEM STATEMENTS

Guidelines and Steps

Divergent Thinking

- More ideas the better
- Build one idea upon another
- Unusual ideas are okay
- Do not evaluate ideas
- Brainstorm
- Cluster and group ideas and formulate problem statement
- Prioritize problem statements using a technique such as paired ranking

Examples:

A well-formed statement:

> There are many areas of uncertainty in our understanding of the biology, ecology and genetics of the Hainan gibbon in Bawangling Nature Reserve. This uncertainty leads to considerable difficulty in identifying defensible quantitative targets for successful population management.

A statement that needs some more work:

> The governmental authorities need to reduce their emphasis on economic development in and around Hainan gibbon habitat and, instead, focus their efforts on more dedicated conservation action.

Scimitar – Horned Oryx (*Oryx dammah*)
Conservation and Reintroduction Workshop

16 – 19 November, 2009
Al Ain Wildlife Park and Resort
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Task 2: Data Assembly and Analysis

Purpose: To develop a detailed working knowledge of the facts and assumptions that are pertinent to your group's issues

Steps:

1. For each of the major priority issues you have defined, ask yourselves the following questions:
   - What are the facts or data that we have concerning this issue?
   - What are our assumptions surrounding this issue?
   - How do we justify our assumptions?
   - What important data are missing that would better help us address this issue?

2. Group the data by importance if possible, using appropriate criteria. Priority can be given at a basic level (high / medium / low), without having to resort to more detailed means such as paired ranking.

Things to consider when assembling your information sets:

- Be as detailed as you can when discussing these data; cite any relevant scientific studies you have consulted, give specific geographic locations for original data, and specify unpublished sources where appropriate.

- Don't hesitate to use additional devices to display your data in way that can be more easily understood. These devices can include tables, matrices, or causal flow diagrams.

The following pages give examples of various methods for assembling and analyzing information of value to the PHVA process.

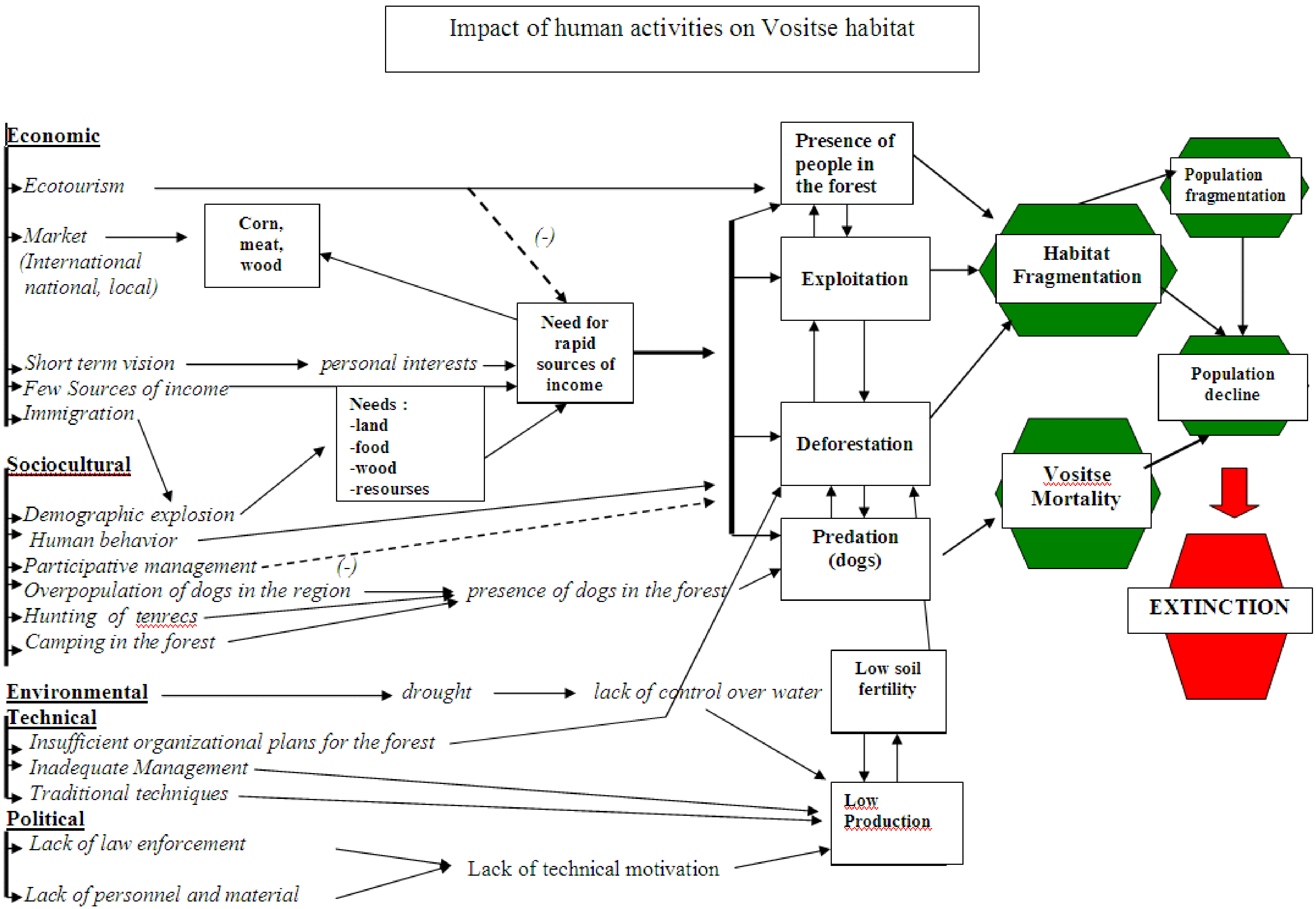
Data Assembly and Synthesis

Issue 1:

Housing development in sagebrush ecosystems results in permanent loss of sage-grouse habitat to residential and commercial uses.

Facts	Assumptions	Information Gaps	Regional Specificity	Bibliography
Housing development is increasing in SG occupied habitat in Colorado in past 15 years.	Housing will continue to increase in SG occupied habitat	Amount and location of second home development (may be able to get some related info from NW Council of Governments web site)	Middle Park, Meeker – White River, NESR, Zone 4B of NWCO	Theobald 2005; CensusScope 2006
Very large ranches have been subdivided into large parcel (100+ acre) subdivision over which regulatory agencies have little control	Subdivision is expected to continue		Grand County	Grand County GIS, county planning records, aerial photography
35-acre parcels have been subdivided into 12/13-acre parcels	Subdivision is expected to continue		Grand County	Grand County GIS, county planning records, aerial photography
Current parcel data and population data that went into PVA model	Population projections, accompanying housing growth, distribution of future housing among parcel size classes	Commercial development	MP, MWR, NESR, NWCO Zone 4B	Colo. Dept. Local Affairs (PVA housing background document, rangewide plan)

Example from Colorado Greater Sage Grouse Statewide Conservation Planning Workshop Final Report (2006)



Example from Madagascar Giant Jumping Rat Population and Habitat Viability Assessment Workshop (2001)

Table 3-1. Ugandan Chimpanzees: Status and Distribution

								Chimpanzee Populations						Human Populations		
Site	No.	Blk.	Status	Area (km^2)	Altitude	Habitat	Continuity	Presence	Quality	Density	N	Survey	Patrols	Dens.	Imm.	Cult.
Mt. Kei	1	A	CFR	200?	Medium	W	C	?		L?	0?	3	0	L	-	0
Otzi	2	B	CFR	50?	Medium	W	C	+		L?	0?	3	0	L	-	0
Rabongo	3	C	NP	2.5 (200 tot)	Medium	G	R/C	+	S	L	20		F	L	-	0
Budongo	4	C	CFR	430 (825 tot)	Medium	THF/G	C/R	+	C	H	650		F	L	+	0
South of Budongo	5	D	CFR & no protect	10	Medium	W	F/R	?		L	0?	3	0	L	+	S
Bujaawe-Wanibubaya	6	E	CFR & no protect	15	Medium	G	F/R	?		L	25	3	0	L	-	S
Bugoma	7	E	CFR	365	Medium	THF/G	C	+	S	H	450	2	S	M	+	S
Kasato	8	E	CFR & no protect	250?	Medium	Mosaic	F/R	?		L?	100 ?	1	0	M	+	S
Kagombe-Kitechura-Matiri-Ibambaro	9	E	CFR & no protect	300?	Medium	Mosaic	C/F/R	+	S	L?	100 ?	1	S	M	+	S
Itwara and Surroundings	10	E	CFR & no protect	>87	Medium-High	THF	C	+	S	H	100		S	H	-	S
Buyaga area (N)	11	E	No protect	400?	Medium	W	F	?		L?	50?	3	0	M	-	H
Mwenge	12	E	No protect and private	700?	Medium	G/W	F	+		L?	50?	3	S/0	H	-	H
Kibale	13	E	NP	400 (760 tot)	Medium-High	THF/G	C	+	C	H	550		F	H	-	S
Semliki Valley	14	F	WCA	15 (200 tot)	Low	G	R	+	S	L	60		F/0?	L	-	0
Semuliki	15	G	NP	219	Low	THF	C/F	+	S	L	150	2	F	L	-	0
Ruwenzori North	16	G	CFR	2.5	High	THF/G	C	+	S	L	0		0	H	-	0
Ruwenzori	17	G	NP	120 (966 tot)	High	THF/G	C	+	S	L	50	2	F	H	-	0
Dura R., E. Kasese	18	H	NP	200?	Medium	G	R	+		L	30	3	S	M	-	0
Kasyoha-Kitomi, Kyambura	19	I	CFR & NP	399	Medium	THF/G	C/R	+	S	H	500	2	S	H	-	0
Kalinzu-Maramagambo	20	I	CFR & NP	580	Medium-Low	THF	C	+	C/S	H/L	350		S	H	-	0
Ishasha	21	I	NP	0.2	Low	G	R	+	S	L?	25	3	F	H	-	0
Bwindi	22	J	NP	321	High	THF	C	+	S	L	100		F	H	-	0

Notes (Refer to text for details):
Number: refer to map, page 43
Status: CFR, Central Forest Reserve; NP, National Park; WCA, Wildlife Conservation Area
Block: refer to map, page 43
Area: Chimpanzee habitat. Numbers in parentheses show total protected area of site if larger than suitable chimpanzee habitat area
Altitude: Low, <1200m; Medium, 1200-1800m; High, >1800m
Habitat: W, Woodland; G, Galley forest; THF, Tropical high forest
Continuity: C, Contiguous habitat block; R, Riverine strips; F, Fragmented forest habitats
Data Quality: C, Census data; S, Survey only
Dens. (Density): L, Low; H, High
Patrols: 0, None; S, Some; F, Frequent
Imm. (Human Density): L, Low; M, Medium; H, High
Cult. (Cultivation): 0, None; S, Some; H, High levels

Example from Chimpanzees of Uganda Population and Habitat Viability Assessment Workshop Final Report (1997)

Scimitar – Horned Oryx (*Oryx dammah*)
Conservation and Reintroduction Workshop

16 – 19 November, 2009
Al Ain Wildlife Park and Resort
Al Ain, United Arab Emirates

Task 3: Goals

Purpose: To identify directions in which to proceed in order to address the stated problems. Once problem statements are generated, the process of developing goals under each begins.

Steps:

1. Look at your group's problem statements and the data you have assembled. Develop specific goals you can focus on to address the problems. Goals should be measurable and contribute to achieving your overall conservation objective for the species. Specify minimum and maximum goals to achieve in the next year and in 5 years. Develop goals for each problem. There can be more than one goal but they should be in order of priority.

2. Prioritize your group's goals using paired ranking.

Questions to consider:

- Does the goal contribute to reducing risk and work toward accomplishing the program?
- Does the goal add to knowledge that would reduce risk and assist the program?
- Does the goal reduce the uncertainty of the risk estimate?
- How would/could the goal be monitored or evaluated?
- If a habitat goal, to what degree is the goal spatially specific (or not)?
- How are risk assessment and risk allocation questions embedded in the goal?
- Are there ways to make judgments made on what's acceptable or not acceptable?
- Is the goal based upon agreed good scientific information? Is it scientifically credible?
- Are there agreed outcomes for evaluation of accomplishment of the goal?

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Task 3: Actions

Purpose: Action steps can be long- or short-term. They are achievable steps that will help you to reach your conservation goals.

Steps:

- Under each goal, list action steps needed to achieve the goal (i.e., break the goal into small, workable steps. Pass each proposed action step through your list of criteria. Those that do not meet the essential criteria need to be reconsidered or rejected.

Characteristics of an Action Step:

Specific **-** for each goal
Measurable **-** outcome or an indicator
Attainable – can be accomplished under current conditions
Relevant – helps solve the specific problem and needs to be done
Timely – can be undertaken in time to achieve the goal

Information to include in each Action Step

Description - a short statement which can be understood by a non-participant reader. Relate the action to achievement of a specific goal and solving the problem.
Responsibility – who **in the room** is responsible for organizing or doing the action?
Time line – beginning and completion of the action. Dates.
Measurable - outcome or result. A specific product or change in condition.
Collaborators or Partners – who is essential to get the action accomplished?
Resources
Personnel and time required
Costs – rough estimate
Special to project
Consequences – Expected impact or outcome or result of the action if accomplished. A change in condition or state of the situation Contribution to achievement of the goal.
Obstacles - For example: Specific conflicts in interests of stakeholders or regulatory requirements or lack of local support that may need to be resolved or specific lack of resources preventing accomplishment of the action.

Example Action Step

Problem Statement

The existing Recovery Plan for the Wyoming toad (*Bufo baxteri*) does not contain reasonable and biologically defensible recovery criteria

Goal

To develop a greater understanding of Wyoming toad population biology in order to refine quantitative targets for successful species recovery in the wild.

Action

Collect accurate demographic and ecological data from toads in the wild through a local demographic study. Collect information while monitoring existing toads and new releases. Data to be collected include:

- Number of egg masses
- Number of males calling
- Capture – recapture (throughout summer).
- Three consecutive days, repeated 3-4 times in the summer, (robust model) will give interval survival and population estimates for individual episodes. Protocols for such a study can be found in Heyer et al. 1994; Corn et al. 1997.
- Use of habitat by different age classes of toads (telemetry using temperature sensitive transmitters)
- Hibernation sites, selection by different age classes (telemetry using temperature sensitive transmitters)
  - *Responsible Parties*: United States Fish and Wildlife Service (USFWS)
  - *Timeline*: Begin spring 2001, continue every year
  - *Outcome*: Accurate demographic data for use in new risk modeling efforts; information on success of releases of toads
  - *Collaborators*: University of Wyoming, United States Geological Survey (USGS), Colorado State University, Wyoming Game & Fish, American Zoo and Aquarium Association (AZA)
  - *Costs*: This would require a full time technician (mid-May – mid September). Approximately $10,000 for gear and vehicle. Government-employed technician about $1000 for 2 weeks, approximately $8,000 for 16 weeks.
  - *Consequences*: Better estimates of population parameter estimates for use in modeling; refinement of targets in recovery plan; collection of data to monitor success of introductions. Consequences of INACTION: inability to construct realistic models, inability to respond appropriately to problems with reintroduction, **inability to make management decisions based on data**
  - *Obstacles*: The major obstacle is a reluctance on the part of the "recovery team" to allow comprehensive research e.g. handling and capture – recapture, funding.

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Filters or Criteria for Selection of Projects

Purpose: Develop criteria to be used in the selection and prioritization of specific actions, projects or programs.

Examples of program filter questions:

- Is the activity/project relevant?
- Does it contribute to achieving the overall goal(s) of species conservation?
- Will it contribute to finding a solution to a high priority problem?
- Can it be done? Is it realistic/feasible?
- Does it fall within the core competencies of those responsible for implementation?
- Do we have the capacity to do it?
- Will the activity/project have wide impact?
- Is there a high degree of urgency for work in this area?
- Is the activity/project innovative?
- Does the activity/project address new issues?
- Will the activity/project be a priority for funding agencies?

Steps:

1. In your working group, review the list of example filters above.
2. Revise the list to reflect the concerns and specific needs of your group and this workshop.
3. Write the revised list of filters on a flip chart and then determine which filters absolutely must be met in order for an action to be accepted.

You can write the filters on a flip chart and then determine which filters absolutely must be met in order for an action to be considered for inclusion**.**