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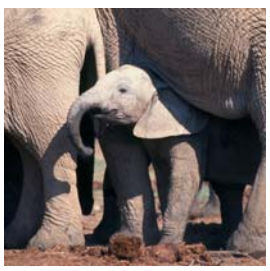
The Living Landscapes Program is a Wildlife Conservation Society initiative that identifies, tests, and implements wildlife-based strategies for the conservation of large, wild ecosystems integrated within wider landscapes of human influence.



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SETTING POPULATION TARGET LEVELS FOR WILDLIFE CONSERVATION: HOW MANY ANIMALS SHOULD WE SAVE?

How many animals do we want to save?

What does it mean to conserve a species within a landscape? Site-based conservation of species typically focuses on populations. By population we mean a group of individuals of the same species with the potential to interbreed. In practice, populations can be difficult to define; nevertheless, populations are a commonly used unit for species-level conservation planning and are often the basis for legal protections, as in the US Endangered Species Act. The objective of the Landscape Species Approach (see box) is to conserve populations of the Landscape Species at the desired level (the "population target level" or PTL). This bulletin describes how to set PTLs for Landscape Species and other animals.

Population target levels are complicated because people relate to and value wildlife very differently and this influences their feelings about what constitutes desired animal populations. People's attitudes to wildlife are often based on the economic, cultural, aesthetic, and spiritual benefits that animals provide,

Key Concepts:

- Wildlife provide many different benefits to people. These benefits include economic, cultural, aesthetic, and spiritual benefits directly, but also indirectly through ecological functions and ecosystem and landscape representation. These different benefits lead to different goals for animal conservation.

- Population target levels refer to the number of animals we want to save in a specific place. The target number of animals can range from hundreds to thousands to millions, depending on the goals being satisfied. Common ways to set population target levels focus on demographic sustainability, ecological function, historical levels, and economic gain. In many cases, reference situations (either in protected areas or reconstructed through historical research), can help us set meaningful population target levels. Analytical approaches can also help.

- There is no one right population target level for all time. The number of animals we conserve will vary in an incremental fashion as our conservation efforts proceed and stakeholder attitudes evolve. Conservation should first ensure that the population is self-sustaining, then work to ensure that the population fully interacts with its environment. Conservation then might aim for allowances for human use, above the levels necessary to maintain ecological integrity. Finally conservation should work toward historical levels, when people had collectively less influence on the planet.

and perpetuating these benefits typically requires that we maintain certain qualities of the population including evolutionary potential, demographic sustainability, ecological function, and social dynamics. Sometimes we seek to conserve wildlife population at historical baselines, or to have as many animals as possible, or just to conserve the status quo (no losses). At other times we conserve animals for what they provide us in terms of conservation of other parts of nature. This is particularly true for animals that are umbrella species, indicators, flagships, or are representative of the landscape itself (i.e., Landscape Species).

Each of these different reasons for animal conservation leads to different PTLs, with different guidelines and analytical methods needed to determine them. Here we review a subset of the methods that are particularly relevant to Landscape Species conservation.

Demographic sustainability

Demographic sustainability, or population viability, is often seen as the lowest common denominator PTL, since most conservation efforts seek to avoid extinction, at the least. Because the demographics of populations have long been studied by ecologists and are amenable to mathematical modeling, a family of related modeling tools called population viability analysis (PVA) has been developed to model future sustainability of populations.

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The Landscape Species Approach

The Landscape Species Approach is a wildlife-based strategy to define ecologically meaningful conservation areas, recognizing the complexity of the biological and social landscape in which conservation occurs (see Living Landscapes Bulletin #2). The Landscape Species Approach depends on selecting a set of species with complementary ecological needs. This suite of Landscape Species collectively represents the biodiversity of the landscape as a whole (see Living Landscapes Bulletin #3). Conservation of the suite of Landscape Species should therefore lead to conservation of not only those species, but of all biodiversity on which both wildlife and people depend.

PVAs have often been used to estimate "minimum viable populations (MVP)", a population target level that enumerates the lowest population size that can persist over a long time period (typically defined as 100+ years or 40 generations) at a given probability (typically 90% or 95%). Although MVPs represent the minimum population level needed for conservation, their numbers can still be quite large. A recently published review of MVPs for 1198 species found a median MVP of ~1400 individuals, though the distribution of MVP values was quite broad across species. Another review argued that conservation efforts should aim to protect the habitat for at least 7000 adults to ensure demographic sustainability. These general guidelines are important for showing us the magnitude of population sizes necessary (generally >1000), and for providing us with a benchmark when species-specific PVAs are unavailable. PVAs are often difficult to implement because they require long-term, and often expensive, studies of animal demographics to estimate the parameters properly.

Fortunately, the tools of PVA can estimate more than these minimum levels. We can also reverse engineer the tool to establish the demographic parameters such as growth rate and fecundity, that are required to achieve a desired PTL (including those levels that seek more than just demographic sustainability), and then direct our management actions to achieve those demographics.

Ecological function

In some cases animals may persist at demographically sustainable population levels, but they persist at such low numbers that they have little or no effect on other species or on the ecosystem as a whole – i.e., they are ecologically extinct. Studies of ecological extinction, and worries about the functional consequences of animals conserved only to MVP, have led to calls for "ecologically effective" or "ecologically functional" populations. To do this, population target levels should be set high enough that the population interacts strongly with other species and ecosystem processes. In the case of keystone species, the structure of entire ecological communities may depend on these strong interactions.

The level at which a population becomes ecologically functional is something scientists are still striving to understand. If we assume that animals in well managed protected areas have reached populations levels based on ecological interactions, then they must, by definition, be ecologically functional. We can then view these as reference populations whose ecological functions can be studied and numbers censused. It may also be possible to adaptively manage conservation efforts while simultaneously monitoring key ecological functions of the population, until the functions, and thus the population, reach the desired level. Historical information from times that predate major human influence may also provide a guide to ecologically functional population levels.

Because functions often relate to the density of animals (the number of animals in a given area), specifying PTLs for ecological function may also require specifying desired density levels as well.

Social dynamics

For many species, social dynamics are part of what we seek to conserve, especially for species that gather in spectacular aggregations for breeding or migration. Ethological studies showing how behavior and social dynamics change with population size may identify population thresholds where certain desired behaviors occur. Some behaviors are necessary for maintaining effective population sizes, especially in species with strong sociality. As with ecological function, many of these social dynamics are density-dependent.

Economic benefits

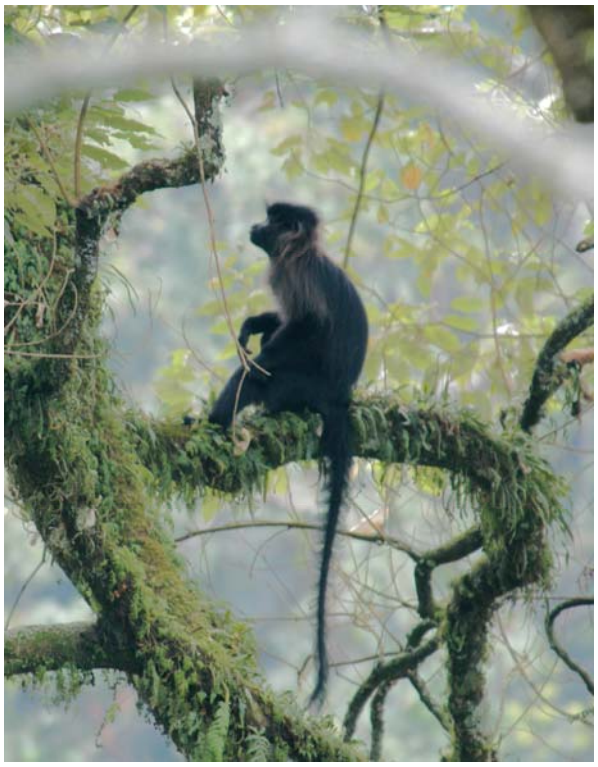
People derive a variety of economic benefits from consumptive and non-consumptive uses of wildlife populations; many of these depend on population size. Many harvestable species have quotas for off-take based on population sizes set by maximum sustainable yield (MSY). Unfortunately there are several known examples where MSY was either misestimated or not adhered to, resulting in population collapses that have been disastrous for both the species and the economic actors using the resource (many of these examples can be found in the fisheries sector). However, if properly managed, consumptive uses can provide sustained economic benefits, and a strong rationale for conserving some animal species.

Animals also provide non-consumptive economic benefits to people. The worldwide benefit of ecosystem services has been estimated to be larger than the entire human economy. Services provided by animals include seed dispersal, nutrient redistribution, landscape engineering, and pollination. Wildlife often enhance tourism opportunities that can provide important inputs to local and national economies through user fees, guide services, food, accommodation and other

economic multipliers. Setting population target levels for non-consumptive uses dovetails nicely with other methods for setting target levels; for example, assessing how aesthetic properties benefit tourism, or how ecological functions contribute to ecosystem services.

Cultural benefits

Beyond economic benefits, animals are often extremely valuable to people as part of our sense of place (what would Africa be like without lions?) and as an integral component to many traditions (including their use in cultural practices such as hunting). Many of these practices require finding animals in the wild and interacting with them in some way; thus populations that satisfy cultural benefits must be abundant enough that humans can find them frequently enough to use them as desired. Integrating ethnographic analysis of encounter rates over cultural use areas could thus yield a PTL, and in fact many recreational managers do just that, through formal and informal means (one fisheries manager used this method to set "recreationally viable population" levels).



Historical baseline

Historical baselines are often used in combination with other information to set population target levels for ecological restoration efforts. Although specific time-points can be selected to guide restoration, restoration ecologists today are more likely to stress restoration of processes that result in population sizes within the "natural ranges of variability," citing times when humanity as a whole had significantly less impact on the natural world than it does today. We know that in historical times, populations of some species were remarkably higher than today, to the extent that sometimes it is difficult to believe some accounts because our "baseline" ideas about what is possible have changed so much. These historical levels not only set an outer bound on what is possible, they can often inspire us to better conservation efforts.

How many Landscape Species do we want to save?

Landscape Species are selected to serve multiple purposes simultaneously. By conserving Landscape Species populations, we strive to reap the accompanying benefit of conserving other species in the same large area that the Landscape Species use and in the same habitat types and management zones. We try to conserve the functions that the suite of species plays in the landscape, especially those that are important for maintaining the structure and function of ecosystems. Finally, Landscape Species are selected to represent threats from human activity and because they are socially or economically important to people. All of these considerations figure in to the calculation of population target levels for conservation.

An incremental approach

When setting PTLs for Landscape Species, or animals in general, it is important to remember that conservation is typically an incremental process. When we set a goal for conservation it does not have to be fixed for all time in one place, but rather conservation is adaptively managed as circumstances change, for people, for species and for conservationists. In the case of animal populations, we have found it useful to think incrementally about our goals for animals. We call this approach "DEAP" for Demography – Ecological integrity – Allowance for human use – and Past (or historical) levels.

A DEAPer approach to setting population target levels

Combining these different ways of setting PTLs leads to the following recommendations:

(1) When first confronting a conservation situation, a premium should be placed on achieving demographic sustainability. This will require understanding what a reasonable MVP would be for the species and whether the population is above or below that level.

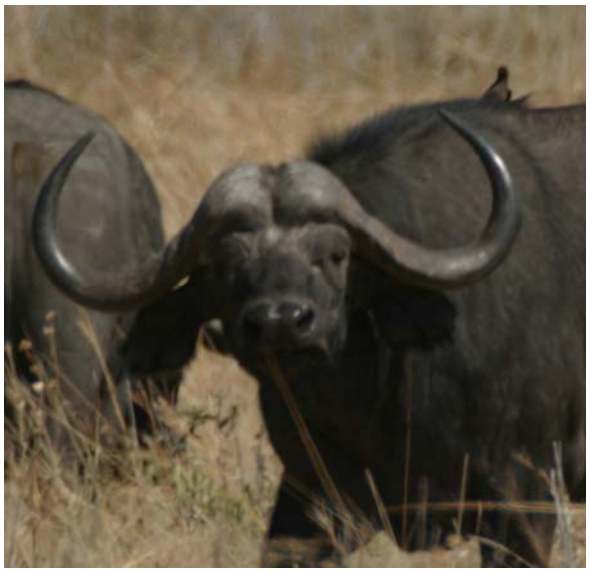
(2) As the situation improves, the focus should shift to ecological functions, behavioral aspects, and other ways in which the population "lives large" (that is, performs functions beyond persistence) and interacts with its ecosystem, evolves over time, and expresses its social dynamics, including the strange and spectacular. This encompassing PTL satisfies the ecological integrity of the population and includes specifying ecologically-effective densities as well as overall population size. Often we will have to refer to other places where the species is performing its ecological functions and use them as a guide. We might need to specify densities as well as ecological functions.

Table 1. Cross-tabulation of the four-tiered system[1] for setting population target levels (PTLs) against eighteen approaches to setting PTLs. The table shows whether the PTL at the top of column is necessary (N) to meet the PTL in the row but not sufficient, or necessary and sufficient (S).

	Demographic sustainability	Ecological Integrity	Allowance for Consumptive Use	Past (Historical) Levels
Population-based Target Levels				
Evolutionary potential	N	S	S	S
Demographic sustainability	S	S	S	S
Social dynamics[2]	N	S	S	S
Ecological function[2]	N	S	S	S
Historical baseline	N	N	N	S
Maximum	N	N	N	S
Status quo	N	S	S	S
Surrogate-based Target Levels				
Place representation	N	S	S	S
Ecosystem representation	N	S	S	S
Threats representation	N	S	S	S
Rallying point	N	N	S	S
Landscape representation[2]	N	N	S	S
Human-based Target Levels				
None	-	-	-	-
Economic benefits[2]	N	N	S	S
Cultural benefits[2]	N	N	S	S
Aesthetic benefits[2]	N	N	N	S
Spiritual benefits[2]	N	N	N	S
Ethical benefits[2]	N	N	N	S

[1]As a mnemonic device, this four-tiered system might be abbreviated "DEAP" for Demography-Ecology-Allowance-Past

[2]These PTLs may require specification of density as well as overall population size.



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(3) After these basic levels of conservation have been met, our population management should aim for margins that provide for those consumptive uses which are compatible with the traditional and economic uses of wildlife and do not endanger the ecological integrity of the population. Some uses are acceptable, or even desired, especially if they enhance conservation of the species or the landscape. Standard tools like maximum or optimum sustainable yield can be applied as long as they are set to maintain ecological integrity, and not just baseline survival, of the population.

(4) Finally, we should seek historical levels, based on reliable past references. Such levels will provide long-term resilience against regular disturbance and catastrophic events, from people or otherwise, and satisfy concerns regarding the huge influence that people have on wildlife today. Research may be required to establish, historically, what the range of population levels might have been. Moving through these four criteria may lead to higher target levels at each tier (demography< ecological integrity< allowance for consumption< past history), but this may not be the case. However, together they conserve species at a level which allows for nearly all that people want from animals (Table 1).

Actually assigning numbers to these four tiers is not easy (see Table 2), but there are some insights we can offer after considering a wide variety of PTLs. First, in setting population target levels, one often needs reference conditions in large, effectively protected areas or else in historical records. Part of why protected areas are so important is because they tell us what functioning nature actually looks like. These reference situations provide the easiest way to know what population target levels should be once our values are clear. Second, one might manage adaptively for a larger animal population while simultaneously monitoring the parameter of interest, whether that is seed dispersal (an ecological function) or spiritual satisfaction. Adaptive management provides a flexible tool that can allow managers to hone in on the desired management goals, including population size and density. Population viability analysis, along with various types of scientific research and modeling methods, rounds out the suite of techniques available to managers.

Where are we now?

Finally, no matter what population target level is set, in order to use it we need to know how big the population is to begin with. Wildlife surveys are an essential part of any wildlife conservation program, allowing us to set goals, monitor progress, and adapt to new circumstances. Counting wildlife, setting goals, and working with people are all integral parts of the Landscape Species Approach to conservation.

To investigate this topic further, read:

Sanderson E.W. 2006. How Many Animals Do We Want to Save?: The Many Ways of Setting Population Target Levels for Conservation. *BioScience* 56(11):911-922.

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Table 2. Population target levels set for the Rungwa-Ruaha landscape, central Tanzania.

Species	Current Level	Demographic Sustainability	Ecological Integrity	Allowance for Human Use	Past (Historical) Level	Population Target Level
Elephants	20,000 – 30,000, based on recent aerial surveys	MVP ~ 6000	~40,000, based on elephant densities elsewhere and size of landscape. Ecological functions include forest disturbance, nutrient redistribution, and creating water holes.	~ Zero. Very few legal trophy kills each year (~ 5 licenses for entire country). Elephants may be killed in human-wildlife conflict.	40,000 – 50,000, based on surveys in the 1980s	~40,000, to provide landscape-wide ecological integrity
African wild dogs	Unknown	MVP ~ 500	~1300, based on dog densities in Selous. Ecological functions include predation and interactions with other carnivores (mostly through subsidies.) Social dynamics include communal hunting and young rearing.	No consumptive use allowed. Wild dogs are often killed in human-wildlife conflict.	Unknown, but probably not more than ~1600	~1300, to provide landscape-wide ecological integrity
Hippos	~600, based on recent aerial surveys	MVP unknown (rule of thumb, ~1400)	Unknown. Ecological functions of hippos include nutrient redistribution from terrestrial to aquatic systems, trampling of vegetation, and aeration of dry season pools.	Hippos are hunted for meat markets, at apparently unsustainable levels currently.	~2200, based on aerial surveys in 1960s	~2200, initial guess for ecological integrity
Buffalo	40,000 – 80,000, based on recent aerial surveys	MVP unknown, but seems likely current levels are sustainable, though local declines have been observed.	Unknown. Ecological functions of buffalo include providing prey and carrion, and nutrient redistribution, and competition with other grazers.	Buffalo are an important hunted species in game reserves. Approximately 120 are taken per year. Large buffalo herds are declining in tourism area of Ruaha NP.	~60,000, based on past surveys	~60,000, to meet historical levels and provide ample buffalo for consumption

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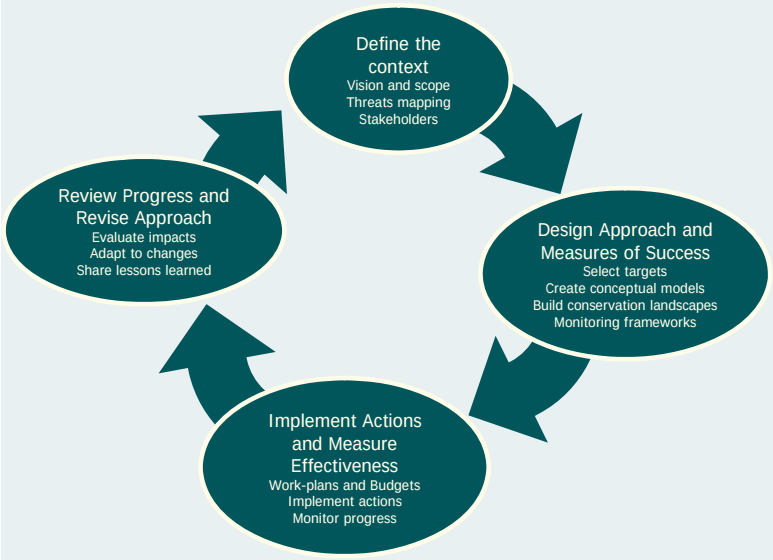
Living Landscapes Program

WCS's Global Conservation Programs work to save wildlife and wildlands by understanding and resolving critical problems that threaten key species and large, wild ecosystems around the world. Simply put, our field staff make decisions about what causes the needs of wildlife and of people to clash, and take action with their partners to avoid or mitigate these conflicts that threaten wildlife and their habitat. Helping our field staff to make the best decisions is a core objective of the Living Landscapes Program.



We believe that if conservation projects are to be truly effective, we must: (1) be explicit about what we want to conserve, (2) identify the most important threats and where they occur within the landscape, (3) strategically plan our interventions so we are confident that they will help abate the most critical threats, and (4) put in place a process for measuring the effectiveness of our conservation actions, and use this information to guide our decisions. The Living Landscapes Program is developing and testing, with our field programs, a set of decision support tools designed to help field staff select targets, map key threats, prepare conservation strategies, and develop monitoring frameworks.

We describe the application of these tools in a series of brief technical manuals which are available by email from:
conservationsupport@wcs.org

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