TECHNICAL MANUAL 7

August 2008

Building Conservation Landscapes - mapping the possible impact of your conservation actions

Planning for successful conservation projects

Effective wildlife conservation requires that we consider the complex mix of biological, social and economic factors that influence the ecological integrity of landscapes, and then focus our conservation efforts on activities that will have the most positive impact on wildlife populations and their habitat. By selecting species carefully and setting appropriate target levels for their conservation, we assume that conservation of the Landscape Species will result in conservation of the landscape itself. This requires that we clearly understand the ecological needs of species and the human activities that impinge on them.

The Landscape Species Approach (LSA), developed by WCS' Living Landscapes Program, provides the coherent framework and practical tools needed to guide site-based conservation based on the needs of wildlife within large landscapes of human influence (Sanderson et al. 2002). This step-by-step process for planning and implementing conservation actions includes: (1) conceptual models for clearly defining a program's goals and objectives, (*see LLP Technical Manual 2*), (2) a participatory approach for prioritizing and mapping human activities that threaten landscapes and the wildlife within them (*see LLP Technical Manual 1*), (3) an objective and transparent process for selecting a complementary suite of target species that if conserved, will help protect all biodiversity under their collective conservation canopy (i.e., Landscape Species; see Coppolillo et al. 2004 and *LLP Technical Manual 5*), (4) procedures for mapping habitat capacity of Landscape Species and the human activities which affect Landscape Species (see *Technical Manual 6*), (5) guidelines for creating a "Conservation Landscape" to map areas of the greatest conservation impact, (6) a process for prioritizing and strategically planning interventions, and (7) guidelines for developing effective monitoring frameworks (*see LLP Technical Manual 3*).

This manual is a short guide for how to construct "Conservation Landscapes" which, to put it simply, are maps that show the possible impact of conservation activities (Figure 1). Once you are able to see on a map the places in your landscape where your conservation impact could be higher or lower, you can begin to make decisions about where you will invest your resources and what kind of interventions will be most effective. By comparing the possible impacts represented in your Conservation Landscapes to your Population Target Levels (PTLs – see Key Terms), the potential costs of acting, and several other factors, you can make informed decisions about where you need to work (an upcoming Technical Manual will discuss the process of directing and focusing conservation interventions).

To complete the steps outlined in this manual, you should have in hand:

- **Biological Landscapes-** maps of the potential distribution of your Landscape Species in the absence of human activities (see Technical Manual 6- each Landscape Species will have one Biological Landscape);
- **Human Landscapes-** maps of the human activities which have, are, or will impact your Landscape Species (see Technical Manual 6); and
- **Population Target Levels (PTLs)-** the number of animals, for each Landscape Species, that you'd like to conserve (see Sanderson 2006 and Bulletin 8).

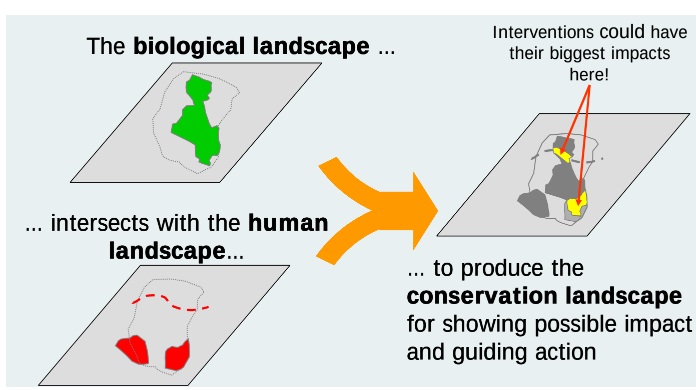


Figure 1. The conceptual overlay of the Biological and Human Landscapes to produce the Conservation Landscape.

Once you have the above, constructing a Conservation Landscape is really just a series of calculations, which can be summarized into six steps that need to be completed for each Landscape Species:

1. Translate the Biological Landscape into units of abundance.
2. For each Human Landscape, determine whether it threatens the Landscape Species.
3. For each Human Landscape, decide your approach for translating the landscape into a Threat Impact Map and incorporating it into your model:
   - Consider whether the human activity affects the Landscape Species by: 1) directly removing animals or 2) changing habitat.
   - Consider whether your Human Landscape represents: 1) the intensity of the human activity or 2) the amount of mortality caused by the activity.
4. Depending on the approach you've chosen, translate each Human Landscape into a Threat Impact Map.
5. Combine the relevant Human Landscapes and the Biological Landscape to calculate a Current Distribution Map.
6. Subtract the Current Distribution Map from the Biological Landscape to calculate the Conservation Landscape (for those actions aimed at recovery).

Consider taking this process further, to think about future threats and how you might prevent them from impacting your Landscape Species. Preventing future declines is often the most important thing for a conservation project to do, especially in cases when the population of the species is currently at (or above) your PTL, or when the species is close to extinction. If you have mapped or would like to map future threats, you can calculate a second version of the Conservation Landscape, one that reflects the possible impact of conservation in terms of *preventing future decline*. You would do this simply by repeating the above steps, but starting with your current distribution map and calculating a possible future distribution (see Figure 12).

Thus, your conservation impact can be measured either in terms of *recovery* (adding animals to the current population) or *prevention* of future declines in the current population.

Step 1: Translate your Biological Landscapes into units of abundance.

Biological Landscapes represent the potential distribution of a Landscapes Species in the absence of human activities (see Technical Manual 6). They are often first expressed in abstract units, like relative habitat capacity (or quality on a scale of 0-100, 0-4, etc.), that cannot be directly compared to Population Target Levels. In order to compare Biological Landscapes to your PTLs and combine them with the Human Landscapes (see the section "Using your Conservation Landscapes" at the end of this manual), you need to translate them into absolute units of abundance (e.g. numbers of individuals or biomass per mapping unit).

Recall from Technical Manual 6, that Biological landscapes are typically maps of habitat capacity or quality (see Key Terms). This is also true for the current and future distribution maps that you will make using the methods described here. For several reasons, our models are simplifications of complex population dynamics, and we expect that true abundances as measured on the ground will not exactly match the abundances that our models estimate (see Van Horne 1983 and Pulliam 1988). This is primarily because our models:

- are e*quilibrium* models (i.e., they assume that the environment is fairly constant, that populations have reached an equilibrium with that environment/habitat, and are not actively increasing or decreasing);
- do not describe metapopulation dynamics (i.e., they do not include how populations are redistributing themselves through time); and
- typically represent a discrete time frame (e.g., a model for a particular season or life stage).

Also recall that Important seasonal or life-stage differences in the landscape potential for particular species should be represented by separate Biological Landscapes. For example, for many marine species, it is important to create Biological Landscapes that represent their potential distributions during the spawning part of their life cycle to other times when they are feeding and growing. For terrestrial species, distribution is often very different during the winter and summer or the wet and dry seasons.

Key Terms

Conservation Landscape – a map that shows the possible impact of conservation activities in various places, typically expressed in units of abundance (e.g., number of animals or biomass). Conservation Landscapes can reflect the potential for increasing populations by mitigating past threats (population recovery) or the potential for preventing future decreases by mitigating future threats (prevention). Conservation Landscapes are similar to Threat Impact Maps, in that they show the possible effect of a human activity (i.e., conservation) on Landscape Species. Conservation Landscapes do not reflect costs of conservation activities or costs of working in particular areas, nor do they reflect political constraints or opportunities. As such, they are not necessarily a reflection of priorities for conservation, although they are a critical element for making such decisions.

Habitat Capacity – the ability of a place to support a species, best expressed in units of abundance. This concept of habitat reflects the effect of all natural constraints on the species, including the environment, physiographic, and resource constraints (e.g., water and food availability), but also the constraints imposed by other species, such as competitors and predators. "Capacity" reflects how many animals a place could support given these constraints. The Biological Landscape, therefore, generally should represent *potential* habitat capacity, meaning capacity in the absence of those human-mediated threats that the project can/will do something about. A "current" habitat capacity map should reflect the impacts of human activities that have occurred up to the current point in time, and a "future" habitat capacity should reflect likely future human impacts. "Habitat Capacity" in this sense will not necessarily reflect abundances as they are observed on the ground at a particular point in time, since populations are rarely in equilibrium with habitat conditions.

Population Target Level (PTL) – a quantitative estimate of your objective for conserving Landscape Species (i.e., how many animals you want to save). Population Target Levels are typically expressed in units of abundance, but can also be expressed in total biomass, density, or other units. Several increasingly ambitious Population Target Levels should be considered, including: demographic sustainability, ecological integrity, sustainable use, and historical levels. For the sake of comparison and to assess how much land is needed to meet PTLs, a project's Biological Landscapes, Threat Impact Maps, and Conservation Landscapes should all be expressed in the same units as their PTLs. See Sanderson (2006) and Bulletin 8 for more detail and methods for setting PTLs.

Threat – a human activity or a human-mediated process (e.g., disease transmission, climate change) that has had (past) or may have (future) negative impacts on biodiversity. More specifically, for the purposes of this manual, threats decrease the abundance of Landscape Species; either by altering habitat or by directly affecting the population (e.g., hunting the Landscape Species). While we tend to think of threats as "mortality factors", threats can also reduce abundance by decreasing reproduction, increasing emigration, or decreasing immigration.

Threat Exposure – either a measure of the probability that a threat will affect an area within a specified time *or* the expected time until a particular area is affected (Wilson et al. 2005). It is sometimes expressed as the "risk" that a threat will occur (e.g., the risk that disease will appear) . Although we do not explicitly include exposure in the examples in this manual, exposure is a dimension of threat that is important to consider when mapping "future threats". Past or current threats essentially have a 100% probability of occurrence in a landscape, although their intensity and impact may vary in space.

Threat Impact – refers to the *net effect* of a threat on the population of the Landscape Species or one of its habitat components (Wilson et al. 2005). Maps of Threat Impact can be expressed in *absolute units of abundance* (lost from or added to the population) or as *a percentage reduction in the population*. Maps of Threat Impact will ideally show the *net* effect of a threat (e.g., the net decrease in the population caused by hunting), rather than simply *gross* removals (e.g., the number of animals shot). In other words, the maps should account for compensatory population factors operating during the same period of time as the threat was occurring (e.g. 100 animals were shot between 2001-2005, but 25 were born, so the net impact of hunting was a decrease by 75 animals).

Threat Intensity – a measure of a Human Activity itself, irrespective of the effect the activity has on the Landscape Species (Wilson et al. 2005). In most cases, a map of Intensity will show the amount or magnitude of the activity in an area (e.g., number of hunters, number of livestock, or amount of pollution).

The simplest method to translate the relative units of habitat capacity into units of abundance is to estimate what the potential abundance would be at the best place in the landscape, and then rescale the rest of the landscape linearly down from that point to zero (see Figure 2). For example, for models scaled from 0–100, the best place in the landscape would occur where scores are 100. The highest potential abundance or density can ideally be taken from studies within your landscape (e.g., in the best habitat within a functioning protected area). It might instead be estimated from other "pristine" areas outside of your landscape where the species has been studied and the habitat is similar, or you may need to make an informed estimate (based on literature or expert opinion). However you decide to proceed, be sure to document the methods and rationale for how you set the highest potential abundance.

Step 2: For each Human Landscape, determine whether it threatens the Landscape Species.

Clearly, not all human activities negatively affect all Landscape Species. For example, in the Nouabalé-Ndoki Landscape in Congo, cable snaring is a threat for forest buffalo but not for elephants (who are too big for cable snares). For each human activity, consider whether it has had or will have important negative effects on the population of the Landscape Species (i.e., has it significantly lowered populations?). If a human activity does not have significant effects, there is no need to proceed through the following steps for that particular activity. Also, recall from Technical Manual 6, that the effects of certain human activities that your project cannot or will not do anything about (e.g., past land-cover conversion), should be incorporated into your Biological Landscape.

While many of the human activities that we consider directly cause mortality in some sense, threats can also decrease reproduction, increase emigration, or decrease immigration. For example, while disturbance caused by roads doesn't necessarily increase mortality, it can decrease reproductive success or simply reduce local abundances by increasing emigration. We use the term "mortality" for simplicity's sake, although it's important to recognize that what we call a "mortality" map could represent these other pathways by which threats can directly effect populations.

Step 3: Decide your approach for translating each Human Landscape into a Threat Impact Map and incorporating it into your model.

At this point in the process of making Conservation Landscapes, you should have a series of Biological and Human Landscapes in hand and have decided which Human Landscapes affect which Landscape Species. The next critical objective, which you'll complete in Step 4, is to translate each Human Landscape into a Threat Impact Map, representing the magnitude of reductions that a human activity has caused or will cause to the population of the Landscape Species or to particular habitat factors.

Step 4 presents four approaches for performing this "translation". Here, in Step 3, your job is to decide exactly which approach to take for each Human Landscape. This decision hinges on two critical questions, the answers to which will determine your approach (see Figure 3 for more guidance).

Question 1: How does the human activity affect the population of the Landscape Species in question?

Some human activities affect the Landscape Species by directly removing animals from the population. These activities may include hunting, fishing, collection of animals for trade, fishing bycatch, vehicle impacts, and human-mediated diseases. Other Human Activities affect the Landscape Species not by directly removing animals, but by altering components of their habitat, like food and water resources. These activities include logging, competition for food by livestock or other exotic species, hunting or poaching of a prey base, and pollution.

As you will see in Step 5, when calculating the Conservation Landscape, human activities that affect habitat components are typically incorporated *into* the models used to make the Biological Landscapes, and so are also referred to as "Inside" Threats. Human activities that directly remove animals from the population of the Landscape Species are, on the other hand, best applied *externally* to Biological Landscape itself, and so are referred to as "Outside" Threats.

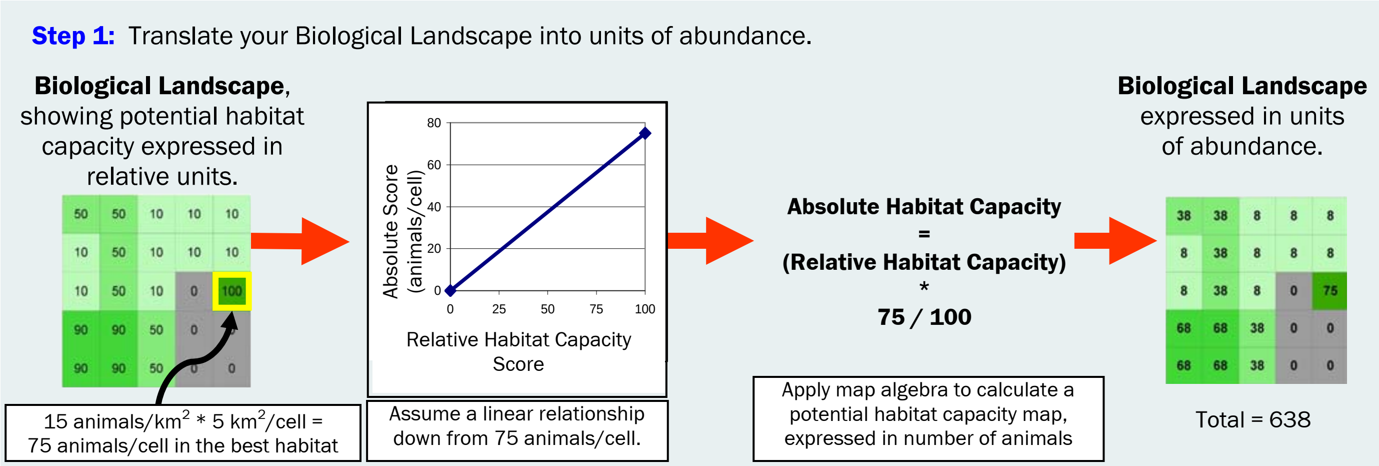


Figure 2. In this example, information from relatively pristine, excellent habitat provides an estimate of maximum equilibrium densities for the species of 15 animals/km2. We assume that this is the density we would observe in the best potential habitat in our landscape, and that densities/abundances scale down linearly from there with habitat capacity.

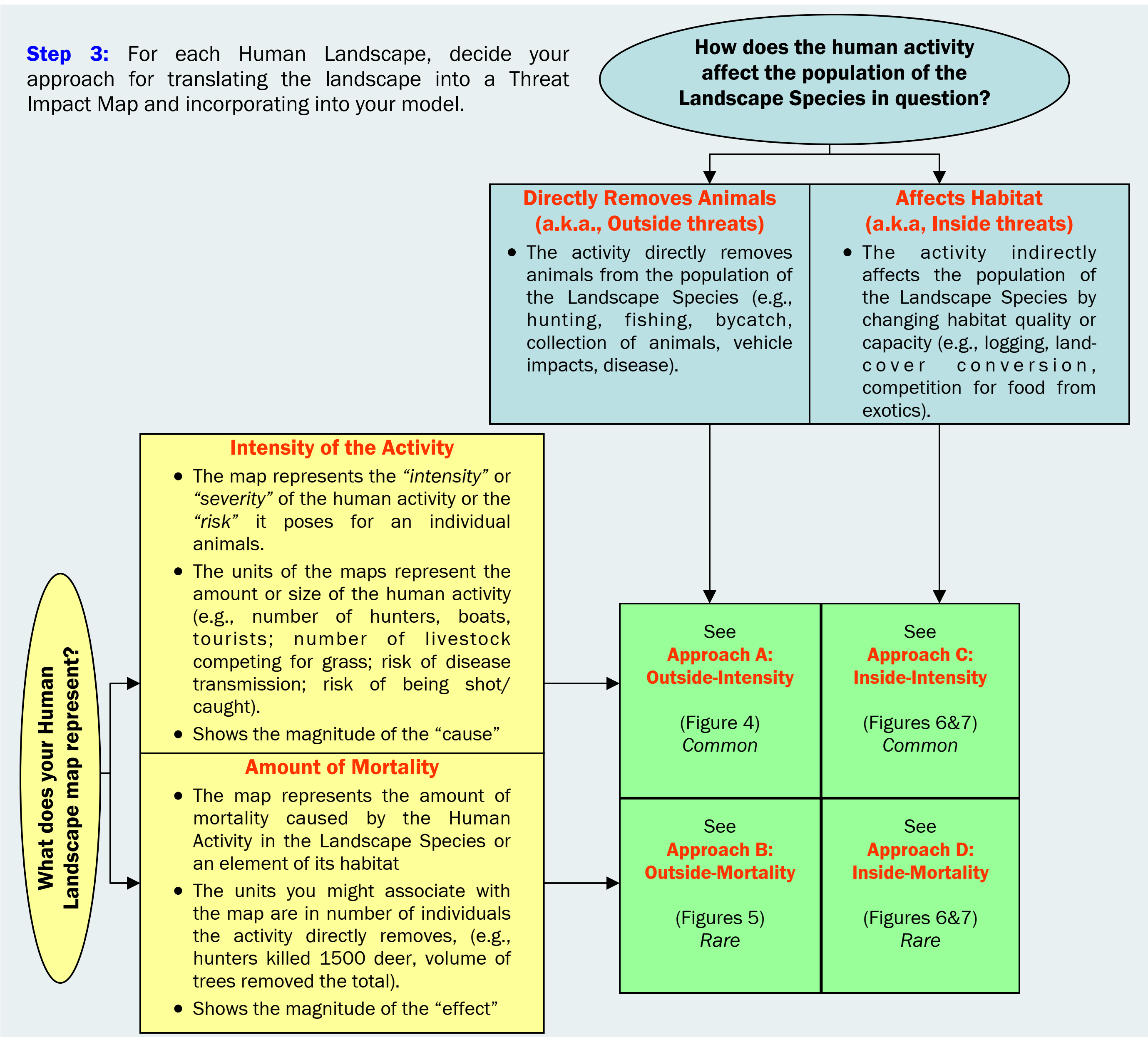


Figure 3. For each Human Landscape, you can use your answers to two key questions to guide you in your approach for translating the landscape into an Impact map and incorporating it into your model.

Question 2: What does your Human Landscape map represent?

A map of the Human Landscape typically represents one of two things. In most cases, the map represents the "intensity" of the human activity, such that the units you might attach to the map describe the amount of the activity (e.g., the number of livestock in a place, the number of fishing boats, the number of hunters, the frequency of fires). Maps representing the "severity" of the human activity or the general "risk" it poses for an animal, also tend to describe the amount of the human activity, and so, at least in our terms, can be considered maps of intensity. Most maps based on a cost-access type of model (e.g. hunting models) or human population information are Intensity Maps.

In a few cases, the Human Landscape represents the amount of mortality caused by the human activity, such that the units that you might attach to the map are actually the relative or absolute number of animals that were killed (or physically removed from the population, such as live collection of animals for trade). Maps of hunting or fishing offtake are the most common examples. Mortality Maps are surprisingly rare because they are usually based on field data collected by observers who physically monitor the number of animals that were killed or removed in various places in the landscape. This is important work, but because it is time consuming and expensive to do, it is done less often.

The answers to the two questions above result in four possible approaches for translating Human Landscapes into Threat Impact maps. See Figure 3 to help you choose which of the four approaches you should take. The "Outside-Intensity" and "Inside-Intensity" approaches are more common than the "Outside-Mortality" and "Inside-Mortality" approaches.

Step 4: Translate each Human Landscape into a Threat Impact Map specific to the Landscape Species.

After deciding on the approach that you will take, the next step is to translate each Human Landscape into a Threat Impact map. The four different approaches are illustrated in Figures 4-7. The two "Outside" approaches are illustrated in Figure 4 and 5. Figure 6 shows a model for a Biological Landscape without any threats incorporated into it, and Figure 7 show how to take maps representing the two "Inside" approaches and incorporated them into that model.

In the case of "Outside-Intensity" threats (Approach A), it is generally best to translate the Human Landscape into an Threat Impact Map expressed as a <u>percent decrease</u> in the population of the Landscape Species (e.g., hunting reduced the elephant population by X percent) (See Figure 4). In this case, the "translation" will involve expressing a relationship between threat intensity and the percentage of the population that the threat removes (e.g., X number of hunters reduce the population by Y percent of the population). For simplicity's sake, you can assume a linear relationship, although more complex curvilinear relationships are probably more realistic (e.g., a predator swamping relationship).

For "Outside-Mortality" threats (Approach B), it is best to translate the Human Landscape into a Threat Impact map expressed in <u>number of animals</u> (e.g., hunting caused a net reduction in population of X animals) or some similar measure of *absolute* abundance (e.g., logging caused a net reduction in forest volume of X m^3) (See Figure 5). Because "mortality" maps are typically *already* expressed in abundance units (number of animals), it is tempting to treat these mortality maps as the finished "Impact" maps we aim to create (i.e., maps showing the net impact that the activity has on the population), and skip this "translation" step. However, it can be problematic to do so because the maps usually show the *gross removal* of animals (100 animals were shot from 2001-2005), not the *net decrease* in the population caused by the threat (e.g., 25 were born during same period, so the net impact of hunting was a decrease by 75 animals). It is, therefore, usually necessary to "correct" the maps by estimating the number of animals that are added to the population (especially through reproduction) during the same period of time over which the mortality occurs; using information on reproductive rates if it is available.

For "Inside-Intensity" threats (Approach C), the translation step will essentially be the same as for "Outside-Intensity" threats, except that the maps will be expressed as a percent reduction in <u>a habitat factor</u> (e.g., prey available, water quality) as opposed to a percent reduction in the population of the Landscape Species (See Figure 7, top section).

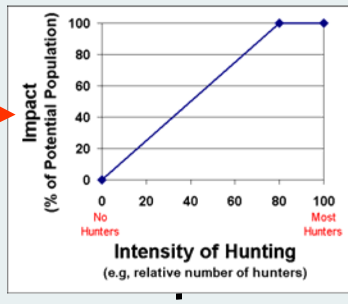
Approach A- "Outside-Intensity": The activity directly removes animals from the population of the Landscape Species, the map represents Intensity of the activity.

Step 4: Translate the Human Landscape into a Threat Impact map, expressed as a % decrease in the potential population.

Human Landscape - Hunting
representing the relative **intensity** of the activity – e.g., relative number of hunters

60	80	80	100	100
60	80	80	100	100
60	80	80	60	60
60	60	60	60	60
20	10	40	60	60

Where hunting intensity is greater than 80, all animals are removed from the population.



Assume a linear relationship down from 80%.

If (Hunting Intensity >= 80), Then Hunting Impact = 100, Else Hunting Impact = (Hunting Intensity * 100 / 80)

Apply map algebra to calculate an impact map, expressed as a % of the potential population.

Impact of Hunting
Expressed as % decrease in the potential population caused by the human activity.

75	100	100	100	100
75	100	100	100	100
75	100	100	75	75
75	75	75	75	75
25	12	50	75	75

Note, a situation could arise where it would be best to translate an intensity map, like the one shown in this example, into an impact map expressed as an absolute decrease in the population (# of animals; see Figure 5) rather than a percentage decrease. This is pretty rare in our experience, but could arise if hunter or trappers took a fixed number of animals no matter the density or abundance of those animals. This might be the case if there was a strict bag limit, or if hunters clearly adapted their effort in order to take a fixed number of animals (e.g., spending longer in the forest in order to shoot the deer they need). In most cases when your Human Landscape is an Intensity map, its probably best to assume that the net reduction in the population is both a function of the number of people (e.g., hunters) and the number of animals.

Step 5: Combine Biological & Threat Impact maps to calculate a Current Abundance map.

Biological Landscape
Potential Habitat Capacity (# of animals)

37.5	37.5	7.5	7.5	7.5
7.5	37.5	7.5	7.5	7.5
7.5	37.5	7.5	0.0	75.0
67.5	67.5	37.5	0.0	0.0
67.5	67.5	37.5	0.0	0.0

Total = 637.5

X (100 - **Impact of Hunting** (Decrease in the Potential Population)) / 100 =

75	100	100	100	100
75	100	100	100	100
75	100	100	75	75
75	75	75	75	75
25	12	50	75	75

By subtracting the map from 100, you are essentially converting from a mortality to a survival rate.

By dividing by 100, you are just converting back to the appropriate scale.

Current Habitat Capacity
(# of animals)

9.4	0.0	0.0	0.0	0.0
1.9	0.0	0.0	0.0	0.0
1.9	0.0	0.0	0.0	18.8
16.9	16.9	9.4	0.0	0.0
50.6	59.4	18.8	0.0	0.0

Total = 204.0

Notice! This example only involves one Human Activity map. What do you do if you have more than one Human Activity that fits this approach? You will need to chose whether the Activities act independently, in which case you add the maps together, or they interact, in which case you would multiply them. See Figure 9-10 for examples.

Figure 4. Approach A for translating and incorporating Human Activities into your model (Steps 4 & 5). This approach is common and is best used when you have a Human Activity map representing the intensity of the activity, and the activity directly removes animals from the population (as opposed to altering habitat).

Approach B- "Outside-Mortality": The activity directly removes animals from the population of the Landscape Species, and the map represents the amount of that mortality.

Step 4: Translate the Human Landscape into an Impact map, expressed in this case as an absolute decrease (# of animals) in the population.

Human Landscape: Trapping
Represents the mortality caused by the activity, measured in number of animals trapped in 2002.

60	60	15	15	15
60	60	15	15	15
30	30	30	0	75
30	30	30	0	0
30	30	30	0	0

/ 3 =

20	20	5	5	5
20	20	5	5	5
10	10	10	0	25
10	10	10	0	0
10	10	10	0	0

Because the population seems to recover easily from mortality because of a high reproductive rate (from field studies of reproductive rates), we assume that the net decrease caused by trapping on the population over time has been only 1/3 of the mortality it's caused.

Note. In the case of maps reflecting direct mortality of a Landscape Species, this translation step may or may not be necessary. Think about whether the spatial pattern in the map and the total reduction it shows represent long-term and persistent reductions in the population. If it represents just short term removals from the population, and does not incorporate how the population recovers for these removals, you may want to do some translation.

Step 5: Combine Biological & Threat Impact maps to calculate a Current Abundance map.

Biological Landscape
(# of animals)

37.5	37.5	7.5	7.5	7.5
7.5	37.5	7.5	7.5	7.5
7.5	37.5	7.5	0.0	75.0
67.5	67.5	37.5	0.0	0.0
67.5	67.5	37.5	0.0	0.0

-

Impact of Trapping
Expressed as an absolute decrease in the population, measured in number of animals.

20	20	5	5	5
20	20	5	5	5
10	10	10	0	25
10	10	10	0	0
10	10	10	0	0

=

Unadjusted Current Habitat Capacity
(# of animals)

17.5	17.5	2.5	2.5	2.5
-12.5	17.5	2.5	2.5	2.5
-2.5	27.5	-2.5	0.0	50.0
57.5	57.5	27.5	0.0	0.0
57.5	57.5	27.5	0.0	0.0

If <0, then 0

Apply map algebra to adjust the distribution map for negative values.

Current Habitat Capacity
(# of animals)

17.5	17.5	2.5	2.5	2.5
0.0	17.5	2.5	2.5	2.5
0.0	27.5	0.0	0.0	50.0
57.5	57.5	27.5	0.0	0.0
57.5	57.5	27.5	0.0	0.0

Figure 5. Approach B for translating and incorporating Human Activities into your model (Steps 4 & 5). This approach is fairly rare because few sites directly measure mortality caused by humans (e.g., number of animals killed or fished).

By translating a Human Landscape into a percent reduction, you are essentially assuming that the impact of the activity is dependent on two things: the intensity of the activity (e.g., number of hunters) and the density or abundance of whatever is being affected (e.g., the Landscape Species or a habitat factor). In most cases, this is a fairly reasonable assumption.

In some rare cases, it's advisable to translate Intensity Maps into Impact Maps expressed not as a percent decrease, but as an absolute number of animals (e.g., X number of deer were killed), in the same way as you would translate a map of mortality (Approaches B or D). Such a case could arise, for example, when there is a strict bag limit on hunting and hunters will adapt their effort to reach that bag limit, no matter how many animals are in a particular location. In this case, you are assuming that the impact of the threat on the population is dependent only on the intensity of the activity and essentially independent of the abundance or density of animals.

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Biological Landscape

Model description: The distribution of this hypothetical Landscape Species (some sort of omnivore like a bear) is primarily controlled by the availability of "unpolluted" water and food resources, which include both prey (maybe new-born ungulates), and fruit (seeds, berries, etc.). We have pretty good GIS data telling us where the water resources are, and how much there is. All of it would good quality, if humans weren't polluting it. We also have pretty good information, maybe from field surveys, on the abundance of ungulates. We don't, however, have direct information on the amount of fruit available, but we do have information on the distribution of the key fruit producing trees, which we assume reflects the distribution of fruit (if all species produce fruit equally).

A. Fruit Tree Volume (cubic meters)

130	130	32.5	0	0
130	130	32.5	130	0
97.5	97.5	97.5	97.5	130
97.5	97.5	97.5	32.5	32.5
130	130	130	32.5	32.5

A/130

Dividing tree biomass by 130 simply places the map on a relative scale of 0-100, so that we can combine it (on an equal footing) with the other variables.

B. Quantity and Quality of Water

100	100	100	80	60
80	100	100	80	60
60	80	100	80	80
60	80	100	100	80
60	80	80	100	80

C. Prey Availability

100	100	100	100	100
80	80	80	80	80
60	60	60	60	60
30	30	30	30	30
10	10	10	10	10

D. Fruit Availability

100	100	25	0	0
100	100	25	100	0
75	75	75	75	100
75	75	75	25	25
100	100	100	25	25

We multiply here because water (B) and food (C & D) can both limit the local abundance; and because prey (C) are preferred twice as much as fruit (D), we've given prey twice the weight. Dividing by 300 simply resets the scale to 0-100.

$$\frac{B * (2C + D)}{300}$$

E. Biological Landscape
Potential Habitat Capacity (relative units)

100	100	75.0	53.3	40.0
69.3	86.7	61.7	69.3	32.0
39.0	52.0	65.0	52.0	58.7
27.0	36.0	45.0	28.3	22.7
24.0	32.0	32.0	15.0	12.0

E * 0.4

Here we are just translating relative habitat capacity into absolute abundance units (see Step 1, Figure 2). In this case, we assumed 40 animals per cell in the best habitat.

F. Biological Landscape
Potential Habitat Capacity (#of animals)

40	40	30	21.3	16
27.7	34.7	24.7	27.7	12.8
15.6	20.8	26	20.8	23.5
10.8	14.4	18	11.3	9.1
9.6	12.8	12.8	6	4.8

Figure 6. An example of a model to build a Biological Landscape, for comparison with Figure 7 where Human Landscapes have been incorporated into the model. For more detail and examples, see Technical Manual 6.

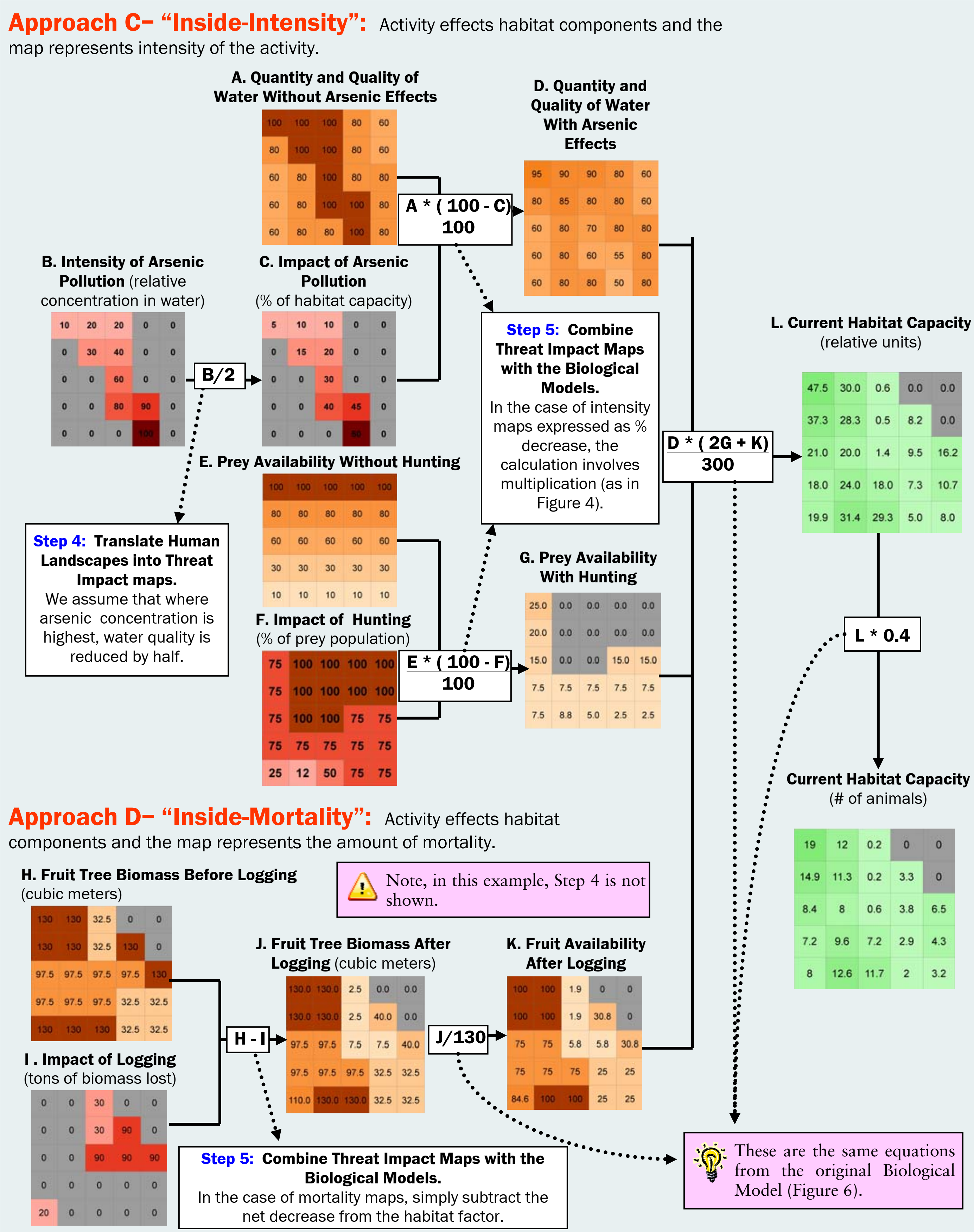

Figure 7. Approaches C and D (i.e., the "Inside" approaches) for translating and incorporating Human Activities into your model (Steps 4 & 5). When human activities affect habitat rather than directly causing mortality, the best approach is to incorporate the Human Landscapes within the model you used to create your Biological Landscape (see Figure 6). Approach C considers a Human Landscape representing the Intensity of the Human Activity, while Approach D considers Human Landscapes which represent mortality of habitat components (e.g., prey).

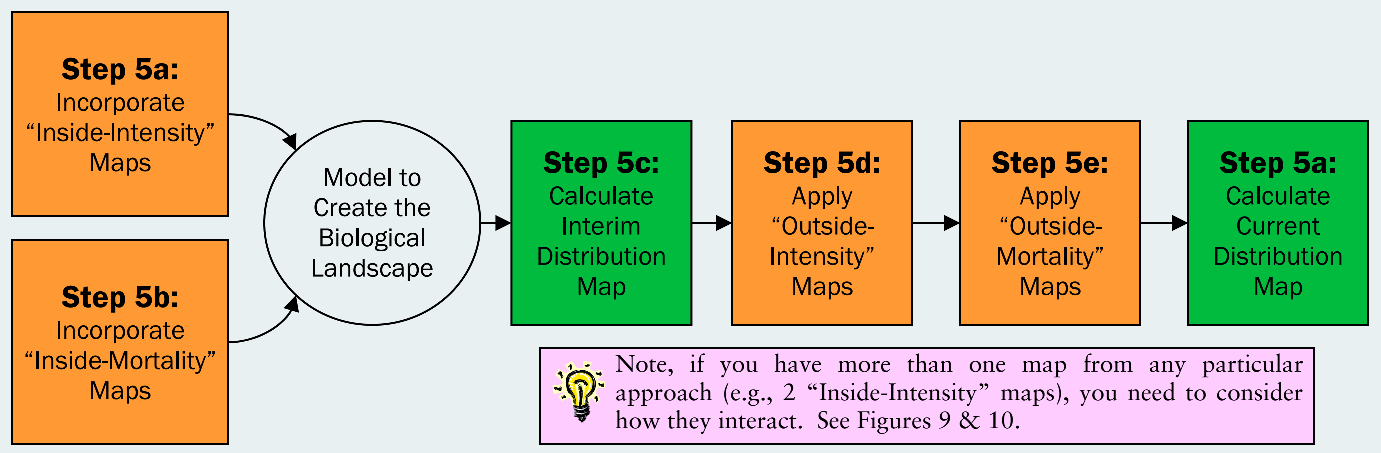

Figure 8. In most cases, multiple human activities affect any particular Landscape Species. If you are using different approaches for incorporating different Human Activities (e.g., "Inside-Intensity" versus "Outside-Mortality"), it is generally best to proceed in the order shown below, beginning first by incorporating "Inside" threats into the model used to produce the Biological Landscape.

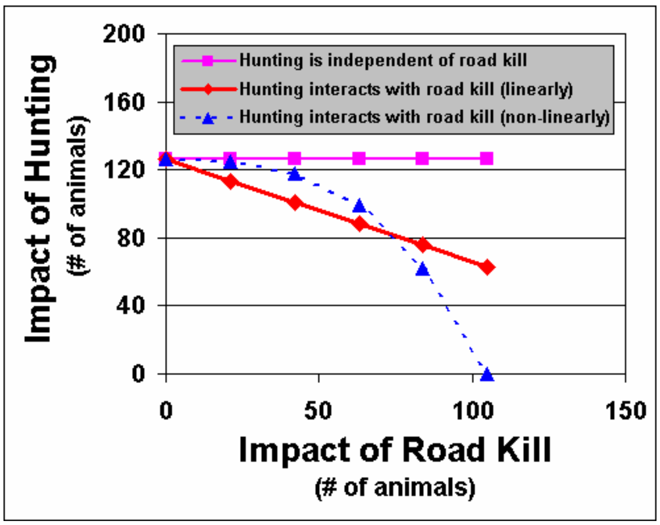

Figure 9. Human Activities can interact with one another in a variety of ways. The graph below shows some examples, where the impacts of hunting are independent of road kill, where the impacts of hunting depend on road kill (and vice versa) in a simple, linear fashion, and where the impacts of hunting are dependent on road kill in a more complex, non-linear fashion. When you add Threat Impact maps together, as in Figure 10a and 10c, you are assuming that the they do not interact. When you multiply them together, as in 10b, you are assuming that they interact in a simple, linear way.

Similarly, for "Inside-Mortality" threats (Approach D), the translation will essentially be the same as "Outside-Mortality" threats, except that the maps will be expressed in the units of <u>a habitat factor</u> (fruit biomass, prey species, etc.) as opposed in units of the Landscape Species itself (See Figure 7, bottom section).

Step 5: Combine the relevant Threat Impact Maps and the Biological Landscape to calculate a Current Distribution Map.

Once you've translated your Human Landscapes into Threat Impact Maps relevant for a particular Landscape Species, you are ready to produce a map of the current distribution. To create this map, you will need to combine the Biological Landscape (potential distribution) with your Threat Impact Maps. How you will perform this combination will depend on what approach you've chosen (refer to Figures 4-7 for a review of each approach).

For Threat Impact Maps expressed as a percent reduction (i.e., those translated from Intensity Maps), the calculation usually involves multiplying your Biological Landscape (Approach A: Outside-Intensity) or a habitat factor (Approach C: Inside-Intensity) by the Threat Impact Map. For Threat Impact Maps expressed as an absolute reduction in abundance (i.e. those translated from Mortality Maps), the calculation usually involves subtracting your Threat Impact Maps from the Biological Landscape (Approach B: Outside-Mortality) or a habitat component (Approach D: Inside-Mortality).

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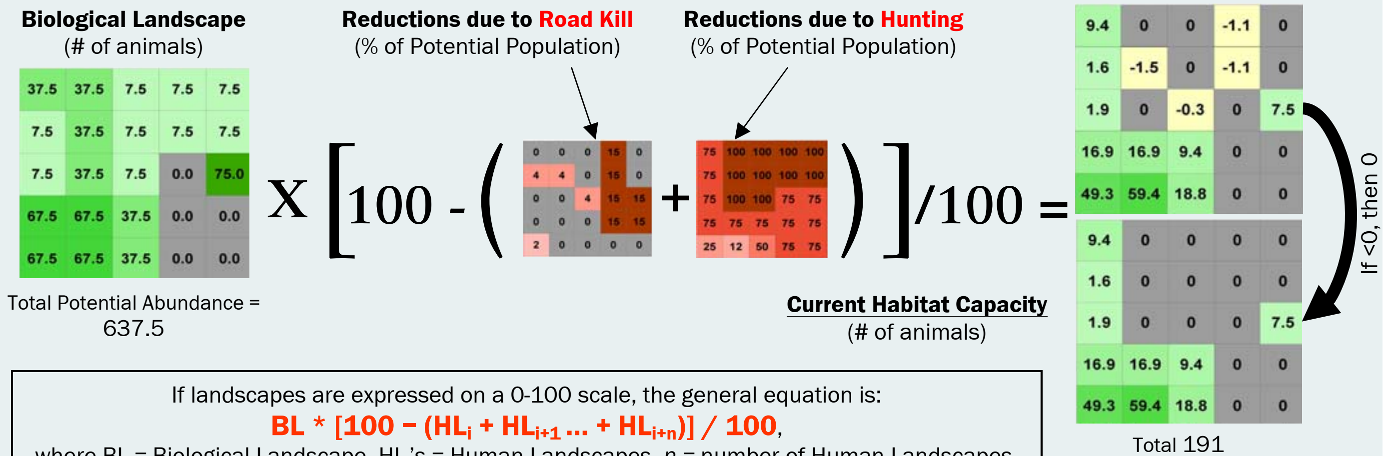
Example A. Combining "Intensity" maps by adding. This approach assumes that Human Activities work independently when affecting populations – that the affect of any one activity is completely independent of the affect of other activities. For example, 100 hunters will shoot the same number of deer, whether or not animals are getting hit by cars in the same area. In this case, Human Landscapes are basically added together. In some cases, you will need to use a conditional statement to eliminate negative values in the resulting map of the current distribution.

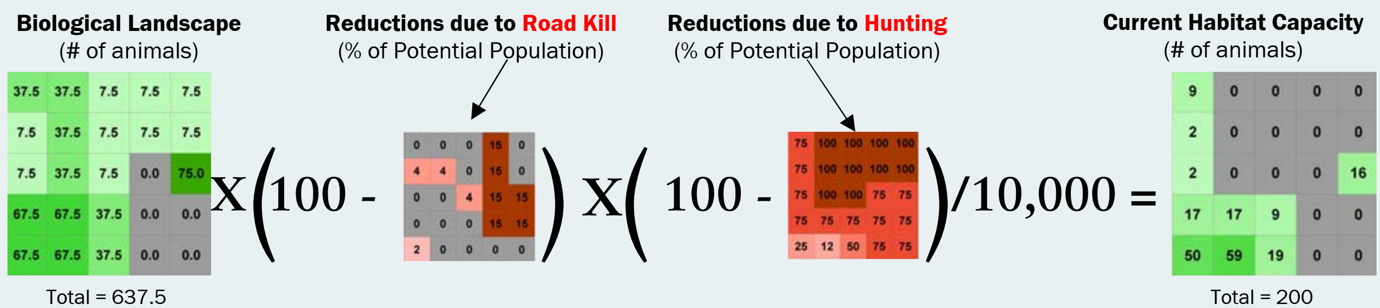


If landscapes are expressed on a 0-100 scale, the general equation is:

$$BL * [100 - (HL_i + HL_{i+1} \ldots + HL_{i+n})] / 100,$$

where BL = Biological Landscape, HL_i's = Human Landscapes, *n* = number of Human Landscapes.

Example B: Combining "Intensity" maps by multiplying. This approach assumes that Human Activities interact when affecting populations – that the affect of any one activity is dependent on the other activities in the same place. For example, 100 hunters are likely to shoot less deer in places where animals are getting killed by cars than in places where road kill does not occur. In this case, Human Landscapes are basically multiplied together.



If landscapes are expressed on a 0-100 scale, the general equation is:

$$BL \times (100 - HL_i) \times (100 - HL_{i+1}) \ldots \times (100 - HL_{i+n}) / 100^n,$$

where BL = Biological Landscape, HL_i's = Human Landscapes, *n* = number of Human Landscapes.

Example C: Combining "Mortality" maps by adding. When both your Threat Impact maps are expressed in absolute units of abundance (i.e., the original Human Landscape represented the mortality caused by the Human Activity), it makes most sense to add them together. This assumes that the two threats do not interact.

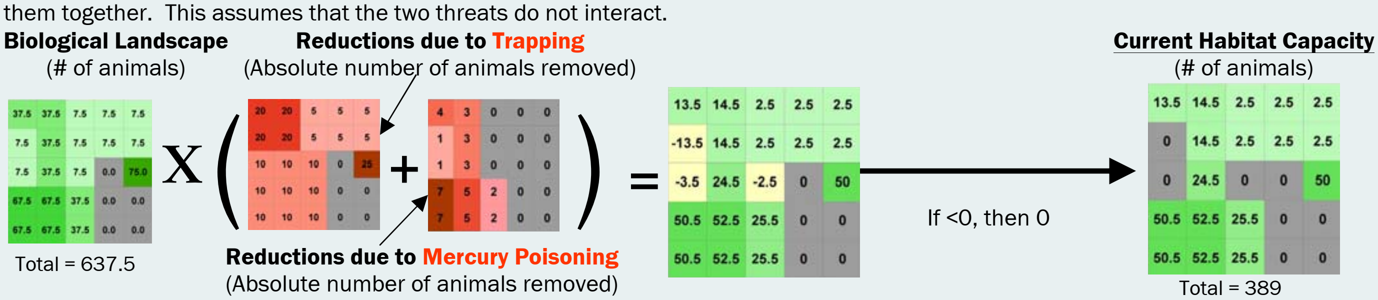


Figure 10. Different ways of combining Human Activities and considering their interaction. If you have more than one Human Landscape that fits one of the approaches outlined in this manual (e.g., Two landscapes under Approach A), you need to decide how to combine those. Examples A or B below should be followed when your Human Landscapes are "intensity" maps, while example C should be used if your map shows mortality. If you don't know which which approach to take, try both and see what makes more sense.

Dealing with multiple threats

The examples provided in Figures 4-7 show what to do with one threat. Of course, in most cases, species are affected by multiple threats at once. In these cases, it is usually best to proceed in this order (Figure 8):

1. Apply "Inside-Intensity" maps to particular habitat factors within the Biological model as in Figure 7a.
2. Apply "Inside-Mortality" maps to particular habitat factors within the Biological model as in Figure 7b.
3. Calculate an "interim" distribution map.
4. Apply "Outside-Intensity" maps to the interim distribution map (as in Figure 4).
5. Apply "Outside-Mortality" maps to the interim distribution map (as in Figure 5).
6. Calculate a current distribution map.

In cases where you have multiple Threat Impact maps fitting a particular approach (e.g., more than one "Outside-Intensity" map), you may need to think about how the threats interact (See Figure 9). If you have more than one Threat Impact Map expressed as a percent reduction, you can either add the maps together as in Figure 10a or multiply them together as in Figure 10b. If you add them, you are essentially assuming that they independently affect the population. For example, the reductions caused by hunting are independent of the reductions caused by road kill. If you multiply them, you are assuming that they interact (albeit in a simple linear fashion).

If all the Threat Impact Maps are expressed in absolute units of abundance, you simply need to add them together (Figure 10c).

Step 6: Subtract the Current Distribution map from the Biological Landscape to calculate the Conservation Landscape.

Once you've calculated a current distribution, the final step of creating a Conservation Landscape is easy – just subtract your current distribution from your Biological Landscape (Figure 11). The resulting map, the Conservation Landscape, like other maps in this process, is expressed in units of abundance and shows how many animals could be added to the population in particular areas if threats were mitigated there – in other words, it is *a map of conservation impact*. It shows the possible impact of your conservation, in terms of recovering animals in various parts of the landscape, and can be put to use in several ways (see the section "Why is the Conservation Landscape Useful?").

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Step 6: Calculate your Conservation Landscape by subtracting the current distribution from the Biological Landscape.

Biological Landscape
Potential Habitat Capacity (# of animals)

40	40	30	21.3	16
27.7	34.7	24.7	27.7	12.8
15.6	20.8	26	20.8	23.5
10.8	14.4	18	11.3	9.1
9.6	12.8	12.8	6	4.8

-

Current Habitat Capacity
(# of animals)

19	12	0.2	0	0
14.9	11.3	0.2	3.3	0
8.4	8	0.6	3.8	6.5
7.2	9.6	7.2	2.9	4.3
8	12.6	11.7	2	3.2

=

Conservation Landscape
Possible Conservation Impact
(# of animals recoverd)

21.0	28.0	29.8	21.3	16.0
12.8	23.4	24.5	24.4	12.8
7.2	12.8	25.4	17.0	17.0
3.6	4.8	10.8	8.4	4.8
1.6	0.2	1.1	4.0	1.6

Figure 11. The final step for producing a Conservation Landscapes is simple – just subtract the current distribution from the Biological Landscape. The result is a map of your potential conservation impact, expressed in the number of animals that you could add to your current population, if the Human Activities responsible for reductions are effectively eliminated. Note, this version of a Conservation Landscape represents recovery potential. If you considered future threats, you could also measure your impact in terms of preventing declines in the current population.

Conservation Landscapes Version 2: Preventing Future Declines

For many conservation projects, the version of the Conservation Landscape described above (i.e., possible recovery) is only half or less of the equation for assessing their conservation impact. Many projects are equally or more concerned with *preventing future declines* in those populations. Often, this is because the potential impact of future threats is so large that, even if the population of the Landscape Species is currently below their Population Target Levels, conservationists feel that they should invest most energy in preventing new threats from occurring (or current ones from getting worse). If this is the case for you, you should strongly consider mapping *future* Human Landscapes, and using these to prioritize how you might prevent future declines in the populations. Once you have future Human Landscape maps, you can create a second version of the Conservation Landscape – one that represents possible conservation impacts in terms of preventing future declines. To make this second version, you would simply repeat the steps outlined in is this manual, but starting this time with your current distribution map and future Human Landscapes (Figure 12). For a more in-depth example, see "Lessons Learned 3" in Technical Manual 6 on Building Biological and Threats Landscapes.

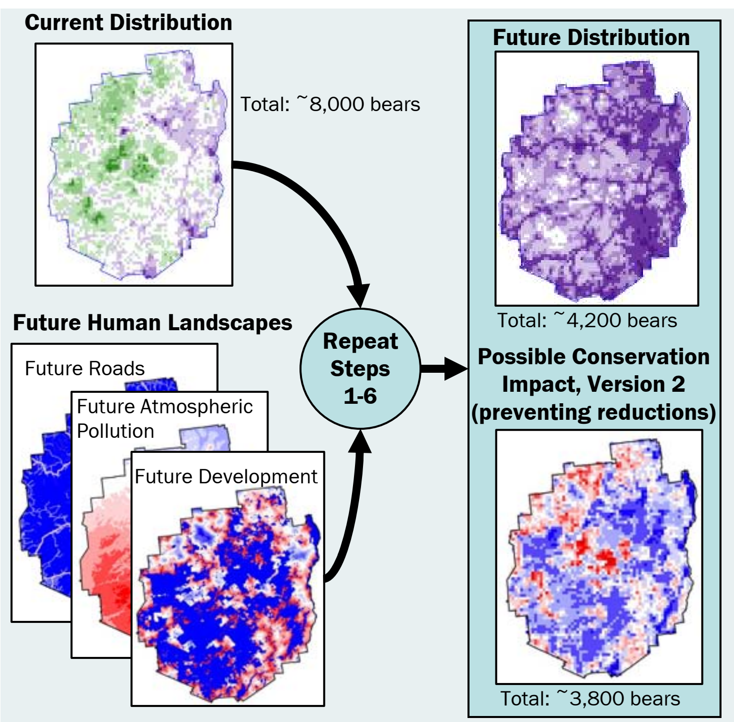

Figure 12. The methods outlined in Steps 1-6 of this manual can be repeated in order to examine the how human activities might impact the distribution and abundance of Landscape Species in the future. By combining the current distribution map and future Human Landscapes, you can produce a map showing what the future distribution of the Landscape Species might look like, and a second version of the Conservation Landscape, this time showing where conservation activity could prevent future reductions in the population. In the example above, it is hypothesized that future human activities might reduce bears from their current level of 8,000 to 4,200 and that conservation activities could potentially prevent the loss of 3,800 bears.

Why is the Conservation Landscape useful?

In the next technical manual, we will elaborate in detail the various ways you can use your Conservation Landscapes. Briefly, a Conservation Landscape can help you answer several important questions:

1. Where are we with respect to our conservation objectives?

   It can be very useful to compare estimates of habitat capacity from the modeling work, both potential and current, to the population goals (PTLs) that you have identified. You can see whether the current habitat capacity is at, above, or below your PTL, and whether you need to increase the population with conservation actions or to focus on preventing future declines in that population (see Figure 13). If estimates of current habitat capacity are above your goal, conservation should aim to stabilize the population, to be on the look out for new or expanding threats in the future, and perhaps to work to longer-term or more ambitious goals (as suggested by Sanderson 2006). Estimates of current habitat capacity that are below your goal suggest that further conservation actions are necessary to restore the population (see question #2).

2. Will our current activities be enough to reach our objectives?

   Using your Conservation Landscapes, you can evaluate whether the activities you are implementing now are likely to get you to your conservation goals (See Figure 14).

3. How should we prioritize new areas and actions, taking into account costs and other factors?

Conservation Landscapes can help you decide where and when to invest resources beyond what you are currently doing. Because Conservation Landscapes show the possible impact of conservation activities in terms of adding animals to the current population or preventing future losses, they are a critical part of priority setting. Other information that we have not captured in our spatial models is also important in the decision-making process, including: information on costs of implementing actions in various places, political and social feasibility of your planned actions, and whether opportunities for acting exist. In the next manual, we will provide some guidelines about how you might use your Conservation Landscapes, together with this other information, to set priorities.

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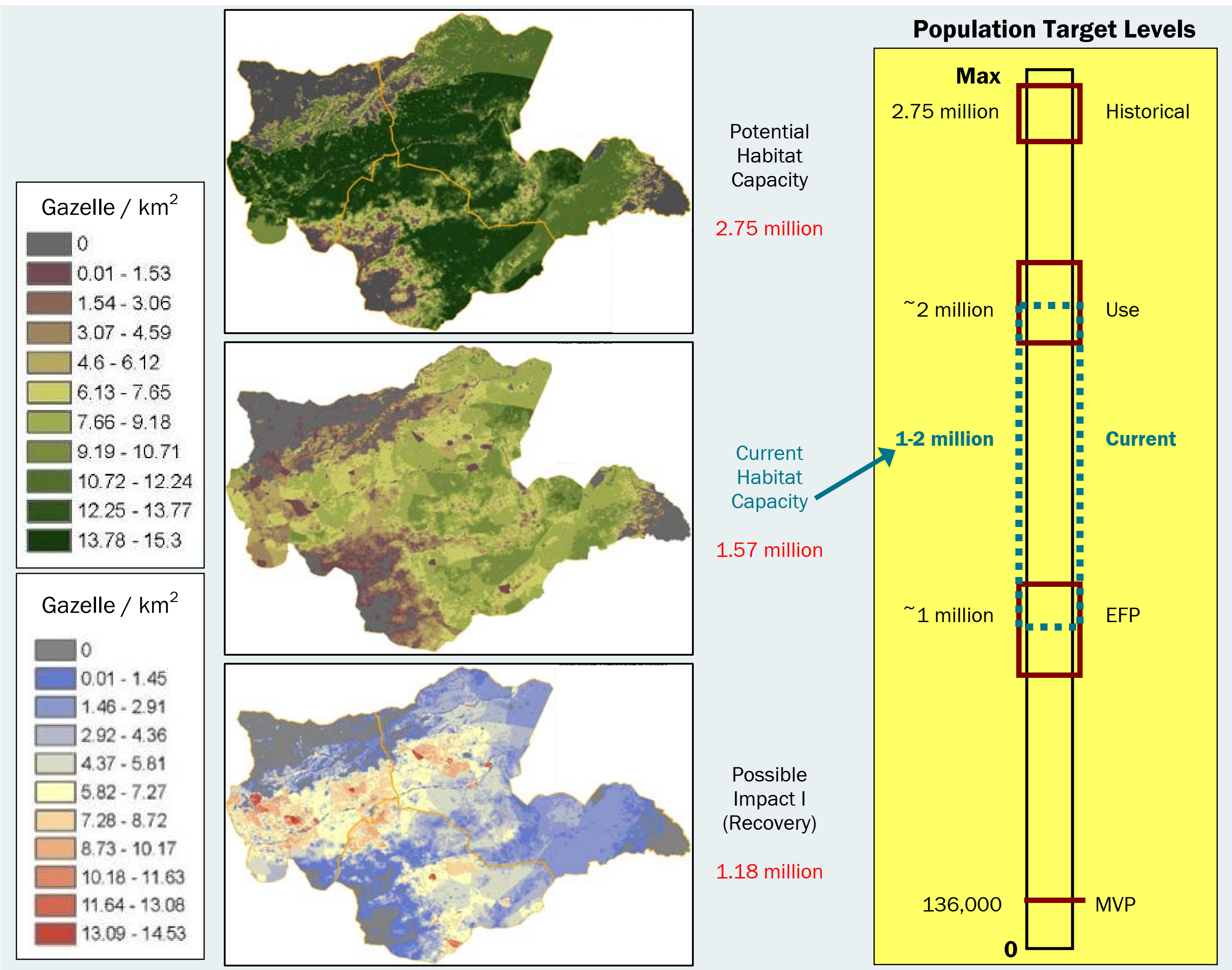


Figure 13. An example of how you can compare the estimates of potential and current habitat capacity you have calculated while producing Conservation Landscapes to your Population Target Levels (PTLs). This example is from the Eastern Steppe of Mongolia, for one of their Landscape Species – the Mongolian gazelle. Remember that for several reason, current abundance and habitat capacity may not be exactly the same (e.g., because the population is not in equilibrium with habitat conditions), although in most cases they should be close.

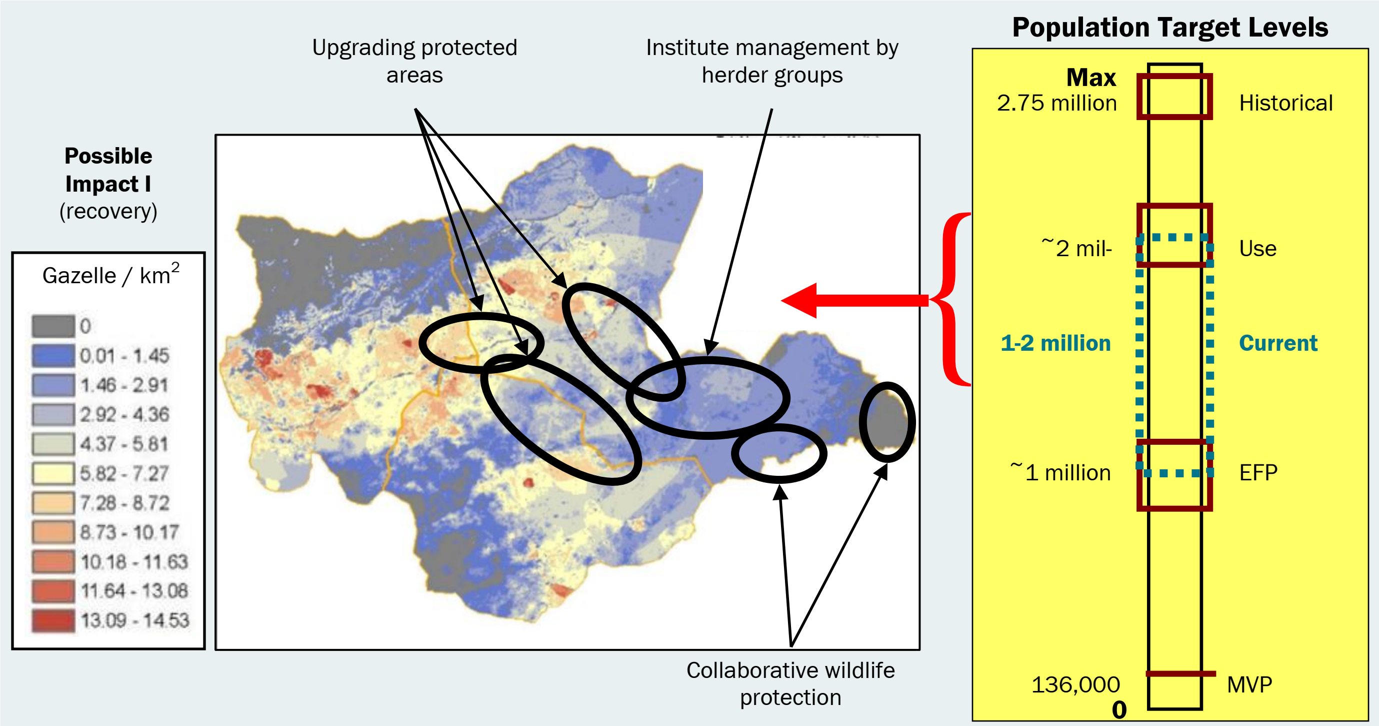
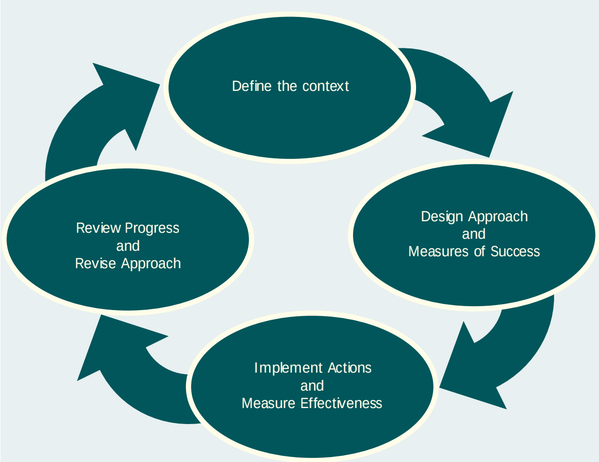


Figure 14. An example of how you can use the Conservation Landscape (representing possible recovery) to calculate whether your current activities will be sufficient to reach your Population Target Levels. This example is from the Eastern Steppe of Mongolia, for one of their Landscape Species – the Mongolian gazelle. Here, the near-term conservation objective is to reach a population of around two million gazelle. Using the Conservation Landscape, it's possible to calculate whether the project's current activities are sufficient to reach this objective.

Living Landscapes Program Manuals

The Global Programs of WCS 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 such that 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 using 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: elect targets, map key threats, prepare a conservation strategy, and develop a monitoring framework.



The application of these tools is described in a series of brief technical manuals which are available by email from conservationsupport@wcs.org. These how-to guides are designed to provide clear and practical instructions. If after using the manual to run a strategic planning exercise you have any suggestions as to how we might improve the instructions please let us know.

Contact

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