TECHNICAL MANUAL 5

October 2006

A quick reference guide to the Landscape Species Selection Software version 2.1

Successful conservation planning

Effective wildlife conservation requires that we consider the complex mix of biological, social and economic factors that influence the ecological integrity of an area, and then focus our conservation efforts on those activities that will have the most positive impact on wildlife populations and their habitat. This requires that we have a clear understanding of not only the ecological needs of wildlife species but also the human activities that impinge on them.

The Landscape Species Approach (LSA), developed by the 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. This step-by-step process for planning and implementing conservation activities includes: (1) conceptual models for clearly defining a program's goals and objectives, (***see Technical Manual 2***); (2) a participatory approach for prioritizing and mapping human activities that threaten landscapes and the wildlife within them (***see Technical Manual 1***); (3) an objective and transparent process for selecting a complementary suite of target species that, if conserved, will help protect all the biodiversity sheltered under their collective conservation canopy (i.e., Landscape Species); (4) procedures for modeling habitat quality of Landscape Species and for modeling the impacts of human-caused threats on habitat quality (***see Technical Manual 6***); (5) guidelines for creating a "Conservation Landscape" to focus conservation activities spatially; (6) a participatory process for prioritizing and strategically planning interventions; and (7) guidelines for developing effective monitoring frameworks (***see Technical Manual 3***).

Obtaining the Software or Other Living Landscapes Program Resources

The Landscape Species Selection software can be obtained by email from conservationsupport@wcs.org. Other Living Landscapes Program technical manuals, papers or bulletins detailing the Landscape Species Approach or the selection process can be obtained in the same way. We recommend that you read the papers by Sanderson *et al.* 2002 and Coppolillo *et al.* 2004, as well as Bulletins 1-4, before proceeding with the selection of Landscape Species.

This technical manual is a quick reference guide to the software developed by the Living Landscapes Program as a decision support tool for the selection of the Landscape Species. The manual is intended to be used hand-in-hand with the Landscape Species Selection software. For more detailed information on the software, please consult the electronic help file that accompanies it.

Landscape Species are defined by their use of large, ecologically diverse areas, the fact that they play important roles in maintaining the structure and function of natural ecosystems, and their susceptibility to human alteration of wild landscapes.

Selecting Seascape Species

Although we refer to Landscape Species throughout this technical manual, this process for selecting surrogate species on which to focus conservation attention has also been applied to marine settings. For example, Seascape Species have successfully been selected for the Glover's Reef Seascape, a tropical Atoll that forms part of the Belize Barrier Reef system, and for the Sea and Sky Seascape, a huge ecosystem encompassing the Patagonian shelf and associated offshore waters.

Landscape Species are selected based on: (1) an aggregate score which is the sum of five criteria (Area Requirements, Heterogeneity, Vulnerability, Ecological Functionality, and Socio-economic Significance); and (2) how well each species complements the habitats, management zones, and threats represented by those species already selected for the suite.

To select Landscape Species you may put together a selection team at your site comprised of field biologists, management personnel and others with local expertise or knowledge of the species being evaluated. Each step in the process (see Box B) will be described and illustrated with data for, and results from, the Landscape Species selection for the Nam Kading Landscape, Lao PDR.

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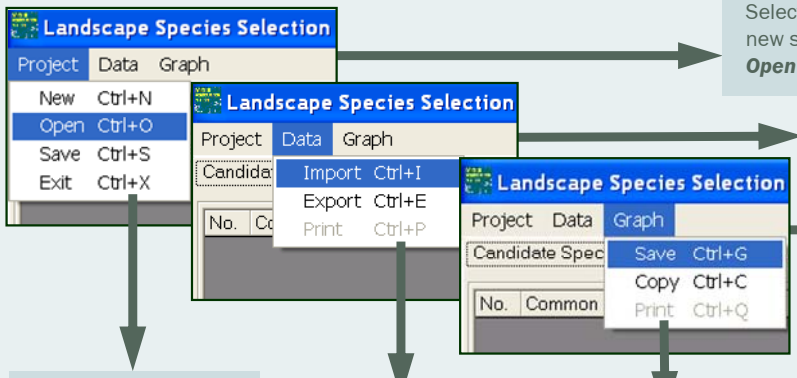
Installing and Running the Landscape Species Selection Software

Having obtained the zip file with the software's installation files, extract all three files it contains (setup.exe, Setup.lst and SpeciesSelection.cab) to the same temporary directory. Run the setup program (setup.exe) that guides you through the installation process. After installation run the Landscape Species Selection software via the Programs | Landscape Species Selection folder off the Start menu on your Windows Taskbar. Further information is provided in the installation README file that can be obtained together with the software installation files (as can example data and project files to help you understand how the software works). Additionally, under Programs | Landscape Species Selection you will find the detailed online help file for the software (press the F1 function key when the software is running to open the help file). If you are running the software for the first time, create a new project (press Ctrl+N – the Control and N key simultaneously), type in data or import it, and remember to save (Ctrl+S) your project data frequently (See Box A). Any project file can be re-opened during subsequent sessions (Ctrl+O).

Landscape Species Selection Software Menus

Box A



Select ***New*** from the ***Project*** menu to start a new species selection software project file and ***Open*** to retrieve an existing project file.

Select ***Import*** from the ***Data*** menu to import tab delimited text files into the various data tables.

Select ***Save*** from the ***Graph*** menu to save any one of the summary graphs as a bitmap image file for inclusion in other documents.

Select ***Save*** from the ***Project*** menu to save an existing species selection software project file and ***Exit*** to close the application.

Select ***Export*** from the ***Data*** menu to save the information in data tables to tab delimited text files that can easily be included in reports.

Select ***Copy*** from the ***Graph*** menu to allow for any one of the summary graphs to be pasted into other documents.

Manipulate the Landscape Species Selection software's project files, import and export data and save graphs using the application's menus.

Landscape Species as 'surrogate' conservation targets

While most conservationists aspire to conserve most, if not all, native biodiversity in our places of interest; as Groves (2003) points out, "it is simply impractical to think about planning individual conservation efforts for all these elements". To operate effectively, we need to focus our planning and action on a much smaller subset of biodiversity, called "conservation targets".

Definitions for Conservation Targets

There is a large and bewildering variety of terms, with slightly different meanings for different people, used to discuss conservation targets. Aside from the terms we have chosen to use (conservation targets and surrogates), others include "focal species", "umbrella species", "keystone species", and "flagships". Try not to get too bogged down in finding the perfect term, as there probably is none. Also do not assume that other people have a clear definition of the terms in their heads. We recommend that when talking to others about these concepts, use terms you are all comfortable with and define them clearly.

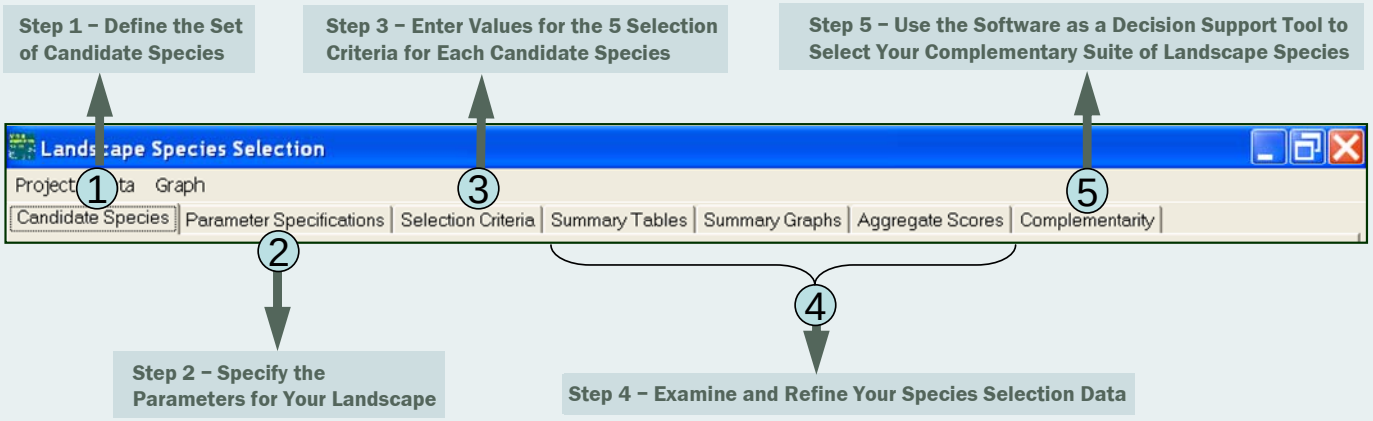
Landscape Species are conservation targets, but more specifically, they are "surrogates" – elements of biodiversity selected, at least in part, as representatives of other elements of biodiversity. We hope that conservation aimed at this small suite of Landscape Species will provide substantial conservation benefit to the other forms of biodiversity within our landscapes, ranging from other species to vegetation communities and ecosystems. Landscape species are, as you will see in this manual, explicitly selected to represent the unique habitats, management zones and the critical threats within our landscapes. By explicitly considering habitats, management zones and threats, we hope to select a suite of species which, in total, form an effective conservation umbrella for the other native species in our landscapes.

Are the Landscape Species sufficient to represent all the native biodiversity you would like to conserve? The answer is most likely "no". Being broad-ranging and often generalist in nature, Landscape Species are "coarse filter" conservation targets – they are meant to capture most other elements of biodiversity, but we do not expect them to be perfect. Some elements of biodiversity, that we call "special elements", are likely to slip through the cracks and will not be effectively conserved by actions aimed at Landscape Species. Special elements are typically endemic or have very local distributions, have very specific habitat needs not represented by the suite of Landscape Species, or are threatened by specific processes not represented by the suite. Special elements are deserving of conservation attention in their own right, but due to the individualized nature of the actions required to conserve them, they provide little of the surrogate function that the Landscape Species provide. We highly recommend that after selecting Landscape Species, you consider what species or vegetation communities may have slipped through the cracks. Consult the IUCN Red List (www.iucnredlist.org), make a note of the endemics or range-restricted species in your landscape, and then ask yourself "If we successfully conserved the Landscape Species, would we be pretty sure that these other elements would also be conserved; and if not, should we aim some of our conservation resources directly at them?"

Stepping Through the Landscape Species Selection Software

Box B

To select Landscape Species with the help of the software follow the steps shown below:

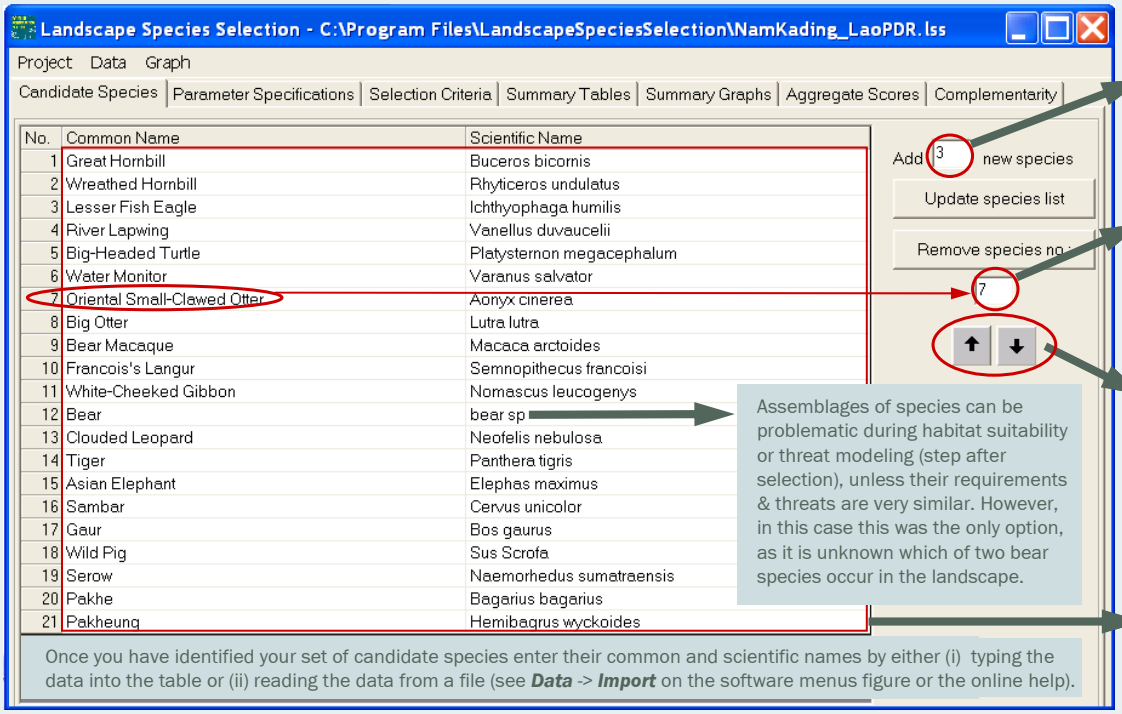


Step 1: Define the set of candidate species

The first step when selecting Landscape Species is to identify a pool of candidate species from which the final suite will be chosen (see Box C). To avoid an unduly onerous selection process, we suggest that the initial pool of candidates consist of all species that have a reasonable chance of being selected, because they exhibit one or more of the five criteria (described under Step 3) to a significant degree. It is also important to include species occupying the full range of habitat types and management zones, and being impacted by the critical threats in the landscape, even though any particular species may not exemplify all of the Landscape Species' characteristics. This is significant because the suite of Landscape Species is assembled based on complementarity in terms of habitat types, management zones and threats (comprising the Heterogeneity and Vulnerability criteria), such that some species may be included by virtue of their complementarity alone, even though they do poorly in terms of other characteristics (Area Requirements, Ecological Functionality, etc.). We also recommend that the selection process should focus on species whose populations in your

Step 1 - Define the Set of Candidate Species

Box C



landscape are currently in trouble (i.e., far below minimum viable populations, ecological densities, or conservation population targets) or those that are vulnerable to major population declines in the future (over the next 10-25 years, depending on your planning horizon).

Step 2: Specify the parameters for your landscape

To define the properties of your landscape and central details of the selection process, specify the following (see Box D):

a. The ***Habitat Types*** in your landscape, the surface area of each, and the level of use required to represent each habitat. Include habitat types required by each candidate species to complete its life cycle or those that are critical to the maintenance of ecologically functional populations (the resolution of the habitat categories should be such that a species would distinguish between them). Consider habitat types that are absolutely required by species in terms of: (1) nutrition (e.g., vegetation communities or areas that supply difficult-to-find nutrients such as salt licks); (2) water (e.g., lakes, streams, rivers, lagoons); (3) security or thermal cover (vegetation communities); (4) reproduction and growth (e.g., spawning sites, denning habitat, nesting sites); and (5) migratory corridors. If your landscape has distinct seasonality or cycles (e.g., El Niño cycles, dry/wet season, winter/summer), consider the habitat types required by candidate species to survive each season or cycle (e.g., vegetation communities needed to survive winters). Also include any unique vegetation communities that need to be protected (e.g., boreal swamps, old-growth mahogany stands, alpine areas). Consider if unique areas important for maintaining landscape connectivity are listed. If a landscape element is not represented by any of the candidate species, then you will need to add a species that does require that element. **NOTE**: You may overlook important landscape elements if you simply list habitats that appear on existing vegetation, land-use or land cover maps.

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Step 2 - Specify the Parameters for Your Landscape

Box D

Enter data for:

(•) Habitat types ( ) Management zones ( ) Human activities ( ) Home range definition ( ) Functions

a & b. Enter information for the habitat types and management zones

No.	Habitat Name	Area	Level of Use
1	Upper Dry evergreen forest	20242824	2
2	Lower Dry evergreen forest	560344	2
3	Mixed Deciduous	60896434	2
4	Mixed Broadleaf	1415455	2
5	Bamboo Forest	460566	2
6	Savannah/Scrub/Regeneration	65391063	2
7	Rock-Limestone Karst	1087229	2
8	Rock - Sandstone Bluffs	108723	2
9	Swamp	864777	2
10	Swiftflowing rivers and rapids	1700	2
11	Seasonal streams and pools	[illegible]	2
12	Mineral Licks	150	2
13	Riparian	1000	2

Level of Use: Landscape species are chosen in part for how well they represent habitats. You need to specify whether a level of "use" value of 2 or 3 qualifies as representing habitats (see the text box for descriptions of the Level of Use values). The value remains constant across candidate species. If you choose a 3 for a particular habitat type, it will be considered "represented" only when a candidate species with a value of 3 for that habitat is included in the suite of Landscape Species. The default value is 2.

Habitat/MZ Name: Once you have identified your set of habitat types or management zones enter their names, area, and level of use by either (i) typing the data into the table or (ii) reading the data from a file (see ***Data*** -> ***Import*** on the software menus figure or the online help).

Area: The surface area of each habitat type (all in the same units). If any one of the surface areas covered by a habitat type is unknown, then leave the Area column blank.

c. Enter information for the human activities

No.	Human Activity	Urgency	Probability of occurence
1	Hunting for trade as food	3	1
2	Hunting for trade as	3	1
3	Hunting for subsistence	3	1
4	Hunting for recreation/conflict	3	1
5	Habitat fragmentation	3	1
6	Shifting cultivation	3	1
7	Logging	3	1
8	Hydropower development	1	0.5
9	Pollution	3	1
10	Fishing for trade as food	[illegible]	1
11	Fishing for subsistence consumption	3	1
12	Prey depletion	3	1

Probability of occurrence: Enter a value between zero and one. This indicates the degree of uncertainty associated with the particular human activity (e.g., if you think there is a 25% chance that a dam will be built enter a value of 0.25). Activities with a higher Probability of Occurrence are more heavily weighted when calculating candidate species' Threat Index part of the Vulnerability score.

Urgency: Describe how soon a particular human activity will occur:

0 = If it occurs, it will not happen in the next 10 years.
1 = If it occurs, it could happen within 3-10 years.
2 = If it occurs, it could or will happen within 1-3 years
3 = Threat is currently happening - must act immediately (Probability of Occurrence must be 1).

Human Activity: Once you have identified all human activities that have **major** negative impacts on the wildlife or the habitats in your landscape enter their descriptions, urgency, and probability of occurrence by either (i) typing the data into the table or (ii) reading the data from a file (see ***Data*** -> ***Import*** on the software menus figure or the online help).

d. Enter information for the home range definition

( ) Continuous data
(•) Default bins (0-1, 1-10, 10-25, 25-50, 50-100, 100+ square kilometers)
( ) User-defined bins (in square kilometers)

Home range definition: Home ranges can be entered as continuous values (in km^2), selected from a list of default bins or from a list of user-defined bins. If you have unreliable home range estimates or diverse taxa with different techniques for home range estimation, then it may be wiser to define home range by binned intervals.

e. Enter information for the ecological functions

No.	Functions
1	Predation
2	Seed dispersal
3	Seed predation
4	Pollination
5	Mechanical disturbance
6	Competitive interactions

Ecological Functions: The default set of functions is shown to the left. You can retain this default set if it applies to the candidate species in your landscape or add to or remove functions. Other examples of functions for both terrestrial and marine systems include: Top level predation, Mid Level predation, Herbivory (algal control), Habitat construction, Habitat maintenance, Waterhole maintenance, Autotrophy, Planktivory, Nutrient redistribution, Prey species, Strong competitor, Scavenger.

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b. The ***Management Zones*** in your landscape, the surface area of each and the level of use required to represent each zone. Many species move among several management zones, and therefore encourage us as conservationists to work with several stakeholders (government agencies, industries, community groups, etc.) and to coordinate management across boundaries. Differences in management may

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also have large impacts on habitat quality and landscape structure (composition, configuration, and connectivity) that are not always captured by the habitat types we list and will affect ecological processes and necessitate management across management zones. When entering the management zones, consider the areas where management practices are substantially different, including local, provincial, national and international political units, protected area boundaries, forest or mining concessions, fishing or hunting zones, and private or communal lands.

c. The ***Human Activities*** that either currently constitute important threats or have the potential to impact your landscape and candidate species in the future, the probability that each threat will occur, and the urgency of the threat. Your project team can define the key threats or you can organize a more formal participatory spatial assessment of human activities to do this (see ***Technical Manual 1*** in this series). Consider all human activities that have major negative impacts on: (1) individual candidate species (e.g., poaching); (2) the habitat types you have listed (e.g., draining of wetlands); (3) the ecological productivity of the landscape (e.g., overgrazing of grassland by livestock); (4) the spatial integrity of the landscape (e.g., fragmentation); or (5) the wild character of the landscape (e.g., second home development).

d. The method for specifying ***Home Range*** size.

e. The ***Ecological Functions*** that occur in your landscape.

See Box D for more detail on the selection software options for the above or Box I for an example of how the habitat types and threats were defined for the Nam Kading Landscape, Lao PDR.

Level of Use

Value = 0: The population of the candidate species does not use the habitat type or management zone. Either the species is never seen there, or only an occasional dispersing or exploring animal is seen.

Value = 1: The population of the candidate species uses the habitat type or management zone, but the persistence and abundance of the species is unlikely to be heavily impacted by reduction in the extent, quality or access to the habitat type or management zone. The species can easily compensate for such reductions by using a different habitat or zone. For instance, the habitat, along with several others, is used for movement between other habitats, but the species is not dependent on the specific habitat for movement.

Value = 2: The population of the candidate species is strongly dependent on the habitat type or management zone, although the population does not require it to persist in the landscape. Reduction in the extent, quality, or access to the habitat or zone will have significant impacts on the abundance and distribution of the candidate species in the landscape, although loss of the habitat is unlikely to cause local extinction. If observations of the species indicate that it spends a lot of time in a habitat or management zone, but it is unclear whether it technically "requires" it, this value is an appropriate choice.

Value = 3: The population of the candidate species requires the habitat type or management zone to fulfill its life cycle. If the habitat or management zone were to disappear from the landscape, so would the candidate species. If the habitat or management zone is destroyed, the species will go locally extinct. For instance, the presence of many bird species is tied directly to the presence of a particular nesting habitat.

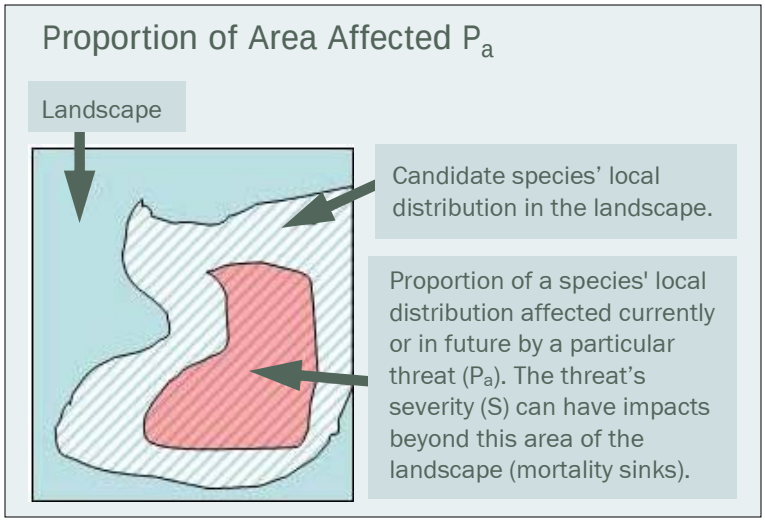
Step 3: Enter values for the 5 selection criteria for each candidate species

To calculate a score for each species in terms of the 5 selection criteria complete the following steps (see Box E):

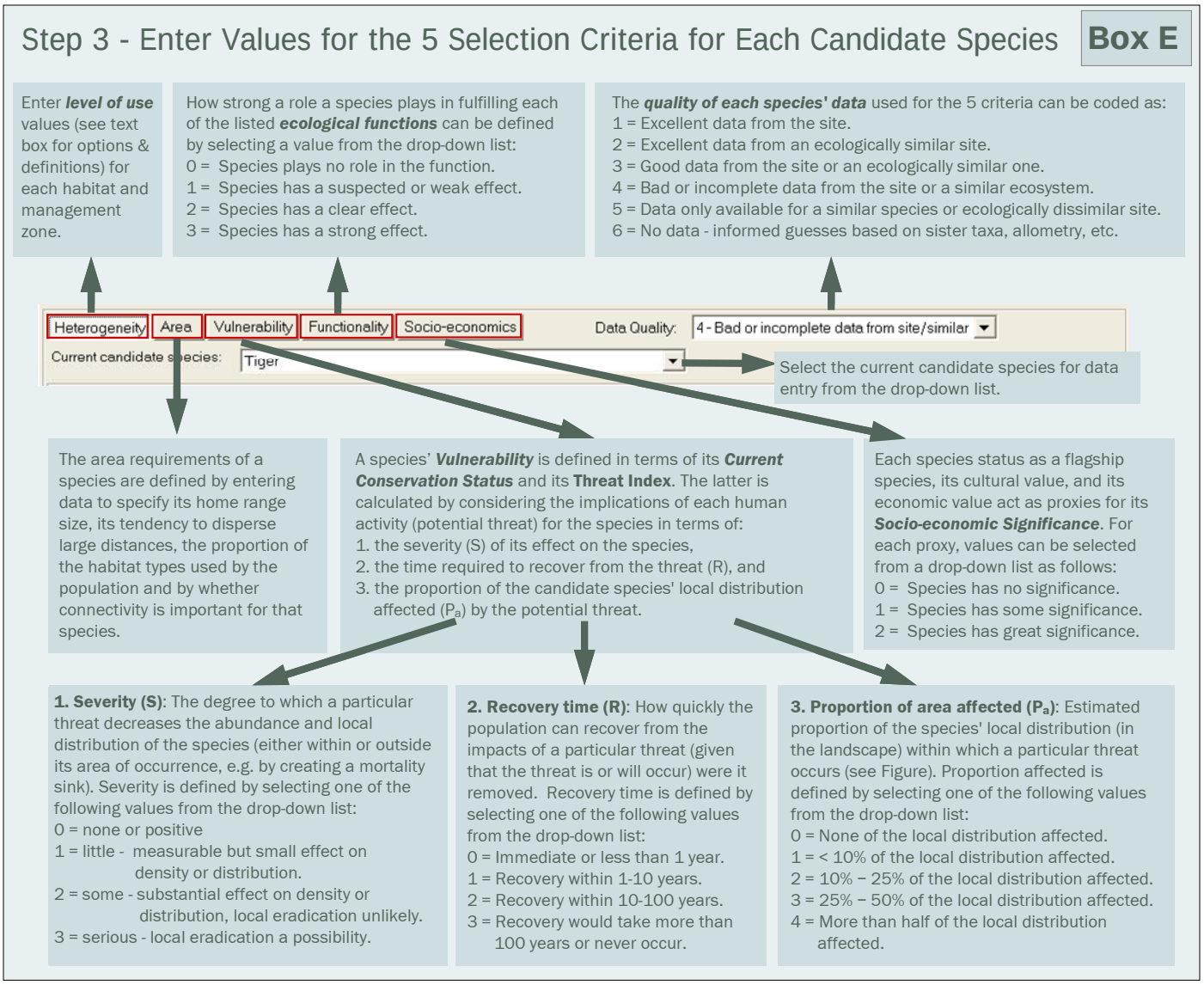
a. For the ***Heterogeneity*** criterion enter Level of Use data that define how each candidate species uses the habitat types and management zones. Species that represent more habitat types and management zones will receive a higher total score for heterogeneity and have a better chance of getting selected. By favoring such species, we reduce the number of total species that are needed to complete the suite by increasing its efficiency. Additionally, by favoring species that depend on and move among several different habitats and management zones, we help ensure that the composition, configuration, and connectivity of landscape elements is maintained.

b. To define each species' ***Area Requirements*** enter data for (1) its home range size; (2) its tendency to disperse over large distances; (3) the proportion of the landscape it occupies; and (4) the importance of habitat connectivity for that species. This criterion favors wide-ranging species with extensive area requirements, which helps ensure that the landscape is sufficiently large and well connected to support most biodiversity.

c. For the ***Vulnerability*** criterion enter information on the Current Conservation Status (CCS) of each candidate species (see Box E) and data to calculate the Threat Index. CCS is a voluntary variable that can be used to favor species in immediate danger of local extinction, where naturally occurring stochastic effects could cause their extinction. Some projects may choose to favor these species relative to species that are not in immediate danger of extinction. Others may choose not to use this variable, because they are equally or more concerned about species that are outside of this immediate "danger zone". Species that are not in immediate danger of extinction, are not declining, and are not likely to decline significantly in the foreseeable future probably should not be on the candidate species list in the first place. CCS is rated on a scale of 0-1, where a value of 0 means that the population of the species in the landscape is severely depleted and in immediate danger of going locally extinct. On the other hand, a value of 1 means that the population of the species in the landscape is in no particular danger of being extirpated locally in the foreseeable future, but its population is declining or may decline significantly within your planning horizon due to human activities. Again, the variable is voluntary - if you do not want the CCS to affect the selection of species, simply leave the value for every species at its default value of 1. The Threat Index is designed to favor the selection of species that are currently being, or are likely to be, impacted by many threats; or those severely impacted by a few threats (or both). By favoring such species, we reduce the number of total species that are needed to complete the suite, thus increasing its efficiency. We also favor species that are more vulnerable to human activities, in terms of population decline or extirpation. The effect of each threat for a candidate species is given a value according to its severity (S), how quickly the species can recover (R) if the threat were removed, and the proportion of the species' local distribution affected (P_a) by the threat. Additionally, threats that are more urgent and that affect a larger proportion of the entire landscape are weighted more heavily when calculating the Threat Index (see Step 4).



Step 3 - Enter Values for the 5 Selection Criteria for Each Candidate Species **Box E**



d. Enter values for the ***Ecological Functionality*** criterion based on how each candidate species fulfills the ecological functions in the landscape. Some species have particularly strong effects on the structure and function of natural ecosystems. Beavers create wetlands by damming rivers, tapir and elephants disperse seeds and thin the forest understory, and top predators can control the abundance and composition of prey communities. Ecologically pivotal species may help conserve healthy communities and ecosystems, thus ecological functionality is one of the five selection criteria used in ranking the species.

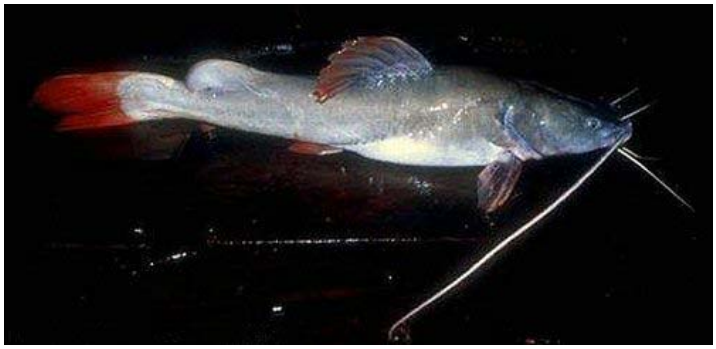
e. Enter values for the ***Socio-economic Significance*** criterion based on each candidate species' status as a flagship species, its cultural value, and its economic value. This criterion exists because social environment can drastically affect conservation outcomes. Wildlife may clash with people and be perceived negatively if they raid crops, prey on livestock, transmit diseases to domestic animals or people, or compete for resources. Wildlife may be perceived positively if they have benefits, such as serving as a cultural icon or totem, forming a significant portion of people's diets, or providing opportunities for income.

f. If you want to keep track of your data quality, then select a value from the ***Data Quality*** drop down list, as you enter data for each candidate species. It is not mandatory that you enter this data and it does not influence the selection process. However, it does have certain advantages, namely: (1) it will maintain transparency and let others appraise the validity of your decisions; and (2) it will provide an index for setting research priorities.

Step 4: Examine and refine your species selection data

a. Review the summary tables

Click the sub-tabs under the ***Summary Tables*** tab to get an overview of all the data entered for the candidate species under the five selection criteria. Explore these tables to closely examine and revise your data. Data can be edited in certain summary tables instead of returning to the ***Selection Criteria*** tab. Most of the tables provide simple overviews of the previously entered data, whereas the Heterogeneity and Vulnerability tables provide additional information. The former displays calculated totals of how many habitat types or management zones are used by each of the candidate species, how many species use a particular habitat type, and aggregate level of use by species/habitat. The latter displays threat indices for each species-threat combination, totals and aggregate threat indices both by species and by threat (see Box F—For example, looking at the box on the bottom left we can contrast the ***Threat Index*** for sambar and wild pig for 'Hunting for trade as food'. Initially it may be surprising that the index is larger for sambar, but this makes sense given the wild pig's reproductive capacity and faster recovery time).



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b. Review the summary graphs

The same information provided in the ***Summary Tables*** is also displayed graphically either by species or by habitat, management zone or threat (see Box G).

c. Review the criterion/aggregate scores

Once you have entered all the data, view either the raw or normalized heterogeneity, area requirements, vulnerability, ecological functionality, socio-economic significance and aggregate

Step 4 - Examine and Refine Your Species Selection Data (Summary Tables) — Box F

Landscape Species Selection - C:\Program Files\LandscapeSpeciesSelection\NamKading_LaoPDR.lss

Project Data Graph

Candidate Species | Parameter Specifications | Selection Criteria | Summary Tables (a) | Summary Graphs (b) | Aggregate Scores (c) | Complementarity

Heterogeneity | Heterogeneity by species | Area | Vulnerability | Vulnerability by species

Vulnerability by human activity | Functionality | Socio-economics | Data quality

Allow summary table editing

Hunting for trade as food

Common Name	CCS	1	2	3	4	5	6	7	8	9	10	11	12	Total by species	No. threats
Great Hornbill	0.6	0	60	30	0	0	10	15	0	0	0	0	0	115	4
Wreathed Hornbill	0.6	0	60	30	0	0	10	15	0	0	0	0	0	115	4
Lesser Fish Eagle	0.4	0	15	0	30	0	0	10	8	20	0	0	40	123	6
River Lapwing	0.6	0	0	8	0	0	0	0	12	4	0	0	0	24	3
Big-Headed Turtle	0.5	60	60	60	0	0	0	0	12	0	0	0	0	192	4
Water Monitor	0.8	48	16	48	0	0	0	0	12	0	0	0	0	124	4
Oriental Small-Clawed Otter	0.4	0	60	0	40	0	0	10	24	20	0	0	40	194	6
Big Otter	0.3	0	60	0	40	0	0	10	24	20	0	0	40	194	6
Bear Macaque	0.8	20	0	60	0	0	0	0	0	0	0	0	0	80	2
Francois's Langur	0.8	5	5	5	0	0	0	0	0	0	0	0	0	15	3
White-Cheeked Gibbon	0.4	0	60	40	0	15	15	15	0	0	0	0	0	145	5
Bear	0.6	0	48	0	0	0	0	0	0	0	0	0	0	48	1
Clouded Leopard	0.6	0	20	0	0	5	0	0	0	0	0	0	10	35	3
Tiger	0.3	0	60	0	0	0	0	0	0	0	0	0	60	120	2
Asian Elephant	0.5	0	12	0	12	0	0	0	24	0	0	0	0	48	3
Sambar	0.7	60	40	60	0	0	0	0	0	0	0	0	0	160	3
Gaur	0.5	20	60	20	0	0	0	0	0	0	0	0	0	100	3
Wild Pig	1	48	16	48	32	0	0	0	0	0	0	0	0	144	3
Serow	0.6	15	45	15	0	0	0	0	0	0	0	0	0	75	3
Pakhe	0.8	0	0	0	0	0	0	0	12	16	48	48	0	124	4
Pakheung	0.7	0	0	0	0	0	0	0	12	16	48	48	16	140	5
Total by threat		276	697	424	154	20	35	75	140	96	96	96	206		
No. species affected		8	17	12	5	2	3	6	9	6	2	2	6		

Only the ***Current Conservation Status*** (CCS) data can be edited here.

Tick the check box to edit your data directly within the summary table, rather than revising data by candidate species under the ***Selection Criteria*** tab.

These column numbers correspond to the human activities listed under the ***Parameter Specifications*** tab. The name of the activity is shown when the mouse cursor is placed in the numbered cell (e.g., the first activity is 'Hunting for trade as food').

The total number of threats impacting each species is shown. Keep in mind, however, that the highest number of total threats does not necessarily equate to the highest ***Threat Index*** (e.g., although the Lesser Fish Eagle is impacted by the same number of threats as the otter its threat index is much lower).

Look at this column to see the aggregate ***Threat Index*** for each of the candidate species. In this landscape the various otter species are highly impacted, as is the Big-headed turtle.

The ***Threat Index*** for each species – threat combination is calculated using the equation: **(U + R) x S x Pa x Po**
As an example, 'Hunting for trade as food' has a ***Threat Index*** value of:
(3 + 2) x 3 x 4 x 1 = 60 for Sambar and
(3 + 1) x 3 x 4 x 1 = 48 for Wild Pig.

The highest aggregate ***Threat Index*** across all species corresponds to 'Hunting for trade as medicine/trophies'. This also happens to impact the largest number of species (17 out of 21).

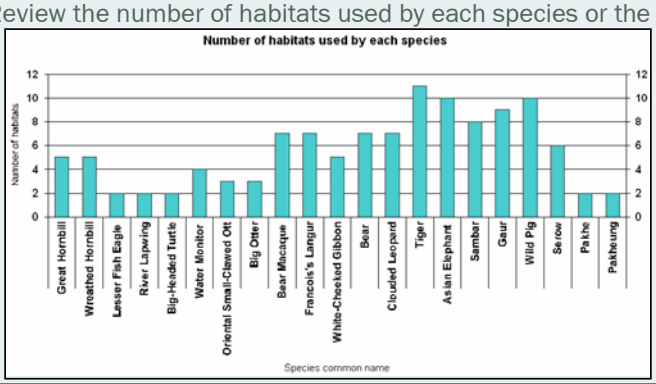
The aggregate ***Threat Index*** is calculated using the equation:

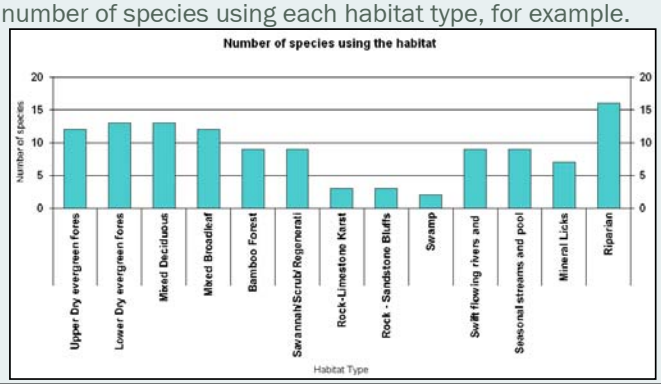
$$\sum\{(U+R)\times S\times Pa\times Po\}$$

Urgency: Recovery time; Severity: Proportion affected; Probability of occurrence

Step 4 - Examine and Refine Your Species Selection Data (Summary Graphs) **Box G**

Review the number of habitats used by each species or the number of species using each habitat type, for example.





scores for each of the candidate species (see Box H). The normalized scores for the five selection criteria are aggregated and used to rank the candidate species. Check to see that this ranking makes sense by reviewing the individual criteria scores. To help with this, click on any of the column headings to sort the data by that column. In our example of the Nam Kading Landscape, the tiger was the highest ranked species (see Box H). This is not surprising when you consider that its heterogeneity, area and socio-economic significance scores are high (with medium to low scores for vulnerability and functionality relative to the other species). Results can also be displayed graphically to further review the original or normalized scores.

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Step 4 - Examine and Refine Your Species Selection Data (Aggregate Scores) **Box H**

Review the ranking of the candidate species according to their aggregate score across all five selection criteria as well as the rankings by individual criterion (click on the Heterogeneity (H), Area (A), Vulnerability (V), Functionality (F) or Socio-Economic (S-E) column to sort entries in ascending order).

Common Name	Rank	Aggregate	H	A	V	F	S-E
Tiger	1	4.2	1	0.98	0.62	0.6	1
Asian Elephant	2	3.949	1	0.9	0.249	0.8	1
Great Hornbill	3	3.873	0.913	0.9	0.593	0.8	0.667
Wild Pig	4	3.842	0.978	0.68	0.74	1	0.444
Gaur	5	3.761	0.978	1	0.516	0.6	0.667
White-Cheeked Gibbon	6	3.696	0.761	0.52	0.748	1	0.667
Oriental Small-Clawed Otter	7	3.692	0.717	0.62	0.999	0.8	0.556
Big Otter	8	3.65	0.674	0.62	1	0.8	0.556
Wreathed Hornbill	9	3.65	0.913	0.9	0.593	0.8	0.444
Sambar	10	3.505	0.978	0.66	0.823	0.6	0.444
Bear	11	3.428	0.761	0.64	0.249	1	0.778
Pakheung	12	3.128	0.565	0.82	0.721	0.8	0.222
Pakhe	13	3.045	0.565	0.82	0.638	0.8	0.222
Bear Macaque	14	2.873	0.87	0.68	0.412	0.8	0.111
Big-Headed Turtle	15	2.827	0.696	0.32	0.989	0.6	0.222
Serow	16	2.654	0.783	0.44	0.387	0.6	0.444
Lesser Fish Eagle	17	2.653	0.587	0.52	0.635	0.8	0.111
Water Monitor	18	2.606	0.826	0.32	0.638	0.6	0.222
Clouded Leopard	19	2.385	0.652	0.84	0.182	0.6	0.111
Francois's Langur	20	2.031	0.891	0.44	0.078	0.4	0.222
River Lapwing	21	1.888	0.543	0.82	0.125	0.4	0

Step 5: Use the software as a decision support tool to select your complementary suite of Landscape Species

The suite of Landscape Species for your site is assembled by choosing highly-ranked candidate species that complement each other in terms of habitat requirements, the management zones they use and the threats that they encounter. To proceed with the selection process (see Box I):

a. Define the parameters controlling selection and complementarity

Define: (1) the Margin of Error to account for the uncertainty in the selection data and manually select among species with similar aggregate scores; (2) the cut-off value for when an individual threat is represented by a species in the selected suite of Landscape Species; and (3) the minimum Current Conservation Status required for a candidate species to be included in the selection process. Setting a cut-off value has the same effect as removing species that are not currently critically threatened with local extirpation from the candidate list before selection proceeds.

b. Run the species selection routine

Landscape Species are selected by:

1. Calculating the aggregate score of each candidate species (Area Requirements + Heterogeneity + Vulnerability + Functionality + Socio-economic Significance), and ranking the species in descending order based upon the aggregate score. If a number of species are within the Margin of Error relative to the top ranked species, the software pauses to allow for manual selection of the next species to include in the suite of Landscape Species. Otherwise, the highest ranked species is selected as the first Landscape Species.
2. Eliminating all habitats, management zones, and threats represented by the first Landscape Species and recalculating the Heterogeneity and Vulnerability criteria scores based on the remaining unrepresented habitats, management zones, and threats.

Calculating Aggregate Scores

Once all the data have been entered, then the raw and normalized scores for the heterogeneity, area requirements, vulnerability, ecological functionality, and socio-economic criteria can be calculated and displayed for each of the candidate species. The maximum possible score within each selection criterion category varies and thus category scores are normalized. The normalized scores are calculated by scaling each species' score within each of the five selection criterion categories according to the maximum score in that category, so that all values fall between zero and one. These normalized scores are then aggregated and used to rank the candidate species, which avoids inadvertent weighting by any one selection criterion. The individual criterion scores are calculated as follows:

Heterogeneity (H): The heterogeneity score for a candidate species is calculated by summing level of use values across all habitat types and adding this to the summed level of use values across all management zones. The habitat level of use score is given a 2/3 weight when calculating the score for heterogeneity, and the management zone use score is given a 1/3 weight. Note that during complementarity, as habitats and management zones are covered by species added to the suite of Landscape Species, the heterogeneity score is recalculated for those candidate species that have not yet been selected.

Area requirements (A): The original home ranges are scaled to fall in the interval [0,3] (i.e., the maximum home range value entered will correspond to 3). In the case of binned home range values, the number of home range intervals is used to scale the home ranges. The area score for a given candidate species is calculated by adding the scaled home range to the proportion of the natural landscape occupied by the species. The area score is incremented by one if it was indicated that there is evidence of long dispersal distances for the species. The area score is also incremented by one if it was indicated that connectivity matters for the species.

Vulnerability (V): The vulnerability score for each candidate species is calculated by: Threat Index + (1-Current Conservation Status). The Threat Index for a particular species is calculated by summing the quantity $(U + R) \times S \times P_o \times P_a$ over all threats and then scaling it to a 0-1 range based on the highest raw Threat Index amongst the candidate species (U denotes Urgency and P_o the Probability of Occurrence of a threat in the landscape, while R denotes the Recovery Time if the threat were removed, S the Severity of the threat, and P_a the proportion of the local distribution affected by the threat for a given candidate species). This index reflects the characteristics of each threat and scales them according to their overall importance. For example, a threat with a very low probability of occurrence will obtain a low score regardless of its severity. The same is true for threats affecting only a small proportion of the landscape. For species with high Current Conservation Status, i.e. those doing well, the vulnerability score reflects only (or mainly) the Threat Index.

Ecological Functionality (F): To quantify the ecological significance of candidate species the number of ecological functions in which they are involved and their significance in each are considered. Significance values are summed over all possible functions to produce an overall functionality score for each candidate species. No distinction is made between functionally significant species occurring at high versus low densities (i.e., ecologically pivotal vs. keystone species, respectively).

Socio-economic significance (S-E): The scores for each of the five socio-economic proxies are summed to obtain the socio-economic category score. Assigning positive and negative values independently effectively separates species with both positive and negative value from those with one or the other.

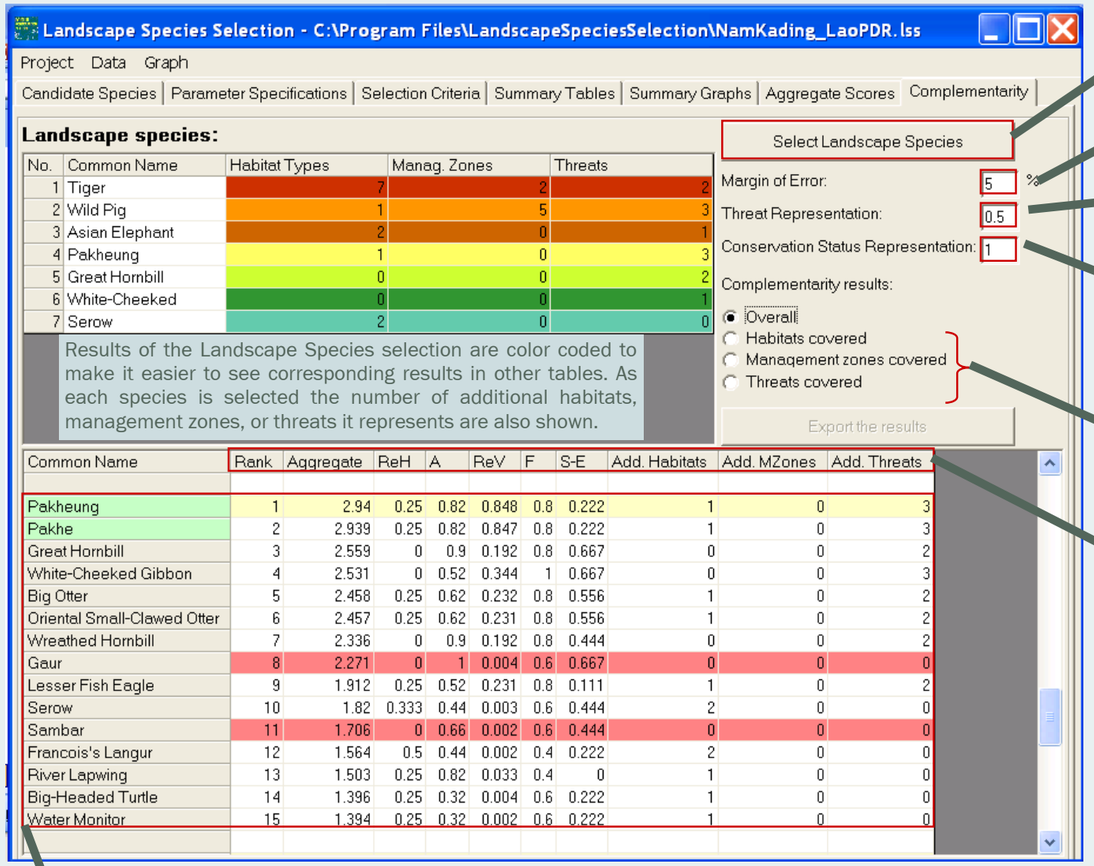
3. Recalculating the aggregate scores for the remaining candidate species, ranking them based on this new score, and selecting the highest ranked species as the second Landscape Species. Again the software will pause if other species scores are within the Margin of Error.
4. Repeating steps 2 - 3 to select all subsequent species.
5. Terminating when all the habitats, threats, and management zones are represented by the suite of selected Landscape Species.

This process favors species that maximize the number of new habitats, threats, and management zones not represented by species already in the suite, while also considering the Area, Functionality, and Socio-economic Significance scores of candidate species.

c. Examine and Refine Your Results

Consider your initial results and repeat the selection process while experimenting with different selection scenarios to compare the results by: (1) Choosing different species when the software asks you to choose among species within the Margin of Error; (2) Changing the Margin of Error value; (3) Changing the value for Current Conservation Status; (4) Changing the Threat Representation value; (5) Changing the value for Level of Use required to represent each habitat (e.g., setting a value of 3 for Riparian habitats in Nam Kading Landscape adds Otter to the suite of Landscape Species).

Step 5 - Use the Software as a Decision Support Tool to Select Your Complementary Suite of Landscape Species



Species within the Margin of Error are highlighted in green (the two fish species Pakheung & Pakhe here). Species removed from the selection process because they do not represent any additional habitats, management zones, or threats are highlighted in light red (i.e., Gaur and Sambar, because either Tiger, Wild Pig or Asian Elephant cover these). The species added to the suite of Landscape Species at each stage is highlighted in beige.

Margin of Error

The Margin of Error stopping rule is meant to make the selection process sensitive to the potential uncertainty associated with the data entered for candidate species during the selection process. If the aggregate score of one or more candidate species is within the Margin of Error (e.g., within 5%) relative to the top ranked species, the software will pause and ask you to manually select the next species to include in the suite of Landscape Species. When making use of this flexibility in the selection process you might use one or more of the following to decide among species: (1) individual criteria scores (e.g., heterogeneity, vulnerability, etc.); (2) the number of and kind of habitats and threats represented by each species; (3) ease of monitoring; (4) specific threats or habitats (e.g., species X is very threatened by poaching); (5) the Current Conservation Status variable within the Vulnerability criterion; (6) previous experience (e.g., much is known about the species or we are currently focusing on this species); (7) opportunity (e.g., there is money available to work on the species); (8) complementary species in terms of trophic level; and/or (9) different scenarios of a final suite of Landscape Species (proceed with the selection with each choice to see what happens to the final suite).

Set the 3 parameters controlling selection and complementarity, then press the button to start the Landscape Species selection process.

Margin of Error: Set a small Margin of Error (e.g., 1%) if you have high confidence in your input data for the selection criteria and a larger value if you have low (e.g., 10%) or virtually no confidence (e.g., 15%) in your input data. The default value is a 5% Margin of Error.

Threat Representation: Set the cut-off value (between 0.5 & 1, default value 0.5) for when an individual threat is represented by a species. For example, the maximum ***Threat Index*** value for 'Hunting for trade as food' is 60, thus any species with an index value of at least 30 would represent this threat in this case.

Conservation Status Representation: Set the minimum Current Conservation Status required for candidate species inclusion in the selection process. If the default value of 1 is used, all candidate species are entered into the selection process. With a lower cut-off value (e.g., 0.5), no species with a CCS value greater than 0.5 is considered for selection.

The habitats covered, management zones covered, threats covered results highlight when each of these were covered by adding a particular species to the suite. The results are color coded by species to facilitate interpretation.

During each step of the selection process the recalculated rank, aggregate score, heterogeneity score, vulnerability score, as well as the original area, functionality, and socio-economic scores for each species are shown. The additional habitats, management zones, or threats represented by each remaining candidate species are shown too.

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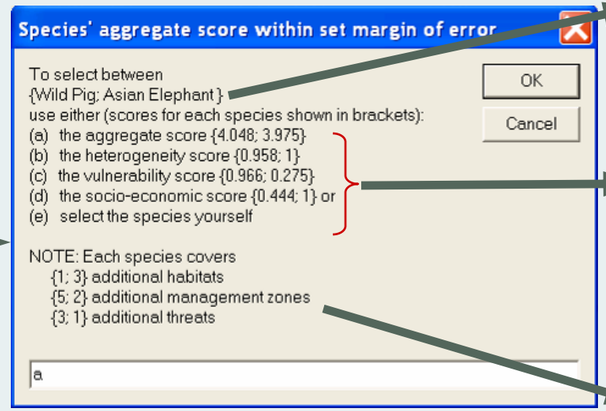
Box I

Habitat Name	First covered by species
Upper Dry evergreen forest	1
Lower Dry evergreen forest	1
Mixed Deciduous	1
Mixed Broadleaf	1
Bamboo Forest	1
Savannah/Scrub/Regeneration forest/grassland	1
Rock-Limestone Karst	7
Rock - Sandstone Bluffs	7
Swamp	3
Swift flowing rivers and rapids (year-round flow)	4
Seasonal streams and pools	2
Mineral Licks	3
Riparian	1

Covered by Serow

Potential threat	First covered by species
Hunting for trade as food	2
Hunting for trade as medicine/trophies	1
Hunting for subsistence consumption	2
Hunting for recreation/conflict	2
Habitat fragmentation	6
Shifting cultivation	5
Logging	5
Hydropower development	3
Pollution	4
Fishing for trade as food	4
Fishing for subsistence consumption	4
Prey depletion	1

Covered by Gibbon



The software stops and asks for a manual selection between Wild Pig (the top ranked species) with a score of 4.048 and Asian Elephant (the second ranked species) with a score of 3.975 (within the 5% Margin of Error).

Depending on your priorities, include a species in your suite of Landscape Species based on the aggregate score or individual criteria scores (heterogeneity, vulnerability or socio-economic) or simply include the species in the suite for other reasons (e.g., ease of monitoring, trophic level, opportunities).

The number of additional habitats, threats, and management zones that each species within the Margin of Error represents. Some redundancy in terms of how these elements are covered by the Landscape Species may be desirable. To avoid a suite of species that is too large, however, select species that provide more coverage (e.g., Wild Pig is more efficient in terms of management zone and threat representation, but Asian Elephant covers a greater number of habitats).

Trying different Landscape Species selection scenarios may lead to further refinement of the selection data. Given that species representation is required for each habitat, threat and management zone, it is key to carefully define these in a way that avoids loss of key information, but yields a reasonably sized suite of Landscape Species useful for efficient conservation planning. For example, in the Nam Kading Landscape the threat from burning was eventually removed, as it was not as critical a threat as initially perceived. When defining threats, a rule of thumb is to split them up if the interventions are likely to be different (hence the definition of four types of hunting threat in our example).

Furthermore, consider which species that do not qualify as Landscape Species might still be included as conservation targets as 'special elements' (see page 3).

Obtain a summary of selection results and export them by clicking on the ***Export the results*** button.

d. Select your Landscape Species

This software is designed to be a **decision support tool** and will probably not provide the final suite of Landscape Species for a particular site. Considering the software's suggestions, compile a suite that will help conserve the composition, configuration and ecological processes of the landscape. The suite is intended to help define: (1) the extent of the landscape; (2) ecologically appropriate management units; and (3) where and when conservation conflicts occur. This information can then be used to help structure conservation actions.

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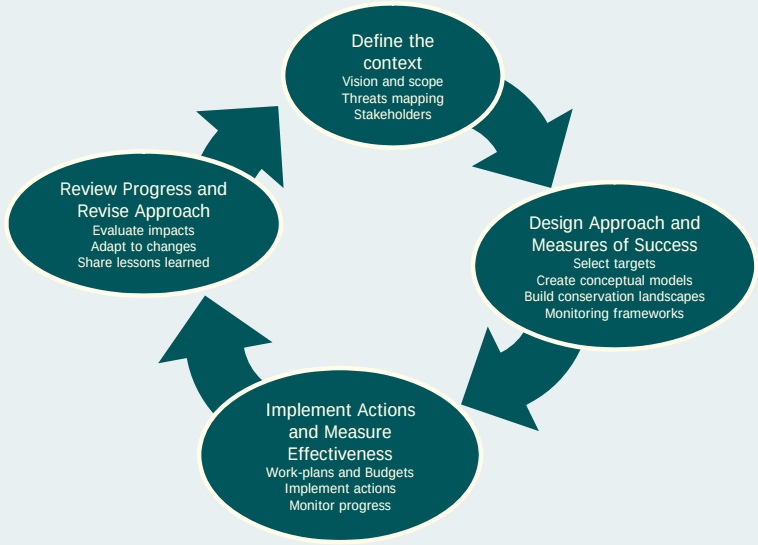
Living Landscapes Program Manuals

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 technical manuals which are available by email from conservationsupport@wcs.org.

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