THE SCIENCE OF STRATEGIC CONSERVATION: PROTECTING MORE WITH LESS

Appendix B – User Manual[1]

This user manual is designed to accompany the Optimization Decision Support Tool (ODST), which can be used to analyze a wide variety of problems related to strategic conservation planning. The guide assumes that the user has read the book entitled, The Science of Strategic Conservation: Protecting More with Less written by Kent Messer and William Allen, III (Cambridge University Press, 2018). This guide is organized so that users can quickly find step-by-step explanations of features available in the ODST. The features of the ODST can be used to conduct analysis similar to those conducted in a variety of contexts that are described in the book such as forest land protection, agricultural protection, watershed restoration, and endangered species protection. The reference guide discusses how conservation optimization can be done using binary linear programming, benefit-cost targeting, hybrid programming, and goal programming. The ODST can also be used to conduct traditional benefit targeting (also known as rank-based models). The reference guide also describes a variety of features which assist with data management, data analysis, and final presentation of results.

[1] This reference guide was originally development by Messer and Fooks (2013).

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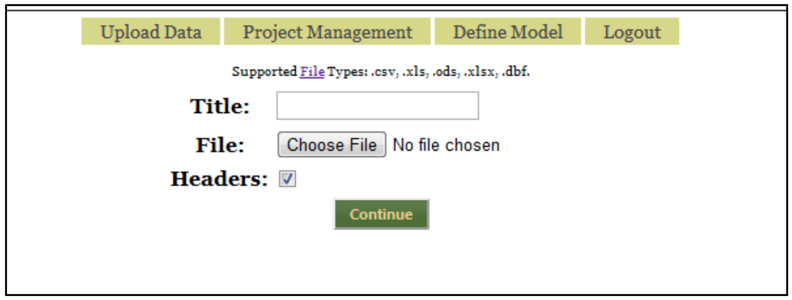
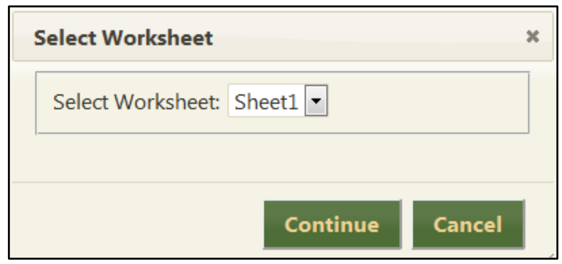
Chapter 1 – Accessing the Optimization Decision Support Tool

The web-based Optimization Decision Support Tool (ODST) can be accessed from any computer connected to the internet using a JavaScript (Chrome and Firefox are currently recommended) enabled web browser. It is accessible via the URL http://odstweb.conservationgis.com/. From the initial Welcome Page click on the Login Button to access the Login Dialog Box. Click on the button that says "Register for a Free Demo Account.

After successfully logging in, you will be taken to the home page. On the left hand side of the screen you will see the session information panel, which shows the username that you are currently logged in under, as well as the current project you are working in if a project is open. Across the top is the main navigation bar, featuring the buttons Upload Data, Project Management, Define Model, and Logout. This will allow you to perform the necessary tasks to conduct an analysis.

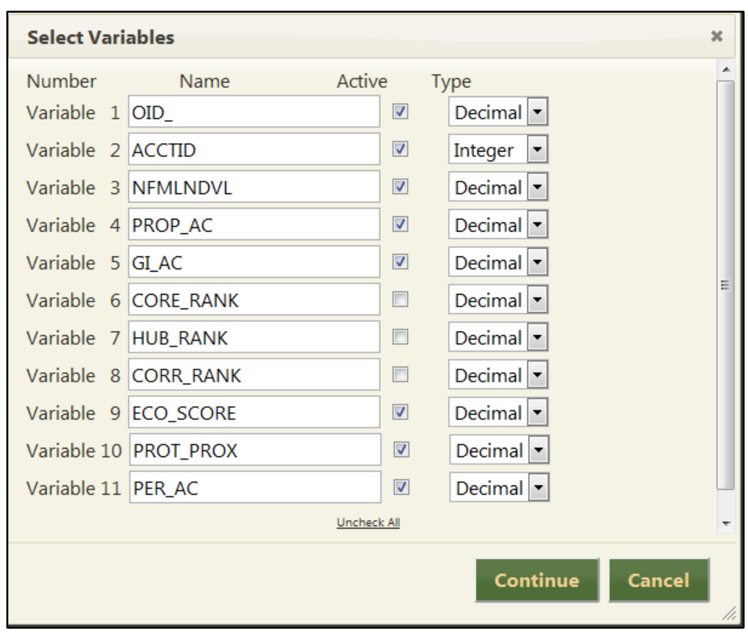
1.1 Loading a Project





A project includes all of the data involved in an analysis, as well as any models associated with that data. To create a new project beegin by uploading a dataset. Data can be imported from CSV, XLS, XLSX, ODS, and DBF file types. To begin, click on the "Upload Data" button. This will open the New Project screen. Input a title for the new project and select a file by clicking the "Choose File" button. If the files contain headers (column titles) in the first row of the spreadsheet, make sure the "Headers" checkbox is checked. If the data does not have headers, click on the box to uncheck it.

After you have finished inputing the basic project inforation, click on the "Continue" button. This will take you through a series of dialog boxes to help you import your data properly. If the file you are uploading has several tabs or worksheets in it you will need to choose which worksheet your data is in in the worksheet selection dialog box. Finally, you will need to select which variables (or fields from your file) you would like to be active. If your data has headers the ODST will try to automatically create variables names from them. Variable names can only contain letters and numbers. Headers with illegal characters will automaically be corrected. You may review and rename variables in the Name columns.



Variables which you expect to be working with or you would like to see reported in the output should be marked as active. Variables that are not active will still be uploaded and stored with the project, but will be hidden so as to not clutter up your working environment. For more on hiding and unhiding variables see 2.3.2.

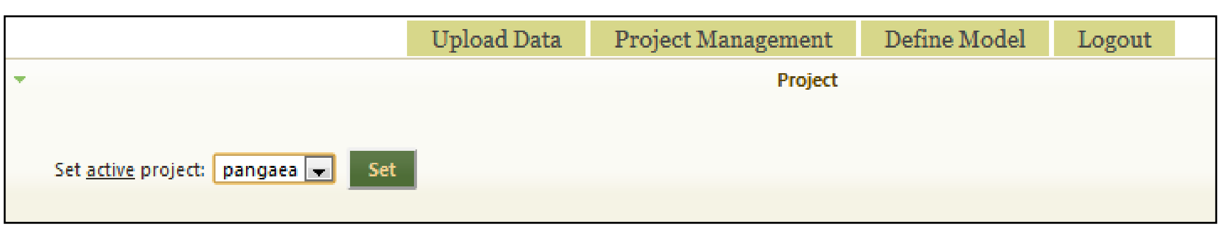
In the final column in the variable selection dialog box is the "Type" column. Any data used in the anaysis must be numic, however text data may also be stored and reported. When scaning the file the coputer tries to guess what the appropriate data type for each variable is. Look over them and change any that are incorrect to prevent errors.

Chapter 2 – Working With a Project Data

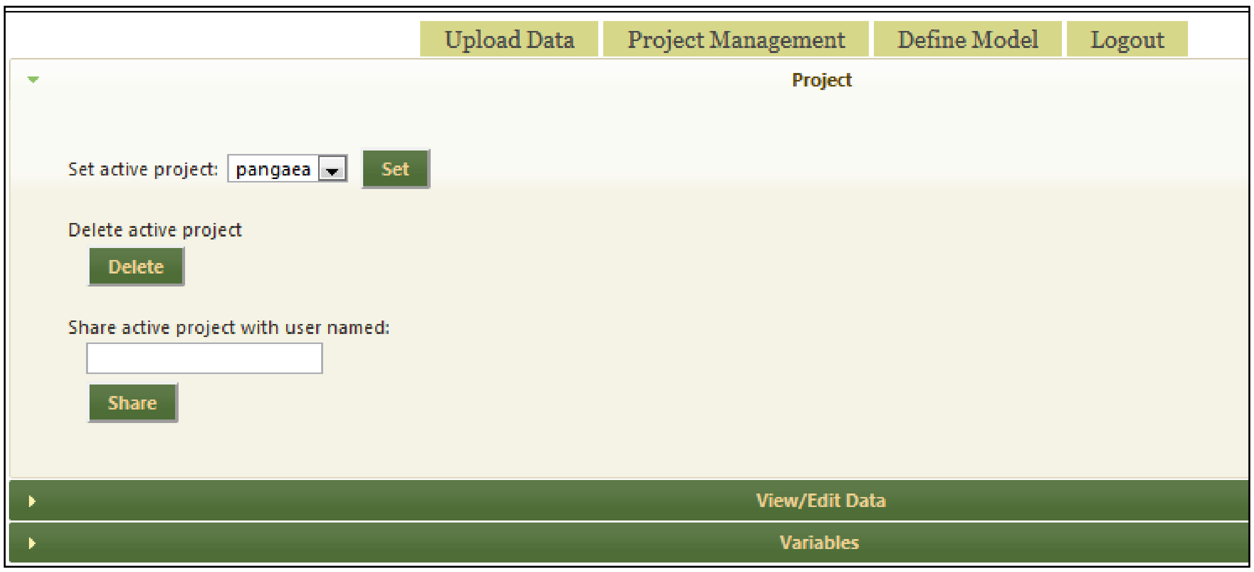
Once your data is uploaded into a project that dataset is set as the active project. The ODST offers several tools to help you review, manipulate, and share your work with others. These can be accessed at any time by clicking the "Project Management" button. If there is no active project set for your session when you click on button you will be able to recall a prior session. If there is a project loaded you will have access to additional project management options, as well as two additional tabs with option to view and manipulate your data.

2.1 Setting, Deleting, and Sharing Active Projects

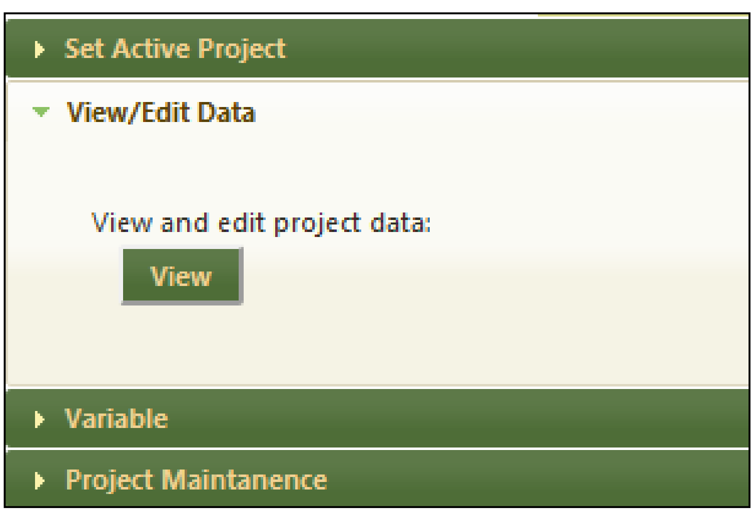
If there is no active project set for your session when you click on the Variable Management button you will be prompted to select a new project. You can do this by selecting a project from the dropdown menu and click the Set button.



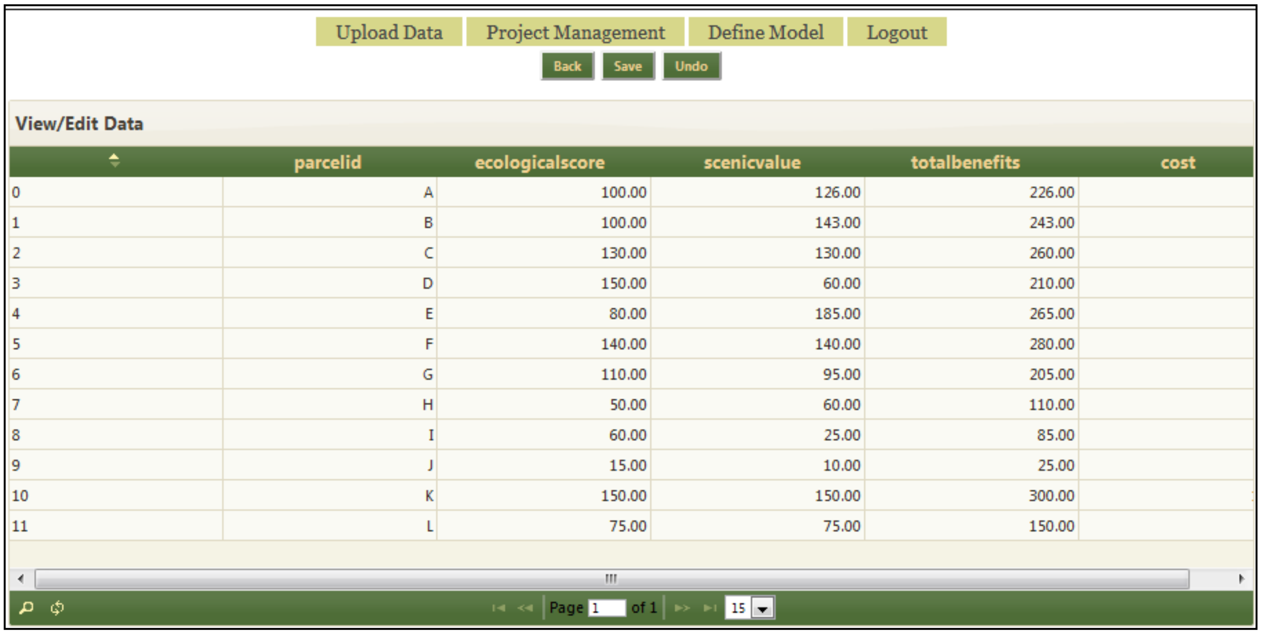
If a project is loaded you will see additional options below Set Active Project. You can still change active projects by selecting the new project from the "Set active project" pull down menu and pressing the Set button. Here you may also delete the active project using the "Delete" button. This will completely remove the project, including data and associated models. You may also make the project available to other users by entering their user name and clicking the "Share" button. The project will then be accessible to them on their project page.



2.2 Viewing and Editing Project Data

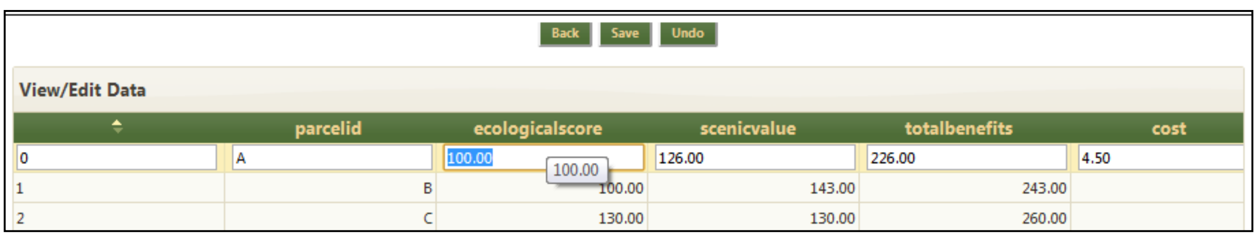


By clicking on the View/Edit Data tab you can get access to the data editor. Click on the View button to bring up the View/Edit Data Table. This will display the entire data set for the project.



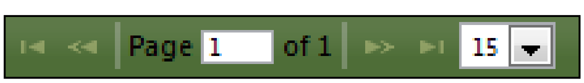
	parcelid	ecologicalscore	scenicvalue	totalbenefits	cost
0	A	100.00	126.00	226.00	
1	B	100.00	143.00	243.00	
2	C	130.00	130.00	260.00	
3	D	150.00	60.00	210.00	
4	E	80.00	185.00	265.00	
5	F	140.00	140.00	280.00	
6	G	110.00	95.00	205.00	
7	H	50.00	60.00	110.00	
8	I	60.00	25.00	85.00	
9	J	15.00	10.00	25.00	
10	K	150.00	150.00	300.00	
11	L	75.00	75.00	150.00	

You can make any row editable by double clicking on it. After you are finished making changed to a row hit enter for the changes to register. Once you have completed making changes click the Save button at the top of the screen to save the changes. If you click the Undo button it will discard all changes made since you last saved.



	parcelid	ecologicalscore	scenicvalue	totalbenefits	cost
0	A	100.00	126.00	226.00	4.50
1	B	100.00	143.00	243.00	
2	C	130.00	130.00	260.00	

By default this will display fifteen projects at a time on a page. If the project has more than fifteen items you can view more by moving through pages using the arrows on the bottom of the View/Edit Data Table. You can increase the number of items listed on a page using the pull down menu next to the page control.



Below the View/Edit Data Table there is a table of descriptive statistics for the project data. The reported statistics are:

Sum: The sum of all the values of that variable or "-" if it is a non-numeric variable

Min: The minimum value of the variable or "-" if it is a non-numeric variable.

Max: The maximum value of the variable or "-" if it is a non-numeric variable.

Mean: The average of the values of the variable or "-" if it is a non-numeric variable.

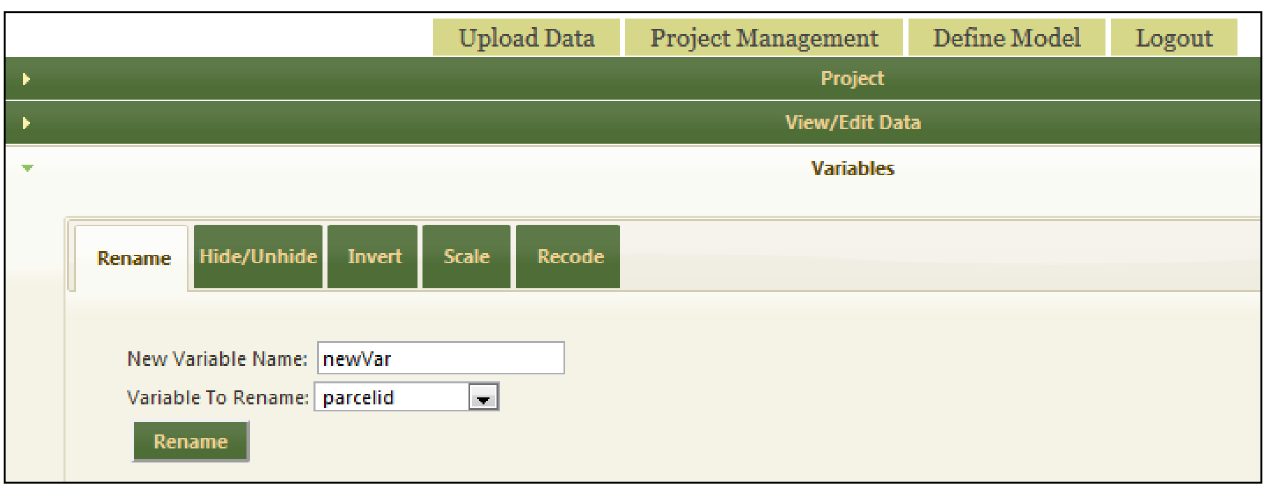
StDev.: The standard deviation of the values of the variable or "-" if it is a non-numeric variable.

Summary Statistics

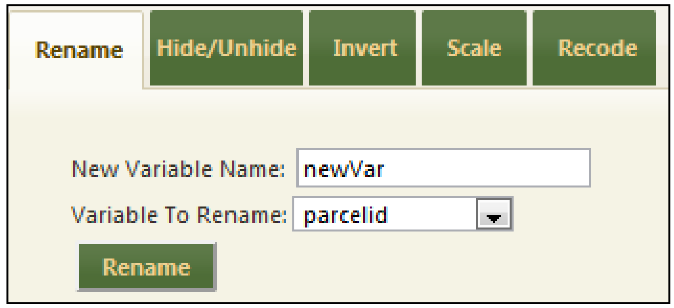
Summary	parcelid	ecologicalscore	scenicvalue	totalbenefits	cost
Sum	-	1,160.00	1,199.00	2,359.00	81.00
Min	-	15.00	10.00	25.00	4.50
Max	-	150.00	185.00	300.00	12.00
Mean	-	96.67	99.92	196.58	6.75
StDev	-	40.64	51.90	82.25	2.07

2.3 Data Operations

Below the View/Edit Data Tab, the Variable tab offers a variety of useful variable manipulations. Click on the corresponding tab to access each operation.

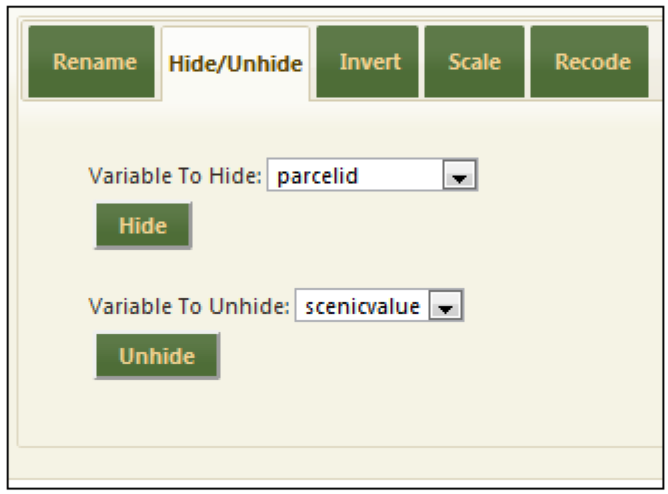


2.3.1 Renaming a Field



Click on the Rename tab to change the name that a variable is displayed under in the project. Type the new name in the top box, and select the variable to rename from the bottom pull down menu.

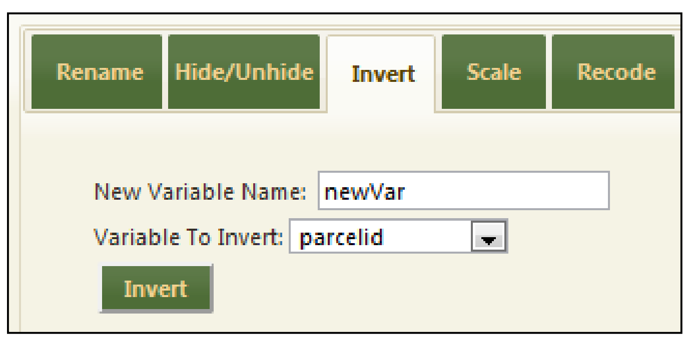
2.3.2 Hiding and Un-hiding Fields



As mentioned in Section 1, you can hide and unhide variables to help keep your workspace clean. A variable that is hidden will not appear in any of the other dropdowns or data summaries. The top dropdown menu lists variables that are currently visible. To hide a variable select it from the dropdown and click the Hide button. The bottom menu lists variables that are currently hidden. To unhide a hidden variable select it from that menu and click the Unhide button.

2.3.3 Inverting a Field

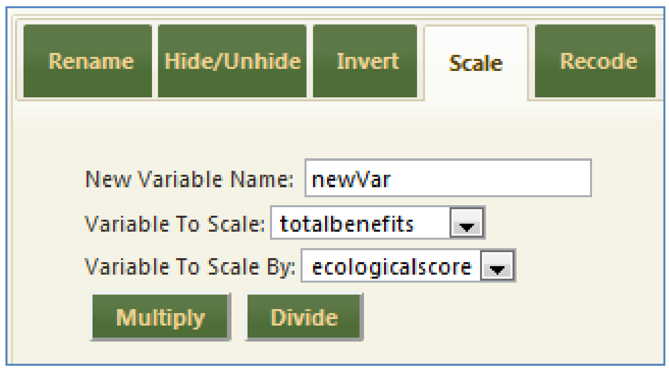
For some variables, such as a project's acres or ecological value, higher numbers indicate a good trait.



However, for some variables, such as the distance to protected areas, higher values indicate a poor trait. The "Invert" option creates a variable which maintains the range and proportionality of the original variable, but reverses the ordering. When a variable is inverted, the values assigned are such that the new minimum value has the same value as the original maximum value and the new maximum value has the same value as the original minimum value. The rest of the values are reassigned within that range such that the relative proportions between items are maintained.

To invert a variable, click on the Invert tab, type the name of the inverted variable to be created in the top box, and select the variable to invert from the bottom pull down menu.

2.3.4 Scaling a Field



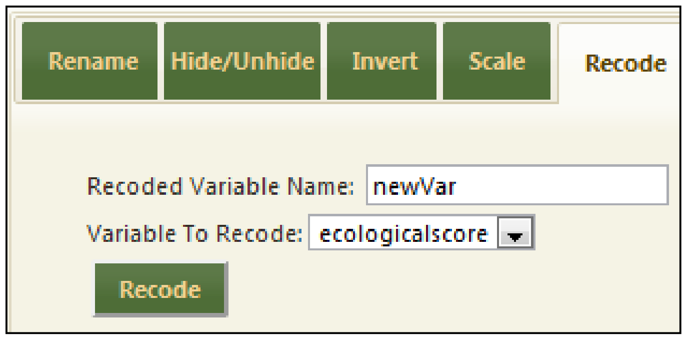
Often benefits measures are calculated on a per-acre basis, such as Land Evaluation and Site Assessment (LESA) scores, where the value represents the average score for an acre in the project. Other measures, such as acres and the total cost, are often calculated on a per-project basis.

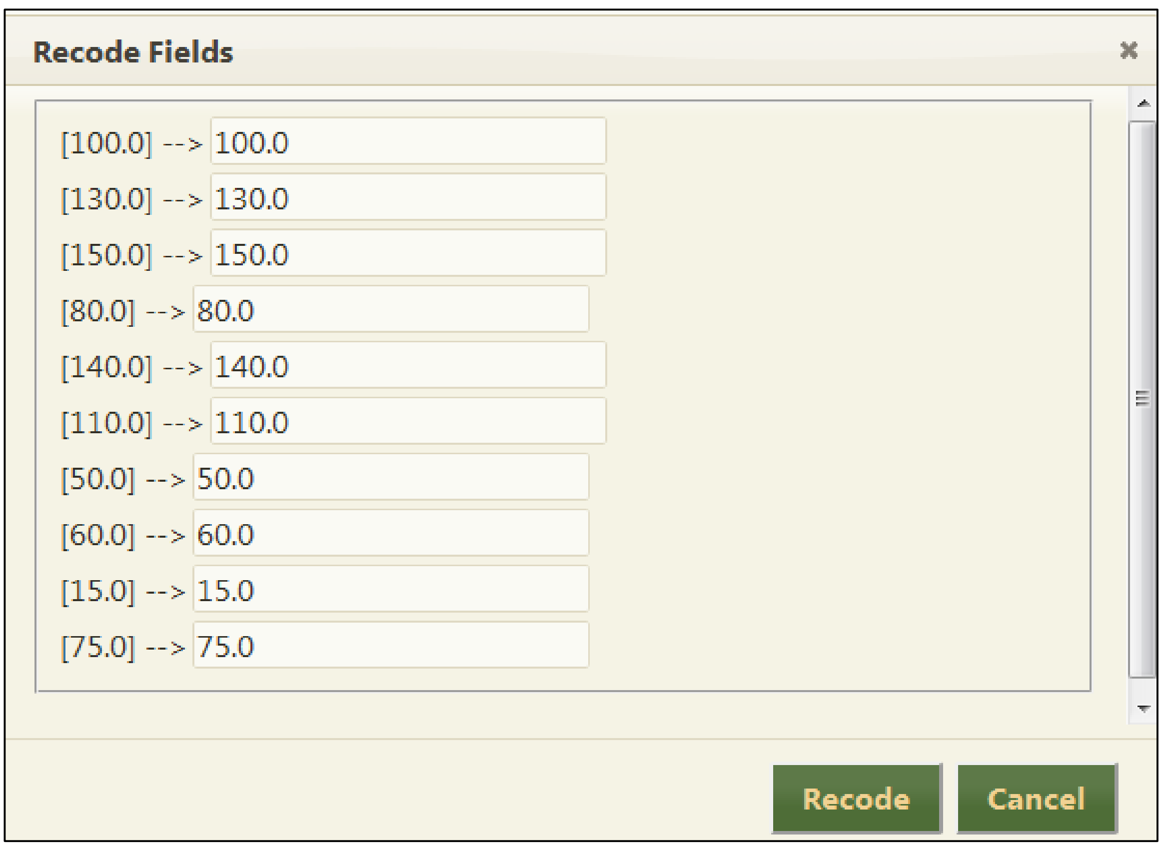
As described in Messer and Allen (2010), failure to keep these measures on a consistent scale can lead to large inefficiencies. To avoid this problem, the ODST has built in a tool that allows the user to scale a benefit measure by another variable such as size. This feature creates a new variable by either multiplying or dividing two variables. To scale a variable by another variable, click on the Scale tab, type the name of the new scaled variable to be created in the top box. Select the variables to scale and scale by in the two dropdown menus below. If dividing, the "scale" variable will be divided by the "scale by" variable. Then click on either the Multiply of Divide button to perform the corresponding action.

2.3.5 Recoding a Field

There may be occasions where some data is incorrectly represented and needs to be fixed. In this case, the "Recode" option can be used to remap values in the data. This feature may also be helpful in situations where the problem is systematic, such as appraisal values of $0 or missing.

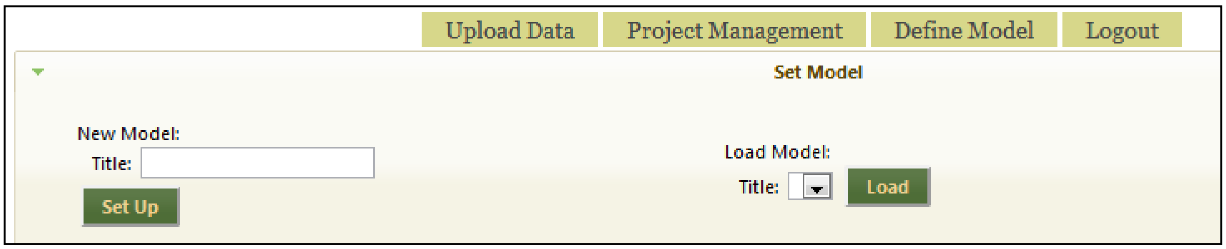
To recode a variable, click on the Recode tab. Enter the name of the variable to be created in the top box and select the variable to recode from the dropdown menu below that. When you click the "Recode" button it will bring up a window listing all of the unique values that the variable to be recoded takes. The left side lists the existing values and the right lists the values to be recoded to. Change any values on the right side and click Recode button to create the new variable with the new values.





Chapter 3 – Building a Model

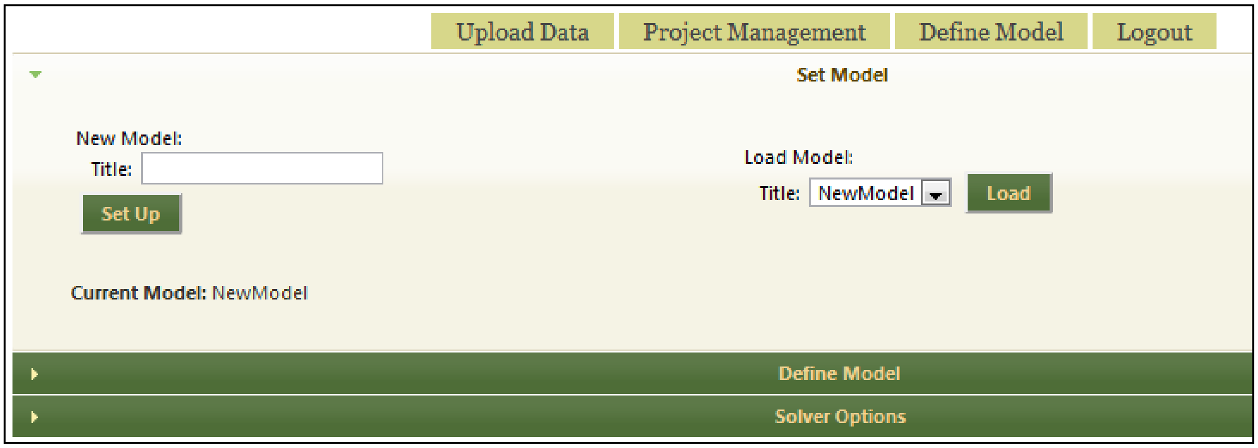
Once a project is established and the data is appropriately structured, any analysis preformed on the data will be structured as a model. A model represents a structure imposed on the data which identifies objectives and constraints that are relevant to the project. Everything needed to create and build a model is listed under the Define Model tab.



3.1 Creating and Loading Models

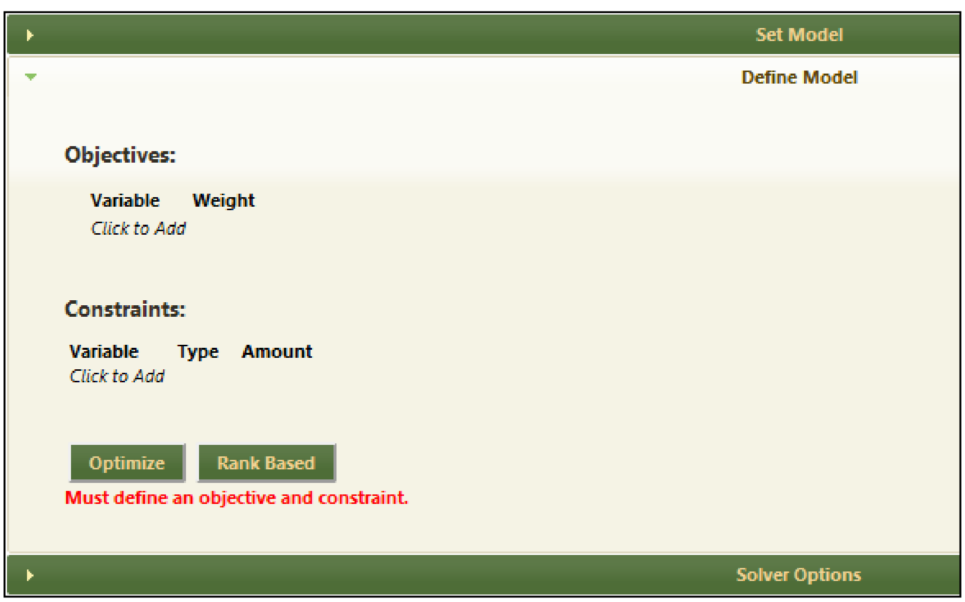
When a project is first created there are no models yet associated with the project? Therefore, when first clicking on the Define Model tab you will have to create a new model by typing a name for the model in the Title box and clicking the Set Up button. If you are working with a project for which one or more models have been created you can create a new model for a new analysis in the same way, or load an existing model by selecting it from the dropdown menu and clicking the Load button. Once a model is loaded, either though creating a new model or loading an existing one, the active model will be listed as the "Current Model" and you will have two more tabs below the Set Model tab: Define Model and Advanced Options.

When a new model is defined it creates two more variables in the project *model*_benefits and *model*_selected where *model* is the model title that was specified. These are a composite benefit index variable and a model result variable which will be further described below.



3.2 Defining a Model

Model Definition is where the objectives and constraints for the model are set. All models must have at least one objective and one constraint. The objective is the weighted sum of the normalized attributes that the user defines as "Benefits". These can be assigned different weights to indicate relative importance, with higher weight amounts indicating more importance. The objective index is saved in the project as *model*_benefits, where model is this name of the current model, and is the variable that the ODST uses for measuring the aggregate benefits. This is calculated by scaling each variable between zero and one, such that the lowest valued item for the variable would be zero and the highest one. These rescaled variables are then multiplied by their respective weights and added together to get the total benefit index.



While normalization is important for conducting analyses that accurately reflect the relative weighting of the attributes of interest, as defined by the user, one challenge is that Conservation Values tend to lack intuitive explanations other than obtaining more is better than obtaining less. Consequently, the user will likely need to track other key characteristics, such as acres protected, that can be more readily interpreted.

Note that as different attributes and different weights are used in different analyses comparisons of the aggregate Conservation Values are not meaningful. In other words, only if the attributes and weights are the same are direct, apples-to-apples type comparisons possible.

Constraints represent a cost/budget limitation, or other constraining factor that must be satisfied. The first type of model introduced below only allows for one budget constraint, where the total some of a defined cost must be less than some fixed budget amount. In the models introduced after that there will be several other types of constraints such as minimum or maximum sum, value, and count constraints.

The ODST supports several different types of optimization models, and the process of setting up each model differs slightly. The next section discusses cost effectiveness analysis which is the most basic optimization approach. The sections following the introduction of cost effectiveness analysis discuss three other optimization approaches which allow more power and flexibility to decision makers. The type of model being used is set under the Solver Options tab and is discussed in Section 3.4.

3.2.1 Conducting a Cost Effectiveness Analysis (CEA)

3.2.1.1 How CEA works

Cost Effectiveness Analysis is set as the default solver. CEA operates on a basic list sorting principle where a value score is sorted from highest to lowest and parcels are successively selected until the budget is exhausted. The ODST offers two different approached to this, represented by the two options to solve the model at the bottom of the tab: Optimize and Rank Based.

"Rank Based" performs a Rank-Based Analysis (also referred to as Benefit-Targeting in the academic literature) is the most common form of project selection used in conservation. The Rank-Based Analysis ranks potential conservation projects from highest to lowest based on the projects' total benefits. Rank-based analysis is what is referred to the Operations Research literature as a type of "greedy agent" algorithm, since once all projects have been ranked the algorithm selects the projects with the highest conservation values that it can afford from the set of top-ranked non-selected projects. If projects have equal rankings, the rank-based analysis will select the project that costs the least. Through an iterative process, projects are selected until the budget is exhausted.

Despite its widespread use, the rank-based approach can lead to inefficient results from both an economic and conservation perspective. The source of the problem is that a project's price is only explicitly factored into the decision process to determine whether there is enough money still available or in the uncommon cases where there is a tie in the benefit ranking. So unless all of the project costs are equal, then the rank-based analysis will lead to an inefficient outcome. In general, the inefficiency of the rank-based based approach is greatest when projects' benefits and costs are positively correlated (Babcock et al. 1997), especially when costs are relatively more variable than benefits (Ferraro 2003).

A user may want to conduct a rank-based analysis to evaluate how it would traditionally select projects. To conduct this analysis, the user must first define the variables of interest, their weights and constraints (if applicable). The rank-based analysis will start when a model is defined and the "Rank Based" button is clicked.

The Optimization Analysis uses the same project-specific benefit information as the rank-based analysis. However, instead of selecting the projects with the highest individual benefits, it identifies the set of projects that maximize total benefits. Consequently, Optimization analysis specifically accounts for the cost of each potential project and identifies the most cost-effective solution. An optimization analysis can be run by clicking the "Optimize" button.

Optimize performs a true Cost Effectiveness Analysis (also referred to as benefit-cost ratio prioritization (Johnston and Duke 2009). This is a common technique used in medical research to evaluate alternative treatments where the benefits are measured in non-monetary units, such as 'quality' or 'pain free' days while the costs can be measured in monetary units (i.e. the costs of the treatments.) In these cases, selection is determined by calculating summing the weighted, normalized benefit measures (the objective index) and dividing it by a project's costs. This approach then uses this benefit/cost ratio by selecting the projects with the highest ratios until the budget is exhausted.

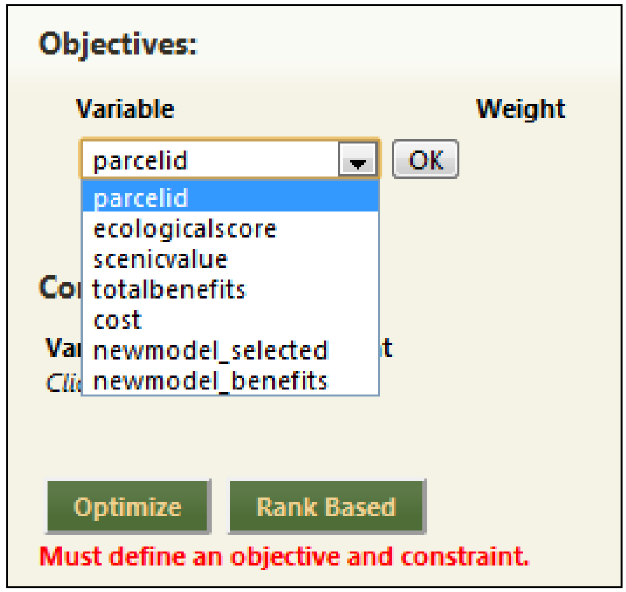
A key advantage of Cost Effectiveness Analysis is that it tends to be easier to explain this selection process to both potential project applicants and also to the general public.[2] However, this approach does not guarantee optimality. This lack of optimality can arise due to an inability to effectively use the entire budget set – this problem can be especially acute in low-budget scenarios where the individual project costs are high. Additionally, in situations where there are multiple

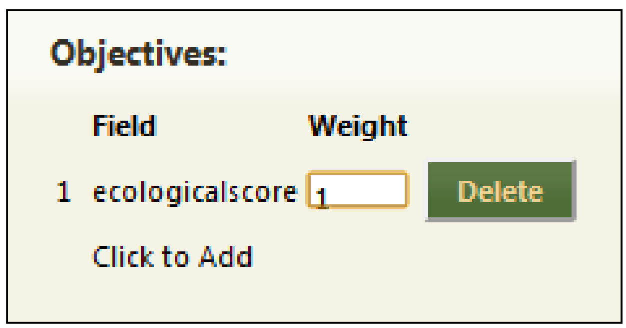
[2] Of course, benefit-cost ratios are also traditionally easier to calculate. However, with the ODST all calculations can be made quickly and easily.

constraints, such as staff constraints in addition to budget constraints, cost effective analysis can also be inefficient (Messer 2006).

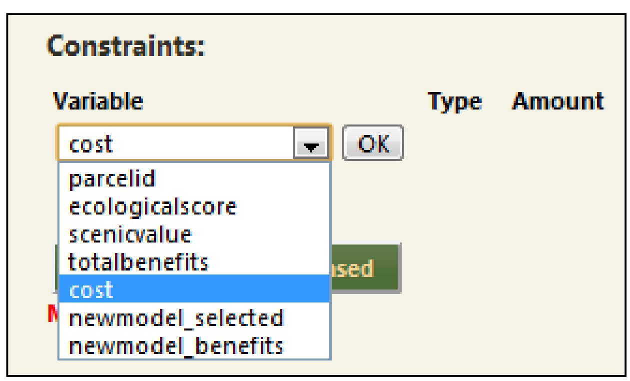
3.2.1.2 Model Definition

A CEA model requires the selection of one or more objectives and one budget constraint. Objectives are selected by clicking on the "Click to Add" text under Objectives. This will produce a drop down menu listing all of the project's variables. Select the variable you want to use as the objective and click the OK button. This will add the variable as an objective with the weight automatically set to one. If you wish to change the weight of any objective you may do so by clicking on the weight number which will open up a text box. Type in the new weight and click enter.



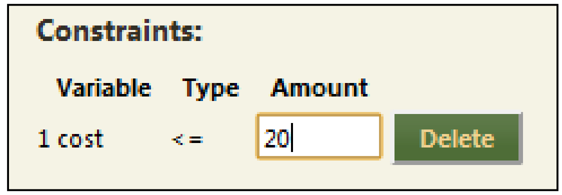


CEA models require exactly one budget constraint. This may be defined by clicking on "Click to Add" under Constraints. Select the cost variable from the dropdown menu and click the OK button. This is automatically set up as a "less than or equal to" type of constraint (<=) and cannot be changed. Once the cost variable is selected the budget must be defined by clicking on the zero under Amount and typing in the budget amount, followed by enter. At any point weights, budget amounts, or cost and objective variables



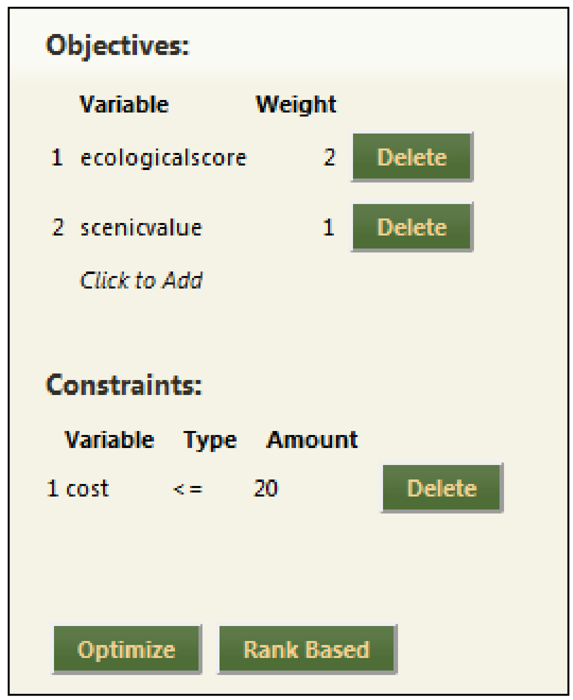
can be changed by clicking on them to bring up a dropdown or text box. Objectives and constraints may be deleted by clicking the Delete button next to them.

A fully defined CEA model will look similar to the one displayed on the left. Once you are satisfied with the model click on the button for the appropriate solution method (as discussed in the previous section) and the ODST will calculate the solution to the model and proceed to the results screen as discussed in Chapter 4.

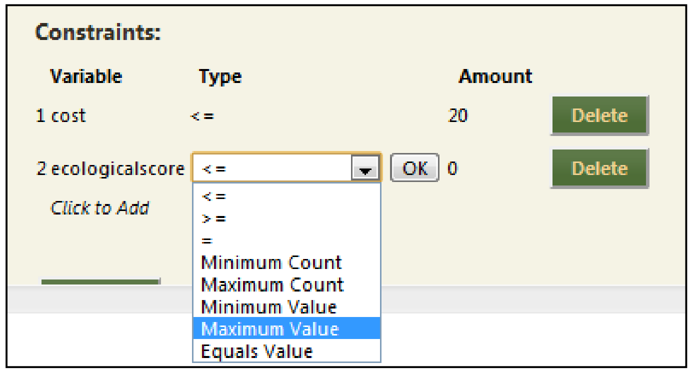


3.2.2 Conducting a Binary Linear Programming Analysis

A Binary Linear Programming model (BLP) considers the selection of projects a 'yes' or 'no' binary choice and then uses the Branch and Bound algorithm developed in the field of Operations Research to solve for the set of projects that maximize the total conservation benefits given user-defined constraints. A key advantage to binary linear programming is that it *guarantees* that it will identify an optimal solution to the problem (assuming a solution exists). The structure of binary linear programming is very flexible and can accommodate a wide range of constraints.



The key difference between CEA and BLP model definitions is that in BLP models multiple constraints of different types may be added. To add additional constraints simply click on “Click to Add” beneath the existing constraints. To change the constraint type, click on the type operator (<= by default) to bring up a pull down menu listing six different types. These types are:



- ***Less Than or Equal To (<=)*** – The total value from the projects selected in the analysis must be less than the indicated Amount. This is the most common constraint as budget constraints as the total cost cannot exceed the definite budget.
- ***Greater Than or Equal To (>=)*** – The total value of the projects selected in the analysis must be greater than the indicated Amount. An example of this is an acreage goal, where group of projects must exceed a certain user-defined number of acres.
- ***Equal To (=)*** – The total value of the projects selected in the analysis must be exactly equal to the indicated Amount.
- ***Maximum Count*** – The total number of the projects selected in the analysis must be less than the indicated Amount. An example of a “Maximum Count” constraint is the total number of projects that an organization can handle in a given time period due to staff constraints.
- ***Minimum Count*** – The total number of the projects selected in the analysis must be greater than the indicated Amount. An example of a “Minimum Count” constraint is a policy that requires that a certain minimum number of projects are funded.
- ***Individual Maximum Value***– The analysis will not select a project that has a value for this variable that is greater than the indicated Amount. This type of constraint can be set on a

project's costs, in situations, where the user determines that an individual project should not be selected if it exceeds a certain cost (either on a total amount or per-acre amount).

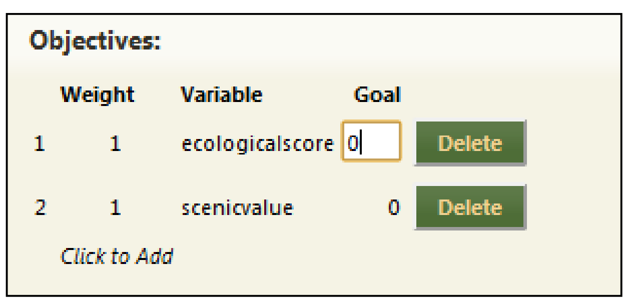
- ***Individual Minimum Value***– The analysis will not select a project that has a value for this variable that is less than the indicated Amount. This type of constraint is very common, especially as organizations have a certain minimum threshold of size or perhaps quality that any selected project needs to equal or exceed.
- ***Individual Equals Value***– The analysis will only select a project if it has a value for this variable that is equal to the indicated Amount. This type of constraint can be helpful if a variable exists that indicates a project's availability for funding from a specific project or has a specific trait of interest.

Once the model is fully specified, again click the Optimize button and the ODST will calculate the results and proceed to the Results Page. Note that for BLP and the rest of the models that follow there is no Rank Based option, as the ranking system used in CEA is not directly comparable with more complex Linear Programming based models.

3.3.3 Conducting a Goal Programming Analysis

Goal Programming (GP) is an extension of BLP that is appropriate when there are some variables that you want to try to achieve certain values for, or when there are multiple competing goals which you are trying to balance. GP allows you to specify specific values for each objective variable and tries to find a solution that minimizes deviation from those targets.

The only difference in specification between a BLP and a GP program is in the objectives. For a GP model you must supply not only the variable name and weight, but also a goal value. This goal value can be a specific target value, or you can



type in “max” or “min” and the ODST will calculate the maximum or minimum possible value for that variable and use it as the target value.

3.3.4 Conducting a Hybrid Programming Analysis

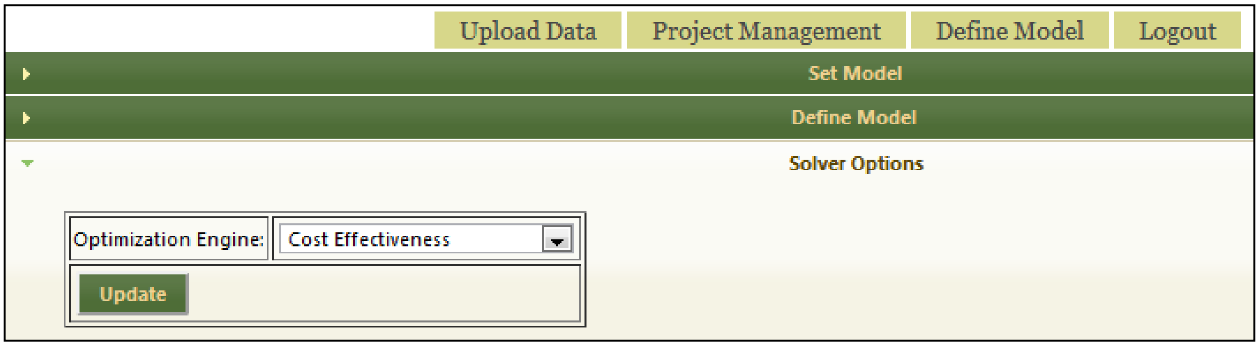
One of the drawbacks of BLP is that it will frequently pass up very high benefit scores in favor of choices that are lower cost and lower benefit. This is often optimal, but sometimes there may be concern that high value choices being passed up are too high of a cost for more, but relatively cheaper choices selected instead. In fact, recent research has suggested that applying BLP when the benefit scores are uncertain or of an unknown relative magnitude can sub-optimally under-select high benefit choices. To adjust for this, the ODST offers Hybrid Linear Programming (HLP). HLP is hybrid in the sense that it is a hybrid of the Rank Based selection approach and BLP. It ranks based on the benefit score and selects the top few highest scoring items. Then it optimizes over the remaining items using BLP and the remaining budget. The specification of HLP is exactly the same as BLP. The number of top projects to select with the Rank Based selection approach is set under the Advanced Settings tab as detailed below.

3.4 Advanced Settings

The choice of model type, as well as engine specific settings for each of the solvers is available under the Solver Options tab. In this tab you may set the model type you would like to you as discussed above from the Optimization Engine dropdown menu and clicking update. Depending on which engine you choose, other options may be displayed.

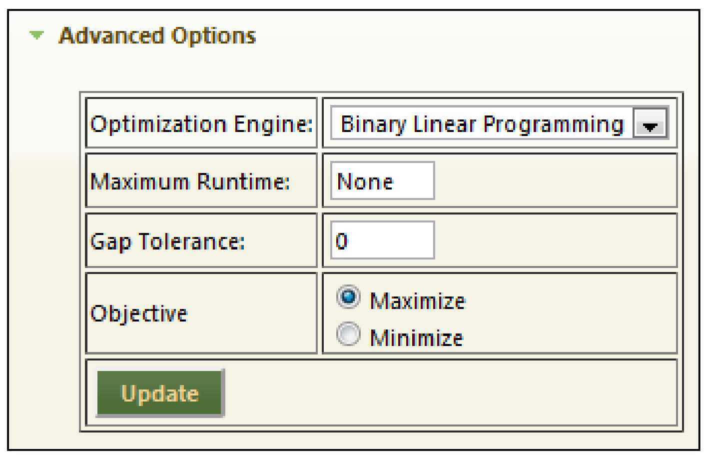
3.4.1 Cost Effectiveness Analysis Settings

The Cost Effectiveness Engine has no additional options beyond switching to a different engine. Note that, since the CEA engine only allows one constraint, when switching to the CEA engine from another engine all constraints will be deleted.



3.4.2 Binary Linear Programming Settings

The BLP engine has two optional settings controlling the performance of the optimization engine, as well as an option specifying the objective type. The performance settings may be useful if the ODST seems to be taking too long to generate a solution for the model. The Maximum Runtime specifies how long in seconds the solver should be allowed to run before giving the best answer that it could find in the allotted time. The Gap Tolerance specifies how close in percentage the solver should get to the answer before returning its best answer. When these are left at the default values of “None” and “0” the ODST will continue searching until it finds the true optimal answer.

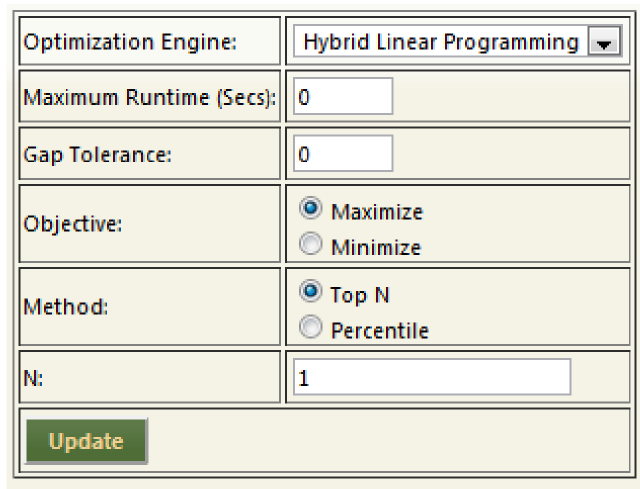


The Objective setting alows you to choose whether the model’s objective should be maximized or minimized. Maximize is the default, and is appropriate for objectives like some sort of environmental score. Minimize, however, could be useful for models such as minimizing the cost of conservation subject to minimum preformance or threshold constraints.

3.4.2 Goal Programming Settings

The GP engine has the same two optional settings controlling the performance of the optimization engine as BLP. These operate in exactly the same way. GP does not offer the Objective option that BLP does as the GP engine is necessarily minimizing deviation from pre-established target.

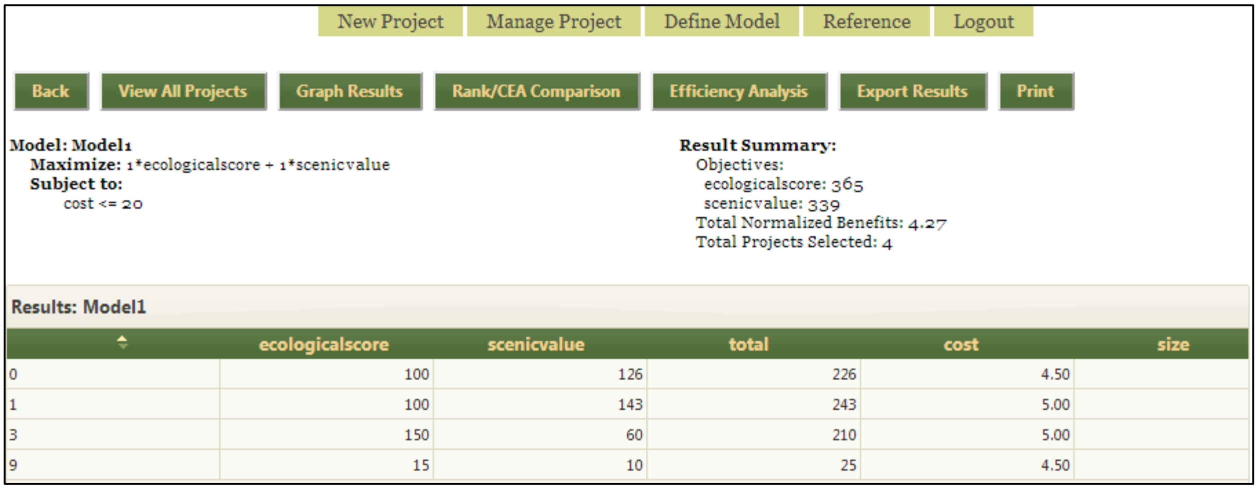
3.4.2 Hybrid Programming Settings



The HLP engine has the same three optional settings as BLP which operate in exactly the same way. It also allows you to specify the number of top projects to be selected. By default this is set to one so that the best project is always selected. To ensure that more than the top one are selected, enter the desired number of top projects here. Keep in mind though, that the more projects this engine selects that BLP would not have selected, the lower the total benefit value achieved will be.

Chapter 4 – Interpreting Results

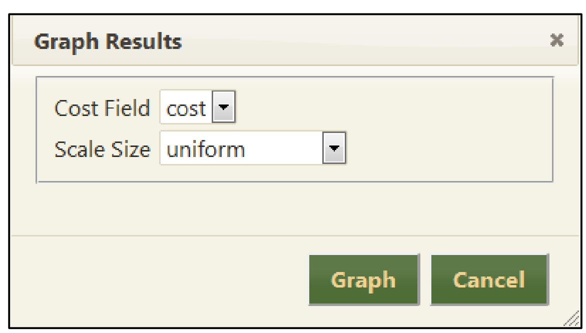
After solving a model, the ODST presents the results in a results screen. This has the same basic options for all model types, with several additional analysis options for CEA models.



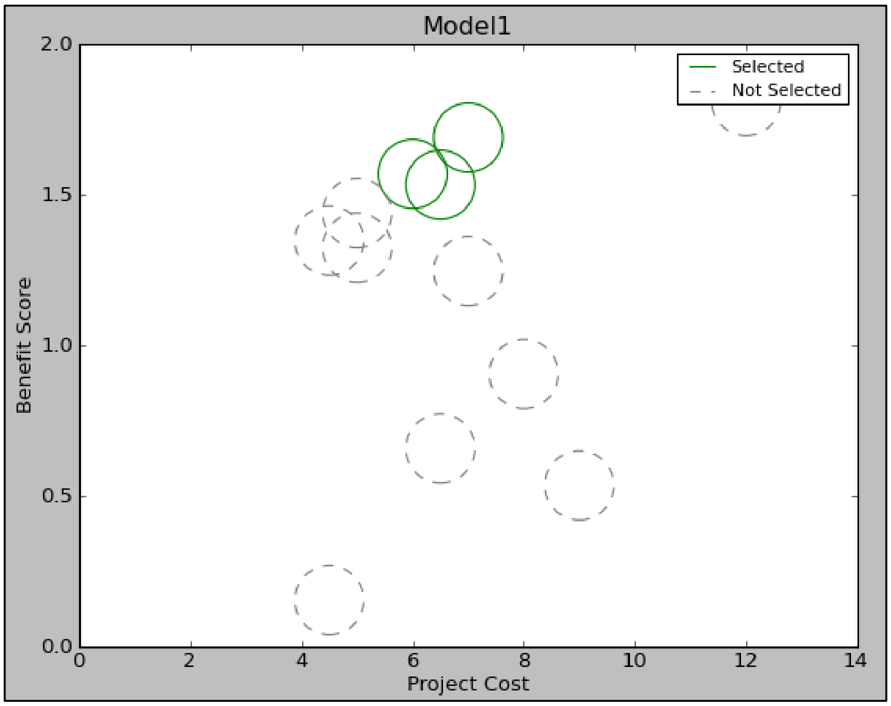
4.1 The Results Screen

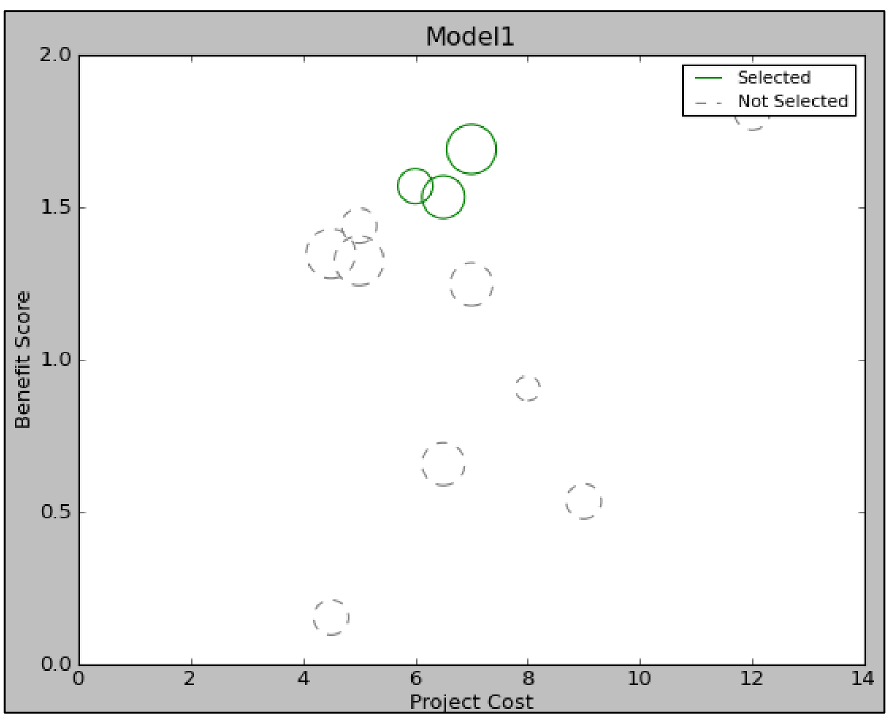
The basic results screen gives a summary of the model being solved in the top left corner, including the objective function and constraints. Below that it provides a summary of results listing the total number of choices selected and the total benefit score achieved. Below that it lists the selected parcels and summary statistics in a format similar to the View/Edit Table (see Section 2.2). If you would like to see all parcels instead of the selected parcels you can do so using the View All Projects/View Selected Projects toggle button at the top of the screen. The Graph Results button open a utility allowing for bubble graphs of the selected projects (see Section 4.2), and the Expert Results button allows the export of the results to a spread sheet (see Section 4.4).

4.2 The Results Graph



The results graph provides a visual representation of selected versus unselected parcels in the form of a bubble graph. First, a dialog box will pop up asking you to specify which constraint variable is the cost variable (which will go on the x-axis), and whether you want the parcel plots to be scaled by a variable (for instance, acres). If you select a uniform scale the plots for all parcels will be the same size (below on left). If you select a variable to scale by, parcel plots will be larger or smaller, depending on the relative magnitude of the scale variable (below on right). This will plot the parcels in terms of benefit score vs. cost. Selected parcels will be colored green and unselected parcels will be grey.



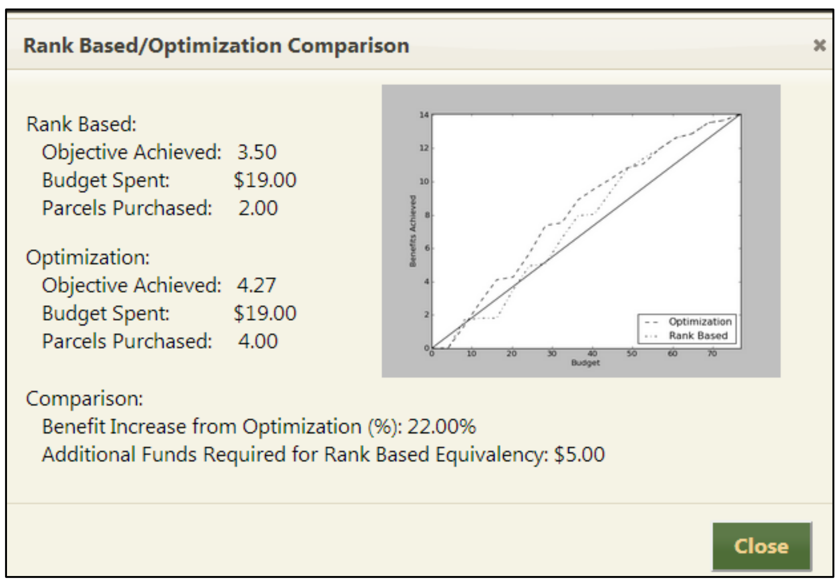


4.3 Benefit Targeting/CEA Post-Analysis

The Cost Effective Analysis results page has the same options and BLP, but with two extra options post-analysis tools. These are discussed below.

4.3.1 Benefit Targeting/CEA Comparison

The Rank/CEA comparison shows you the results of the benefit targeting (also known as Rank Based) and CEA optimized models side by side. The total objective achieved, budget spent, and number of parcels enrolled are listed for both models. Below that there are some comparison statistics which show the percent improvement available by using CEA instead of Rank Based selection, and how much additional budget would be required to achieve the same level of benefits as CEA achieves using Rank Based. On the upper right side of the window is a graph displaying a Lorenz Curve comparing the two approaches. This shows the relative performance of the two at different budget levels, starting from no budget and going to enough budget to protect all parcels. Typically one would expect that the difference would be greatest around the halfway point.

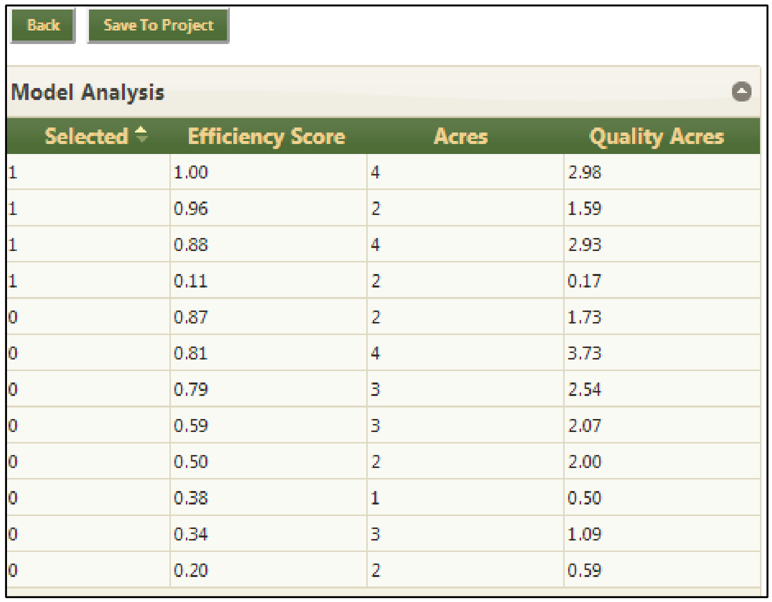


4.3.2 Efficiency Analysis

Clicking on the Efficiency Analysis button provides a table with additional model analysis. If the project has an acreage variable select it in the dialog box that pops up for calculation of the Quality Acres score. Efficiency Score is defined as the Cost/Benefit ratio for each parcel divided by the maximum Cost/Benefit ratio, and Quality Acres is the Efficiency Score multiplied by the acreage. These provide standardized quality scores for each parcel which could be useful in comparing parcels. These variables may be added to the project dataset by clicking the "Save To Project" button.

4.4 Exporting Data

Once an analysis is complete, the project data can be exported to either an Excel (xls), comma separated (csv), or dBase (dbf) file formats. Click on the Export Results button on the results page to access the export dialog box. Select the file type, type in the desired file name, and click the export button and the file will be downloaded to your computer.



Selected	Efficiency Score	Acres	Quality Acres
1	1.00	4	2.98
1	0.96	2	1.59
1	0.88	4	2.93
1	0.11	2	0.17
0	0.87	2	1.73
0	0.81	4	3.73
0	0.79	3	2.54
0	0.59	3	2.07
0	0.50	2	2.00
0	0.38	1	0.50
0	0.34	3	1.09
0	0.20	2	0.59