State Structure and Utility Curve Exercise: Description

We have provided you with an Excel workbook that contains two worksheets: 1a_Bisecting and 1b_Freeform. We would like you complete the exercise in worksheet 1a, while worksheet 1b is optional depending upon your satisfaction with the outcome of the exercise contained in worksheet 1a (see below for further explanation). We will only use your response to one of the two exercises; if you complete both exercises, you will need to identify which response you would like us to use. Your responses to these exercises will help us determine 1) the proper division of the native cover state space (for the vegetation state structure, as well as the utility function) and 2) ascertain the values along the diagonal of the Rest utility matrix (figure 1).

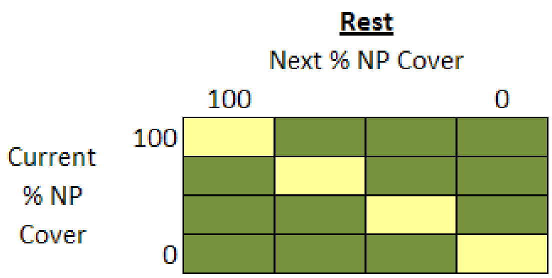

Figure 1: Utility matrix for Rest, highlighting the diagonal. The purpose of the exercise is to elicit information necessary to determine the appropriate division of the native cover state space into discrete groupings, and to determine the values along the diagonal of the utility matrix.

As discussed during our conference call, the mechanics of the exercises are simple, but wrapping your head around what it actually means, and thus how to respond, can be quite complex. Thus, while an explanation of each exercise is included below, we have included an unrelated, non-prairie example of the bisecting method at the end of the exercise description. Please read through the example if you feel you need further clarification on the exercise or you want a different perspective of how the same method is used to tackle a different problem. You may find it illuminating to think about the exercise as applied to an unrelated, non-prairie problem. And, of course, if further explanation/clarification is needed, don't hesitate to call or email me.

<u>Worksheet 1a_Bisecting</u>

While the percent of native prairie cover is quantifiable, we need to measure your relative strength of preference for management units with different percent covers of native prairie. We assume that the higher the percent cover of native prairie, the more attractive it is; thus, we give a management unit with 100% native prairie cover a value of 100. Similarly, we assume that the lower the percent cover of native prairie, the less attractive it is; thus, we assign a management unit with 0% native prairie cover a value of 0. But we need to find the values of the native prairie covers that fall between the most-preferred and the least-preferred percent cover. To get at these values, we are using an approach known as *bisecting* that will enable us to create a value function and estimate the values of any percent native prairie cover between the most and least preferred percent cover.

This worksheet has three sliders on it that we are asking you to move, in sequence from top to bottom, to answer the following questions.

Step 1: Slider #1 – Midpoint Value

Think about the percent native prairie cover that has a value to you that is halfway between the least-preferred cover (0%) and the most-preferred cover (100%). For example, you might think the native prairie cover with the midpoint value is 20%. That choice would imply that an increase in percent cover from 0% (the least-preferred cover) to 20% is just as attractive to you as an increase in cover from 20% to 100% (the most-preferred cover). A midpoint response of 20% would imply that gains in native prairie cover from a starting point of very little native prairie cover are more valuable than equivalent gains in native prairie cover when starting from higher percent covers. Alternatively, you might think the midpoint value for native prairie cover is 80%; this choice would imply that an increase in percent cover from 0% (the least-preferred) to 80% is equally attractive to you as an increase in cover from 80% to 100% (the most-preferred). A midpoint response of 80% would imply that gains in native prairie from a starting point of high cover are more valuable than equivalent gains in native prairie cover when starting from low cover. Another way of interpreting a midpoint choice of 80% is that you have high standards, and you are not at a point of medium satisfaction until you have a high percent cover. A midpoint choice of 50% would imply that increases in native prairie cover from a low starting cover (0%) are just as valuable to you as equivalent increases in native prairie cover when starting from a higher cover (50%).

When you have decided upon your midpoint value of native prairie cover, move the slider to that position. The midpoint that you choose will show in the cell to the right of the slider. The midpoint that you choose will be assigned a value of 50 and will appear in the figure to the right.

Step 2: Slider #2 – 1st Quarter Value

After you have set Slider #1 to the native prairie cover that you value as halfway between the least-preferred cover (0%) and most-preferred cover (100%), the percent you selected will automatically be filled in as the maximum for Slider #2; that is, this value anchors the right endpoint of the slider. Now we ask that you identify the native prairie cover that has a value to you that is halfway between the least-preferred cover (0%) and the midpoint cover that you previously selected. Interpret your choice here the same way you did when selecting your midpoint value cover for Slider #1. Set Slider #2 to reflect your choice. The native prairie cover that you choose will appear in the cell to the right of slider. The cover that you choose will be assigned a value of 25 and will appear in the figure to the right.

Now move on to Slider #3.

Step 3: Slider #3 – 3rd Quarter Value

Your midpoint choice on Slider #1 will automatically be filled in on Slider #3 as the minimum cover; that is, the value you chose anchors the left endpoint of this slider. Now please identify the native prairie cover that has a value to you that is halfway between your midpoint-preferred cover and your most-preferred cover (100%). Again, interpret your choice here the same way you did when selecting your midpoint value cover for Slider #1 and your quarter-point value cover for Slider #2. Set Slider #3 to reflect your choice. The native prairie cover that you choose will appear in the cell to the right of the slider. The cover that you choose will be assigned a value of 75 and will appear in the figure to the right.

With these three sliders set to your midpoint value and your two quarter-point values, we have five points (including the starting value of 0 and the high value of 100) and can plot your value function curve for native prairie cover. The shape of the value function curve can be seen in the figure on the right side of the worksheet.

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Assessing the Value Function Curve: What does it mean?
In figure 2 you see three extreme cases of value function curves: linear, convex, and concave. Below is a description of what each of these curves means in terms of your values.

If the utility function curve is perfectly linear (i.e., you selected quarter and midpoints that correspond to 25%, 50%, and 75% NP cover), it means you feel that a gain of *x* percentage points of native prairie cover is equally valuable no matter where it occurs. That is, a perfectly linear curve implies that you feel that a 10 percentage point gain in NP cover, for example, is equally valuable regardless of the NP cover with which you start (i.e., an increase from 0 – 10% NP is equally valuable as an increase from 50-60% NP, which is also equally valuable as an increase from 90-100% NP).

If the utility function curve has a convex shape, it means that a gain of *x* percentage points of native prairie cover is more valuable to you when it occurs at low levels of native prairie cover than when it occurs at high levels of native prairie cover. As a result, your most rapid increases in happiness occur at relatively lower thresholds of native prairie cover (i.e., "low standards").

Lastly, if the utility function curve has a concave shape, it means that a gain of *x* percentage points of native prairie cover is more valuable to you when it occurs at high levels of native prairie cover than when it occurs at low levels of native prairie cover. Consequently, your most rapid increases in happiness occur only at relatively higher thresholds of native prairie cover (i.e., "high standards").

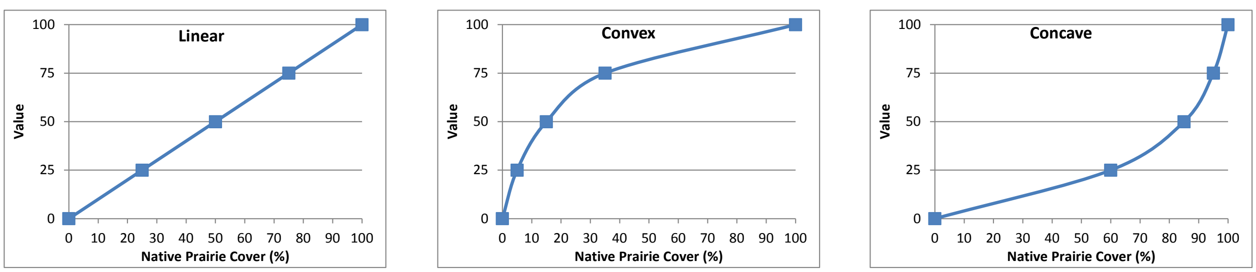

Figure 2: Three extreme value function curves: linear, convex, and concave.

Note that your prairie cover choices can generate a great variety of curve shapes: both linear and nonlinear, with 0, 1 or 2 bends, and both symmetric and non-symmetric. The curve is just a graphical way of representing how quickly or how slowly your preferences change for given increases in native prairie cover.

Finally, as you conduct this exercise, keep in mind the "Important Things" mentioned below, particularly Important Thing #1 (think "Disneyland").

- ➔ If you are happy with your chosen values and the resulting curve, you have completed the exercise on the first worksheet and are done.
  - ➔ If you are not happy with the curve produced in this exercise (e.g., you have a curve in your mind's eye, but cannot successfully reproduce that curve given the options on this bisecting worksheet), go to the second worksheet entitled "1b_Freeform", where you will find expanded opportunity to produce a curve that is more variable in shape.

Worksheet 1b _Freeform (Optional)

You will see two columns. The first column is for percent native prairie; it ranges from 0% to 100% and is discretized by 10 percentage points. The second column is for value. You will notice that we have filled in a value of 0 for 0% native prairie (the least-preferred cover) and a value of 100 for 100% native prairie (the most-preferred cover). The cells for the remaining nine native prairie covers are blank.

- ➔ Your job is to assign values between 0 and 100 to the native prairie covers in such a way that the resulting curve matches how you value native prairie at these different cover amounts. You do not need to provide a value for all nine cover amounts; you only need to provide enough values to accurately represent the curve you have in your mind. Please note that your chosen values must increase from 0 to 100 as the amount of native prairie cover increases; if this rule is violated, the column of values will become highlighted in pink. The intervals by which the values increase, however, is completely up to your discretion.

Important Things to Keep in Mind as You Complete this Exercise

1) The utility has ABSOLUTELY NOTHING to do with the likelihood of particular outcomes occurring; that is the sole role of the model set. Rather, the utility focuses ONLY on how you would feel given particular outcomes did in fact occur. This is very important to keep in mind as you complete the exercise. For example, if you only have management units with very little native prairie cover and you think it is unlikely that you can achieve greater than 40% native prairie on your units, that is a likelihood issue that belongs in the model set, not the utility; therefore, don't respond that you'd be ecstatic if you achieved 40% native prairie cover. Ask yourself what you really want; don't sell yourself short by letting your ideas about probability drive how you set your values for native prairie cover or how you rank your preferences (i.e., don't "settle"). Approach your values by temporarily suspending your beliefs about likelihood; imagine you are a kid in Disneyland and everything is possible. Don't let "reality" jade you and cloud your representation of your preferences and values.

2) When completing this exercise, remember that you are acting as an agent of the FWS. Think larger than your particular refuge or wetland management district. Complete the exercise by keeping in mind the values of the FWS refuge system with regards to the objective: increase native prairie cover at the least cost.

3) While it is fair to consult colleagues to help you gain perspective in regard to Important Thing #2, please be sure to work independently of other members of the Science Team. Part of the strength of the exercise will be in obtaining *independent* assessments of utility, which are key to exploring sensitivity of management decisions to variations in the utility function.

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An Unrelated, Non-Prairie Example (taken from Goodwin & Wright 1998):

A business owner is searching for a new office space for his business and has seven different offices to choose among (offices A – G). Two attributes of an office space that he believes are important in making his choice are office size and office appearance (i.e., attractiveness to potential customers). Below is a detailed description of how to use the *bisecting approach* to measure preference for office size.

Attribute Size: Bisecting Approach

Office size is quantifiable, but we need to measure the owner's relative strength of preference for offices of different sizes. The square footage of each of the seven offices is shown below.

Office	Square Feet
A	1000
B	550
C	400
D	800
E	1500
F	400
G	700

It may be that an increase in area from 500 ft^2 to 1000 ft^2 (an increase of 500 ft^2) is very attractive to the owner because this would considerably improve working conditions. However, the improvements to be gained from an increase from 1000 ft^2 to 1500 ft^2 (also an increase of 500 ft^2) might be marginal and make this increase less attractive. Because of this, we need to translate the office areas into values. This can be achieved by a *bisecting approach*.

The owner feels that the larger the office, the more attractive it is. The largest office, Office E, has an area of 1500 ft^2, so we can give that size a value of 100. Similarly, the smallest offices, Office C and Office F, both have areas of 400 ft^2, so we can attach a value of 0 to that size. Now we need to find the value of the office sizes that fall between the most-preferred and least-preferred sizes. We use an approach known as *bisecting* that will enable us to create a value function and estimate the values of *any* office size between the most and least preferred sizes.

This method requires the owner to identify an office size whose value is halfway between the least-preferred size (400 ft^2) and the most-preferred size (1500 ft^2). This area does not have to correspond to that of one of the 7 offices under consideration. We are simply trying to elicit the owner's preferences for office size in general, and having obtained this information, we can then use it to assess his preference for the specific office sizes which are available to him. Initially, the owner suggests that the midpoint size would be 1000 ft^2. This implies that an increase in size from 400 ft^2 (the least-preferred size) to 1000 ft^2 is just as attractive as an increase from 1000 ft^2 to 1500 ft^2 (the most-preferred size). However, after some thought he rejects this value because he feels that the increases from smaller sizes will reduce overcrowding and thus be much more attractive than increases from larger sizes which would only lead to minor improvements. He then decides that 700 ft^2 is the midpoint value; that is, an increase in size from 400 ft^2 (the least-preferred size) to 700 ft^2 is just as attractive as an increase from 700 ft^2 to 1500 ft^2 (the most-preferred size). So, the value of 700 ft^2 is set to 50.

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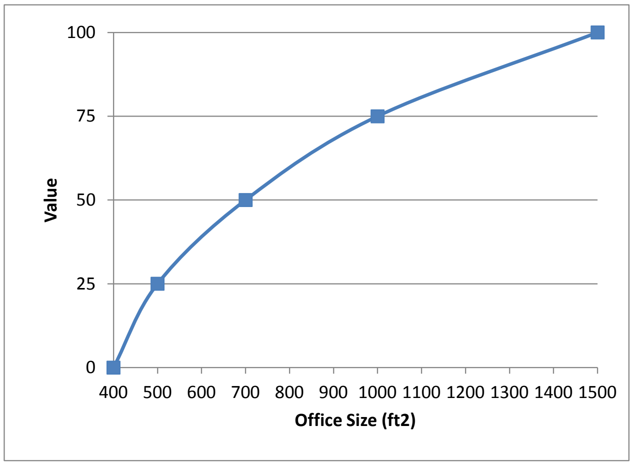
Having identified the midpoint value, the owner is now asked to identify the “quarter-points”. The first of these will be the office size that has a value halfway between the least-preferred size (400 ft^2) and the midpoint size (700 ft^2). He decides that this is 500 ft^2, so the value of 500 ft^2 is set equal to 25. Similarly, we ask the owner to identify an area that has a value halfway between the midpoint size (700 ft^2) and the most-preferred size (1500 ft^2). He judges this to be 1000 ft^2, so we set the value of 1000 ft^2 equal to 75.

We now have the values for five office sizes and this enables us to plot the value function for office size (see figure below).

Office Size	Value
400 ft^2	0
500 ft^2	25
700 ft^2	50
1000 ft^2	75
1500 ft^2	100



This value function can be used to estimate the values for the actual sizes of the offices under consideration. For example, Office B has a size of 550 ft^2; the curve suggests that the value of this office size is about 30.