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STATE OF NEVADA
Sagebrush Ecosystem Program

SAGEBRUSH ECOSYSTEM COUNCIL
STAFF REPORT
MEETING DATE: May 31, 2013

DATE: May 30, 2013

TO: Sagebrush Ecosystem Council Members

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SUBJECT: Update and detailed briefing on the "Coates model"

SUMMARY

This item provides an update to the Sagebrush Ecosystem Council (SEC) on the progress in the development of the Coates model through the efforts of the Sagebrush Ecosystem Technical Team (SETT). A brief update is provided on the progress in obtaining funds from Nevada Department of Wildlife (NDOW) and Department of Conservation and Natural Resources (DCNR) for this effort. A detailed briefing is provided to further inform the SEC regarding the Coates model, what it does, and how it is developed in order to help the Council further understand how it can be used to make management decisions. Finally, a brief discussion is presented on state and transition models and the opportunities to complement them with the Coates model.

PREVIOUS ACTION

April 22, 2013. The Council directed staff to 1) proceed in development of the Coates model and 2) investigate the use and application of state and transition models to complement the Coates Model.

BACKGROUND

At the Council Meeting on April 22, 2013, the directors of NDOW and DCNR, Tony Wasley and Leo Drozdoff, respectively, committed to each provide half of the approximately $850,000 needed to contract Dr. Peter Coates, U.S. Geological Survey (USGS), to complete the habitat suitability modeling and mapping effort for the state of Nevada. The total project cost is estimated to be $845,861. The breakdown and source of funding are as follows: DCNR Question 1 Bond Funds ($422,930), Ruby Pipeline Habitat Mitigation Program Funds ($372,179), and NDOW Federal Grant Pitman-Robertson Funding ($38,063 plus a license dollar match $12,688). The DCNR Question 1 Funds and the Ruby Pipeline funds are competitive grants. Lara Niell, SETT, has submitted applications to each of these grants and the applications are currently being processed. All of the monies obtained will be transferred to the Bureau of Land Management (BLM) to manage the contract because a contract between the USGS and the BLM has a much lower overhead cost than between the USGS and NDOW. This will result in a savings of over $100,000. Tony Wasley and Amy Leuders, state director Nevada BLM, are coordinating to establish vehicles for the money transfer. The BLM will manage the contract and the BLM and the SETT will provide technical coordination with the USGS in the development on the model. Dr. Coates has been given notice to begin work and has hired key staff this week.

On May 7, 2013, the SETT met with Dr. Erik Blomberg, wildlife biologist, USGS - Western Ecological Research Center, to further discuss the modeling process in more detail. Erik works with Dr. Coates and will be an integral member of the USGS team working on this effort. On May 9, 2013, the SETT met with Dr. Louis Provoncher and Michael Cameron, The Nature Conservancy (TNC), to further discuss their modeling approach, how it incorporates state and transition models and how it may be used to complement work completed through the USGS effort.

The following is an informational briefing on the Coates Model to help the Council further understand what exactly the Coates model is, what it does, and how it is developed to help the Council further understand how it can be used to make management decisions. A summary of the discussion with TNC are provided at the end.

What is the "Coates Model"?

The model predicts likelihood of use of a sage-grouse at a point on the landscape based on the presence of certain environmental factors (landscape resources, such as pinyon-juniper cover). The model is based on a resource selection function analysis, where we are identifying what environmental factors (what resources) sage grouse are selecting for and avoiding, based on the availability of those factors across a landscape. An environmental factor that sage-grouse use disproportionately more than what is available to them, is considered "selected for", while one that is used disproportionately less than is available, is considered "avoided by" (See Box 1). The model works by statistically evaluating known points on the landscape that sage grouse use (telemetry data) with landscape resources (predictor variables such as pinyon-juniper cover) and evaluating which factors are used disproportionately more or less than those factors are available to the grouse across the landscape. This evaluation is expressed mathematically and the computation results in positive or negative relationships of use by sage grouse for each specific factor that is considered in the model, as well as the relative "strength" of that relationship. These effects/relationships (called selection coefficients) provide a more detailed understanding of which resources are valuable to sage grouse (positive relationship) or are a risk to sage grouse (negative relationship). Once these effects are estimated, the coefficients can be used to estimate the probability of occurrence (or relative suitability) by sage-grouse across the landscape, including estimating in areas where telemetry data is sparse or missing. These statistical models then are tied to the spatial data (for the resources evaluated) at the state level, and a map is generated that depicts a continuous surface of relative probability of use (or habitat suitability) by sage-grouse (See Figure 1). Additional testing and validation data points are used to evaluate the threshold to distinguish

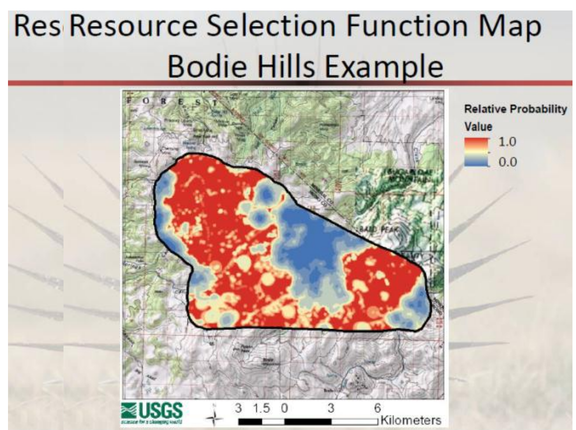


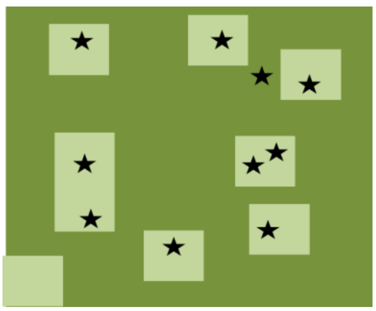
Figure 1. Example habitat suitability map showing relative probability of use for a portion of the Bi-State population.

between habitat and non-habitat, and to evaluate the predictive ability of the resulting map.

In summary, the “Coates model” is a statistical analysis of telemetry data and resource data that results in a statistical equation that is the “model” (See Box 2). The equation is tied to spatial data and becomes the habitat suitability map (See Figure 1).

The remainder of this briefing presents data input needs (telemetry data and resource data [predictor variables]), steps for developing the model (regional analysis, establishing the model, testing the model), and, finally, management examples for using the output of the model.

Box 1. Disproportional use compared to availability



Dark green is 75% of landscape. Light green is 25% of landscape. Nine of the 10 stars (90%) are using the light green. The stars are using the light green resource disproportionately more than it is available (90% versus 25%). If the stars were not selecting (or avoiding) one of the landscape types, then you would expect 75% of the stars in the dark green and 25% of the stars in the light green.

Box 2. A simple version of the model: the statistical equation.

$$w(x) = \exp(\beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k \ldots)$$

w(x) is probability of use by sage grouse for a specific point on the landscape (the probability of use for one “pixel” in the landscape.

β is the selection coefficient (the correlation of each predictor variable) for each predictor variable –the selection coefficient is determined using statistics.

X represents the value of the resource data (predictor variables) at the specific point on the landscape

The 1 2 and *k* are stand-ins for the name of each predictor variable. 1, for example, could be pinyon-juniper cover, 2 could be big sagebrush cover. *k* represents whatever would be the final variable in the model.

It is not necessary for the Council to understand all these details, but the details are provide for those who may want a visual of what ”the model” actually is.

<u>Data input needs</u>

Telemetry Data

There are approximately 50,000 VHF telemetry locations in the state for sage grouse and some sites consist of over 30,000 locations from GPS transmitters. These are generally clustered in study areas, based on where work was conducted.

The more data available for developing the model, the more robust the model output. In order to develop individual seasonal-use models, only telemetry data collected from those corresponding seasons could be employed. One limitation is that there are less than 5,000 VHF telemetry points for each fall and winter seasonal habitat. We will have additional high frequency GPS locations at specific sites. We have approximately

20,000 VHF telemetry points for each breeding and brood rearing. Considering these data limitations, it is possible that seasonal use could be modeled in specific areas of the state (such as Eureka County), but not for all seasons and not across the entire state. As more telemetry data is collected each year, the modeling framework provides a relatively easy process to refine models to incorporate seasonality and include additional variables, perhaps those derived from higher resolution imagery. As part of the work with USGS, additional areas within the state that are lacking telemetry data will be targeted for data collection. Once obtained, this data can be used to develop new regional models or to test or refine existing models.

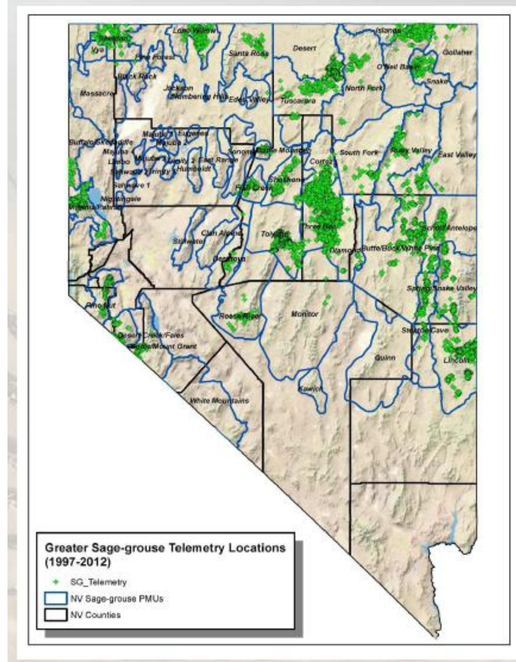


Figure 2. Telemetry locations in the state of Nevada.

Remember that where we do not have telemetry data does not mean that "there are no birds there", but just that we don't have data there.

Predictor Variables

Listed below is a sample of the environmental factors that will be evaluated to identify positive or negative relationships with sage-grouse use (resources that sage grouse are selecting or avoiding) across the state of Nevada. These variables were used for the recent Bi-State mapping effort. However, at the state-wide level additional variables will be developed and incorporated into habitat models, including a refined conifer layer providing detailed information on relative encroachment. These input variables are added a priori, without a pre-assigned value (positive or negative) and the statistical analysis estimates the relationship to sage-grouse (if any).

1. Land cover map based on numerous products (mostly derived from Landsat imagery).
   Vegetation classes including:
   a. Big Sagebrush Low elevation
   b. Low Sagebrush
   c. Mountain Big Sagebrush
   d. Non-Sagebrush Shrubland Lowland
   e. Non-Sagebrush Shrubland Upland
   f. Forested
2. Pinyon-juniper land cover map by phase of encroachment based on cover values reported in the literature;
   a. Phase 0 - sagebrush community with no encroachment
   b. Phase I - <10% tree canopy cover
   c. Phase II - ≥10% and <50% cover
   d. Phase III - ≥50% cover
3. Topographic indices variables based on digital elevation models (DEMs);
4. Elevation

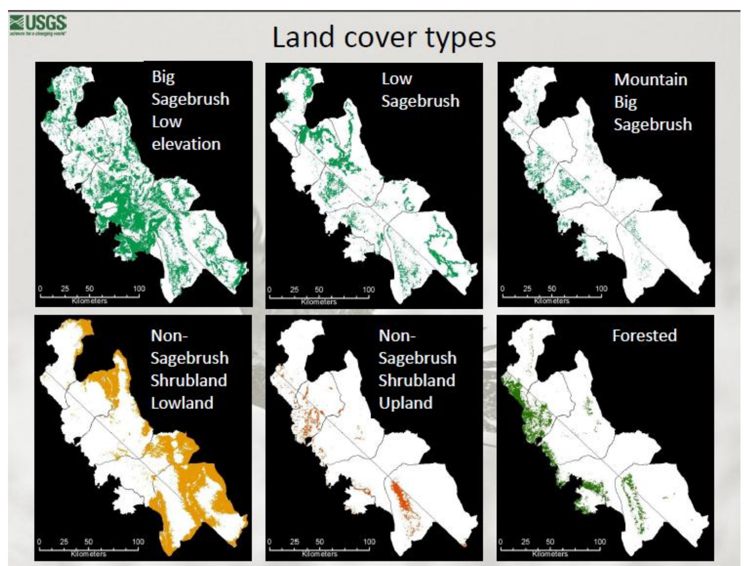


Figure 3. Examples of land cover types/vegetation classes for the Bi-State Population

   a. Slope
   b. Aspect
   c. ruggedness indices
   d. compound topographic indices;
5. Anthropogenic indices variables
   a. Roads
   b. Structures
   c. Agricultural lands
   d. Cities
   e. Recreational indices.

The variables incorporated into the model are included because they are assumed to be important predictors of sage-grouse habitat, based on biological understanding and previous research. As mentioned above, however, the statistical analysis evaluates what the correlation is between sage-grouse habitat use and each individual variable (not us telling the model), which allows this to be an objective, instead of subjective, and quantifiable model.

We can add additional variables as we think they would be relevant, but to do so the input data needs to be available in a spatially, quantifiable format.

Developing the Model

Regional Analysis

Factors affecting sage grouse are likely different in different parts of the state. The composite model will actually be comprised of multiple regional models, each developed for different areas of the state to account for spatial variability. This will allow us to better understand the resources that are influential to specific populations or regions.

The boundaries of these regions may follow an established grouping (such a PMU, MLRA), may lump or split an established grouping, or may be created to meet the specific needs of this effort (such as limited telemetry data in some areas). These regions will take into account climatic variation, vegetative composition, and existing telemetry data.

In regions of the state where we do not currently have sufficient telemetry data to develop a model, that area will be grouped with other areas with similar environmental factors allowing us to make broader predictions. An estimate of confidence will be placed on each region, based on model predictability. When we obtain additional data in the future, we will use those data to validate (or test) the existing model (see Testing the Model). If the model does not fit this new data well, then we would refine the model focusing on the select region.

Establishing the model(s)

These are very generalized steps for developing the model for each individual regional model in the state.

1) Compile the predictor variables in a spatial format (GIS coverages) for all areas (this is the environmental resource data that we'll be evaluating).

2) Overlay telemetry points (sage grouse "use") and generate random points (these determine what is "available" to sage grouse).

3) Extract environmental information from points (what is the amount of each resource at each point- for example, what is the cover of pinyon juniper at points used by sage grouse[telemetry locations], what is cover of pinyon-juniper

at available points). In this process we will consider spatial scale as it relates to sage-grouse.

4) Estimate model parameters (selection coefficients) of each environmental factor by contrasting the "used" from the "available" points. (This, stated very simply, creates our statistical equation.)

5) Use model parameters to develop a predictive surface of habitat suitability across the landscape. Results are quantitative but can be illustrated in a heat maps (e.g., delineated by color classes) of habitat suitability (0 – 1; 0 = low, 1 = high). (This creates the "habitat suitability map".)

Testing the model

The model is not of much use if it cannot provide reliable inferences about where sage grouse are likely to occur. So, we will "test" it to quantify how accurate it is. This is accomplished by using additional telemetry points (not used in the model development) to see how well the model predicts these locations. "How well"/"how reliable" is determined through advanced statistical methods, which will not be discussed here. However, this level of reliability will be included in the maps, so that we are able to review the estimate of confidence for a region. Efforts will be made to gather additional telemetry data in areas where confidence is low to be able to further refine the model and increase predictive ability.

Management Examples using the Model Output

The results of this modeling effort are intended to be used as a conservation planning tool (CPT). One obvious and useful outcome of this process is the map showing the relative suitability for sage grouse across the state. The other important component to the CPT is, that we will have estimates of selection coefficients (relationships to predictor variables) for the resources to understand the associated relative value or risk that each resource poses to sage-grouse in different regions of the state.

There are no habitat definitions that come out of this modeling. We can use statistical methods to establish thresholds or set particular values and then translate those into habitat definitions that would meet our management needs. As discussed in the U.S. Fish and Wildlife Service comments regarding the sage-grouse management areas developed in the 2012 plan, the threshold or value that we identify will need to be justified. However, we will employ statistical techniques to identify the most "best" threshold based on the data. The overview of the map can be evaluated for areas of connectivity- identifying locations that maintain corridors in a fragmented landscape.

The model can be used to evaluate potential landscape scenarios, both from benefit from improvement perspective (pinyon-juniper thinning project) or costs from a disturbance (transmission line route). This would allow for a quantitative evaluation of effects. For projects that we would assume would benefit sage-grouse (e.g., pinyon-juniper thinning) we need to evaluate if other resources in the area would meet the needs as well. For example, one evaluation might be whether or not the presence of the trees is the only factor limiting sage-grouse use in the area, or is there something else, perhaps steep slopes, that would limit use of the area by sage grouse negating the need for tree removal. This tool would provide support to these types of decisions. Furthermore, the habitat suitability index can provide a very valuable metric for ecological forecasting, such as Nature Conservancy's Landscape Conservation Forecasting tools. This metric provides a means to understand how landscape level changes can impact sage-grouse probability of occurrence at multiple spatial scales.

One final thing to remember is that, as with other maps produced previously (NDOW habitat categorization maps, sage-grouse management area map), the habitat suitability map does not show where sage grouse are and are not. It shows relative suitability, probability of occupancy, but not what is "occupied". As with maps, this is a depiction, not reality, and as with models, it is predictive, not absolute, and is limited by the scale at which it was modeled and by the data evaluated by the model.

As the model and habitat suitability map are developed, we will work with the USGS to outline additional uses and limitations of the "Coates Model."

<u>State and Transition Models</u>

TNC's state-and-transition model is a computer-based, predictive ecological model that uses *habitat suitability* and *ecological departure* as metrics in order to assess future condition and determine the likelihood of success of a particular land management action, such as pinyon-juniper removal, in a specified area. Habitat suitability, in the TNC model, is determined using remote sensing data to generate current vegetation maps that are categorized as natural vegetation succession and uncharacteristic classes. Natural succession classes are based on the standard LANDFIRE model of up to five classes, ranging from early- to late-succession and are typically expressed as percent canopy cover. "Uncharacteristic" classes were created to account for areas dominated within invasive vegetation, such as cheatgrass. Ecological departure measures the difference between *expected* (using NRCS ecological site soil surveys or satellite imagery) and *observed* occurrences of vegetation classes. SAT models can be used to predict changes in habitat condition and help optimize plans for restoration of sage-grouse habitat. These models could be a tool to determine the likelihood of success and the potential return on investment when prioritizing areas for restoration for the SEC's proposed Conservation Crediting Program.

<u>FISCAL IMPACT</u>

The habitat suitability model and mapping effort by the USGS is estimated to be $845,861. The breakdown and source of funding are as follows: DCNR Question 1 Bond Funds ($422,930), Ruby Pipeline Habitat Mitigation Program Funds ($372,179), and NDOW Federal Grant Pitman-Robertson Funding ($38,063 plus a license dollar match $12,688).

<u>RECOMMENDATION</u>

This staff report is to further familiarize the Council with the Coates model. If Council members have questions they may individually contact Lara Niell, or request through Tim Rubald that Dr. Coates be invited to a future Council meeting for further discussion.

<u>POSSIBLE MOTION</u>

No motions are proposed here.

Attachments:

None

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