Kyle Reneman

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TGIS 415

Prairie Proliferation through Fauna Dispersion Dynamics

Prairies are a unique ecosystem in Western Washington. Known as the evergreen state, any environment not defined as possessing conifer trees stands out, and is readily noticeable. The prairie is such a biological community. A minority in terms of land mass, it serves several valuable ecological functions that make the unique species of flora and fauna found therein worth sustaining.

A prairie is a habitat that is comprised of primarily grasses and forbes. The western Washington prairie deviates slightly though from the more common Midwestern prairie or plains by typically possessing some sort of tree, and in a relative high abundance (Bossard 2000). Said trees are deciduous, hardy, and are selected against when over large expanses of time, the prairie develops into a pine forest. Prairies by their nature are a transient feature and in terms of ecological time, and are quickly replaced by pine forest overtime. However, local Native Americans valued larger prairie fields, and artificially maintained some of them through forest fires in order for a consistent supply of food and other resources to be available for harvest from this ecosystem (Valkonen 2008).

From an ecological standpoint, prairies are the frontier community of the area. Whenever a calamity or habitat altering occurrence happens, it is the prairie that colonizes the open land. This colonization is crucial for ecosystem development as the environment readies the area for increased development, leading to the more defined habitat, like evergreen forest (Valkonen 2008). This process, known as sequencing, is served by several specialized species of flora have been adapted to this habitat, and are known to be exceptionally good colonizers. Furthermore to take advantage of this niche habitat an entire fauna community has evolved to live in this environment. Notable members include specialized grazers, field destabilizers, and pollinators which have grown symbiotic attachment to several of the grasses unique to this area.

Prairies are however, exceedingly uncommon. One of the rarest habitats in the pacific north west, they are currently at 3% of their pre-urbanization ranges (Fimbel 2004). Due to the transient nature of the system, the area it develops in tends to be highly scattered, and randomized through cataclysmic activity. Furthermore human development has significantly modified the prairie habitat in multiple ways. The most dramatic and subtle way the prairie ecosystem has been modified is due to strict anthropogenic control over forest fires. Before man civilized the area, forest fires were a much more common occurrence, which provided a ready source of land for prairies to develop in (Fimbel 2004). Modern firefighting methods however have largely ceased forest fires in western Washington, meaning no substantial prairie has been developed naturally in the area in the recent biological memory. Secondly, the areas that prairies were found at traditionally are favored building spots as there is little need for tree clearing, which simplifies building procedures. These combined factors have made the prairie an endangered habitat with a disproportionately large amount of endangered or threatened species endemic to it.

Perhaps even more risky than the rarity of this ecological community is the fact that it is a dispersed community (Fahrig 1985). This was not a problem when prairie habitat was being constantly generated through burning, but with the largely static habitat areas, this fragmentation is a crucial issue. Fragmentation refers to the concept that of bodies of a habitat when considered in the larger environmental matrix has high surface area and great distance between bodies. This is not favorable for multiple reasons. The first basic one is that if communities are isolated, their genes are isolated as well, creating a weaker genetic diversity, making the community on a whole for susceptible to being wiped out due to disease (Gardner 2010). It also means that should a community be wiped out through habitat destruction, surviving members are unable to adequately relocate to another system, a feature that dramatically increases population fatality. Finally, invasive species tend to favor edges of a habitat for proliferation, so if the total habitat has a high surface area, this increases the potential regions for invasive species introduction (Gardner 2010). A prairie habitat is traditionally going to be much more fragmented than a more usual ecosystem due to its fringe nature, but connectivity between patches was present (Valkonen 2008).

Connectivity refers to the idea that there are paths that species of a habitat can disperse to find new habitat. A habitat whose environmental matrix is well connected survives all of the above issues raised more effectively, and is considered by modern ecological indexes to be a healthier ecosystem (Leftkovich 1985). Due to the frontier nature of prairies, the prairie patches need to be well connected so that it can serve its ecological function of colonizing newly cleared lands. If it cannot, then habitat restoration is significantly delayed and several more tertiary species will not develop (Valkonen 2008).

How all of this relates to the project is fairly direct. By mapping modern prairies containing these niche species and mapping there dispersion patterns one can find out ideal locations for new prairie habitat, should one wish to restore the area to such an ecosystem. More than that, if one can find an area where dispersion overlaps from more than one prairie then if that area becomes a viable prairie, then one has created a connection between the two habitats. Using the technology of GIS, it becomes possible to pinpoint these areas, and find out where these places are, considering the surrounding landscape features which might complicate this operation.

Planning

In order to do this project several aspects were considered. The first step in this project was to define the prairie. Several literary sources were utilized to this end, but the end result was to define as a clearing habitat that was not a permanent feature and could sustain endangered endemic species listed under both Washington state's and the federal endangered species list/ species of concern. In the first quarter of this study, along with learning of techniques which would assist in the methodology and analysis of this study, the idea was fleshed out. Through the course of several group sessions with class members, the idea of what constitutes a prairie habitat, how to map it, and how to manipulate it was refined. What became obvious early own was the need of a simple index to categorize and attach a magnitude to the many features which would be part interplaying in the project. As there are features which inhibit prairie growth, and feature which assist growth, the index would have to be malleable enough to consider both. This culminated into an action plan at the end of the quarter, and guidelines as how to proceed in the next.

In the final quarter of the course, the project was largely well enough defined to actually work on it. An immediate change which came about was to decrease the scope of the project. The original scope had been all of western Washington, which proved to be unwieldy for several reasons. The first reason was that the distance between patches became so vast that there was no longer a way to feasibly connect them with the index. Also as the world progresses northerly, the way the prairies are expressed in the environmental matrix became significantly modified. Prairies on the San Juan Islands, for example, were absolved from most of the index creating a reductio ad absurdum situation.

Another change was to weigh values in the index, this came as a result of combining certain factors together which created disparity in the importance of how certain features were. This was done primarily due to the lack of data in the human environment section of the index, creating human features as effective barriers unable to be traversed instead of being considered rough terrain.

Finally, another change was how to consider species information. Due to the extreme rarity of some species, instead of mapping exact populations of species, which in some cases created meaningless data for analysis, a buffer denoted species dispersion was created, which presumed the existence of a species based around the existence of the plants that species relies upon.

Methods

The first step of this project was to download all meaningful data. This was a process that evolved throughout the project, and changed as data sources became apparent. Among the first data collected was a political base map of Washington State for purposes of placement, urban vector data, street data, county data, and parcel data. Later in the quarter impervious surface and city extent data was collected so as to serve as a background for the habitat matrix. The human element for the purposes of this project, served as a barrier to an extent by which habitats could be connected. Literature on the topic shows that this area tends to be hostile to species dispersion, and does not serve as a valid route.

The next step of this project was to consider habitat data. The first thing considered was the important fauna to this habitat. This was done by utilizing the department of ecology's endangered species list. A list of species considered for this project was rectified, and a dispersion value given. For the purposes of the index, it was simplified into three categories: butterfly (*Lepidoptera spp.*), mammalian, and invertebrate. This was done largely due to extreme similarities in dispersion habits which allowed for the simplification of such data. Lepidoptera species considered came from the Washington State monitored list (http://wdfw.wa.gov/conservation/endangered/) which possessed the butterfly species that are under most scientific scrutiny to determine approximate populations. The values for travel distance varied the most in this categories, with transit length of anywhere from about 1.5 Km to 20.4 Km. However, the mean distance came to be about 4.6 Km which was used for this project. This distance was not representative of a lifelong transit, but it was determined through interviewing the IAS staff that this value was a reasonable estimate of potential distance that a butterfly might travel in a matrix devoid of potential habitat. The mammalian matrix was less varied in distance, primarily due to the travel habits of the species. As all species in the category were related to the *rodentia* family (voles, squirrels, native field mice) similar travel characteristics are observed. Instinctually, these species do not traverse out of their habitat, as they become more susceptible to predation. The ranges were therefore significantly reduced; with some species only traversing a couple hundred meters out of their patch of prairie. Therefore the range of travel reflected a range of about three hectares, or 550.56 feet. Finally for ground invertebrates, which included the Bluegray Taildropper, the Columbia Oregonian, and the Columbia Pebblesnail, little research has been done regarding their dispersion as an individual, and proved non-viable for traditional mapping. Therefore, in order to represent these species in the index, each county was given a value in the index which represented the amount of species which the county had (Gray's Harbor = 20, Lewis County = 40 Pierce = 0). The values determined by through count statistics of the index and the values were weighed according to 15% the mean rounded, which corresponded to the species richness exhibited by this category.

The next step was to find important flora and modern prairie locations. This was done utilizing resources derived from the department of natural resources GIS data page online. This gave an area which would serve as a core nexus for analysis. Within the geodatabase provided, the patches were classified by plant cover, so this data was modified to exclude exotic habitat. Plant data excerpted from a separate shapefile was used to consider what buffers would be used on what patches of prairie.

The primary analysis was done by taking the largest dispersion range (Lepidoptera) and blanketing it over western Washington in regards to prairie area. It was found that an area in the south Puget Sound had the highest concentration of patches and was therefore deemed to be the most worthy of analysis. Dispersion was done by dedicating each dispersion to a data frame and buffering pertinent prairies to the index determined range to that Prairie.

An area was determined if it achieved a connection between two or more patches. More viable area was determined through the number of connections a given area had, more connections corresponding to more viability. However, to exactly enumerate the number of overlaps of buffers required tools outside of the ARC toolbox. By utilizing the feature to point function, a point with the buffer data, was created, then SEGME's count points in polygon tool was used to enumerate how many points were in an area by creating a field in the attribute table of the buffer with that information. The count was then subtracted by one to avoid counting its own patch, and this value served as the count by index. The urban layer was then applied by intersecting the values to the buffered regions and this served to exclude intercepted non- Lepidoptera areas for further analysis.

Results

Fig 1: Results Normalized by Area

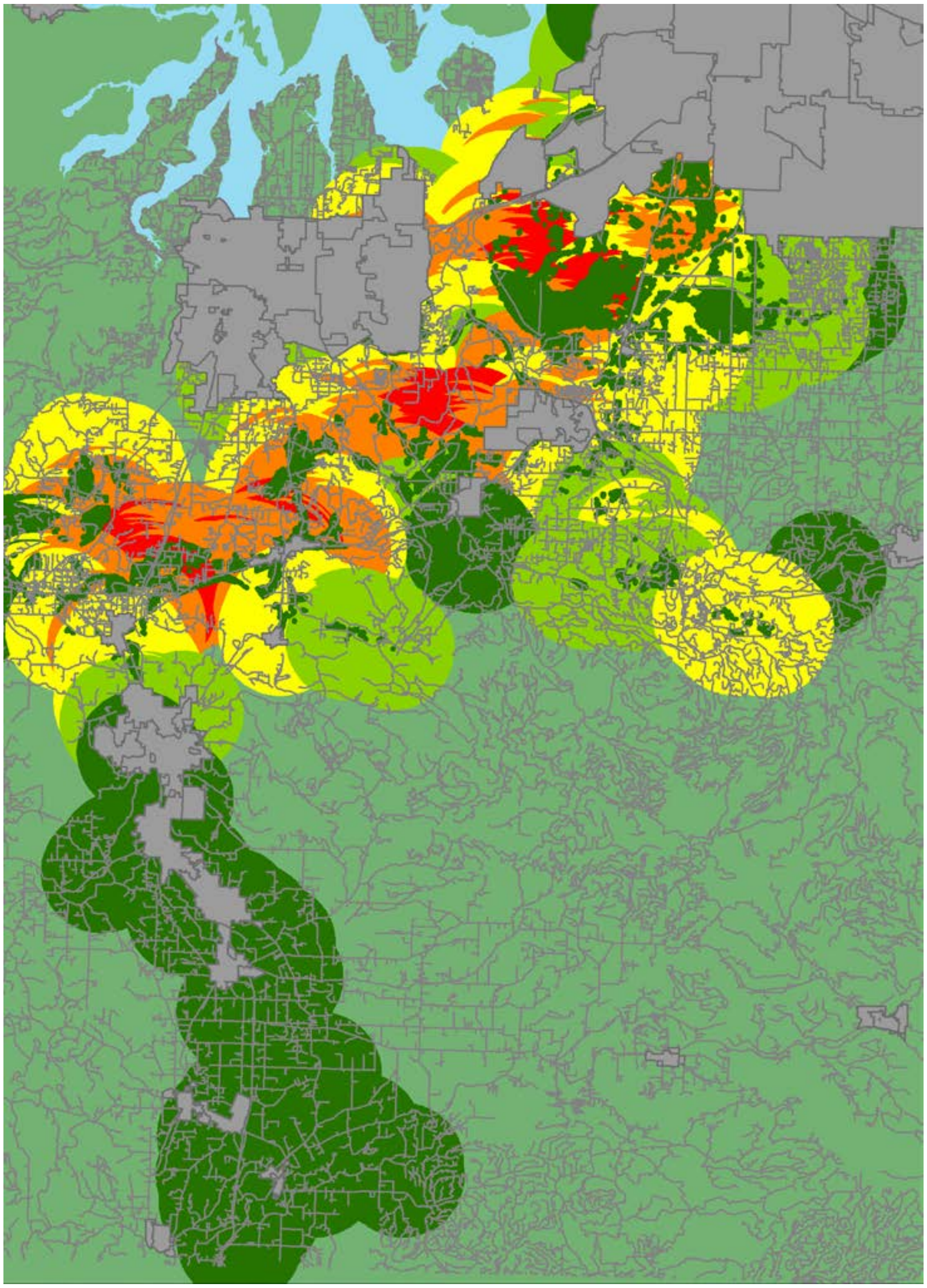

Fig 2: Results Normalized by Surface Area

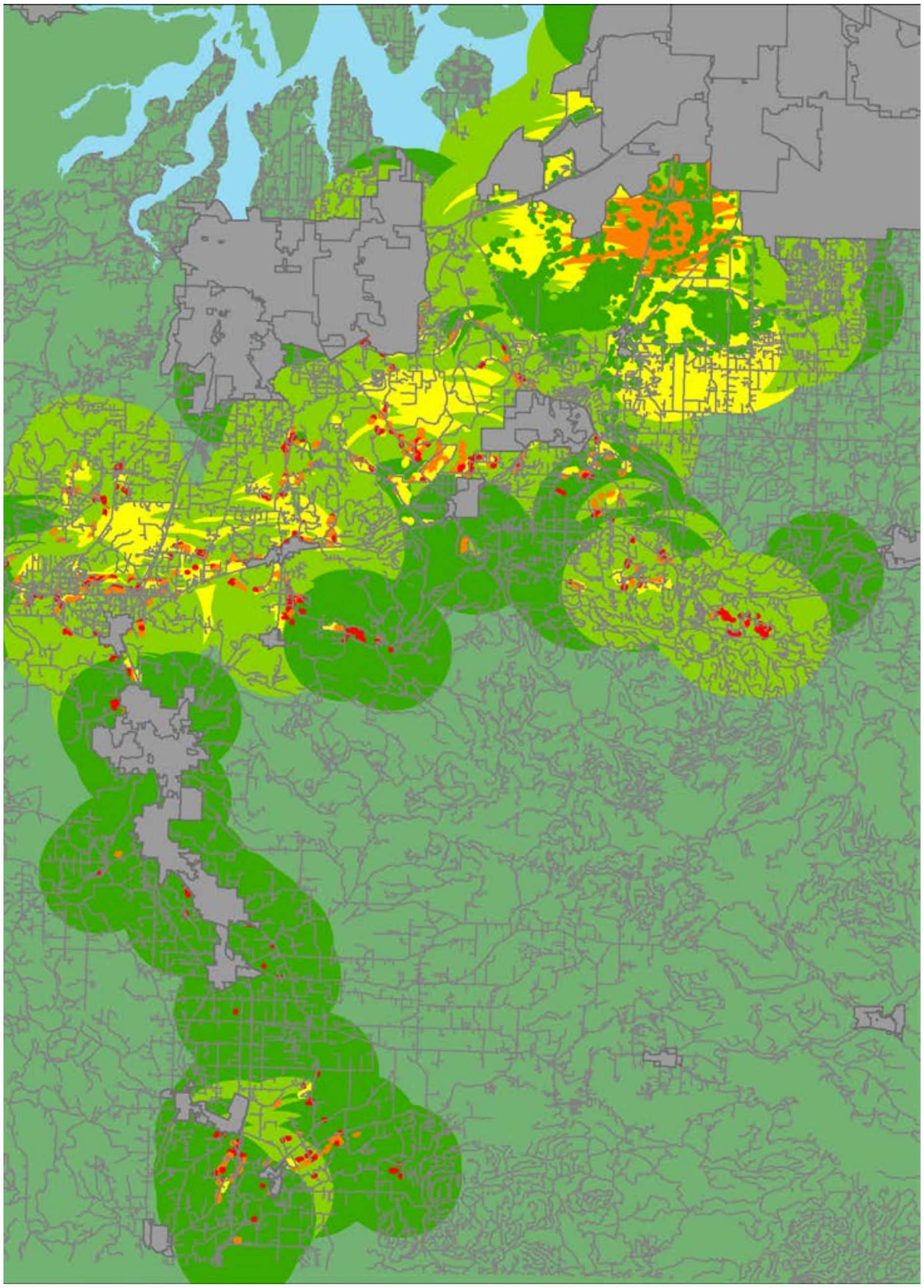

Fig 3: Location of Study

Results show viability on which the redder a given area is the viable according to the index it is. Gray is urban effects, and the area represented is the south Puyallup/Lakewood area. Classes are scaled by Natural Breaks (Jenk's). Current prairies are patches set to lowest viable value so as to inhibit the index favoring area which are already functional prairies.

Discussion

The reason for the two results is to explore a habitat distribution concept known as SLOSS (Single Large Several Small) (Gardner 2010). The premise behind this idea that the two most ideal habitat compositions are either fewer larger patches which preserves habitat continuity, a larger population, and less edge where invasive species tend to inhabit, or several smaller patches which have some connectivity, greater dispersion which safeguards against calamities, and permit movement over a large area. By normalizing by area, larger patches were favored which seemed to favor the Lepidoptera movement. This is understandable as the buffer area for the Lepidoptera was large enough that the area of highest connectivity tended to be farther away from the patches to the end of the extent where there was most overlap. The increased size of the prairie patches permitted the possible area for overlap to increase, which in turn allows for higher connection values.

The second normalization done by surface area was done so that close patchy areas that could be more easily connected could be shown. Areas with high surface area would be patchier than large areas, and to be able to connect close patches to create a continuous habitat would be ideal for less mobile creatures. The connection values were less as well so the ground invertebrate category had a greater impact.

Both results considered, the areas which had the most viability included south Tacoma, southeast Olympia, and northeast Lakewood. Prairie habitat has already been well established in these areas, so improving connectivity in these areas would be most viable.

Critical Analysis

The areas outlined by the results are areas which have been traditionally noted as having large amounts of prairie. The unincorporated Lakewood area was built on one of the larger prairie systems, and remnant prairies are still found in this area (Fimbel 2004). This survey data provides some modicum of evidence to suggest that the tested patches are viable prairie, but a large issue with this study is in fact being confident in that the original prairies are already healthy prairies. This was safeguarded by the study by verifying for the presence of flora unique to this habitat, but this then assumes patch uniformity (Lefkovich 1985) This assumption could negatively impact the model by interpreting that all of a given patch is productive habitat, when in reality it is stratified in its ability to support a habitat (Beyer 2010).

In their 1985 study, Lenore Fahrig and Merriam Gray modeled for patch uniformity (or as it was called – patch homogeneity) by observing field mice population dynamics in woodlots, which served as patches. In this study they found that patch isolation, even while considering other population dynamics, played a significant role in how abundant a population was. Studies such as this bring credence to the notion that general species abundance of multiple communities increase when connected.

Therefore, the most ideal locations for future sites would be locations in closer proximity to other patches, preferably to the point of connection. This would allow for seamless mobility of the majority of the prairie inhabitants, thereby improving general healthiness of prairies in Washington State. While this synopsis does not pinpoint an exact location prairie restoration, the results still provide areas in which new habitat could theoretically increase abundance for endemic species.

Should future work be done in this topic, a possible avenue for more detailed analysis is to find out what type of setting is currently at these areas in order to determine which areas would be most feasible for restoration. Preliminary examination of raster data shows that some of the area outlined as viable could be restored with reasonable effectiveness. However, an opportunity now exists to programmatically identify which areas could benefit from this type of remediation. LiDAR and other remote sensing mechanisms have had some success in determining land cover (Boles 2004). A similar study could be applied here to find which areas have a distinct homogeneity to canopy cover at a height indicative of an invasive species. Such an analysis would permit finding sites which would be most desirable in terms of restoration to remediate.

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