Geodesigning Wildlife Corridors: Development of an Automated Design Model

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Extended Abstract

Connectivity conservation has yielded a number of tools and approaches for modeling landscape connectivity within ArcGIS and other platforms. All approaches make assumptions about how wildlife will move through the landscape given their individual interaction with local landscape conditions. These interactions and subsequent movement are represented as the relative permeability of the landscape or as the cost of movement to the individual. While connectivity modeling tools vary greatly in their underlying methodological processes and employ varying modeling techniques to model permeability and cost, the most common output is the delineation of spatially explicit wildlife corridors which link user defined locations. Such outputs result in linearly arranged features, which either represent structural connections between locations given landscape characteristics, or functional pathways through which individuals are expected to move.

While modeling corridors has been an instrumental development in advancing landscape connectivity and enhancing conservation planning, issues remain in translating modeled corridors into implementable elements within conservation and land use plans. The primary shortcoming of corridor modeling being addressed here focuses on the relative lack of specificity found throughout the interior of traditional corridor outputs. While the boundaries of these features are clearly delineated and can be planned for, the lack of specificity regarding what the interior of these features consists of is particularly enigmatic. This is to say, while current tools are very helpful in delineating the corridors themselves, they neglect to provide planning and design guidance for programming their interiors. This represents a considerable knowledge-gap for practitioners interested in implementing such features as a part of a conservation and land use planning strategy.

This team proposes that a modeled corridor by itself is not a design, but rather a first step towards design. While modeled corridors are an invaluable planning mechanism that can be consulted and used to help guide coarse-grain decision making, design requires attention to site specific characteristics, functions, and even more qualitative variables such as aesthetics as a means of informing the fine-grain decisions necessary for implementation. Further, the team believes that the growing field of Geodesign holds promise in moving towards this end as it strikes the needed balance with developing the analytically based methods required in conservation planning and the graphic and communicative language necessary for design implementation. As a result, this work illustrates and discusses the development of a new tool while showcasing the marriage of Geodesign with real-world applications in conservation planning and design.

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The Automated Design Model (ADM) discussed here is intended to provide additional insight and guidance in the physical design of a wildlife corridor's interior by populating it with vegetation arranged in patterns known to impact wildlife movement. Developing such a tool sheds light on the suggested physical structure and design of the modeled corridors interior, both aspects which current tools do not address. Additionally, the automated nature of this tool allows for large swaths of the landscape to be designed based on site specific characteristics and considerations whereas until now, such efforts would be impractical due to the massive time constraints which would be required to develop such large designs by hand. Finally, the ADM allows for analysis, modeling, and design to all be accomplished within an ArcGIS environment using ArcScene without the need to employ other graphic design platforms.

The ADM has been created using Spatial Modeler within an ArcGIS v10.2 environment. The ADM starts by evaluating the landscape's capability to support various species of native vegetation. Capability models were developed for a suite of native vegetation species specific to the Sonoran Desert region of southern Arizona within the U.S. and the State of Sonora in Mexico. Individual species capability models were developed utilizing a standard raster-based overlay process which parameterized landscape characteristics and abiotic factors known to impact the distribution and persistence of each vegetation type. The resulting output of each individual species model yields a capability surface which delineates the portions of the landscape most capable of supporting each vegetation type. The end result of this step yields a library of scored capability surfaces for each plant species.

The ADM then employs a selection algorithm which identifies the vegetation type from the library which exhibits the highest capability score for each cell within the corridor. This results in the selection of the vegetation type that is most appropriate for each cell. Once selected, a dataset is written which codes each cell based on its vegetation association. An additional query is then initiated by the ADM to identify the next best vegetation type for each cell and a corresponding dataset is derived. Where cells are equally capable of supporting multiple vegetation types, a random selection generator is employed to break ties. Together, these surfaces are utilized as the foundation for populating the modeled corridors interior with the most appropriate site specific vegetation.

Selecting the most appropriate vegetation however is not alone a recipe for facilitating wildlife movement. The model can be further customized based on the requirements of the focal wildlife species for which the corridor is being designed. Similar automated techniques are employed to refine additional design variables such as vegetation heterogeneity, density, vertical stratification, seed/fruit production, drought tolerance, and cover characteristics. The ADM also has the ability to place vegetation in patterns which are known to either facilitate or impede wildlife movement. The ADM arranges the vegetation in these patterns in order to promote movement throughout the corridors core and discourage movement out of the corridors perimeter or border. Here a series of pattern generators are employed to alter the relative dispersal, clustering, and linearity of the spatial locations of all vegetation assemblages. Once completed, the ADM is capable of visualizing the modeled results in 3-D within ArcScene.

The team believes that tools such as this ADM will aid in the development and design of functional wildlife corridors and contribute to the effectiveness of corridors as an increasingly viable conservation planning strategy. Further, the team believes that such developments will aid in spanning the gap between modeling, design, and eventual implementation of wildlife corridors in a wide spectrum of planning applications. Finally, development of the ADM provides for a more seamless design interface allowing for analysis, modeling, and design to all be completed within the ArcGIS environment without the need to export geospatial data to an alternative graphic design platform.