WEC280

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Conservation Subdivision: Design Phase – Wildlife-friendly Transportation Network [1]

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Introduction

Figure 1. A wildlife box culvert under a four-lane road that passes through Paynes Prairie State Park, Florida. A number of reptiles, amphibians, and mammals use this wildlife passage. Photo Credit: Dan Pennington, 1000 Friends of Florida.

As urban communities grow, design and management strategies for new developments become critical factors that determine impacts on natural resources. How can we accommodate growth and yet conserve natural resources, such as biodiversity, water, and energy? In this document, we focus on conserving biodiversity when land is subdivided. The term biological diversity or *biodiversity* refers to the variety of life and its processes. Biodiversity includes species diversity, habitat diversity, and genetic diversity. For the purposes of this article, we focus on biodiversity of *native* species. Native species are plants and animals that were present within a specific region before Europeans made first contact. Non-native (or exotic) plants or animals are defined as those species that were not present in the region before European contact.

Recently, a popular concept called *clustered development or conservation subdivision* has been advanced by the landscape architecture community. Conservation subdivision is intended to integrate growth with biodiversity conservation. Conservation subdivisions typically are developments where homes are clustered on small lots with the remaining areas conserved as open space.

The concept of conservation subdivision has gained traction in many planning and design fields. The goals for conservation subdivisions are twofold: 1) to improve biodiversity within a designated subdivision; and 2) to minimize development-related impacts on surrounding habitats. Often, though, most of the effort is on the design of the entire site. To

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conserve and improve biodiversity within urban environments effectively, one must consider the following three phases of development: **design, construction, and post-construction.** Overall, these three phases must be addressed in order to create and maintain biodiversity within residential subdivisions. The "Conservation Subdivision" series of EDIS documents discusses biodiversity conservation pertaining to all three phases of development. This fact sheet focuses on decisions made in the design phase.

The design phase is typically where, among other aspects, lot size and open space are designated, and roads are distributed throughout the site. Goals for the development project are discussed and prioritized. In this phase, homes and lots are placed across the site and the remaining area designated as natural open space. Basically, everything is laid out on paper and vertical structures (buildings) and horizontal structures (roads, lots, conserved areas, and shared spaces) are given specific spaces within the development.

Next, during the construction phase, a whole host of built environment professionals (e.g., architects, contractors, and subcontractors) take whatever is on paper and implement it on the ground, constructing homes, streets, waste treatment systems, and landscaped areas (e.g., built lots and parks). In the absence of fully trained or engaged contractors or landscapers, many things can happen during this phase that could decrease the viability of onsite and nearby natural habitat. For example, even if the most important large trees are preserved across the subdivision and built areas are designed around them, the placement of topsoil and routes used by heavy construction vehicles could impair the survival of these trees. If heavy construction vehicles continually run over the root zones of trees or if topsoil is placed against their trunks, the roots may not be able to acquire nutrients, water, and oxygen and the trees may die.

In the final phase, post-construction, buyers purchase the homes, move into the community, and manage their own homes, yards, neighborhoods, and common areas. It is now the responsibility of residents to manage in ways that do not compromise the original intent of the community designers. Additional problems can arise if residents are not fully engaged – imagine residents moving in and planting invasive exotic plants in each of their yards. Residents could also improperly apply fertilizers and pesticides. The spread of invasive plants and stormwater runoff could then severely reduce the diversity of animals and plants found in the conserved areas.

Again, all three phases, design, construction, and post-construction, must be addressed in order to create and maintain biodiversity within residential subdivisions. The overall effort begins with the design phase. During the design phase, planners determine where to place roads and how best to design these roads. The placement and design of roads can hinder or promote wildlife survival. This fact sheet discusses road designs and placement strategies that will minimize impacts on local wildlife populations and enhance wildlife movement.

Create a Wildlife-friendly Transportation System

New subdivisions often mean new roads in and around natural areas that contain a variety of wildlife species. Crossing roads is dangerous: thousands of animals are killed on roads and highways each day. Roads are harmful not just because they are dangerous to individual animals, but because they can isolate wildlife populations that previously were connected. Animals within a population interact more with each other than with neighboring individuals from other populations, but individuals occasionally move from one population to the next. Discrete groups of animals of the same species that are separated but that interact at some level are called "metapopulations" (Figure 2).

Movements of animals from one population to the next are essential to maintain healthy regional populations. One reason these separate but somewhat connected populations are important is the resilience to catastrophic disturbances. Natural disturbances, such as fire, flood, diseases, and storms, can wipe out individuals from one area. After this disturbance, individuals from the other populations can recolonize this area. If the entire population of a species were

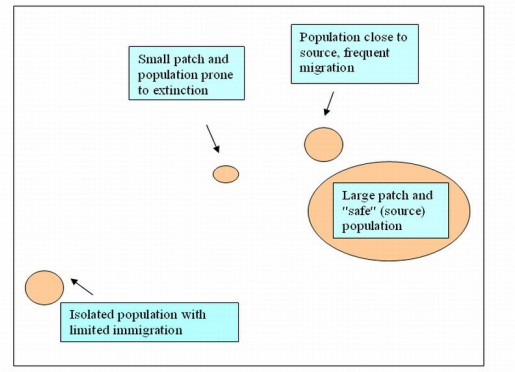

Figure 2. A cluster of wildlife populations of various sizes and degrees of isolation. Together these populations comprise a metapopulation, which is to say, they are all part of an interbreeding group even though some of the component populations will share genes more than others. Illustration Credit: Colin Meurk.

located in one area, however, a disease epidemic or other natural disaster could wipe out the entire species. Separate populations guard against this scenario—kind of like "not putting all your eggs in one basket." Also, the occasional mixing of genes between populations prevents inbreeding problems when groups become small and isolated. Inbreeding occurs when closely related individuals breed with each other, which often results in the expression of harmful recessive genes. For example, the atrial septal defects (holes in the heart) in some Florida panthers are thought to be a result of inbreeding.

The design and management of developed land between natural areas supporting separated wildlife populations is important because if the developed land doesn't allow animals to travel, then they will be unable to disperse from one natural area to the next. Urban and rural landscapes situated between natural areas can be designed and managed to promote dispersal. The design and placement of roads is one important factor that could inhibit the movement of wildlife. Below, we discuss some road design considerations that will promote the movement of both aquatic and terrestrial species.

Roads and terrestrial animal movement:

Roads too difficult for wildlife to cross not only result in an increase of unsightly "road kills" but cause the isolation of wildlife populations. Road placement is critical. First, both the land within the planned subdivision and the surrounding land should be analyzed to determine where wildlife corridors could be located (for details see http://edis.ifas.ufl.edu/uw320). If possible, roads should be placed in areas that do not cross these important wildlife corridors. If a bisecting road cannot be avoided, construct culverts and underpasses that wildlife can use. Typically culverts are used for the passage of water under a road; they can easily be designed to accommodate wildlife as well. There is no set formula to determine the necessity for a wildlife-friendly culvert or dictating the size of the culvert. These design specifications will depend on the conditions of nearby habitat, what wildlife species the culvert will serve, how wide the road is, and the amount of vehicular traffic anticipated. In general, wider roads that are heavily traveled and are located in more natural habitat most warrant a passage for wildlife underneath the road. A wildlife biologist should be consulted to determine where culverts should be placed and what type of culvert should be constructed to benefit local wildlife species. Some important considerations for culverts:

- Within the culvert, be sure that some dry areas occur even during extremely wet conditions. If the culvert is completely filled with water, then terrestrial animals will not use it.
- For small animals like salamanders, install a small, one-foot-diameter pipe next to the larger culvert to allow their safe passage. (Smaller critters will often avoid large culverts.)
- Use a natural substrate along the bottom of any culvert. Animals are reluctant to walk on steel or other unfamiliar material.
- Consider installing speed bumps above the culverts. Speed bumps protect those animals that decline to use the culvert and go across the road. Any street lighting should be placed far away from the culvert to avoid frightening wildlife. Plant vegetation screens around the culverts that do not block the entrances but provide shelter and cover for animals.
- In some cases, fencing may be required to funnel wildlife into culverts. In certain circumstances, for instance, when roads bisect a wetland, the road should be raised several feet with cement lining the sides. The elevation and

cement prevent animals from climbing onto the road and force them to go through the culverts instead. Here, vegetation growing over the sides of the roads (from below) must be cut back to prevent critters from climbing up the vegetation and accessing the road.

- Some species traveling during the day will avoid the dark, "tunnel-like" interiors of culverts. Allow daylight to enter long tunnels with skylight grates on top of the road.

An excellent resource to explore to find out more about how to design wildlife underpasses can be found in this online guide published by 1000 Friends of Florida—http://floridahabitat.org/wildlife-manual/transportation. A more detailed discussion can be found about appropriate wildlife crossings in this reference: High, Wide, and Handsome: Designing More Effective Wildlife and Fish Crossings for Roads and Highways—http://repositories.cdlib.org/jmie/roadeco/Reudiger2001a/.

In addition to culverts, some other design considerations can make roads and the areas near them more habitable for terrestrial wildlife. Street margins can contain additional wildlife habitat. Street swale construction can be planted with native trees and shrubs. Further, a meandering street form, traffic-calming devices like speed humps, and posted neighborhood speed limit signs will create a walkable and safer street layout that diminishes the dominance and speed of cars, benefiting both wildlife and humans alike!

Roads and aquatic animal movement:

For roads that cut off connections between waterbodies (e.g. wetlands or streams), this will restrict the ability for aquatic species (e.g. fish) to disperse from one waterbody to another. The dangers to these species are the same as those for terrestrial species—isolation leading to inbreeding and vulnerability to disease or other catastrophic events. Culverts work for aquatic species, too. The first step is to identify which aquatic species in the area may need culverts; this will vary depending on location and surrounding habitat. Hire an aquatic biologist to identify such animal species and to locate areas where they are most likely to cross under a road. Once the connections between aquatic habitats are identified, several design options are available. The best solution is to re-route roads to avoid connections between streams and wetlands. When this is not possible, some kind of below-road culvert may be required. Following are some considerations for aquatic species:

- To accommodate most species of native freshwater fish, connections between wetlands and other waterbodies require water at least 10 centimeters deep. Note that long stretches of fast-flowing or polluted water, flap gates, or overhanging culverts act as barriers to fish. To permit fish to move through a culvert, rough up the smooth bottom with cement or rocks to slow water flow.

- Sometimes, restoring a water passage under a road between two previously disconnected ponds can inadvertently harm wildlife in one of the formerly isolated ponds. For example, an isolated pond or canal used by Oscars (*Astronotus ocellatus*) should stay isolated. (Oscars are an exotic predator fish that has become an invasive pest in some waterbodies.) Your aquatic biologist should examine all waterbodies along a proposed connection in order to prevent the spread of diseases or exotic predators into a new area.

- For more technical information on culvert designs for safe fish passage, see the 2007 U.S. Department of Transportation Fish passage Synthesis Report—http://www.fhwa.dot.gov/engineering/hydraulics/pubs/07033/index.cfm.

Additional Resources

For additional information on conservation subdivisions and conserving urban biodiversity, a variety of online guides, books and other publications exist.

Books and Scientific Publications

Arendt, R.G., 1996. Conservation Design for Subdivisions: A Practical Guide to Creating Open Space Networks. Island Press, Washington, D.C.

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Department of Wildlife Ecology and Conservation Extension

http://www.wec.ufl.edu/extension/

Florida Fish and Wildlife Conservation Commission – Planting a Refuge for Wildlife http://myfwc.com/RECREATION/View_iybrefuge.htm

Living Green

http://www.livinggreen.ifas.ufl.edu

Program for Resource Efficient Communities

http://www.buildgreen.ufl.edu

Sustainable Site Initiative

http://www.sustainablesites.org/

United States Department of Transportation, Fish Passage Synthesis Report

http://www.fhwa.dot.gov/engineering/hydraulics/pubs/07033/index.cfm

High, Wide, and Handsome: Designing More Effective Wildlife and Fish Crossings for Roads and Highways http://repositories.cdlib.org/jmie/roadeco/Reudiger2001a/

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