SNAPSHOT: *by Billy Krimmel*[1]

Native Landscaping and Metapopulations: *Thinking beyond the individual garden*

When we use native plants to landscape our gardens, we create habitat for the myriad species of animals that depend on these plants for food, shelter, and other needs. To native fauna, native landscapes are beacons of livable habitat amidst a bleak expanse of non-native plants and pavement. So how do native birds, bees, and butterflies find our gardens in the first place? What happens when they leave? As individual native gardens flicker in and out of existence, what happens to the faunal species that occupy them?

The Metapopulation Concept

These questions all steer us to think about cities, suburban areas, rural areas, and 'wild' areas as interconnected metapopulations of species. At its most basic, a metapopulation is a group of spatially separated populations that interact through dispersal and migration. The metapopulation concept arose in the biological sciences as a way to explain population dynamics of agricultural pests in a patchy environment by considering how habitat quality, population extinction, and patch colonization impact the pest population as a whole (Levin 1974). The concept is now applied widely (e.g., Hanski 1998, Hanski and Gaggiotti 2004) when thinking about the connectivity of interbreeding populations, from predicting species resilience in the face of disturbances like climate change (e.g., Opdam and Wascher 2004) to reintroducing endangered species to the wild (Akcakaya et al. 2006) and managing fisheries (e.g., Kritzer and Sale 2004).

In landscaping, the concept of metapopulations guides us to design human-occupied areas in ways that support wildlife resilience by connecting patches of habitat to one another. The concept applies not only to thinking about how individual species persist and move through these patches, but also how connectivity affects genetic diversity of a given species (e.g., Pannell and Charlesworth 2000).

Metapopulation theory uses the language of corridors, sources, sinks, death, extinction, reproduction, colonization, and migration. Corridors are strips of habitat that connect patches to one another. Exactly what a corridor requires for species movement depends upon the needs of the species and the limitations of the broader land use, but in general a corridor enables species to move between patches. Sources, or source populations, are patches of habitat where species reproduction is greater than death — these are where species move *from*. A source may be a wild area with lots of native species, or it could be a native garden where a particular species reproduces in such high numbers that its kin colonize other areas. Source populations increase the resilience of the metapopulation. Sinks, or sink populations, are patches of habitat where death outpaces reproduction — these are where species move *to* and die in greater numbers than their reproductive output. Sink populations reduce the resiliency of the metapopulation. Colonization refers to a species initially occupying a previously unoccupied patch (i.e., a monarch finds your patch of milkweed, lays eggs and you have monarch larvae for the first time).

This type of thinking can apply both to the wildlife that move throughout patches, and also to the species of plants that comprise the patches. Their connectivity is important, because it allows more flow of genes between populations, reducing genetic isolation and the long-term dangers that come with it (i.e., Husband and Barrett 1996),

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A mini-grassland of *Festuca californica* growing under a backyard coast live oak tree (*Quercus agrifolia*). *Photo courtesy Bob Battagin, 27 August 2018, Woodacre, California*

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creating more resilient plant populations. This is particularly important as we face unprecedented changes to our climate that will demand genetic adaptation by species in order to deal with changing environmental conditions.

Your Garden is Part of a Metapopulation

Your native garden is a small patch of habitat for populations of native plants and animals. If other small patches with native populations exist nearby (e.g., if your neighbors have native gardens, or if native plants are growing as volunteers or 'weeds' nearby), individuals from the population in your patch may interbreed with the individuals from those other populations. If either population becomes locally extinct (i.e., ceases to exist in a particular patch), it can be recolonized by migrating individuals from the other patches. More patches means easier recovery from local extinctions because dispersal between patches enables recolonization of unoccupied patches, and thus a more resilient metapopulation of the species. But without migration and dispersal and the corridors required for these vital processes to occur, patches cannot be recolonized.

Corridors are particularly important to native species in human-occupied landscapes (e.g., Anderson and Danielson 1997) because of how extensively we have fragmented habitat through development of buildings, roads, fences, etc. In recognition of this, human-made corridors (e.g., tunnels and bridges) have been built across roads to enable large mammals to move between populations (e.g., Shilling and Girvetz 2007). Rivers and streams also serve as important migration corridors for a number of species (e.g., Lake et al 2007) because they are often the most contiguous corridors of vegetation within cities (see Figure 1) and thus the best options for movement across long distances. Unfortunately, when not well-managed, these riparian areas can also function as corridors for invasive species (Stohlgren et al. 1998). Similarly, roadsides and railroad rights-of-way offer tremendous opportunities for connecting small populations to one another and also to larger populations like national forests and parks; however, these can also serve as corridors for invasive species, many of which may have been planted along them intentionally (e.g., US DOT 2000). Imagine if we seeded the sides of our highways with appropriate native plant species — suddenly all the planning and money we put into these rights-of-way connecting human populations could also connect native species of plants and animals.

Moving Forward

Applying the metapopulation concept to habitat restoration in human-occupied areas allows us to focus on the key factors that determine the resilience of native species populations and apply our efforts accordingly.

What are the key source populations for species we want to support in human-occupied spaces? These source populations may be wild areas outside of city limits, riparian areas with healthy populations of native species, or other large, well-established native species populations.

Figure 1: A modified map depicting vegetation patches in the Sacramento area. The most continuous patches are along the American and Sacramento Rivers (the solid bands). Riparian areas like these can be important corridors for native and/or invasive species, depending on how they are managed. *Graphic by Emily Schlickman*

How can we connect key source populations to uncolonized patches within human-occupied landscapes? Corridors between wild and fragmented areas are particularly important to establishing gene flow between wild and human-occupied areas.

How do we create high-quality patches for species within cities? Many animals require certain types of plants for food and habitat, and also may require other habitat features like places to nest or take shelter from adverse weather. Many plants require certain pollinators in order to reproduce, which may not be present without nearby populations or effective corridors for movement. Holistic design and implementation of native gardens is important for them to function as viable habitats.

How do we facilitate movement between patches within human-occupied spaces? If patches are close enough together, many species may be able to move through flight (e.g., birds, insects, etc.) or may be carried by the wind (e.g., seeds, small insects, etc.). Unfortunately, the reality is that native gardens are rare within human-occupied spaces, so movement between them may require smaller corridors to connect them to one another. The sides of city roads, bike paths, and sidewalks are good opportunities for such corridors.

Opportunities and Challenges

Cities and suburban areas are designed so that people can move efficiently within them. Thus, much of the heavy lifting of building corridors for native species has already been done via construction of roads and train tracks. On small scales, neighbors can create contiguous habitat patches in their front yards and sidewalks, or individual patches in their backyards, schools, or community centers,

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where migration between patches is high due to spatial proximity. Homeowner associations can create resilient habitats in their communities by requiring local native plants in landscapes and along sidewalks.

The metapopulation concept provides a powerful framework for thinking about how we can restore native species in human-occupied landscapes. There are both opportunities and challenges ahead in establishing metapopulations of native species in cities and suburbs. As public awareness of forest fires, invasive species, and climate change increase, there is more motivation for investing in long-term ecological resilience, which is exactly what metapopulation theory considers. This is particularly important for large-scale seeding projects, such as post-fire erosion control, where non-native seed is widely used because it is less expensive than native seed. But if we think bigger — and consider the added value of these large spaces as source populations for native species rather than isolated patches — our cost:benefit calculus might conclude that native seeds are worth the short-term cost.

The next time you drive around your community or to a wild area, think about what it would take to connect your garden to other gardens and wild areas through migration corridors. What opportunities and challenges exist? And keep an eye out for native populations of tarweeds (*Hemizonia congesta, Holocarpha heermannii, Madia elegans, Madia sativa*), fiddleneck (*Amsinckia menziesii*), turkey mullein (*Croton setiger*), sacred datura (*Datura wrightii*), and evening primrose (*Oenothera californica*) growing along roadsides. Many California native plants already thrive in highly-disturbed conditions like roadsides and could make good candidates for future seeding projects.

Additional resources can be found at **www.urbangardenecology.com** and **Helpabee.org**.

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The mission of the California Native Grasslands Association is to promote, preserve, and restore the diversity of California's native grasses and grassland ecosystems through education, advocacy, research, and stewardship.