<u>Testing an Ecological *Cost* of Habitat Corridors: Spread of Invasive Species</u>

Key-words: conservation, habitat corridors, invasive species, ants

Background: As extensive tracks of habitat become fragmented, populations in the remaining habitat become isolated and increasingly vulnerable to extinction. A frequently touted solution is the creation or maintenance of habitat corridors – strips of habitat that connect otherwise isolated patches of the same habitat and that presumably increase animal movement between patches[1-3]. Although corridors make intuitive sense, their actual effectiveness remains controversial[4,5]. The controversy has arisen because: (1) studies frequently reach opposite conclusions[1], (2) the vast majority of studies are non-experimental, small-scale or poorly replicated[2], (3) confounding factors are often overlooked (e.g., the additional area and edge habitat that corridors inevitably bring with them)[1], and (4) corridors may facilitate the spread of invasive species[6].

I will test the effectiveness of corridors in restoring communities of native ants in a highly threatened ecosystem, longleaf pine savanna. I am fortunate to be able to address or overcome many of the above problems and constraints of previous studies. Specifically, I will be working in a series of experimental landscapes (Fig. 1) created in 1999 by my advisor (Doug Levey) and Nick Haddad (NC State). These landscapes are large (40 ha each, including buffer) and well replicated (n = 8). The rationale for their design is complex[1]. In brief, each contains five "patches" (ca. 1 ha) that have been planted with longleaf pine, wiregrass, and other characteristic species of longleaf pine savanna. The restoration process includes frequent burns. The matrix is densely planted loblolly pine plantation, which is generally a hostile environment for the species in young longleaf. Each landscape is comprised of one "central" patch and four "peripheral" patches. The central patch is connected to one peripheral patch by a 150m corridor. The other three peripheral patches are unconnected and are of two types, "winged" and "rectangular". The areas of winged and rectangular patches are equal to the area of the "connected" peripheral patch plus its corridor, allowing one to disentangle connectivity (corridor) effects and area effects. Likewise, the "edginess" of winged and connected patches is equivalent, allowing one to disentangle connectivity and edge effects.

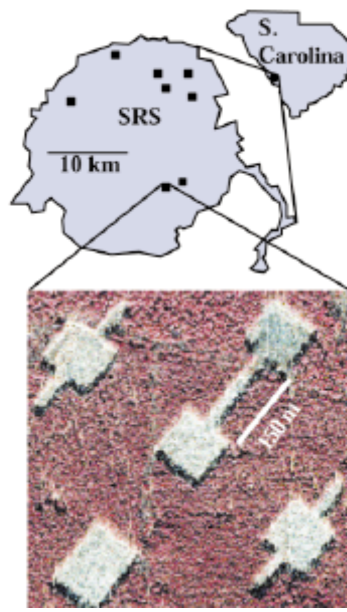

Figure 1: Savannah River Site (SRS) Corridor experiment. Patches are regenerating longleaf pine savanna. Upper right patch = "Connected "; Lower-right patch = "Winged"; Lower-left ="Rectangular". N = 8 of these sets

Although I did not participate in the design or creation of these landscapes, I've worked in them for eight months and have **crafted my own project**, focusing on ants (My advisor works on birds; this is my own work). I became enamored with ants while censusing them in my spare time last summer. They are unusually diverse in longleaf pine savanna[7], easy to observe, amenable to experimentation (e.g., removal), and can have major impacts on restoration of plant communities through their roles as seed predators[8] and dispersers[9]. Perhaps more intriguing, an exotic invasive species, the red imported fire ant (*Solenopsis invicta*) is abundant but patchily distributed within and among the landscapes. It's unclear whether corridors facilitate spread of fire ants and it's recently controversial whether fire ants are detrimental to native ants[10]. I will test for corridor effects on all ant species in the landscapes, holding area and edge effects constant. The truly unique aspect of my project will be my ability to assess the role of corridors in the spread of an invasive species and then to weigh potential costs of such spread (reduced species richness of native ants) against the presumed benefits (increased species richness of native ants). **No previous corridor project has examined the interplay between the spread of invasive and native species**, despite high-profile arguments for doing so[6]. I aim to fill the void.

Preliminary Work: *S. invicta* occurs in all eight experimental landscapes, but is extremely variable in density among patches, ranging from 3 to 34 colonies/ha (J. Resasco unpubl. data). I have conducted surveys of common ants and created a large reference collection of all species. More generally, I have previous experience with dispersal dynamics of invasive species[11]. (My application for this Fellowship last year received an Honorable Mention. My research statement was only "Very Good", largely because I had no experience in the landscapes at that time.)

Hypotheses: I hypothesize that **(H1)** *Corridors will increase species richness of longleaf pine savanna ants*. **(H2)** *Corridors will increase abundance of* S. invicta. **(H3)** S. invicta *abundance will be negatively correlated with the species richness and abundance of native ants.* **(H4)** *Removal of* S. invicta *will increase the species richness and abundance of native ants.*

Methods: The experimental manipulation required for **H 1-3** has already occurred. Testing these hypotheses now requires data on spatial and temporal variation in ant abundance. I will census ants using two standard techniques: tuna bait stations (≈10g) and 70 mm diameter pitfall traps. To control for edge effects within patches, I will conduct these censuses at distances of 5, 10, and 20m from the nearest edge. These surveys will be done in May and September for four years (Years 1 to 4) to follow the temporal dynamics of longleaf pine restoration. To test **H4**, I will eliminate all *S. invicta* colonies from one peripheral patch of each type (connected, winged, rectangular) in each experimental landscape. This will leave the fourth peripheral patch (either winged or rectangular) as a control. Starting in Year 2, I will remove colonies as described in a recent study[10], repeating the treatment as needed to keep selected patches free of *S. invicta*.

Analyses: Tests of **H1** and **H2** will employ the same Mixed Linear Model used in previous studies at this site[1-3], with landscape as a random effect and patch type and distance to edge as fixed effects. Species richness will be standardized via rarefaction. **H3** will be tested via regression. **H4** will be tested as a Before–After-Control–Impact (BACI) design.

Broader Impacts: Many conservation plans simply assume that habitat corridors are effective[4]. Data are sorely lacking. My project provides an opportunity to integrate straightforward tests of corridor theory with restoration of a highly threatened habitat. Likewise, invasive species are often blindly assumed to have detrimental effects on native species, but *restoring native biodiversity may not be as simple as removing non-native species*[10]. My project will test the extent to which this is the case. Finally, the U.S. Forest Service is keenly interested in *applying* our results in their longleaf management plans at SRS -- I am already collaborating with them, attempting to bridge research and restoration. Apart from this project's broader impacts on conservation, I believe ecologists have a responsibility to educate the general public about their work. Such outreach is especially critical for children and youth from groups under-represented in science. I will use this project to bring new material to my current and future outreach activities (STEP and SPICE, respectively; see Personal Statement).

Literature Cited: **(1)** Tewksbury, JJ *et al.* (2002) *PNAS* 99, 2923–12926 (**2)** Townsend, PA and Levey, DJ (2005) *Ecology* 86, 466–475 (**3)** Damschen, EI *et al.* (2006) *Science* 313, 1284–1286 (**4)** Simberloff, D *et al.* (1992) *Conserv. Biol.* 6, 493–504 (**5)** Hilty, JA *et al.* (2006) Corridor Ecology. Island Press (**6)** Proches, S *et al.* (2005) *Science* 310, 779–783 (**7)** Lubertazzi, D and Tschinkel, WR (2003) *J. Insect Sci*. 3, 1–17 (**8)** Orrock, JL and Damschen, EI (2005) *Ecol. Appl.* 15, 793–798 (**9)** Ness, JH *et al.* (2004) *Ecology* 85, 1244–1250 (**10)** King, JR and Tschinkel, WR (2006) *J. Anim. Ecol.* 75, 1370–1378 (**11)** Resasco, J *et al.* (2007) *Int. J. Remote Sens.* 28, 3739–3745