Invited Feature

Ecological Concepts in Conservation Biology: Lessons from Southeastern U.S. Ecosystems[1]

Ecosystems of the southeastern United States were considerably altered, directly and indirectly, by human actions long before their composition and processes could be characterized. Consequently, there are almost no unaltered ecosystems to guide restoration and management. For decades, most actions practiced in the name of conservation of Southeastern ecosystems were based on models and concepts developed elsewhere. The unique environments and species present in the Southeast were downplayed by a scientific community dedicated to a quest for ecological generality. As a result, management practices often altered ecosystems, producing variants not in presettlement landscapes. Such alterations of habitats, often associated with invasions of nonnative species, have resulted in new, large-scale, often unpredicted changes in native ecosystems. This ever-increasing barrage of anthropogenic changes seriously threatens all ecosystems in the southeastern United States.

This Invited Feature explores the applicability of ecological concepts to conservation of Southeastern ecosystems. We invited contributors whose research spanned a wide range of habitat types, from alpine relicts of the Appalachian Mountains to subtropical hammocks of south Florida. The result is a diverse mixture, with each contribution addressing different concepts.

The Southeast is home to numerous endemic species, subspecies, and races of plants, many of which are rare and the focus of conservation efforts. Two contributions address concepts related to the distribution of rare species and habitats over space and time. Susan Wiser and coworkers examine rare species that occur on high-elevation rock outcrops of the southern Appalachian Mountains, habitats thought to be remnants of once widespread periglacial tundra vegetation. Their models of the distributions of these species indicate that, contrary to the implicit assumptions of plant community ecologists, species ranges are not necessarily set by availability of suitable habitat. Thus, preservation of one or two examples of a habitat with such relict insular distribution is likely to be inadequate as a conservation strategy. Large-scale spatial patterns and processes must be considered in conservation planning.

Paul and Hazel Delcourt examine how changes in the distributions of Appalachian species over the last 20 000 yr might serve to guide conservation in anticipation of global warming. Rare plant species of the southern Appalachians are disproportionately concentrated at open high-elevation habitats which are unlikely to persist with global warming. Global warming as rapid as that predicted to occur during the next century is unlikely to allow sufficient time for narrow habitat specialists to colonize new sites. Despite current efforts to preserve populations of rare high-elevation plant species, extinction is likely unless biological reserves are created that include corridors for migration.

Two contributions address the role of natural disturbances within Southeastern ecosystems. Eric Menges and Christine Hawkes raise the question of whether the concept of fire as a periodic disturbance reinitiating succession is appropiate for fire-dominated communities. They suggest that variation in fire frequencies may influence the types of species present, the types of microsites, and the dynamics of vegetation in the intervals between fires. The basic concept that has dominated the fire ecology of Florida scrub, a fire-maintained, sclerophyllous shrub-dominated community endemic to Florida and coastal Alabama, has been that fire every few decades is sufficient to maintain herbaceous species, which persist via seed banks in the intervals between fires. Data suggest, however, that fire alone is not sufficient; open patches without shrubs are also necessary.

[1] Reprints of this 83-page Invited Feature are available for $12.50 each. Prepayment is required. Order reprints from the Ecological Society of America, Attention: Reprint Department, 2010 Massachusetts Avenue, N.W., Suite 400, Washington DC 20036.

Thus, principles of fire ecology in ecosystems that burn periodically should not be based solely on fire effects on hardwood shrubs. Long periods of fire exclusion may result in increases in shrubs, which then are not readily removed when fire is reintroduced. As a result, indigenous herbaceous plant species may be suppressed or eliminated, unless areas without shrubs are present. Restoration and management (especially of fire-suppressed scrub) should be based on models that incorporate both fire regimes and microhabitats within the landscape.

The second contribution focusing on disturbance ecology explores the concept of invasibility of disturbed forest communities. Carol Horvitz and coworkers delimit guilds of species with similar life histories for the native vegetation of south Florida subtropical hardwood forests, locally called ''hammocks.'' They then examine the exotic species that have invaded hammocks and show that life-history traits of nonnative invaders often resemble those of natives, rather than those of pioneer species as is often postulated for ''invasive species.'' Such guilds of species containing native and exotic species were found to be somewhat general to subtropical regions. The responses of native and exotic species to the opening of the forest canopy by Hurricane Andrew in 1992 indicated that exotic species in certain guilds potentially have the ability to swamp natives as a result of their responses to major disturbances. This study suggests that concepts of invasibility useful in guiding conservation of forest ecosystems, especially in the hurricane belts of the warm-temperate and subtropical regions of the southeastern United States, will differ from those commonly applied to invasions of highly disturbed ecosystems. Understanding guilds of native species may prove useful in predicting invasibility by exotic species and how invasibility is influenced by natural disturbances.

A complementary contribution by Doria Gordon explores the consequences of successful invasion by exotic plant species. The current flora of Florida contains many exotic species, 31 of which are considered as category-1 invaders with the potential to invade and disrupt native plant communities. About half of these species appear to change ecosystem characteristics or processes, such as geomorphology, hydrology, biogeochemistry, disturbance regimes, structural characteristics of communities, and demographic properties of native populations (recruitment, survival, or growth). This review provides a convincing case that long-held concepts about invasibility do not effectively address the long-term consequences of exotics that become integral components of ecosystems. Plant communities that span a wide range of environments, and which range from highly disturbed to relatively undisturbed, are being altered in various ways that are likely to result in new environments, ones for which the native species might be less well adapted (and thus less competitive) than exotic species. Consequently, concepts useful to guide restoration and management of ecosystems invaded by many exotic plant species need to be based on restoration of environmental conditions that have been modified by the invading species.

These five contributions point toward a need for ecological concepts and models known to be directly applicable to the ecosystems being studied. General models, especially those developed in other bioregions and subsequently applied to Southeastern ecosystems, appear inadequate when examined closely with relevant field data. New and system-specific models need to be developed with respect to fire effects on natural ecosystems, ecosystem responses to climate change, invasibility of native ecosystems, and the effects of invaders on ecosystem processes. Although each concept is discussed in the context of particular plant communities, as a group they suggest that restoration and management based on general theories may be misguided. Alternatively, ecosystem-specific concepts based on empirical relationships between specific environments and organisms that occur in those environments may be much more successful in guiding restoration and management of ecosystems.

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