Understanding relationships among invasive species and soils

By Pete Biggam

Soil plays a key role in many biological and physical processes. It is involved in nutrient cycling, the hydrologic cycle, and energy capture and transfer. It serves as the rooting material for most terrestrial vascular plants, and provides essential habitat for numerous ground-dwelling species. Unfortunately, past and present impacts from a wide variety of invasive plant and animal species threaten the ability of park soils to function properly. By increasing our understanding of the physical, chemical, and biological properties of soil, we may be able to do a better job of controlling the distribution and extent of invasive species.

Ironically, invasive plant species have been used in the past in an effort to protect valuable soil resources. In the 1930s, the USDA Soil Conservation Service promoted the planting of kudzu *(Pueraria Montana* var. *lobata)* for controlling accelerated soil erosion in the southeastern United States, and Russian olive *(Elaeagnus angustifolia)* was also highly recommended as a windbreak to reduce erosion in the Midwest and western United States. However, invasive plants can damage soil and water resources through the displacement of native plant species. This in turn affects the type and amount of soil litter available to minimize surface runoff and water and wind erosion.Today, we have a better understanding of the relationships among invasive plant species and soils. Studies have shown that numerous invasive plant species have an affinity for certain physical and chemical properties of soil, and may outcompete native species on these sites if the soils are disturbed. Diffuse knapweed *(Centaurea diffusa)*, Russian knapweed *(C. repens)*, and spotted knapweed *(C. maculosa)* tend to do well on drier sites with coarse-textured, well-drained soils with elevated levels of calcium carbonate. Medusahead *(Taeniatherum caput-medusae)* is well suited to establishment on soils that are high in clay. Yellow star-thistle *(Centaurea solstitialis)* can outcompete native and other invasive plant species on shallow, rocky soils. Salt cedar (*tamarix* spp.) can establish itself on highly saline soils along riparian corridors and can tolerate highly alkaline conditions. It has the ability to absorb salts from the subsoil and store them in its leaves. As these leaves are shed and deposited on the soil surface, salt leaches back into the topsoil, increasing salinity and further reducing the ability of native plants to compete with this invader.

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Figure 1. Northern temperate forests are being invaded by exotic earthworms that rapidly consume the organic matter in the soil. USGS PHOTO

In park units in arid and semiarid ecosystems, biological soil crusts are a dominant feature and play a valuable role in stabilizing soils. Disturbance of the soil surface and introduction of invasive plants can result in loss of biological crust cover, which in turn can reduce soil stability and alter nutrient cycles, soil moisture, and temperature regimes, affecting the soil food webs.

At Dinosaur National Monument, Colorado, the relationships among soils and invasive plants are being addressed in the Cub Creek weed management and restoration planning project. Resource managers have determined that infestations of Russian knapweed tend to be limited to the coarser textured soils, and have yet to encroach upon the soils of predominantly clay textures. Staff plan on using the recently completed soil survey for the monument to help identify other potential areas susceptible to establishment of Russian knapweed, as well as identifying areas that may be less susceptible for establishment, based upon soil textural properties identified in the soil survey.

Resource managers have traditionally focused on the impacts of invasive plants on soils; however, invasive animal species also threaten this resource. The wild hog *(Sus scrofa)*, common in many units of the National Park System, is notorious for extensive disturbance of soil and vegetation communities as a result of its rooting habits when foraging. Lacking sweat glands, the hogs search out poorly drained soils and create wallows where they cool off and rid themselves of parasites. Wallowing compacts the soil and destroys its structure, opening up new areas for invasive plants to colonize. Recent studies have also warned of the invasion of northern temperate forests by exotic earthworms (fig. 1). These seemingly innocuous animals have the potential to greatly alter ecosystem processes by rapidly consuming the organic matter in the soil, depriving native plants of beneficial places to germinate and grow (see Information Crossfile, pages 9 and 31, for more information). The result is a seemingly bare forest floor that invites invasion by exotic plant species (fig. 2).

The NPS Soils Inventory and Monitoring Program is working to obtain soil resource inventories for approximately 275 national park units. These inventories will contain additional information on the relationships among specific invasive plants, animals, and soil types that will help us gain insights into the ways in which invasive plants and animals affect our valuable soil resources.

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Figure 2. The result of the earthworms is a bare forest floor that invites invasion by exotic plant species. USGS PHOTO