Invasive Plants of California's Wildlands

EDITED BY

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DEDICATION

We dedicate this book to

Oren Pollak

JUNE 1959–NOVEMBER 1998

our friend, colleague, and dedicated
steward of California's wildlands;

and to

Professor Marcel Rejmánek

who sparked and encouraged our interest in invasive plants,
continues to share his knowledge of plant ecology,
and endeavors to extend understanding of invasive plants.

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forest following introduction of chestnut blight, *Cryphonectria parasitica* (National Academy of Science 1975).

IMPACTS OF INVASIVE PLANTS ON WILDLANDS

Non-native plant invasions can have a variety of effects on wildlands, including alteration of ecosystem processes; displacement of native species; support of non-native animals, fungi, or microbes; and alteration of gene pools through hybridization with native species.

Ecosystem Effects

The invasive species that cause the greatest damage are those that alter ecosystem processes such as nutrient cycling, intensity and frequency of fire, hydrological cycles, sediment deposition, and erosion (D'Antonio and Vitousek 1992, Vitousek 1986, Vitousek and Walker 1989, Vitousek *et al.* 1987, Whisenant 1990). These invaders change the rules of the game of survival and growth, placing many native species at a severe disadvantage (Vitousek *et al.* 1996). Cheat grass (*Bromus tectorum*) is a well studied example of an invader that has altered ecosystem processes. This annual grass has invaded millions of acres of rangeland in the Great Basin, leading to widespread increases in fire frequency from once every sixty to 110 years to once every three to five years (Billings 1990, Whisenant 1990). Native shrubs do not recover well from more frequent fires and have been eliminated or reduced to minor components in many of these areas (Mack 1981).

Some invaders alter soil chemistry, making it difficult for native species to survive and reproduce. For example, iceplant (*Mesembryanthemum crystallinum*) accumulates large quantities of salt, which is released after the plant dies. The increased salinity prevents native vegetation from reestablishing (Vivrette and Muller 1977, Kloot 1983). Scotch broom (*Cytisus scoparius*) and gorse (*Ulex europaea*) can increase the content of nitrogen in soil. Although this increases soil fertility and overall plant growth, it gives a competitive advantage to non-native species that thrive in nitrogen-rich soil. Researchers have found that the nitrogen-fixing firetree (*Myrica faya*) increases soil fertility and consequently alters succession in Hawaii (Vitousek and Walker 1989).

Wetland and riparian invaders can alter hydrology and sedimentation rates. Tamarisks (*Tamarix chinensis, T. ramosissima, T. pentandra, T. parviflora*) invade wetland and riparian areas in southern and central California and throughout the Southwest, and are believed to be responsible for lowering water tables at some sites. This may reduce or eliminate surface water habitats that native plants and animals need to survive (Brotherson and Field 1987, Neill 1983). For example, tamarisk invaded Eagle Borax Spring in Death Valley in the 1930s or 1940s. By the late 1960s the large marsh had dried up, with no visible surface water. When managers removed tamarisk from the site, surface water reappeared, and the spring and its associated plants and animals recovered (Neill 1983). Tamarisk infestations also can trap more sediment than stands of native vegetation and thus alter the shape, carrying capacity, and flooding cycle of rivers, streams, and washes (Blackburn *et al.* 1982). Interestingly, the only species of *Tamarix* established in California that is not generally regarded as invasive (athel, or *T. aphylla*) is regarded as a major riparian invader in arid central Australia.

Other wetland and riparian invaders and a variety of beach and dune invaders dramatically

alter rates of sedimentation and erosion. One example is saltmarsh cordgrass (*Spartina alterniflora*), native to the Atlantic and Gulf coasts and introduced to the Pacific Coast, where it invades intertidal habitats. Sedimentation rates may increase dramatically in infested areas, while nearby mudflats deprived of sediment erode and become areas of open water (Sayce 1988). The net result is a sharp reduction in open intertidal areas where many migrant and resident waterfowl feed.

Coastal dunes along the Pacific Coast from central California to British Columbia have been invaded and altered by European beachgrass (*Ammophila arenaria*). Dunes in infested areas are generally steeper and oriented roughly parallel to the coast rather than nearly perpendicular to it as they are in areas dominated by *Leymus mollis, L. pacificus*, and other natives (Barbour and Johnson 1988). European beachgrass eliminates habitats for rare native species such as Antioch Dunes evening-primrose (*Oenothera deltoides* ssp. *howellii)* and Menzies' wallflower (*Erysimum menziesii* ssp. *menziesii*). Species richness on foredunes dominated by European beachgrass may be half that on adjacent dunes dominated by *Leymus* species (Barbour *et al.* 1976). Changes in the shape and orientation of the dunes also alter the hydrology and microclimate of the swales and other habitats behind the dunes, affecting species in these areas.

Some upland invaders also alter erosion rates. For example, runoff and sediment yield under simulated rainfall were fifty-six percent and 192 percent higher on plots in western Montana dominated by spotted knapweed (*Centaurea maculosa*) than on plots dominated by native bunchgrasses (Lacey *et al.* 1989). This species is already established in northern California and the southern Peninsular Range and recently was found on an inholding within Yosemite National Park (Hrusa pers. comm.).

Some invasive plants completely alter the structure of the vegetation they invade. For example, the punk tree (*Melaleuca quinquenervia*) invades marshes in southern Florida's Everglades that are dominated by sedges, grasses, and other herbaceous species, rapidly converting them to swamp forest with little or no herbaceous understory (LaRoche 1994, Schmitz *et al.* 1997). Such wholesale changes in community structure may be expected to be followed by changes in ecosystem function.

Habitat Dominance and Displacement of Native Species

Invaders that move into and dominate habitats without obviously altering ecosystem properties can nevertheless cause grave damage. They may outcompete native species, suppress native species recruitment, alter community structure, degrade or eliminate habitat for native animals, and provide food and cover for undesirable non-native animals. For example, edible fig (*Ficus carica*) is invading riparian forests in the Central Valley and surrounding foothills and can become a canopy dominant. Invasive vines are troublesome in forested areas across the continent. In California, cape ivy (*Delairea odorata*) blankets riparian forests along the coast from San Diego north to the Oregon border (Elliott 1994).

Non-native sub-canopy trees and shrubs invade forest understories, particularly in the Sierra Nevada and Coast Ranges. Scotch broom (*Cytisus scoparius*), French broom (*Genista monspessulana*), and gorse (*Ulex europaea*) are especially troublesome invaders of forests and adjacent openings and of coastal grasslands (Bossard 1991a, Mountjoy 1979). Herbaceous species can colonize and dominate grasslands or the ground layer in forests. Eupatory (*Ageratina*

adenophora) invades and dominates riparian forest understories along California's southern and central coast. Impacts of these ground-layer invaders have not been well studied, but it is suspected that they displace native herbs and perhaps suppress recruitment of trees.

Annual grasses and forbs native to the Mediterranean region have replaced most of California's native grasslands. Invasion by these species was so rapid and complete that we do not know what the dominant native species were on vast areas of bunchgrasses in the Central Valley and other valleys and foothills around the state. The invasion continues today as medusahead (*Taeniatherum caput-medusae*) and yellow starthistle (*Centaurea solstitialis*) spread to sites already dominated by other non-natives. Yellow starthistle is an annual that produces large numbers of seeds and grows rapidly as a seedling. It is favored by soil disturbance, but invades areas that show no sign of being disturbed by humans or livestock for years and has colonized several relatively pristine preserves in California, Oregon, and Idaho (Randall 1996b).

In some situations invasive, non-native weeds can prevent reestablishment of native species following natural or human-caused disturbance, altering natural succession. Ryegrass (*Lolium multiflorum*), which is used to reseed burned areas in southern California, interferes with herb establishment (Keeley *et al.* 1981) and, at least in the short term, with chaparral recovery (Schultz *et al.* 1955, Gautier 1982, Zedler *et al.* 1983).

Hybridization with Native Species

Some non-native plants hybridize with natives and could, in time, effectively eliminate native genotypes. The non-native *Spartina alterniflora* hybridizes with the native *S. foliosa* where they occur together. In some *Spartina* populations in salt marshes around south San Francisco Bay, all individual plants tested had non-native genes (Ayres *et al.* in press).

Promotion of Non-Native Animals

Many non-native plants facilitate invasions by non-native animals and vice versa. *Myrica faya* invasions of volcanic soils in Hawaii promote populations of non-native earthworms, which increase rates of nitrogen burial and accentuate the impacts these nitrogen-fixing trees have on soil nutrient cycles (Aplet 1990). *M. faya* is aided by the non-native bird, Japanese white-eye (*Zosterops japonica*), perhaps the most active of the many native and non-native species that consume its fruits and disperse its seeds to intact forest (Vitousek and Walker 1989).

EARLY INVASIONS BY NON-NATIVE PLANTS

The first recorded visit by European explorers to the territory now called California occurred in 1524, but people of Old World ancestry did not begin to settle here until 1769. Available evidence indicates that the vast majority of non-native plants now established in California were introduced after this time. There is compelling evidence that red-stem filaree (*Erodium cicutarium*), and perhaps a few other species, may have established even earlier, perhaps after being carried to the territory by roaming animals or by way of trading networks that connected Indian communities to Spanish settlements in Mexico (Hendry 1931, Hendry and Kelley 1925, Mensing and Byrne 1998). Once settlers began to arrive, they brought non-native plants acci-