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Outlook for Plant Invasions: Interactions with Other Agents of Global Change

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Japanese honeysuckle
(*Lonicera japonica*)

It is the daunting task of this chapter to peer into the future and speculate about the prospects for plant invasions. We know that the globe is changing in its physical, biological, and cultural features. What impact might these changes have on the rate at which plant invaders arrive in our natural communities and on the effects they have there? One can certainly list some major changes underway in the environment and review the ways in which the arrival or establishment of invaders might be affected; that is how I will begin. However, it is clearly unwise to think of these factors in isolation from one another, and so I go on to discuss possible synergistic relationships among the factors. I will also try to put into a larger management context the entire issue of plant invasions as affected by global change.

I began initially by trying to review the thoughts of others who have worked on these issues. I was surprised to discover the extent to which ecologists studying invasions, and those working on issues of global change, have failed to discuss connections between the two themes. Checking several recent books reviewing global change and its biological consequences, I found surprisingly few cases where invasions, weeds, or nonindigenous (NI) or exotic species were even listed in the index. Those books or chapters that do speak of plant invasions do not treat

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them as a feature of global change in themselves, or as a process that might be affected by other aspects of global change. Conversely, there has been virtually no mention of global environmental change in major recent reviews of invasions (e.g., di Castri et al. 1990; Drake et al. 1989; Groves and di Castri 1991; Mooney and Drake 1986). Thus I have few models to follow in this discussion.

Primary Agents of Global Change

Vitousek (1994) summarized many of the important changes taking place today on the globe; he emphasized that less attention has been devoted to some well-documented major changes (e.g., changing nitrogen cycling, carbon dioxide increases, or land-use changes) than to the less-certain prospects for global climate change. His article also pointed out that biological invasions are themselves a major agent of global change. With credit to Vitousek, I will go through a list of abiotic and biological changes occurring today, discussing the prospects for them to influence the rate of arrival and establishment of new invaders.

Atmospheric Changes: Increasing Carbon Dioxide Concentrations

The best-documented aspect of global change is the increase of atmospheric concentration of carbon dioxide. Not surprisingly, this is also the area of global change where the most work has been done on potential impacts to weedy invasive plants. Because plants differ in photosynthetic pathway, and because these biochemical pathways differ in their efficiency at low concentrations of carbon dioxide, it seems reasonable that a change in atmospheric concentration of carbon dioxide should alter the competitive relationships among plants with different pathways of carbon fixation. There have been numerous experimental studies comparing the response of C_3 and C_4 pathway species to increased carbon dioxide; most demonstrate that C_3 species benefit more than do C_4 species, growing either alone or in competition (e.g., Bazzaz and Carlson 1984; Carter and Peterson 1983; Patterson 1986; Patterson et al. 1984). This has led some to speculate that C_3 weeds should become more competitive and more troublesome in C_4 crops (or in natural communities dominated by C_4 species), while C_4 weeds should become less problematic with C_3 crops (Patterson and Flint 1980). Similarly, Johnson et al. (1993) speculated that increasing carbon dioxide has affected the balance between C_4 semidesert grasses and C_3 desert shrubs, helping to explain the conversion of many desert grasslands to shrub-dominated systems. One might conclude, then, that C_4-dominated communities may be increasingly vulnerable to invasion by C_3 species. On the other hand, not all C_3 plants respond to increased carbon dioxide with increased biomass or reproduction; there are definite differences among species in the magnitude and even the direction of response (Garbutt and Bazzaz 1984), making generalizations dangerous.

Altered carbon dioxide concentrations may have differential effects, even within a genus: for example, Sasek and Strain (1991) found that the NI Japanese honeysuckle (*Lonicera japonica*) responded much more vigorously in vertical growth and new leaf production than did the North American indigenous (IN) coral honeysuckle (*L. sempervirens*) when both were grown at elevated carbon dioxide. The authors reported that both vines responded more vigorously than has been reported for other growth forms of woody plants, suggesting that vines might be expected to become even more serious invaders. Similarly, kudzu (*Pueraria montana* [*P. montana*]) responded to increased carbon dioxide with more rapid leaf expansion rates, greater height growth, and increased branching (Sasek and Strain 1988, 1989). These studies attributed the tremendous response of vines to the fact that they do not divert much of their increased carbon