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Global change, global trade, and the next wave of plant invasions

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Many non-native plants in the US have become problematic invaders of native and managed ecosystems, but a new generation of invasive species may be at our doorstep. Here, we review trends in the horticultural trade and invasion patterns of previously introduced species and show that novel species introductions from emerging horticultural trade partners are likely to rapidly increase invasion risk. At the same time, climate change and water restrictions are increasing demand for new types of species adapted to warm and dry environments. This confluence of forces could expose the US to a range of new invasive species, including many from tropical and semiarid Africa as well as the Middle East. Risk assessment strategies have proven successful elsewhere at identifying and preventing invasions, although some modifications are needed to address emerging threats. Now is the time to implement horticulture import screening measures to prevent this new wave of plant invasions.

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One need only peruse a nursery catalog or visit a local gardening center to realize the enormous array of plant choices available to the everyday American gardener. Unfortunately, this wealth of consumer choices comes at a steep cost. Non-native plants introduced through the horticulture trade often become invasive (Mack and Lonsdale 2001; Reichard and White 2001), which we define here as introduced species whose populations are surviving and reproducing beyond the location of introduction (*sensu* Blackburn *et al.* 2011). Although only a portion of species that become invasive cause ecological damage (Williamson and Fitter 1996; Sax *et al.* 2002), and some have benefited biodiversity (Davis *et al.* 2011; Schlaepfer *et al.* 2011), invasive plants as a whole substantially reduce native species abundance and diversity (Vilà *et al.* 2011) and alter ecosystem func-

tion (Ehrenfeld 2010; Vilà *et al.* 2011). Several well-known invasive plants in the US were deliberately introduced, including kudzu (*Pueraria lobata*; planted to stabilize soil), oriental bittersweet (*Celastrus orbiculatus*; planted for aesthetics), purple loosestrife (*Lythrum salicaria*; planted for aesthetics), and tamarisk (*Tamarix* spp; first planted for aesthetics and later to act as wind breaks). Indeed, Mack and Erneberg (2002) estimated that over 60% of established, non-native species in the US were deliberately introduced. Moreover, the introduction process can select for species more likely to become invasive, because traits useful in horticulture – such as rapid establishment, broad climatic tolerance, and high resource allocation to flowers – can also increase invasiveness (Mack 2005). Global change is already aiding the spread of invasive species and increasing their ecological impacts (Dukes and Mooney 1999; Bradley *et al.* 2010a). As global change proceeds, however, it will influence not just the success of introduced plants but the introduction process itself (Hellmann *et al.* 2008). Gardeners are poised to plant new species from warmer regions, as earlier onset of spring (Schwartz *et al.* 2006) and warmer temperatures decrease the requirement for winter-hardiness in ornamental plants (Arbor Day Foundation 2006). Similarly, as human populations increase in the arid and semiarid regions of the world, such as the American Southwest (Mackun and Wilson 2011), demand for drought-tolerant plants is expanding – a trend likely to accelerate in areas where climate change exacerbates drought (eg Seager and Vecchi 2010). At the same time, economic globalization offers opportunities to import new types of plants from previously untapped parts of the world. Here, we review how global changes in trade and climate could influence supply and demand for introduced ornamental plants. We predict the consequences for future plant invasions in

In a nutshell:

- New horticultural trading partners supply novel species that may become invasive
- Increasing demand for drought-tolerant species promotes the introduction of invasive species in dryland regions
- Gardeners are likely to plant new species as soon as rising temperatures allow, favoring the assisted migration of introduced species relative to non-horticultural natives
- Emerging trade supply coupled with shifting demand due to climate change makes the US susceptible to a new array of invasive plants

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