

GLOBAL WARMING FAVORS INVASIVE SPECIES

Elements of global change include change in atmospheric composition, greenhouse-gas-driven climate change, increasing nitrogen deposition, and changing patterns of land use that fragment habitats and alter disturbance regimes (Dukes, J. S., and H. A. Mooney. 1999. Does global change increase the success of biological invaders? *Tree* 14[4]:135–39). These elements can affect species distribution and resource dynamics in terrestrial and aquatic ecosystems. They can favor groups of species that share certain physiological or life history traits. New evidence suggests that many nonnative invasive species are favored by conditions from recent global change. An increase in the abundance of such species may alter basic ecosystem properties. For example, many invasive nonnative plants such as cheatgrass, kudzu, and Japanese honeysuckle are favored by elevated levels of CO₂. The stimulated plant growth from elevated levels of CO₂ may increase fuel loading and under the right conditions increase the frequency and severity of fires. Information from experimental studies suggests that rising CO₂ levels may slow the process of succession in grasslands and thereby increase the dominance of nonnative species in many ecosystems. Most plants increase their water-use efficiency if grown in CO₂-enriched environments. If under such circumstances the rate at which plants transpire decreases, the soil beneath plants dries out more slowly and where plant growth is limited by water, species

that can take advantage of the extra moisture may eventually prevail. The abundance of a native species, Hayfield tarweed, in California seems to have increased from such circumstance. But so did seemingly the invasive yellow starthistle. The effects of elevated CO₂ levels are however not readily predictable because they may depend on other factors such as local resource availability, photosynthetic pathways of species, and competition by other species.

Global warming from greenhouse gases is expected to be most intense in winter at high northern latitudes. Changes in global temperatures are also expected to change precipitation regimes. Again, experiments revealed that under some circumstances a short-term increase in water availability can affect the long-term establishment of nonnative species even after treatments are discontinued. Long-term observations revealed that an increase in annual precipitation in arid and semiarid regions of western North America could increase the dominance of invasive nonnative grasses. On the other hand, global warming may decrease or shift the range of some nonnative species.

Observations suggest that climate change will affect interactions among native and nonnative animal species. For example, higher temperatures will favor the Argentine ant to the detriment of native ant species and will decrease habitat for cold, cool, and even some warm-water species. Warm-water nonnative organisms that may expand their ranges are the cane toad, largemouth bass, green sunfish, and bluegill. Generalists that unlike specialists do not depend on specific conditions will adjust better to changing environmental conditions. Invasive species are usually generalists.

Nitrogenous compounds that are released into the atmosphere by fossil fuel combustion, fertilization of agricultural fields, and other human activities return to the surface in precipitation and dry deposition and fertilize a large and growing portion of the terrestrial biosphere. Such nitrogen deposition disadvantages slow-growing native plants that are adapted to nutrient-poor soils but favors faster-growing plants such as grasses. The increase of nitrogen deposition has already altered the species composition of heathlands and chalk grasslands in the Netherlands. Nitrogen deposition may also have already allowed the invasion of California coastal prairie by introduced annual grasses.

Research is required to better predict the effects of global climate change on plants and animals. Experiments must be designed that simultaneously reveal the effects of global change on specific nonnative species and answer general questions about invasion biology.