

Rising Atmospheric Carbon Dioxide and the Success of Invasive Plant Species

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1. What is an invasive plant species?

A plant species, previously unknown to a geographic area, whose introduction results in widespread economic or environmental damage.



Kudzu, an example of an invasive species. It is prevalent throughout the South-eastern United States.

2. How much damage?

Economic cost: Approximately 13 billion per year.

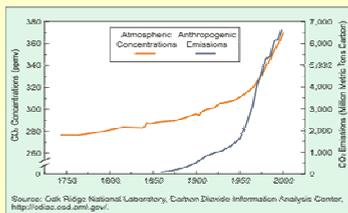
Environmental cost: Impacts species diversity. The Bureau of Land Management estimates that 2300 acres per day are lost to invasive species.



Yellow star thistle and Canadian thistle, two examples of invasive species dominating large areas of rangeland and pasture land in the U.S. during the 1980s and 90s.

3. Why should rising atmospheric carbon dioxide affect invasive plants?

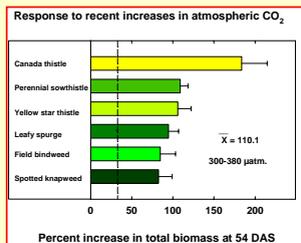
Carbon dioxide represents the sole source of carbon for photosynthesis. Although the rise in carbon dioxide has been shown to stimulate the growth of numerous crop species, almost nothing is known regarding its impact on invasive plants.



Background atmospheric carbon dioxide as determined from the Mauna Loa observatory. Current levels are between 375 and 380 ppm. Carbon dioxide has risen 20% since 1960. Carbon dioxide stimulates plant photosynthesis and growth by supplying additional carbon for carbohydrate production.

4. Carbon dioxide and invasive species in managed systems

Six invasive plants, ranked among the worst for N. America farms, were grown at 300 and 380 ppm carbon dioxide.



The increase in invasive plant biomass was significantly higher when compared to all other species (dashed vertical line in graph) at 54 days after sowing (DAS). The change in carbon dioxide (300-380 ppm) represents the increase during the 20th century. These data suggest a strong response to rising carbon dioxide among invasive plants.

5. Carbon Dioxide and unmanaged (natural) systems: Cheat-grass and fire ecology.



Cheat-grass: *Bromus tectorum*

Dries 4-6 weeks earlier than perennials.

Develops dense stands

Grows in 6-22 inch precipitation area (high fire)

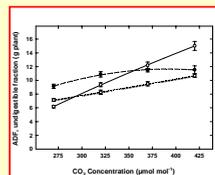
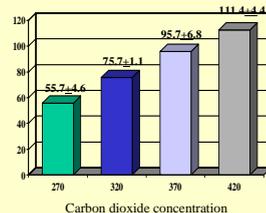
Readily ignites.



Impact: Elimination of woody non fire adapted perennials, large monocultures of cheatgrass and reductions in species diversity.

6. Carbon dioxide and cheat-grass (cont.)

Examined 3 different populations collected in the Sierra Nevada range to small, recent changes in atmospheric carbon dioxide.



Data on left indicate significant increases in average plant biomass (g per Plant ± SE). Data on right indicate qualitative changes in decomposition. Both figures indicate that recent increases in carbon dioxide have affected the biomass and retention (longevity) of cheat grass

7. Can rising carbon dioxide select for invasive species within communities?

Survey of existing literature.

System	Invasive Species	CO ₂ Favors?	Reference
Desert	<i>Bromus madriensis</i>	Yes	Smith et al. 2000, <i>Nature</i> 408:79
Prairie	<i>Prosopis glandulosa</i>	Yes	Polley et al. 1994, <i>Ecology</i> 75:976
Woods	<i>Prunus laurocerasus</i>	Yes	Hattenschwiler & Korner 2003 <i>Funct. Ecology</i> 17:778.

As we have seen, individual invasive plants may have a strong response to rising carbon dioxide; a survey of literature studies also suggests that the response may be strong enough to select for such species among all other plant species present in a community.

8. Why not control these invasive plants chemically?

Examined Canada thistle at ambient and elevated carbon dioxide with and without application of recommended amounts of an herbicide, Round-up.



Plants in background were pulled by hand, and were not eliminated. Plants in foreground were sprayed with recommended dosage of Round-up. At ambient carbon dioxide, control of Canada thistle was ~85%, but control at the higher carbon dioxide concentration was zero. Initial data suggest that the greater tolerance was due to a carbon dioxide induced dilution effect related to greater root growth.

9. Some preliminary conclusions.

1. Invasive plants result in significant economic and ecological damage.
2. Data for invasive plants in both managed and unmanaged systems indicate a larger than expected growth increase to both projected and recent increases in carbon dioxide. This suggests that rising carbon dioxide may be a factor in the successful establishment of invasives.
3. Initial data indicate that rising carbon dioxide may affect the chemical control of some invasives.