The Impact Of The Invasive Plant *Delairea odorata* On Carbon Cycling

Ronnette Biancah Naungayan, Jaimelynn B. Alvarez, and Christine Case

Biology Department, Skyline College, San Bruno CA

Abstract

Cape Ivy (*Delairea odorata*) is an invasive plant from South Africa, introduced to the U.S. in the mid-1800s. The vine out-competes native species and has created large monocultures along California's central coast, replacing native coastal sage scrub. The purpose of our project is to assess the effect of *Delairea* on carbon cycling. Above-ground biomass (AGB) can be used to estimate net primary productivity and nutrient cycling potential of an ecosystem. Dead and living vegetation were collected from randomized 0.25-m^2 areas in test and control plots. AGB and moisture content were determined by comparing wet and dry weights. A non-destructive calculation based on diameter was used to estimate AGB in large shrubs and trees. Our preliminary results show that *Delairea* and coastal scrub areas have similar AGB (84.6 g/m^2 ± 1.8). However, coastal scrub has a (130%) higher carbon stock stored in dead AGB. We are measuring soil respiration in the study plots to assess carbon mineralization. Results thus far suggest that *Delairea* abundance may have pervasive effects. The high carbon stock in coastal scrub suggests it may help remove CO_2 from the atmosphere. Therefore, the low carbon stock in *Delariea* represents a change from negative CO_2 flux as well as loss of habitat and nutrition for soil animals. Better understanding of the impacts of *Delairea* will help develop effective restoration measures.

Aim

The purpose of this project is to assess the effect of *Delairea* on carbon cycling.

Background

- Cape Ivy (*Delairea odorata)* was introduced to the U.S. as an ornamental vine from South Africa, and has escaped. *Delairea* invasion is associated with loss of species diversity (1).
- *Delairea* is an herbaceous vine which climbs over most other vegetation forming a solid cover that blocks light (4).
- Although *Delairea* is a perennial that grows during the spring, it experiences die-back during the dry summer and fall (4).
- It out-competes other species and forms monocultures in three different biotic communities on the west coast of the U.S.: coastal scrub, willow riparian and alder riparian (1).
- Plants act as a sink for CO_2 through photosynthesis. The carbon is sequestered in above-ground biomass (AGB) in living plants and in leaf litter and deadwood. Native coastal scrub plants are drought-adapted woody perennials, which increases soil carbon sequestration. Respiration by soil microorganisms (soil respiration) is limited by availability of organic substrates (3, 5, 6).
- Soil respiration uses organic matter and decreases sequestered carbon (2).
- We will determine the effects of *Delairea* invasion on carbon cycling by studying carbon flux between soil respiration and AGB.

Methods

Study Sites

- Study sites were in the Golden Gate National Recreation Area (GGNRA) adjacent to Skyline College. All sites were on west-facing hillside.
  - Test site: *Delairea* monoculture (**Figure 1**).
  - Control sites: Native coastal sage scrub and *Eucalyptus globulus* stand.
  - The *Eucalyptus* control is used because *Delairea* is growing under *Eucalyptus* to 17.50 meters.
  - *Eucalyptus* allelopathy has been well-documented (7) so we selected another control adjacent to the GGNRA with established *Eucalyptus* trees and no understory.
- Dead and live plant material and soil were collected from a randomized plot at each site. Randomization was done using www.random.org.

Above-Ground Biomass

1. Collected and separated plant material into live and dead fractions.
2. Weighed live and dead biomass.
3. Oven dried samples for 72-96 hr at 40ºC.
4. Reweighed samples until they were a constant weight.

Soil Respiration

1. Collected soil samples.
2. A steel cylinder (25.4 × 152.4 mm) was driven 25.4 mm into the soil, providing a finite soil area for CO_2 sampling.
3. A Vernier CO_2 Sensor was inserted into the cylinder and CO_2 emission was measured using Vernier LoggerPro software.

Figure 1. *Delairea* study site. The test area has no other herbaceous plants and is undisturbed by humans. *Delairea* is growing under *Eucalyptus globulus* and extending 17.50 meters from the *Eucalyptus* stand.

Results

- *Delairea* AGB had the greatest moisture content, three times higher than coastal sage scrub (**Figure 2**).
- The *Eucalyptus* control area has more AGB that of the other sites. The woody plants (*Eucalyptus* and coastal scrub) have more AGB than *Delairea*, which has less dead AGB (**Figure 3**).
- *Delairea* stored less carbon than the woody plants (**Figure 4**).
- Return of CO_2 to the atmosphere is higher in soils under invasive species than native coastal scrub (**Figure 5**).

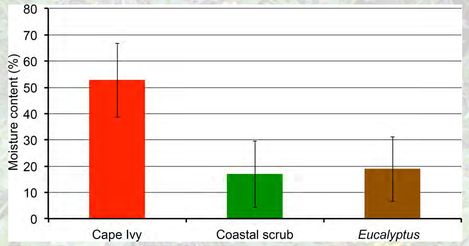

Figure 2. AGB Moisture content at the study sites. *Delairea* showing the highest percentage, followed by *Eucalyptus* and coastal sage scrub. Error bars = 1 S.D.

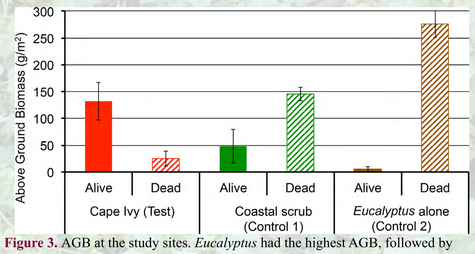

Figure 3. AGB at the study sites. *Eucalyptus* had the highest AGB, followed by coastal sage scrub and *Delairea*. Error bars = 1 S.D.

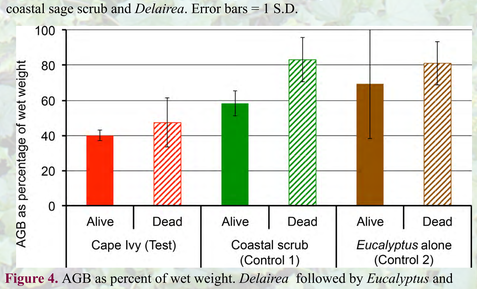

Figure 4. AGB as percent of wet weight. *Delairea* followed by *Eucalyptus* and coastal sage scrub. Error bars = 1 S.D.

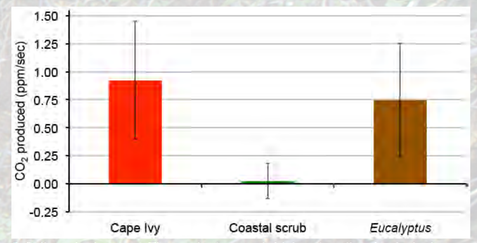

Figure 5. Soil respiration rates. The respiration rate is highest in soil under the herbaceous invasive *Delairea*. Error bars = 1 S.D.

Discussion & Conclusion

- Abiotic chemicals secreted by *Eucalyptus* roots are not a factor in determining the effect of *Delairea* on carbon cycling.
- The high moisture maintained by *Delairea* may inhibit growth of drought-adapted native species.
- AGB is sequestered carbon; therefore, loss of AGB equals the loss of carbon stocks, which increases the global negative effects of climate change. *Delairea* uses CO_2 to grow, but this CO_2 is immediately returned to the atmosphere.
- *Eucalyptus* is an established invasive, however, it stores more carbon than *Delairea*.
- *Delairea* not only reduces biodiversity, it does not contribute to CO_2 removal from the atmosphere.

Literature Cited

(1) Alvarez, M.E., and H. Cushman. "Community-level consequences of a plant invasion: Effects on three habitats in coastal California." *Ecological Applications* 12.5: 1434-1444. 2002

(2) Andrews, J., and W. H. Schlesinger. "Soil respiration and the global carbon cycle." *Biogeochemistry, Controls on Soil Respiration: Implications for Climate Change* 48.1: 7-22. 2002.

(3) "Carbon Cycle." *Carbon Cycle*. N.p., n.d. Accessed. 9 July 2013. < dilu.bol.ucla.edu >.

(4) "Invasive Plants of California's Wildland - *Delairea odorata.*" California Invasive Plant Council (Cal-IPC). 2006-2013. Accessed. 4 July 2013. < www.cal-ipc.org >

(5) Lai, R. "Forest soils and carbon sequestration." *Forest Ecology and Management* 220.1-3: 242–258. 2005.

(6) Zak, Donald R., et al. "Plant production and soil microorganisms in late-successional ecosystems: a continental-scale study." *Ecology* 75: 2333–2347. 1994.

(7) Zhang, D, et al. "Potential allelopathic effect of *Eucalyptus grandis* across a range of plantation ages." *Ecological Research* 25.1 (2010): 13-23.

Acknowledgements

- The authors wish to thank Dr. Christine Case, our mentor, for all the support, patience, guidance, and her extensive knowledge that abled us to present this research and to have a wonderful learning experience.
- Kylin Johnson, Skyline College's Biology Laboratory Technician, for providing the materials used in our research.
- Stephen Fredricks and Skyline College's MESA for their support and for giving us the opportunity to attend SACNAS National Conference.