CIPM Research Grants Final Report (Awarded 2006)

Title - Developing the ecological basis for biological control of Cape ivy (*Delairea odorata*) in southern California

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Proposal

A biological control program against Cape ivy (*Delairea odorata*) is nearing the point where testing can be take place under field conditions outside of quarantine. Test sites proposed by USDA are in northern California, but substantial expansion of Cape ivy in southern California suggest that this weed management tool should also be applied in other, ecologically dissimilar regions. In order to implement any modern weed biocontrol program, it is essential to document the status and nature of current weed infestations to justify the introductions, and to develop baseline information in order to assess whether introductions are ultimately successful in achieving goals of reducing pest plant abundance and promoting recovery of associated, native vegetation. We will provide such baseline information on the distribution of Cape ivy in coastal southern California, the ecosystems and native plants that are affected by its infestation, and will conduct experiments to quantify these impacts. We will also prepare sites for research introductions of two biocontrol agents into field cages, and assess population dynamics of the insects and effects on host plants once agents are approved for release by APHIS.

During this project, our objectives have been on documenting the distribution of Cape ivy in Santa Barbara and Ventura Counties, and its impacts to native 'host' plants', along with developing field baseline data for subsequent testing of biocontrol agents. Another objective was to compare growth traits of Cape ivy with native vines in regional ecosystems. This comparison was intended to characterize ecophysiological traits that may make Cape ivy a successful invader, and to determine whether its growth form and behavior may cause it to be more detrimental to riparian vegetation than native, co-occurring vines.

Results

Cape ivy has been documented in at least 32 locations in Santa Barbara County, and another 12+ sites in Ventura County; we are continuing these surveys, including characterization of seasonal phenology for comparison with northern populations (it flowers somewhat earlier and over a longer period in southern California, primarily

November through May). An unusually severe frost interrupted seasonal measurements, causing major dieback during the most active growth period but without mortality to the vines themselves. Commonly infected species (Cape ivy within under canopy of host plants) included both riparian and upland species [*Quercus agrifolia, Hetermomeles arbutifolia, Salix exigua, S. laevigata, Ribes speciosum, Rosa spp., Salvia mellifera, Juglans californica, Alnus rhombifolia, Sambucus mexicana, Rubus ursinus, Artemisia douglasiana*]; host data are being compiled quantitatively during the 2007-08 growth season. Cape ivy was associated with a reduction in the species richness and diversity in our primary study area (Fig. 1, 2).

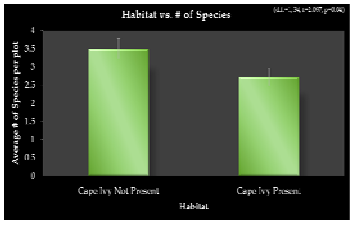

Fig. 1.Species richness.

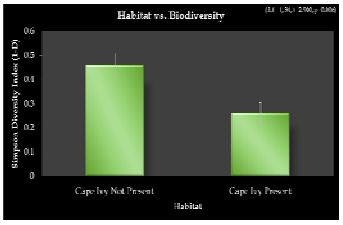

Fig. 2. Species diversity.

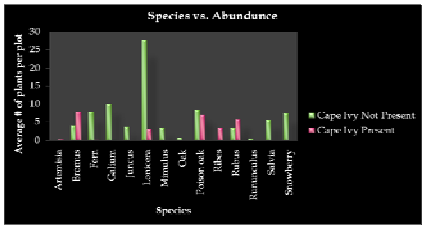

Fig. 3. Relative abundance.

Several native species appeared to be displaced or strongly inhibited by Cape ivy, whereas those not as greatly affected were often other non-native taxa [e.g. *Bromus* sp., Himalayan blackberry (*Rubus discolor*)] or other vine-like plants [poison oak (*Toxicodendron diversiloba*), *Lonicera hispidula*] (Fig 3). Natives comprised a much larger portion of the assemblage in habitats without Cape ivy (Fig. 4). Cape ivy reduces

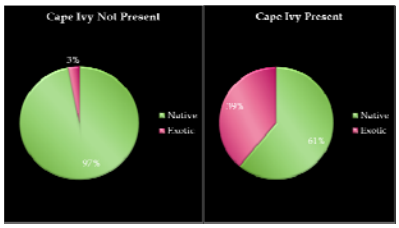

Fig. 4. Proportion non-indigenous.

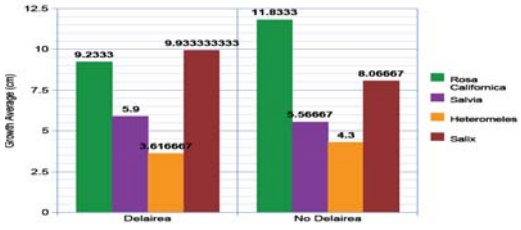

Fig. 5. Experimental combinations.

light availability to understory plants (58% vs. 88% of open light), and greatly reduces open space, with bare ground comprising 40% in ivy-free locations vs. <5% bare space in infested sites.

An experimental garden plot was established in which four native species were installed with vs. without Cape ivy, with two replicate plants in treatments with Cape ivy so that, once biocontrol agents are approved for field testing, we will monitor impacts to the target and recovery. Currently plants are establishing but no effects of infestation are yet apparent (Fig. 5). These include two typical riparian plants (*Rosa californica, Salix laevigata)* and two more commonly found in upland sites (*Heteromeles arbutifolia, Salvia mellifera*). The latter two represent chaparral areas infested by Cape ivy but well away from riparian conditions, and presumably promoted by coastal fog on Pacific-facing slopes. Fog studies have also been initiated to verify how moisture conditions may allow these typically moisture-dependent plants to flourish in surprisingly arid chaparral.

Ecophysiological studies indicated that Cape ivy (DEOD) has a lower photosynthetic rate when compared to native vines (Fig. 6; CO_2 produced per unit surface area). It is, however, more efficient in its use of available water (Fig. 7; C fixed per H_2O

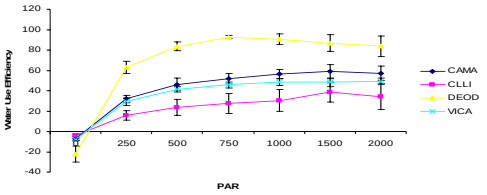

Fig. 6. Water use efficiency.

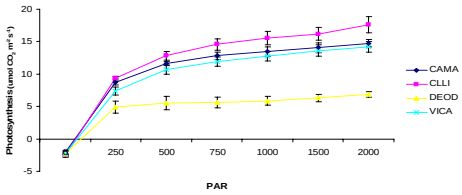

Fig. 7. Photosynthetic rates.

used), suggesting a mechanism by which it may have advantage over associated native vines. Its uptake and allocation of N is intermediate (Fig. 8), which is surprising for a plant of high water content (Fig. 9).

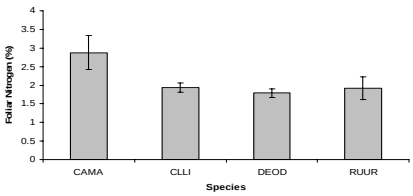

Fig. 7. Foliar nitrogen content.

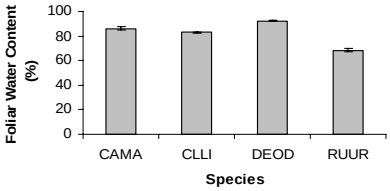

Fig. 8 Leaf water content.

Discussion

Results to-date suggest that the presence of Cape ivy is associated with a decrease in biodiversity which is most likely the result of decreased light availability and reduced bare soil. Cape ivy yields a nearly year-long dense canopy that may be a major factor in reducing growth and/or establishment of native understory plants. It also produces a dense mat at the ground surface which further inhibits other plant species, perhaps via both physical and chemical mechanisms that are being explored. The vine-like growth form of Cape ivy may facilitate invasion by other non-natives, particularly shade tolerant taxa (e.g. *Vinca minor, Tropaeolum majus, Piptatherum miliaceum*, etc), as Cape ivy-infested sites are dominated by non-native species.

While Cape ivy is not the only vine present in California plant communities, our work shows that it differs considerably from native vines in its allocation of resources, and phenology, as well as its ability to dominate in and under canopy areas during winter/spring when native vines are still in their winter-deciduous condition. In California's Mediterranean climate there may be an advantage for species like Cape ivy, which are able to produce more plant tissue with reduced water requirements. The growth patterns and phenology of Cape ivy also lends itself to continual year-round growth while many native vines have difficulties dealing with summer drought and/or become dormant (usually dropping their leaves) throughout the winter months. Thus many native vine species are limited to a small period of growth spanning from late spring into early summer. Future studies will continue to assess relative growth and metabolic capacities of Cape ivy as compared with native vines, and we are now establishing a collaborative research arrangement to study how growth form facilitates invasive capacity. In collaboration with Dr. K. Sankaran in India, we plan to expand this work to include another Asteraceaus highly invasive vine, *Mikania micrantha*, in the South Pacific and Indian region (also a target for biocontrol, but native to semi-tropical areas of North America).

The baseline experimental sites are set up so that we can use both 'natural' field populations (2 sites) and the common garden plot to evaluate biocontrol agent efficacy

under field conditions, along with 'parasitized' native host plants in both field and common garden conditions. Such trials, unfortunately, await approval from APHIS, and there is no clear indication of when the enabling permits will be available.

Publications

No publications as yet, but several presentations have been given, or are scheduled:
Ecology and control of Cape ivy; So. Calif. Wetlands program; May 2007; T. Dudley
Biocontrol of Cape ivy; Ventura Co. Watershed Council; April 2007; T. Dudley
Ecology and control of Cape ivy; Rincon Creek Council; March 2007; T. Dudley
Ecological role of Cape ivy in southern California riparian ecosystems; Calif. Invasive Plant Council; October 2007; N. Molinari, K. Seward, F. Burton & T. Dudley
Ecophysiology of invasive Cape ivy; Senior Thesis & presentation; F. Burton

Products

1. Toro Canyon/SBBG: This CIPM grant was key to developing a project funded by the Wetlands Recovery Program to conduct Cape ivy control, including biocontrol (if available in the timeframe of the grant), for >10 acres of infested riparian habitat at a site recently donated to the Santa Barbara Botanic Garden.
2. Collaborative study of *Delairea* and *Mikania* – as noted earlier, we are developing a comparative study of these two invasive vines of global concern, intended as a collaboration between Dr. Sankaran of the Kerala Forest Research Inst., India.
3. Public presentations, as noted above.
4. Memo's of Understanding with 8 regional natural area managers (San Luis Obispo, Santa Barbara and Ventura Co.) to use infestations at their properties or management areas for field testing of Cape icy biocontrol agents, in co-ordination with USDA-ARS researchers, specifically Dr. Joe Balciunas

Long-Term Goals and Continued Progress of Research

Parallel goals are to complete field testing and regional implementation of Cape ivy biocontrol and riparian restoration, and to foster public understanding and acceptance of biocontrol as a safe and cost-effective tool for managing invasive plants, and specifically invasive vines, in natural areas.

Benefits of Seed Money

As noted above, these seed funds have been critical to initiating diverse ecological studies of Cape ivy biology and impacts in this region, and to fostering co-operation on a national biological control program for Cape ivy, as well as to provide the basis for developing an international research program evaluating strategies that facilitate dominance of invasive vines.

Advancing This Research

As noted above, we now have a major program underway that will lead to critical field testing of biocontrol agents in the region, as well as to undertake a large-scale invasive plant control program on the property of one of the leading botanical institutions in the country (Santa Barbara Botanic Garden). We have in place a program to involve students from the UCSB Center for Biodiversity & Ecological Restoration, as well as

from Cate School (a preparatory academy near the Garden site) in basic and applied research concerning impacts and control of invasive plants (particularly Cape ivy). This has a public outreach component, as already announced in the local newspaper, so that there is an exciting intergration of Research, Management, Outreach and Education.

UCSB student undertaking research as part of the immediate CIPM project are:
Nicole Molinari, graduate student jointly advised by T. Dudley & C. D'Antonio
Frankie Burton, graduate in Environmental Studies
Katherine Seward, undergraduate research asst., College of Creative Studies, UCSB
Naoyoshi Tamagawa, undergraduate research asst., College of Creative Studies, UCSB

Website – http://rivrlab.msi.ucsb.edu/

BUDGET

Category/Subject	**CIPM**	**In-Kind**
Salary/Labor		
T. Dudley	$500	$1775
N. Molinari	800	880
K. Seward	800	(course credit)
D. Chang		
Total Salary	$2,100	$2,655
Supplies		
Clippers, stakes, meter tapes, screen, flagging, plants, notebooks, media etc.	200	1080
Travel		
Personal vehicle use: 1,035 mi. @ .445/mi	200	260
Total	**$2,500**	**$3,995**