Seed bank limitation, management and overcoming cycles of exotic plants species hierarchical shifts

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Order of Topic Emergence

- Restoration and seedbanks
- Introduction of the Orange County Invasive Plant Management Project
- General seedbank NROC seedbank results
- Vegetation and seedbank relationships
- Environment, management and land use history
- Integrating seedbanks into restoration and management
Restorations Have Multiple Potential Trajectories

Modified from Larios in prep.
Soil Seed Banks

• A long history of invasion has the potential to lead to native seed bank depletion over time (Bossuyt & Hermy 2003)

• Prolific seed production coupled with high dominance could lead to an imbalanced seed bank.

![Graph showing average seedlings per m² for Grassland and Shrubland.](Modified from Cox and Allen 2008)
Orange County Invasive Plant Management Project

- Are native seedbanks of Orange County reserves intact or seed limited?
- How does the vegetative plant community relate to the seedbank?
- Are there environmental, land history or management variables associated with seedbank composition and microsite availability?
- How can seedbanks be integrated into management and restoration planning?
One hundred and thirty one sites in Orange County were surveyed spring of 2011

- Plant species percent cover collected from quadrats along five 10m transects.
- Soils were collected at 5cm depth, air dried and sieved.
- Composited samples at site level were mixed with sand (40%).
- Soils were spread into trays 2.5cm deep and maintained at field capacity
- Allowed to go dormant, smoke treated soils and repeated watering
Seedbank Species Composition

- 36 families
- 95 Species
- 45% Exotic species
  - (Juncus bufonius 20%)
- 54% Native species
- 1% unknown Species

- 24% Asteraceae
- 9% Poaceae
- 7% Fabaceae
- Aizoaceae
- Lamiaceae
- Phrymaceae
- Cactaceae
Exotic species dominated seedbanks at all management levels.

Native forb seedbank highest in intermediate (p = 0.053)
Native shrubs highest seedbank in active (p = .0003)
The Native Seedbank Correlates with Vegetation

- 3% of species in seedbank only
- 47% of species in vegetation only

Native succulents were absent from the seedbank.

Native Forbs

Seedbank Relative Emergence

<table>
<thead>
<tr>
<th>Relative Aboveground Percent Cover</th>
<th>0.00</th>
<th>0.05</th>
<th>0.10</th>
<th>0.15</th>
<th>0.20</th>
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</table>

Native Shrubs

- Artemisia californica

Artuemisia californica is the most abundant native species, only four other shrub species have abundance close to A. californica.
The Exotic Seedbank Correlated with Vegetation Better than Native seedbank (All of the most abundant exotic species)

3% only seedbank
11 % only above ground (less common species)

• Transient seedbanks
  – *Sonchus asper*
  – *Brachypodium distachyon*
  – *Bromus diandrus*

• Persistent seedbanks
  – *Erodium* spp

### Graph 1
- **Y-axis**: Relative Aboveground Percent Cover
- **X-axis**: Seedbank Relative Emergence
- Lines for:
  - Brachypodium distachyon
  - Bromus diandrus
  - Vulpia myuros

### Graph 2
- **Y-axis**: Relative Aboveground Percent Cover
- **X-axis**: Seedbank Relative Emergence
- Lines for:
  - Erodium botrys and *E. brachypodium*
  - *Erodium cicutarium*
  - Melilotus indicus
  - Anagalis arvensis
  - *Sonchus asper*
  - Mustards
Seedbank and Vegetation Related Similarly to Environment

Seedbank

Vegetation
Land Use History Effects on the Seedbank

Sites having experienced:
- Agriculture had larger native forb seedbanks.
- Mechanical disturbance had larger exotic forb seedbanks.
- Fire had smaller exotic grass seedbanks.
- Sites with more fires had larger exotic forb seedbanks and smaller native forb seedbanks.
Management Effects on Seedbanks

Sites experiencing:

- Inoculation with mycorrhizae had larger native grass seedbanks.

- Topsoil, irrigation and/or weeding had larger native shrub seedbanks.
Exploit difference in exotic and native species phenology to control the exotic species seedbank

Management strategies

- Grow kill
- Selective weeding
- Patch management
Native shrub percent cover significantly increased with native seed and/or plant input.

Habitats that should support native shrubs only saw increased shrub cover when seed/plants were added.
Not all Seeding Methods are Equal

- Native shrub cover was greater and seedbanks were larger in sites with hydro or broadcast seeding.
- Native grass seedbanks were larger in sites that experienced imprint seeding.
Conclusions

- While diverse, NROC seedbanks are exotic dominant regardless of management level.
- Native shrub and grass seedbanks were small or not present at most management levels.
- Native species are likely seed and microsite limited.
Restoration Implications

- Management of the seedbank will be the most important strategy for restoration.
  - Controlling exotic seed input.
    - Mowing, Fire, Weeding...
    - Volunteers need awareness of tracking seed
  - Determination of current seedbank to guide management decisions (small scale seedbank experiments)
  - Re-establishing native seedbanks where depleted
  - Increasing microsites that facilitate native species seed persistence and seedling establishment.
    - Are there conditions or disturbances that lead to seedbank production and seedlings that establish as adults?
    - Control weeds and increase heterogeneity in the landscape.
Restoration Implications

• Site preparation is essential
  – Trade immediate results for long-term and higher levels of success.
  – Exploit differences in phenology of natives and exotics (grow kill cycles).

• Creation of establishment microsites
  – Important to identify where seedbanks are persisting and where they are not.
  – Seedbank = potential for future community
  – Vegetation only = risk to community loss to stochastic events (fire)

• Proper management methods need to be determined for different species and applied in the proper environmental conditions.
  – Native shrub and forb vegetation and seedbanks benefit from hydro and broadcast seeding, whereas native grass vegetation and seedbanks benefit from imprint seeding and mycorrhizal inoculation.
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Species Relative Contribution to the Seedbank of NROC

Brassica nigra/Hirschfeildia incanta
Juncus bufonius
Crassula connate
Bromus rubens
Festuca myuros
Lolium multiflorum/perenne
Anagallis arvensis
Medicago polymorpha