Determinants Of Plant Species Assemblages In The Californian Marsh Plain: Implications For Restoration Of Ecosystem Function

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Tidal Linkage, Tijuana Estuary, CA
• **Topographic heterogeneity** (Zedler et al. 1999)
• **Tidal inundation** (Mahall & Park, 1967)
• **Elevation** (Snow and Vince, 1984)
• **Salinity** (Callaway et al. 1990)

• **Seed availability** (Hopkins and Parker, 1984)
• **Physical disturbance** (Tolley and Christian, 1999)
• **Biotic interactions** (Callaway and Pennings 2000)
Californian salt marsh plain

- Easily sampled (<1 m height)
- No invasive plant species
- Composition constant in time
- Small species pool

Oneonta Slough, CA
Marsh plain species

*Batis maritima*

*Frankenia salina*

*Jaumea carnosa*

*Limonium californicum*

*Salicornia virginica*

*Salicornia bigelovii*

*Suaeda esteroa*

*Triglochin concinna*
General objective

Investigate the factors that determine composition and richness of marsh plain plant assemblages
Topographic heterogeneity
Species richness is greater < 1m from creek margins (Zedler et al. 1999)

Bahía de San Quintín, México
Volcano Marsh,
Bahía de San Quintín. México
~5000 hectares of wetland
Sampling scales (m$^2$)

- 0.1
- 0.25
- 1
- 2.5
- 10

$n = 715$
Do assemblages differ in cells ± creeks?

Plot

Where ○ = Different species
Assemblages differed between cells ± creeks

Plot

- 188 unique assemblages
- 14% overlap cells with and without creeks

Where 〇 = Different species
# Frequency of common assemblages

<table>
<thead>
<tr>
<th>Species</th>
<th>Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batis</td>
<td>Creeks: 14, No creeks: 12</td>
</tr>
<tr>
<td>Frankenia</td>
<td>Creeks: 9, No creeks: 21</td>
</tr>
<tr>
<td>Jaumea</td>
<td>Creeks: 16, No creeks: 0</td>
</tr>
<tr>
<td>Limonium</td>
<td>Creeks: 14, No creeks: 23</td>
</tr>
<tr>
<td>Salicornia</td>
<td>Creeks: 9, No creeks: 21</td>
</tr>
<tr>
<td>S. bigelovii</td>
<td>Creeks: 14, No creeks: 23</td>
</tr>
<tr>
<td>Salicornia sp.</td>
<td>Creeks: 16, No creeks: 0</td>
</tr>
<tr>
<td>Triglochin</td>
<td>Creeks: 14, No creeks: 23</td>
</tr>
<tr>
<td>Suaeda</td>
<td>Creeks: 9, No creeks: 21</td>
</tr>
</tbody>
</table>
Seed availability
Planted

Friendship Marsh, Tijuana Estuary. May 2002
Friendship Marsh, Tijuana Estuary. May 2003
Salt marsh seeds:

- Tidally transported (Huiskes et al. 1995)
- Travel long distances, for long time (Koutstaal et al. 1987)
- Several species are tidally transported (Bakker et al. 2002)
Outgoing tide

Emergent seedlings

37 500
37 400

Outgoing tide

Incoming tide

Emergent seedlings

0
100
200
300
400
500

Emergent seedlings

2 200
2 100

Incoming tide

Salicornia virginica
Marsh plain
Non-marsh plain

Reference

Restored
Salicornia virginica

Seedling density

Seedlings m⁻³

Time

2000
2001
2002
Biotic interactions
Triglochin concinna

- Low biomass
- Simple canopy
- High tissue N
- Sparse cover, frequent

Negative relation with Salicornia virginica cover
Bahía San Quintin. 0.1 m² plots

\[ r = 0.26 \]
\[ F = 15.48, P < 0.001 \]
<table>
<thead>
<tr>
<th></th>
<th>+ Triglochin</th>
<th>- Triglochin</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Biomass</strong></td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td><strong>Light penetration</strong></td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td><strong>Seedling recruitment</strong></td>
<td>S. virginica, S. bigelovii, S. esteroa</td>
<td>minimal</td>
</tr>
<tr>
<td><strong>Species richness</strong></td>
<td>high</td>
<td>low</td>
</tr>
</tbody>
</table>

Phenology from Sullivan and Noe (2001)
Tukey HSD, $P = 0.05$
Nitrogen stable isotopes

<table>
<thead>
<tr>
<th>Isotopes</th>
<th>Abundance (Air)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{14}\text{N}$</td>
<td>99.636</td>
</tr>
<tr>
<td>$^{15}\text{N}$</td>
<td>0.371</td>
</tr>
</tbody>
</table>

$\delta^{15}\text{N} = \frac{^{15}\text{N} / ^{14}\text{N} \text{ sample}}{^{15}\text{N} / ^{14}\text{N} \text{ standard}} - 1 \times 1000$

Higher $\delta^{15}\text{N} =$ Higher abundance $^{15}\text{N}$
Natural $^{15}\text{N}$ abundance marsh plants

Plant age $\leq$ 3 years

Includes all marsh plain species except S. *bigelovii*
**T. concinna**
- Low biomass
- Simple canopy
- N accumulator
- Winter active

**S. virginica**
- High biomass
- Complex canopy
- Strong N competitor
- Summer active

Both: succulent, clonal, perennial
Hypothesis: When N was limiting and as the interaction time increased *Triglochin* would dominate and *Salicornia* biomass would be reduced
Water level treatments

![Diagram showing water height changes over time with different levels of water treatment: High, Medium, and Low. The graph indicates periods of wet and dry soil surface.]
1-year experiment

Aboveground

Salicornia

Triglochin

Biomass (g pot-1)

Water level

Low | Medium | High

Low | Medium | High
1-year experiment

**Belowground**

*Salicornia*

![Bar chart showing biomass (g pot⁻¹) for *Salicornia* at different water levels: Low, Medium, High. The chart displays a clear increase in biomass from low to high water levels.]

*Triglochin*

![Bar chart showing biomass (g pot⁻¹) for *Triglochin* at different water levels: Low, Medium, High. The chart shows a decrease in biomass from low to high water levels.]

**Water level**

- Low
- Medium
- High
Root: shoot ratio

Salicornia Triglochin

Tissue N content (mg g⁻¹)

Salicornia Triglochin

N content

$P < 0.001$

$P < 0.001$

$P < 0.001$

$P < 0.001$
Management recommendations

• Incorporate tidal creeks into restoration designs

• Plant multispecies assemblages

• Emphasize non-tidally transported species - Avoid Salicornia virginica

• Plant Triglochin to increase N retention

• Consider landscape position and surrounding vegetation
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