THE EFFECT OF SOIL SALINITY AND FLOODING ON THE GROWTH OF *CARPOBROTUS EDULIS* (L.) N.B. BR.: IMPLICATIONS FOR ITS SPREAD INTO THE BALLONA WETLANDS.

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INTRODUCTION

The approximately 84-hectare Ballona Wetlands, located south of Marina del Rey and west of Playa Vista (Fig. 1), is the last remaining, large, coastal wetlands in Los Angeles county. Ballona Wetlands is surrounded by an urban environment and has lost much of it's connectivity with other natural habitats (Zedler, 2001). The Ballona Creek Flood Control Channel was built in 1934. It allows freshwater to drain into the sea, but the one-way tidal flap gates initially placed in the channel shortly after its construction have reduced the influence of tides in the Ballona Wetlands. The soils are consequently drier (Zedler, 2001) and although tidal zonation is still evident, there are fewer zones by comparison to other coastal wetlands. Many exotic plant species occur in this wetland, including the invasive *Carpobrotus edulis*. In the Ballona Wetlands, *C.edulis* extends into the upper salt grass (*Distichlis spicata*) zone(Fig. 2), but not into the elevationally lower pickleweed (*Salicornia virginicus*) zone (a cordgrass – *Spartina foliosa* – zone is absent in Ballona). The distribution of *C. edulis* into the pickleweed-adjacent salt grass is not typical for all southern California coastal wetlands (e.g., Bolsa Chica; pers. obsv.). Indeed, *C. edulis* is generally considered a weed of especially coastal dune habitats. However, it is possible that environmental factors such as flooding and salinity that may normally contribute to limiting the spread of *C. edulis* into coastal wetlands, are not as effective in the Ballona Wetlands with its muted tidal action. As part of an ongoing investigation into the potential for the spread of *C. edulis* into the Ballona Wetlands, the effect of soil salinity and flooding on the growth of *C. edulis* was investigated.

Reference:

Zedler, J.B. (2001) Handbook for Restoring Tidal Wetlands, CRC Press, Boca Raton

Figure 1. Ballona Wetlands surrounded by metropolitan Los Angeles.
Aerial photograph supplied by the FRIENDS of BALLONA WETLANDS

Figure 2a. *Carpobrotus edulis* extending to the edge of the pickleweed zone in the Ballona Wetlands.

Figure 2b. *Carpobrotus edulis* and *Distchlis spicata* in the salt grass zone.

MATERIALS AND METHODS

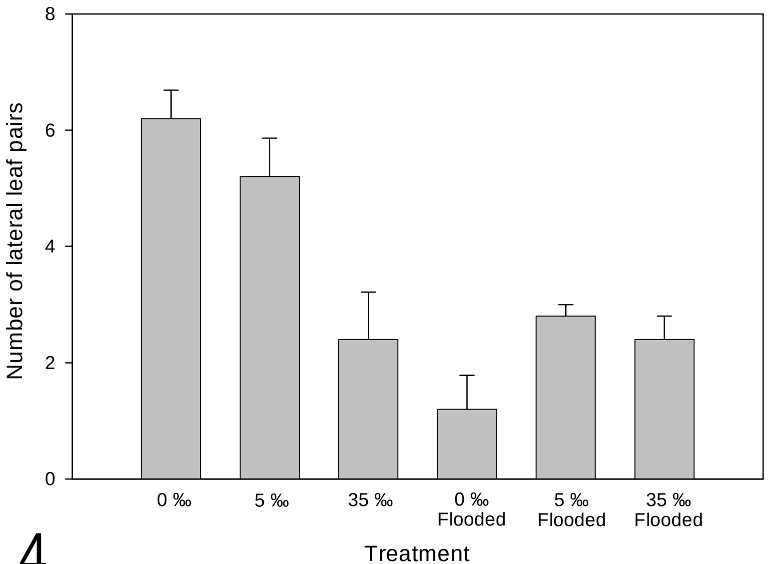
Cuttings of *C. edulis*, collected from a common site in the Ballona Wetlands, were subjected to salinity treatments of 0‰, 5‰, and 35‰ NaCl made by the addition of Instant Ocean® to a Hoagland's nutrient solution and used to irrigate freely-draining pots or to permanently flood the plants. Plant growth was estimated at 12 weeks through measures of leaf dimensions, biomass, and number. Stomatal densities were determined from impressions of the adaxial leaf surface. The Na^+ content was determined by flame photometry. Soil samples, taken from three sites dominated by *C. edulis*, and for two of these sites, from the adjacent pickleweed zone, were analyzed for water and Na+ content. Data were statistically analyzed used one-way and two-way ANOVA (Statgraphics®).

RESULTS

After 12 weeks, the growth of *C. edulis* across all salinities was reduced by flooding (Fig. 3). While the number of lateral leaf pairs was higher for the non-flooded, 0‰ treatment (Fig. 4), leaf length and width were greatest for the non-flooded, 5‰ treatment (Fig. 5). The plants grown in the non-flooded conditions had higher leaf water (Fig. 6) and Na+ contents (Fig. 7) than flooded plants. Plants in flooded conditions exhibited evidence of flooding stress including leaf yellowing and increased stomatal densities (Fig. 8). Soil samples taken from the pickleweed zone had a higher soil water and Na^+ content than those from the adjacent *C. edulis*-dominated salt grass zone or from beneath pure stands of *C. edulis* ($P< 0.05$).

Figure 3a. Examples of plants from each the 0‰, 5‰, and 35‰ non- flooded treatments.

Figure 3b. Examples of plants from each the 0‰, 5‰, and 35‰ flooded treatments.



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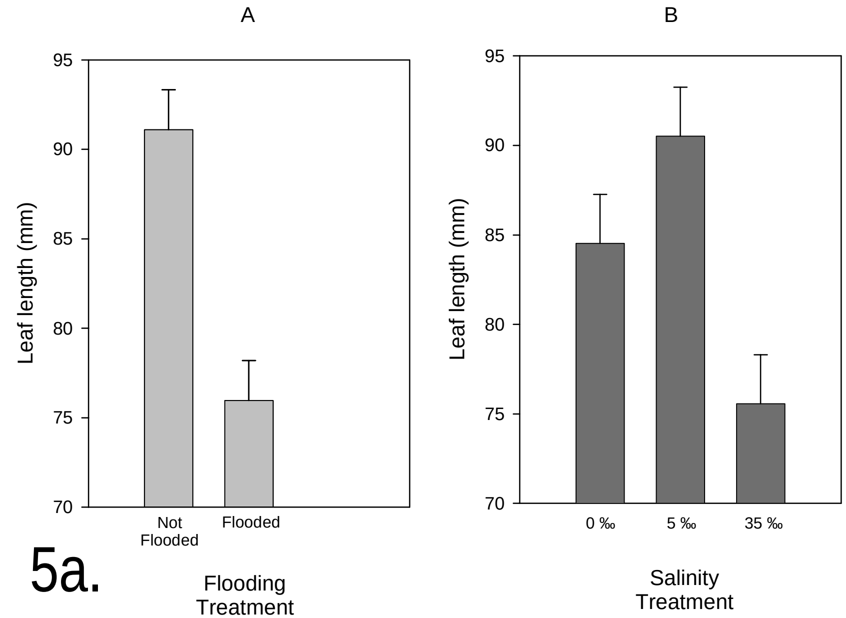
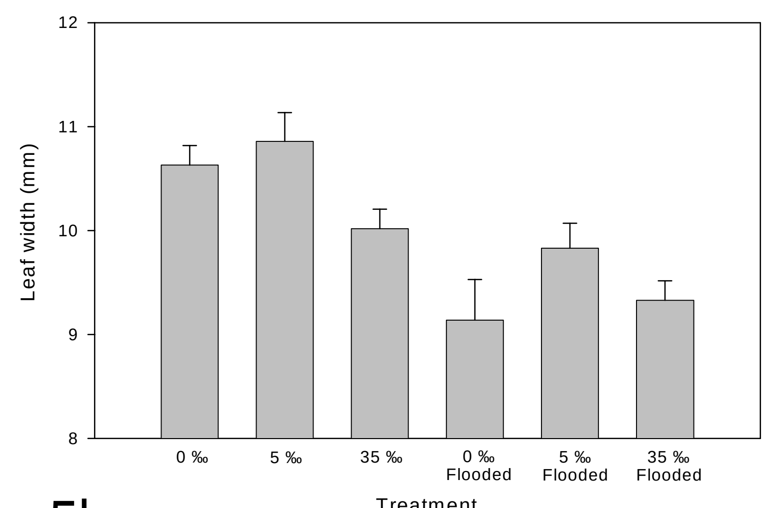


5a.



5b.

Figure 4. Number of lateral leaf pairs versus salinity and flooding treatment. Data are means +s.e. (n = 5 plants; P = 0.0000).

Figure 5a. Leaf length versus flooding (A) and salinity(B). Data for both comparisons are means + s.e. (A: n= 15 plants; P < 0.0001) (B: n = 10 plants; P < 0.005).

Figure 5b. Leaf width versus salinity and flooding treatment. Data are means + s.e. (n = 5 plants; P < 0.0001)

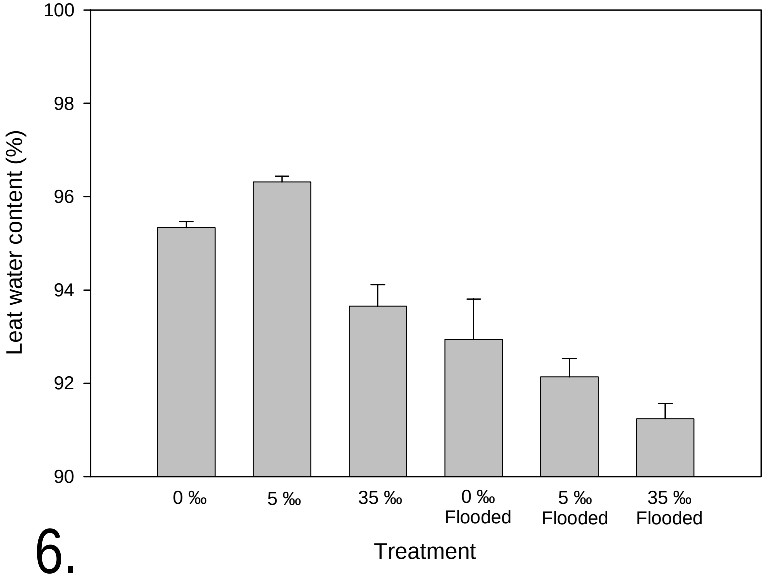


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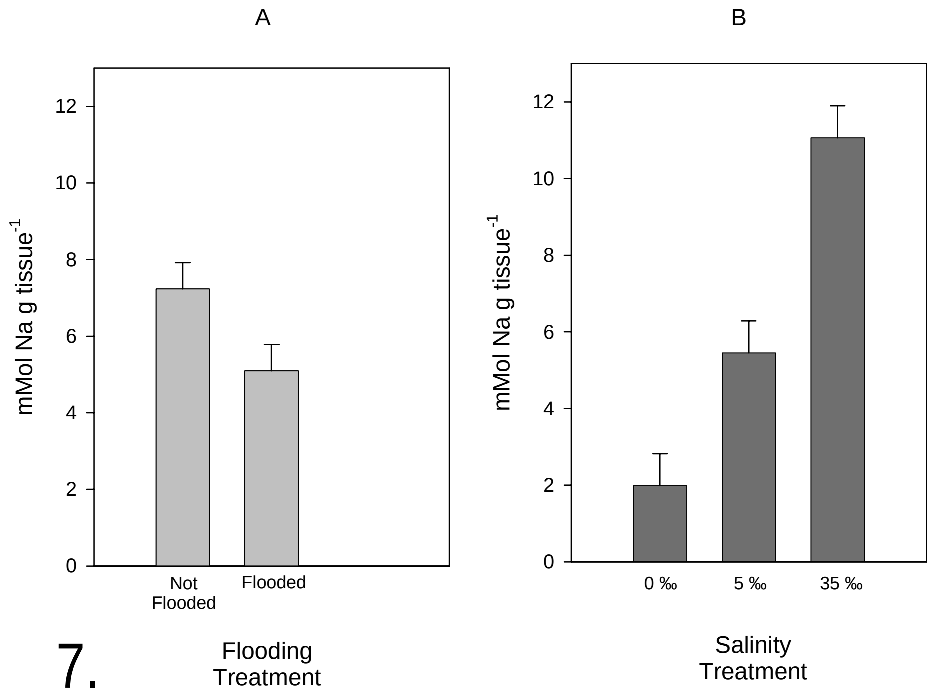
Figure 6. Leaf water content versus salinity and flooding treatments. Data are means + s.e. (n = 5 plants; P < 0.0001).



7.

Figure 7. Tissue sodium content; A: mMol Na^+ g^{-1} dry weight versus flooding, B: mMol Na^+ g^{-1} dry weight versus salinity. Data for both comparisons are means + s.e. (A: n = 15 plants; P = 0.0357) (B: n = 10 plants; P < 0.0001).

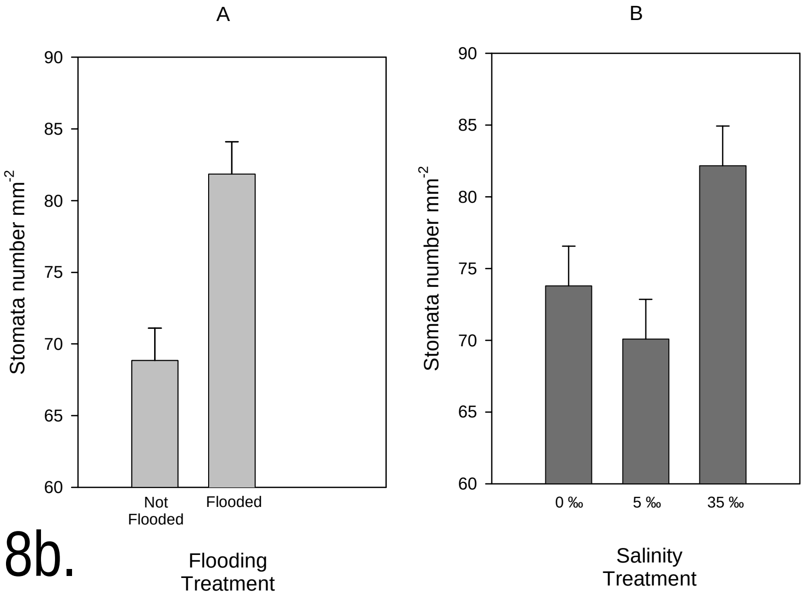


Figure 8a. Flooded plants exhibited symptoms of flooding stress such as leaf yellowing.

Figure 8b. Stomatal densities (stomata mm^{-2}) versus flooding, A; and salinity, B. Data for both comparisons are means + s.e. (A: n = 15 plants; P = 0.0004) (B: n = 10 plants; P = 0.0146).

CONCLUSIONS

- *Carpobrotus edulis* has a moderate salinity tolerance and a low flooding tolerance.

- In the Ballona Wetlands, *C. edulis* is unlikely to spread into the pickleweed zone with its higher soil water content.

- Enhanced tidal flushing would possibly eliminate *C. edulis* from the salt grass zone in the Ballona Wetlands (c.f. Bolsa Chica).