Non-destructive methods for estimating productivity of dominant vegetation in tidal marshes of San Francisco Bay, California

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INTRODUCTION AND OBJECTIVES

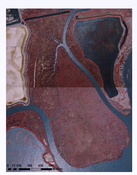
Tidal wetlands in the San Francisco Bay Estuary span a salinity gradient from pure salt to fresh water environments. The resulting effects on vegetation create a complex assortment of species distributions and vegetative structure. There is a growing trend in ecosystem restoration throughout the entire bay and it is crucial to have system-wide methods of assessing ecosystem function in all marsh types. One character that is commonly used to assess patterns in vegetation is primary productivity. Traditional methods of estimating productivity include the clip plot method, which entails removing the end-of-year standing biomass, sorting plots by species in the lab, and measuring mass. This is a highly labor- and time-intensive method and is not easily assessable by institutions or resource managers with limited budgets. Therefore, there is a need to develop sampling methods that are accurate, efficient, and apply to multiple species that occur in a system as diverse as the San Francisco Bay Delta. The main goal of this investigation was to:

- Test multiple techniques for estimating end-of-year standing biomass and devise productivity sampling protocols for dominant species in the San Francisco Bay-Delta to be used by resource managers

METHODS

This research was conducted as part of the Integrated Regional Wetland Monitoring Program (IRWM), an intensive multidisciplinary project focused on assessing ecosystem function in six natural and restored wetlands in the SF Bay-Delta. Productivity data were collected at all sites in 2004 and 2005, although we only present 2004 data from two natural sites: Coon Island and Browns Island. We tested the accuracy of four methods of estimating productivity against end-of-year standing biomass:

1. Leaf Area Index (LAI) – a unitless measure of canopy density
2. Average stem height of dominant species
3. Individual stem height and density
4. Total stem length – cumulative stem height of all individuals



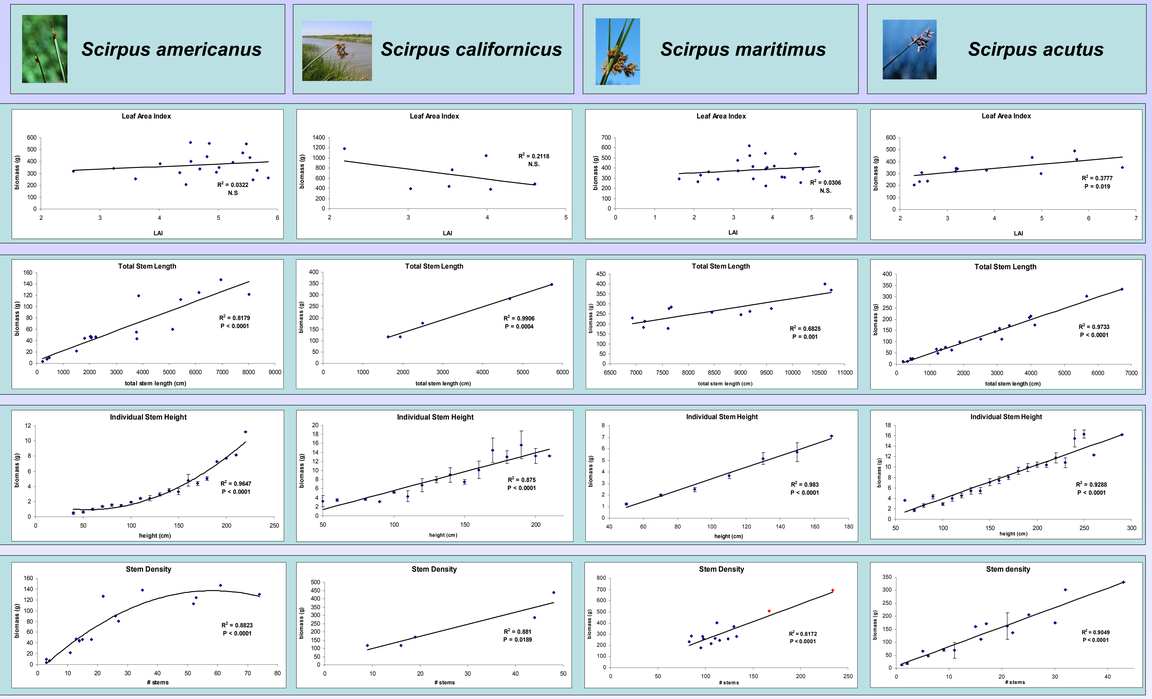
Coon Island
- Brackish marsh
  5 – 25 ppt
- Dominant species
  Scirpus maritimus
  Salicornia virginica
  Typha angustifolia
  Scirpus acutus
  Scirpus californicus

Browns Island
- Brackish marsh
  0 – 12 ppt
- Dominant species
  S. acutus
  S. americanus
  Typha species

In the field, multiple 0.25-m^2 monospecific plots were randomly chosen. In each plot, LAI was measured using a LiCOR Plant Canopy Analyzer, and the average height of all species was recorded in 5-cm increments. All standing biomass was collected for the following dominant species: **Scirpus maritimus*, *S. californicus*, *S. acutus*, *S. maritimus*, *Salicornia virginica*, and *Typha angustifolia*. Not all species were collected at each site. The plots were brought into the lab where they were rinsed, sorted by species and live/dead material, dried, and weighed. All *Scirpus* species were further sorted by 10-cm height classes, and the number of stems was counted. The data were analyzed using simple linear regressions.

* Recent nomenclature changes: *S. maritimus* = *Bolboschoenus maritimus*; *S. acutus, S. californicus*, and *S. americanus* = *Schoenplectus* sp.

RESULTS



Key Results

- Average height of the dominant species had no significant relationship with biomass for any species (data not shown)
- Leaf area index was significantly related to biomass for *S. virginica* and *T. angustifolia* (R^2 = 0.81, P = 0.0009 & R^2 = 0.71, P = 0.001, respectively; data not shown) but did not uniformly predict biomass for the four *Scirpus* species
- Individual stem height, total stem length, and stem density were all highly correlated with biomass for all *Scirpus* species, although the best-fitting method varied among species

DISCUSSION AND CONCLUSIONS

Most of the methods of estimating productivity that we tested were able to significantly predict the biomass of the dominant species studied, although we were unable to identify a single method that applied to all species. Leaf area index accurately predicted biomass for *T. angustifolia* and *S. virginica*. Within the *Scirpus* species, individual stem height and stem count were strong predictors of biomass; however, total stem length, a surrogate for both stem height and density, appeared to have the strongest relationship with biomass.

Although no single method applied to all species, the combination of LAI and total stem length provide a powerful predictive method for estimating plant productivity across a strong salinity gradient. Implementation of these methods would:
1) Minimize damage to wetland vegetation
2) Reduce labor costs and increase efficiency

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