A Research Design to Estimate the Contribution of *Spartina densiflora* to the Net Primary Productivity of Humboldt Bay's Salt Marshes

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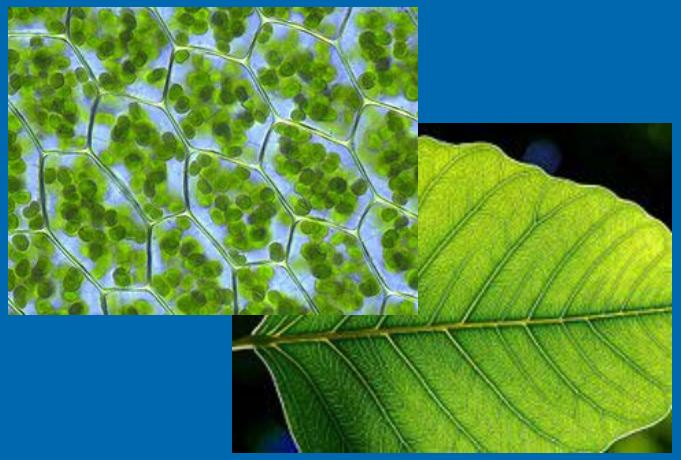
Photosynthesis

Carbon Dioxide & Water & Light Energy → Sugar & Oxygen

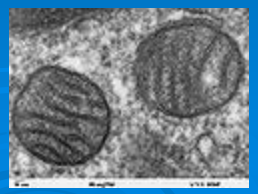
(CO_2 + … → $C_6H_{12}O_6$ + …)



Cellular Respiration

Sugar & Oxygen → Carbon Dioxide & Water & Energy

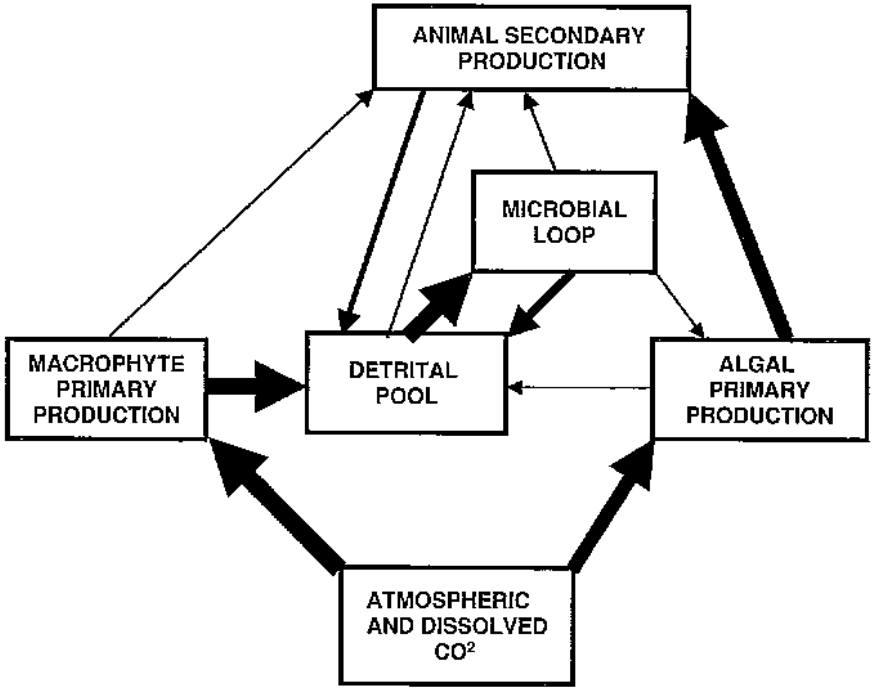
($C_6H_{12}O_6$ + … → CO_2 + …)



What is Net Primary Productivity?

- The rate of carbon “in” minus the rate of carbon “out”
- Essentially the rate of growth
- NPP is usually measured in units of grams of carbon per square meter per year (g $C/m^2/yr$)

The Flow of Carbon in Wetlands



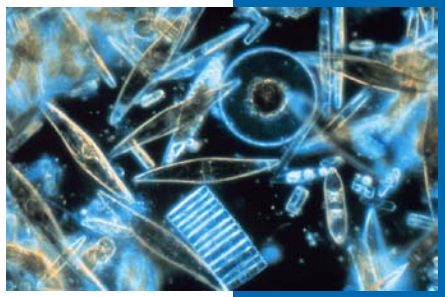


FIGURE 7.3

Schematic showing how animal secondary production in wetlands is based trophically on carbon from living macrophytes, detritus, and algae, with the link with algae being particularly strong.

Example of a Wetland Food Web

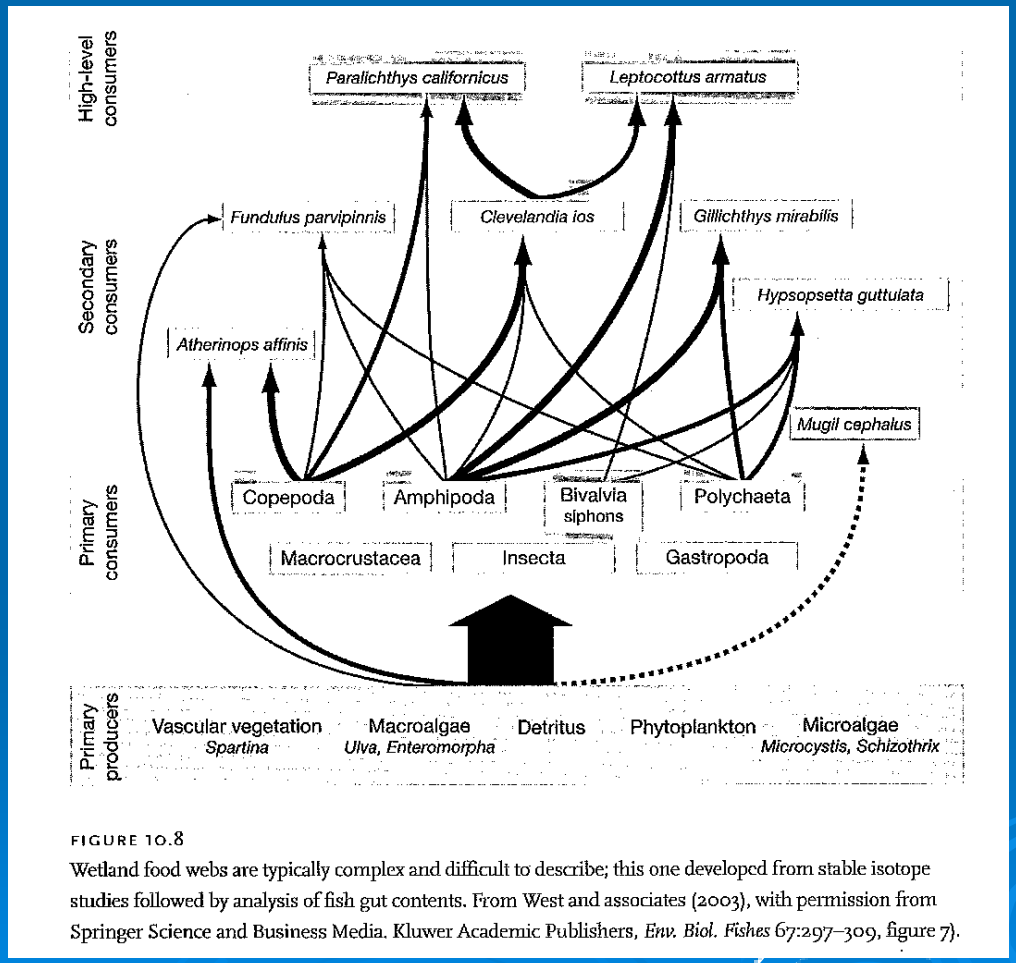
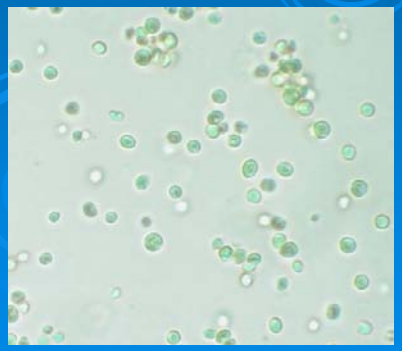


FIGURE 10.8

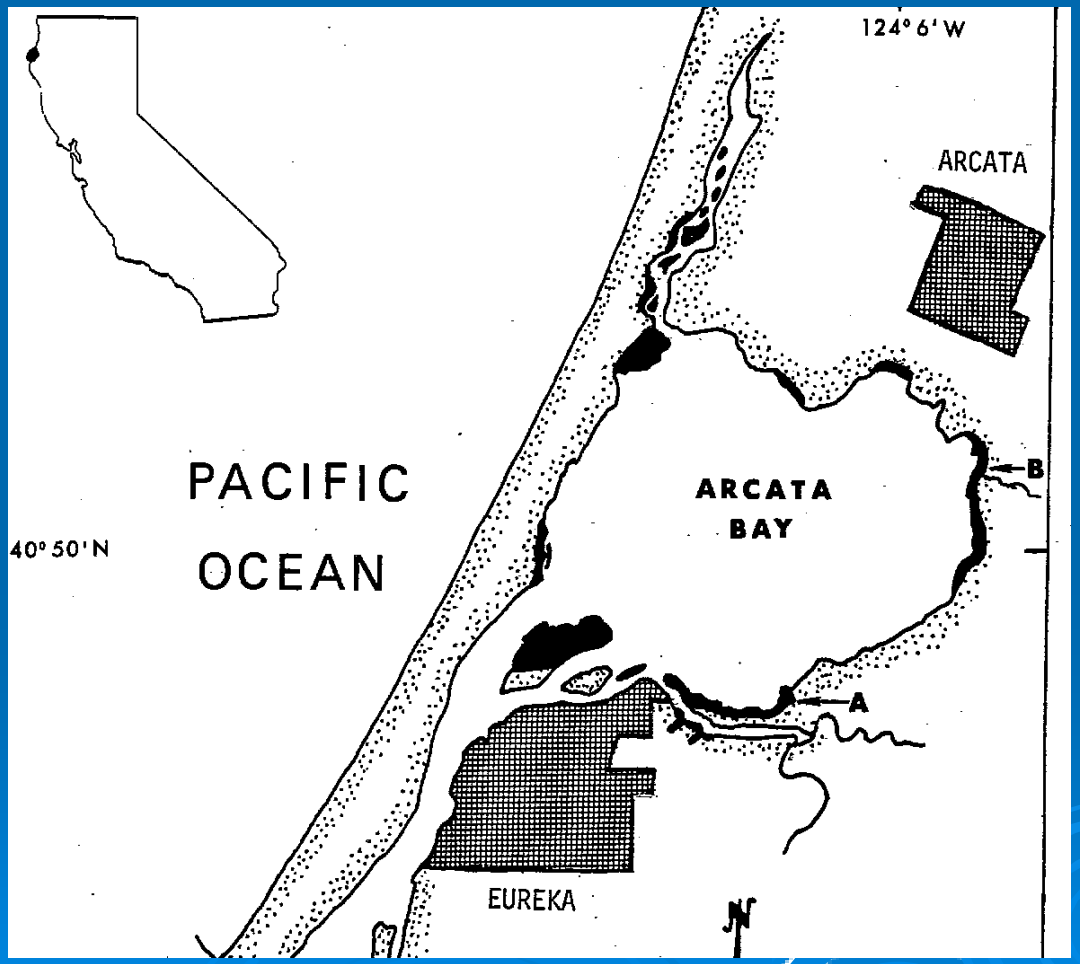
Wetland food webs are typically complex and difficult to describe; this one developed from stable isotope studies followed by analysis of fish gut contents. From West and associates (2003), with permission from Springer Science and Business Media. Kluwer Academic Publishers, *Env. Biol. Fishes* 67:297–309, figure 7).



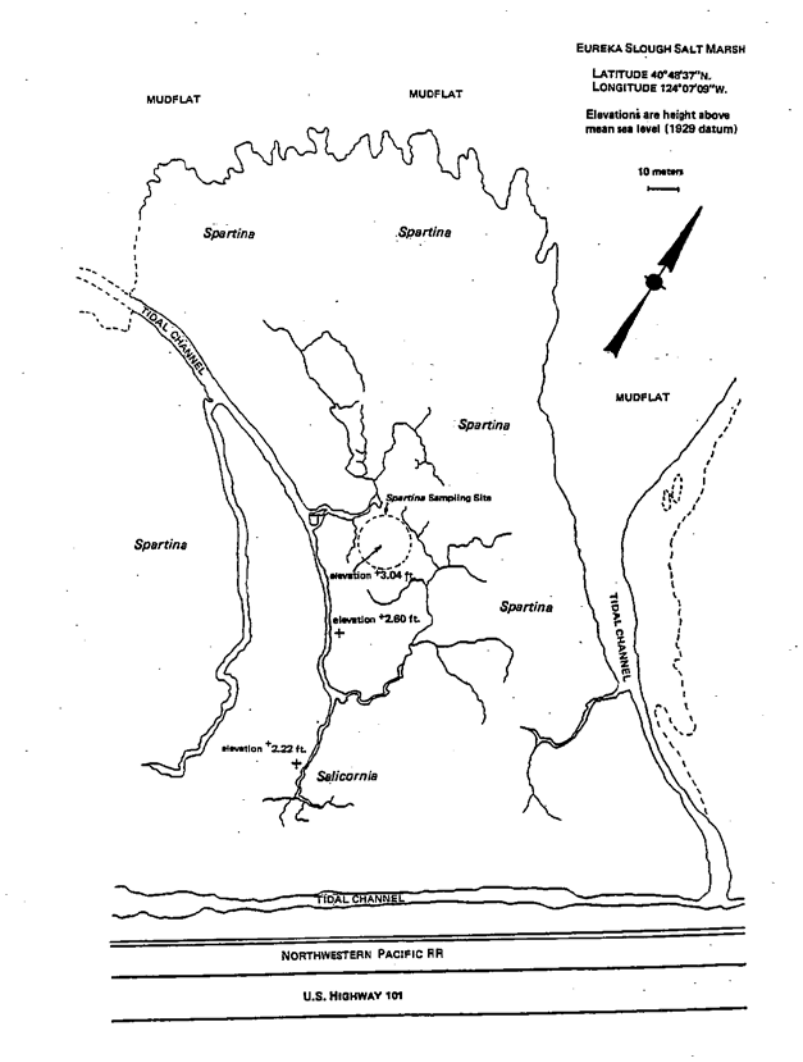
How is Net Primary Productivity Measured?

- Early Marine NPP:
  - Light and Dark Bottle Method
    - Gaarder and Gran (1927)
- Early Terrestrial NPP:
  - Maximum Minus Minimum Live Biomass
  - Smalley's (1959) Method
    - Both live and dead biomass are sampled
    - Production = Δ live biomass + Δ dead biomass
    - Negative values = 0
  - Wiegert and Evans' (1964) Method
    - Estimates rate of decomposition

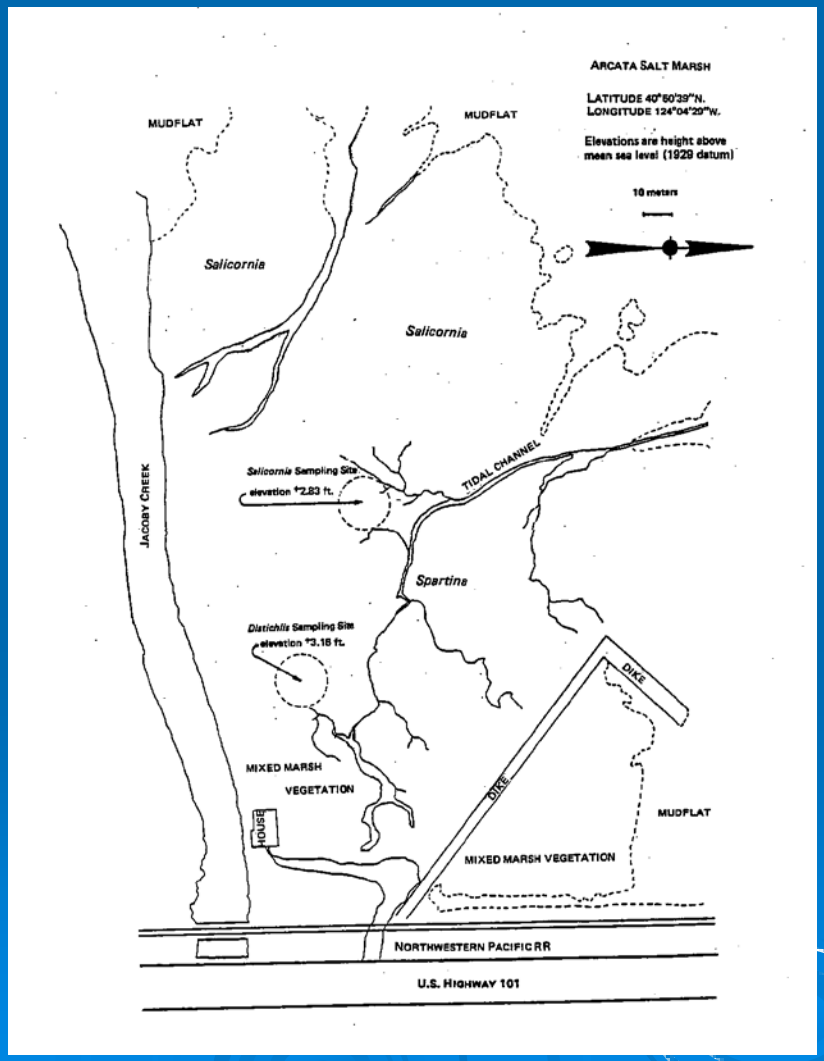
John D. Rogers HSU Master's Degree Study



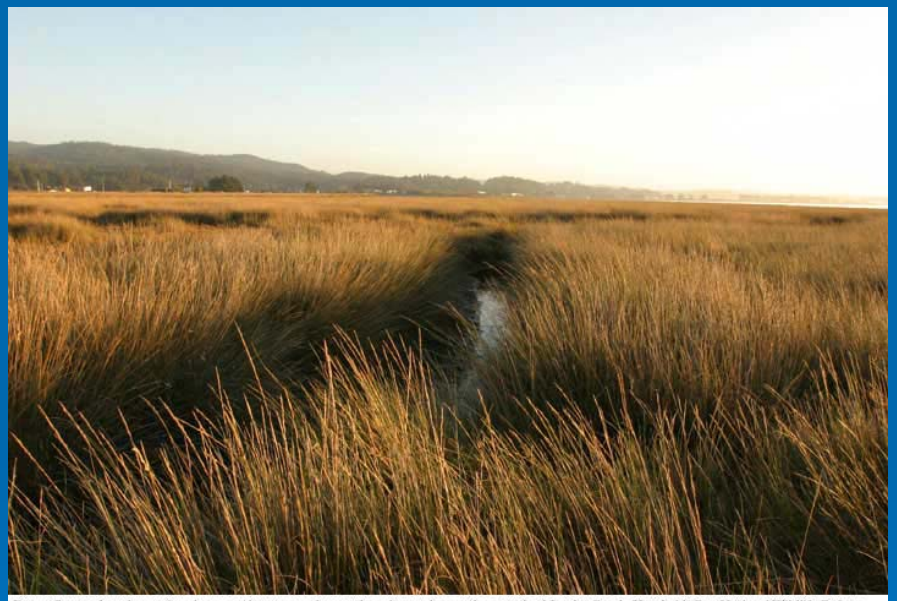
Site A
Eureka Slough



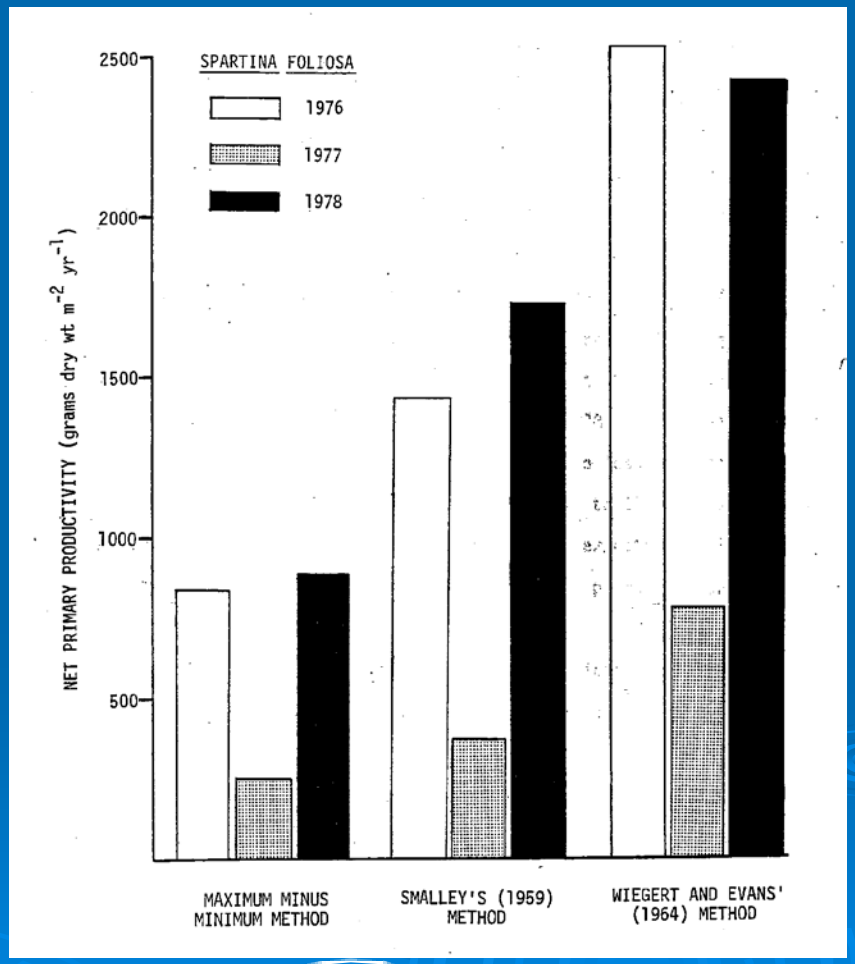
Site B
Jacoby Creek



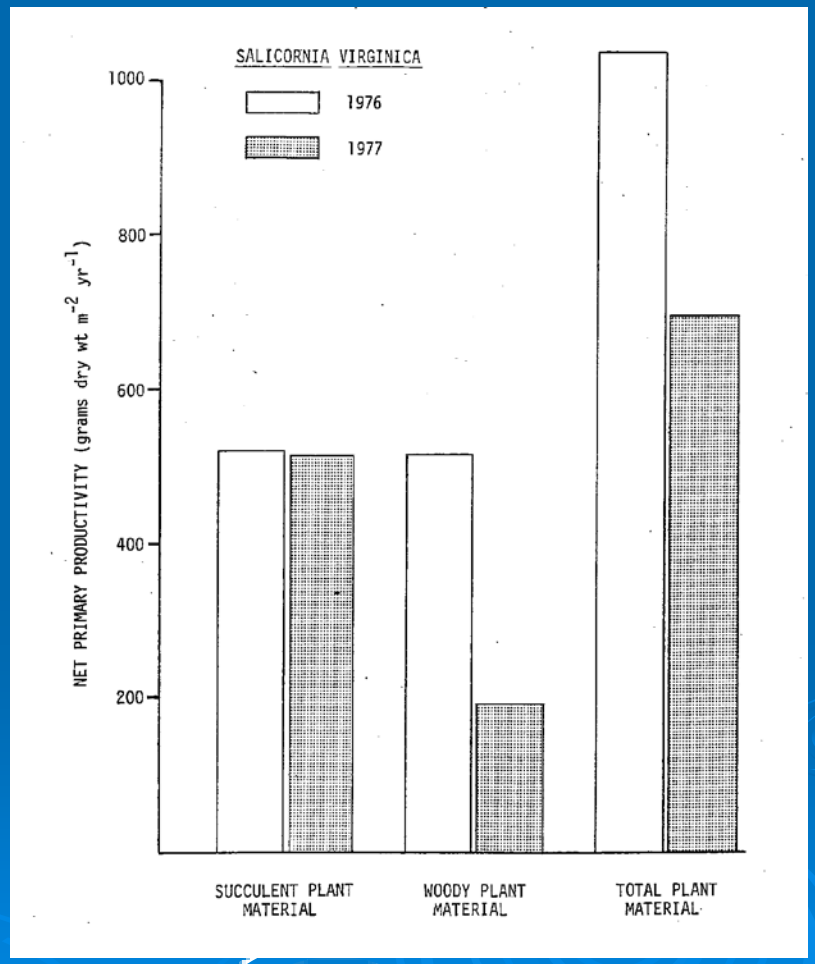
Spartina densiflora Net Primary Productivity (Rogers 1981)



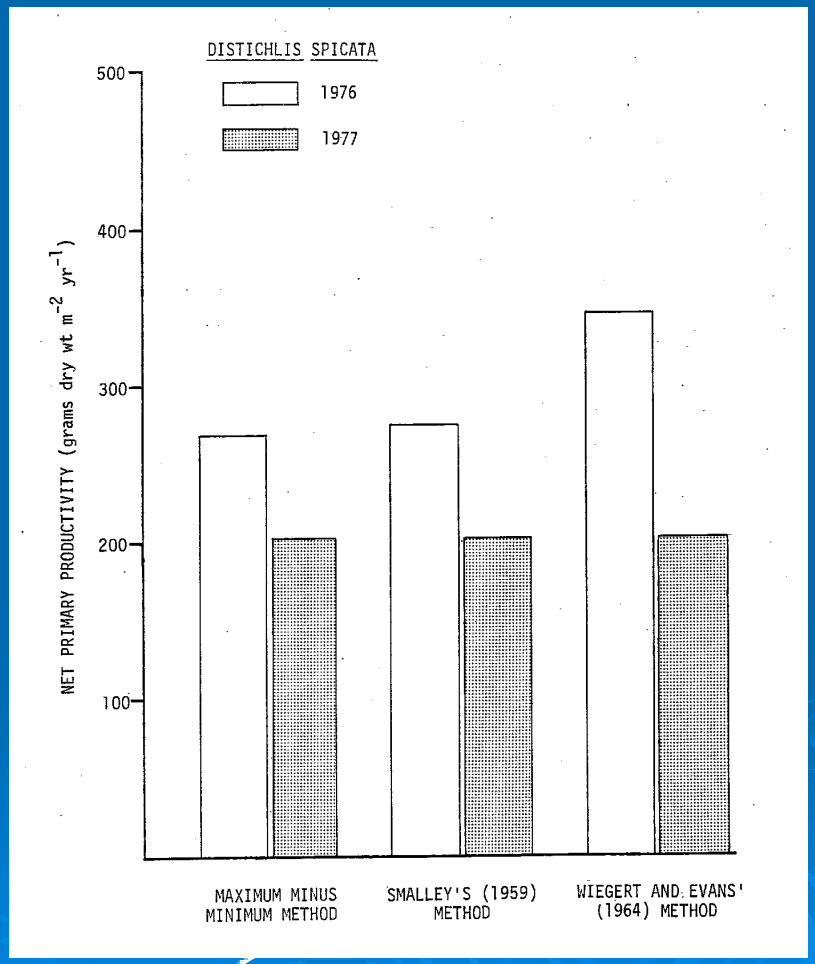
Dense-flowered cordgrass forming a continuous meadow on the salt marsh near the mouth of Jacoby Creek, Humboldt Bay National Wildlife Refuge.



Sarcocornia Pacifica Net Primary Productivity (Rogers 1981)



Distichlis Spicata Net Primary Productivity (Rogers 1981)



Some Problems With Early Methods Used to Measure NPP

- Belowground production
- Herbivory
- Litterfall
- Volatile organic compounds
- Root exudates
- Symbionts

Modern Methods Used to Measure NPP

- Gas Flux
- Isotopes
- Chlorophyll
- Fluorescence Kinetics
- Satellite Imagery

Measuring Salt Marsh NPP

- Terrestrial and Marine
- Annual and Perennial Plants
- Elevation
- Tides
- Parasitic Plants

Algal Mat Productivity: Comparisons in a Salt Marsh (Zedler 1980)

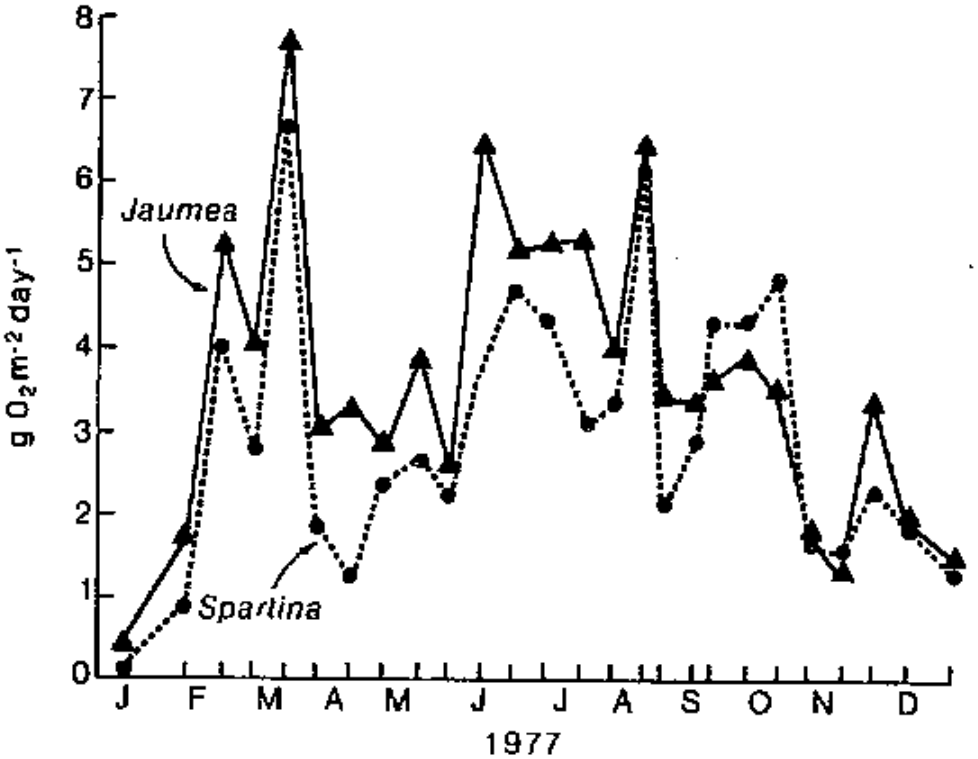


Fig. 4. Estimated daily GPP of the four algal mat sampling stations. Algal mats are named by their overstory dominants.

A Closed Chamber CO_2 Flux Method for Estimating Marsh Productivity (Streever et al 1998)

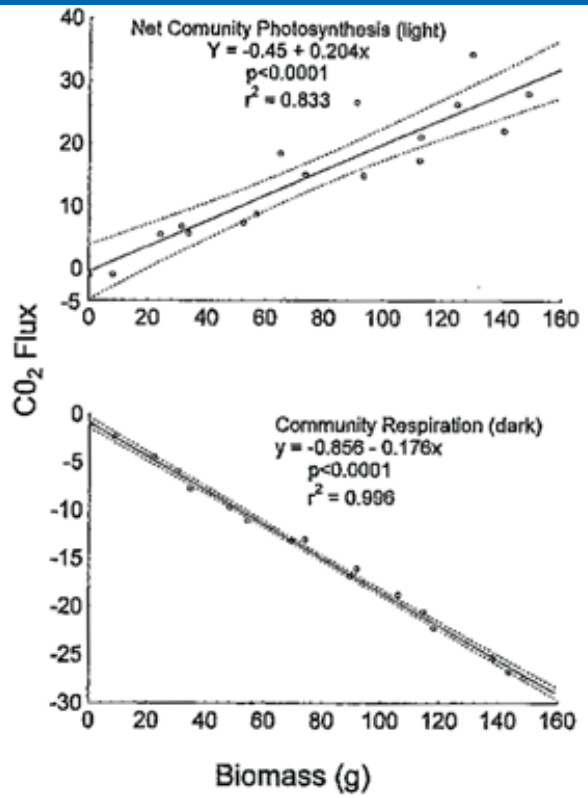


Fig. 2. Ability of the method to detect a relationship between CO_2 flux and dry biomass for *Sporobolus virginicus* was assessed. A strong relationship exists between CO_2 flux measurements and aboveground plant biomass under light (top) and dark (bottom) conditions. Dashed lines show the 95% confidence band for slope of the regression lines. CO_2 flux measurements are expressed in terms of $\mu g\ C\ m^{-2}$ plant cover s^{-1}.

Initial Methods for the Measurement of the Contribution of *Spartina densiflora* to the NPP of Humboldt Bay's Salt Marshes

- Monthly cover monitoring, density monitoring, plant dimension measurements, and biomass sampling
- Monthly *in-situ* closed chamber CO_2 flux / relative humidity / temperature / photosynthetically active radiation measurements
- Monthly *in-situ* sealed bottle dissolved oxygen / temperature / photosynthetically active radiation measurements