Factors Controlling *Spartina* distribution in Humboldt County: Implications for Wetland Restoration Projects

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Spartina densiflora

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Goal and Purpose

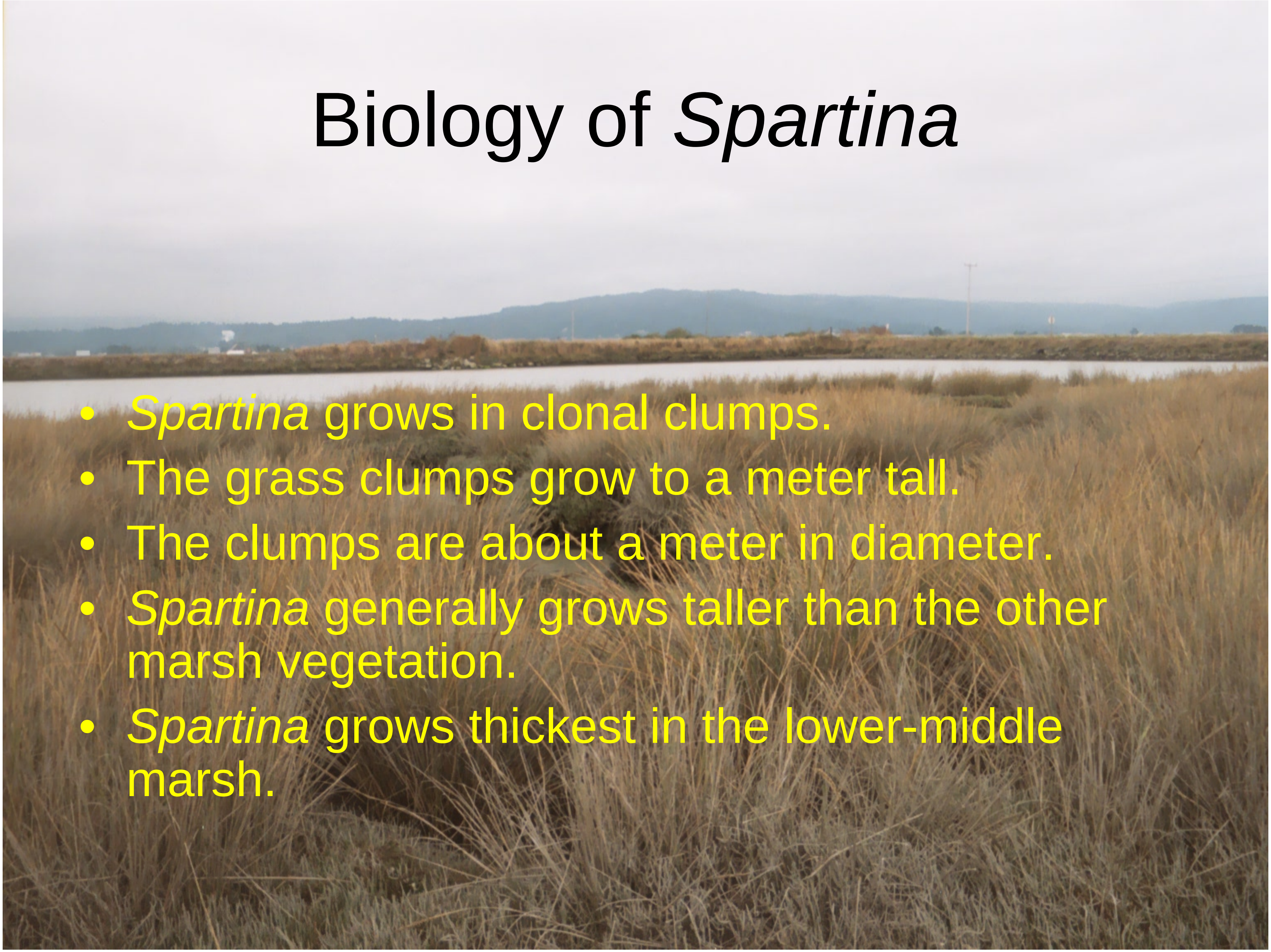
- **Goal**: To model the abundance of *Spartina* in the salt marshes of Humboldt bay.
- **Purpose**: To use the knowledge gained, to manage *Spartina* in existing marshes and in future marsh restoration efforts.

Native salt marsh vegetation, with some *Spartina* present

A. Eicher

Biology of *Spartina densiflora*

- **The plant colonizes new marsh with seeds.**
- **Disturbed areas are easily colonized by *Spartina* seedlings.**
- **It grows best in wet, mucky soils and along drainage channels.**
- **In 1980 Newby found a strong correlation between plant tissue phosphorus levels and *Spartina* abundance.**



Biology of *Spartina*

- *Spartina* grows in clonal clumps.
- The grass clumps grow to a meter tall.
- The clumps are about a meter in diameter.
- *Spartina* generally grows taller than the other marsh vegetation.
- *Spartina* grows thickest in the lower-middle marsh.

Spartina densiflora habitat

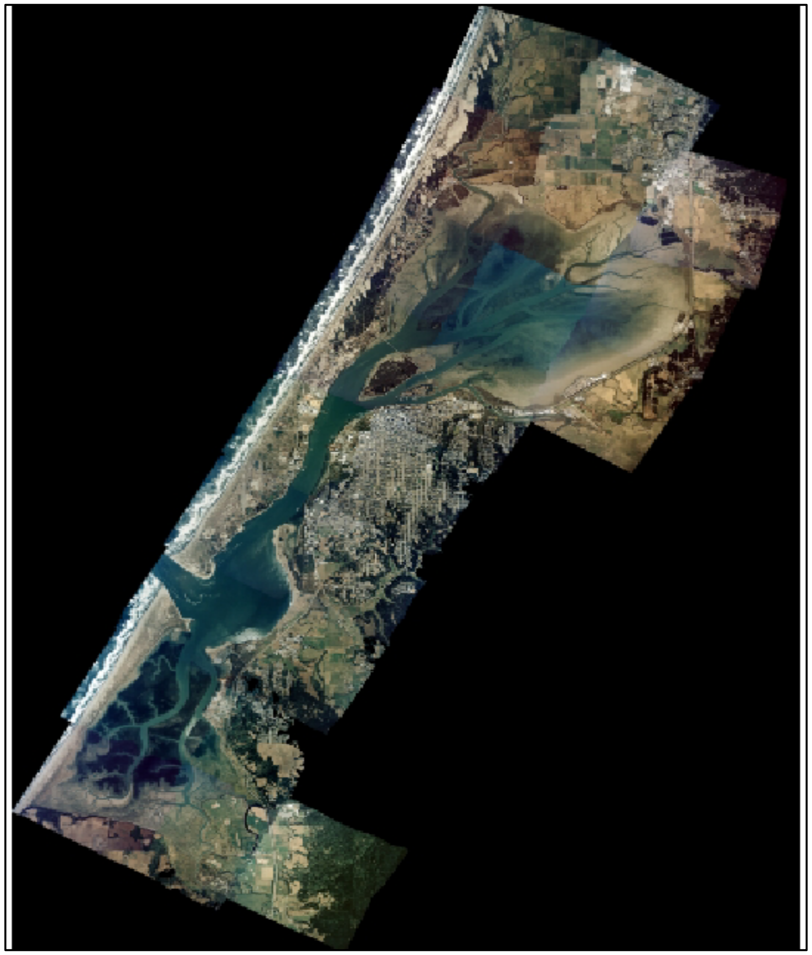
A large collection of variables were collected in the marsh. Half of the variables were statistically significant with respect to the presence of *Spartina densiflora*. Those variables are listed below.

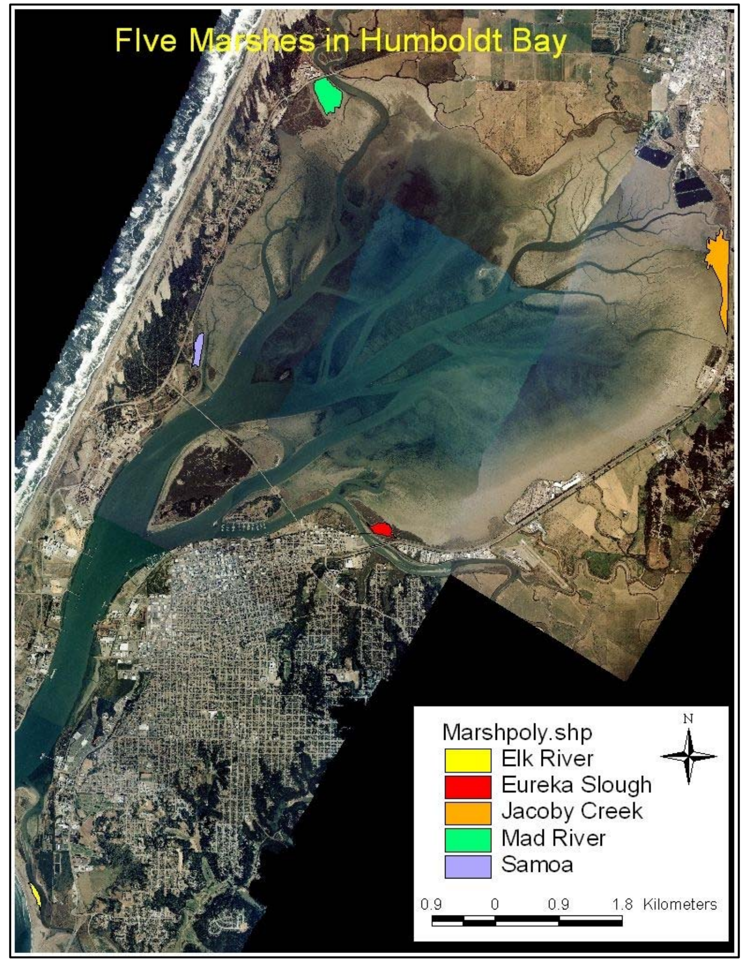
Variable	R-squared	Probability	Regression Equation
Phos * ElevN	0.4507	0	0.0295 + 0.00883*Phos*ElevN
Phosphorus	0.4088	0	-7.23 + 0.0458*Phosphorus
Redox	0.2086	0	0.457 - 0.000896*Redox
Redox * Salinity	0.1994	0	0.462 - 0.0000211*Redox*Salinity
ElevN * Avg Dist to Ditch	0.1226	0	0.702 - 0.00795*ElevN*AvgDistToDitch
Elev Normalized StDev	0.1186	0	0.782 - 0.763*ElevNStDev
Dist. to Ditch Avg	0.1059	0	0.700-0.0518*AvgDistToDitch
Salinity Site StDev	0.0908	0	0.634 - 0.296*SalinitySiteStDev
Dist. To Ditch StDev	0.0772	0.0001	0.753 - 0.0572*DistToDitchStDev
Phosphorus Site Avg.	0.074	0.0001	0.167 + 0.0346*PhosphorusSiteAvg
Elev Normalized	0.0681	0.0003	1.66 - 0.187*ElevN
Elev Normalized squared	0.0662	0.0003	1.04 - 0.0139*ElevNsq
Elev Normalized cubed	0.0629	0.0005	0.882 - 0.00134*ElevNcu
Cosine(Aspect)	0.0491	0.0021	0.435 + 0.122*Cos(Aspect)
Salinity Site Avg	0.0475	0.0025	-0.546 + 0.0238*SalinitySiteAvg
pH	0.0331	0.012	-0.640 + 0.181*pH
Organic Content (percent)	0.0306	0.0158	0.578 - 0.00107*OrgContent
Redox Site Avg	0.0267	0.0242	0.462 - 0.00121*RedoxSiteAvg
Slope Position FS	0.0088	0.0477	0.5600 - 0.1784*FS (categorical variable)
Elev Normalized Avg	0.0206	0.0483	1.74 - 0.198*AvgElevN

Project overview

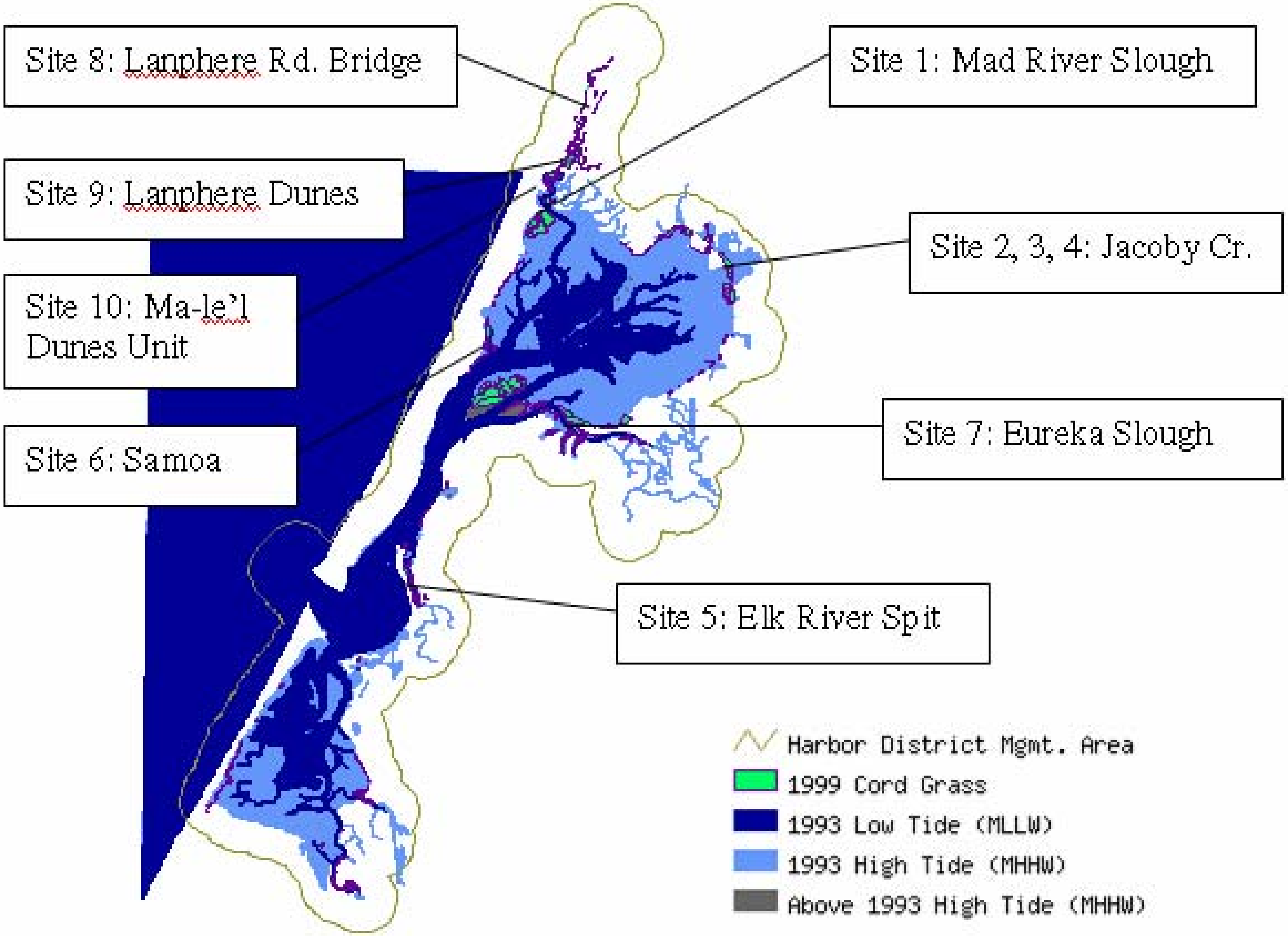
- **Variables analyzed for**
  - Relationship to *Spartina*
  - Relationship to each other
  - How they make a marsh resistant to *Spartina*
  - How they make a marsh susceptible to *Spartina*

Five marsh sites surveyed and used to create the *Spartina* abundance model





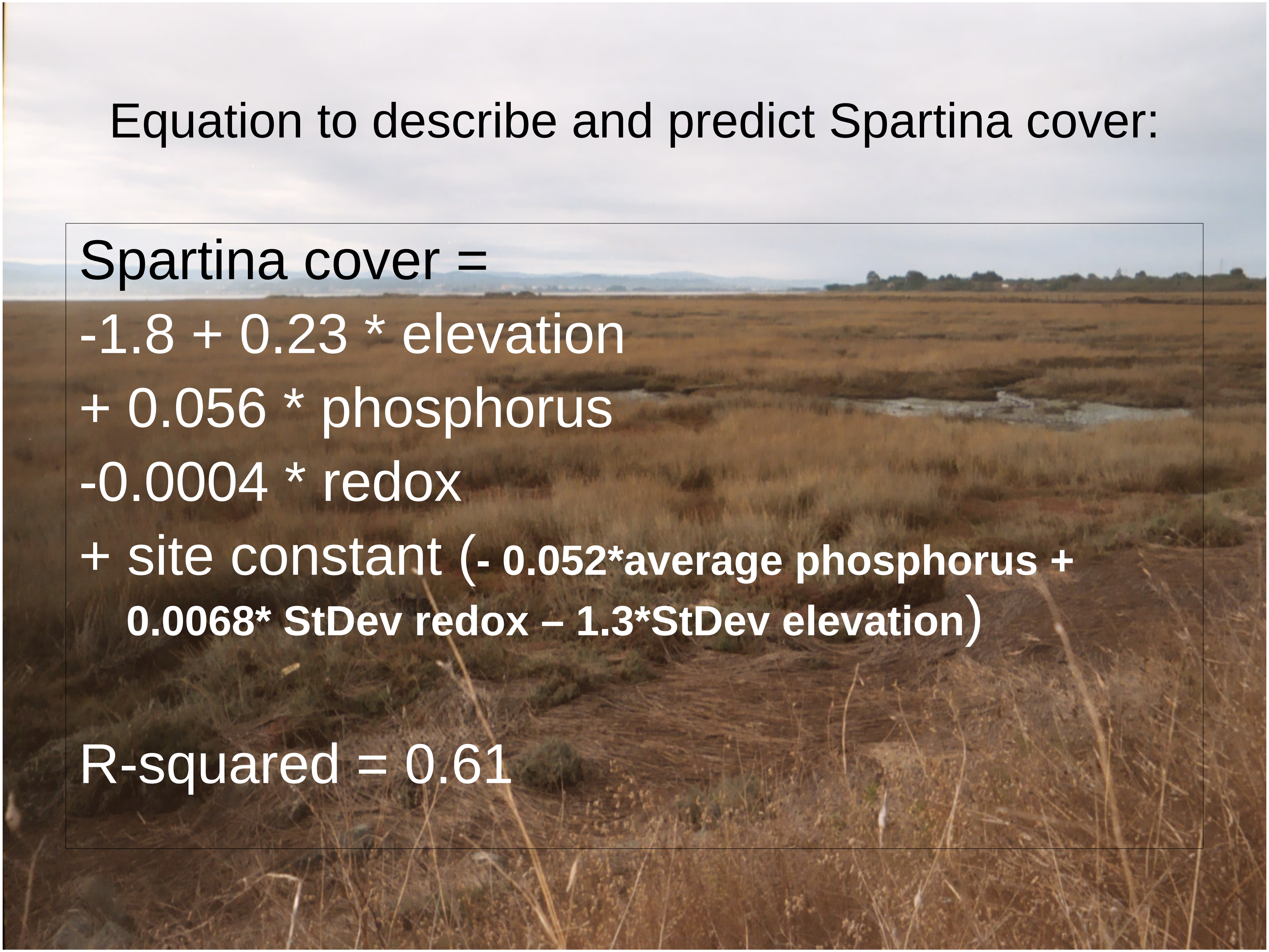
Cheiko


Site 8: Lanphere Rd. Bridge
Site 1: Mad River Slough
Site 9: Lanphere Dunes
Site 2, 3, 4: Jacoby Cr.
Site 10: Ma-le'l Dunes Unit
Site 7: Eureka Slough
Site 6: Samoa
Site 5: Elk River Spit
Harbor District Mgmt. Area
1999 Cord Grass
1993 Low Tide (MLLW)
1993 High Tide (MHHW)
Above 1993 High Tide (MHHW)

Harvesting data

Habitat of *Spartina densiflora*

- The logistic regression was 85% successful at separating *Spartina* habitat from non-habitat, using the six covariates or environmental gradients found to be important in creating the linear regression model.



Equation to describe and predict Spartina cover:

Spartina cover =

-1.8 + 0.23 * elevation

+ 0.056 * phosphorus

-0.0004 * redox

+ site constant (**- 0.052*average phosphorus + 0.0068* StDev redox – 1.3*StDev elevation**)

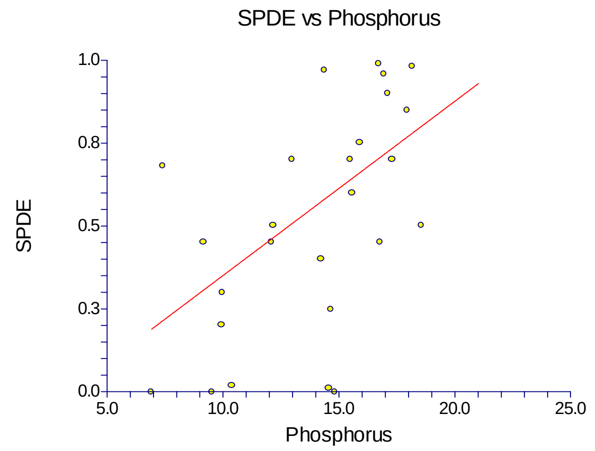
R-squared = 0.61

Variables used in modeling *Spartina*

- Can be used to tell us how these environmental gradients control the abundance of Spartina.
- That information can be used in planning marsh restoration efforts, to minimize Spartina colonization of those sites.
- These environmental gradients also interact with each other, and understanding those interactions will help in marsh restoration efforts.

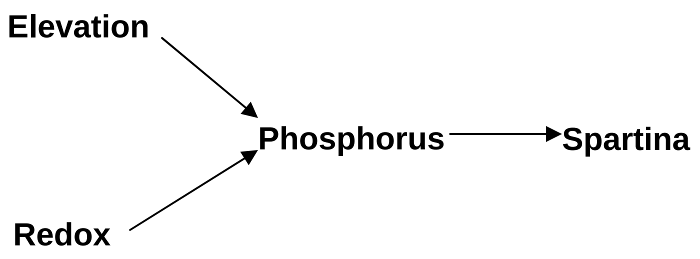
Available Phosphorus

- Spartina abundance = -7.23 + 0.0458*Phos.
- R-squared = 0.41
- The regression of Phosphorus to Elevation has an $R^2 = 0.55$
- The regression of Phosphorus to Redox has an $R^2 = 0.33$



<u>Summary of relationships</u>

1. High phosphorus, high Spartina abundance.
2. Low elevation, high phosphorus.
3. Low redox potential, high phosphorus.



Redox

- Spartina abundance = 0.478 – 0.000896*Redox
- R-squared = 0.21
- Regression of Redox to Elevation has an $R^2 = 0.23$
- Regression of Redox to Phosphorus has an $R^2 = 0.33$

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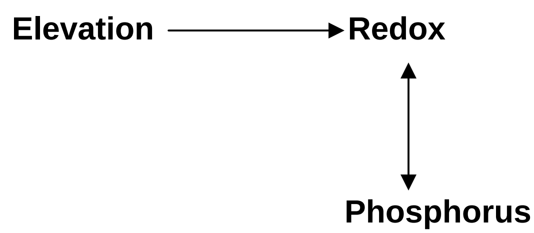
<u>Summary of relationships</u>

1. Low Redox, high Spartina abundance
2. Low Elevation, low Redox
3. Low Redox, high Phosphorus



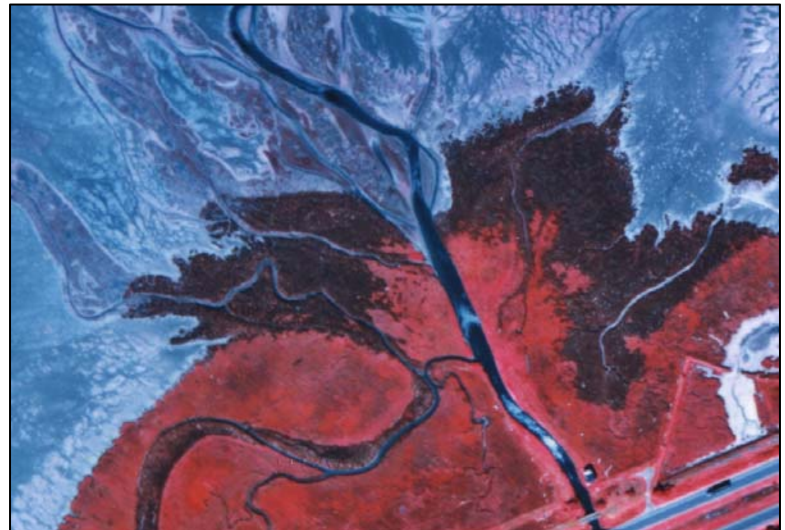
Elevation

- Spartina abundance = 1.77 – 0.187*Elevation
- R-squared = 0.07
- Regression of Elev. + E^2 + E^3 to Phos. has an R^2 =0.55
- Regression of Elev. to Redox has an R2 = 0.23

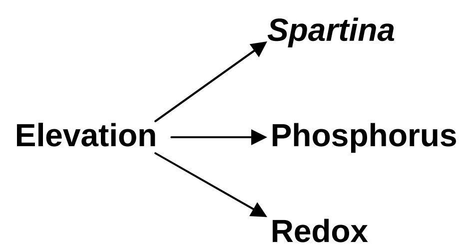
Summary of relationships

1. Low to middle Elevation, high Spartina abundance
2. Low Elevation, high Phosphorus
3. Low Elevation, low Redox

Jacoby Creek salt marsh



Fish and Wildlife Service

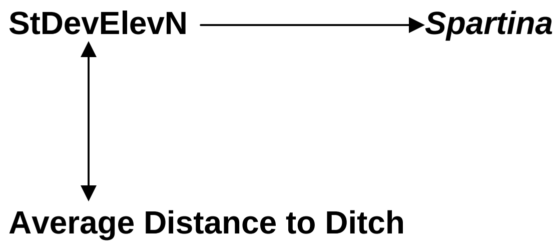


Other variables used in the model: **Standard Deviation of Elevation**

- The standard deviation of elevation is a measure of how much variation in plot elevation exists at a single site.
- A small standard deviation of the plots indicates that a site is relatively flat and will retain lots of pooled water when the tide goes out. *Spartina* grows best in sites with a small standard deviation of elevation (upper photo).
- A site with a large standard deviation of elevation has a relatively large elevation gradient, drains well, and does not have much *Spartina* (lower photo).

Standard Deviation of Elevation

- ***Spartina*** abundance = 0.782 – 0.763*StDevElevN
- R-squared = 0.12
- Regression of StDevElevN to AvgDistToDitch has an R^2 = 0.81, which show that sites with a large elevation gradient have fewer drainage ditches



<u>Summary of relationships</u>

1. A site with a large elevation gradient has little *Spartina*
2. A site that is relatively flat has a high abundance of *Spartina*, and lots of drainage ditches

Summary of effects that make a salt marsh susceptible or resistant invasion by Spartina densiflora

A marsh site resistant to *Spartina* invasion has the following characteristics:

- High average elevation
- Large elevation gradient
- Few deep channels
- Abundant, shallow, vegetated drainage channels
- Well drained (less reduced) soils, with little pooled water or mucky spots
- Low available Phosphorus in the soil

A site susceptible to *Spartina* invasion has the following characteristics:

- Low average elevation
- Small elevation gradient
- Many deeper channels
- Lots of areas that retain pooled water when the tide recedes
- Very reduced soils
- High available phosphorus in the soil
- Bare soils, easily colonized with *Spartina* seedlings

Further research

- Conduct experiments on phosphorus, redox, and elevation in the salt marsh
- Create models using other plant species
- Combine plant models, using computer simulation, into a vegetation model
- Extend vegetation model with soil sedimentation-erosion models into a time-step model

Summary and Conclusion

- **The goal- build a descriptive model** of *Spartina densiflora* abundance, based on the environmental gradients that controlled its growth.
- Use logistic regression to define the **habitat** of *Spartina densiflora*.
- Analyze **environmental gradients** for their effect on *Spartina*.
- Sites that have a large elevation gradient, are well drained, and have a high average elevation are **resistant to *Spartina*** colonization.
- Sites that are relatively flat, are not well drained, and have a low average elevation are **susceptible to *Spartina*** colonization.
- The information collected here, combined with previous studies, could be used to **model salt marsh restoration projects**. The effects of alternate marsh topographies and the associated environmental gradients would help land managers to make informed decisions about those projects.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