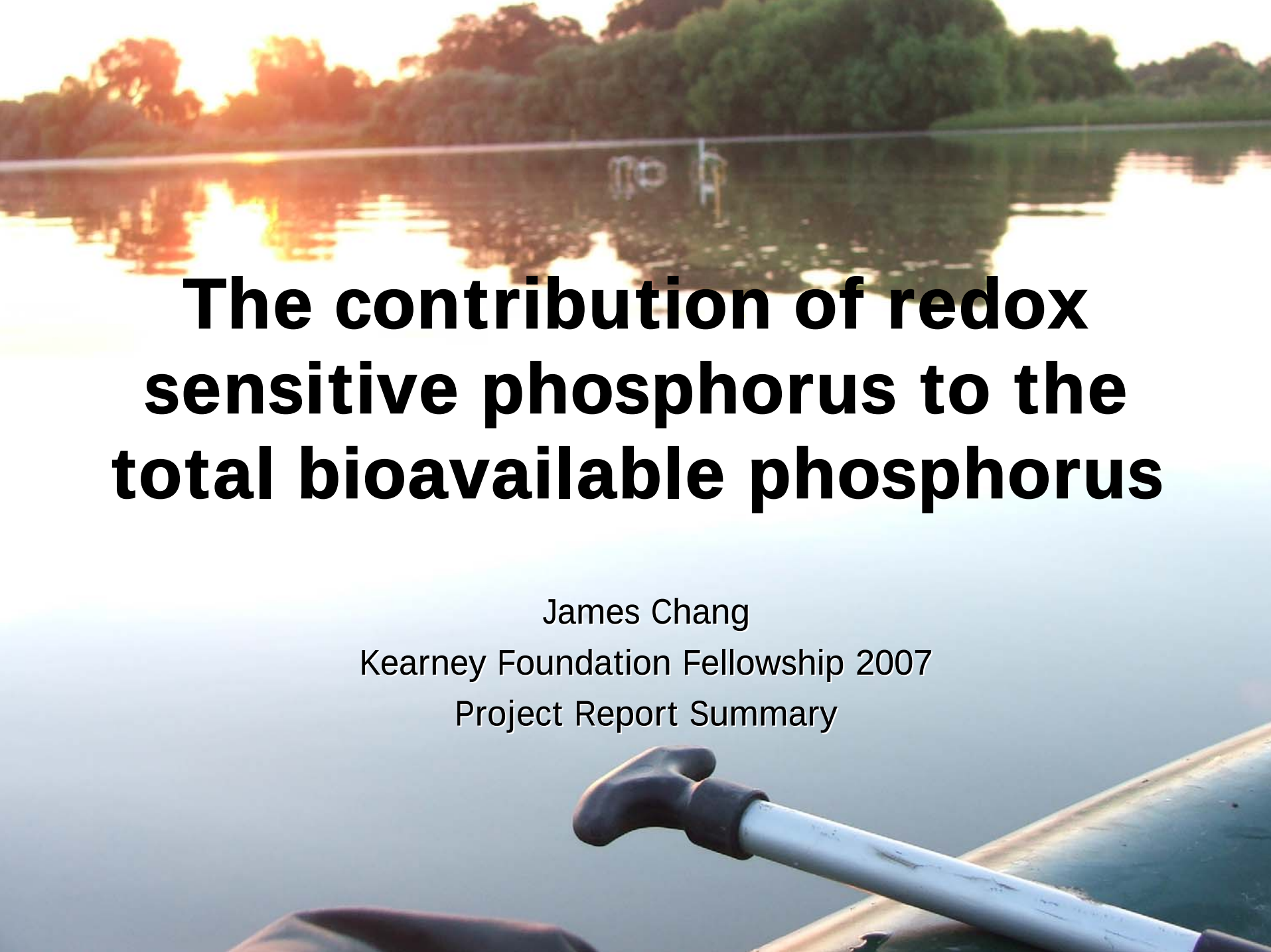

The contribution of redox sensitive phosphorus to the total bioavailable phosphorus

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Project Report Summary

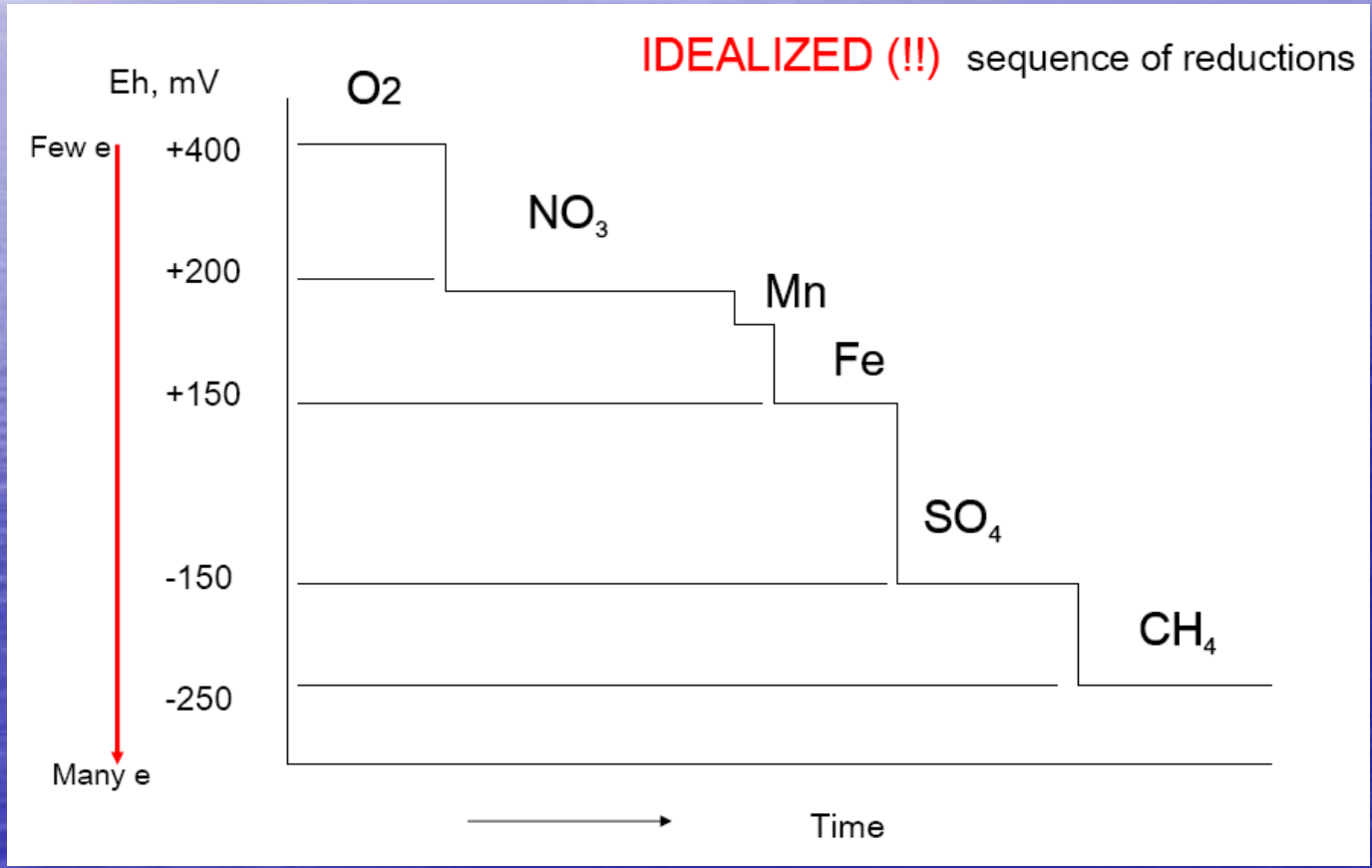
Objectives

- to investigate the contribution of redox sensitive phosphorus (RSP) to total available phosphorus by tracing RSP in the water column, in the suspended sediment, and in sediment cores.
- to show the spatial distribution of RSP in constructed wetland soils and relate this distribution to diurnal studies of dissolved oxygen (DO).

REDOX Reactions in Wetland Sediment

- Redox reactions occur in wetland sediment as microbes use different electron acceptors for respiration.
- The most desirable electron acceptor is oxygen
  - But since the diffusion of oxygen is so slow in water, wetlands soils become anoxic as oxygen is depleted by microbes during respiration.
- The next most favorable electron acceptor is nitrate. Then there is an descending order of preferences: Manganese, Iron, Sulfate, Carbon Dioxide.

Hierarchy of preferred electron acceptors in REDOX reactions (figure from Rejmánková, E. 2007)



REDOX Sensitive Phosphorus

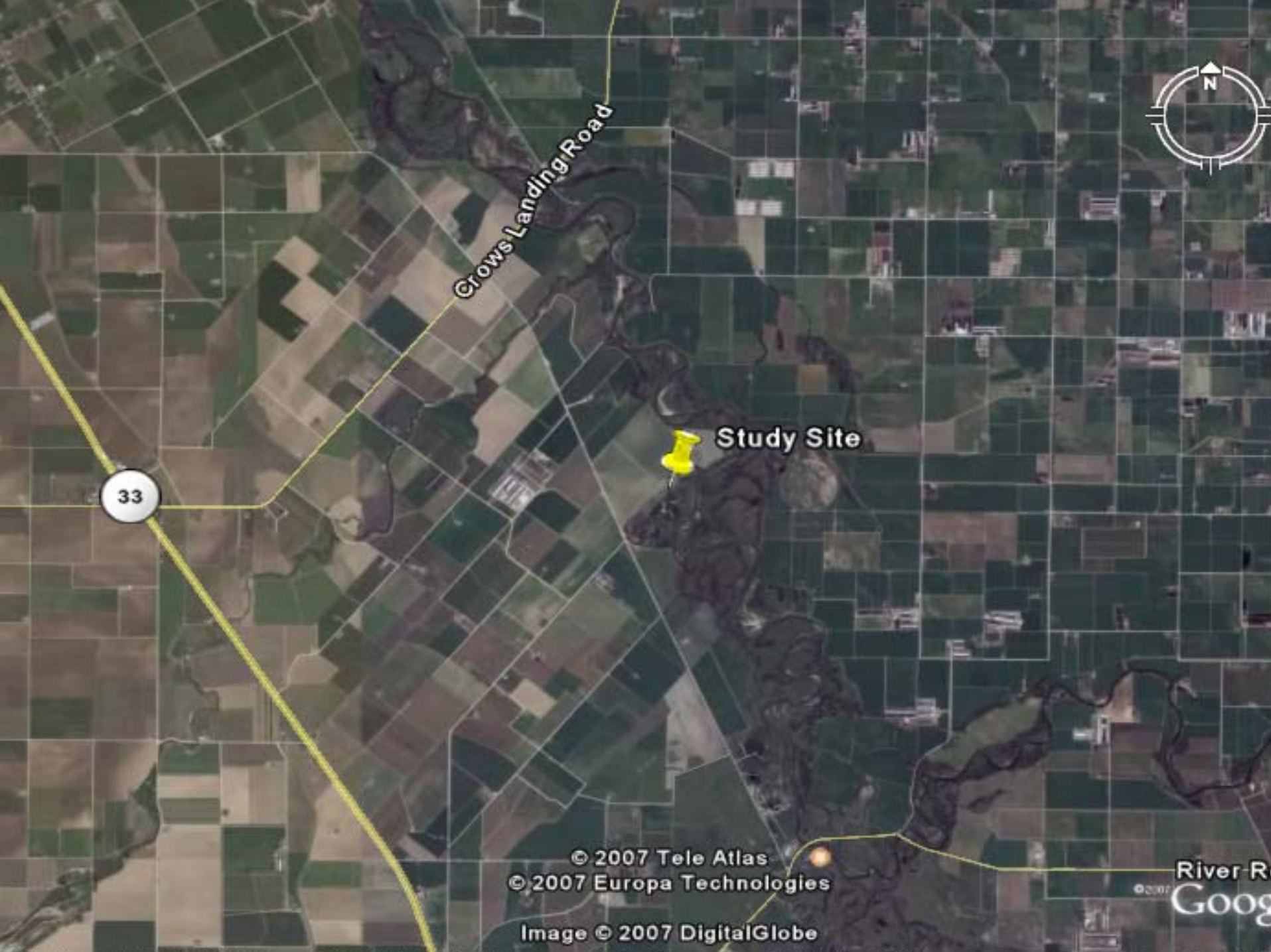
- Although phosphorus is not directly involved in REDOX reactions, the reduction of ferric iron (Fe^{3+}) to ferrous iron (Fe^{2+}) allows the RSP to become soluble.
- RSP can also be referred to as iron bound phosphorus
- As the phosphate become soluble reactive, it is available for biological uptake.

Significance of the project

- Most of the degradation of water quality in natural systems is contributed by non-point sources (Baker 1992, cited by Mitsch et al. 1995).
- The degradation of water includes eutrophication in rivers, lakes, and marine ecosystems.
- The abundance of nutrients such as nitrogen and phosphorus can also encourage the growth of invasive plant species (Vymazal 2007).
- Constructed wetlands are an applied system to improve the water quality of non-point source waste water, such as agricultural tailwater, before discharging into a natural system.

Study Site

- Privately owned constructed wetland (W1) occupying 7.3 hectares located directly adjacent to the San Joaquin River near the city of Modesto.
- W1 has an open water design, similar to a pond.
- The wetland is 3 years old and has been used for treating agricultural tailwater from about 4,000 acres of contributing farm land and for recreational duck hunting by the owner.
- Agricultural tailwaters entering this wetland are primarily contributed by farms growing deciduous nuts and fruits.
- W1 is a seasonal wetland that is flooded between mid-spring and early fall.


Crows Landing Road
Study Site
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N
© 2007 Tele Atlas
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Image © 2007 DigitalGlobe
©2007 Google™
Pointer 37°23'36.92" N 120°59'42.08" W elev 52 ft Streaming 100%
Eye alt 3375 ft

Water Sample Analysis

- Grab samples were collected weekly in the input and output for the entire season.
- RSP was extracted using the dithionite extraction method on an unfiltered sample.
- The sample must be unfiltered to include the iron bound phosphorus or any precipitated forms of phosphorus.
- The concentration of RSP is analyzed colormetrically, using the ammonium molybdate method after an autoclave digestion.

Grab Sample Results

- The concentrations of RSP in grab samples were 0.21 ± 0.07 ppm in the input and 0.22 ± 0.12 ppm in the output, which isn't significantly different.
- The concentrations of RSP in grab samples in the diurnal study is yet to be analyzed.

Suspended Sediment Analysis

- Suspended sediment samples were collected in 25 detachable sediment traps in the wetland.
- These samples were collected monthly.
- Bicarbonate dithionite extraction methods were used to determine the concentration of RSP in the soil from the sediment traps.
- The concentration of RSP was analyzed colormetrically, using the ammonium molybdate method after an autoclave digestion.

Suspended Sediment Results

- The concentrations of RSP in the sediment traps ranged from 60 to 200 mg P/kg (Fig 1).
- The spatial distribution of RSP is highly variable. Samples analyzed on June 12th were high in concentration mostly likely due to an error in the procedure.
- This error was associated failing to homogenize the sediment and performing the bicarbonate dithionite extraction primarily on clay particles.

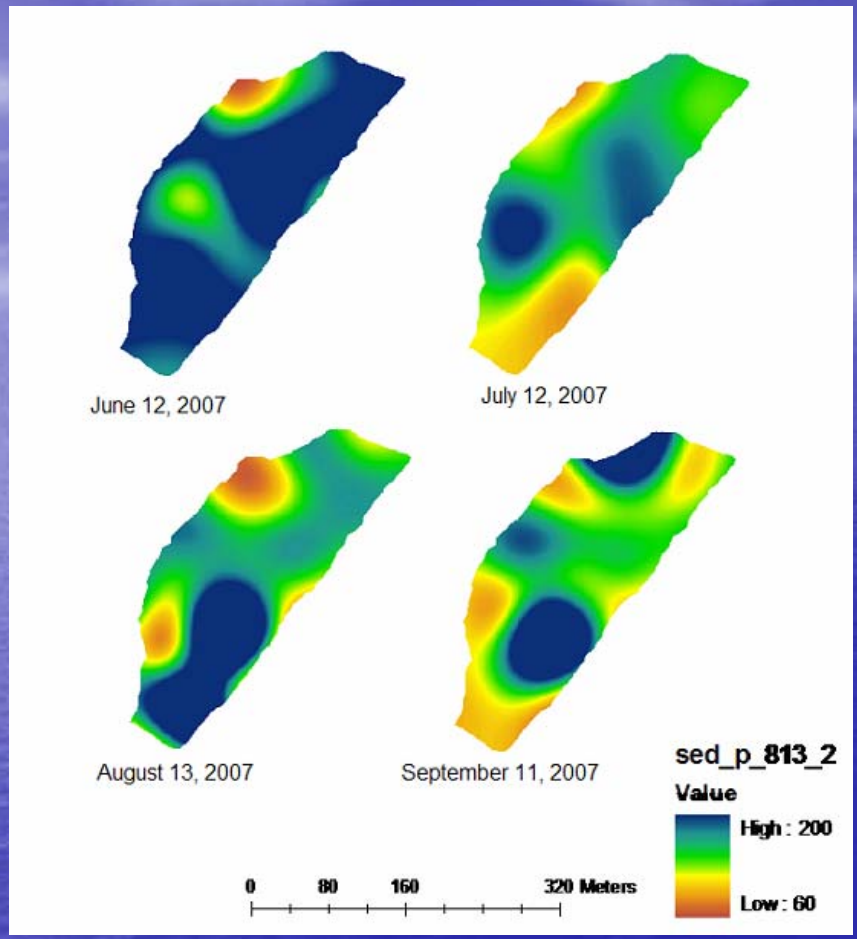

Figure 1. Isopleths of the iron reducable P in the suspended sediment from sediment traps.

Sediment Cores

- The sediment cores were taken for interests in the upper 0-5 cm layer.
- Samples were immediately purged with nitrogen gas to keep the soil under anoxic conditions.
- Sediment core samples have not yet been extracted.
- They were kept frozen until they thawed and extracted for RSP.
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Expected Results from Sediment Core Sampling

- What we may expect to see in the sediment core samples is a lower concentration of RSP compared to the RSP in the suspended sediment.
- As the suspended sediment settles and becomes exposed the anoxic soil, the phosphate becomes released.
- We can also expect to find higher concentrations of iron in the sediment cores that is not bound to phosphorus.

Restating Objectives

- to investigate the contribution of redox sensitive phosphorus (RSP) to total available phosphorus by tracing RSP in the water column, in the suspended sediment, and in sediment cores.
- to show the special distribution of RSP within W1 and relate this distribution to diurnal studies of dissolved oxygen (DO).

Conclusions?

- No conclusion can be made about the data at this point as the results are still in progress.
- Potentially, future results can be drawn together to further depict the biogeochemical processes within this wetland and how they may influence phosphorus availability.

References

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