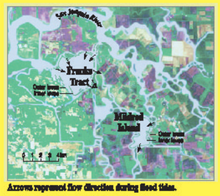
Frank and Millie's Secrets Revealed

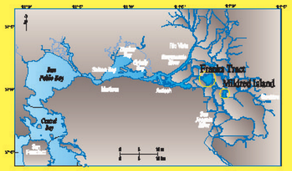
Exclusive! Comparison of "*Similar*" Shallow Tidal Habitats in the Sacramento-San Joaquin River Delta

Lisa V. Lucas, James E. Cloern, Janet K. Thompson, and Nancy E. Monsen

USGS science for a changing world

A Really Moving Story!





Comparison of existing habitats is one way ecosystem science can reveal and reduce restoration uncertainties. Here we compare Franks Tract (FT) and Mildred Island (MI), two examples of "shallow tidal habitat," a habitat type targeted for restoration in the Sacramento - San Joaquin River Delta. The basis of comparison was production and distribution of phytoplankton biomass as the food supply to pelagic consumers (zooplankton). We focused on this function because declining productivity in the pelagic foodweb may be one contributor to the decline in Delta fish populations.

Source or Sink?

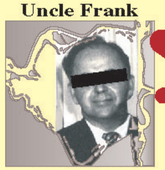
The freshwater clam, *Corbicula fluminea* is a major sink for phytoplankton biomass.

TRUE: Uncle Frank and Aunt Millie were real people.

TRUE: Frank and Millie know nothing about this poster.

FALSE: Lisa chose these sites because of their names.

Uncle Frank

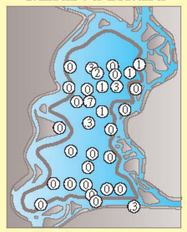


Aunt Millie

Franks Tract

Corbicula was abundant throughout FT - high benthic grazing

Mildred Island



Corbicula was sparse throughout MI - low benthic grazing

Benthic Grazing Rate (m/d)

Effective rate of phytoplankton growth, μ, is a metric for comparing food supply to pelagic grazers in MI and FT.

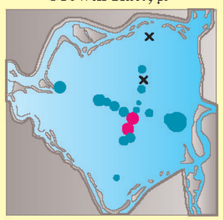
μ = depth-average of local sources and sinks of phytoplankton biomass

Positive μ – system is local net source of phytoplankton biomass to pelagic grazers

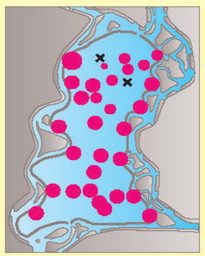
Negative μ – system is local net phytoplankton sink

So Shocking!

Effective Phytoplankton Growth Rate, μ



Net sink for phyto-plankton biomass



Net source of phytoplankton biomass to pelagic food web

μ(1/day)
0.8 to 0.9
0.6 to 0.7
0.4 to 0.5
0.3
0.2
0.1
0
-0.1 to -0.5
-0.6 to -1.0
-1.1 to -1.5
-1.6 to -2.0
-2.1 to -3.0
-3.1 to -4.0

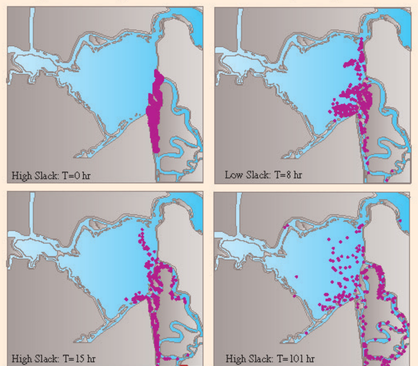
differences in growth rate begin to explain differences in chlorophyll

Where is it *GOING*?

LEAKY!

A model of tidal hydrodynamics (DELTA-TRIM) was used to understand transport using numerical particles.

Tidal sloshing between shallow FT, where clam grazing is high, and deep channels, where clam grazing is low



Tidally averaged **import** of channel water to FT

Explains the paradox of sustained biomass in FT, where growth is negative

Dispersion by multiple levee breaks + tides

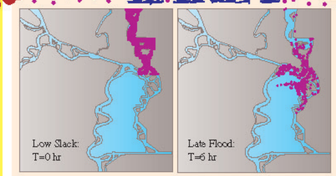
Explains the weaker spatial gradients in FT than in MI and stronger gradients on neap

Super Clam Hates Millie but Loves Frank!

LAKEY

Is Franks Tract a Roach Motel*?

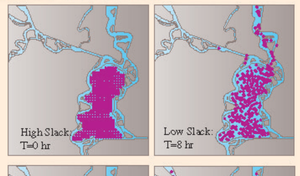
*phytoplankton check in but they don't check out.



Tidal sloshing between shallow (high-μ) MI and deep (low-μ) channels

Tidally averaged **import** of northern channel water to MI

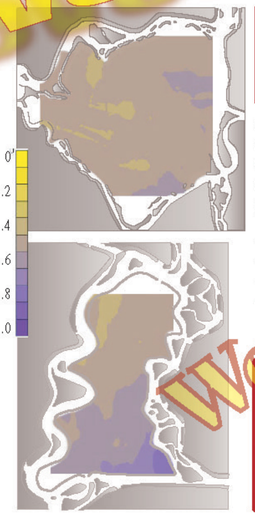
Explains N-S chl *a* gradient and tidal variations in chl *a* patterns



Longer **residence time** in southern MI than in northern MI

Contributes to N-S chl *a* gradient

What does this all mean?



Potential Zooplankton Growth Rate
normalized to max. growth

Zooplankton growth rate is a strong function of chl *a*[1]. We transformed maps of chl *a* into maps of potential zooplankton growth:

- spatially variable in MI and FT
- food-limited
- comparable in FT and MI (ave ~ 0.6), but for different reasons

MI was a net producer

FT was a net importer

Wow!

Startling Discoveries!

Seemingly similar, nearby habitats can function very differently.

Loose Lips

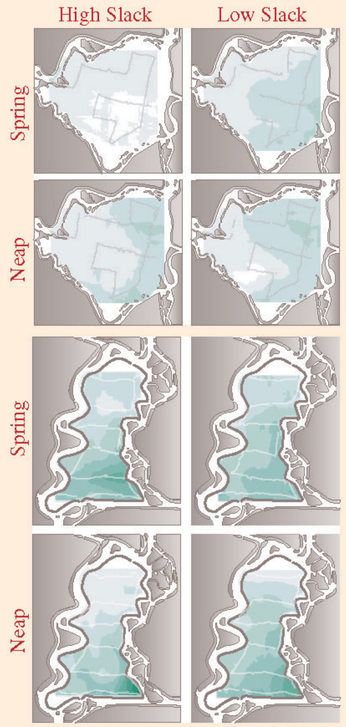
"Millie functioned as a producer of food for zooplankton, Frank functioned as an importer."
– Jim '*Coscinodiscus*' Cloern

Before new habitats are created, short-term comparative studies of similar ones can:

- reveal possible restoration outcomes
- identify critical processes
- optimize the likelihood of meeting restoration goals.

Sampling up close and personal

Phytoplankton Biomass, June, 1999



- Chl *a* varied within and between FT and MI
- Average chl *a* and its spatial gradients were greater in MI than in FT
- Chl *a* increased southward in MI
- Chl *a* increased eastward in FT
- Spatial patterns shifted over tidal (hourly) timescales
- Spatial gradients were sharper during neap tide than during spring tide

Chlorophyll *a* (μg L-1)
0 1 2 3 4 5 6 7 8 9 10

(Lines are the boat paths where chlorophyll fluorescence was measured every second or every ~2 m.)

Acknowledgements: Andy Arnsberg, Doug Ball, Laurent Chauvaud, Jay Cuetara, Jody Edmunds, Lenny Grimaldo, Jean-Marc Guarini, Steve Hager, Peter Kitinidis, Francis Parchaso, Heather Peterson, Tara Schraga, Mike Simpson, Bill Sobczak, Robin Stewart, Anke Mueller-Solger[1], and Jon Yokomizo.

October 2001 Jeanne Sandra DiLeo 2/2002