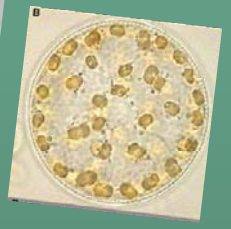
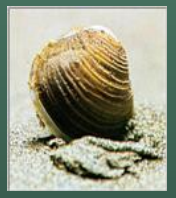
Clams – where, how, and can we limit the damage.

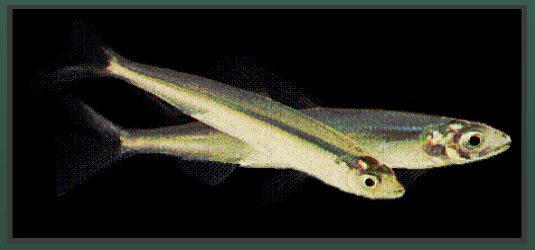
Jan Thompson (USGS – Menlo Park)

With critical help from
Francis Parchaso (USGS)
Karen Gehrts, Dean Messer, and the benthic monitoring team at DWR

Is it broken?







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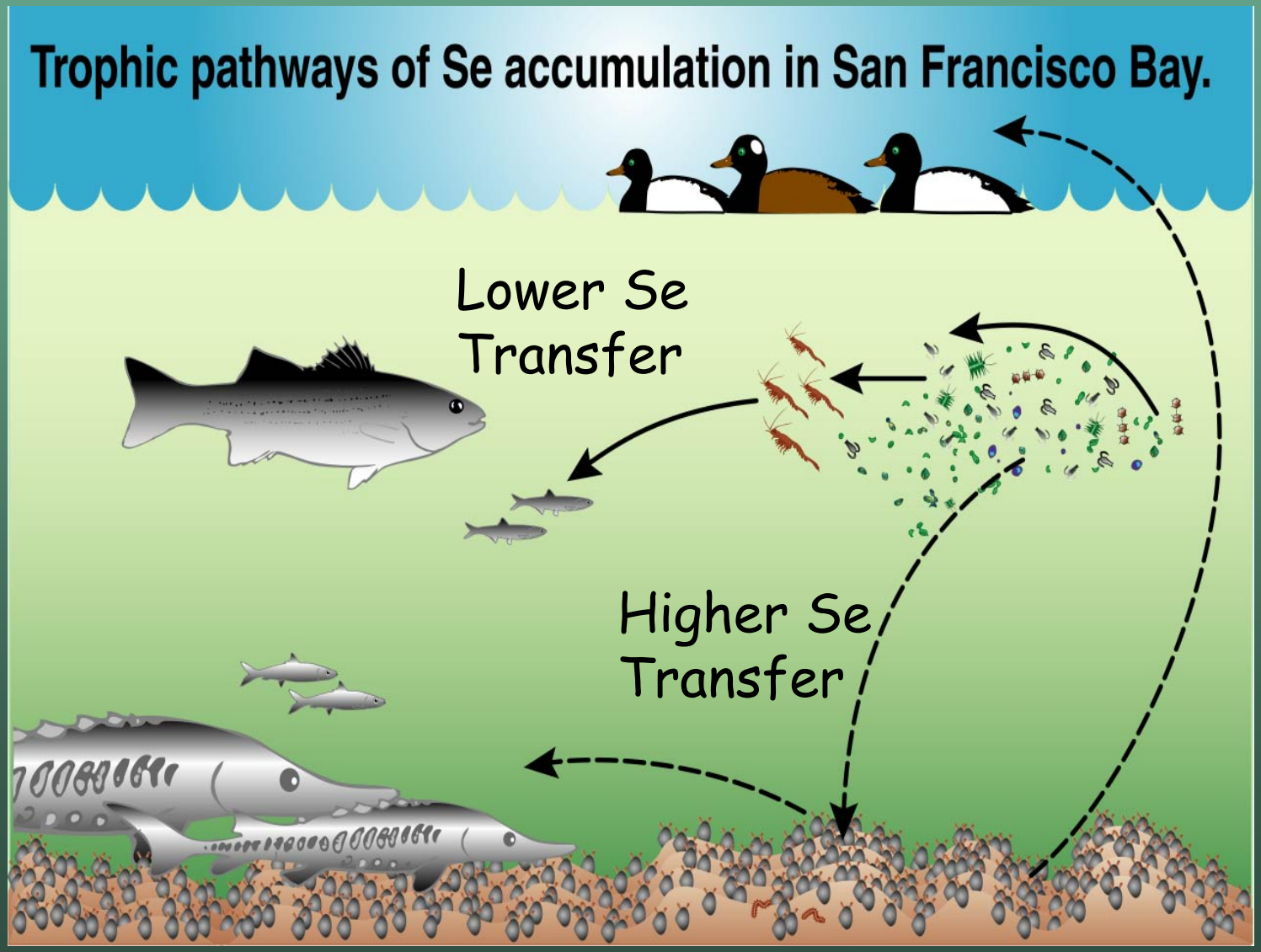
We need to take care in not breaking it a new way



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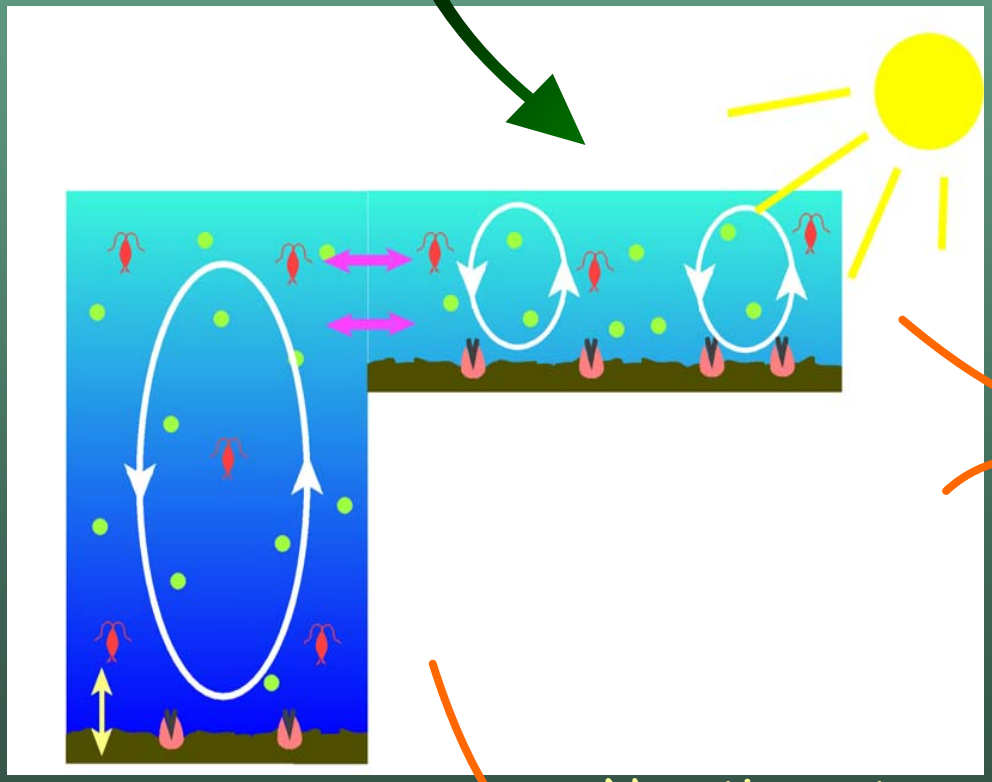
How to build a bloom: Because phytoplankton growth rate is optimal in the shallow water, blooms start in the shallow water and are advected to the channel



Courtesy of Lisa Lucas

Faster growth because more frequent access to light –grazing limited to zooplankton

Negative net production - not enough light because of slower water column turnover

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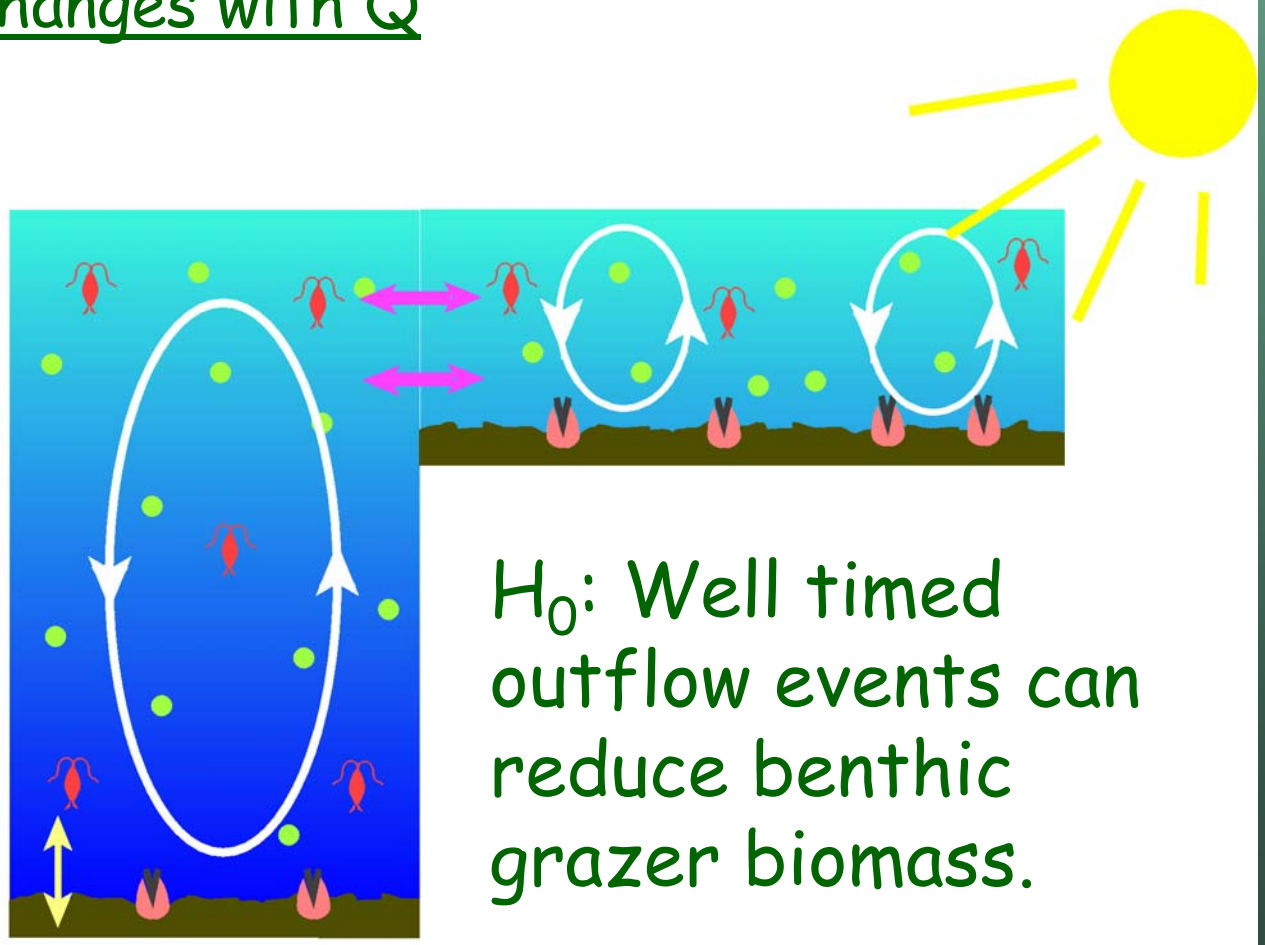
There is a critical balance between residence (exposure) time, light availability, grazing in the shallow water, and sloshing distance that maximizes phytoplankton growth rate.

Each of these variables changes with Q



H_0: Well timed outflow events can reduce benthic grazer biomass.

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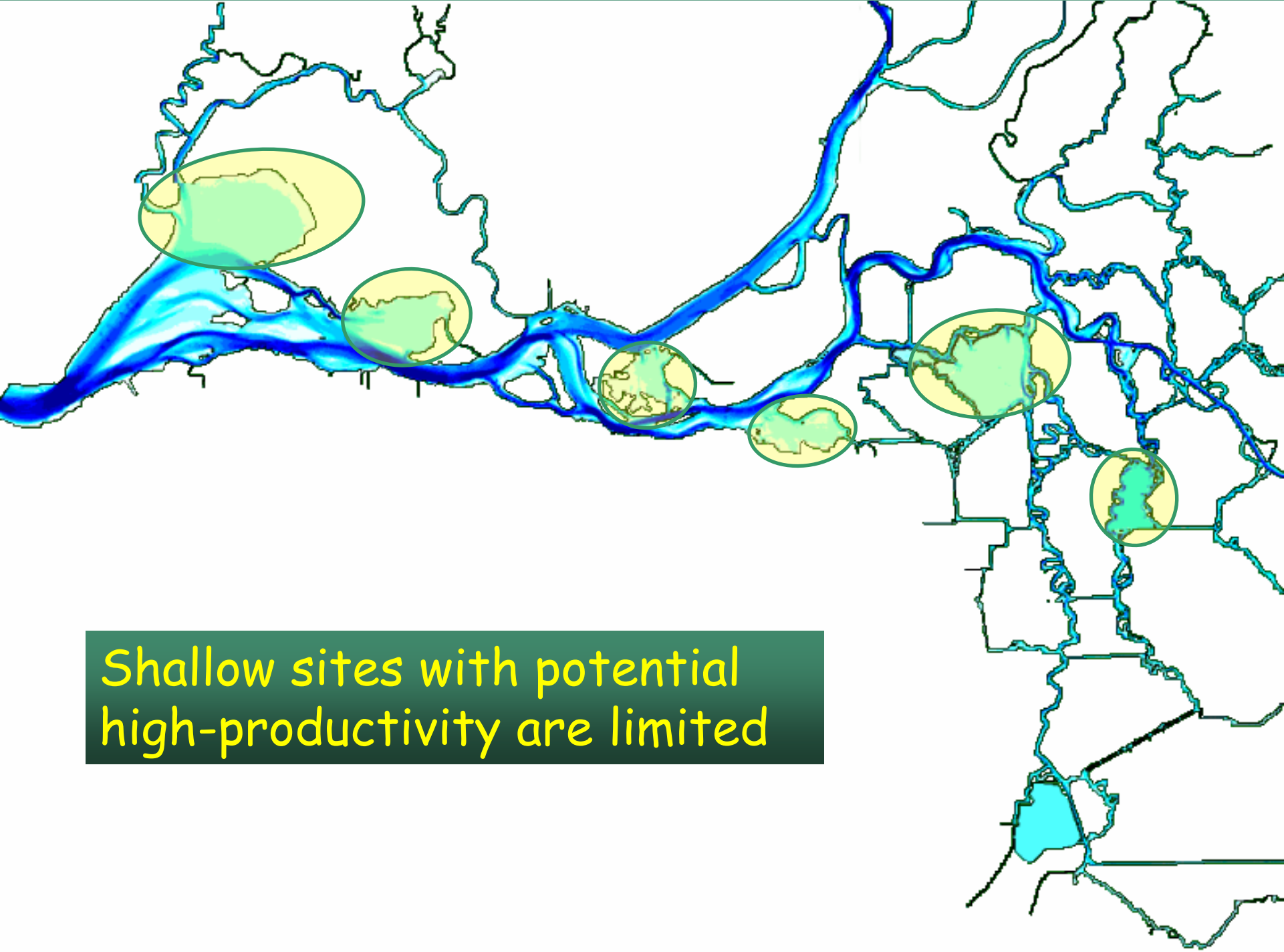
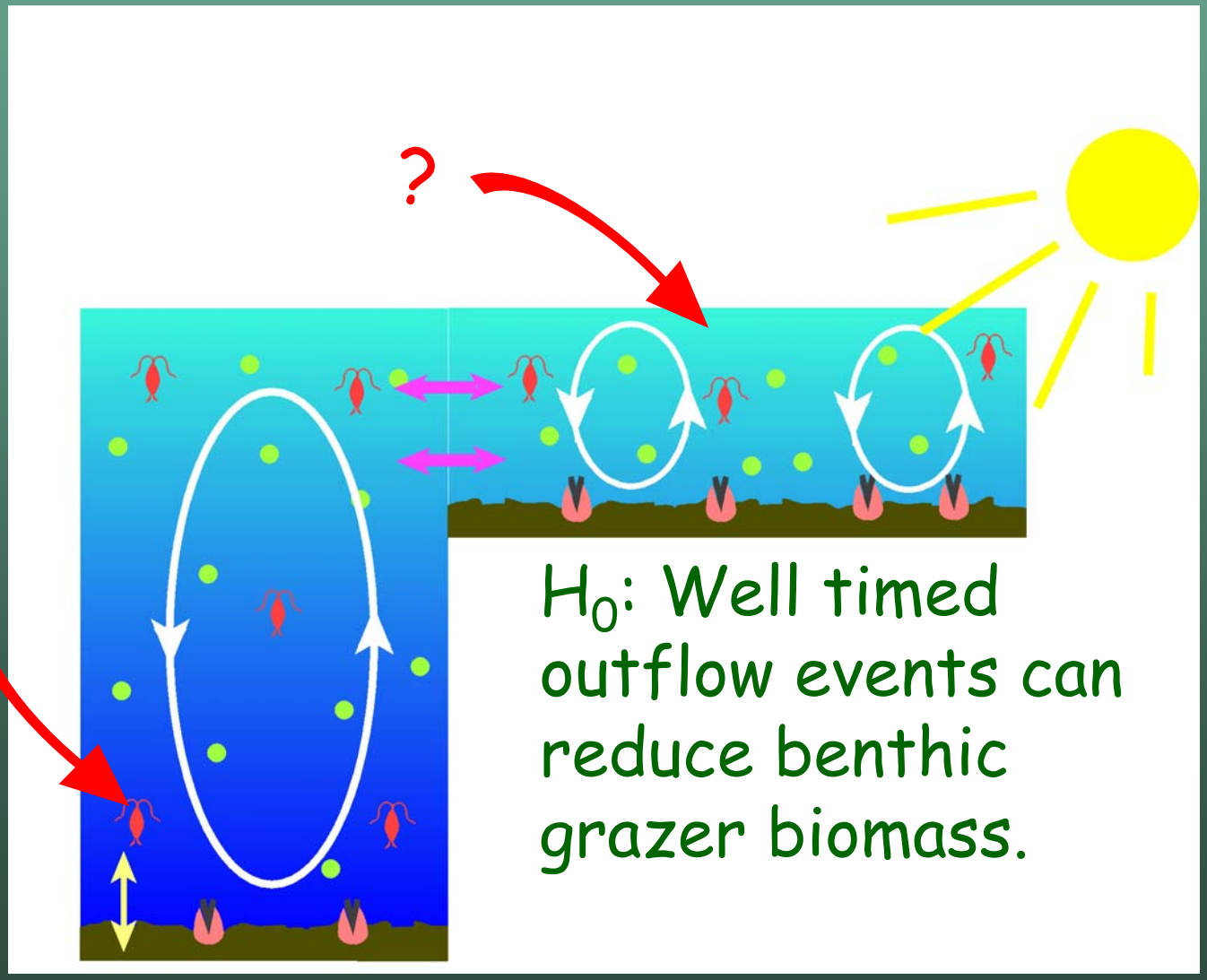


Shallow sites with potential high-productivity are limited

Warning: We know little (anything?) about zones where zooplankton may be more prone to bivalve filtration



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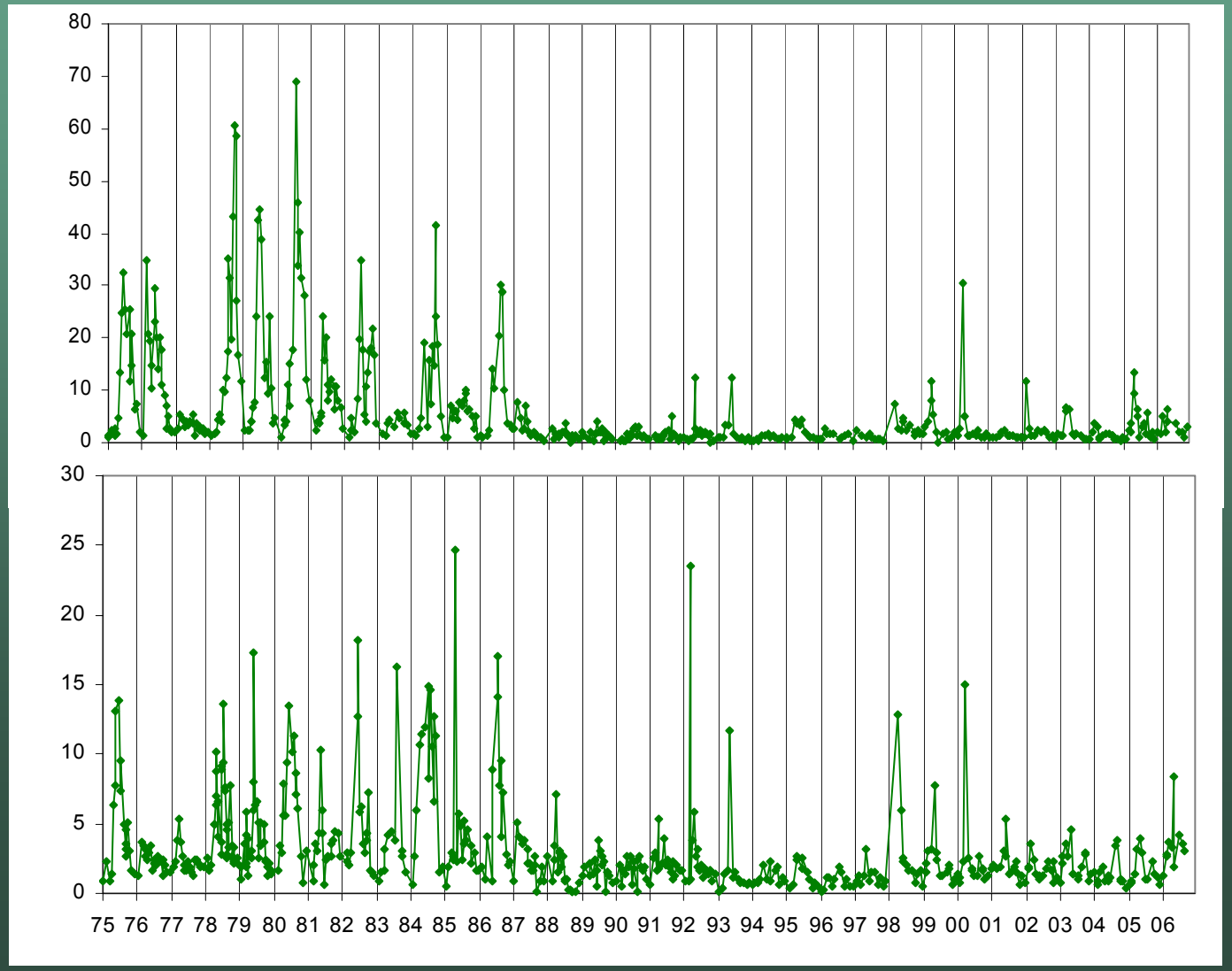
Paradigm: Overgrazing by bivalves in the shallow portions of the system resulted in declines in phytoplankton biomass througout the bay/estuary



Grizzly Bay (D7) DWR & USGS

Channel at Chipps Is. (4.1) USGS

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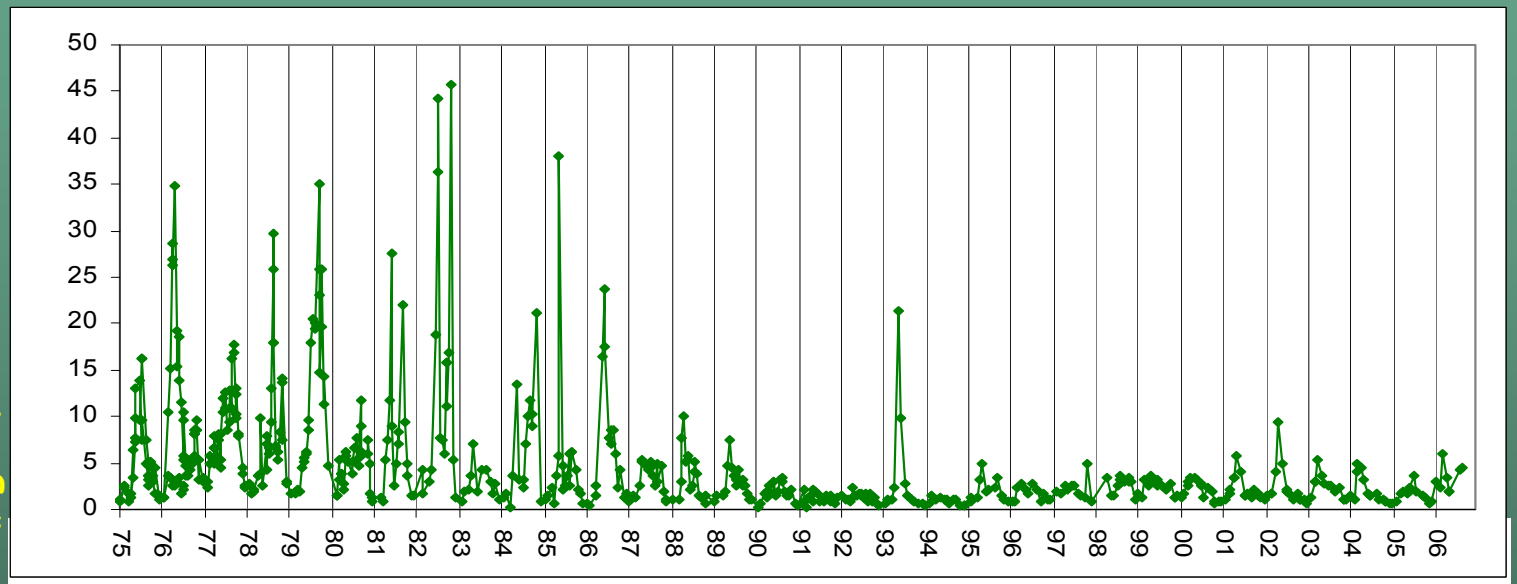
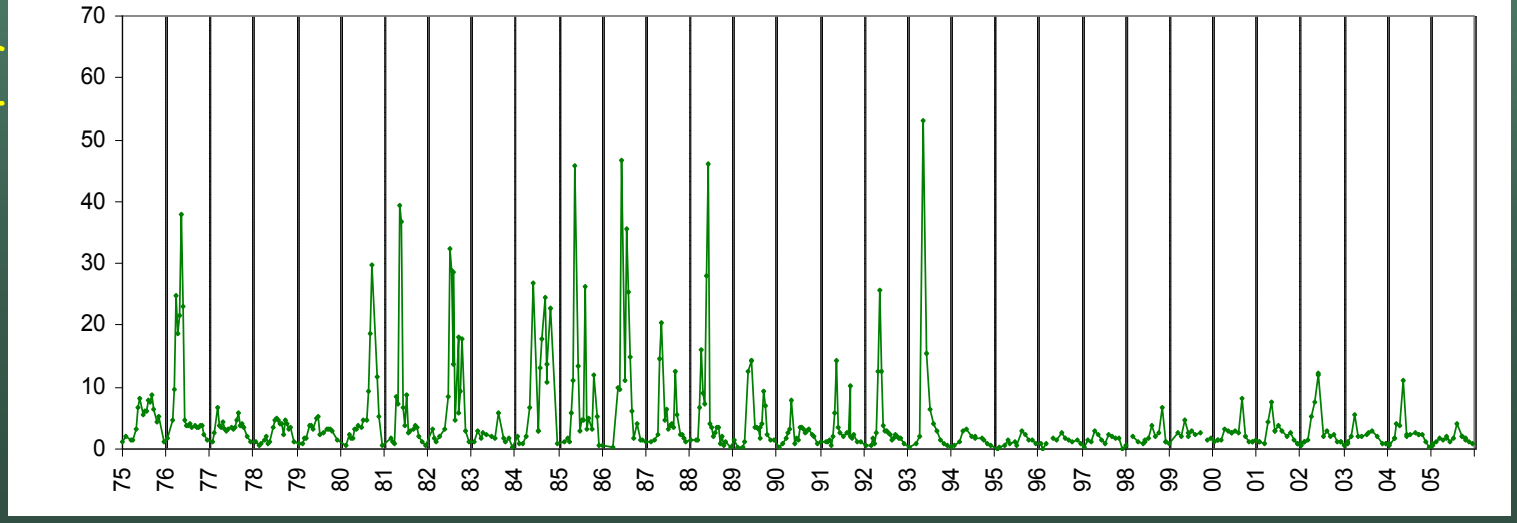
The effects reach beyond the locale of the bivalves due to dispersion.

Chlorophyll a (µg/L)



Channel Sac R (D4)-DWR



Channel SJR (D16)-Twitchell Is. DWR

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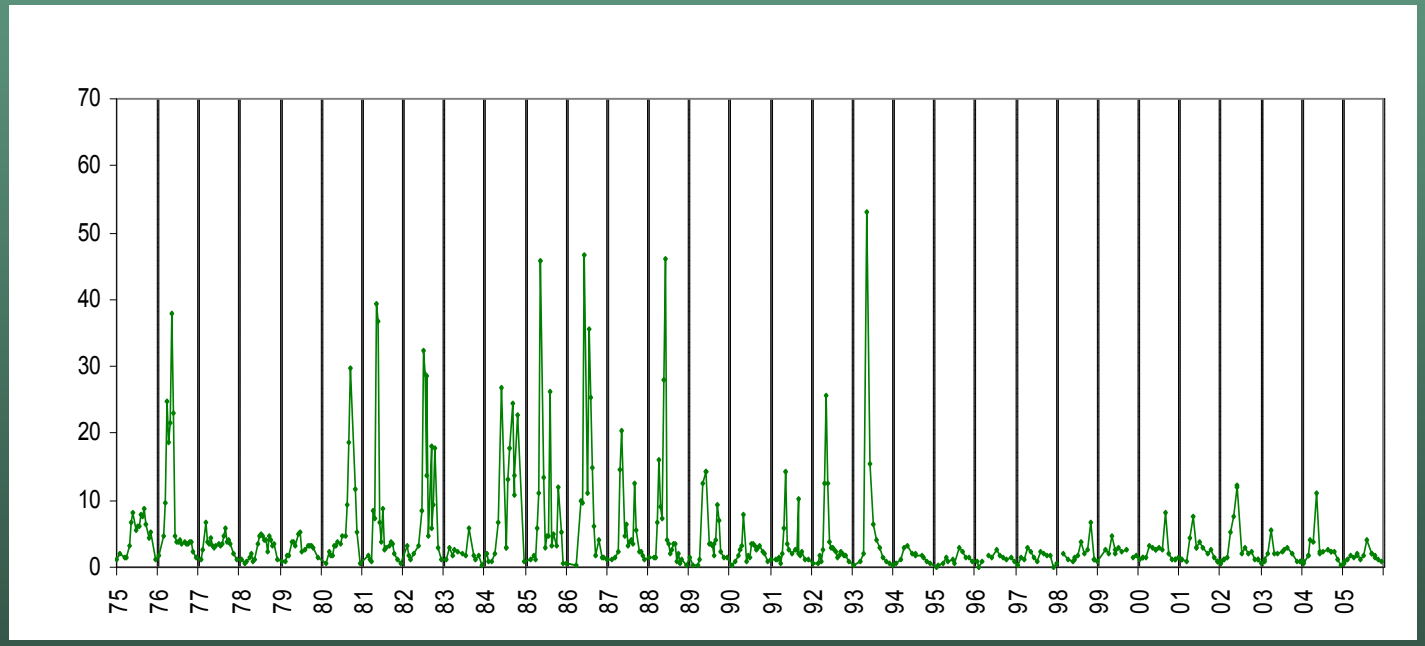
The good news: *Corbicula* co-existed with phytoplankton in the estuary since 1940's so if we don't/haven't changed these clam population in some critical way, maybe we can go back in time?



Channel SJR (D16)-Twitchell Is. DWR

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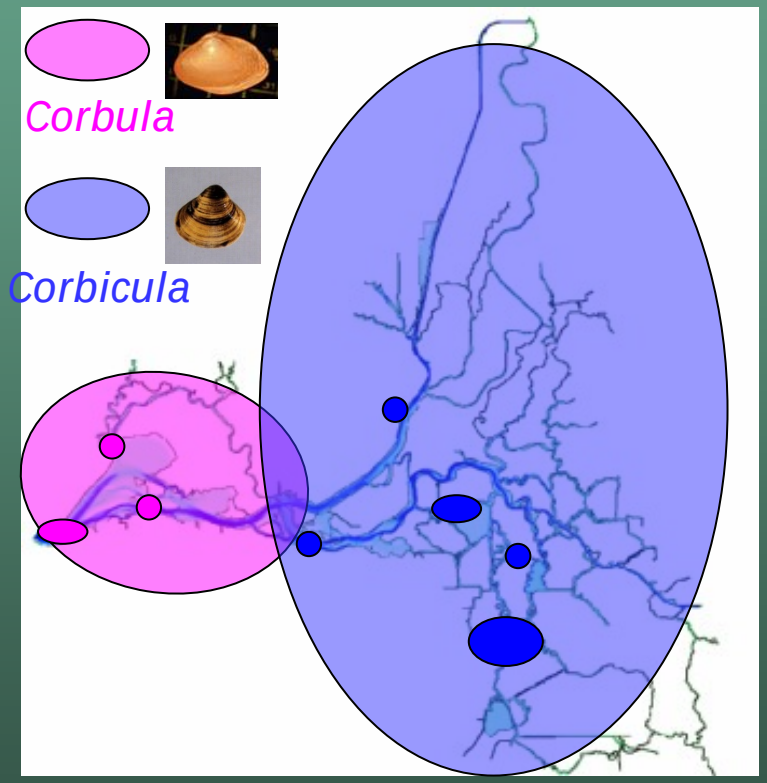
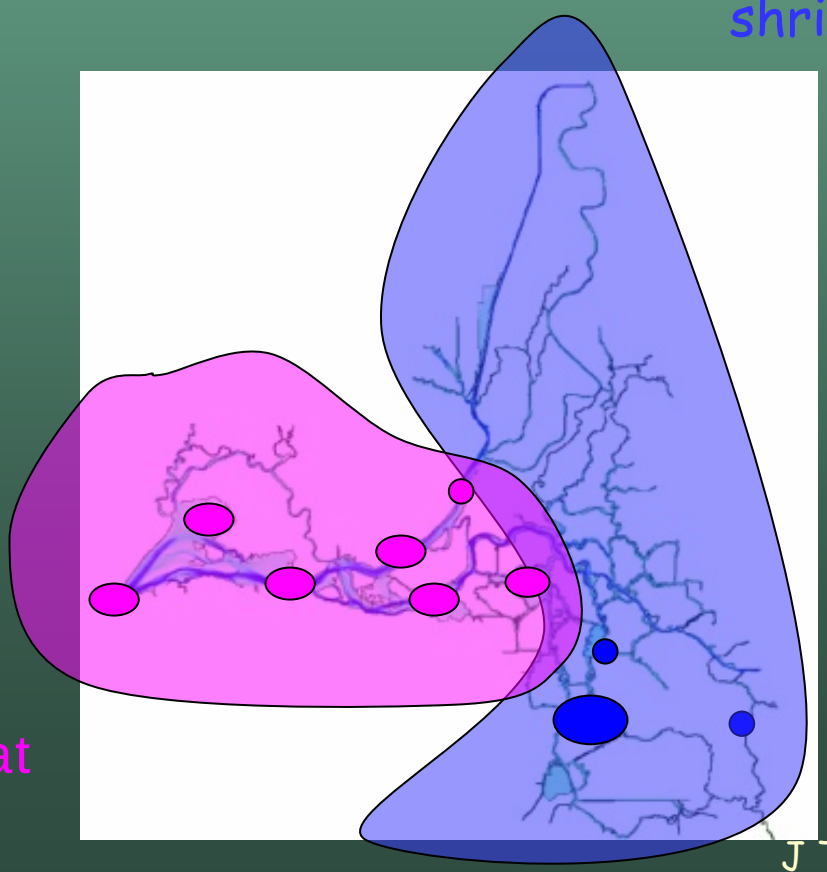
The Questions:

1) Can we push the freshwater long enough and at the right time, to push *Corbula* out of phytoplankton production zone without expanding *Corbicula's* range
2) Then – will the salt water allow *Corbula* to expand their range while allowing ADULT *Corbicula* to survive the salt water

Lesson 1: This is a food limited system even for clams. There will be no net gain in clam biomass unless there is net gain in available, labile carbon – with the exception of the SJR.



Corbicula habitat shrinks



Corbula habitat increases

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Lesson 2: That does not mean that *Corbula* ≠ *Corbicula*. They may differ in preferred habitat which may affect pelagic food production. Contaminant accumulation differs (*Corbula* has a higher Se accumulation rate).

Corbula

400 L/g/d
at 16°C**

Corbicula

70 L/g/d
at 16°C*

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*Foe and Knight 1986 **Cole et al. 1992

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Lesson 3: There is one major physiological trait that MAY allow us to manipulate the two clam species without encouraging one while discouraging the other

	Corbula	*Corbicula*	Exploitable?
Adult °C	Unknown	≈2-34 °C	No
Juvenile °C	Unknown	≈2-30 °C	No
Reproduction °C	?-23-? °C	≈15-26 °C	No
Substrate	Not Cement	Includes Cement	No
Food Sources	Phytoplankton, Bacteria Zooplankton	Phytoplankton, Bacteria Zooplankton & Deposit Feeding	No
Life Span	2-3 yr	5-7 yr	No

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Osmotic tolerances of the clams are significantly different but they do overlap as adults.

Corbula

Corbicula

Adult Salinity: 35 – 10 (*Corbula*); 0* – 0 (*Corbicula*)

Recruit Salinity: 30 – 2 (*Corbula*); 0 (*Corbicula*)

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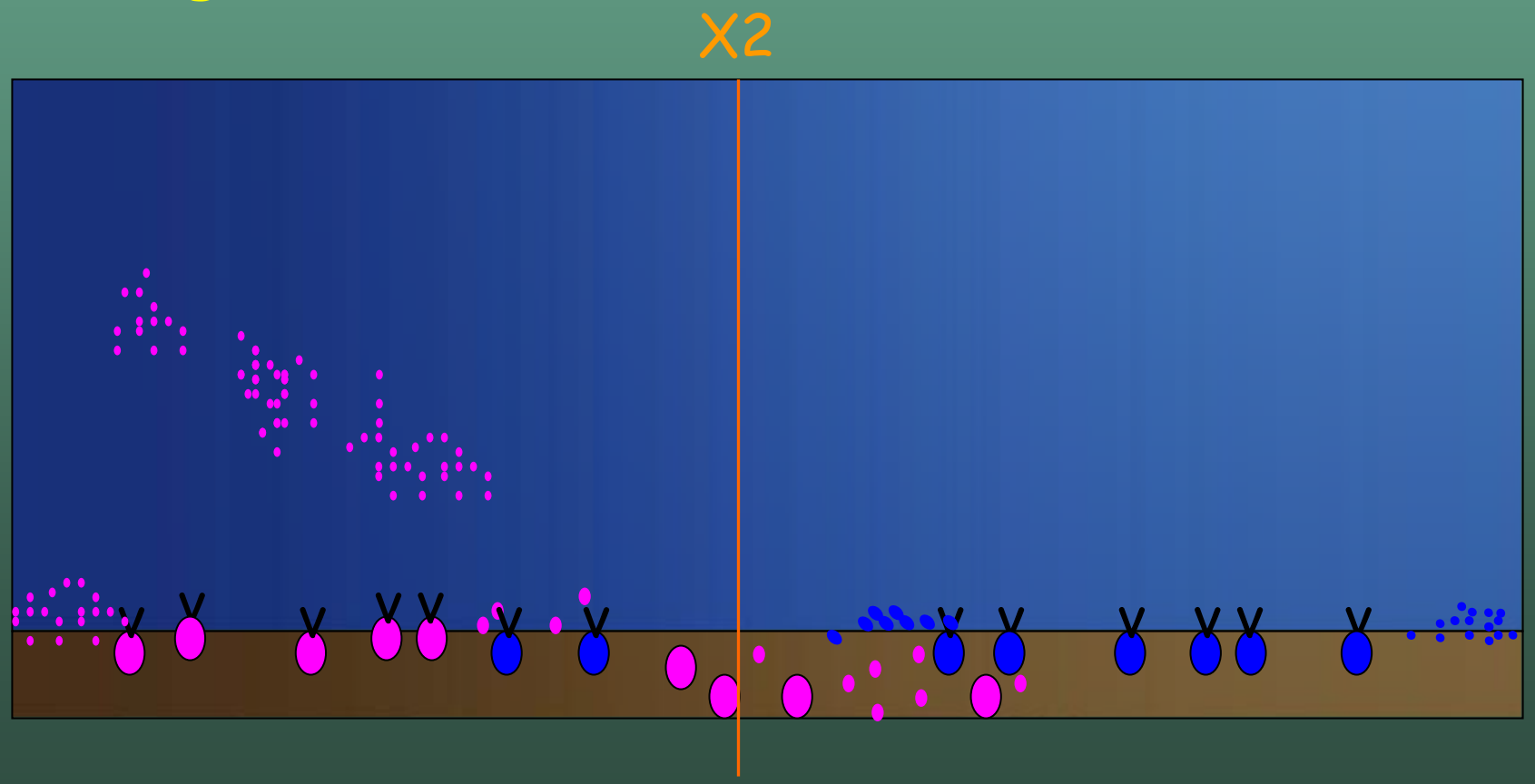
These clams are both classic "opportunists" and so they have many adaptations. A look at the populations in the overlap region (around X2) shows the strengths of the species. In the overlap – advantage *Corbula*.



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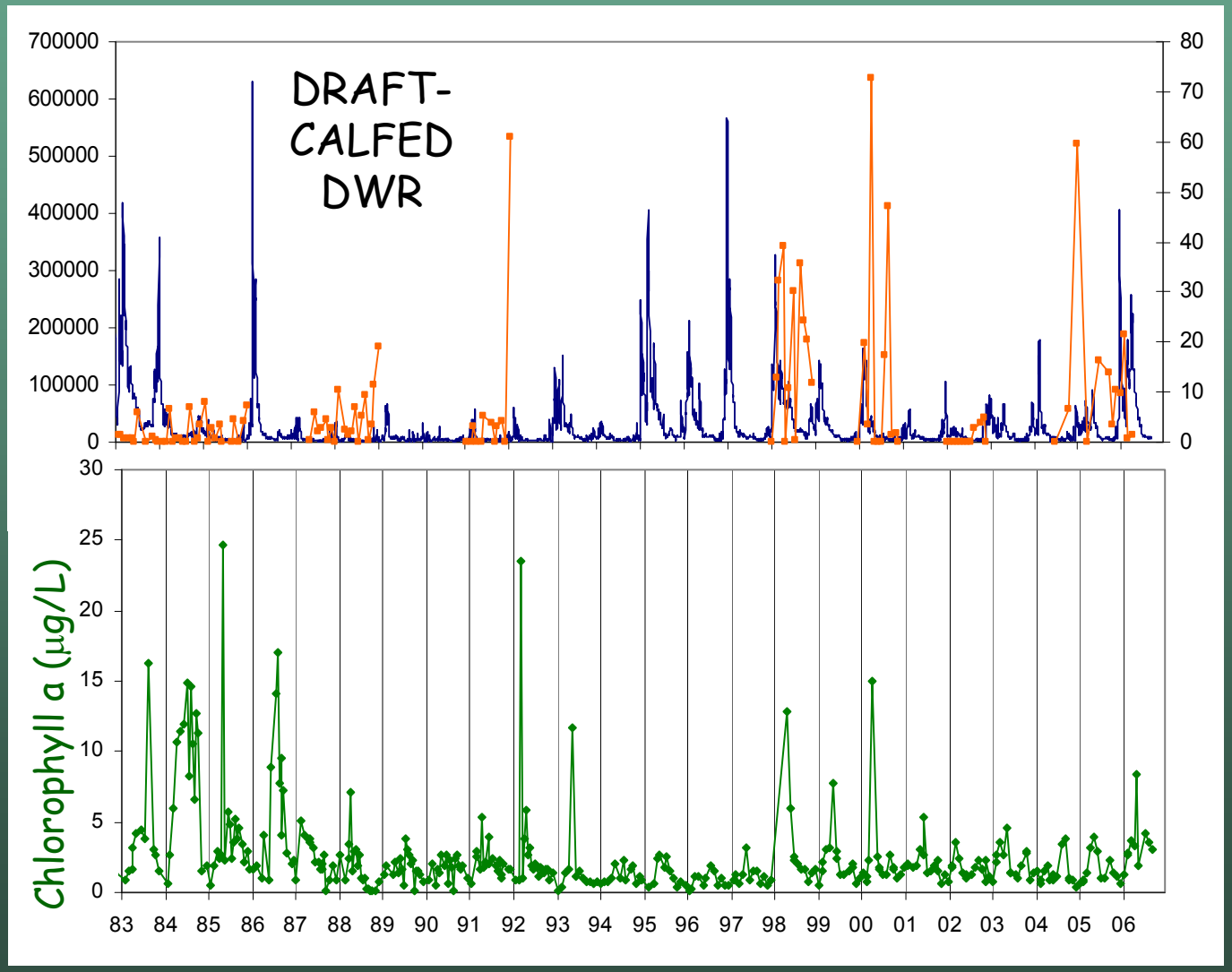
What do we know about *Corbicula* that may cause problems?

- Lesson 1: There is some indication that *Corbicula* biomass has increased since the drought.
- Lesson 2: Reproduction is amazing.
- Lesson 3: Recruitment does not always translate to biomass
- Lesson 4: They are food limited but can outlast most other species
- Lesson 5: They can limit phytoplankton biomass in shallow water.
- Lesson 6: They 'understand' neighbor living and connectivity
- Lesson 7: It's not all about clams

Lesson 1: The data are sparse but so far there is some indication that *Corbicula* biomass has increased since the decline in phytoplankton biomass in the 1980's.



Channel at Chipps Is. (4.1) USGS

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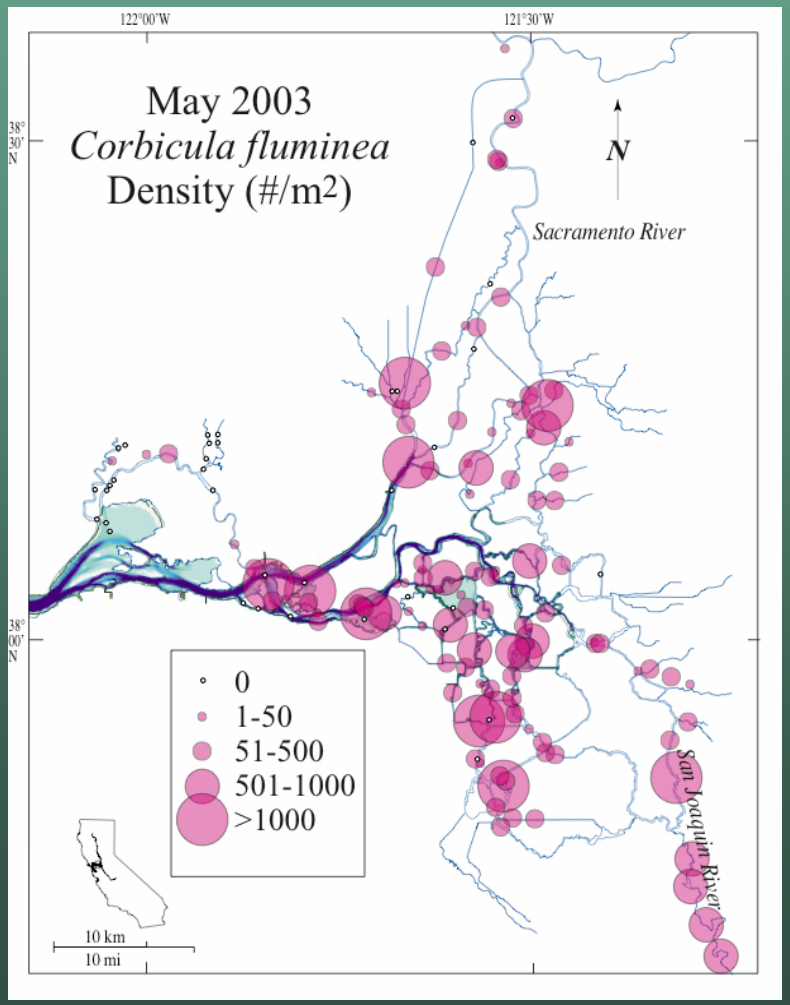
Lesson 2: Reproductive habits allow this species to be ready at all times to expand their range.



- They are hermaphroditic and release brooded juveniles only when food is available
- Babies are always present
- Both adults and juveniles are transported with currents

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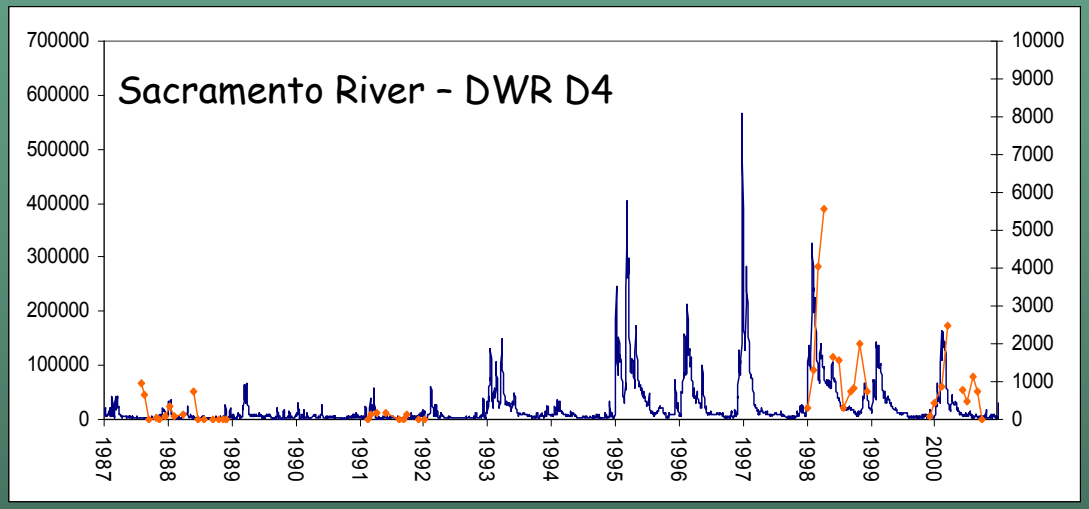
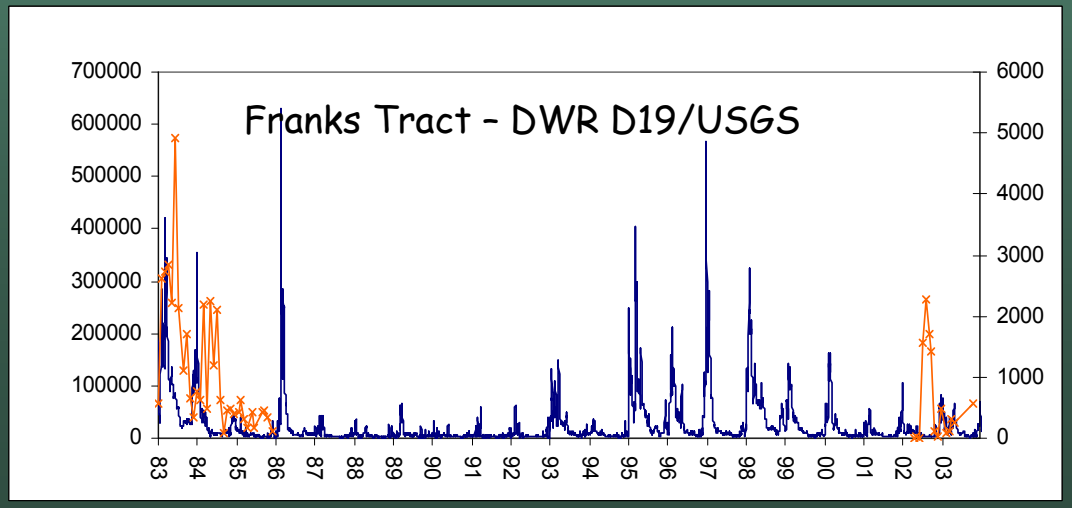
Lesson 2: Reproductive habits allow this species to be ready at all times to expand their range. Recruitment is positively related to delta outflow – particularly in channels but also in flooded islands.





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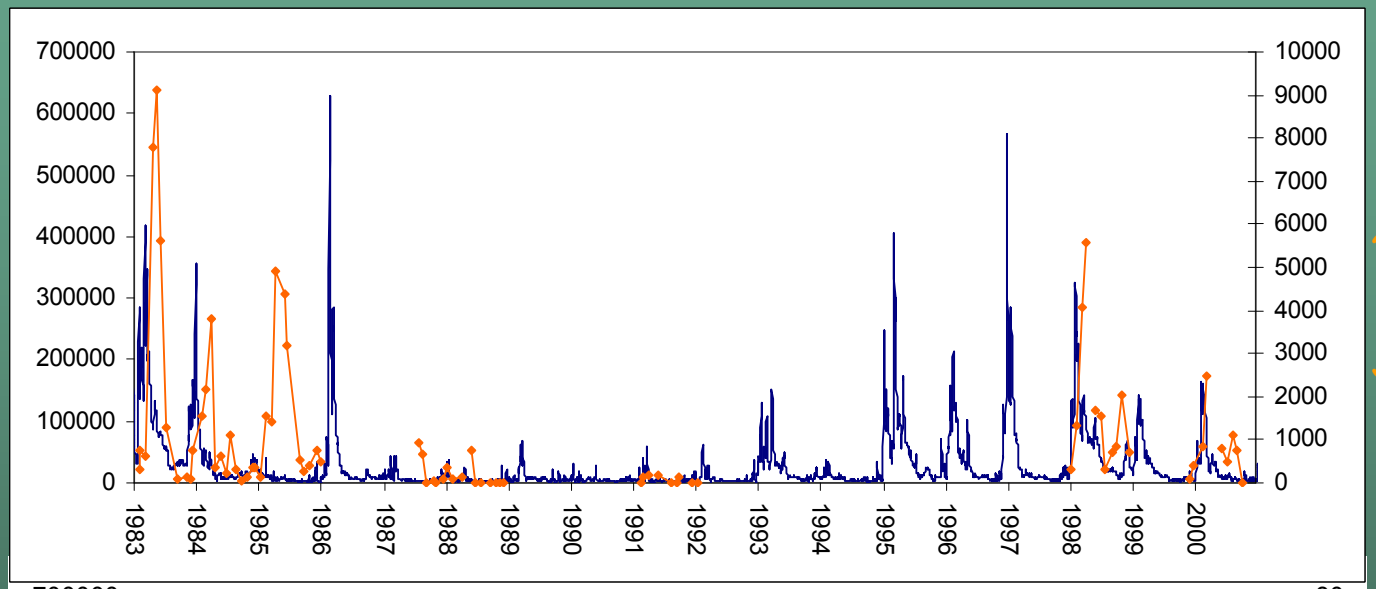
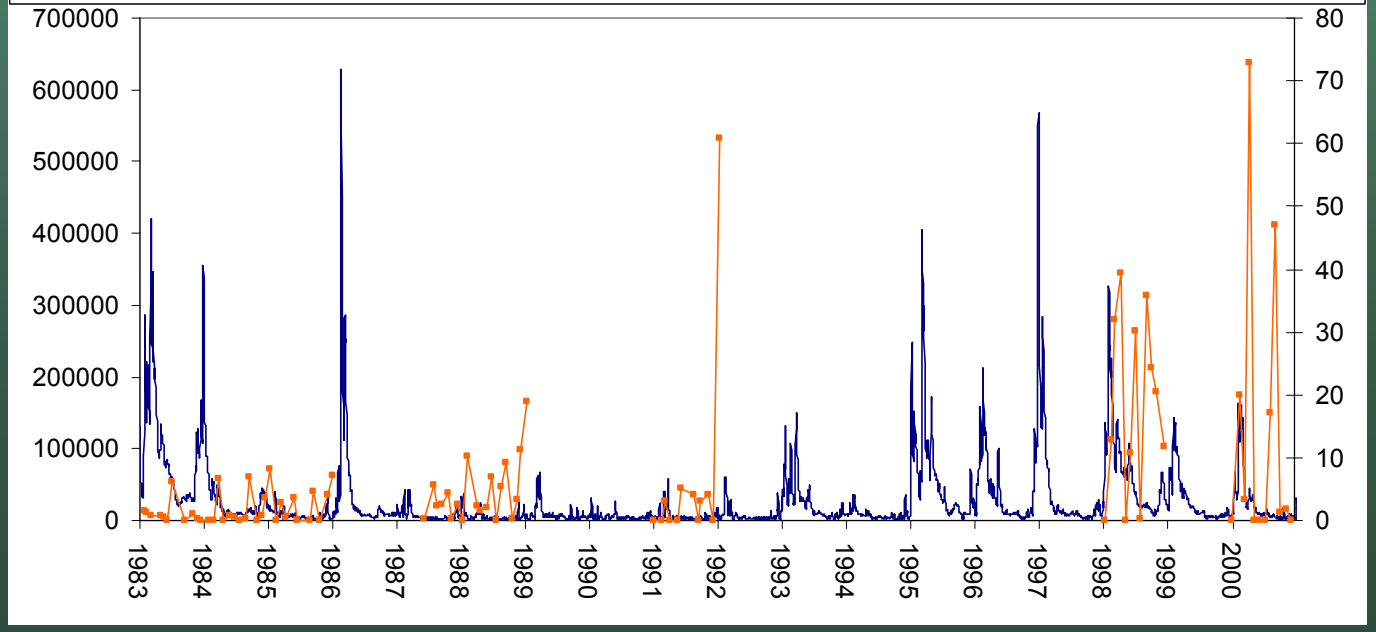
Lesson 3: Recruitment does not always translate to biomass due to mortality and transport



CFS



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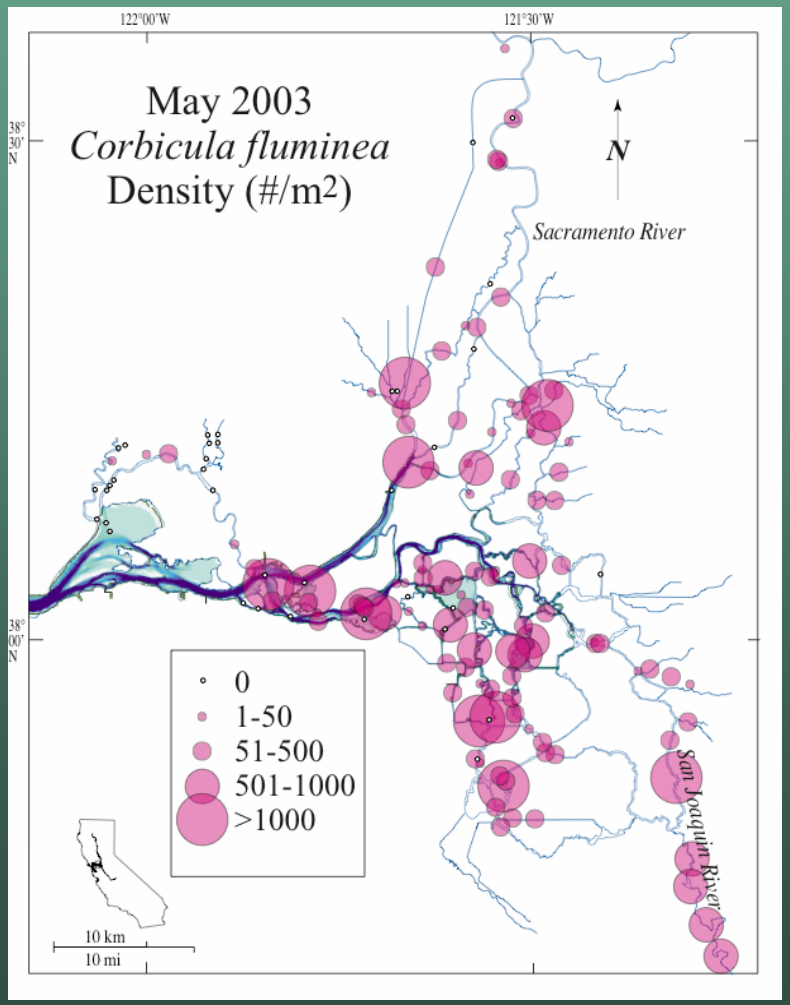
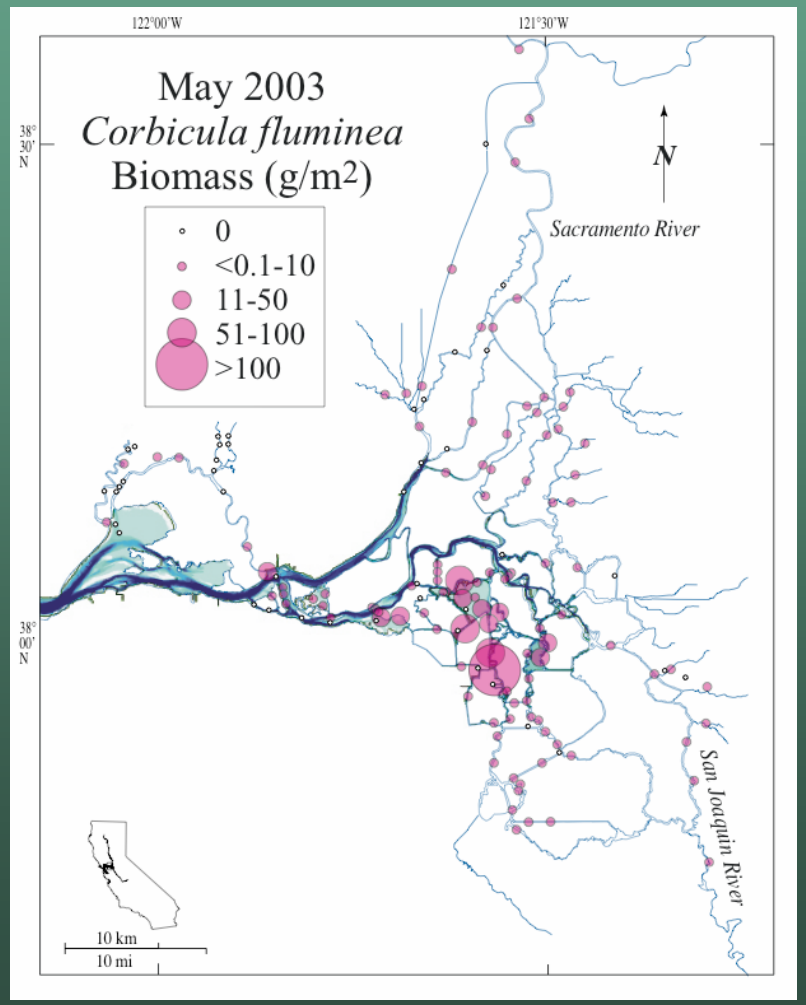
Lesson 4: They are food limited so locations with large *Corbicula* biomass are few despite high recruitment. *Corbicula* can deposit feed and wait out the bad times.





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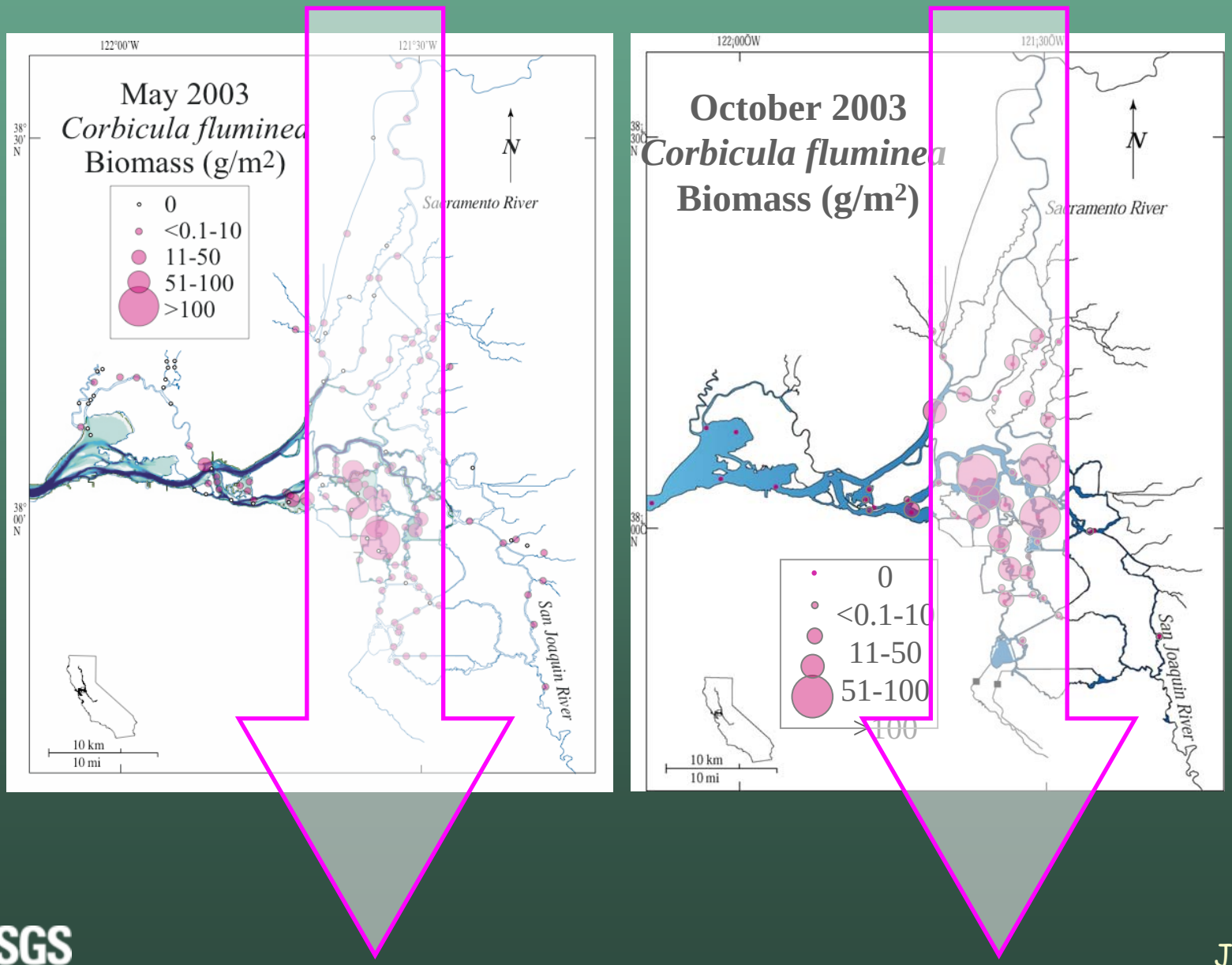
Thus *Corbicula* appear to thrive in the freshwater corridor



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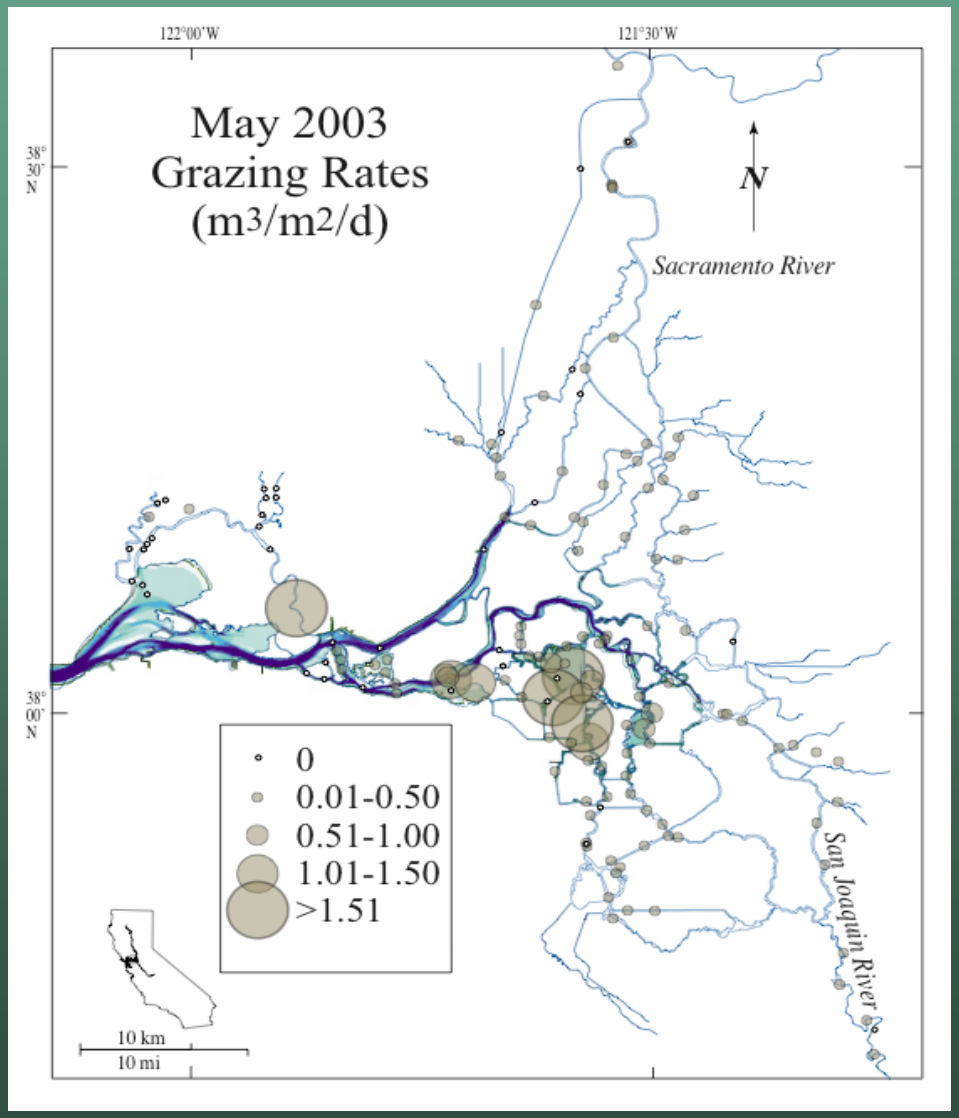
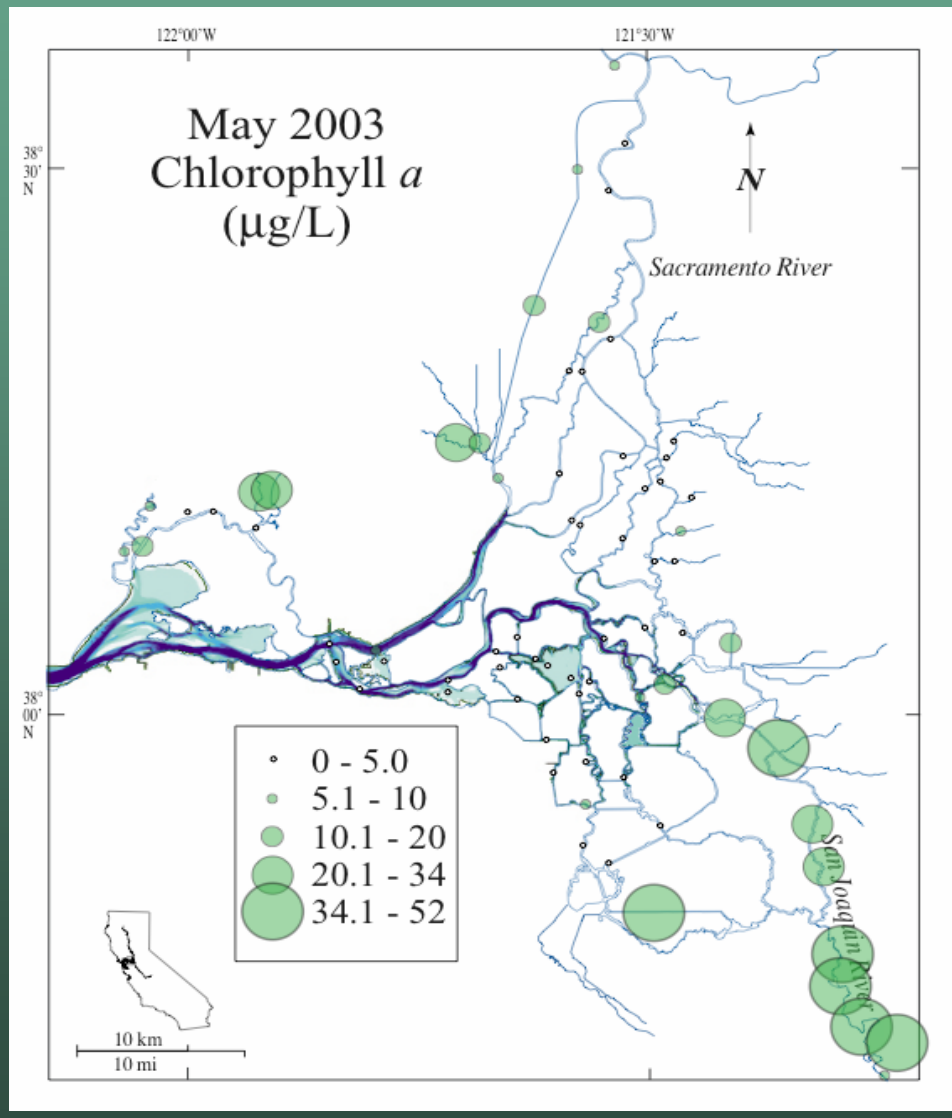
Lesson 5: *Corbicula* can and do limit phytoplankton biomass from accumulating in shallow water habitats in the Delta.





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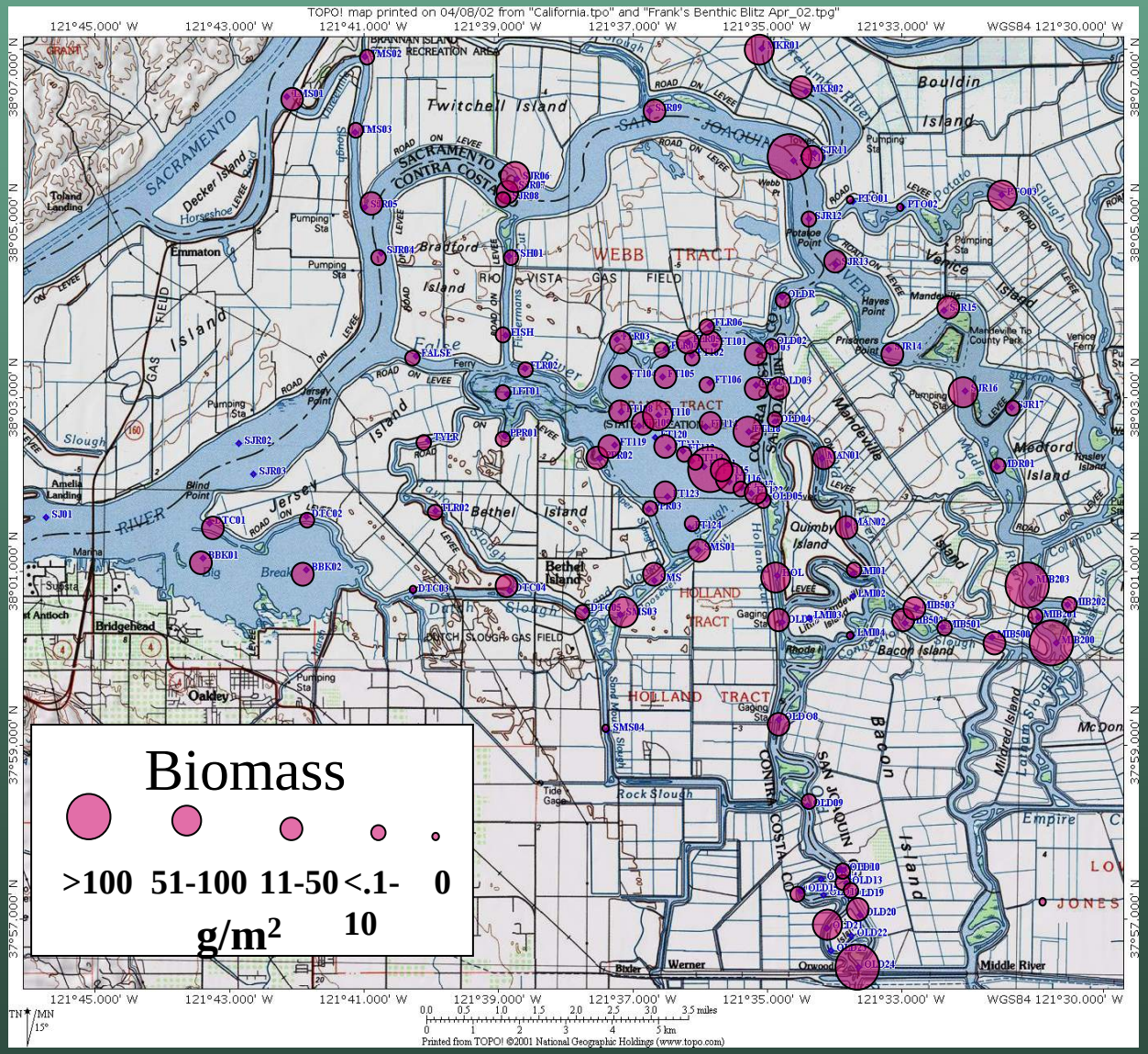
Lesson 6: *Corbicula* concentrate in areas of higher phytoplankton growth rate (Franks Tract)



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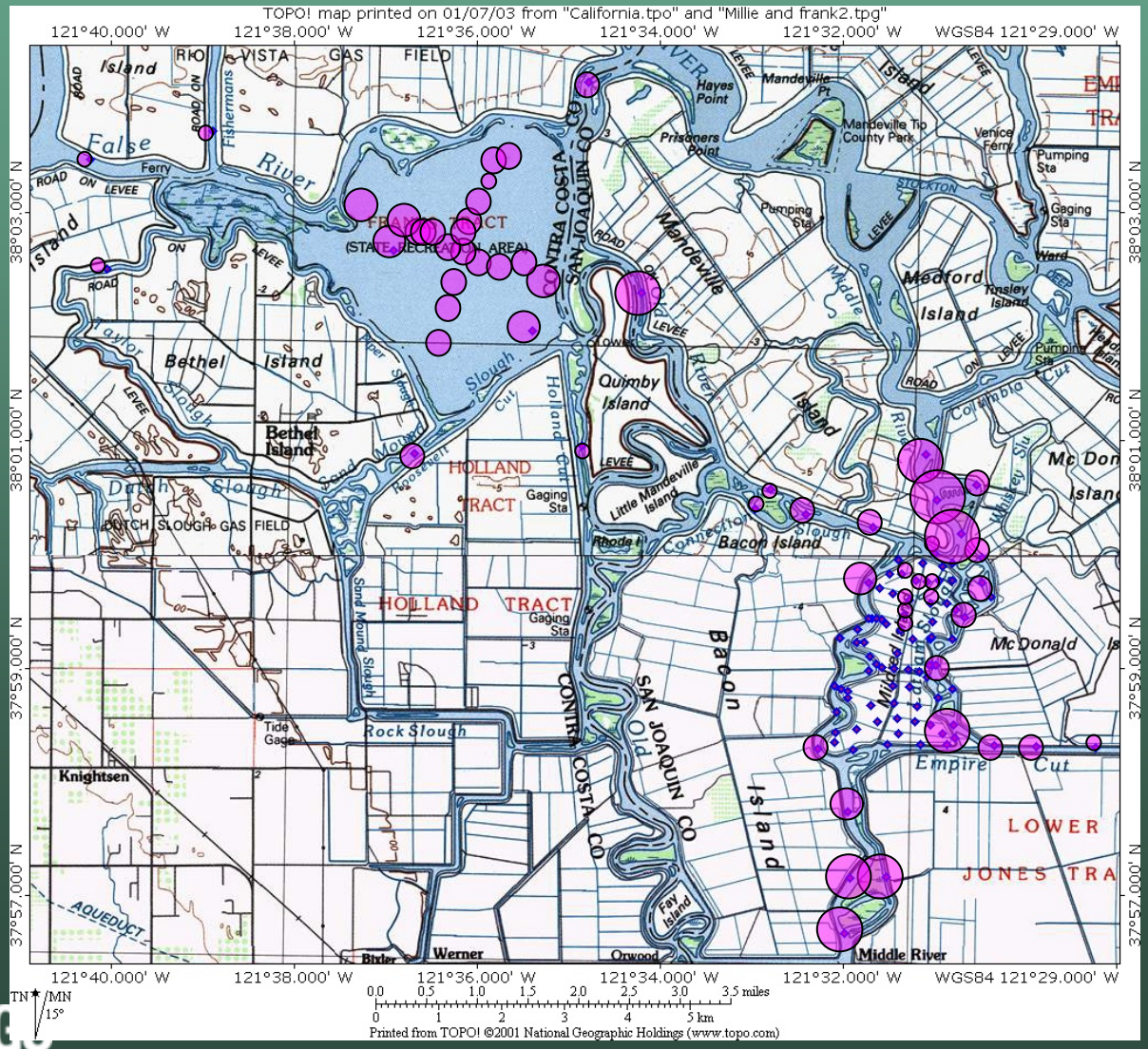
Lesson 6: If they can't live in a productive habitat they will make use of the connectivity.



Corbicula Biomass

g/m^2

- 0
- <10
- 10-50
- 50-100
- 100-150
- >150

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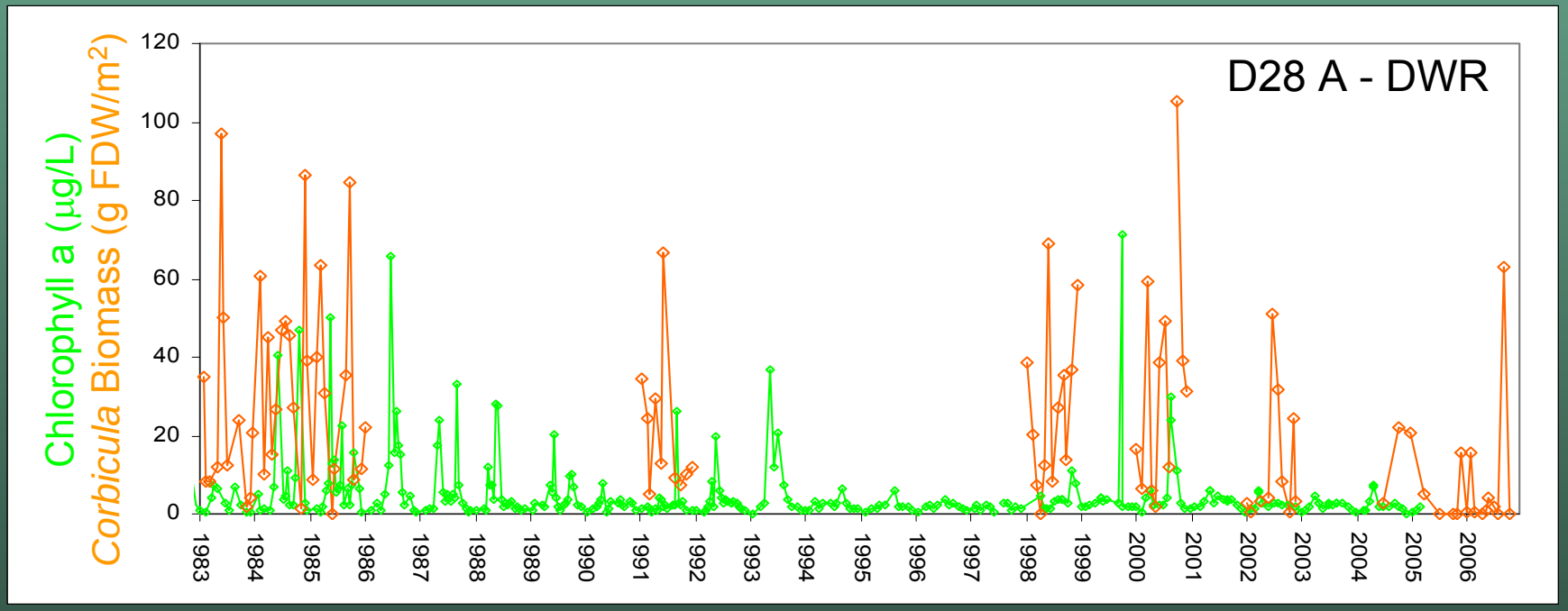
Lesson 7: It's not all about clams – Jassby (2006) shows D28 chlorophyll to be declining but *Corbicula* are if anything also declining – barrier at Middle River?



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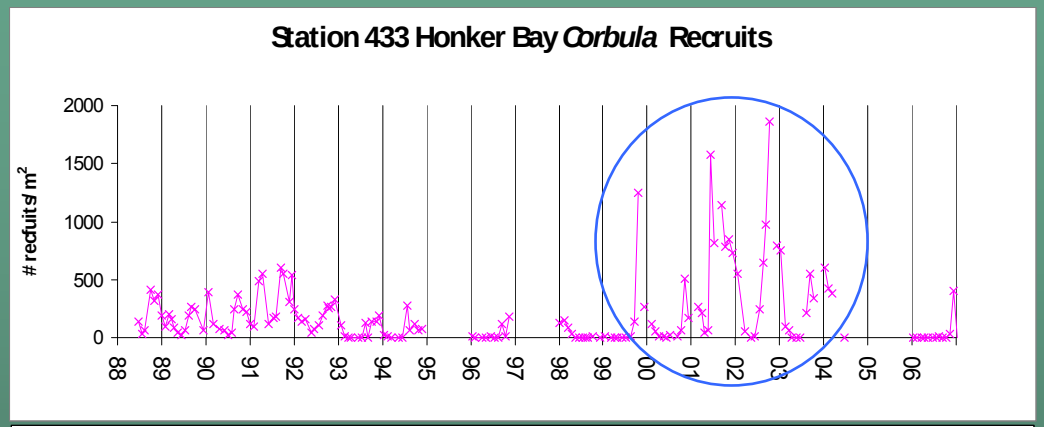
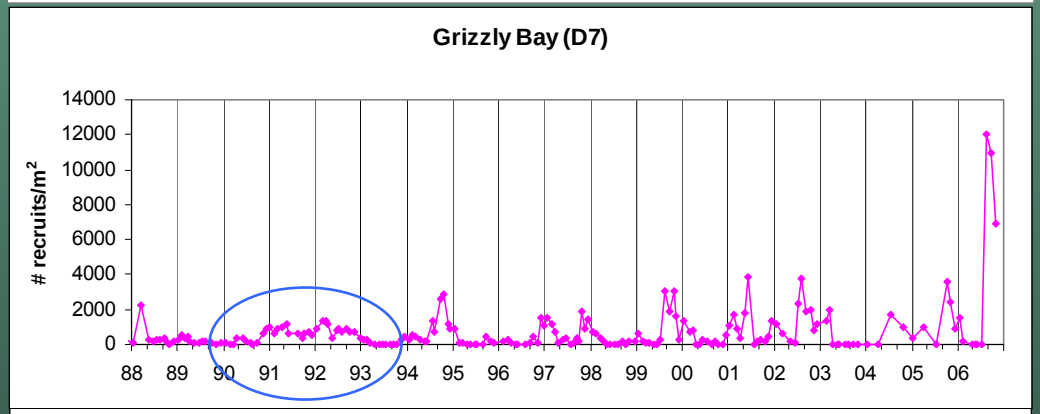
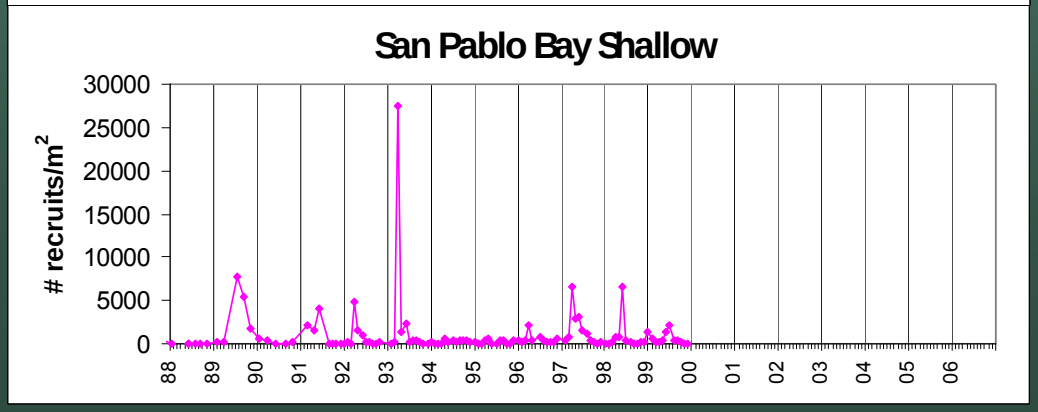
Corbula offer different challenges and the caveats for success are large

- Lesson 1: Reproduction varies by location and time period
- Lesson 2: Recruitment is dependent on salinity
- Lesson 3: Predators limit most shallow water *Corbula* to one year allowing a short, small, localized bloomlet to occur in some years
- Lesson 4: Long duration high outflow events temporarily limits population abundance
- Lesson 5. Babies respond quickly to food and can limit bloom within 2 months of settling (South Bay)
- Lesson 6. Honker Bay clams show us it isn't always about clams

Lesson 1: Corbula reproduction varies by location and time period







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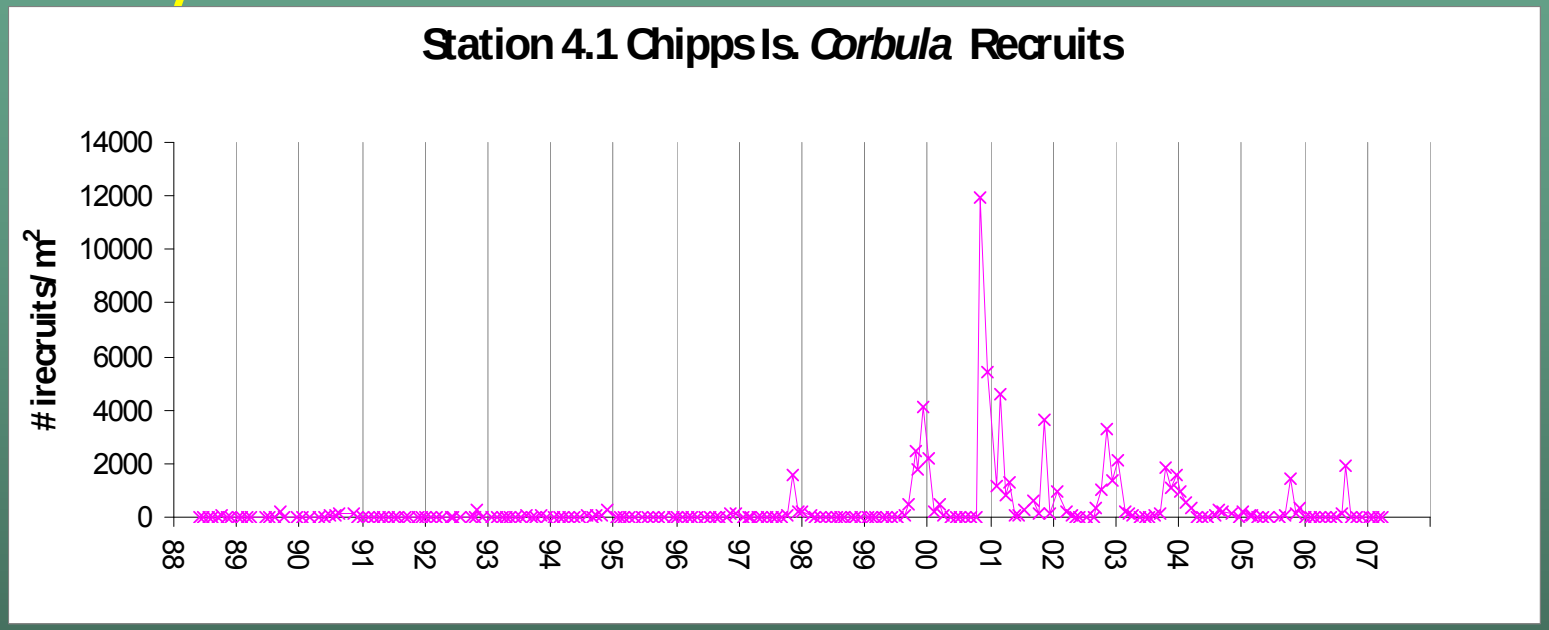
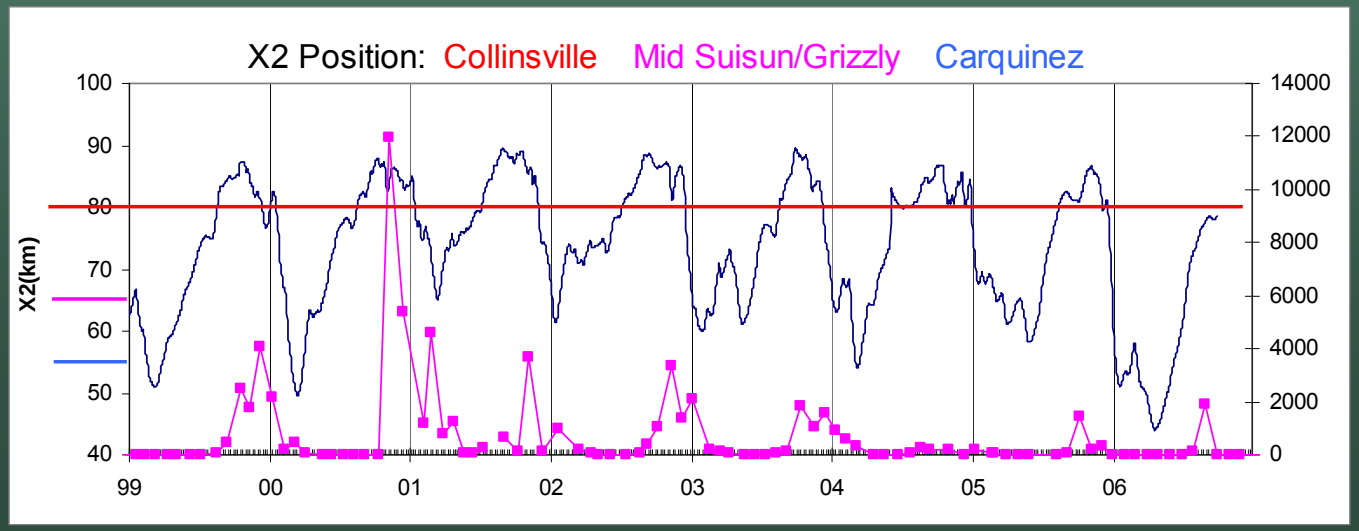
Lesson 2: *Corbula* recruitment is dependent on salinity





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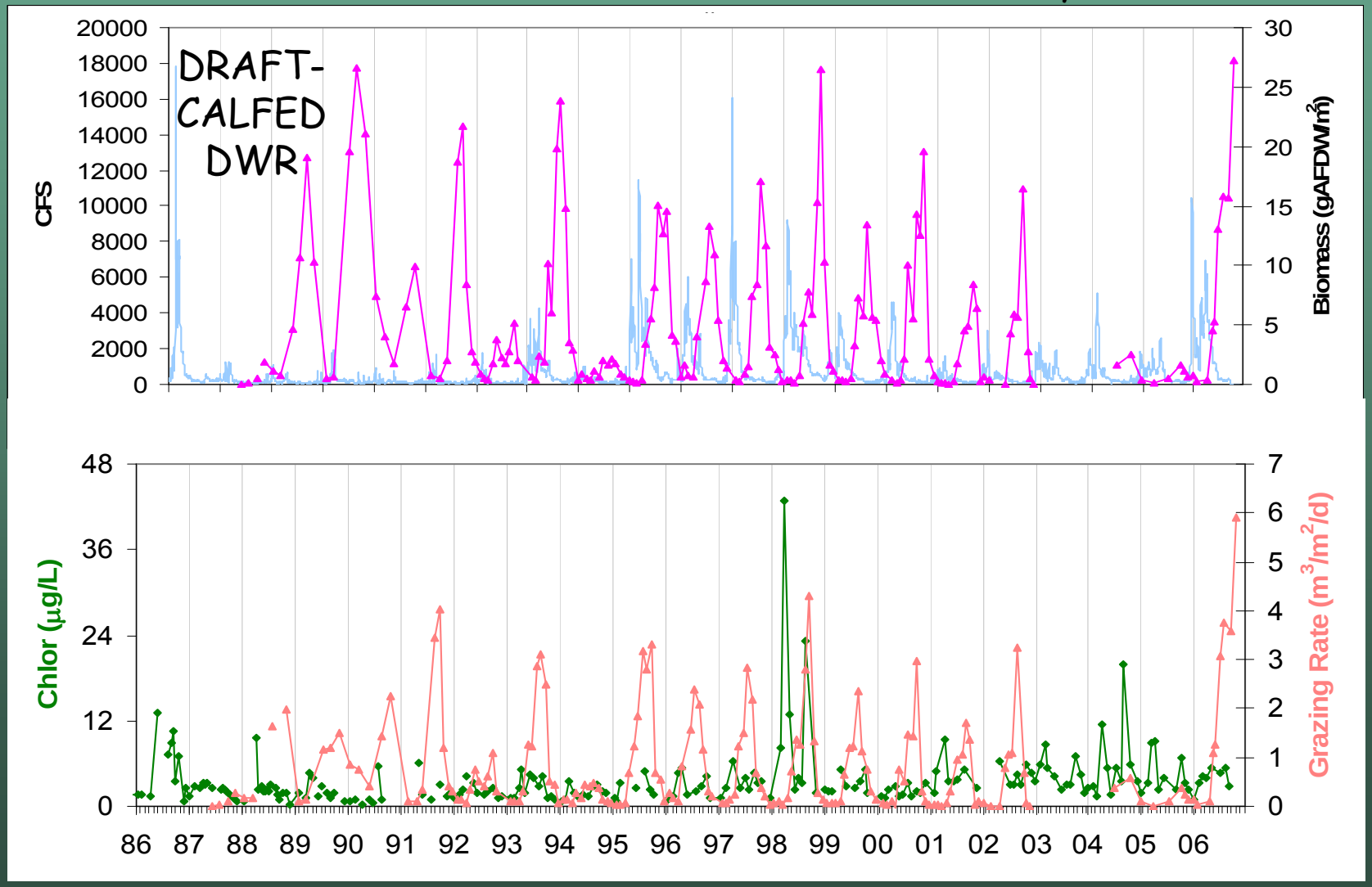
Lesson 3: Predators limit most shallow water *Corbula* to one year allowing a short, small, localized bloomlet to occur in some years

San Pablo Bay – D41A (DWR)



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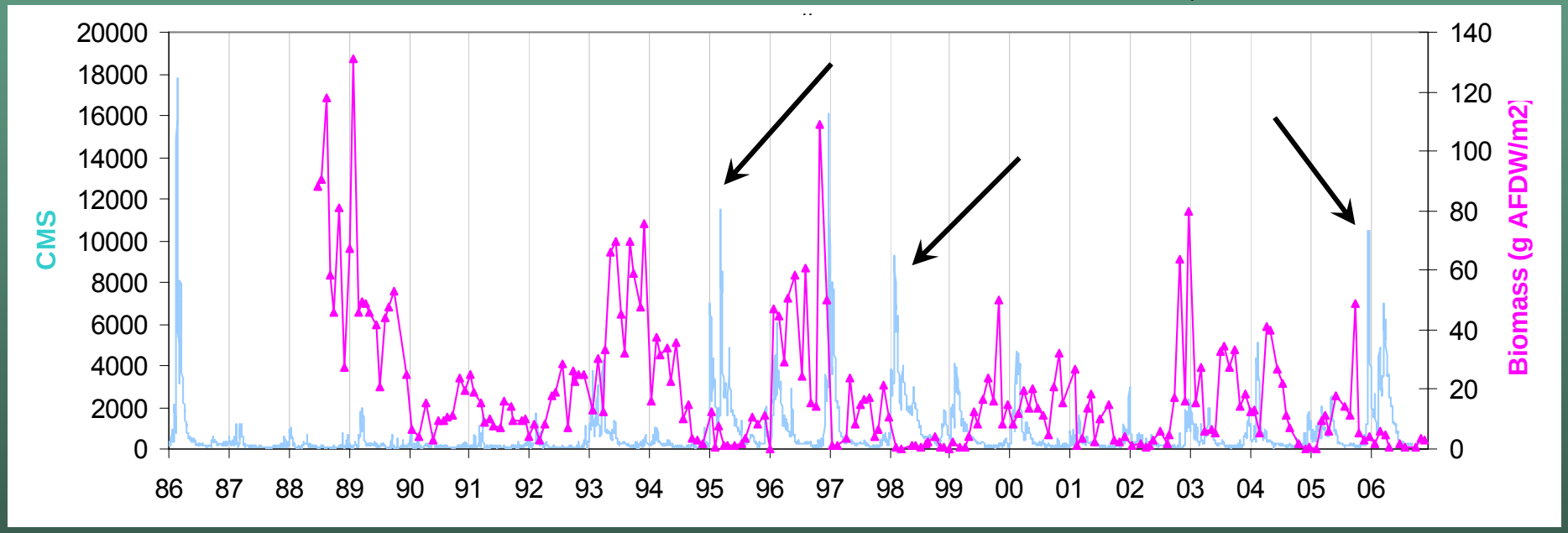
Lesson 4: High outflow events temporarily limits population abundance in the channel

Channel – Carquinez USGS 8.1



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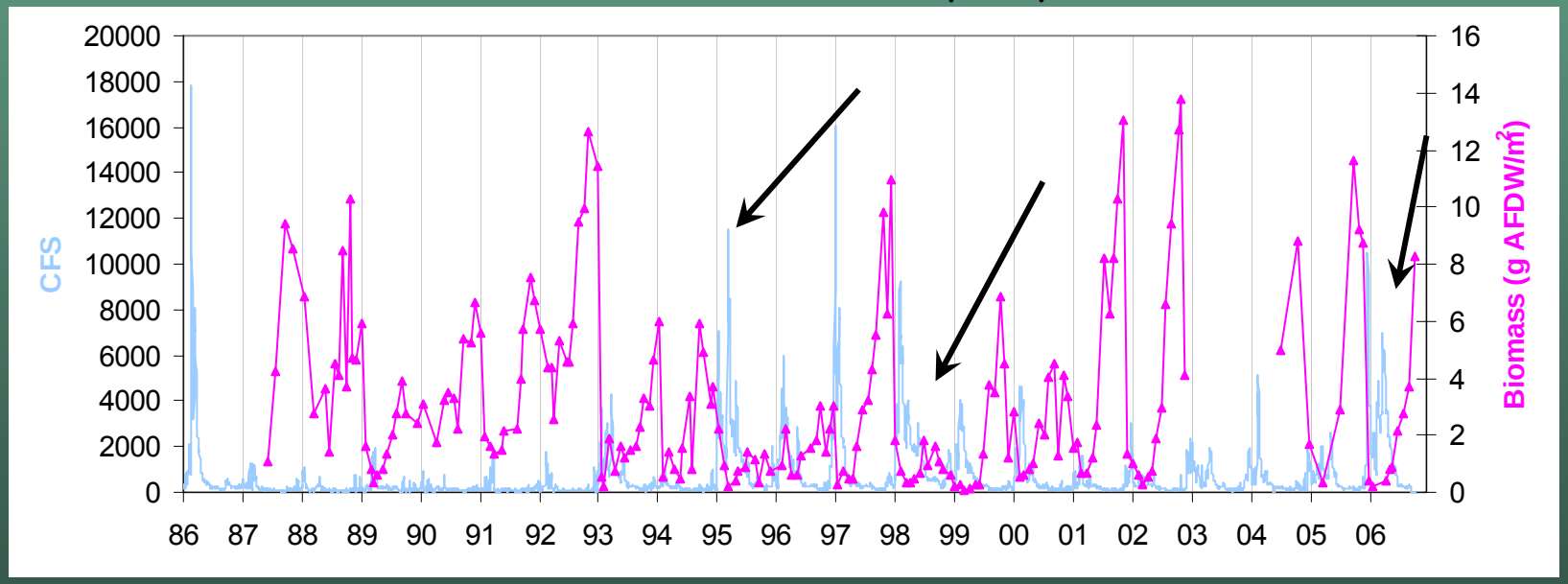
Lesson 4: Long duration high outflow events temporarily limits population abundance in the shallows

Grizzly Bay Shallow – D7 (DWR)



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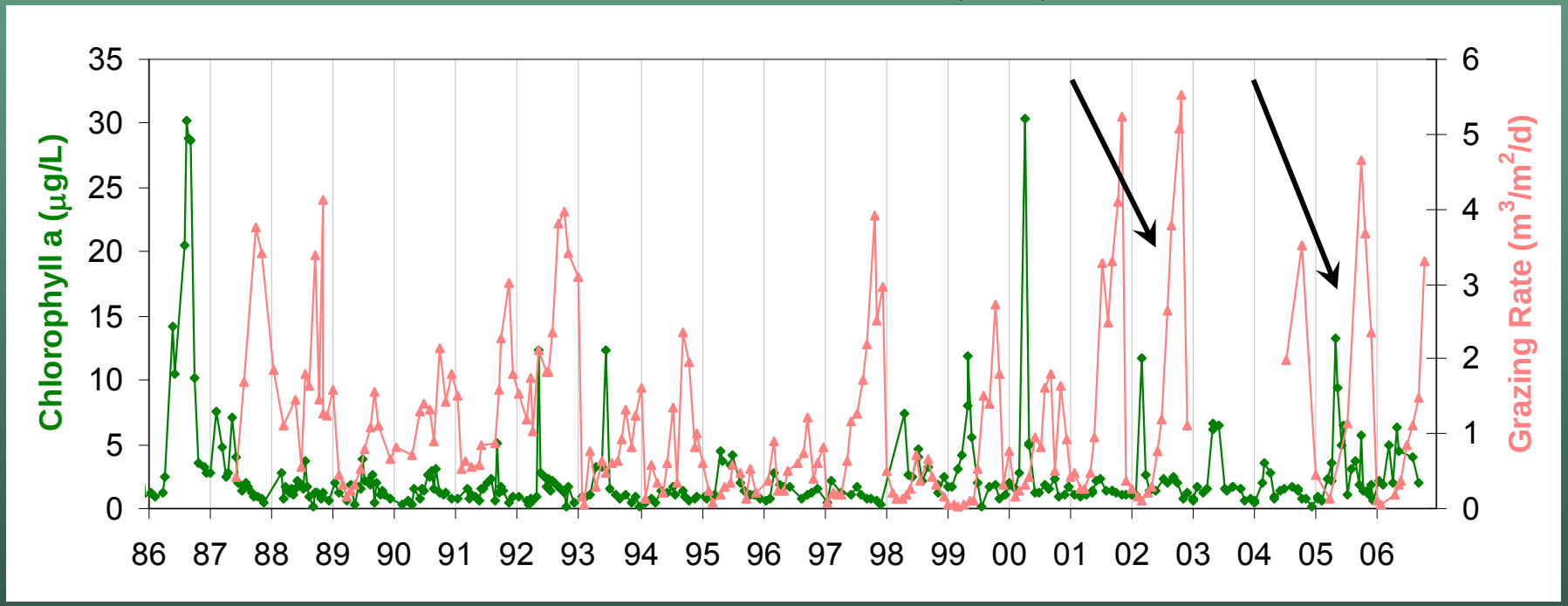
Lesson 5. Babies respond quickly to food and can limit bloom within 2 months of settling

Grizzly Bay Shallow – D7 (DWR)



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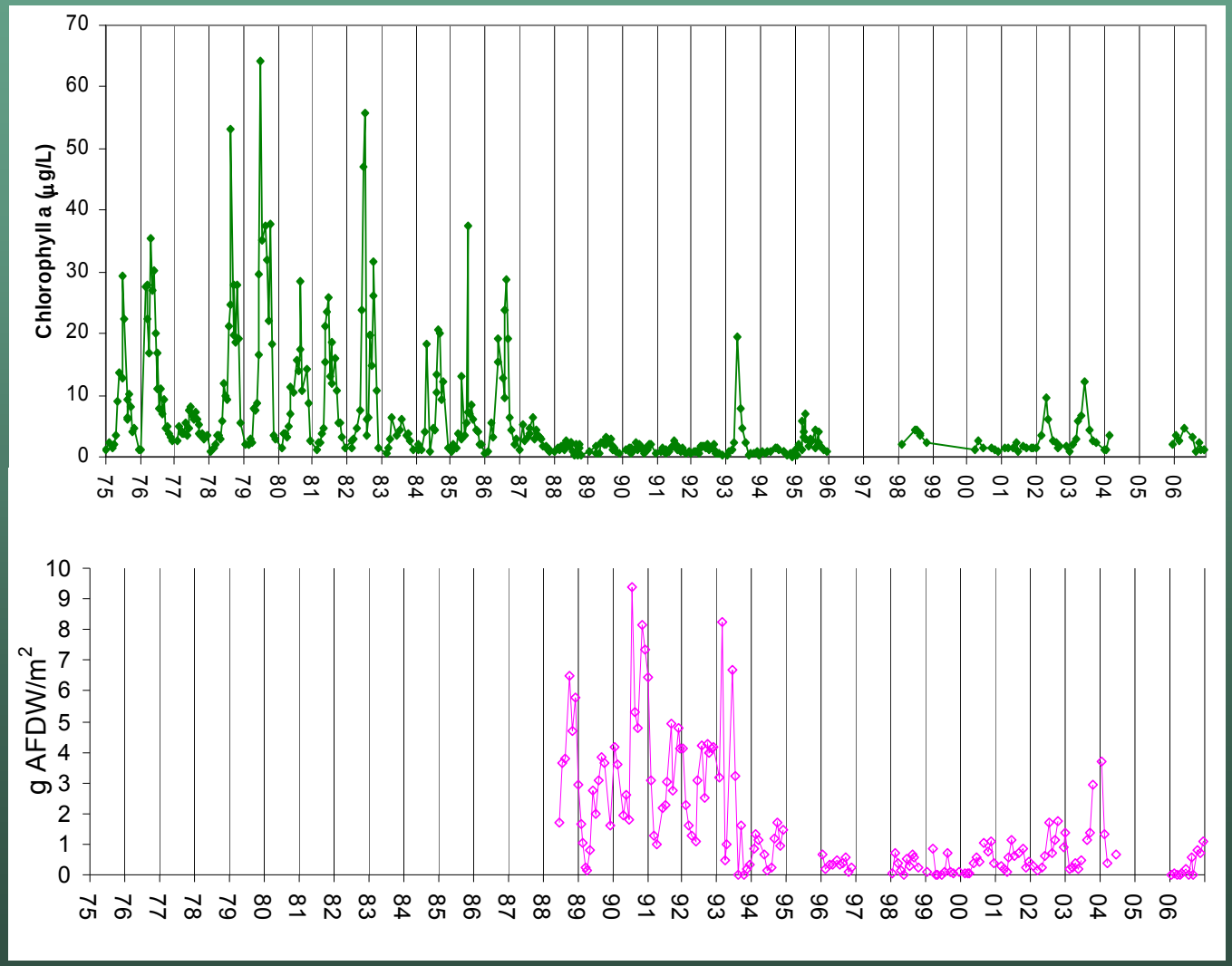
Lesson 6. Honker Bay clams show us it isn't always about clams



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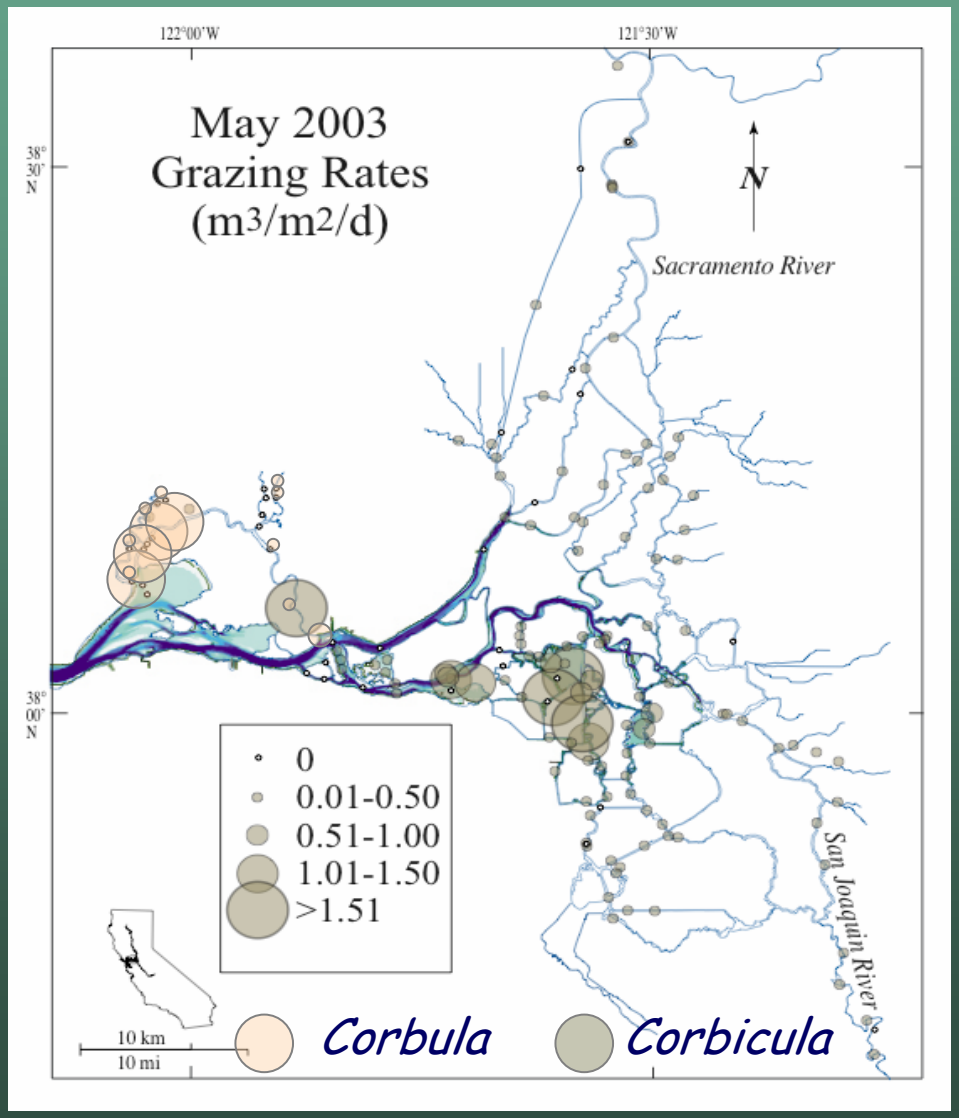
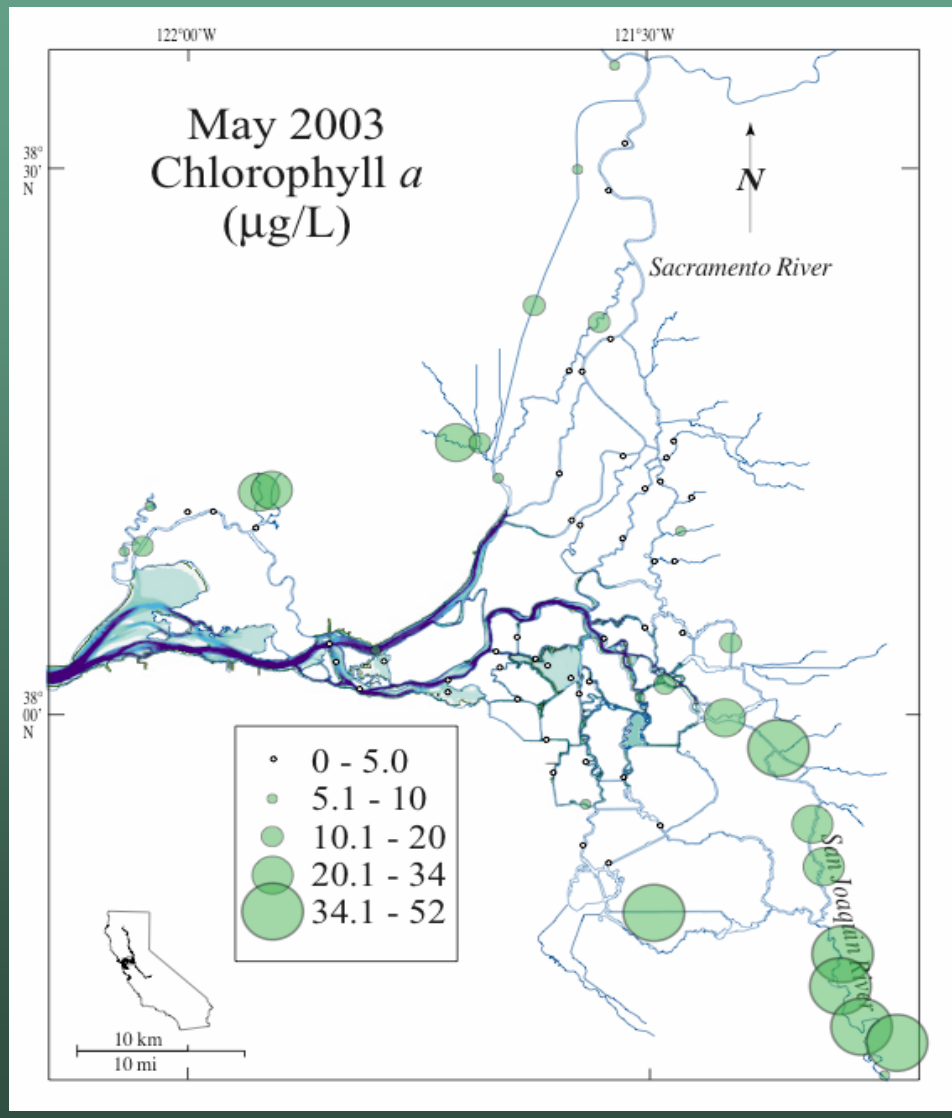
Caveats (partial list)

- If we get a phytoplankton bloom it may be shorter, earlier
- We may get higher grazing rates in fall. This is a problem for Se – any thing else?
- The predators need to follow Corbula up Bay or we will lose the spring "window"
- The clam overlap zone may increase in size and grazing rate.





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