

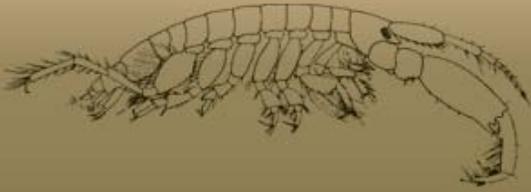
*Can you teach a long-term
benthic monitoring program new
tricks?*

Assessment and redesign to
address different scales.

*Marc Vayssières, Karen Gehrts and Cindy
Messer - CA Dept. of Water Resources*



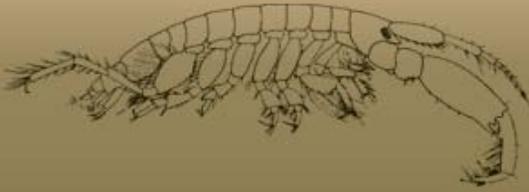
Outline



- Our monitoring program
- Programmatic Review Questions
- Two Special Studies:
 - Large scale representativity
 - Small scale representativity
- Proposed new sampling design



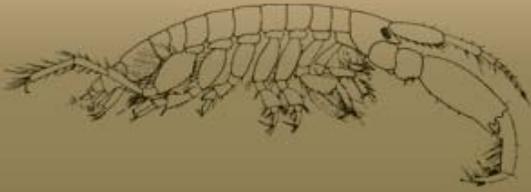
Environmental Monitoring Program



- Mandated by Water Right Decision
- compliance with water quality standards
- document effects of diversions and flow manipulation
- Environmental Water Quality, Phytoplankton, Zooplankton, Benthic macro-invertebrates
- Part of the Interagency Ecological Program
- Joint effort of CA Dept. of Water Resources and US Bureau of Reclamation.
- With assistance from CA Dept. of Fish and Game and US Geological Survey.



Benthic Monitoring Program

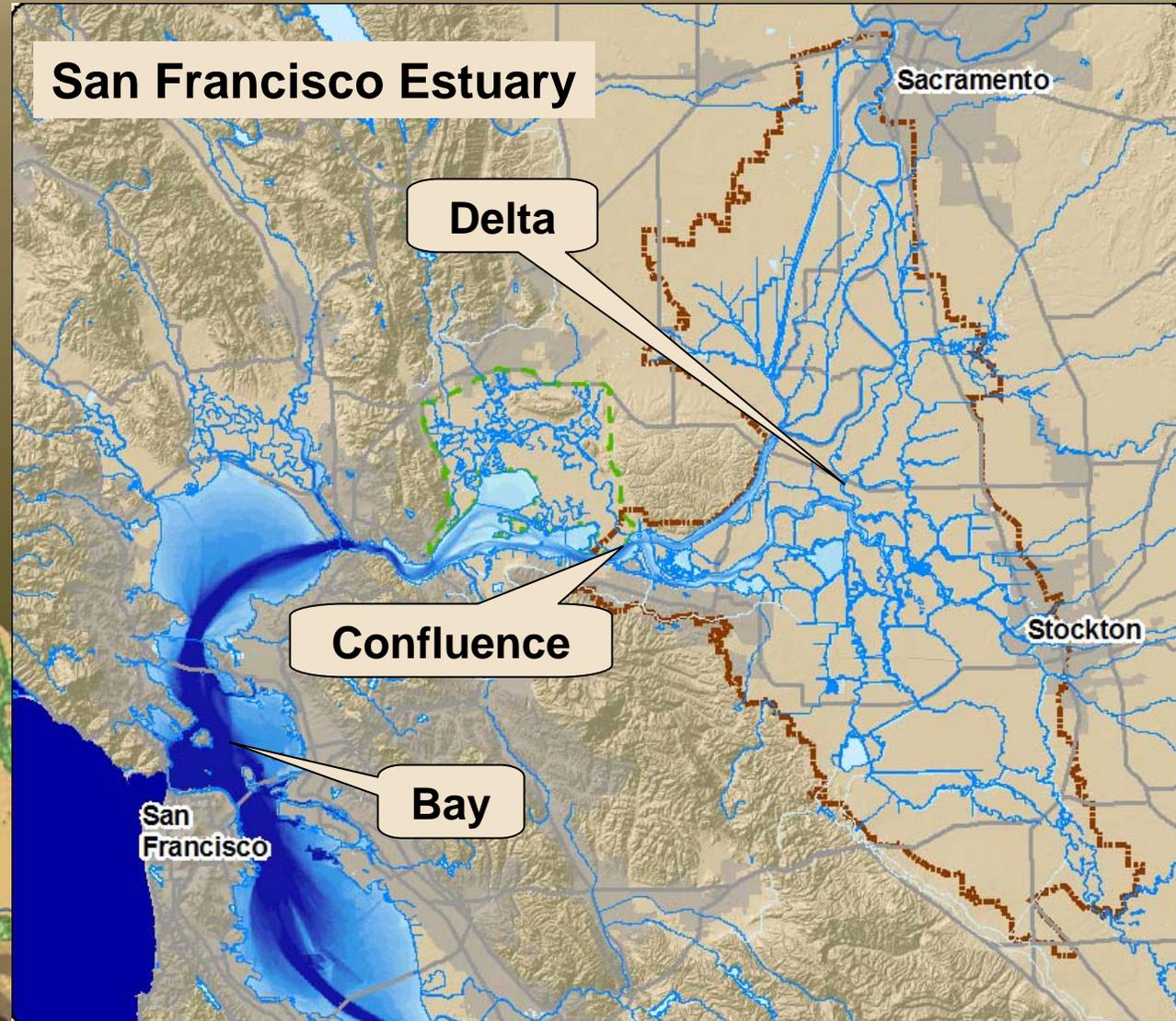
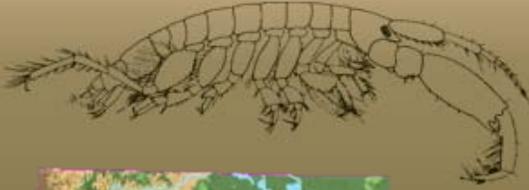


- Methods

- Ponar dredge (0.05 m²)
- 4 grabs at each site
- Washed over No.30 steel mesh (0.6 mm)
- Preserved in formalin
- Taxonomy to species level



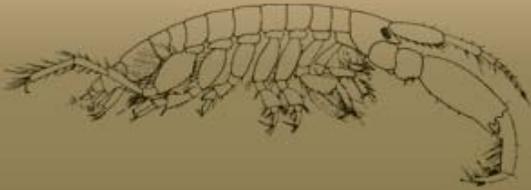
Benthic Monitoring Program



Geographic extent



Benthic Monitoring Program



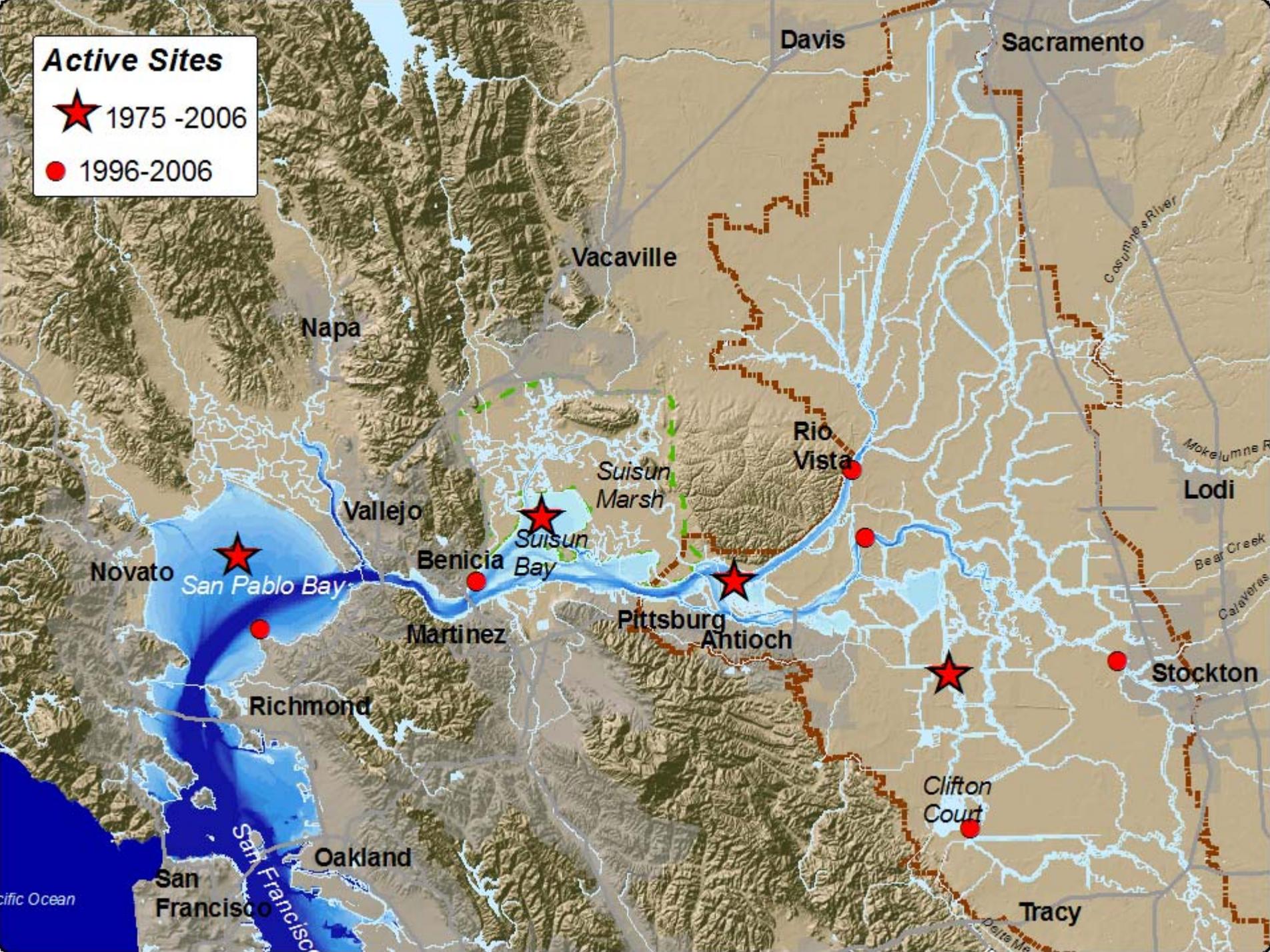
- Began in 1975, 3 phases:
 - 1975-80 : 49 sites, once or twice per year
 - 1980-95 : 9 sites, monthly
 - 1996-06 : 10 sites, monthly
- Benthic database (1975 to present):
 - 390 species of macro-invertebrates
 - 9500 grabs



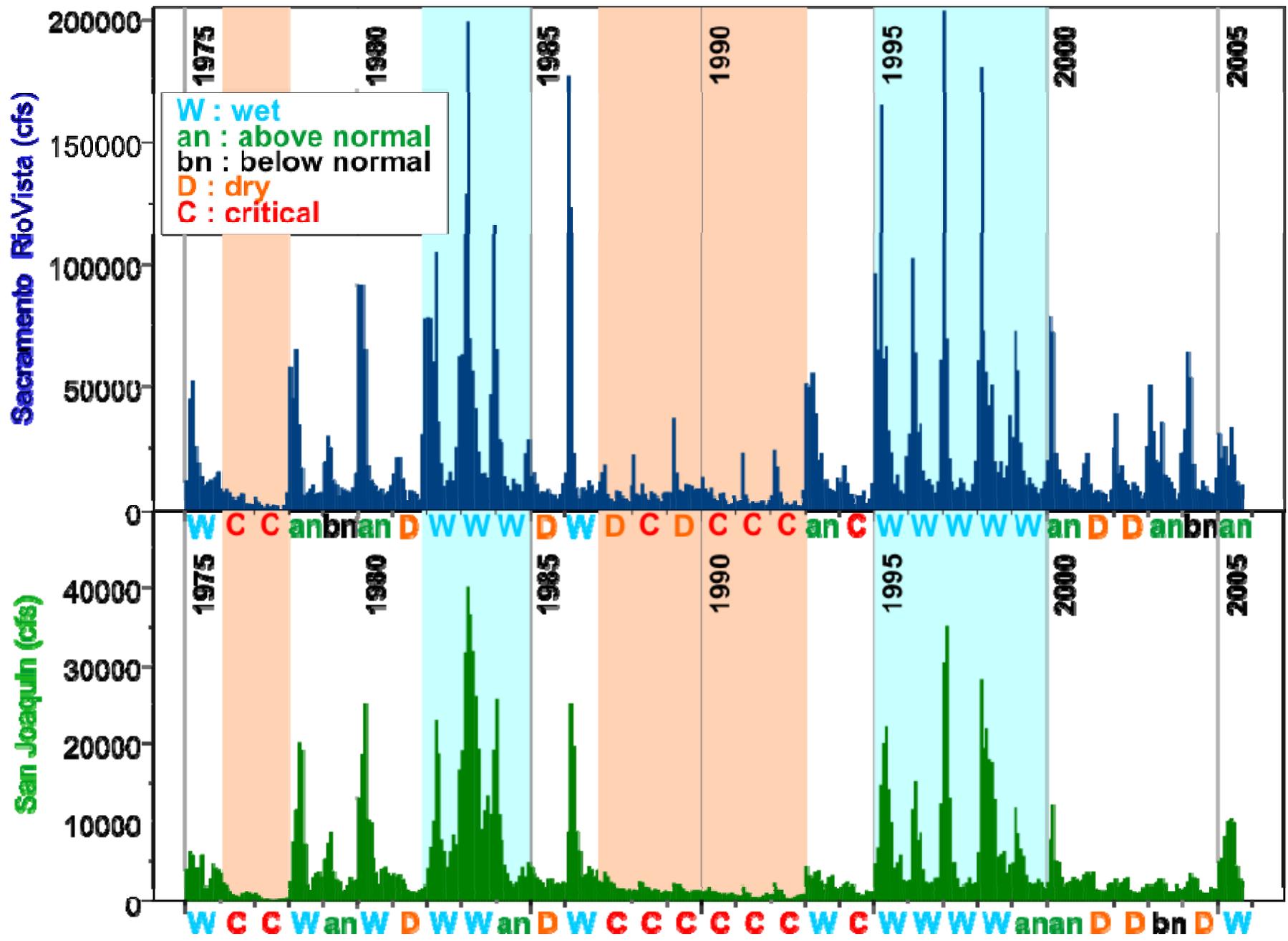
Active Sites

★ 1975 -2006

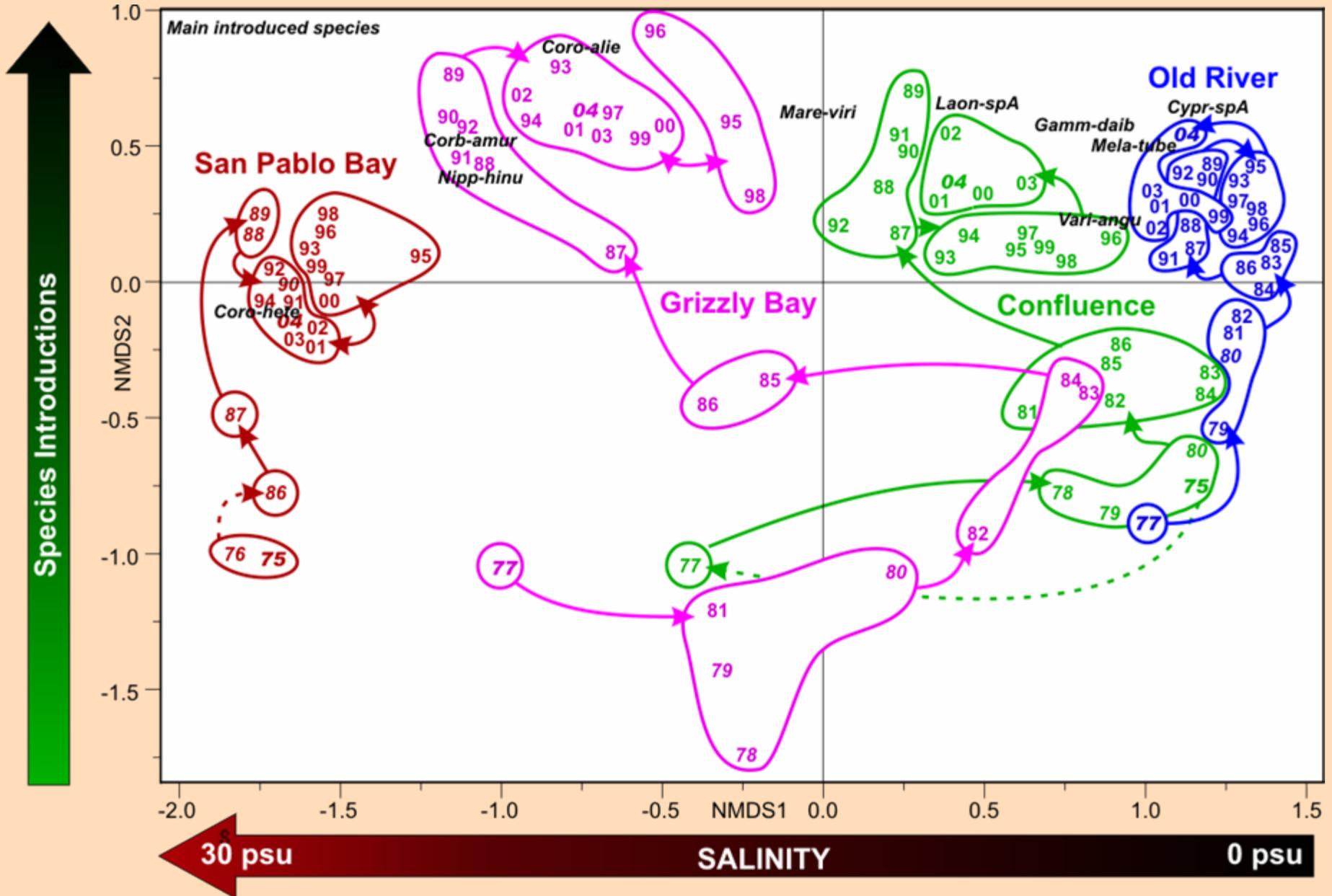
● 1996-2006



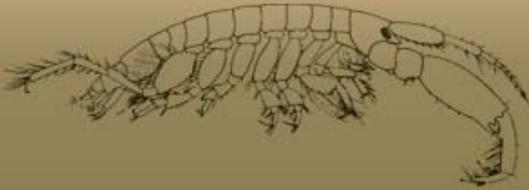
Monthly Average Flows 1975-2005



Ordination of the Four Long Term Sites (1975-2004)



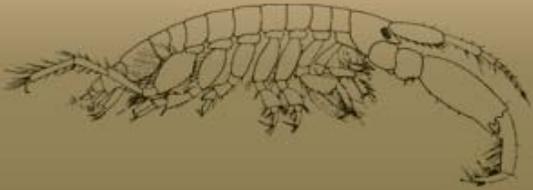
Programmatic Review



- IEP's Science Advisory Group (2001-2002)
 - Questioned the large scale and small scale representativity of sampling design
 - recommended to research and propose a new sampling design over the next three years
- Decisions:
 - Curtailed sampling from monthly to quarterly (2004-05)
 - Used resources to conduct 2 special studies
 - Upper-Estuary wide survey (May 2003)
 - Local neighborhoods survey (April-July 2005)



Study 1: Large Scale Representativity



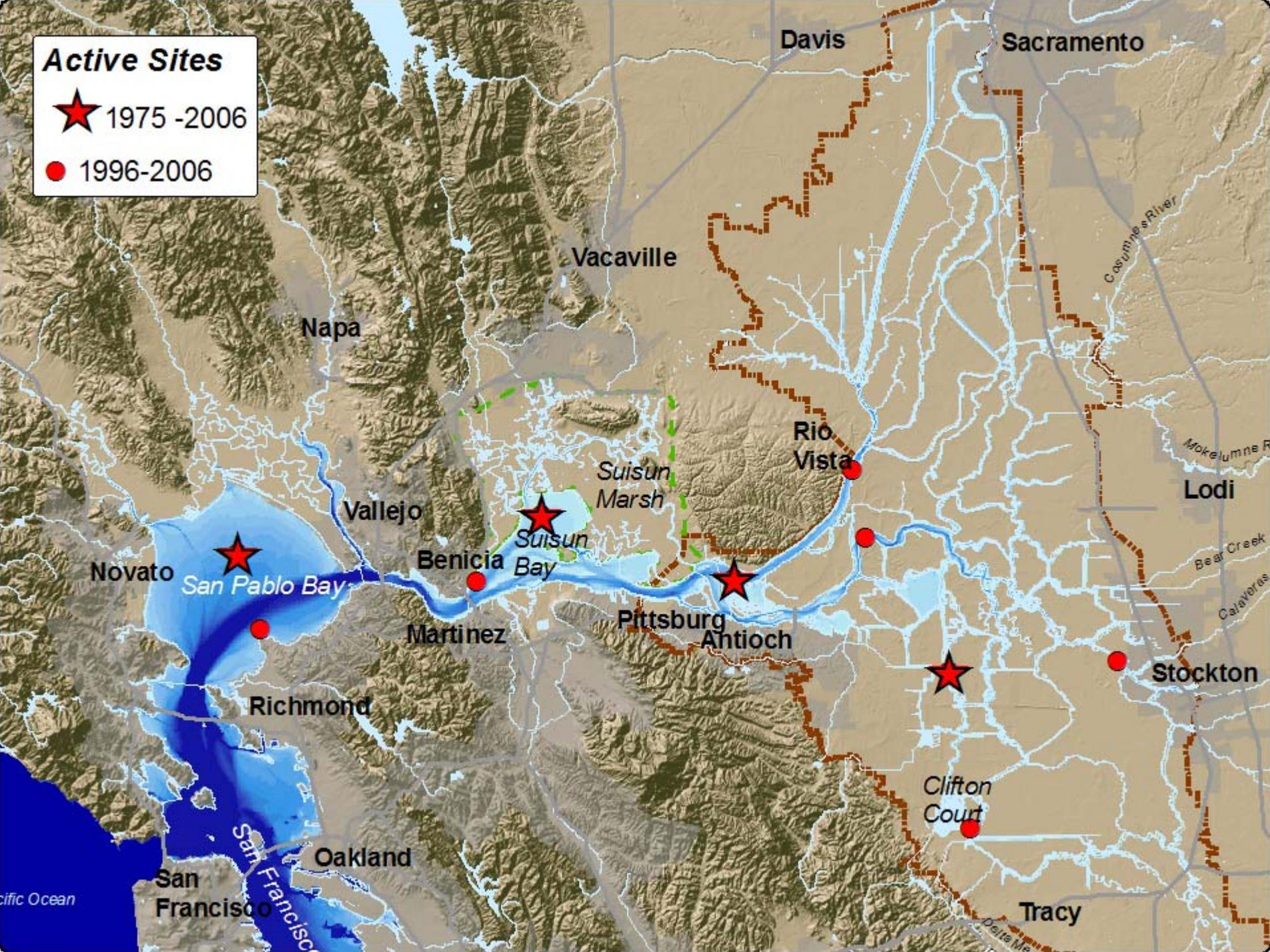
- Question:
 - Is the EMP missing any benthic community in the Upper SF Estuary?



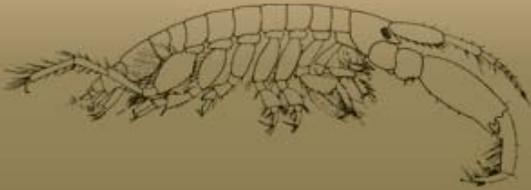
Active Sites

★ 1975 -2006

● 1996-2006



Study 1: Large Scale Representativity



- Data:
 - 153 grabs from 153 locations during the “Benthic Boogie” (with USGS) in May; + 39 in October.
 - 40 grabs from 10 regular monitoring sites each time
- Methods
 - Bray-Curtis similarity on square root of species abundance
 - Ordination (Non metric multi dimensional scaling)
 - Clustering (Partitioning Around Medoids)
 - Indicator and discriminating species



Benthic Assemblages

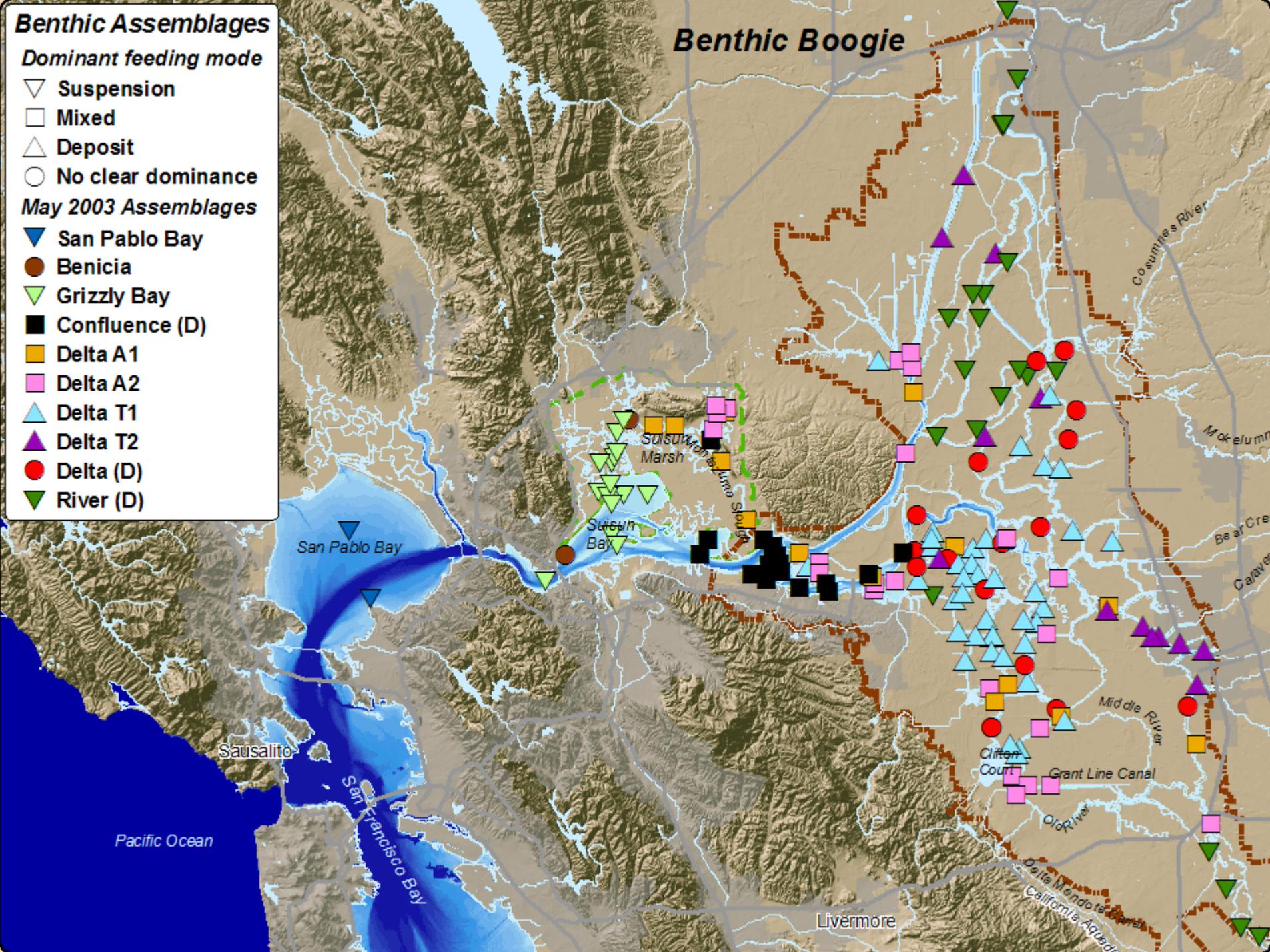
Dominant feeding mode

- ▽ Suspension
- Mixed
- △ Deposit
- No clear dominance

May 2003 Assemblages

- ▾ San Pablo Bay
- Benicia
- ▽ Grizzly Bay
- Confluence (D)
- Delta A1
- Delta A2
- △ Delta T1
- △ Delta T2
- Delta (D)
- ▽ River (D)

Benthic Boogie



Benthic Assemblages

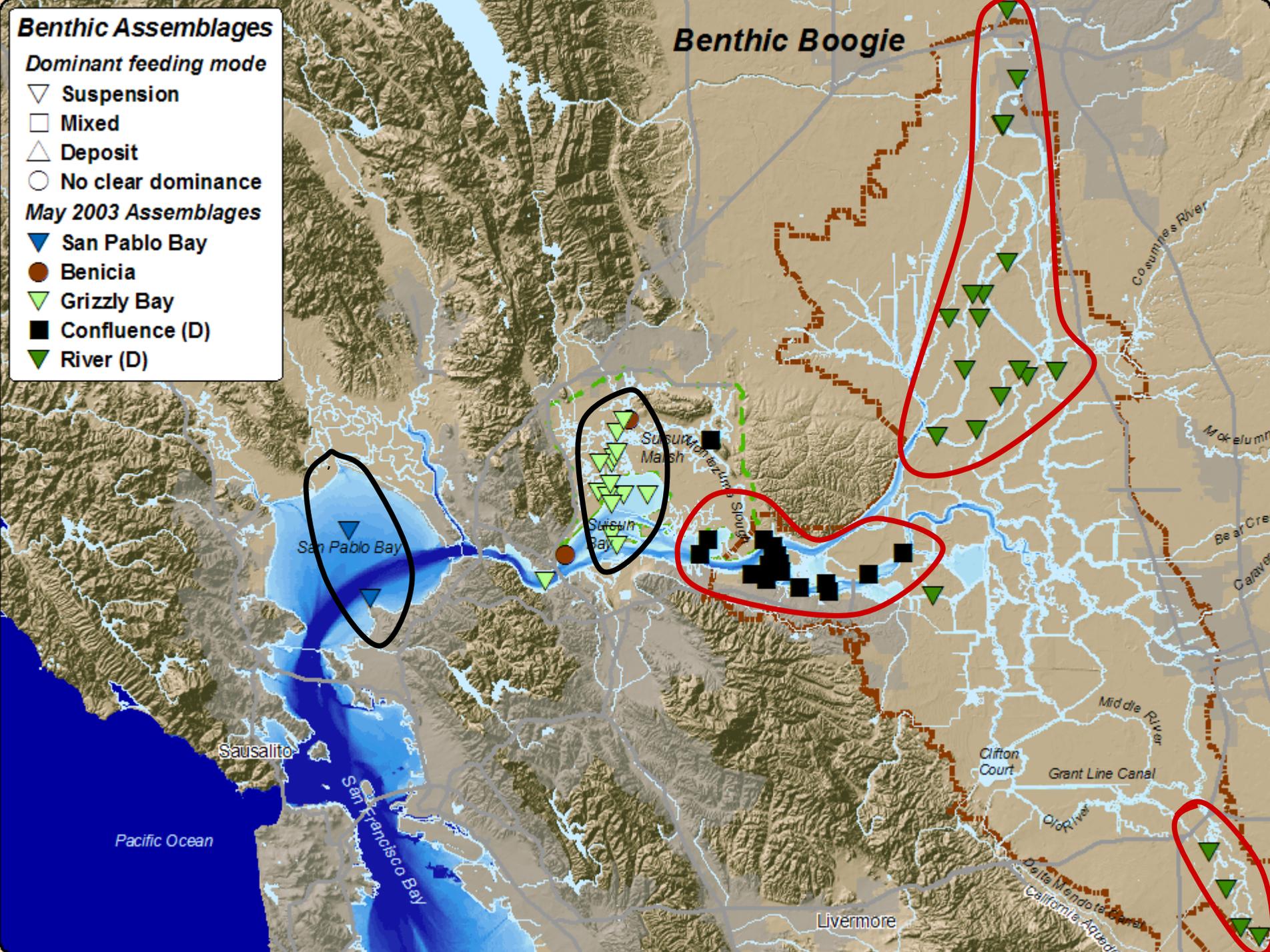
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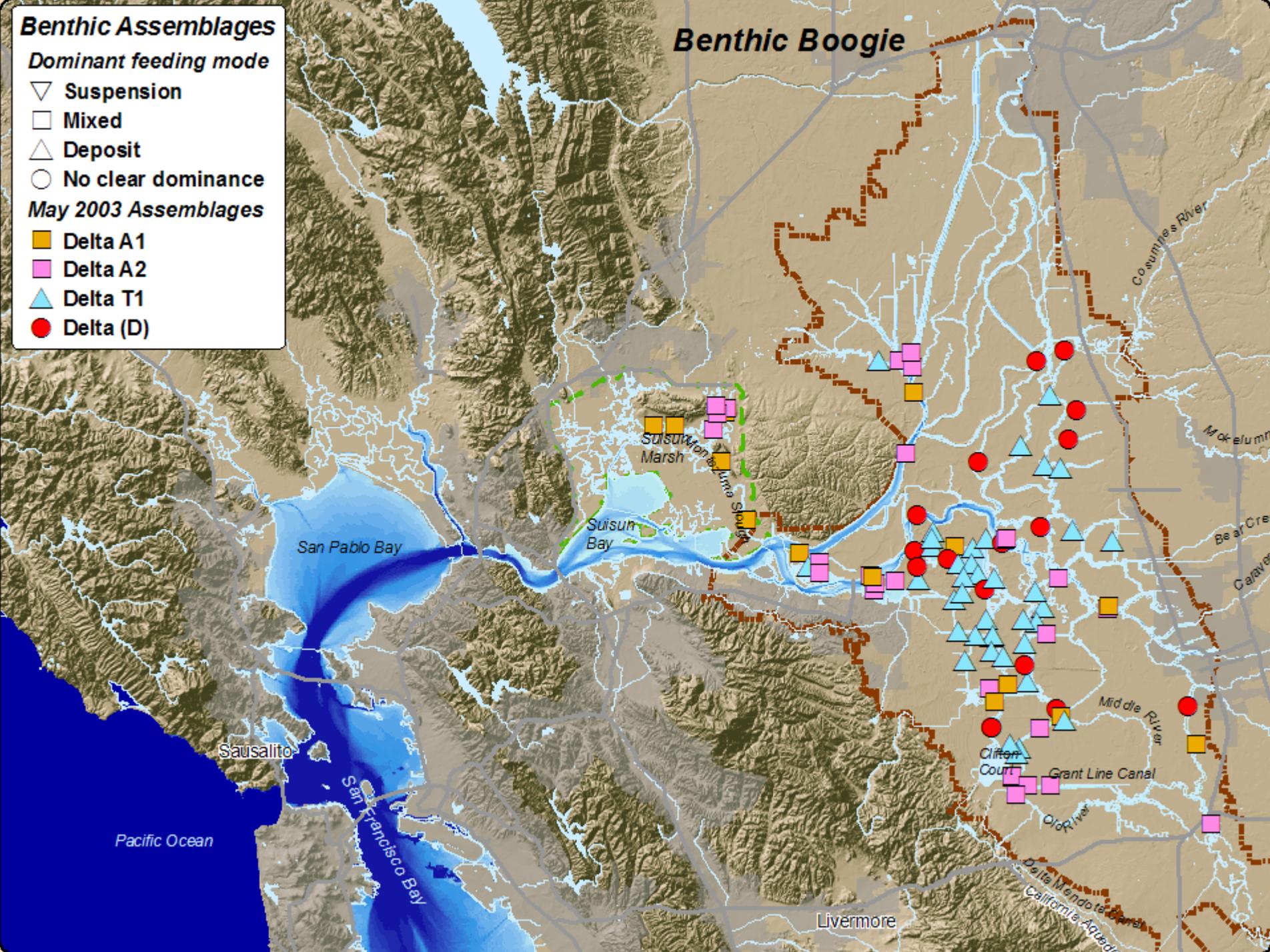
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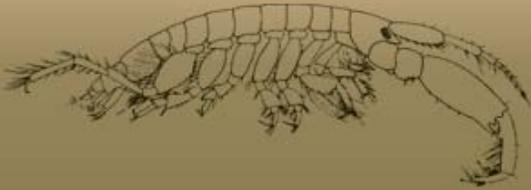
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Benthic Boogie



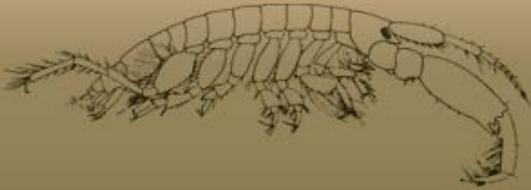
Study 1: Large Scale Representativity



- Findings:
 - The four grabs taken at monitoring sites were clustered together in the analyses
 - 2 of the 10 assemblages were without a regular monitoring site. Both are depauperate.
 - Assemblages in fall survey consistent with spring, but some sites changed.



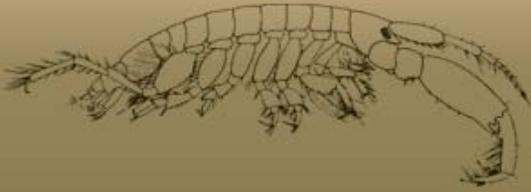
Study 1: Large Scale Representativity



- For new design:
 - Sampling at many more locations is desirable:
 - Large parts of the Delta need to be better represented.
 - Some assemblages depend on local habitat features.



Study 2: Small Scale Representativity



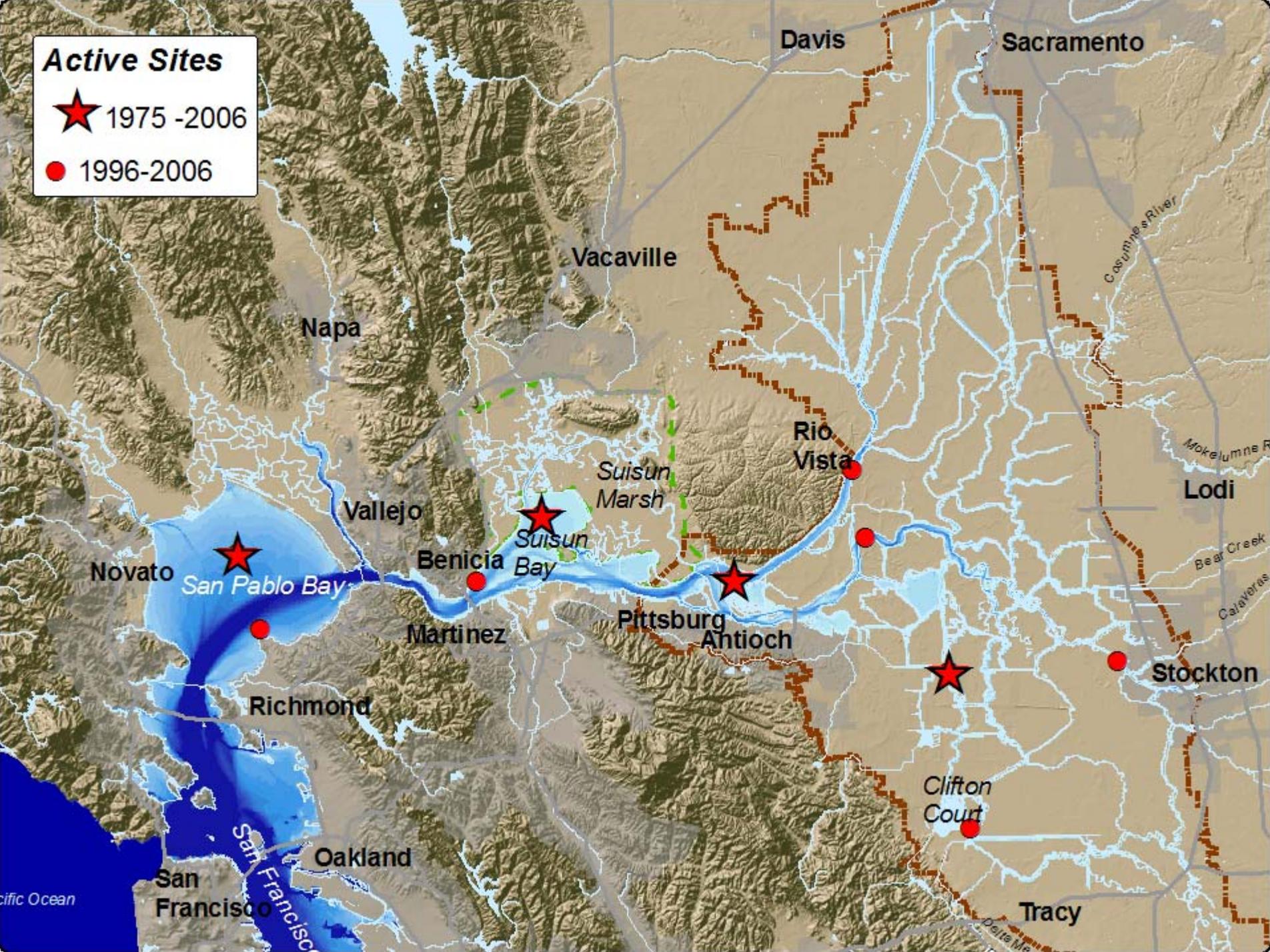
- Question:
 - Are EMP's monitoring sites representative of the benthic community in their neighborhoods?



Active Sites

★ 1975 -2006

● 1996-2006





Vacaville

Napa

Cosumnes River

Rio Vista

Suisun Marsh

Vallejo

Suisun Bay

Benicia

San Pablo Bay

Martinez

Pittsburg

Antioch

Sto

Richmond

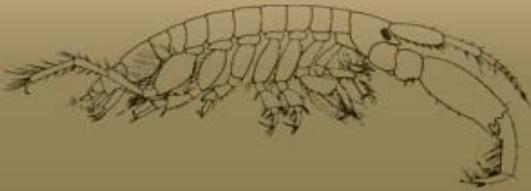
Clifton Court

Oakland

San Francisco

Tracy

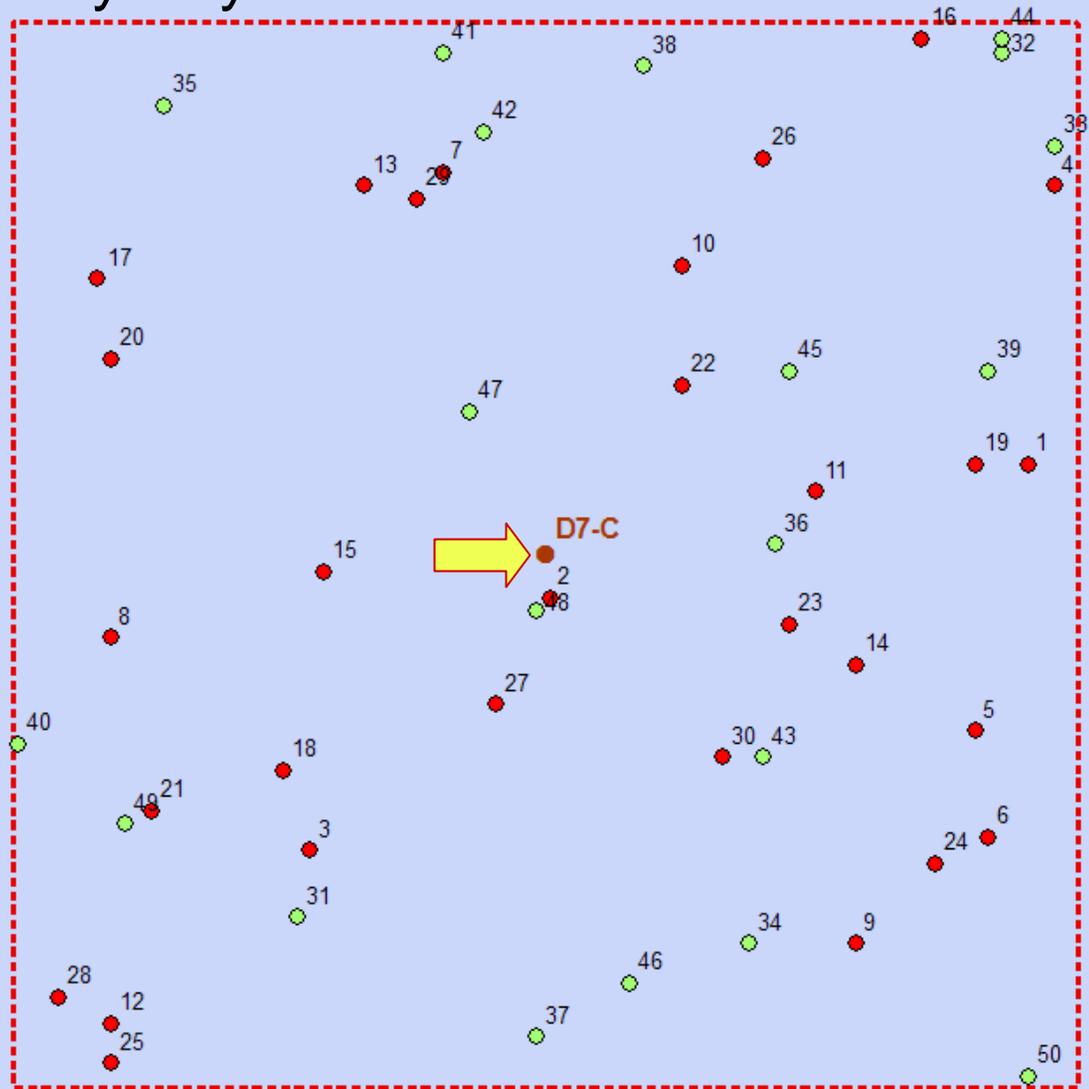
Study 2: Small Scale Representativity



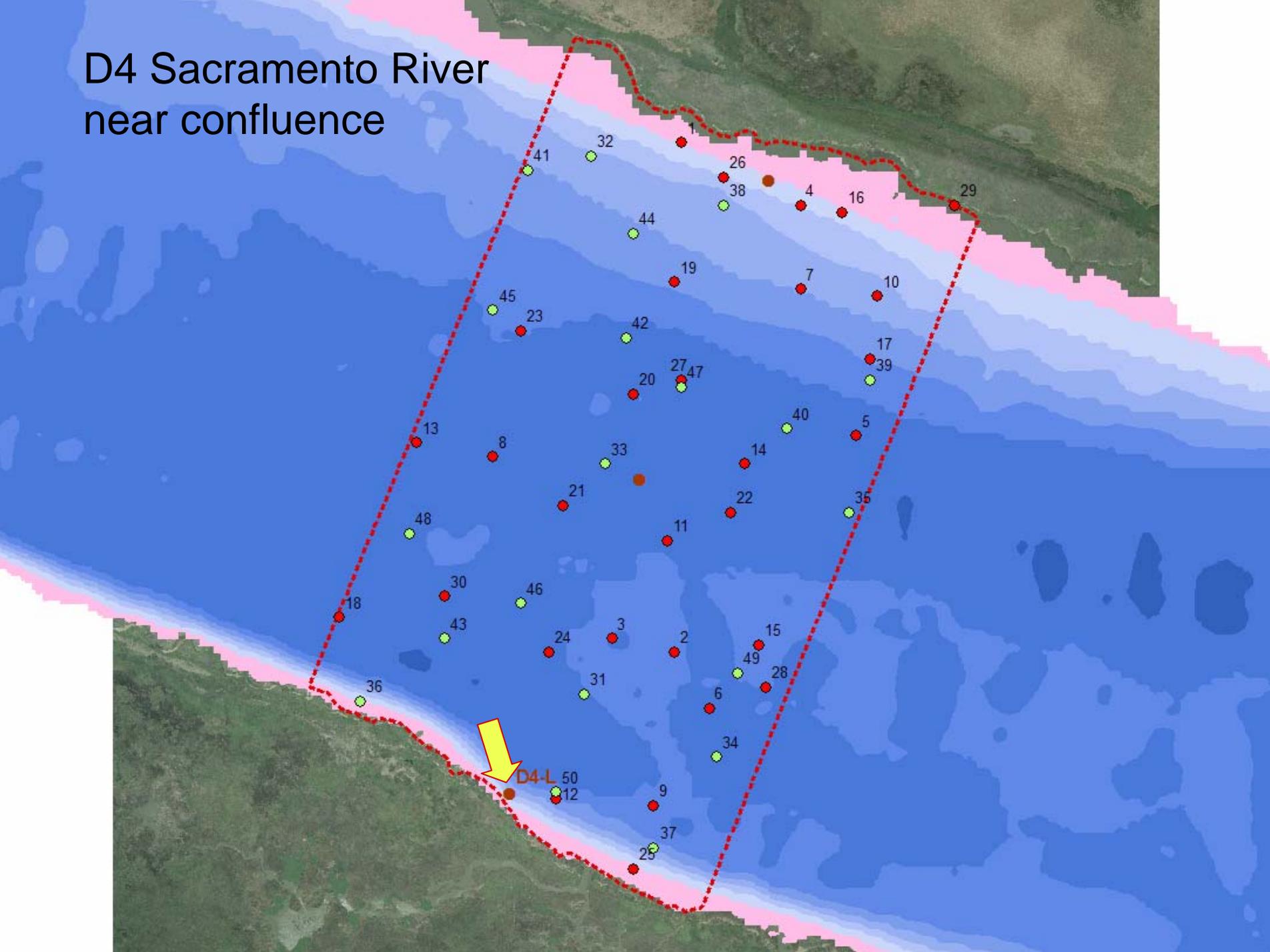
- Data:
 - 30 grabs taken in 64ha neighborhoods of 6 of EMP regular sites in April and in July
 - 4 regular monitoring grabs at each site
- Methods
 - Generalized Random Tessellation Stratified design in each neighborhood
 - Bray-Curtis similarity on sqrt of species abundance
 - Ordination (Non metric multi dimensional scaling)



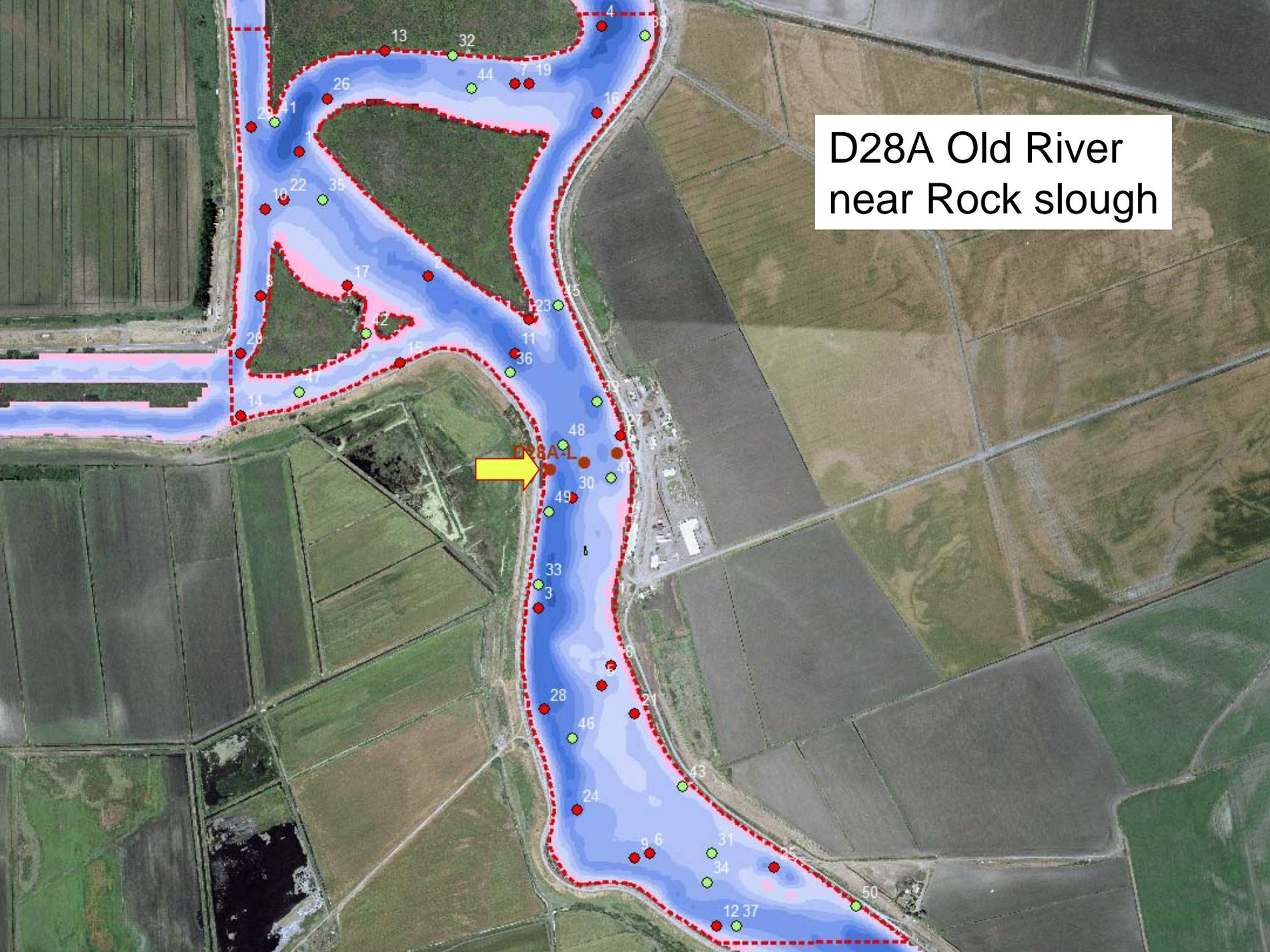
D7 Grizzly Bay



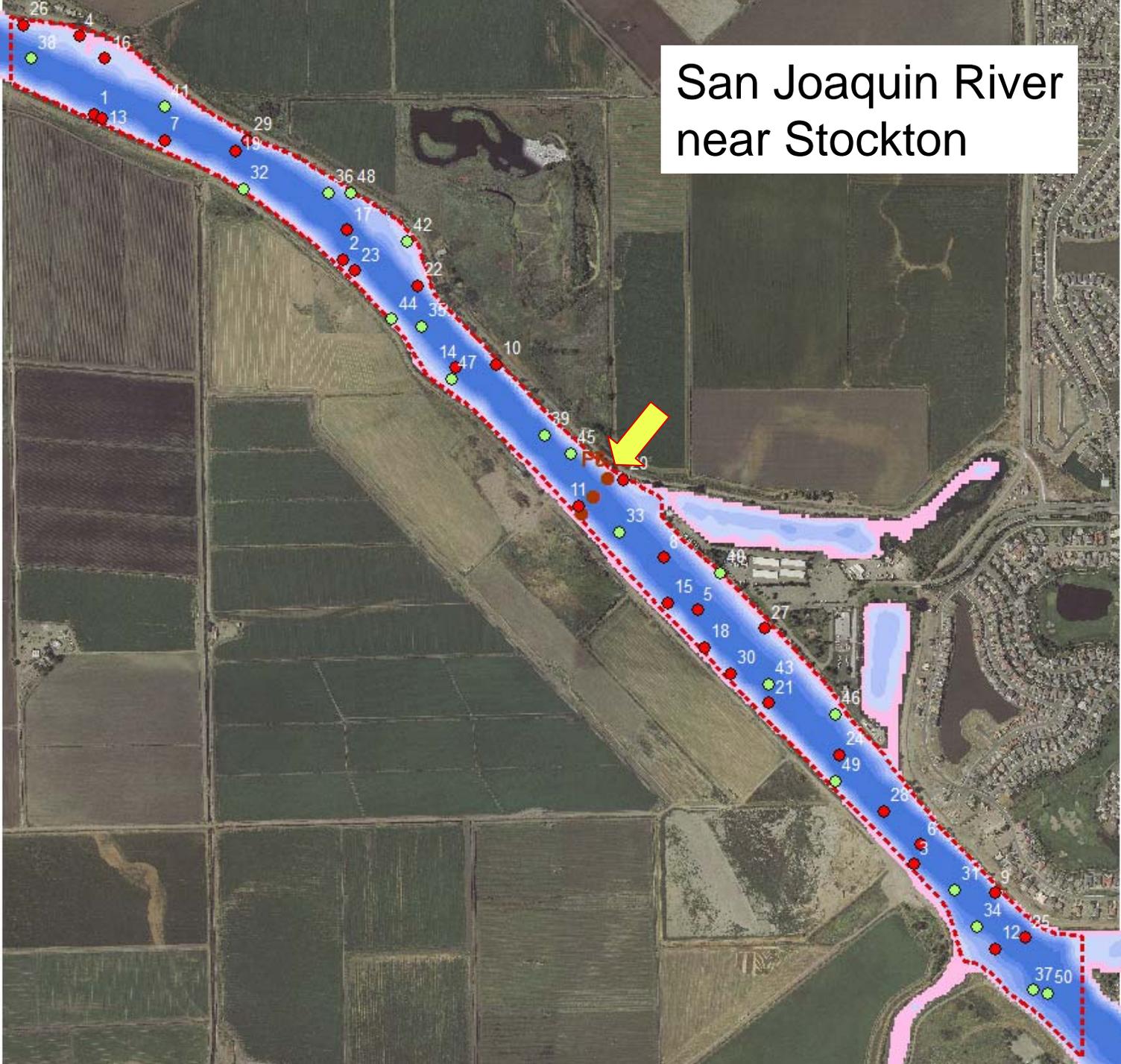
D4 Sacramento River near confluence



D28A Old River
near Rock slough

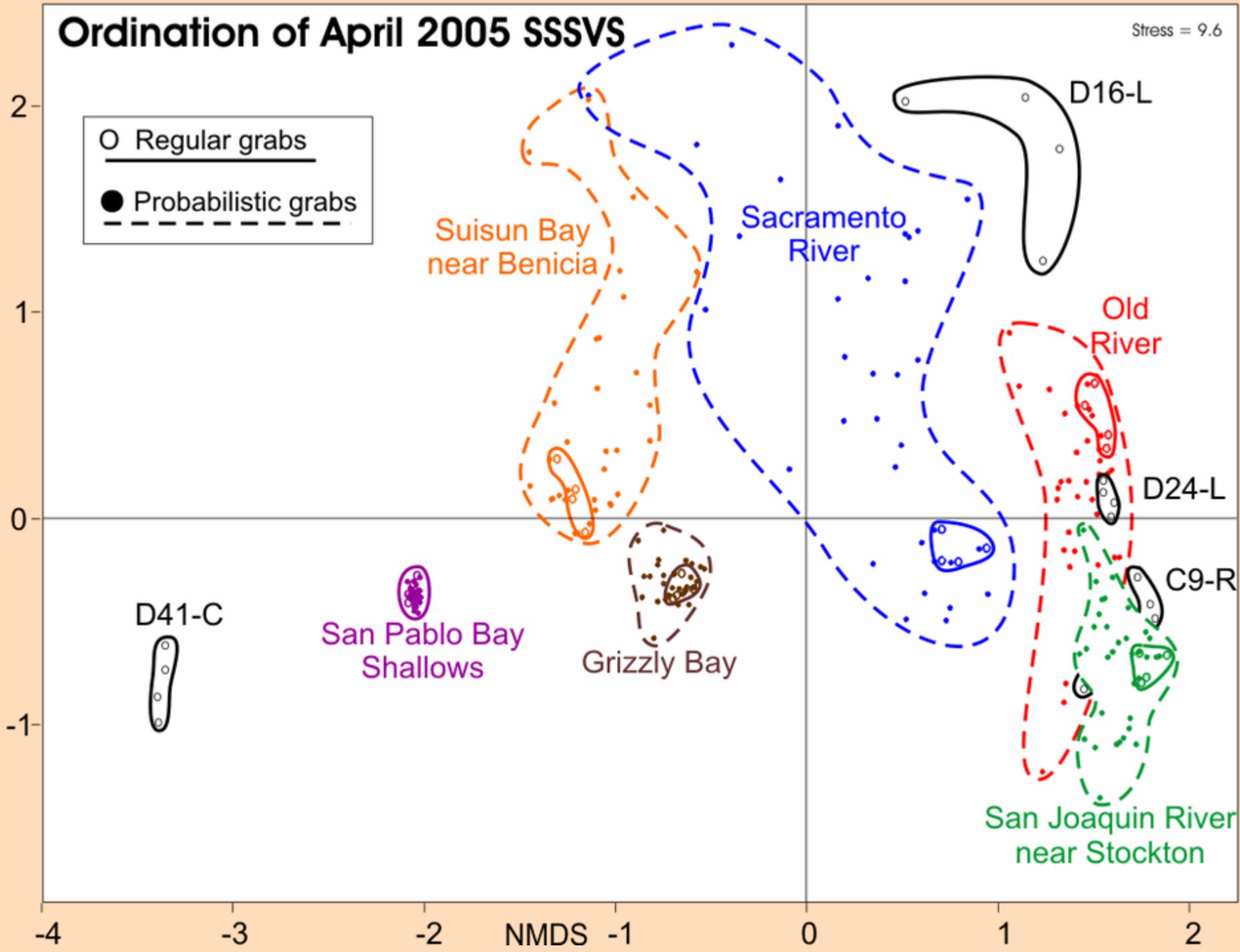
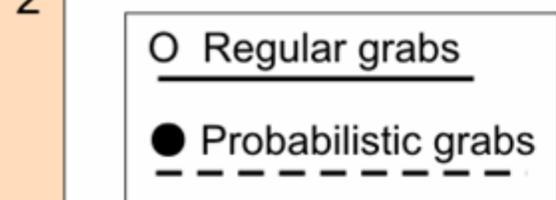


San Joaquin River near Stockton



Ordination of April 2005 SSSVS

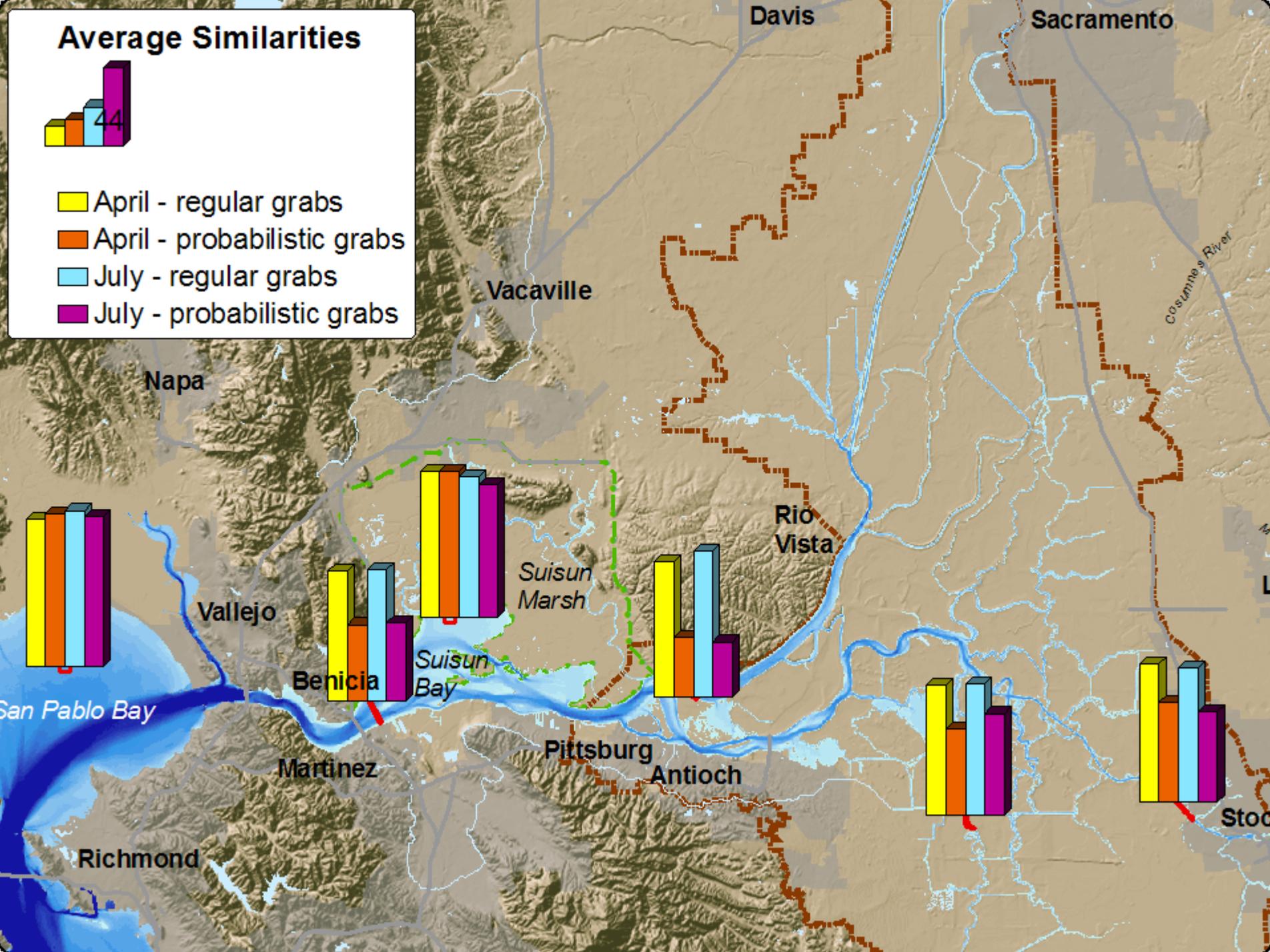
Stress = 9.6



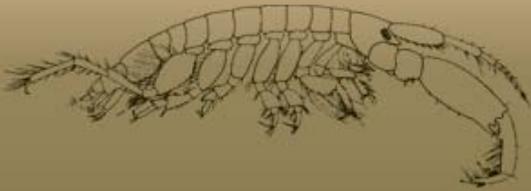
Average Similarities



- April - regular grabs
- April - probabilistic grabs
- July - regular grabs
- July - probabilistic grabs



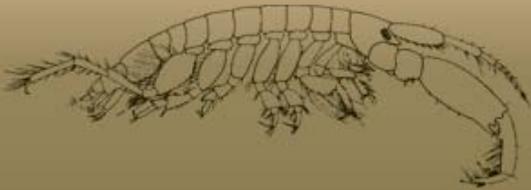
Study 2: Small Scale Representativity



- Findings:
 - Representativity of the 4 regular grabs is:
 - Excellent in shallow embayments.
 - Lowest in large flowing channels.
 - Intermediary in smaller, lower flow rivers.
 - Representativity tied to bathymetry, hydrology, substrate and amount of edges.
 - Current monitoring sites were chosen for their species richness and abundance.



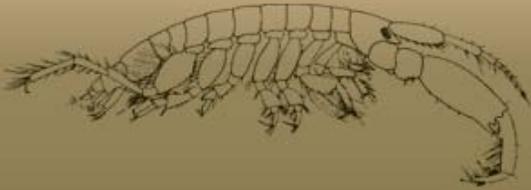
Study 2: Small Scale Representativity



- For new design:
 - Remove bias by sampling random sites
 - Stratification is necessary in selecting random locations in the Upper Estuary.
 - Embayments with the most surface area have the least variability, ...



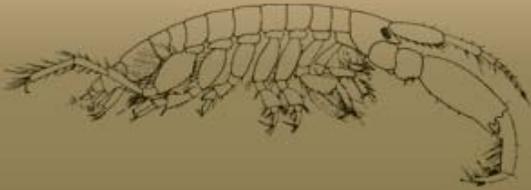
Proposed Sampling Design



- Keep sampling monthly at 5 or 6 sites:
 - Seasonal patterns, long time series, “sentinel sites”
- Add 2 spatially extensive surveys / year
 - spring and fall.
 - 25 sites visited each survey
 - 225 sites visited twice (and new set each year)
 - Randomly chosen using Generalized Random Tessellation Stratified (GRTS) survey design (Olsen R.A. & Stevens D.L.)



Proposed Sampling Design



- More extensive, unbiased coverage will allow for regional estimates of ecosystem processes such as bivalve grazing (with biomass info), etc.

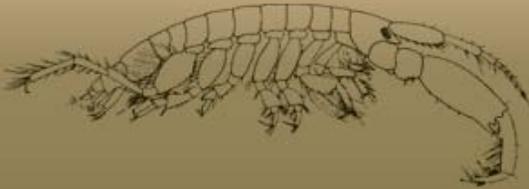




*Can you teach a
long-term benthic
monitoring
program new
tricks?*

Yes, but it will
require work

Thanks to the EMP people



Benthic Assemblages

May 2003 Groups

- ▼ [9] *Ampelisca* - *Corbula* - *Nippoleucon* - *Corophium*
- [8] *Corbula* - *Nippoleucon*
- ▼ [2] *Corbula*, *Corophium*, *Tubificoides*
- [3] *Marenzelleria* - gammarid | depauperate
- [6] *A. spinicorne* - Gammarid - Polychaete
- [4] *A. stimpsoni* - *Corbicula* - Tubificid
- ▲ [7] Tubificid - polychaete
- ▲ [5] Tubificid - midge
- [1] *Corbicula* - *Varichaetadrilus* | depauperate
- ▼ [10] *Corbicula* - midge | depauperate

Dominant feeding mode

- ▽ Suspension
- Mixed
- △ Deposit
- No clear dominance

Benthic Boogie

