

# Environmental Monitoring Program Benthic Element



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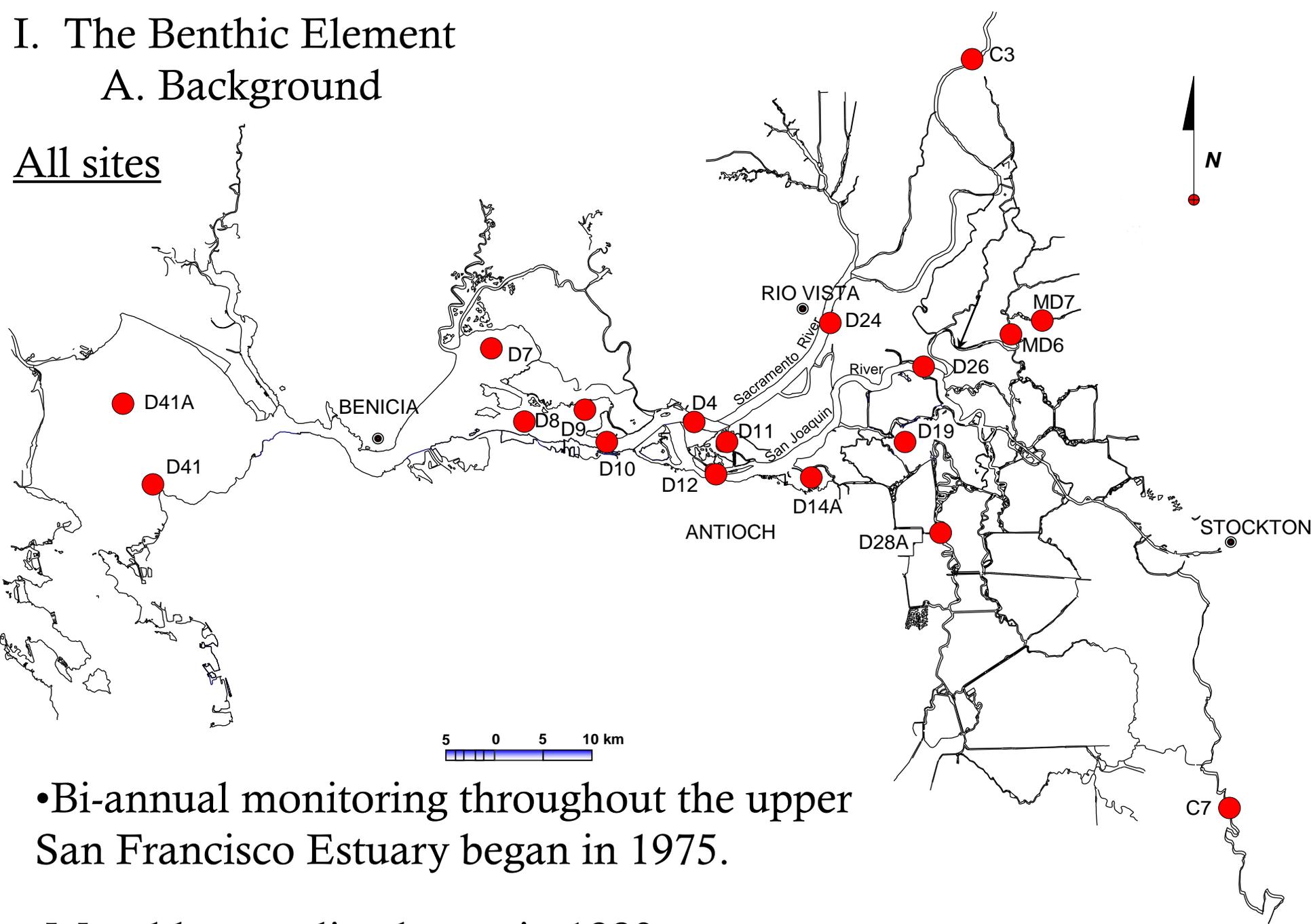
# I. Environmental Monitoring Program

- Mandated by Water Right Decision D-1641
- Purpose is to maintain compliance with water quality standards
- Document possible effects of diversions and flow manipulation
- Water Quality, Phytoplankton, Zooplankton, Benthos

# I. The Benthic Element

## A. Background

### All sites



- Bi-annual monitoring throughout the upper San Francisco Estuary began in 1975.

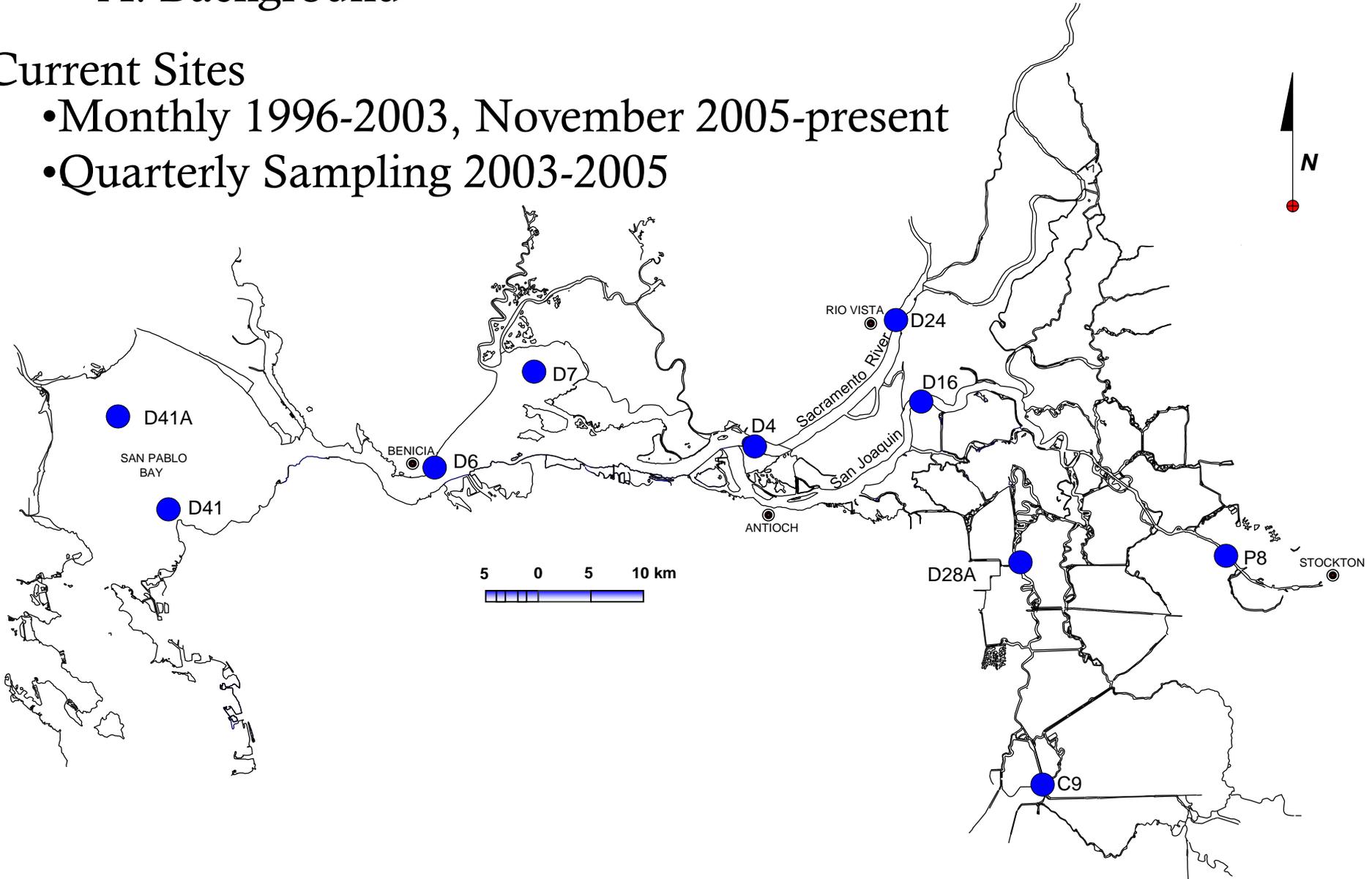
- Monthly sampling began in 1980

# I. The Benthic Element

## A. Background

### Current Sites

- Monthly 1996-2003, November 2005-present
- Quarterly Sampling 2003-2005



## II. The Benthic Element

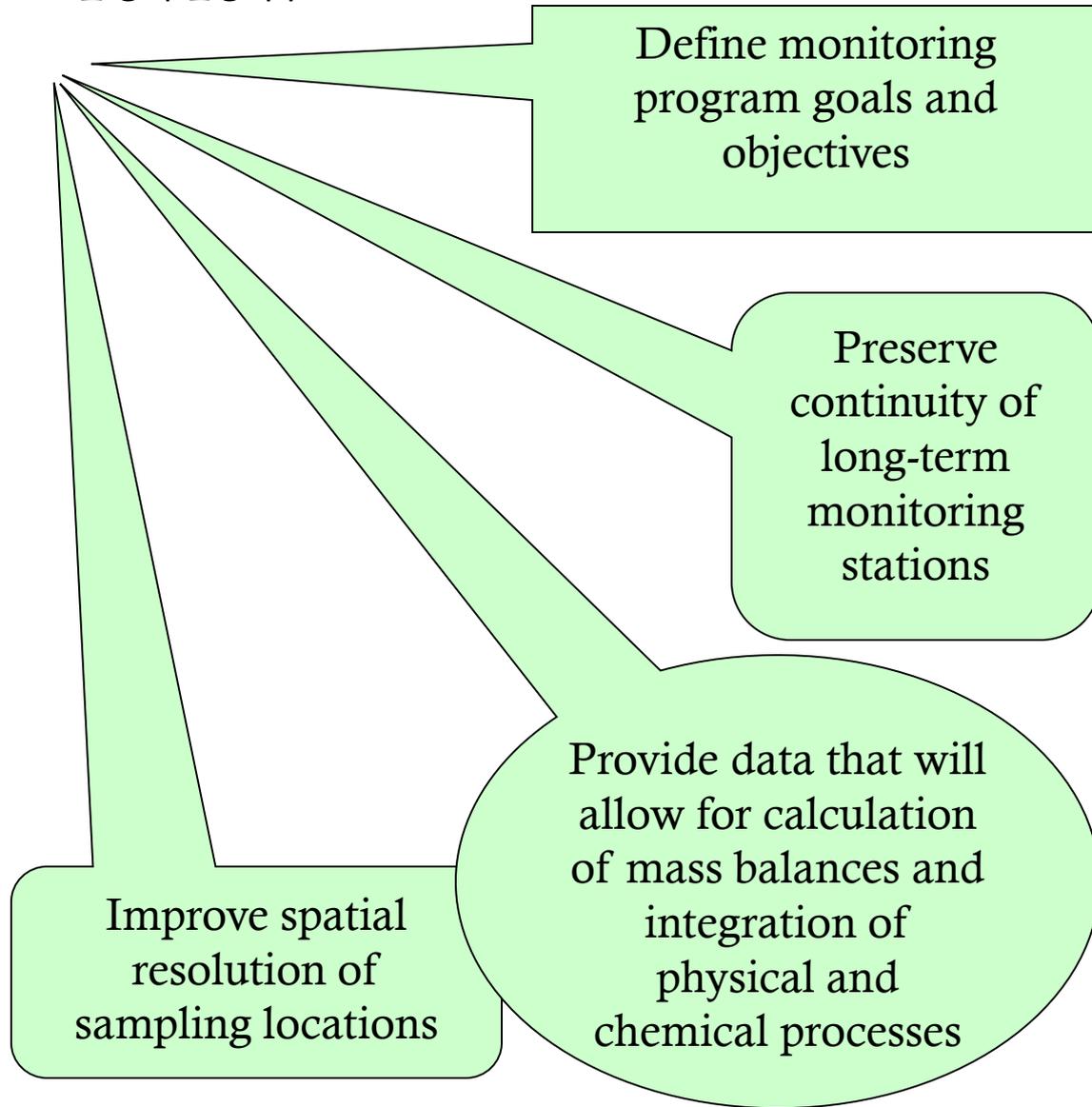
### A. Background

### B. The Review

- D-1641 requires a review of the EMP every three years “to ensure that the goals of the monitoring program are attained” (D-1641 Condition 11 (e), p. 149).
- The most recent review occurred in 2001-2003.
- The recommended course of action for the benthic element was to research and propose a new sampling design

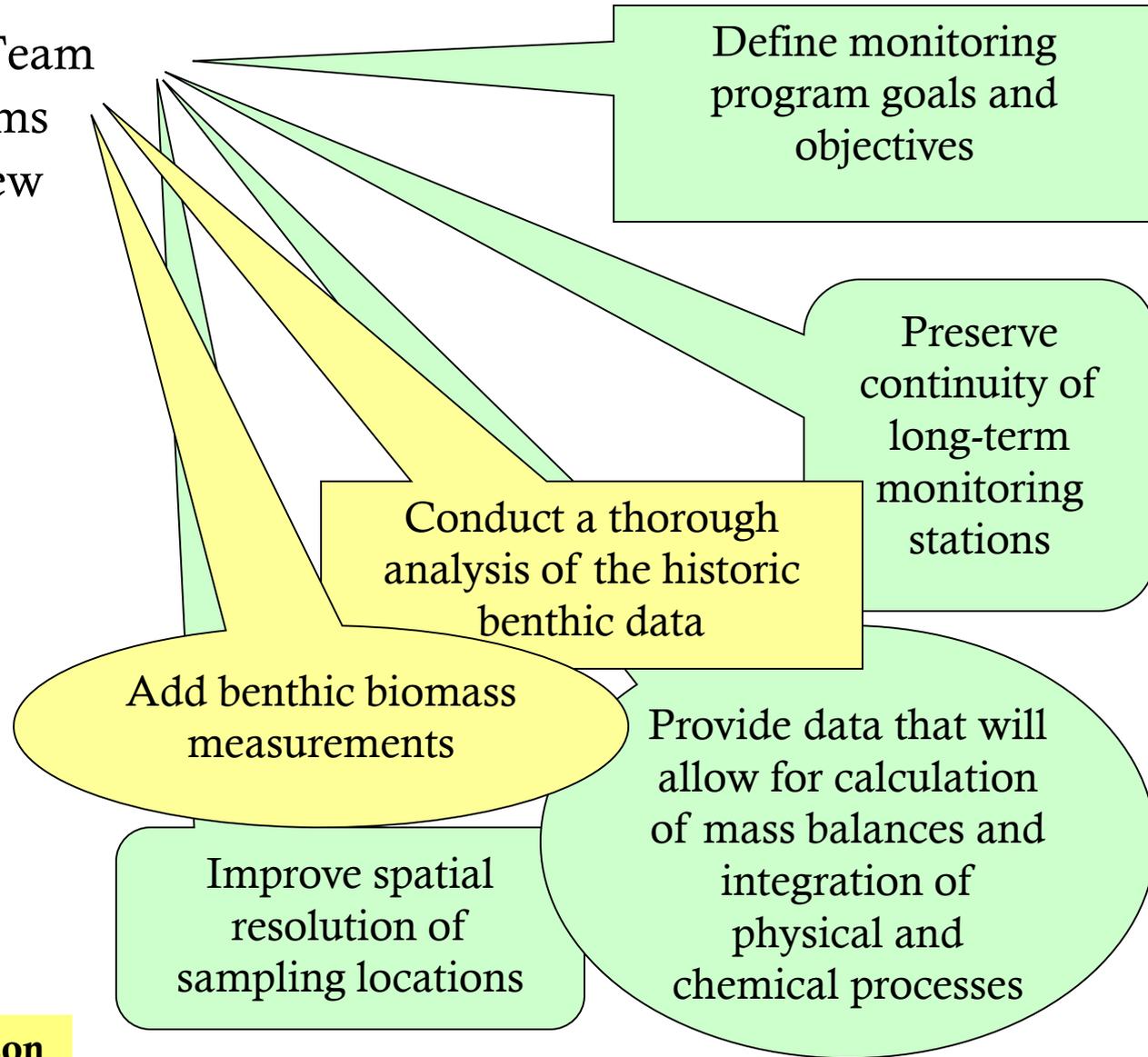
# The current paradigm is shaped by scientific review

- IEP Science Advisory Team
- EMP Subject Area Teams
- The EMP review team
- BEET



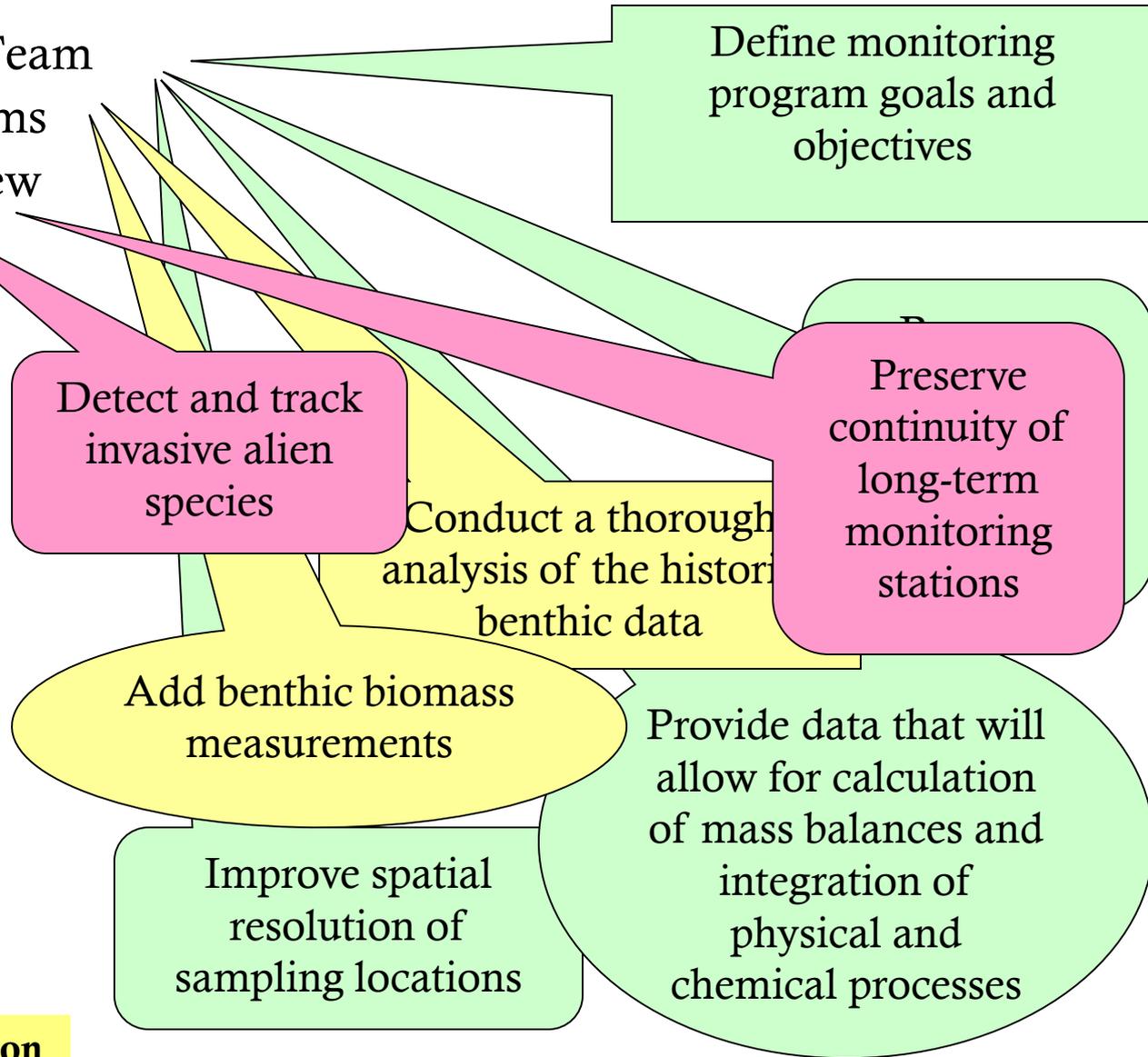
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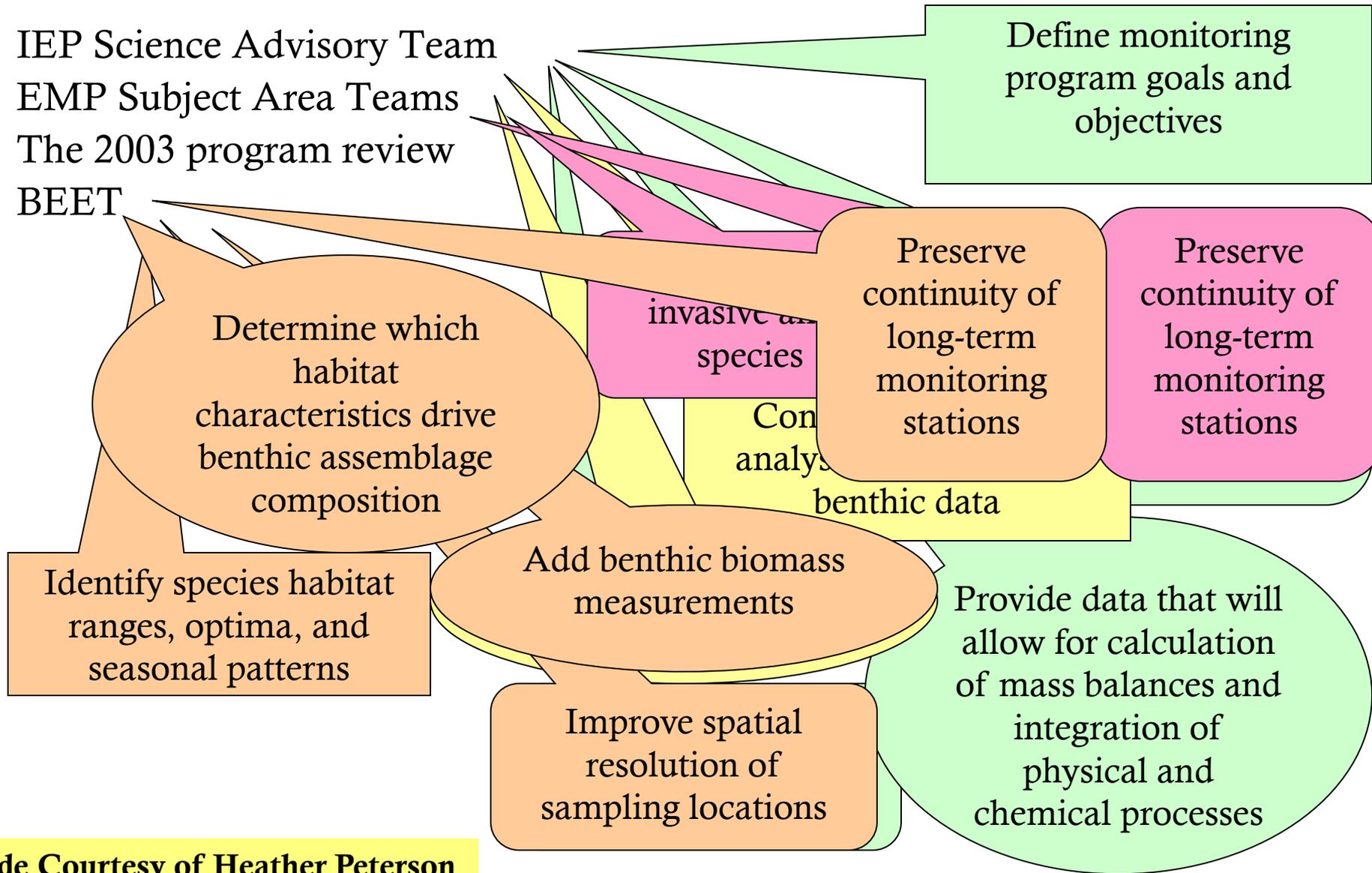
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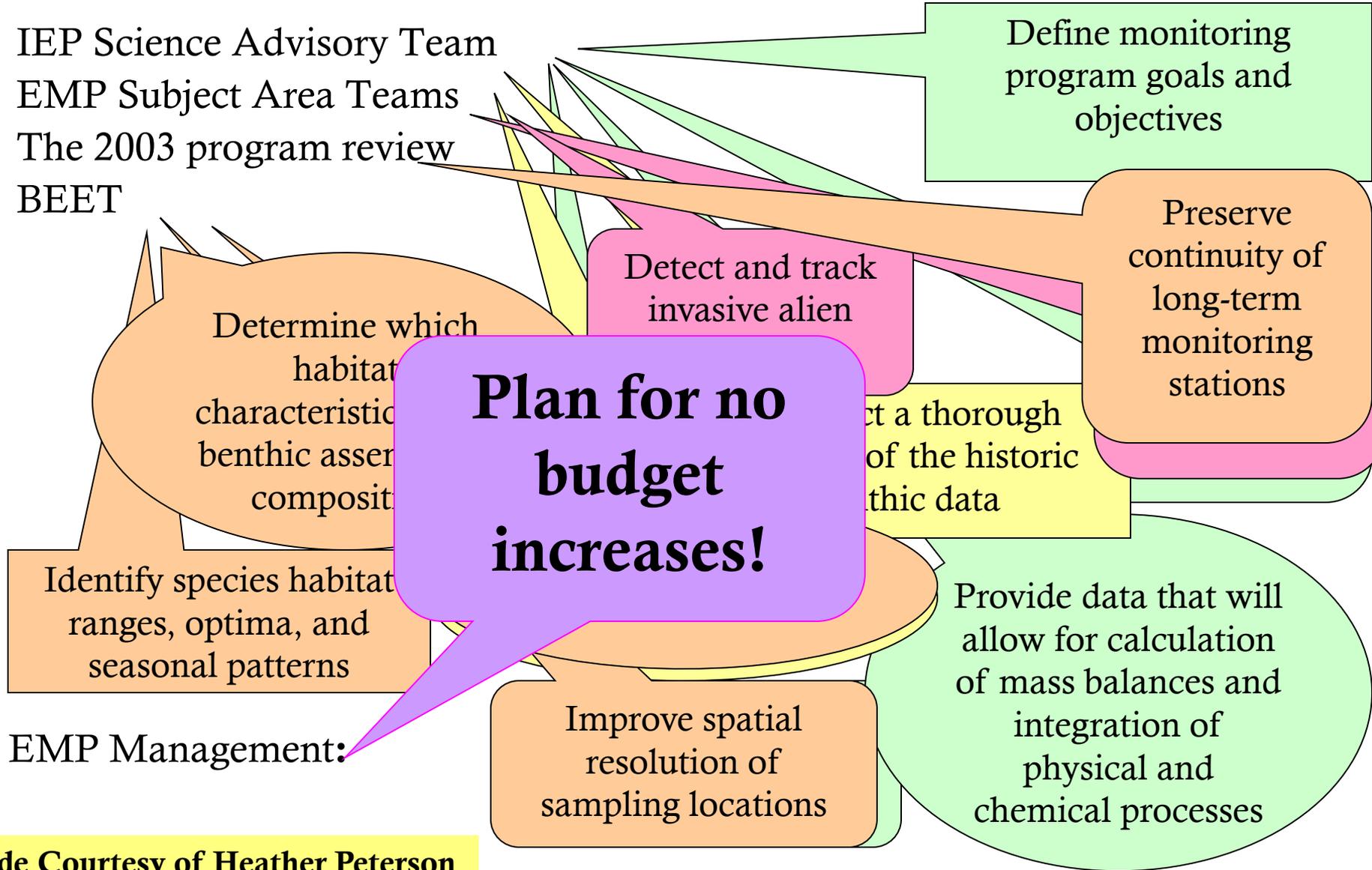
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# The current paradigm is shaped by scientific review... and management

- IEP Science Advisory Team
- EMP Subject Area Teams
- The 2003 program review
- BEET



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### III. Special Studies

#### A. Retrospective Analysis

#### B. Benthic Boogie

- Purpose was to assess benthic grazing rates and to determine the effect of physical habitat features
- A spatially intensive benthic survey of the upper Estuary in May and October, 2003.
- The study was initiated by the USGS
- Excellent opportunity to assess the geographic distribution of benthic assemblages in regions and habitats that are not covered through the regular benthic monitoring element

### III. Special Studies

#### A. Retrospective Analysis

#### B. Benthic Boogie

- 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

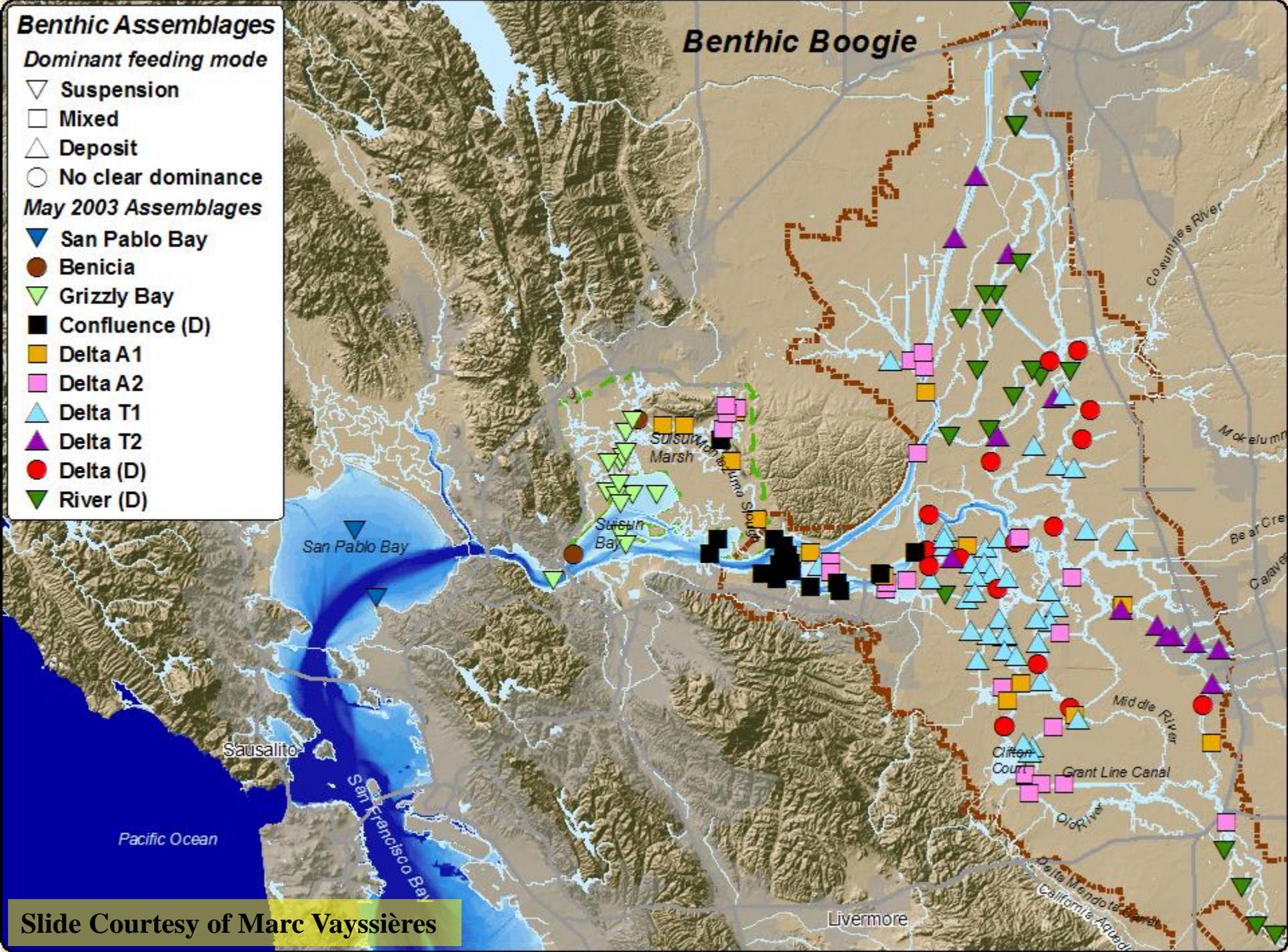
## Dominant feeding mode

- ▽ 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



Slide Courtesy of Marc Vayssières

# Benthic Assemblages

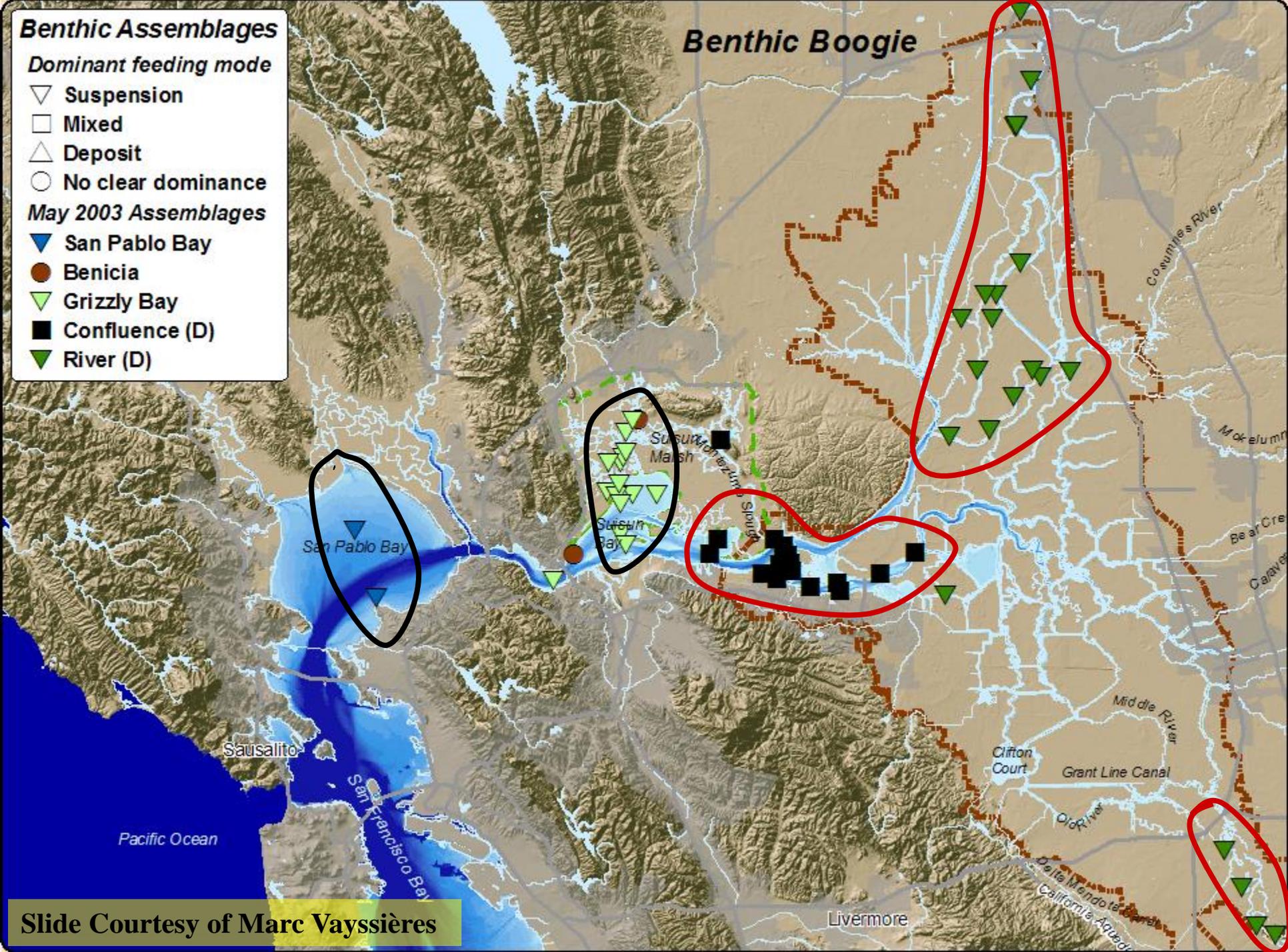
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# Benthic Boogie



# Benthic Assemblages

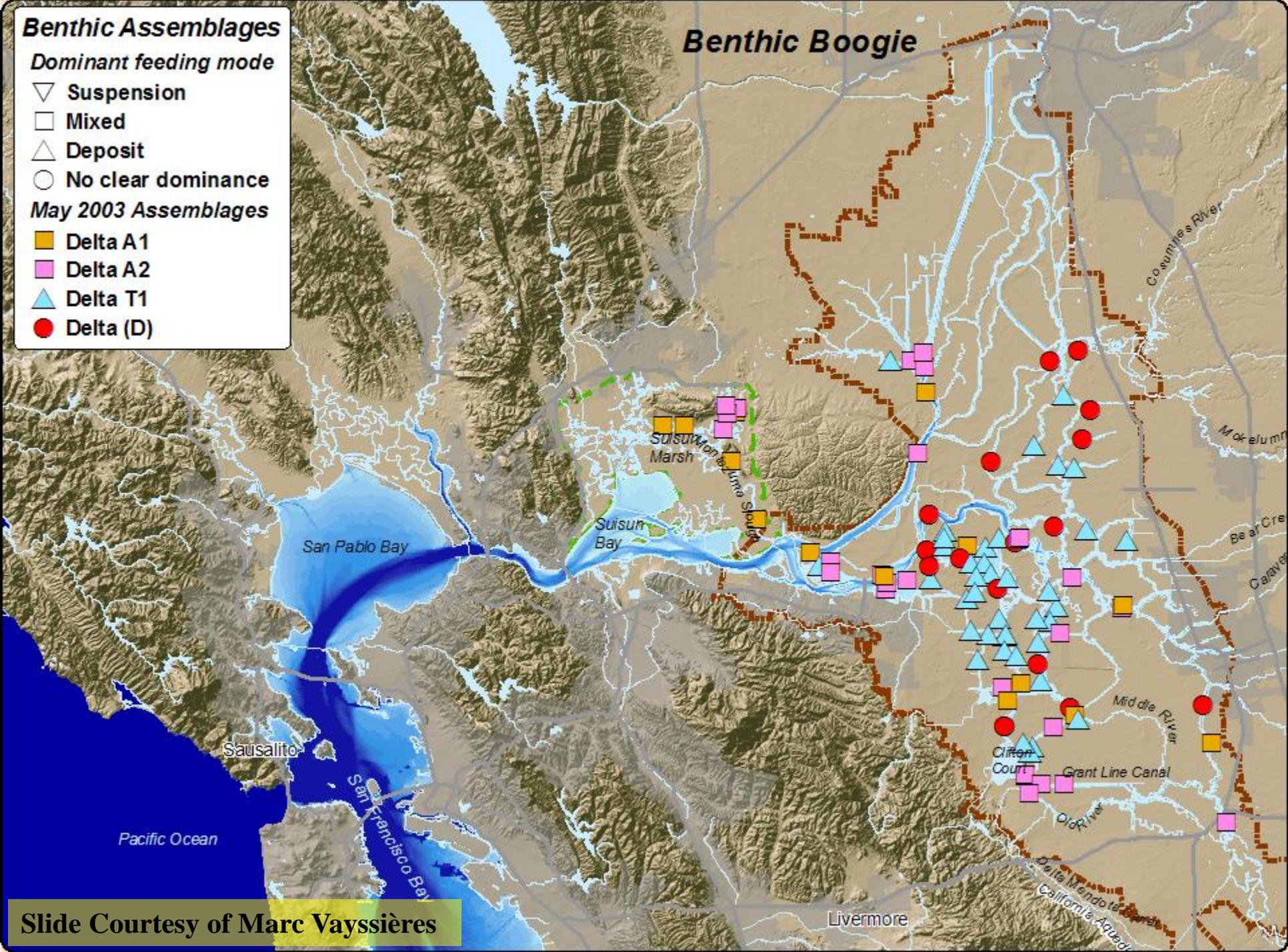
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## May 2003 Assemblages

- Delta A1
- Delta A2
- △ Delta T1
- Delta (D)

# Benthic Boogie



### III. Special Studies

#### A. Retrospective Analysis

#### B. Benthic Boogie

- 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.

### III. Special Studies

A. Retrospective Analysis

B. Benthic Boogie

- Thoughts for a 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.

### III. Special Studies

A. Retrospective Analysis

B. Benthic Boogie

C. S.S.S.V.S

#### Objectives:

- To assess the small scale spatial variability of benthic organisms at the EMP monitoring stations.
- To provide recommendations for the possible redesign of the benthic monitoring element of the EMP

### III. Special Studies

A. Retrospective Analysis

B. Benthic Boogie

C. S.S.S.V.S

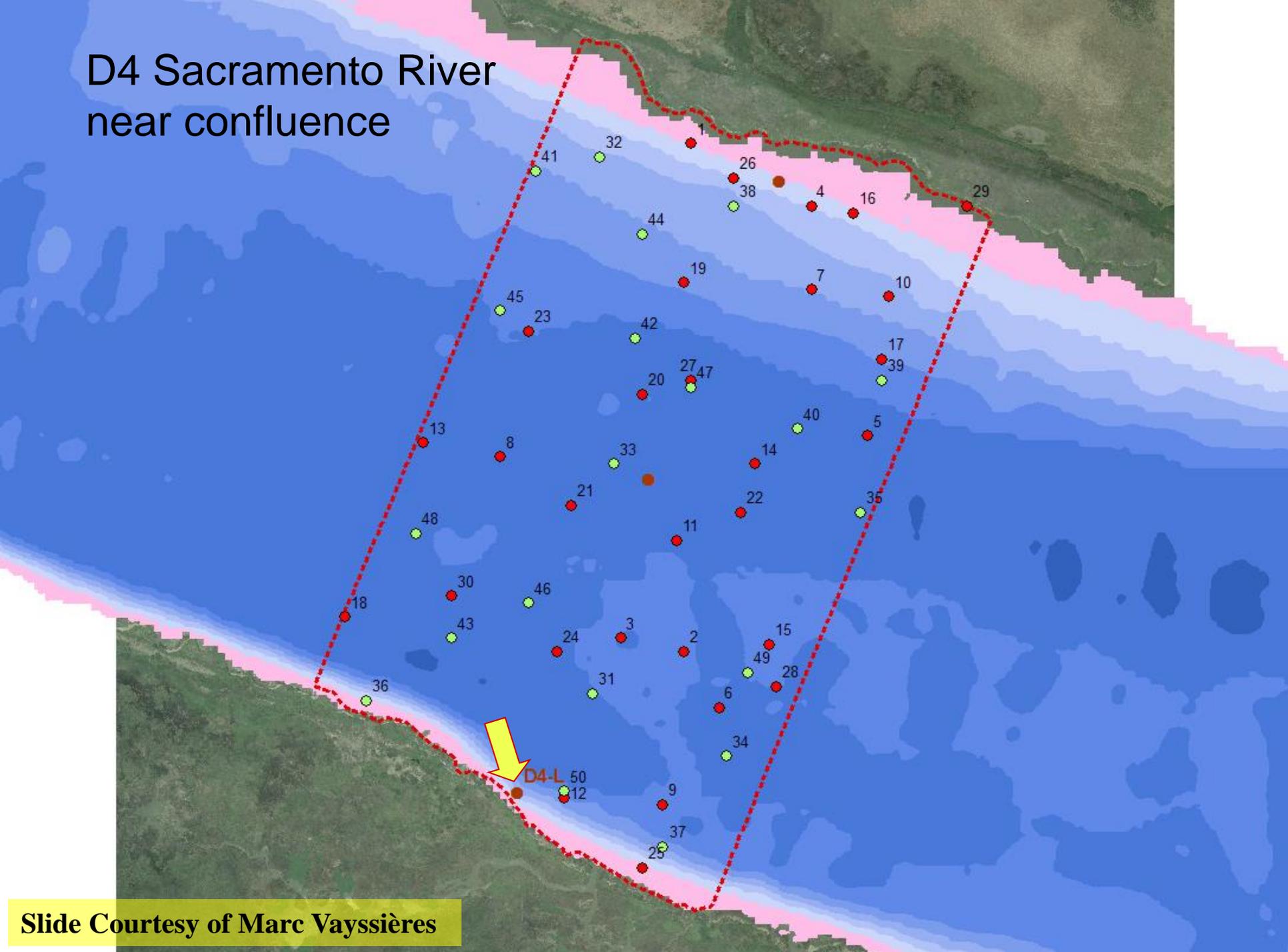
- Data:

- 30 grabs taken in 64ha neighborhoods of 6 of EMP regular sites in April and in July, 2005
- 4 regular monitoring grabs at each site

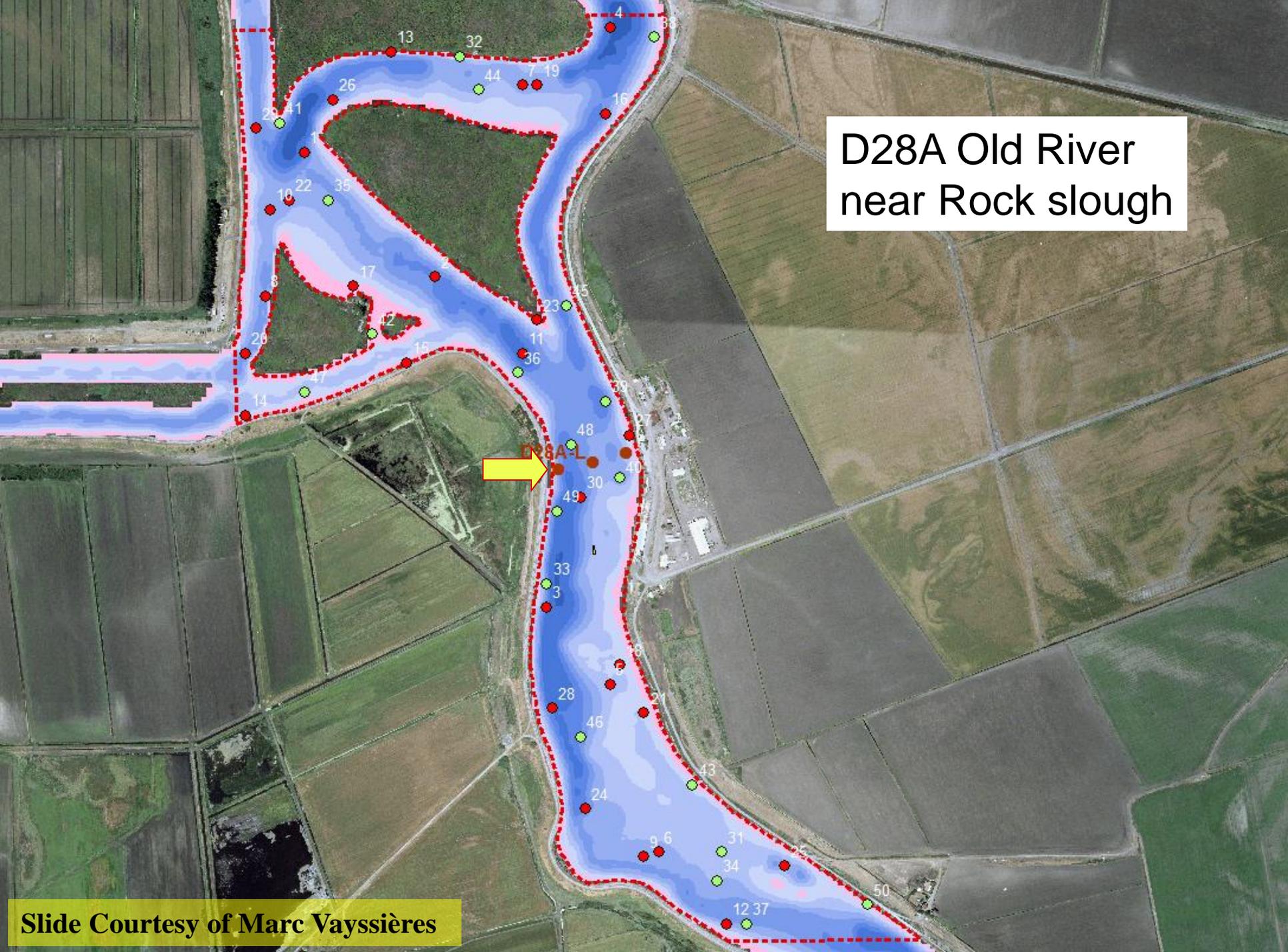
- Methods:

- Generalized Random Tessellation Stratified (GRTS) design in each neighborhood
- Bray-Curtis similarity on sqrt of species abundance
- Ordination (Non metric multi dimensional scaling)

# D4 Sacramento River near confluence

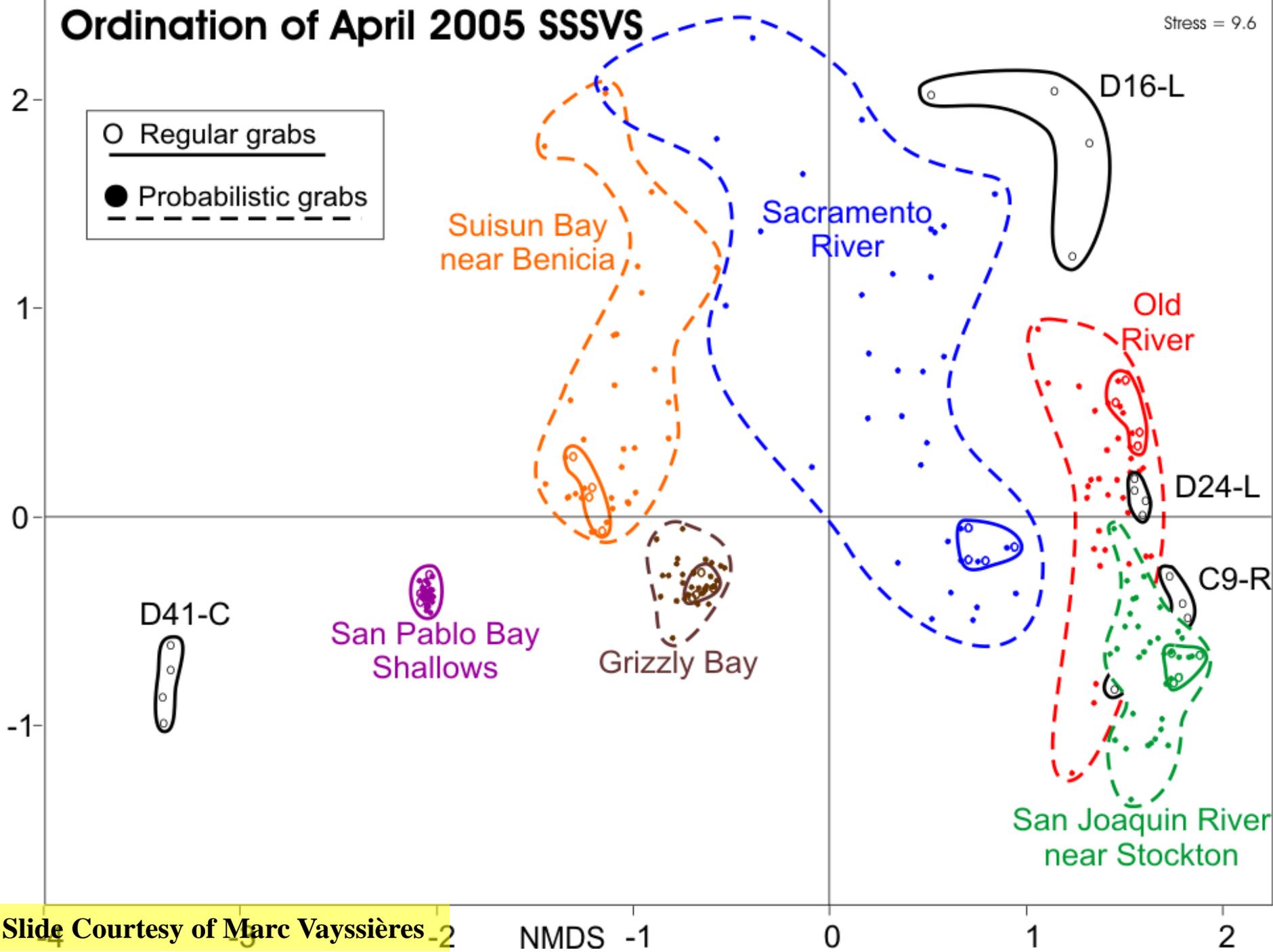
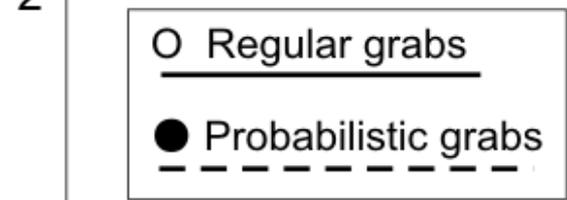


D28A Old River  
near Rock slough



# Ordination of April 2005 SSSVS

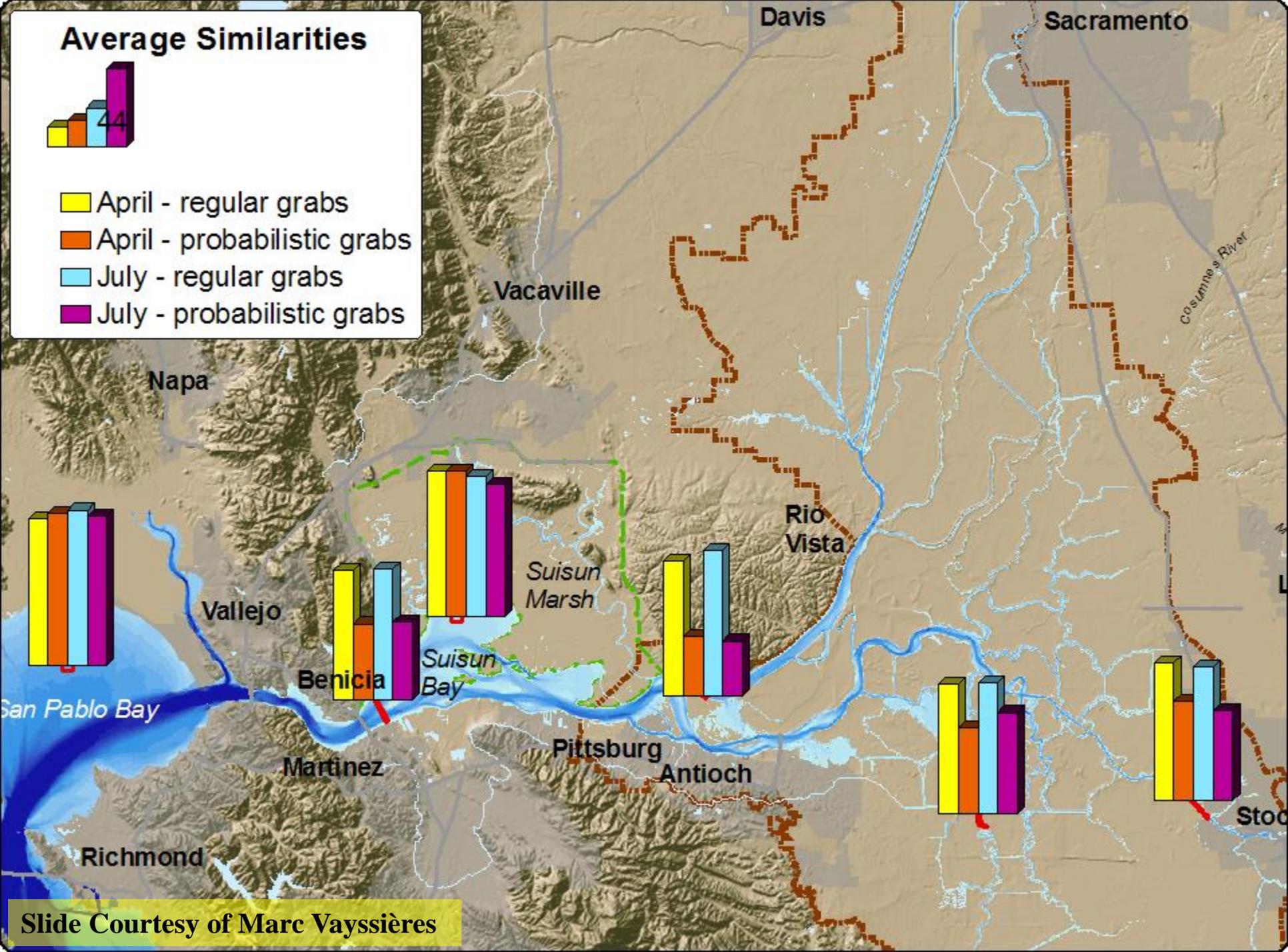
Stress = 9.6



# Average Similarities



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



### III. Special Studies

A. Retrospective Analysis

B. Benthic Boogie

C. S.S.S.V.S

- 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.

### III. Special Studies

- A. Retrospective Analysis
- B. Benthic Boogie
- C. S.S.S.V.S

- Thoughts for a 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, ...

### III. Special Studies

- A. Retrospective Analysis
- B. Benthic Boogie
- C. S.S.S.V.S
- D. Benthic Biomass

#### Objectives

- To develop a reliable and efficient protocol to measure benthic biomass
- Use the data to evaluate the function of the benthic community in the ecosystem and how these functions may affect “at risk species”.
- Establish the utility of these data as an assessment tool for ecosystem change in the upper San Francisco Estuary

### III. Special Studies

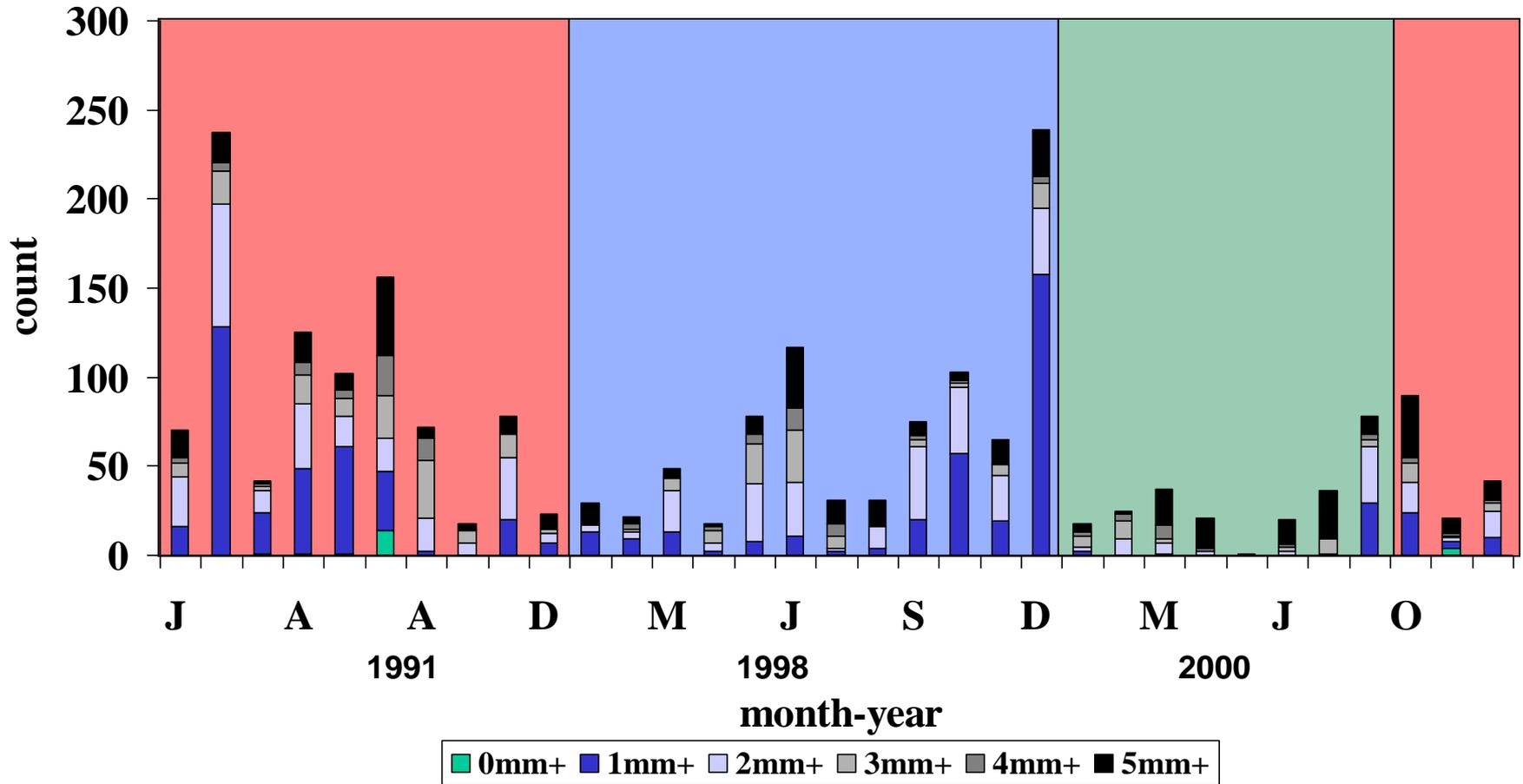
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### Methods

- Bivalve lengths are measured using micrometer, calipers or HLImage<sup>++</sup> imaging software
- A conversion factor will be used to determine ash free dry weight (AFDW) from the Bivalve length measurements
- AFDW measurements will be converted into carbon units using published conversion factors

# Findings:

*Corbicula fluminea* size classes at D28A during 1991, 1998 and 2000



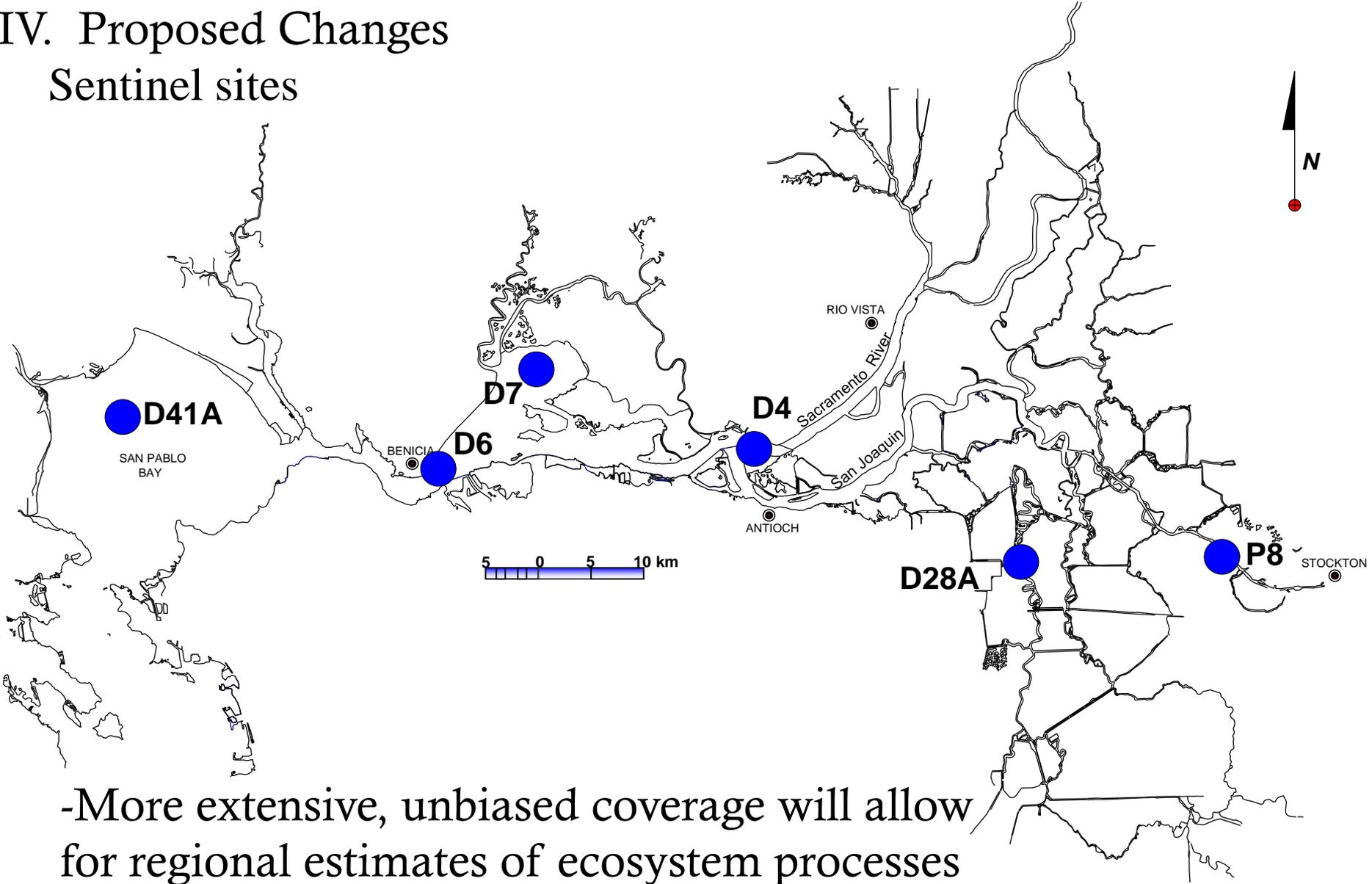


# IV. Proposed Changes

- Keep sampling monthly at 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.)

# IV. Proposed Changes

## Sentinel sites



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



Questions or Comments?

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