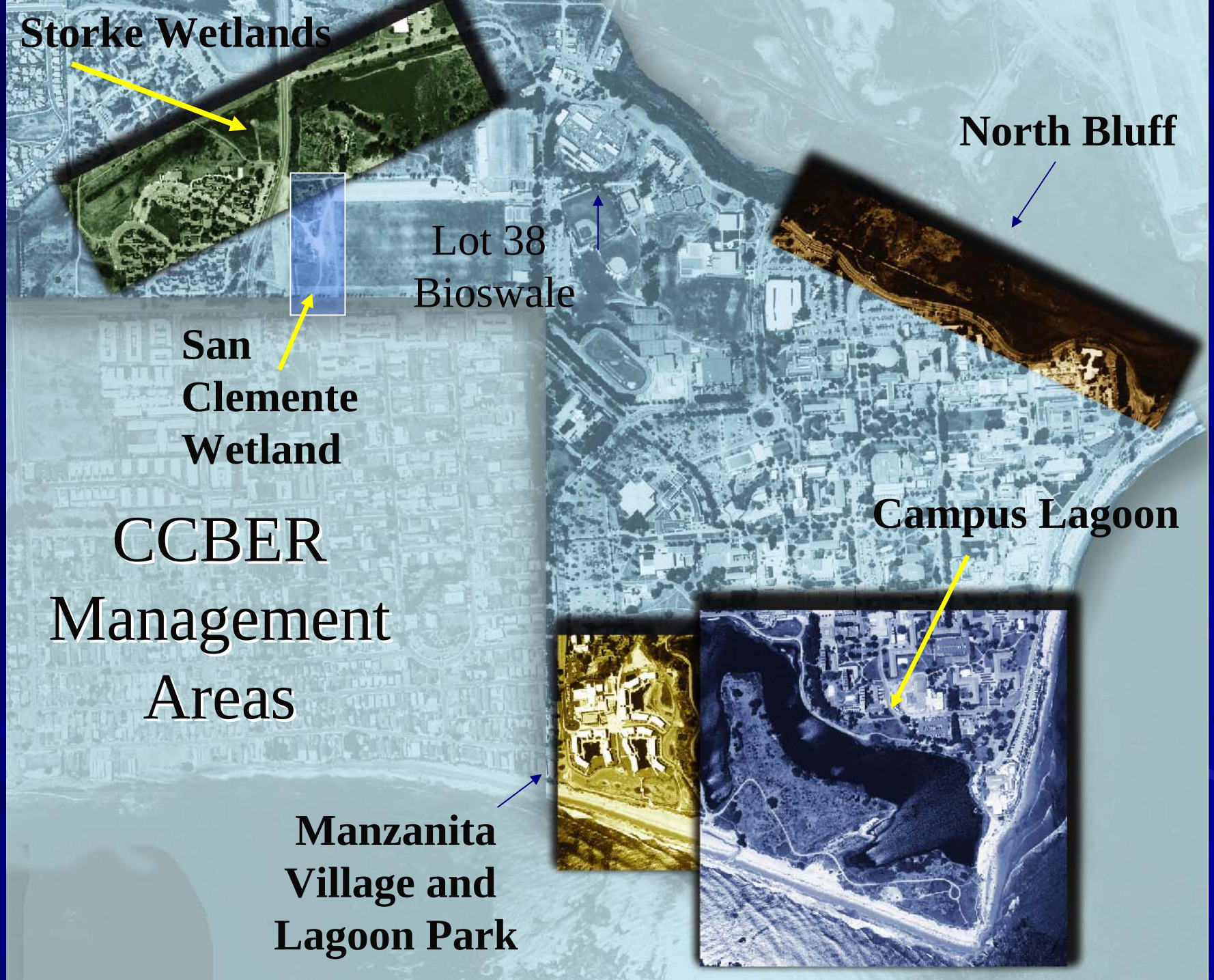
Manzanita Village Storm Water and Urban Runoff Biofiltration System

Lisa Stratton

Cheadle Center for Biodiversity and Ecological Restoration (CCBER)

UCSB



CCBER Management Areas

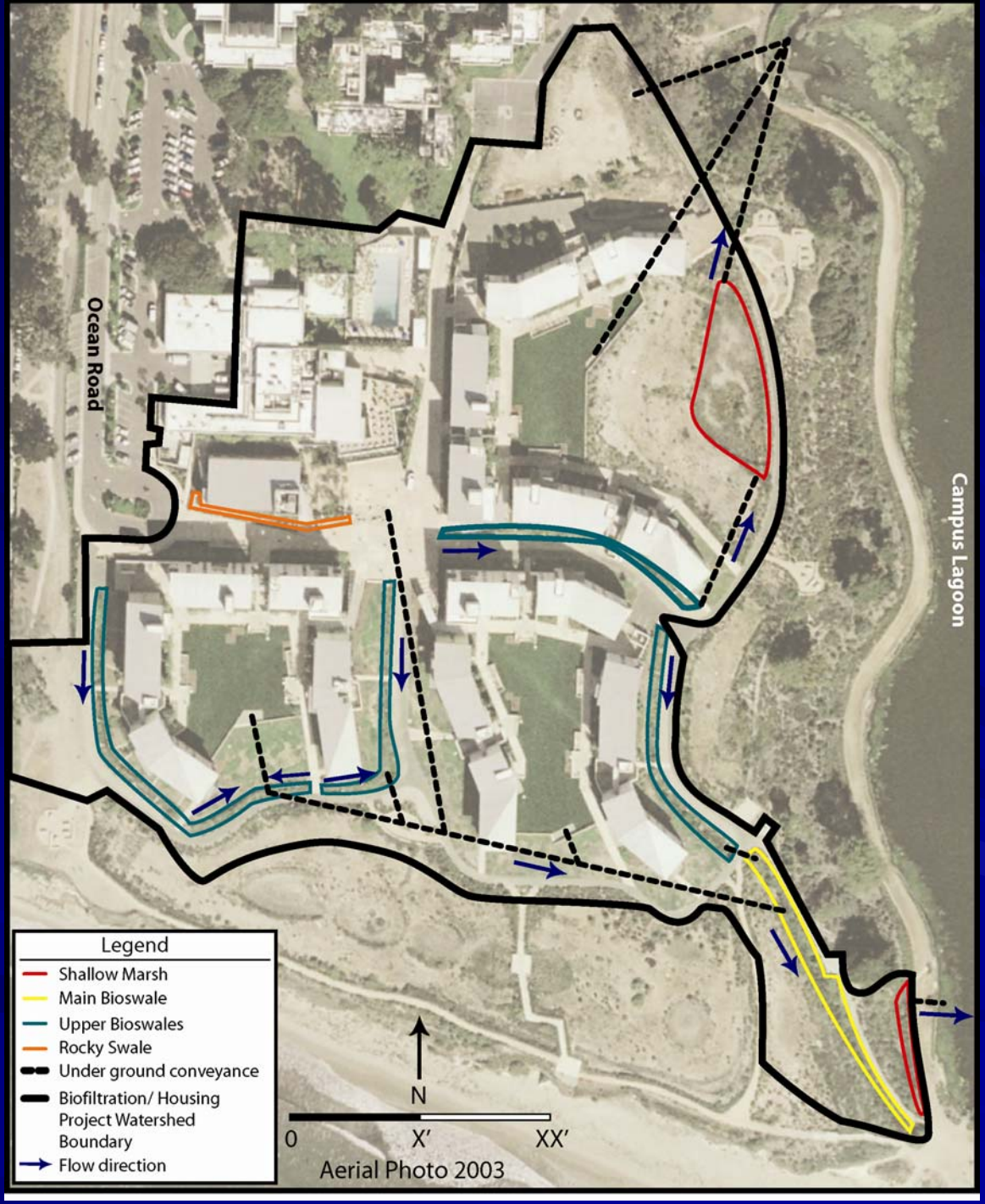
Manzanita Village

Manzanita Bioswale System

Project Partners

- UCSB Housing and Residential Services
- Cheadle Center for Biodiversity and Ecological Restoration (Wayne Ferren, Melanie Powers, Moe Gomez)
- Penfield and Smith
- Van Atta Associates
- Valley Crest
- MSI Analytical Lab

1998 El Niño


Ocean Road
Campus Lagoon
Legend
Shallow Marsh
Main Bioswale
Upper Bioswales
Rocky Swale
Under ground conveyance
Biofiltration/ Housing
Project Watershed
Boundary
Flow direction
N
0
X'
XX'
Aerial Photo 2003

Main bioswale

Installation of dual conveyance pipe

Topsoil and basins

Coconut net and rock check dams

Main bioswale

Planting

Planting completed
September, 2001

September, 2002

Basin 1 – Constructed Wetland

Excavation and survey

Berm and bench construction

Erosion control

Basin 1 – Constructed Wetland

Planting

Planting complete

1-year after planting

Lagoon Park

Main Bioswale

Basin 1 Wetland

Initial Manzanita Swale Design

- Rocky landscape swales
- Drop boxes
- Underground conveyances
- Culverts into Campus Lagoon

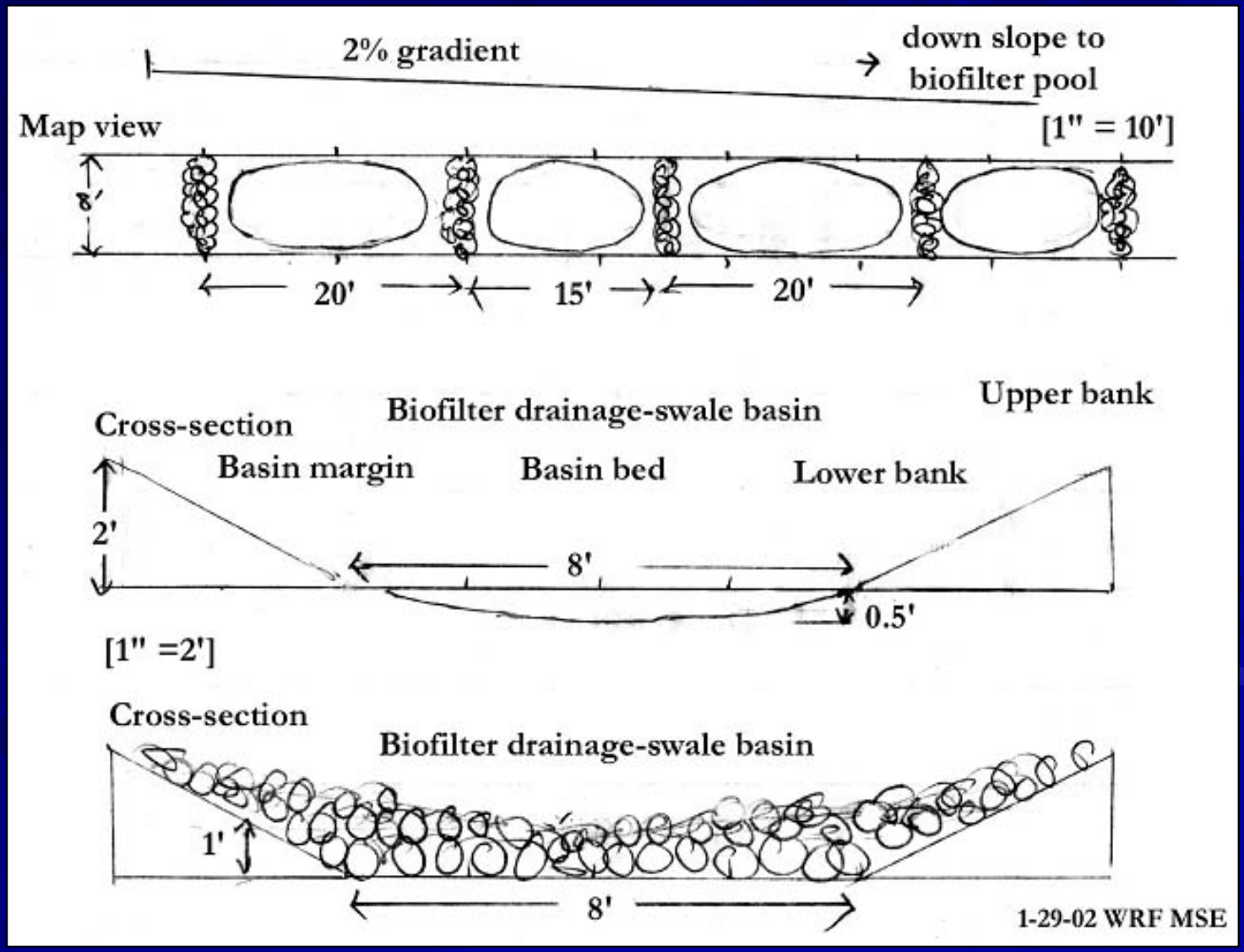
Marine Terrace Deposits

Exposed Clay Subsoil

Excavating the bioswales

Clay soil

Manzanita Bioswale Design



Bioswale Cross-section

Anemopsis californica
Baccharis douglasii
Distichlis spicata
Leymus triticoides
Euthamia occidentalis
Frankenia salina
Juncus textilis

Juncus mexicanus
Juncus patens
Juncus phaeocephalus

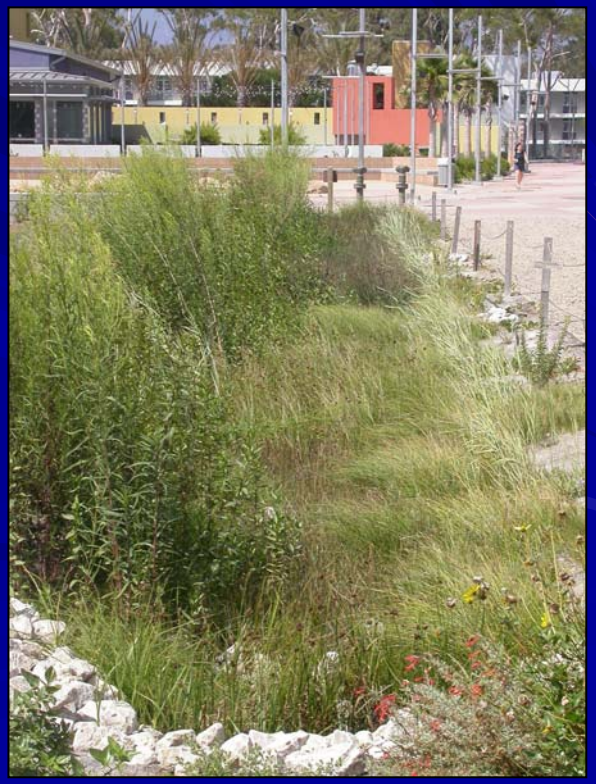
Basin Bed

Manzanita Bioswales

Layout and planting, September 2002

Planting completed, September 2002

August 2003



Manzanita Bioswales

- 1300 linear feet of swales
- Four swale systems
  - 43 bioswale basins
- Multiple inlets from roof drains
- Experimental plant palettes

Design Criteria	Manzanita Village Design
Slope	2 % Upper Bioswales; 6.5% Main Bioswale
Base width	4 ft
Length	Avg 300 ft
Design depth	Observed Avg 6 in
Side Slope (H:V)	1:1
Design Capacity	Not designed
Max treatment velocity	Not designed
Max conveyance velocity[2]	Not designed
Min residence time	Not applicable due to design
Shape	parabolic

lo- marsh zone

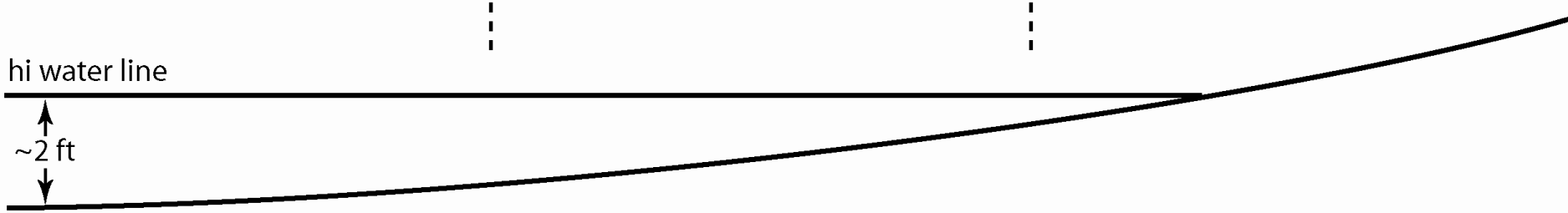
Schoenoplectus americanus
Schoenoplectus californicus

hi-marsh zone

Eleocharis macrostachya
Eleocharis montevedensis
Schoenoplectus maritamus
Schoenoplectus pungens
Schoenoplectus robustus

marsh margin

Anemopsis californicus
Baccharis douglasii
Carex praegracilis
Disticilis spicata
Euthamia occidentalis
Hordeum brachyantherum ssp. brachyantherum
juncus acutus
Juncus bufonius
Juncus occidentalis
Juncus patens
Juncus phaeocephalus
Juncus textilis
Leymus triticoides
Rosa californica
Schoenoplectus cernus



Biofiltration Systems

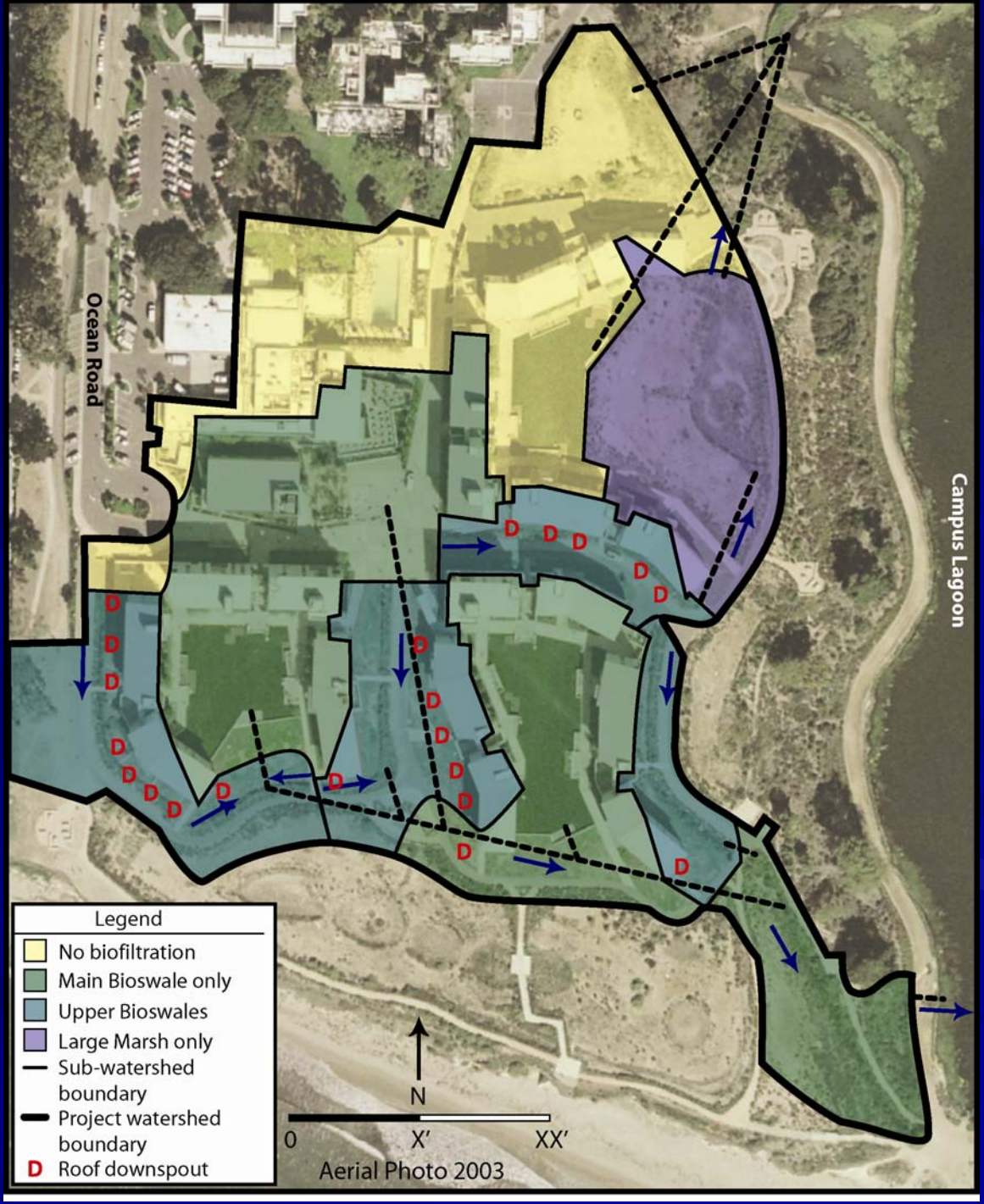
Bioswales or
Vegetated Swales

Wetland Basins
and Channels

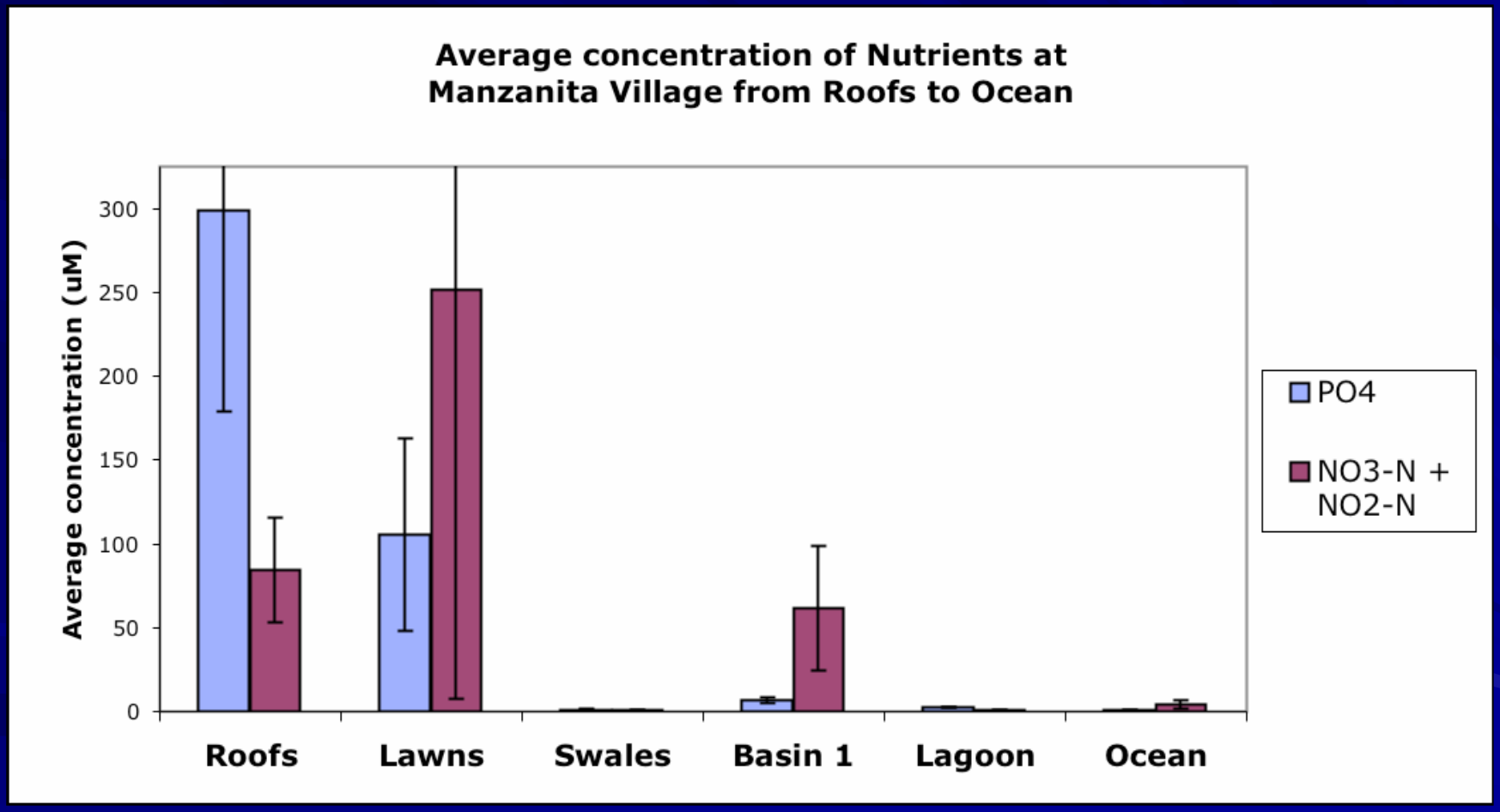
Constructed Wetlands

Functions of Bioswales and Constructed Wetlands

- Conveyance of storm water and urban runoff
- Biofiltration of pollutants
- Groundwater and water table recharge
- Slow down hydrologic cycle to natural rate
- Sediment & trash traps
- Landscape aesthetics
- Habitats for plants and wildlife
- Education and interpretation
- Research


Ocean Road
Campus Lagoon
Legend
No biofiltration
Main Bioswale only
Upper Bioswales
Large Marsh only
Sub-watershed boundary
Project watershed boundary
D Roof downspout
N
0
X'
XX'
Aerial Photo 2003

Water Quality Data



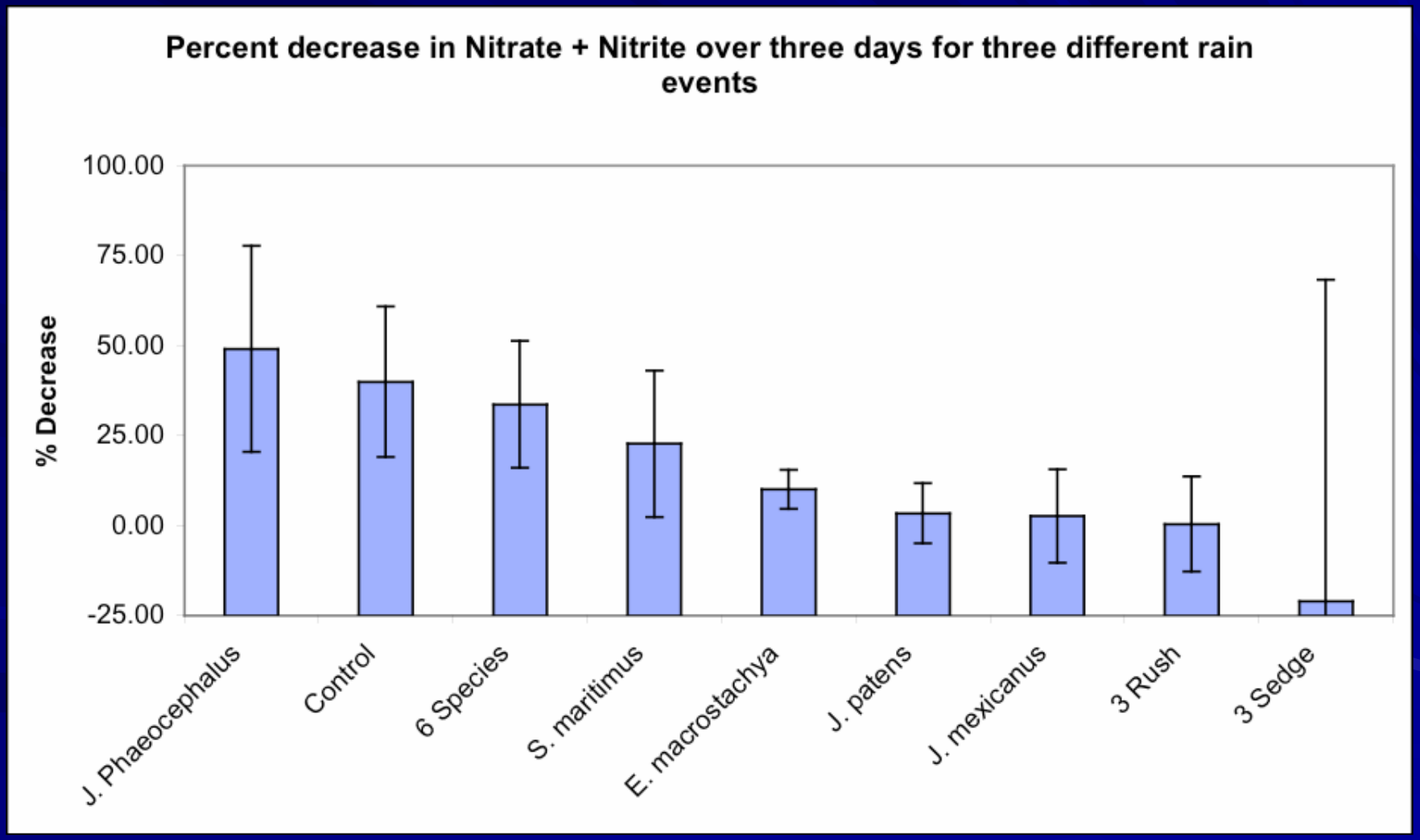
Experimental plant palette

- 3 Rushes:
  - *Juncus mexicanus*
  - *Juncus patens*
  - *Juncus phaeocephalus*

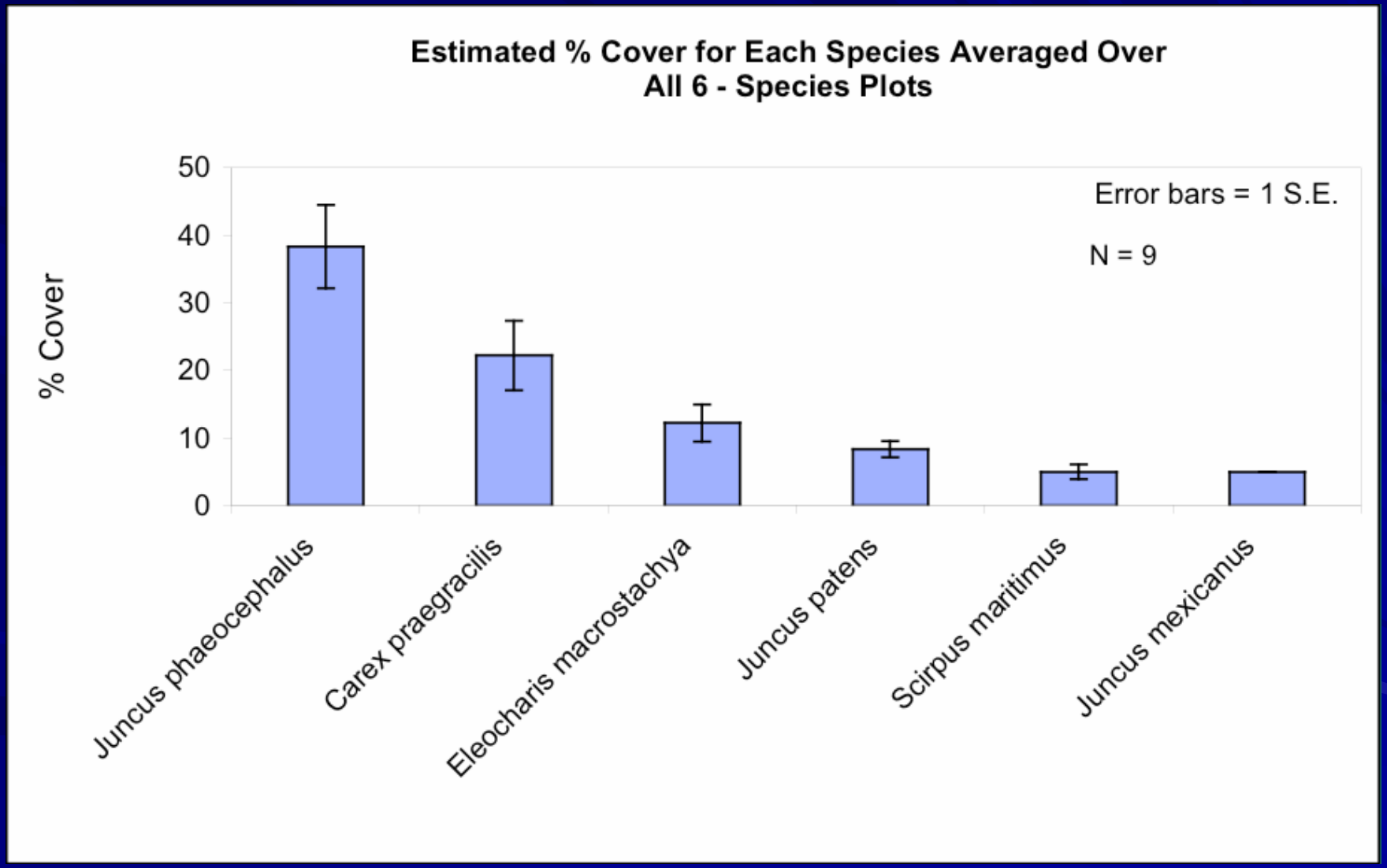
- 3 Sedges:
  - *Carex praegracilis*
  - *Eleocharis macrostachya*
  - *Scirpus maritimus*

Post Rain Data

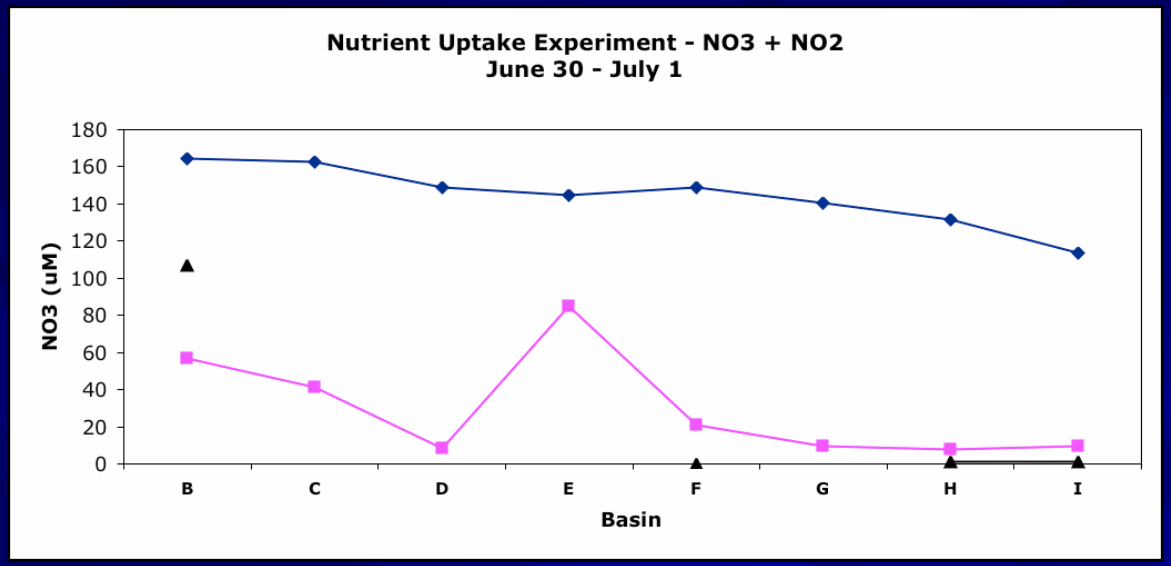
By Planting Treatment

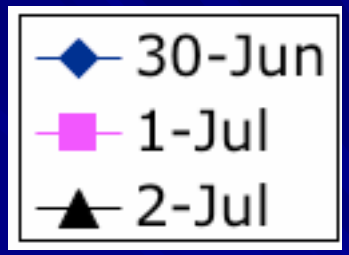


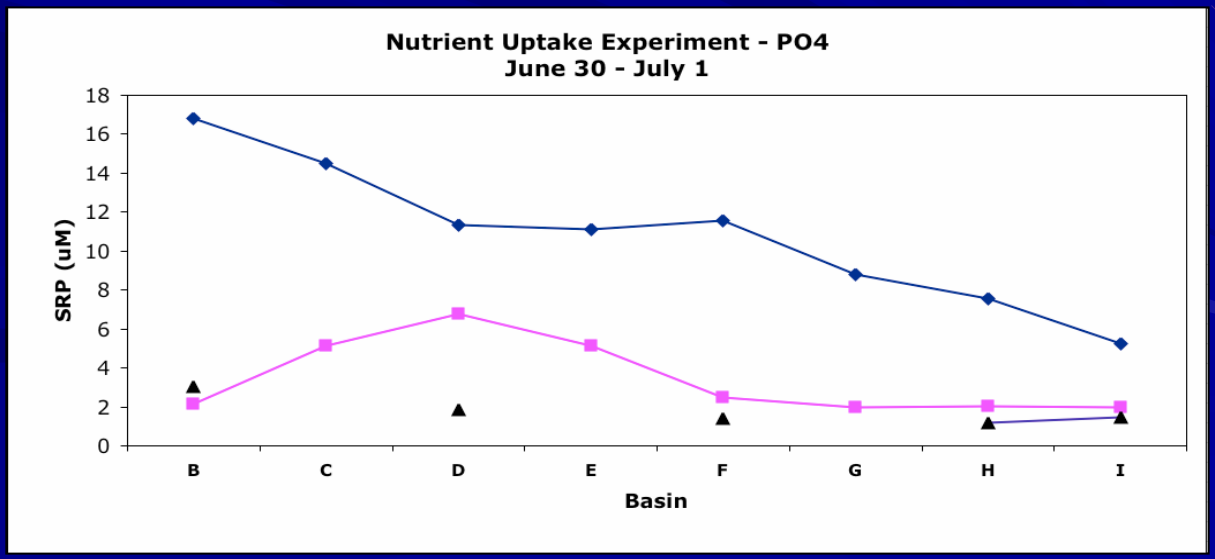
Species Diversity



Experimental Work







Sampling Locations

Key

1 = Ocean Road SD

2 = Upper CDS SD

3 = Art building SD

4 = UCEN SD

5 = Anacapa SD

6 = East Campus SD

7 = Bioswale

8 = Lagoon W. Outfall

9 = Lagoon UCEN Islands

10 = Lagoon E. Outfall

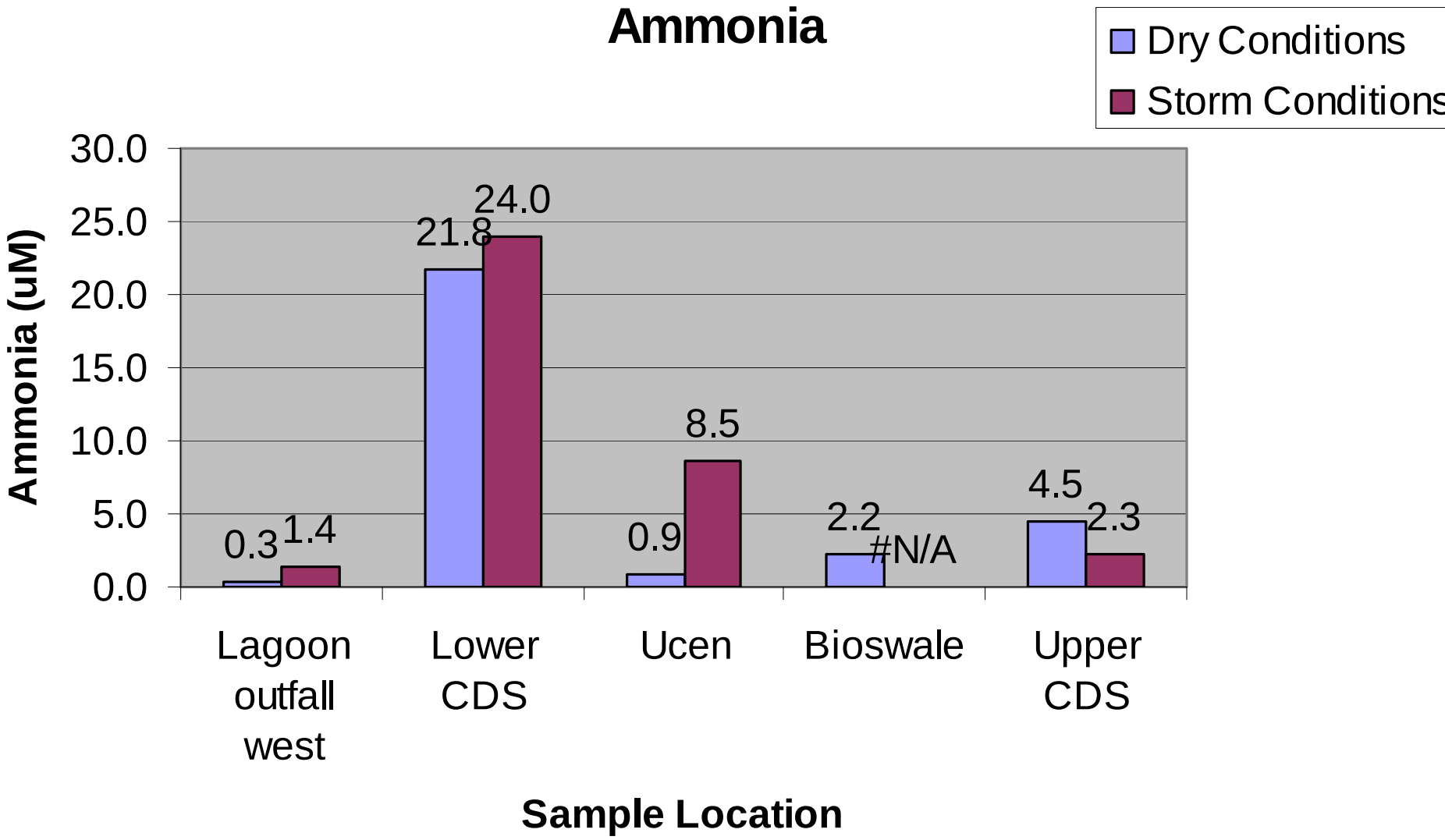
11 = Lagoon N.

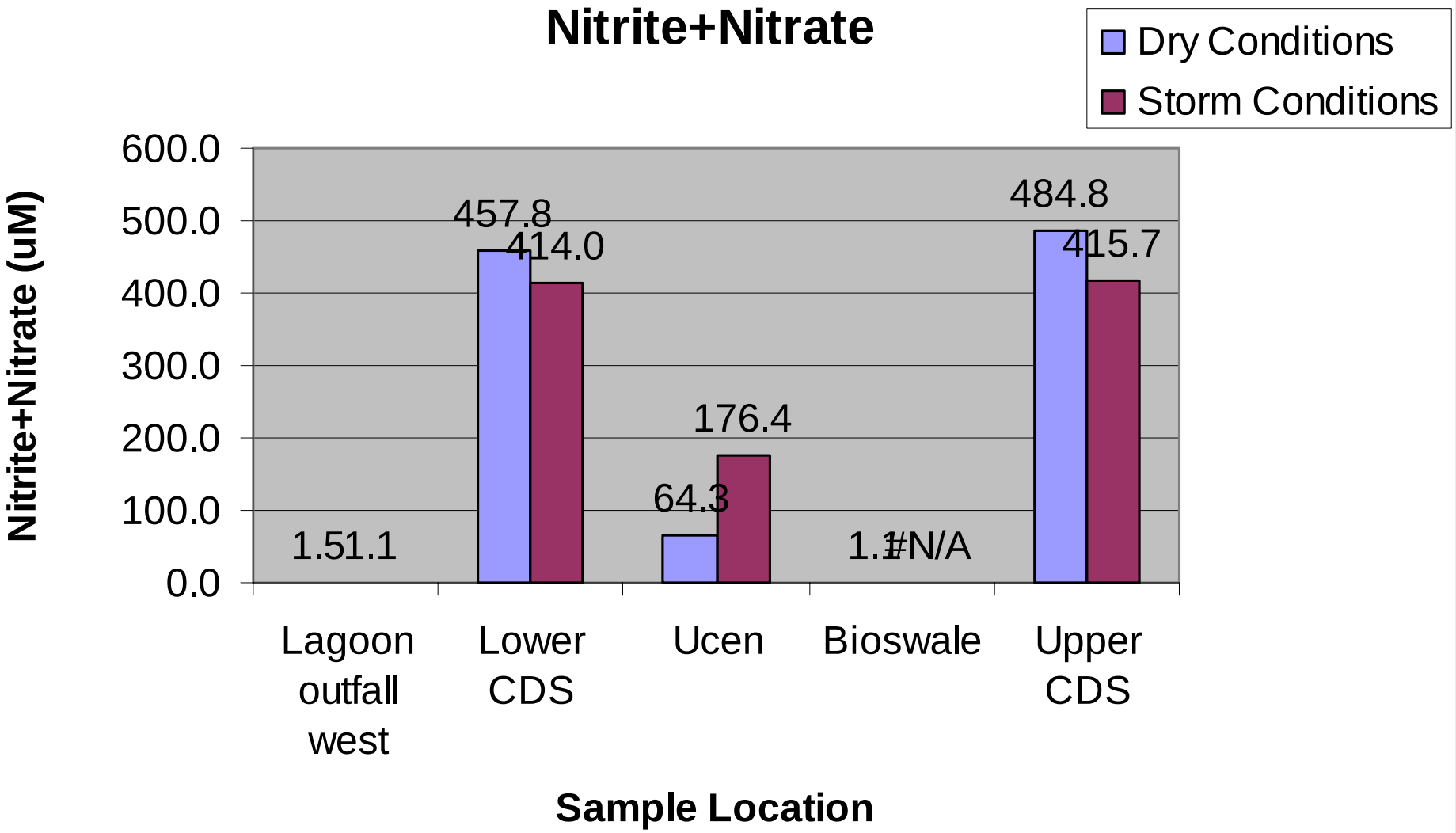
12 = Lagoon W.

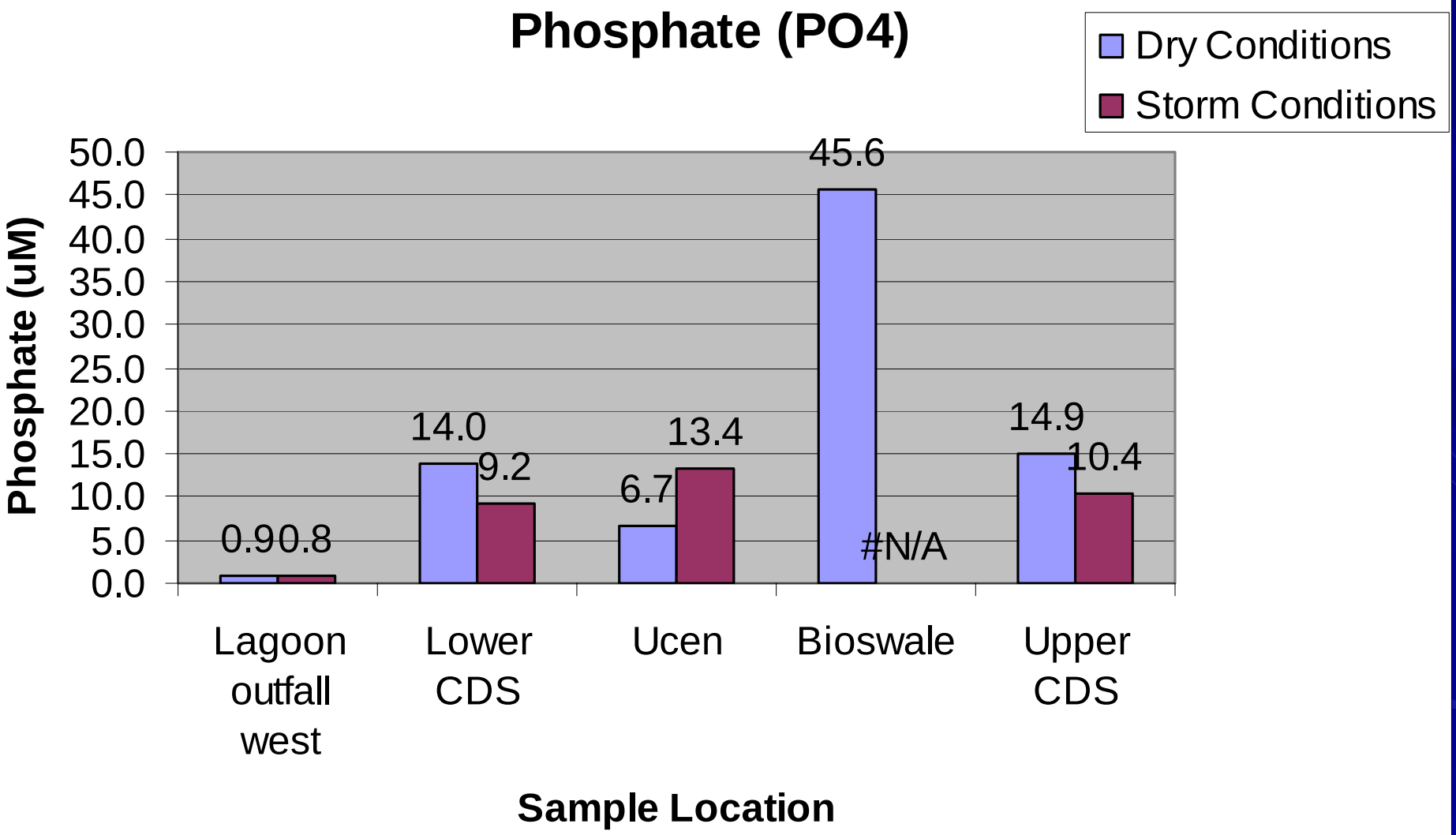
13 = Lagoon E.

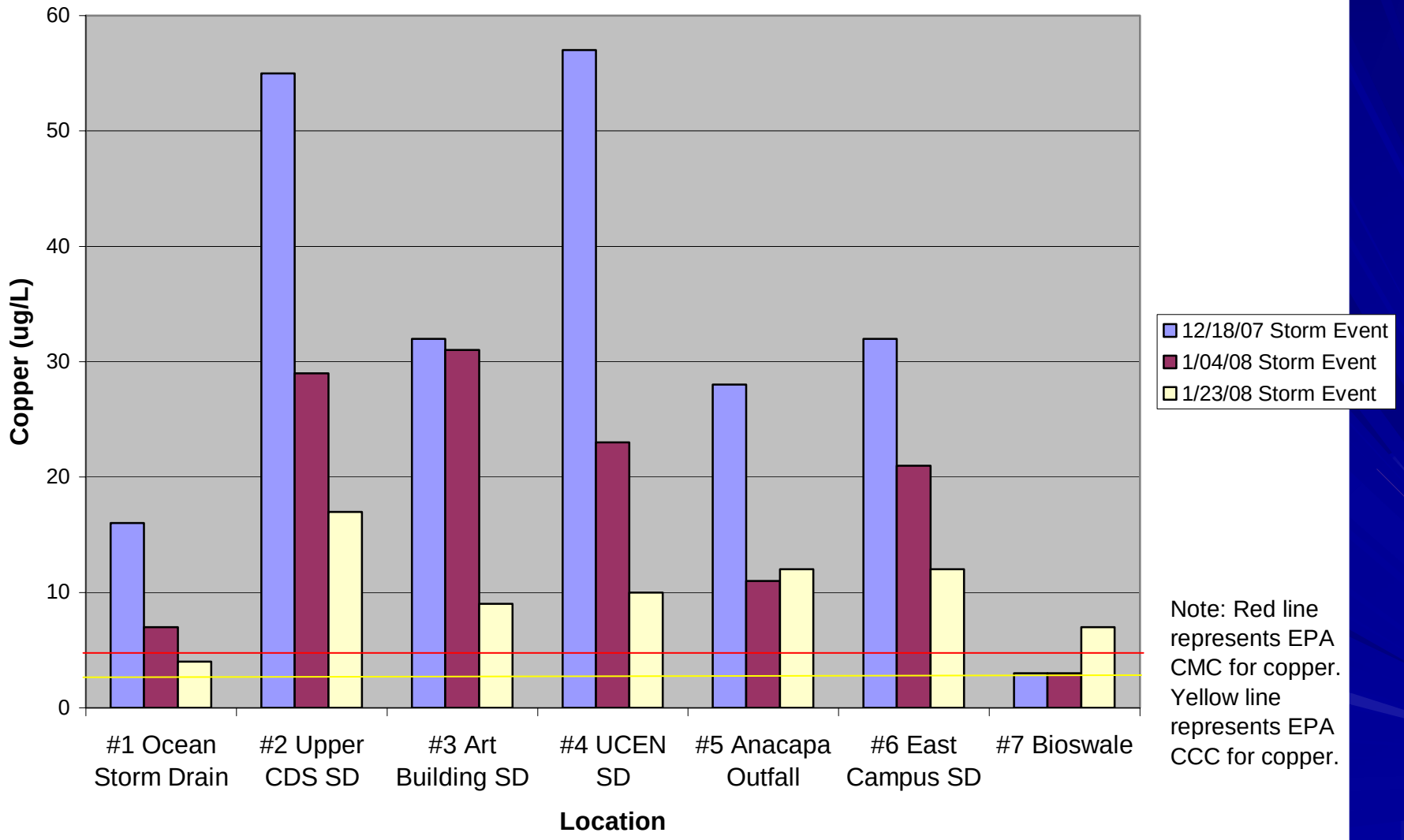
14 = Campus point

Note: Sites 11-14 (yellow) are only copper sampling sites.


Ammonia
Dry Conditions
Storm Conditions
Ammonia (uM)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0.3
1.4
21.8
24.0
0.9
8.5
2.2
#N/A
4.5
2.3
Lagoon outfall west
Lower CDS
Ucen
Bioswale
Upper CDS
Sample Location


Nitrite+Nitrate
Dry Conditions
Storm Conditions
Nitrite+Nitrate (uM)
600.0
500.0
400.0
300.0
200.0
100.0
0.0
1.5
1.1
457.8
414.0
64.3
176.4
1.1
#N/A
484.8
415.7
Lagoon outfall west
Lower CDS
Ucen
Bioswale
Upper CDS
Sample Location


Phosphate (PO4)
Dry Conditions
Storm Conditions
Phosphate (uM)
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0.9
0.8
14.0
9.2
6.7
13.4
45.6
#N/A
14.9
10.4
Lagoon outfall west
Lower CDS
Ucen
Bioswale
Upper CDS
Sample Location



Note: Red line represents EPA CMC for copper. Yellow line represents EPA CCC for copper.

- Conveyance of storm water and urban runoff – 75% site
- Biofiltration of pollutants – Reduction in nutrients and metals
- Groundwater and water table recharge – Supports a diversity of native plants
- Slows down hydrologic cycle to natural rate – no erosion, little run-off from dry season or small storms
- Sediment & trash traps – Successful w/ maintenance
- Landscape aesthetics – High!
- Habitats for plants and wildlife - Diversity of birds, reptiles and amphibians observed
- Education and interpretation – Signage, tours, classes, presentations
- Research – e.g. water quality

Recommendations

- Ideally design development in conjunction with biofiltration system for maximum benefits
- Aim for 10 minute minimum residency time and prioritizing high pollution sources
- Avoid shady sites (poor plant growth)
- Consider mosquito breeding times and treatment options (e.g. pool < 5 days in bioswales and use control measures in marshes)
- Combine with other LID concepts

Thank you

- Nate Simons, Christiana Herr, Darwin Richardson
- CCBER Staff
- UCSB Housing and Residential Services & Design and Facilities Mgmt
- Students of UCSB: Coastal Fund
- Wayne Ferren, VanAtta Associates
- Central Coast RWQCB

Manzanita Village

Hydrologic Connectivity

Manzanita Biofiltration System

- Bioswales
  - Upper and mid-watershed structures
  - Water accumulation and conveyance
  - Biofiltration
- Constructed Wetlands
  - Lower watershed structures
  - Water accumulation
  - Biofiltration

Manzanita Bioswales

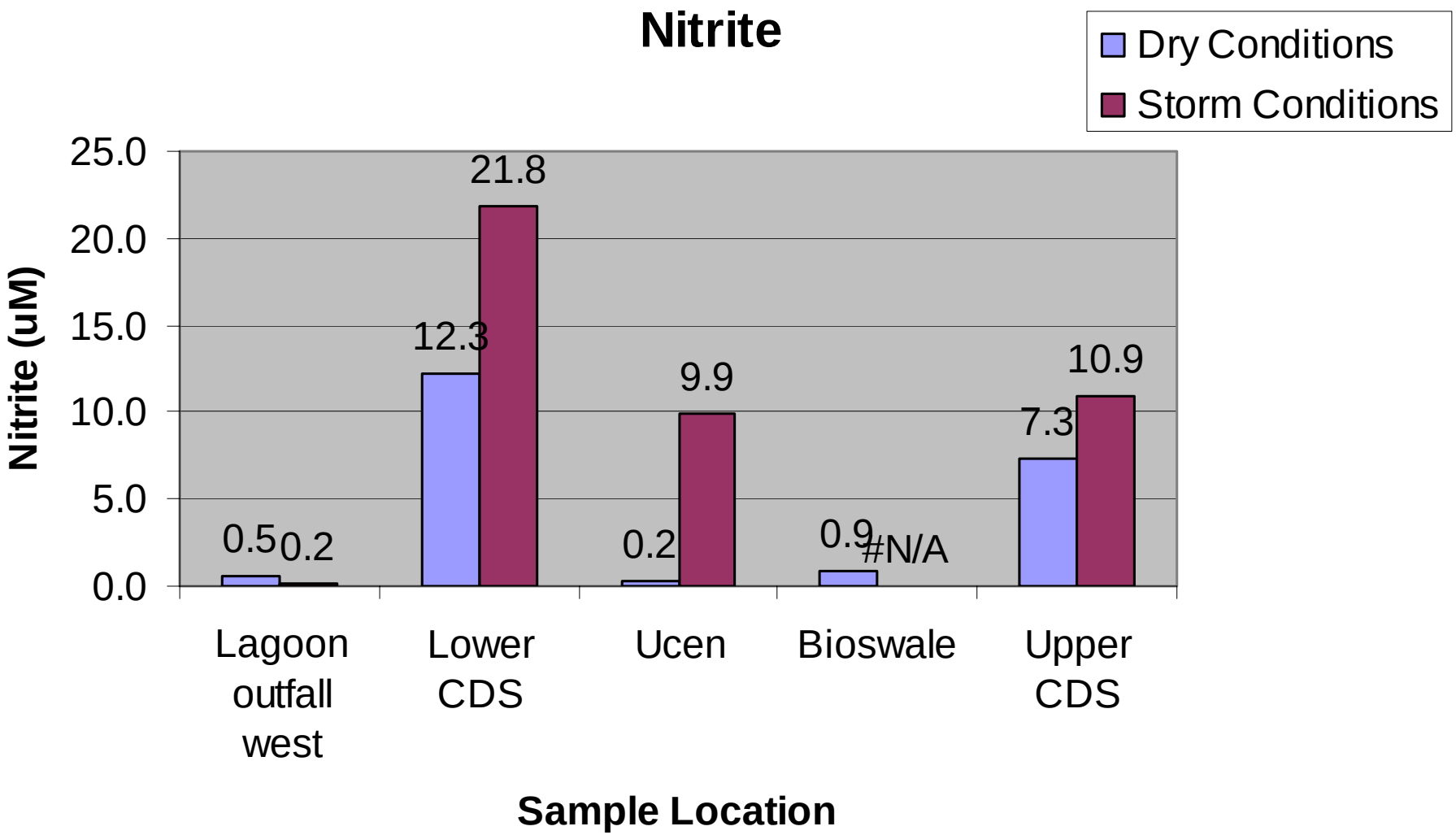
Basin and berm design

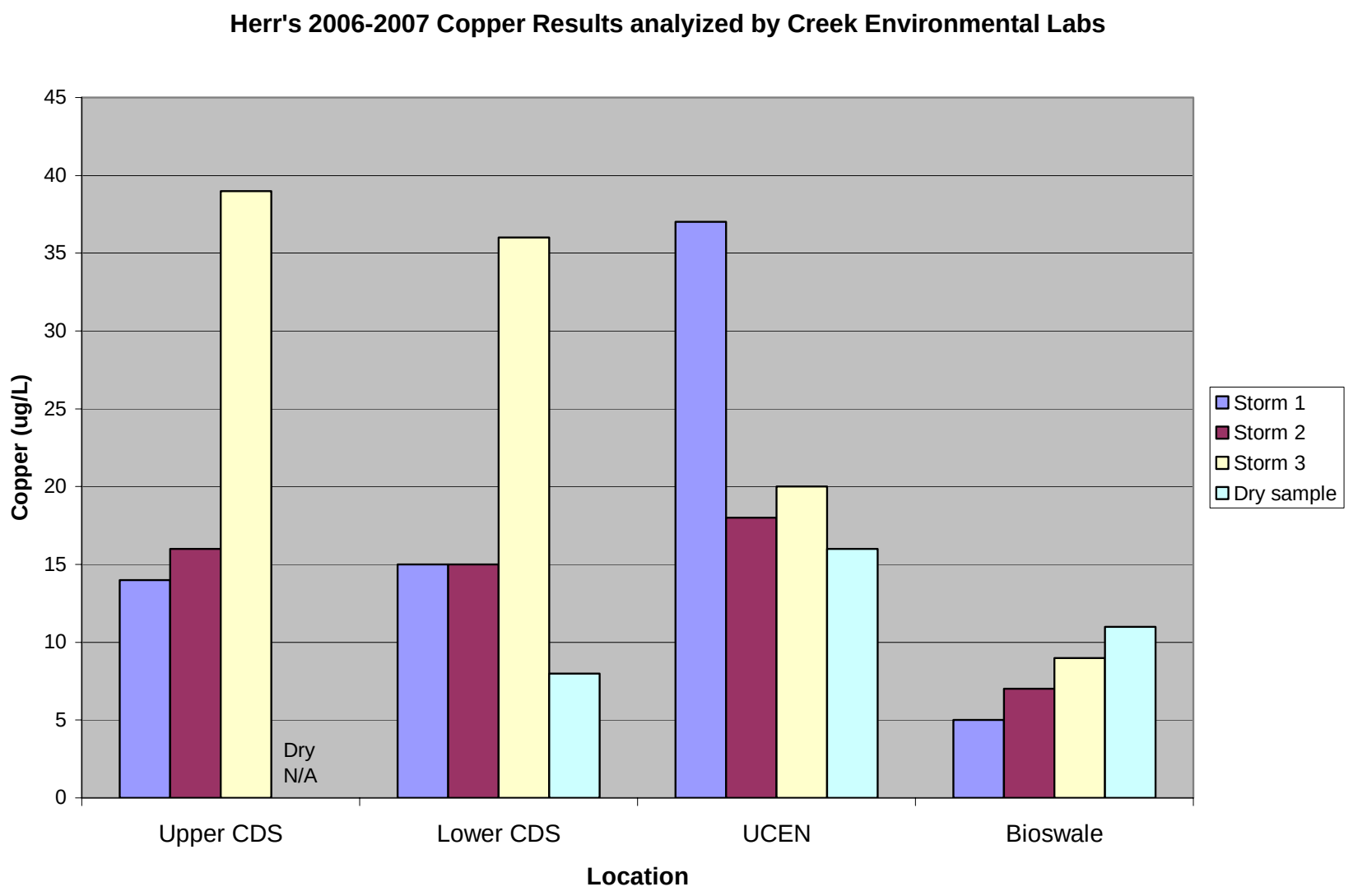
Coconut net

Bioswale Maintenance

- Vegetation maintenance
- Composting / Mulching
- Sustainability

Monitoring and Experimentation


Nitrite
Dry Conditions
Storm Conditions
Nitrite (uM)
25.0
20.0
15.0
10.0
5.0
0.0
0.5
0.2
12.3
21.8
0.2
9.9
0.9
#N/A
7.3
10.9
Lagoon outfall west
Lower CDS
Ucen
Bioswale
Upper CDS
Sample Location


Herr's 2006-2007 Copper Results analyized by Creek Environmental Labs
Copper (ug/L)
45
40
35
30
25
20
15
10
5
0
Dry
N/A
Upper CDS
Lower CDS
UCEN
Bioswale
Location
Storm 1
Storm 2
Storm 3
Dry sample