SAN DIEGO BAY NATIVE OYSTER RESTORATION PLAN
Technical Advisory Meeting

December 19, 2013

Meeting Agenda

- 9:30 – 9:45 Project Introduction
- 9:45 - 10:15 Existing Data – Physical Conditions and Oyster Presence and Distribution
- 10:15-10:45 Oyster Settlement and Growth
- 10:45 – 11:15 Oyster Distribution
- 11:15 – 11:30 Physical Data - Wave Energy
- 11:30 – 12:30 Identify Preferred Potential Sites and Additional Data Needs
- 12:30 – 12:45 Wrap-up

Project Team and Partners

- San Diego Unified Port District
- California Coastal Conservancy
- NOAA
- Southwest Wetlands Interpretive Association (SWIA)
- U.S. Fish and Wildlife Service – Coastal Program
- California State University Fullerton
- ESA PWA
- Merkel and Associates

Project Goal

- Create a biologically rich native oyster bed in San Diego Bay as part of a complete marsh system, which restores an ecological niche that was historically present, is ecologically functional and resilient to changing environmental conditions, and also protects bay tidelands and shoreline.

Project Objectives

1. Evaluate existing and historical distribution of oysters in the Bay.
2. Determine suitable locations for oyster bed restoration, using existing and new data.
3. Identify appropriate energy environments and sites in the Bay that could most benefit (in terms of erosion control and ecological function) from oyster bed creation.
4. Use a pilot-scale approach to establish demonstration oyster beds.
5. Determine the extent to which oyster reefs enhance habitat for invertebrates, fish, and birds, relative to areas lacking structure and relative to pre-restoration conditions.
6. Evaluate the potential for oyster beds to reduce water flow velocities, attenuate waves, reduce erosion, and promote sediment capture.

Schedule

Task	Task Title	Estimated Completion Dates
1	Preliminary Studies 1. Literature Review 2. Oyster Studies 3. Physical Studies	 1. December 31, 2013 2. November 31, 2013 3. August 16, 2013
2	Conceptual Design 1. Identify potential restoration sites 2. Investigate potential restoration sites 3. Select restoration sites 4. Draft Conceptual design	 1. October 1, 2013 2. February 1, 2014 3. March 1, 2014 4. May 1, 2014
3	Project Plan 1. Draft Project Plan 2. Final Project Plan	 1. May 1, 2014 2. July 1, 2014
4	Meetings and Presentations	Monthly or as needed
5	Project Management	At least quarterly

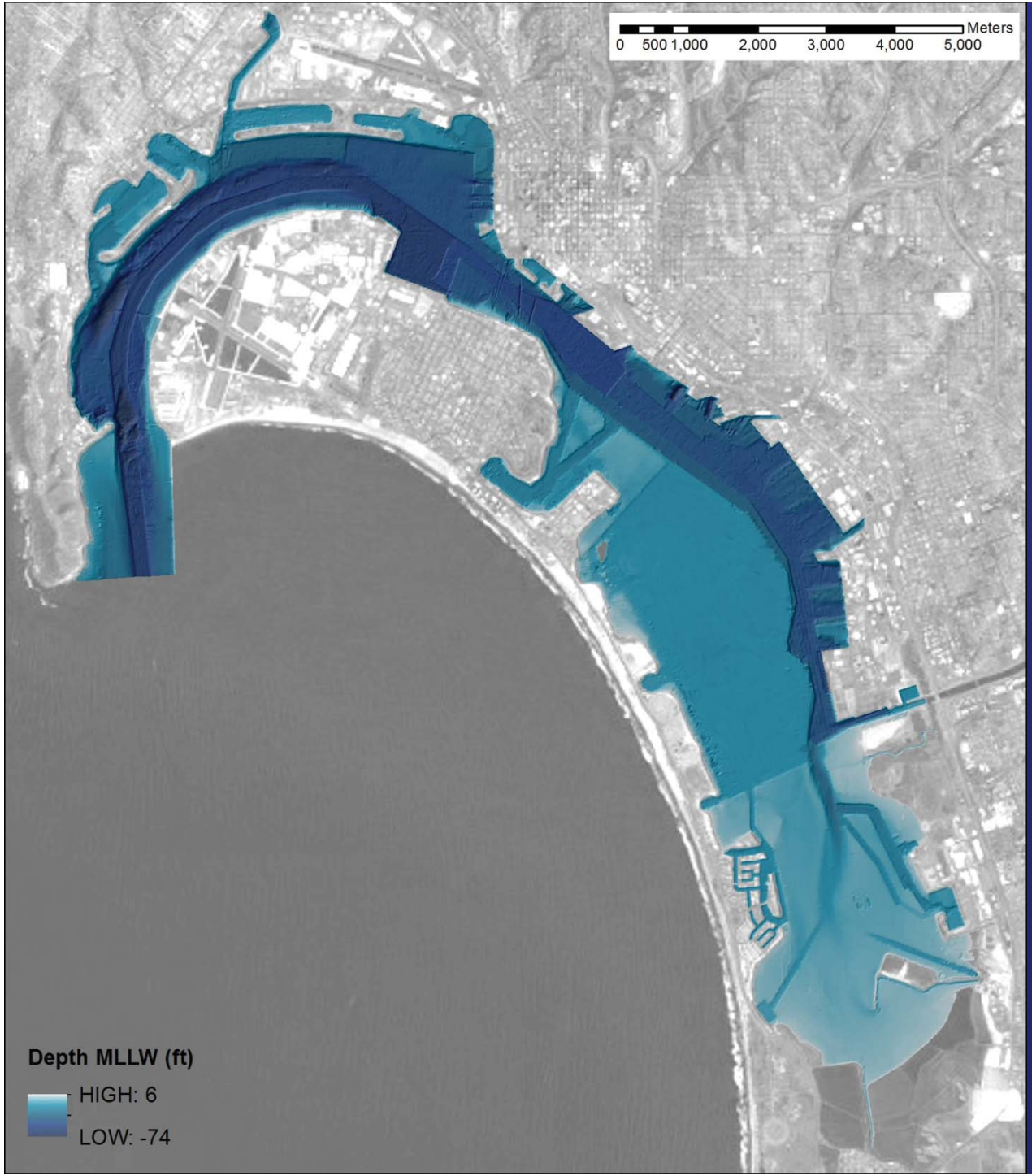
Data Collection Approach

- What information have we collected?
  - Existing physical data (bathymetry, shoreline substrate)
  - Habitat types
  - Occurrence of native and non-native oysters
  - Oyster settlement and growth
  - Wave energies

Physical Studies – EXISTING DATA

- Collect existing GIS data for San Diego Bay
  - Bathymetry
  - Habitats
  - Shoreline Structures
  - Ownership and Management Entities
  - Sediment
  - Water quality
  - Wind and wind waves

Bathymetry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Depth MLLW (ft)
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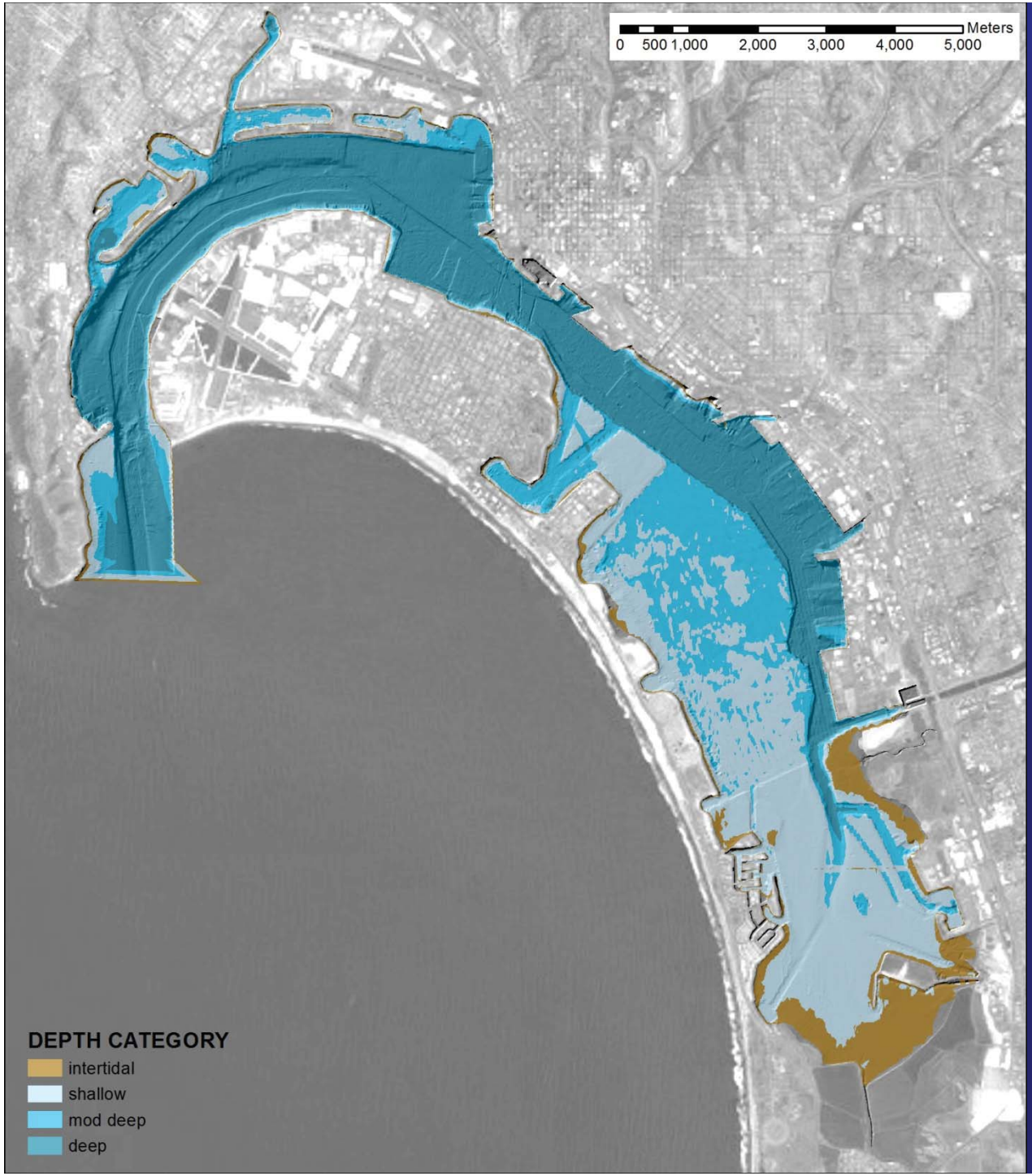
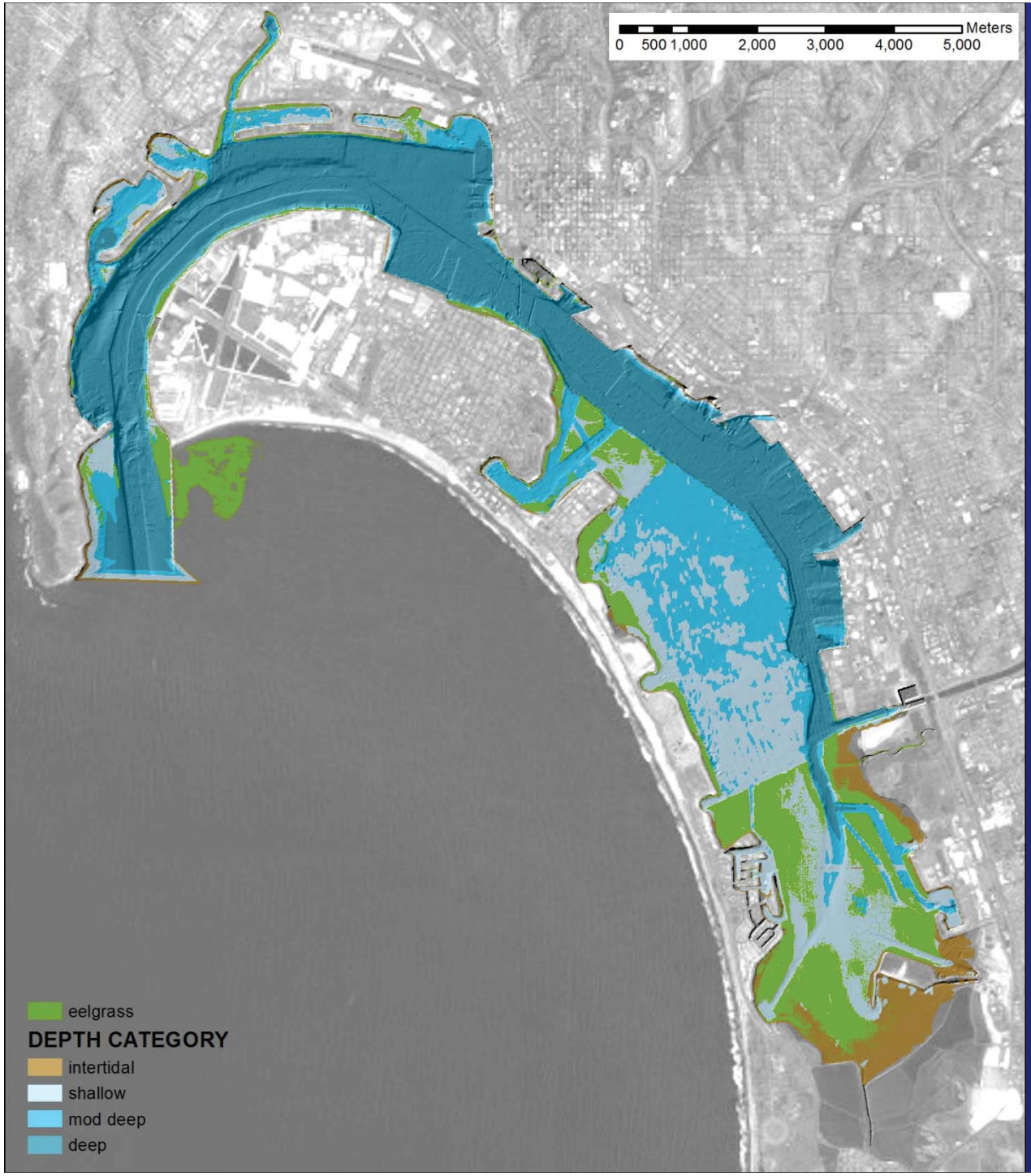
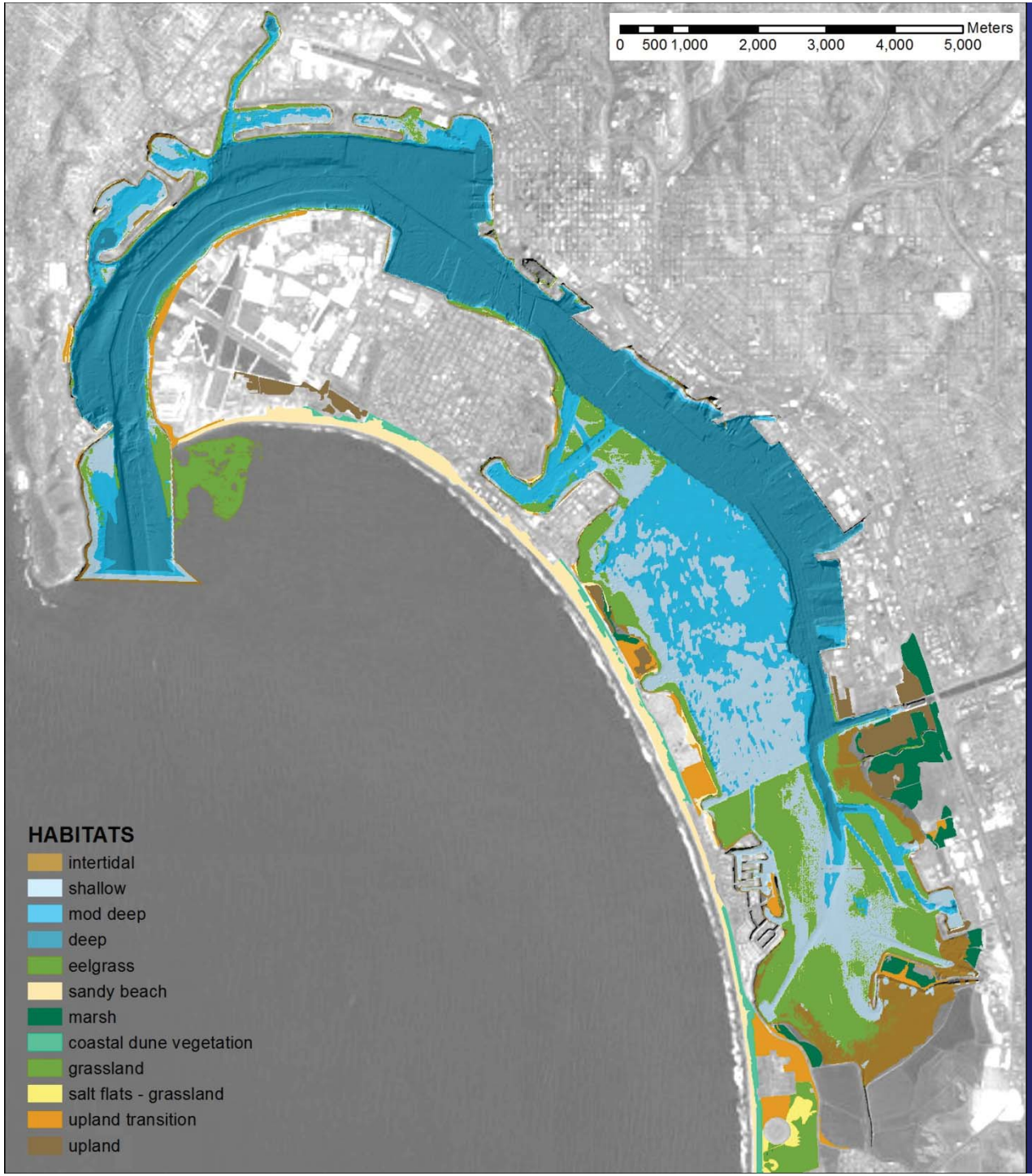
LOW: -74



Depth Categories



Eelgrass and Depth Categories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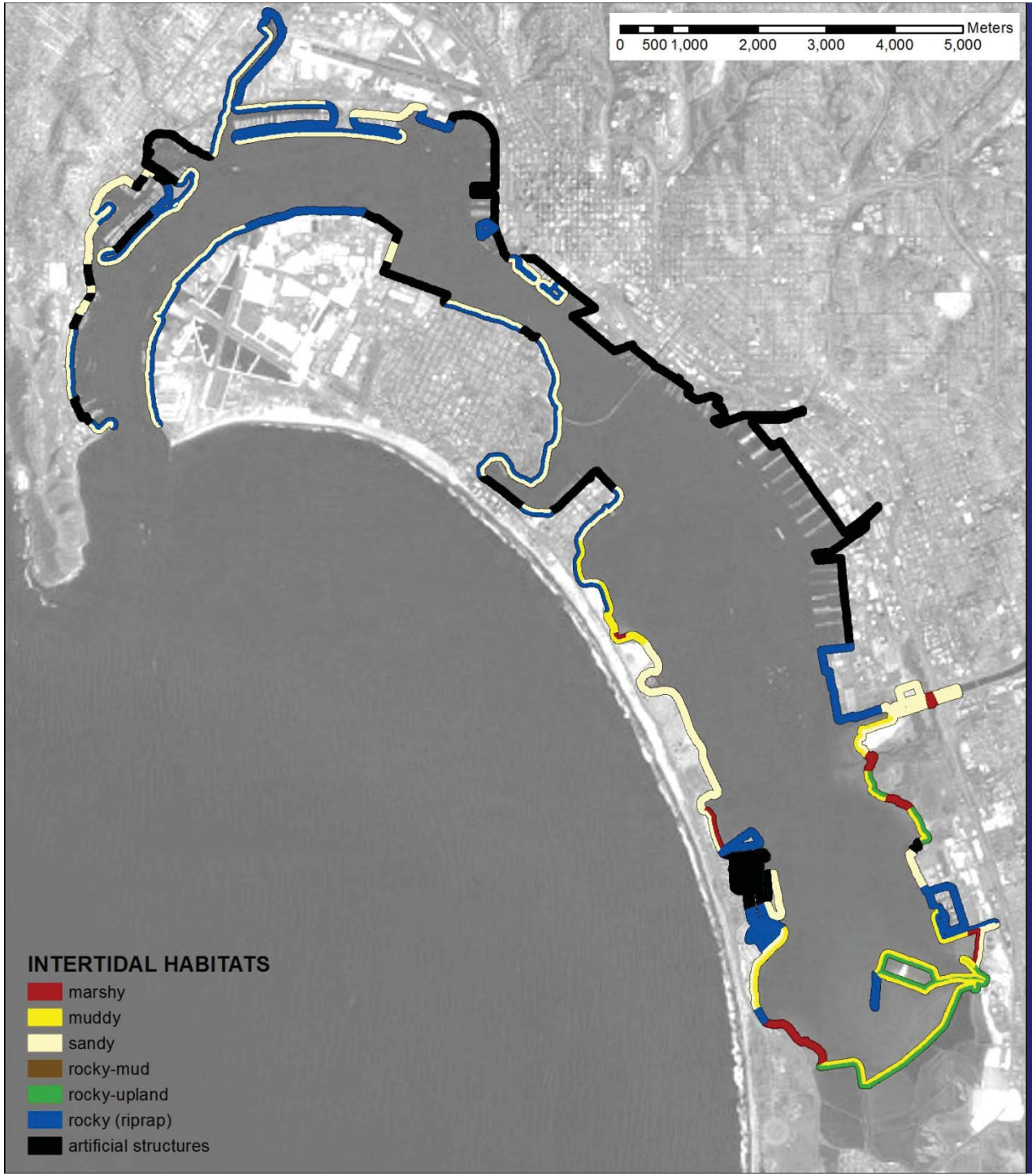
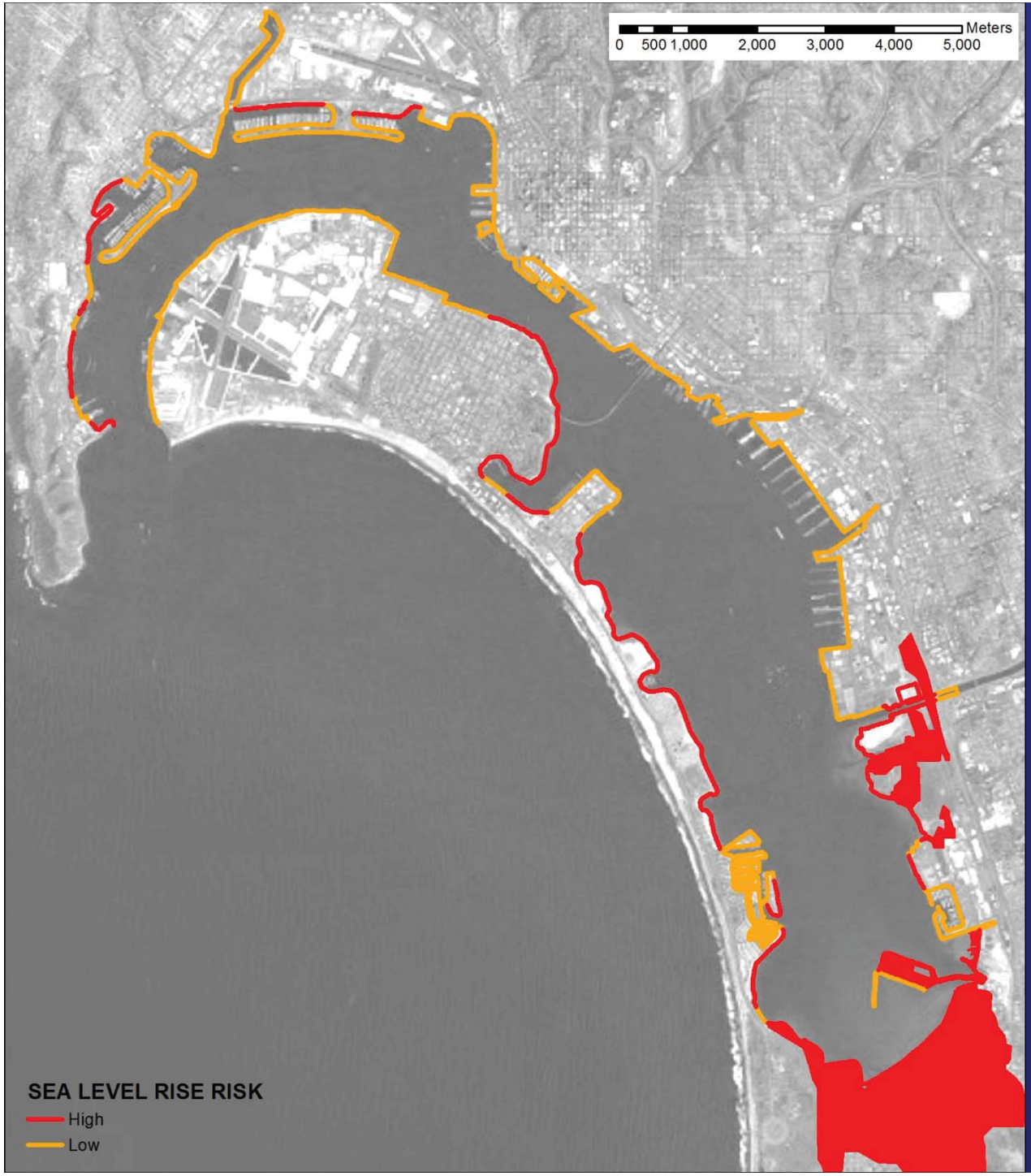
HABITATS
intertidal
shallow
mod deep
deep
eelgrass
sandy beach
marsh
coastal dune vegetation
grassland
salt flats - grassland
upland transition
upland

Habitats

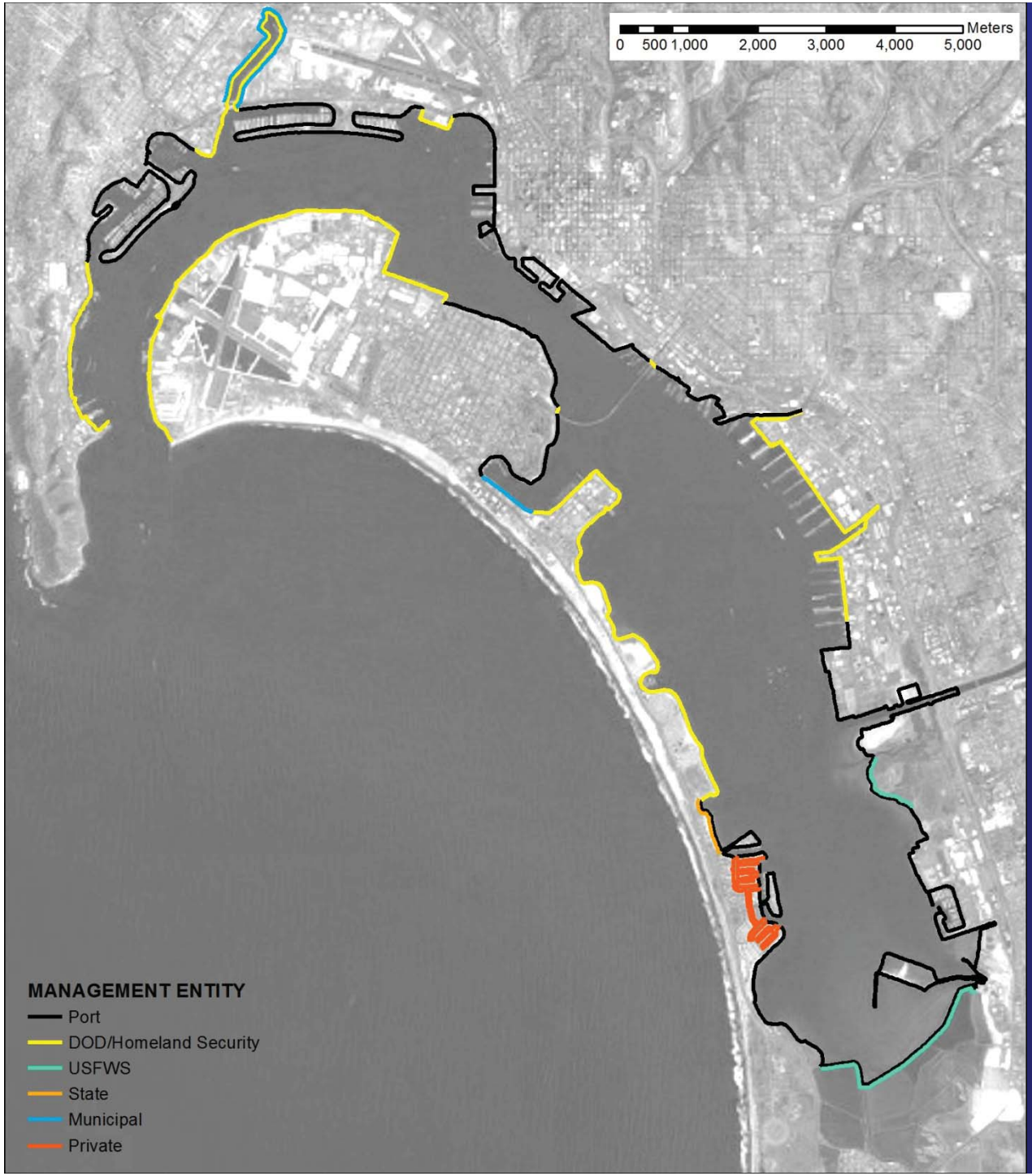


Shoreline Substrate

Sea Level Rise Risk



Management Entities and Stakeholders



Oyster Distribution Studies

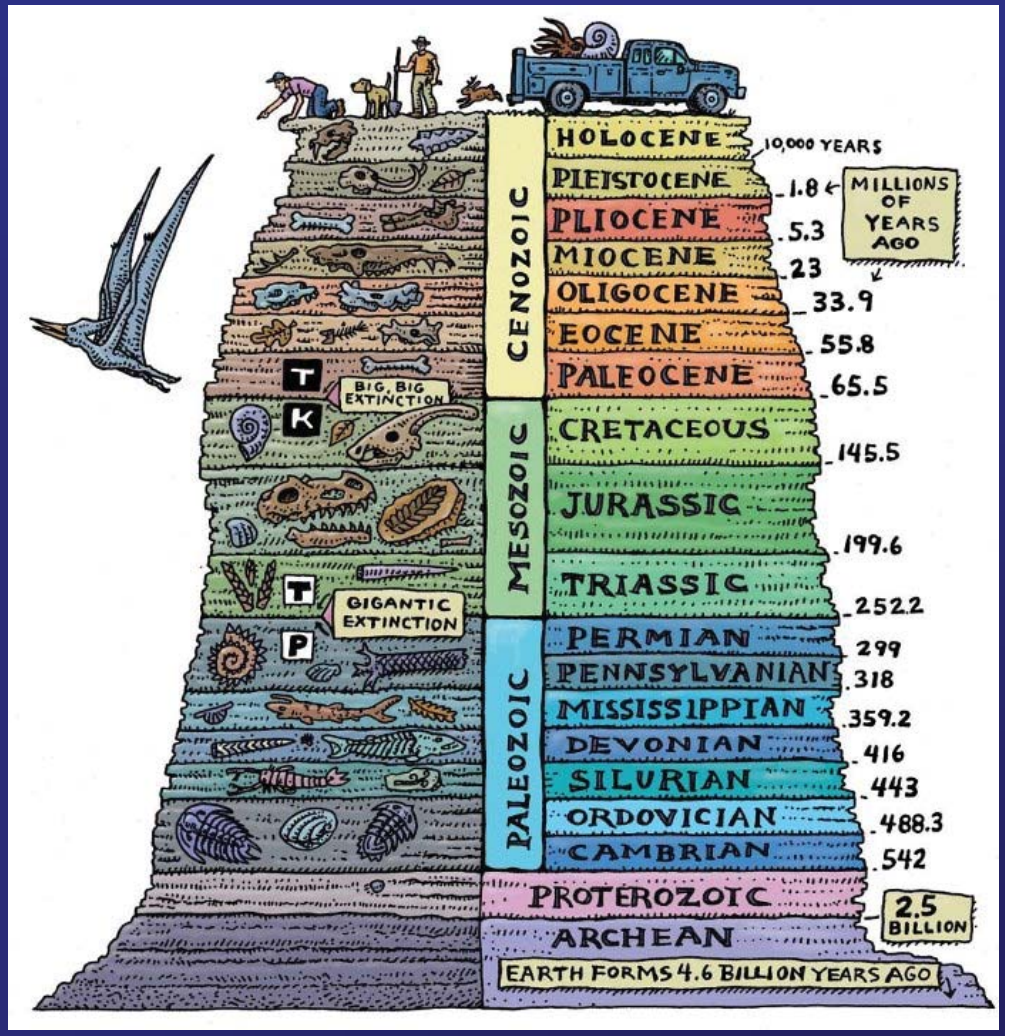
- What is known about historic presence of oysters in San Diego Bay?
- What is the current distribution of oysters in San Diego Bay?
- What is the distributional relationship between native and non-native oysters?

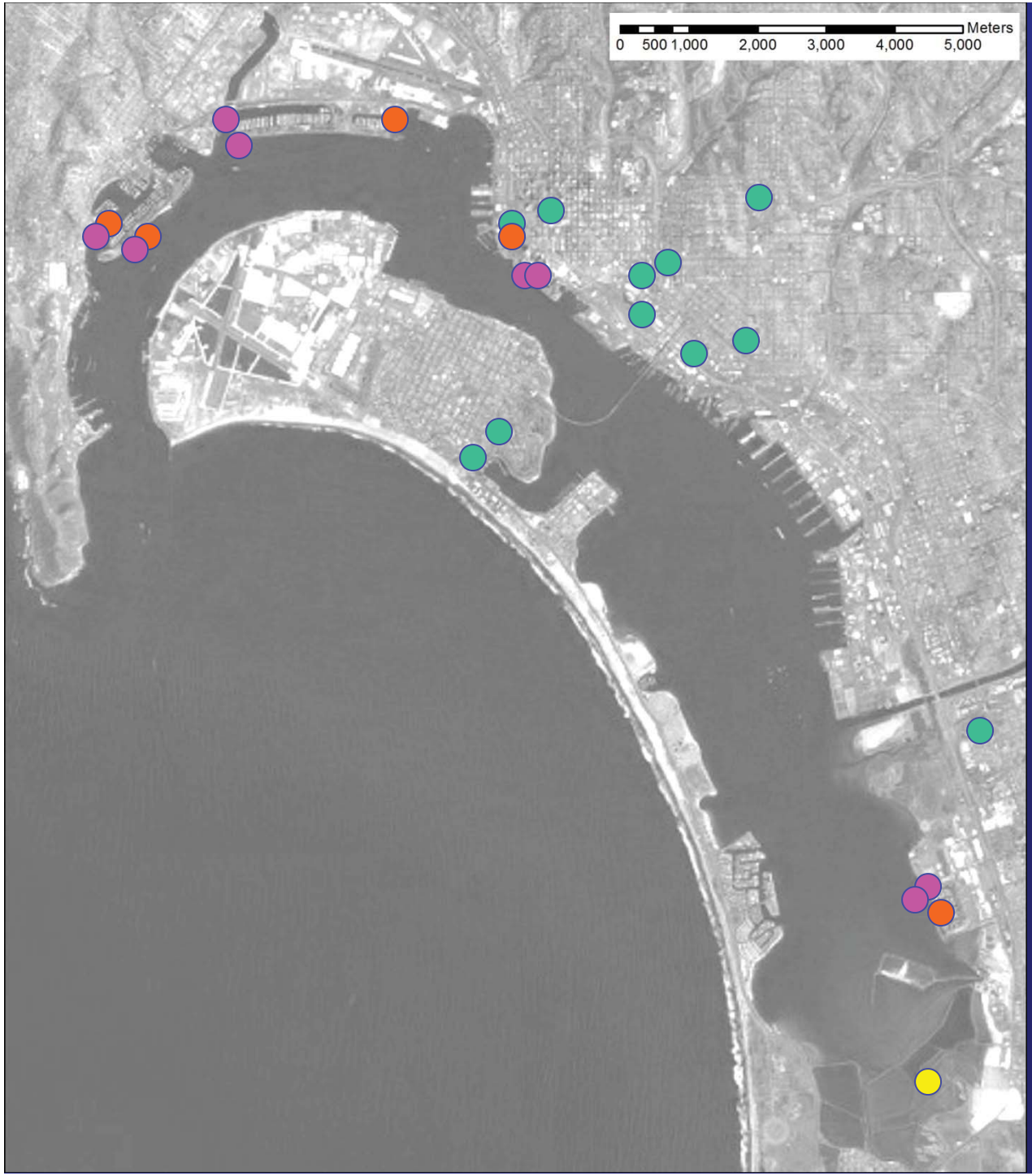
Oyster Distribution Studies - METHODS

- Literature Review
- Qualitative: Bay-wide oyster presence survey
  - Oysters of both species classified as high, medium or low density

Historic presence in San Diego Bay

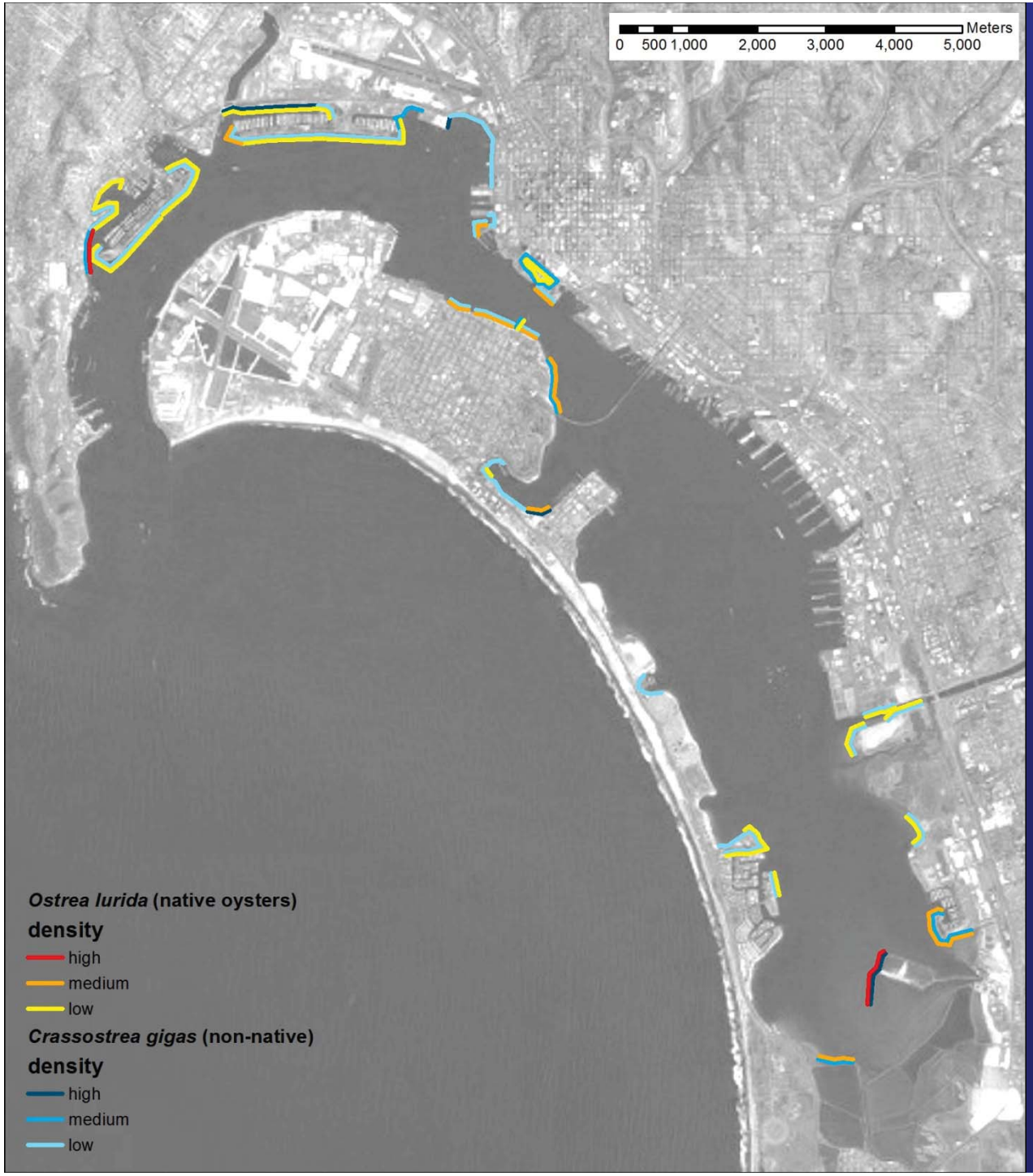
- *SDMNH has extensive "Ostrea lurida" collections from San Diego Bay at least as far back as Pleistocene*
- *Pliocene collections include other oyster species collected in San Diego but whose current distributions are in the Sea of Cortez*
- *Difficult to find quantitative data or even mention of "beds" but presence noted in multiple published documents from Ingersoll (1881) onward*
- *Example: Ingersoll mentions that at La Punta on the south side, there are sufficient numbers of oysters of sufficient size to have commercial importance (but coppery flavor noted)*





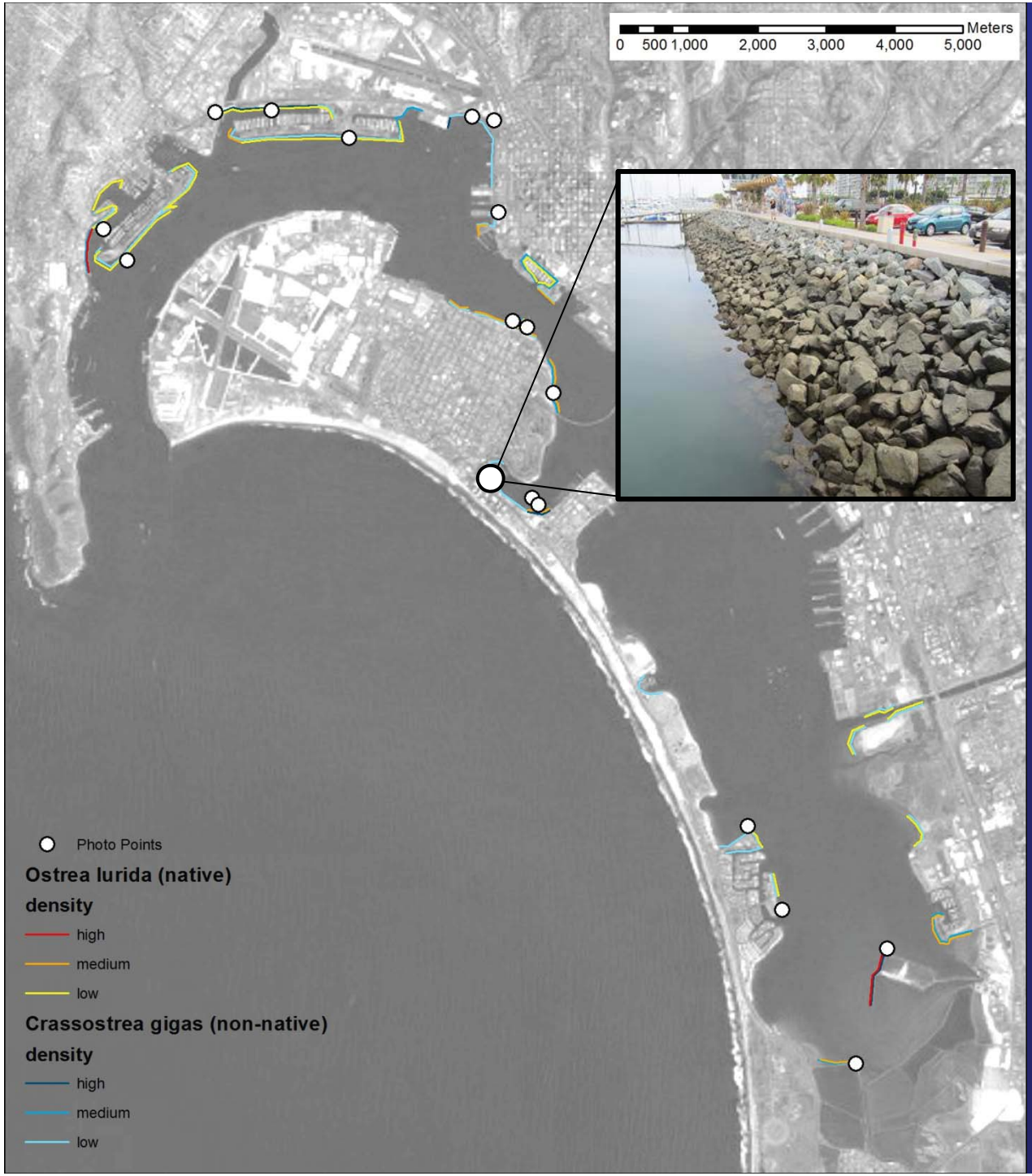
Historic Presence

- *Pleistocene (11,000-2.5 mya)*
- *1881*
- *2000*
- *2005-2007*



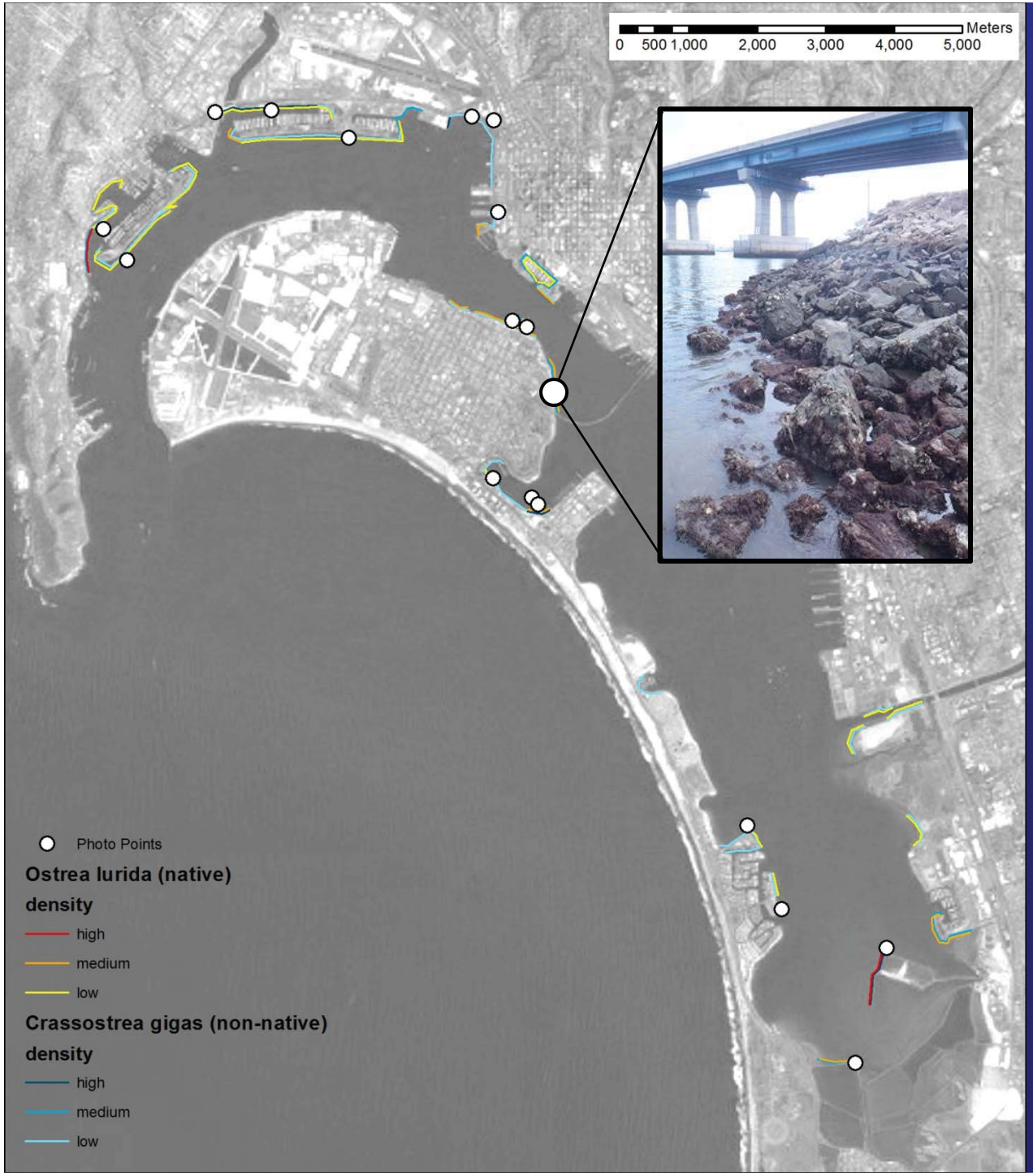
Oyster Distribution Studies - RESULTS

- Qualitative
- Densities are relative to each other
- Native and non-native oysters co-occur at most locations
- Species display zonation



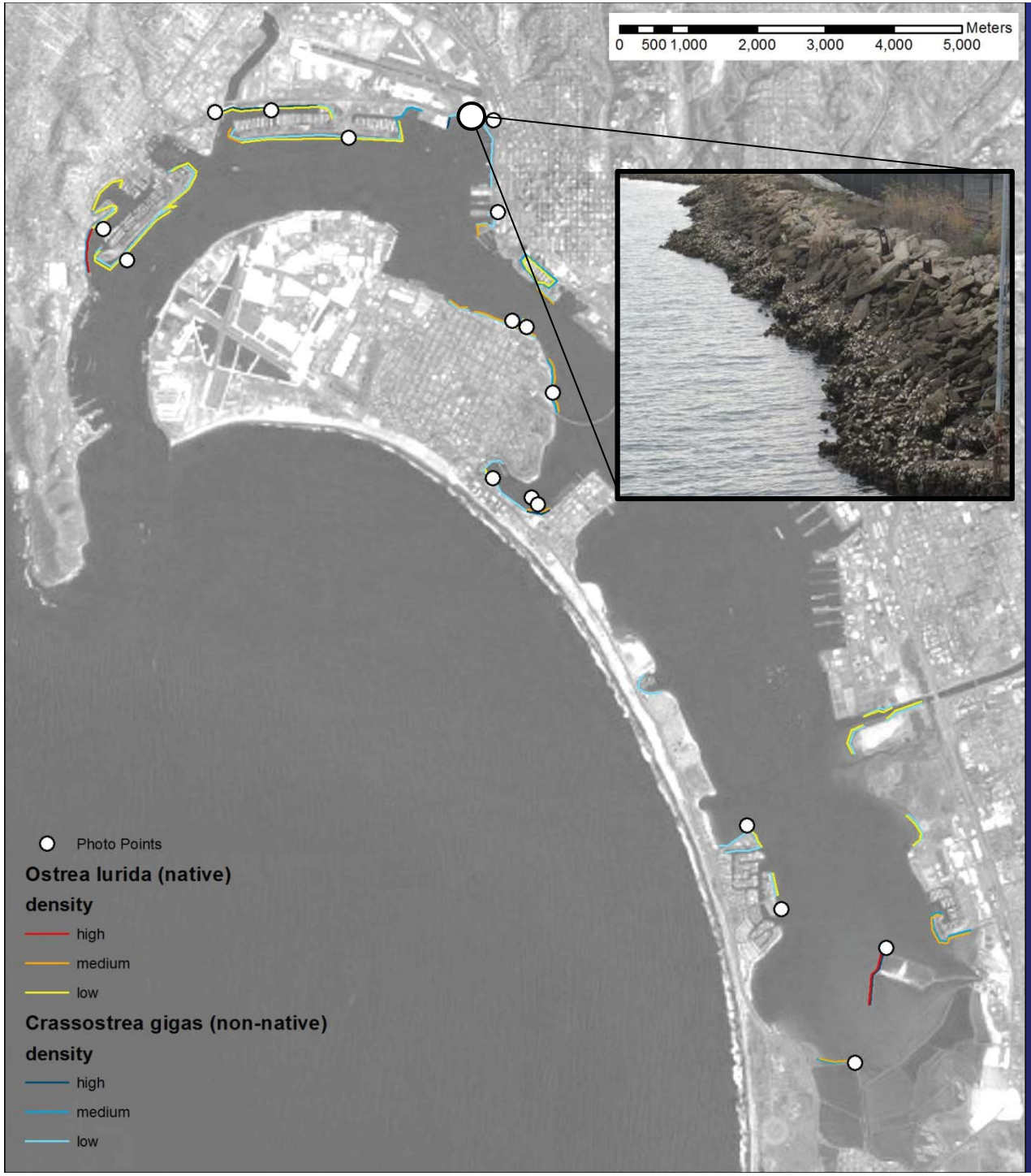
Oyster Distribution Studies - RESULTS

- Low relative density. Just a few non-native oysters are observed.



Oyster Distribution Studies - RESULTS

- Medium relative densities
- Zonation apparent



Oyster Distribution Studies - RESULTS

- High relative densities of non-native oysters

Oyster Zonation – San Diego Bay

Oyster Zonation – Alamitos Bay and Huntington Harbor

Oyster Zonation – Alamitos Bay and Huntington Harbor

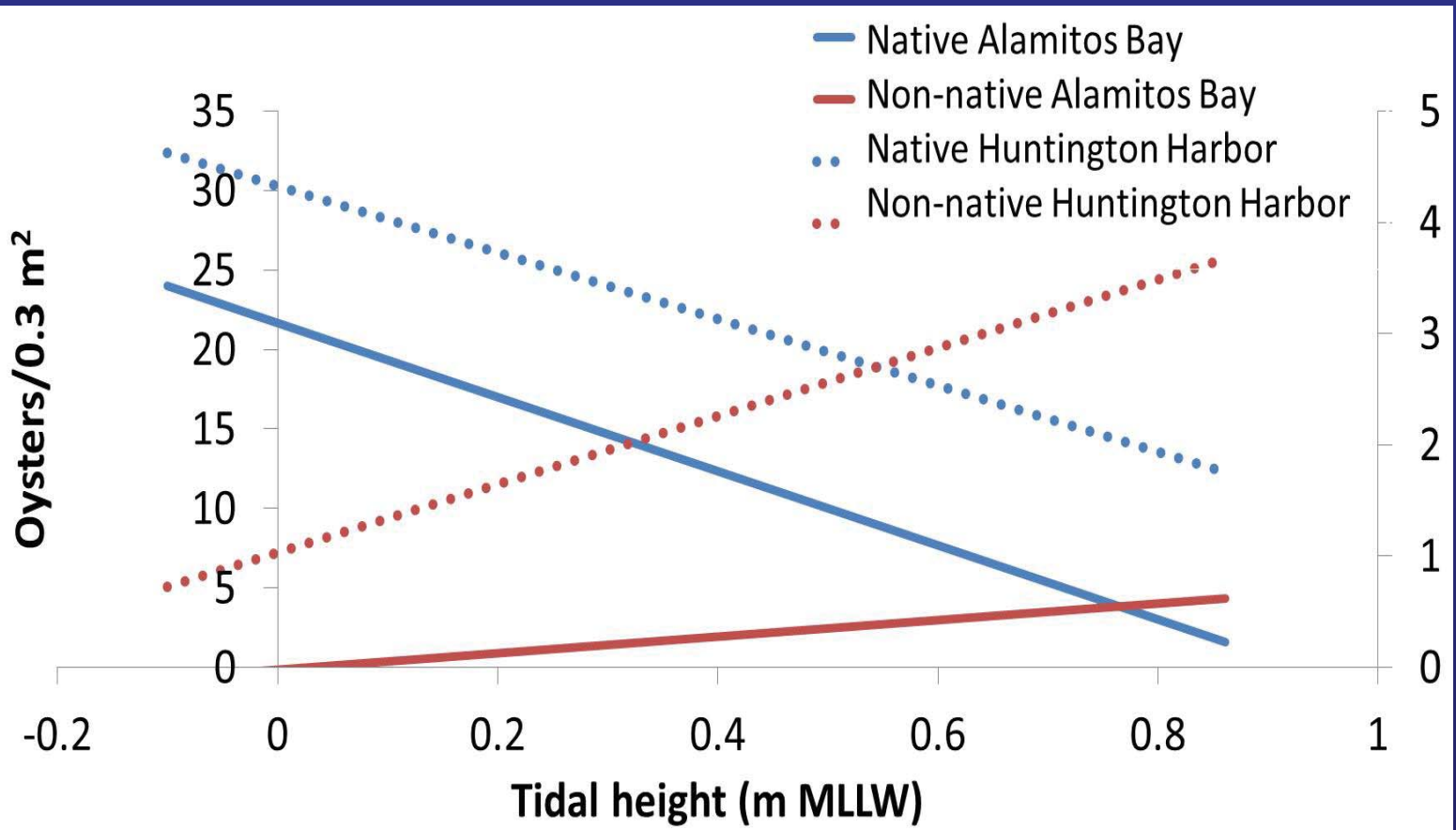


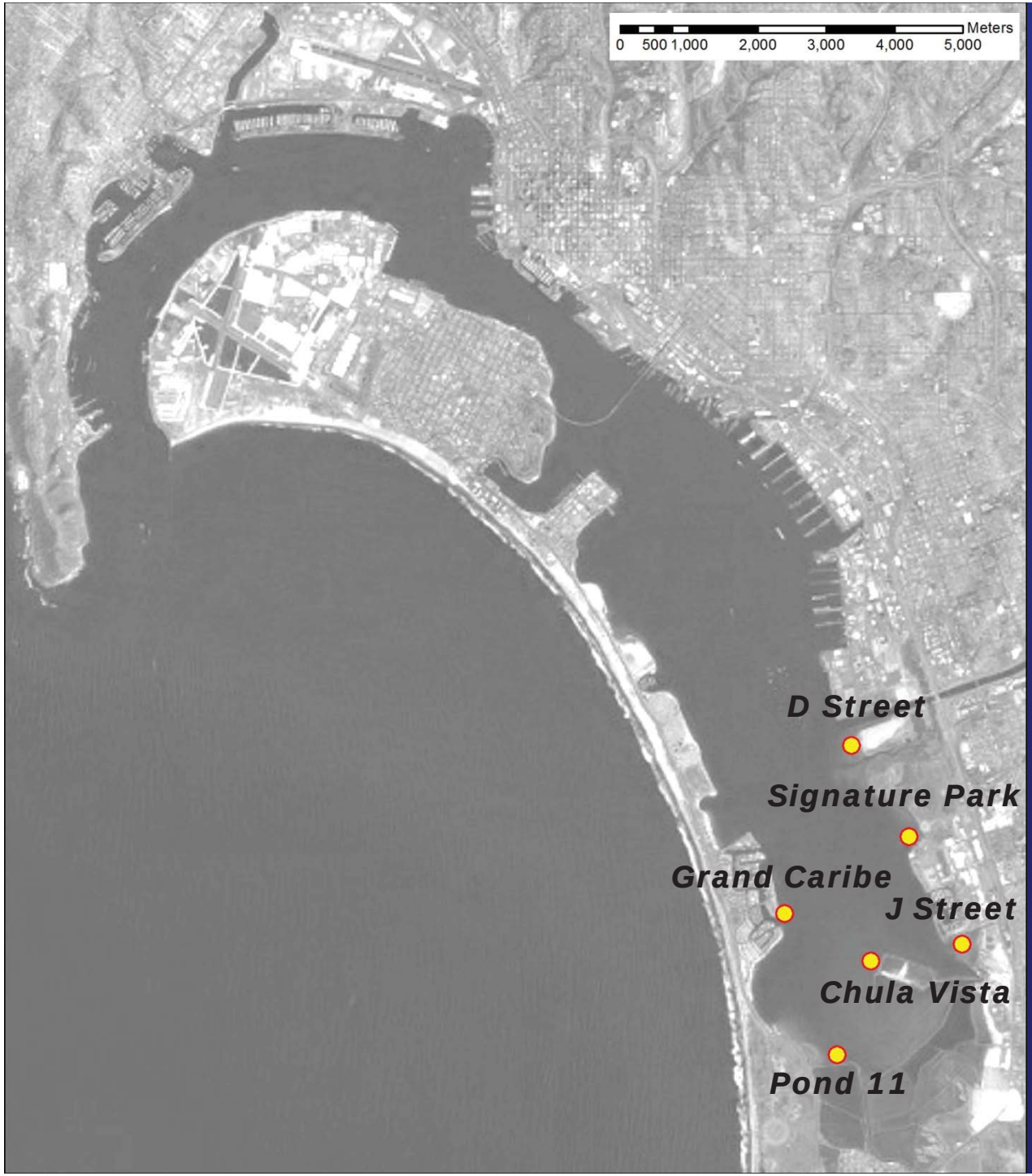
Figure 3. Density of native (blue) and non-native oysters (red) as a function of tidal height in Alamitos Bay (AB, solid) and Huntington Harbor, CA (HH, dotted, secondary y-axis). Data analyzed via standard least squares regression; native (AB) n=20, p = 0.0032, R^2=0.2777, non-native (AB) n=20, p = 0.0053, R^2=0.3388, native (HH) n=19, p = 0.1582, R^2=0.137, non-native (HH) n=19, p = 0.0061, R^2=0.4267.

Existing Physical Data and Oyster Presence – Preliminary Conclusions

- Overall, San Diego Bay transitions from deep waters with armored shoreline to shallow waters without armoring.
- The majority of unarmored shoreline, intertidal habitat and marshlands occur south of Coronado Bridge.
- Historically, native oysters have occurred in the bay for millions of years.
- Native and non-native oysters currently occur throughout the bay.
- Oyster species display zonation.

Oyster Settlement and Growth Studies

- Do native oysters settle onto and grow on new substrate in San Diego Bay?
- What is the peak season/time for settlement?
- At what rate does settlement occur?
- What is the growth rate of settled oysters?
- Do non-native oysters and other non-native species also settle onto new substrate?
- How do results compare to another southern California wetland?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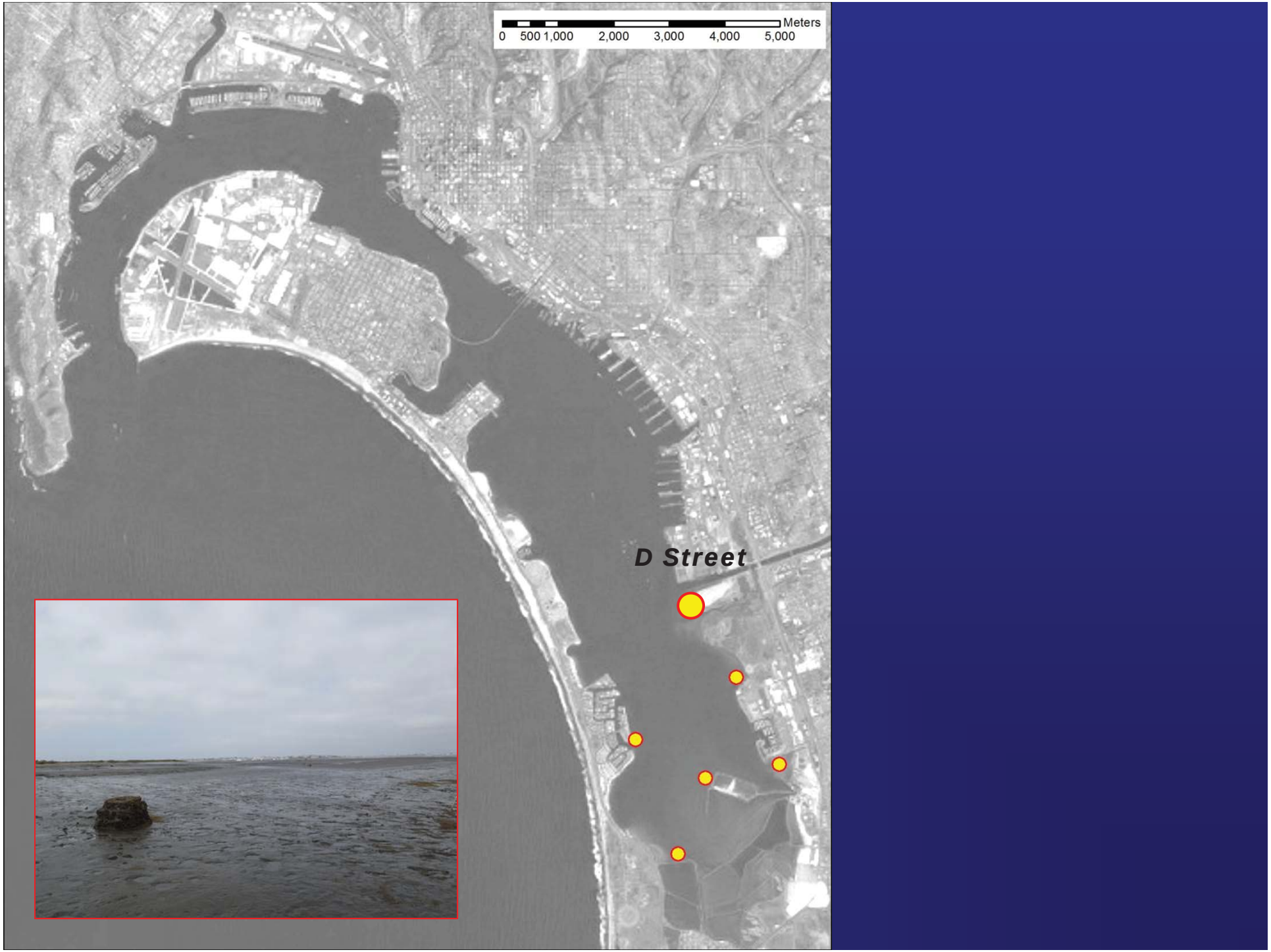
D Street
Signature Park
Grand Caribe
J Street
Chula Vista
Pond 11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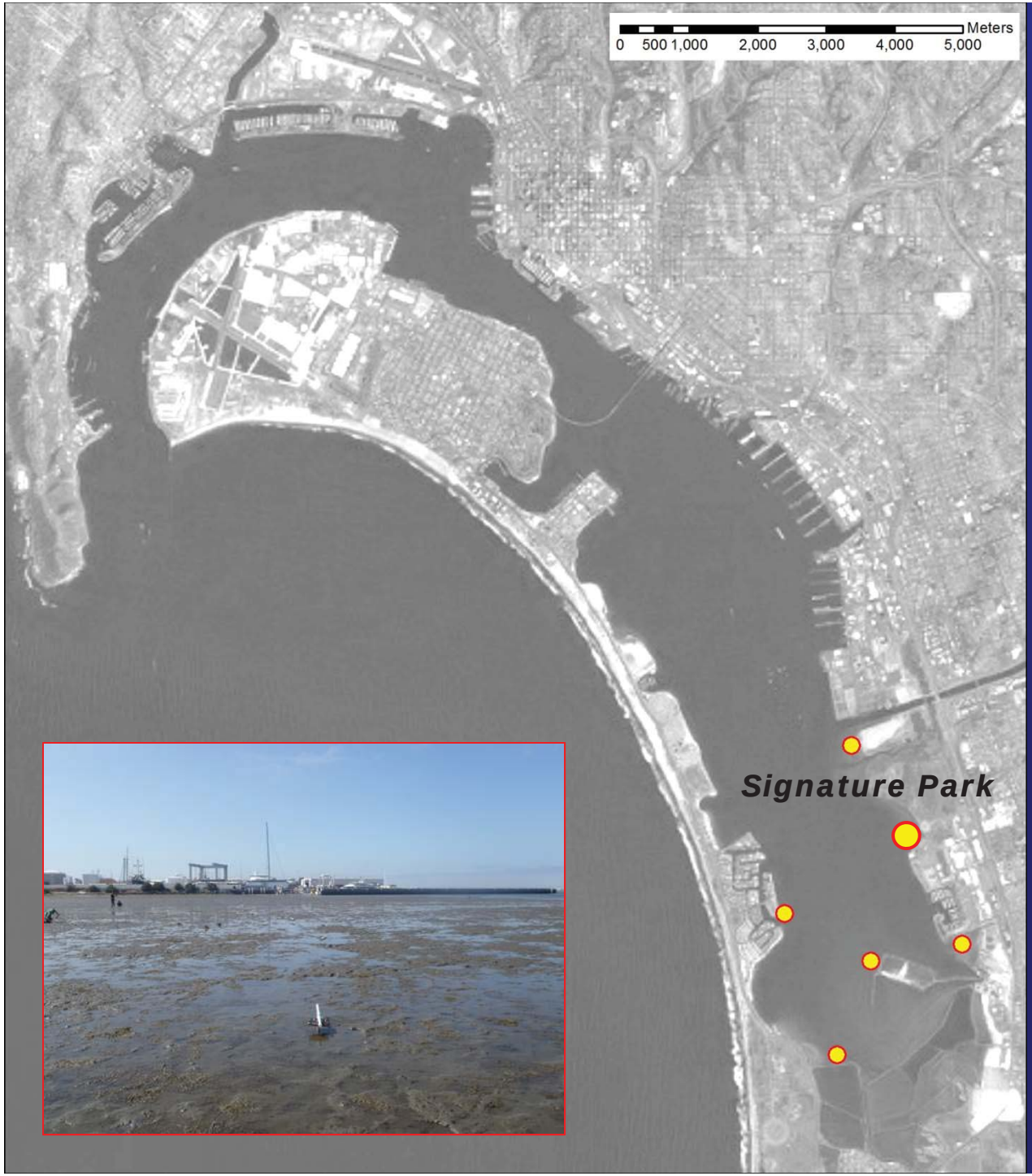
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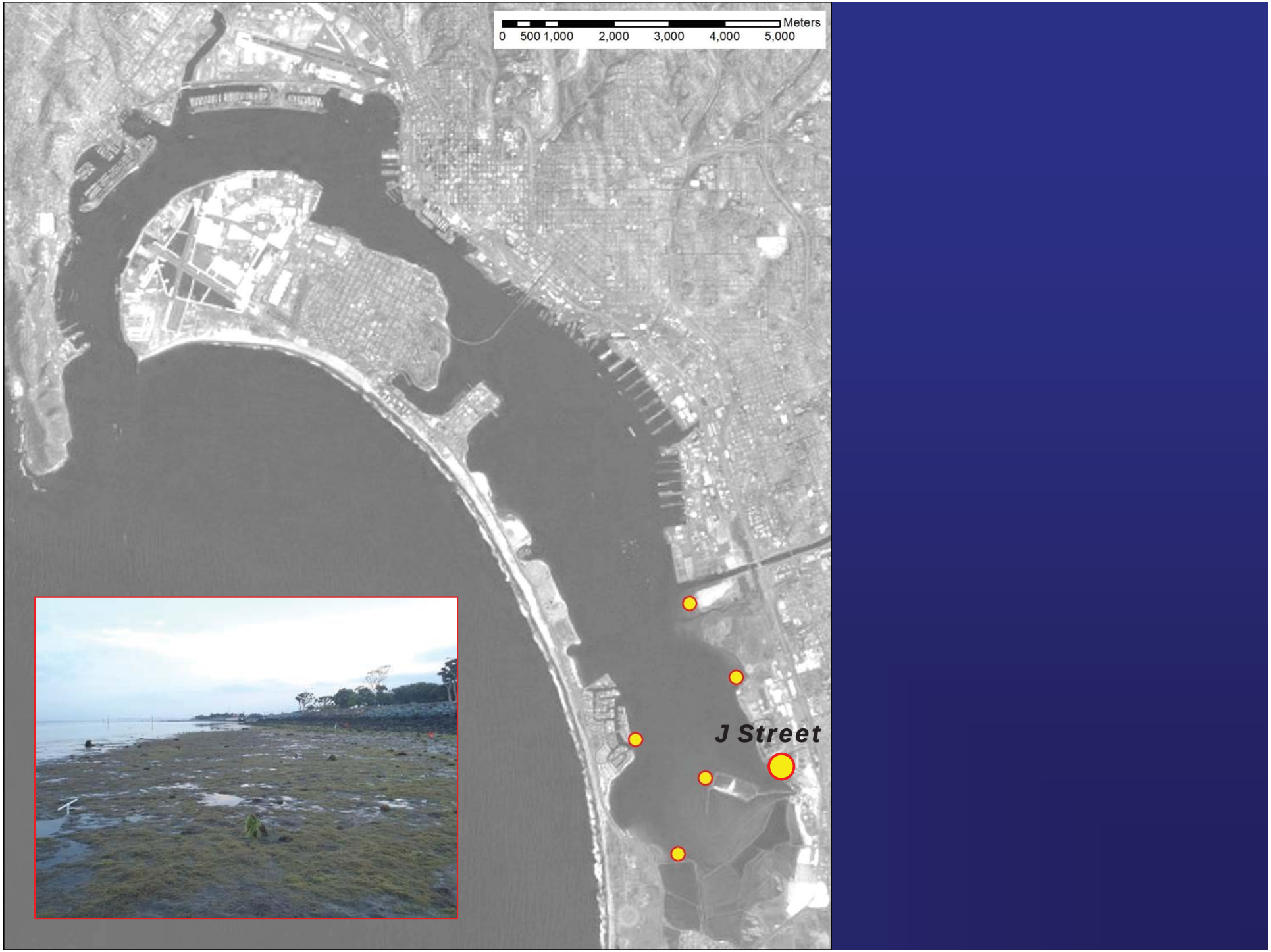
Signature Park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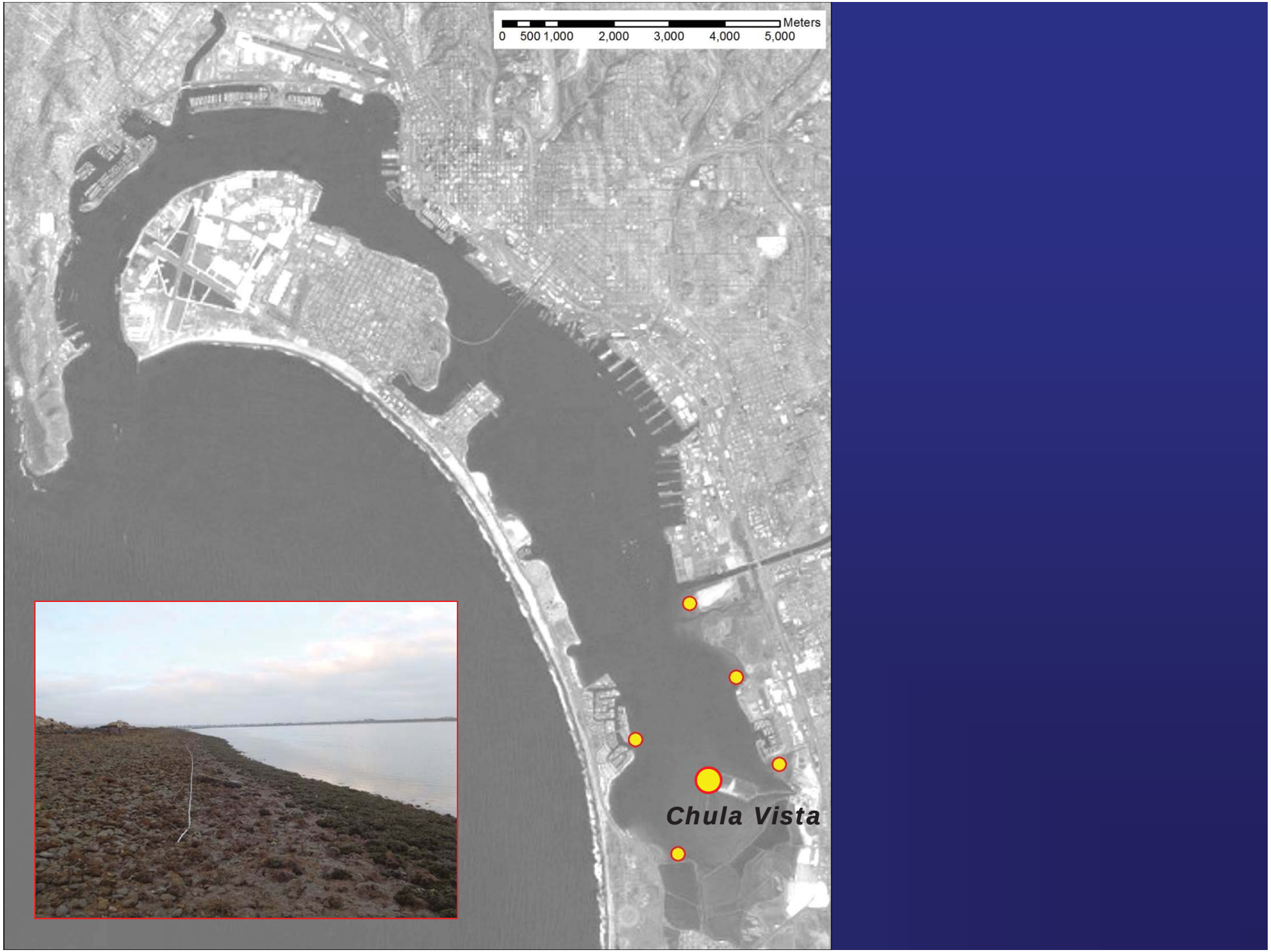
J Street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Chula Vista


Meters
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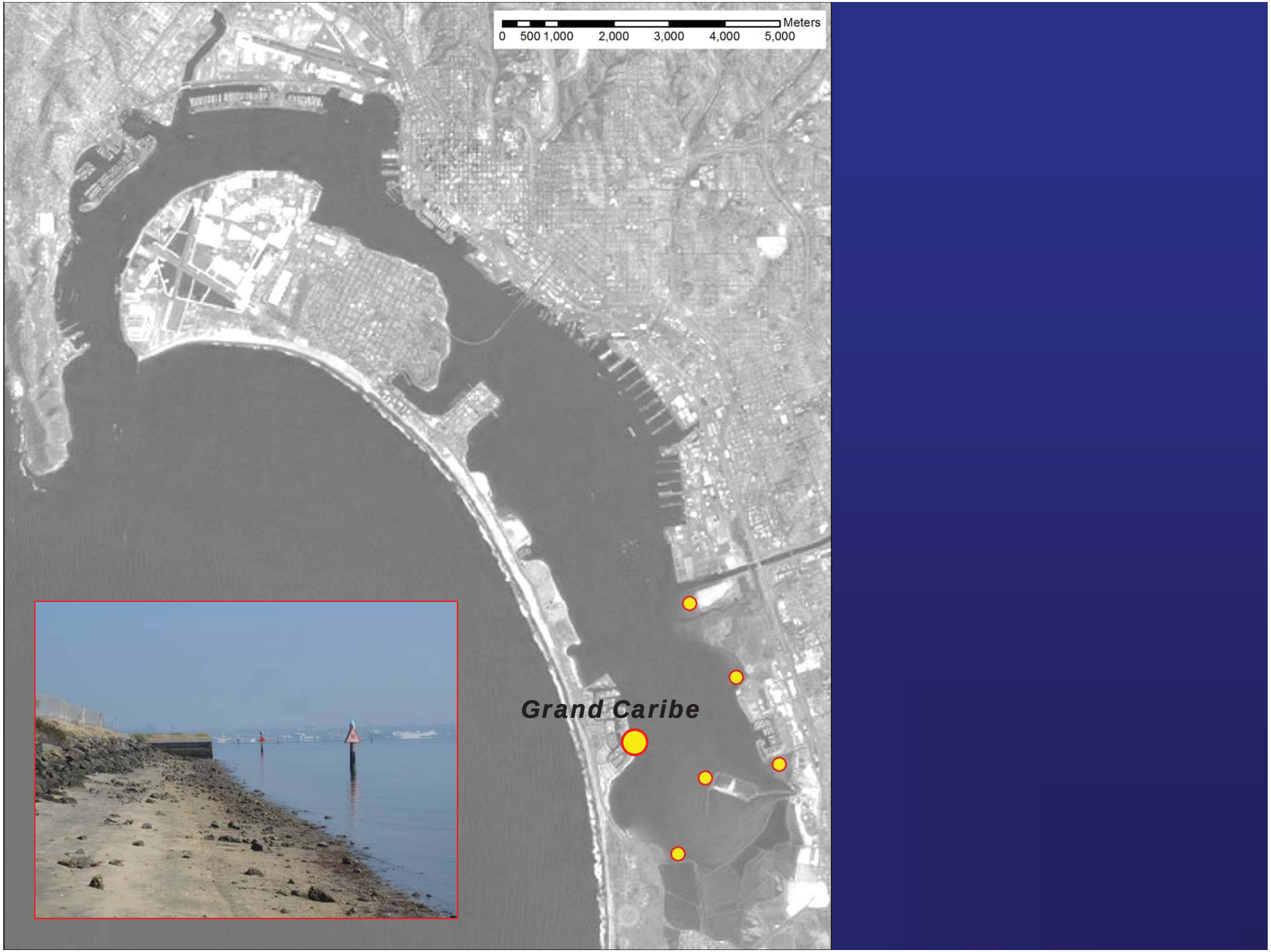
NORTH
SOUTH
Pond 11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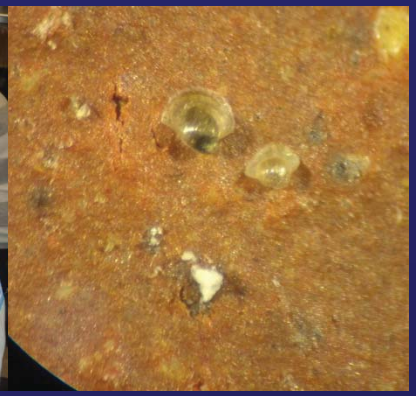
Grand Caribe

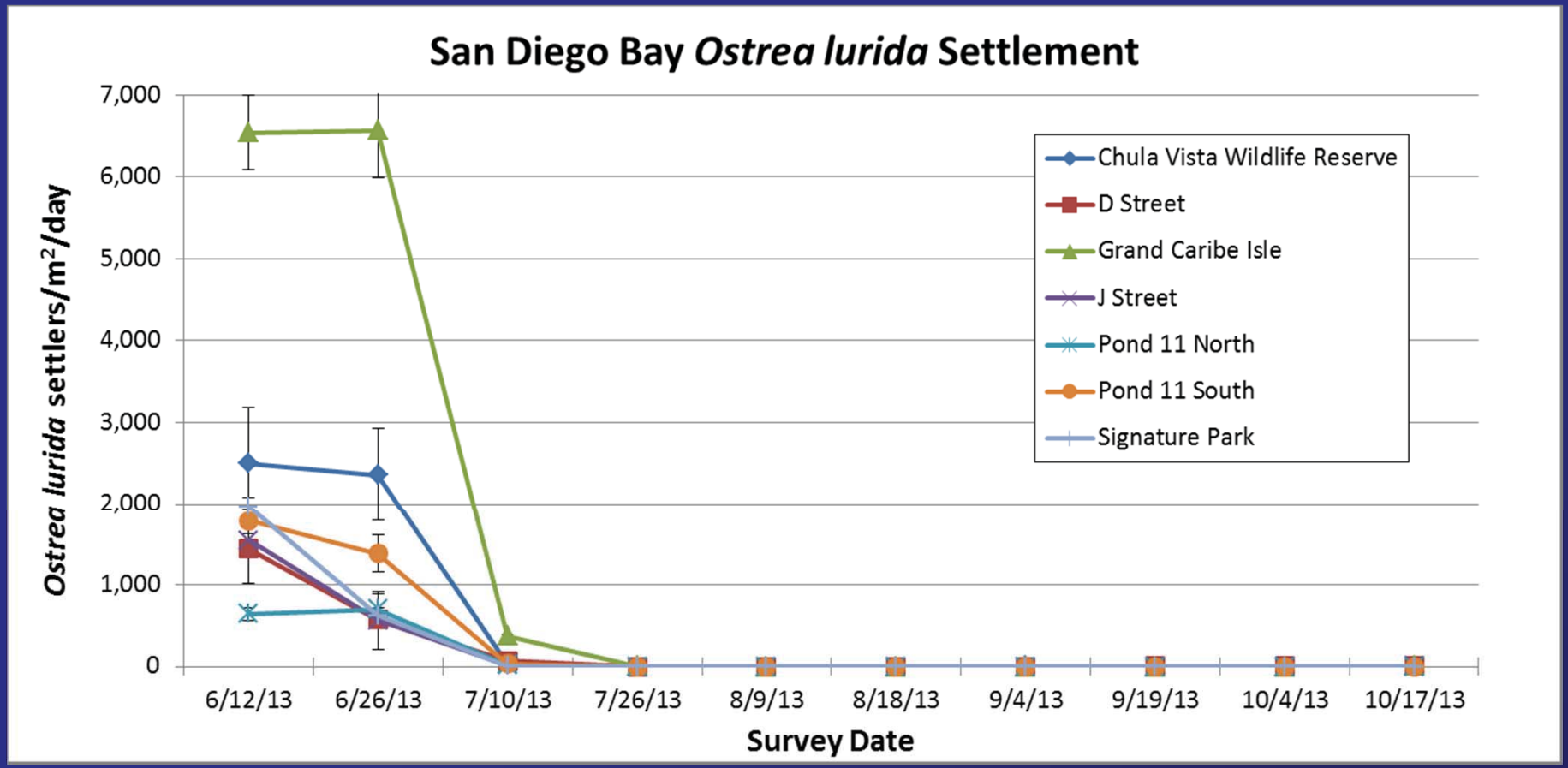
Oyster Settlement- METHODS

- Study dates: May – October 2013
- Four PVC Ts with ceramic tiles placed at each site
- All Ts placed at same tidal elevation
- Tiles collected biweekly
- All settled oysters counted in lab
- New/clean tiles returned to the field



Oyster Settlement – RESULTS



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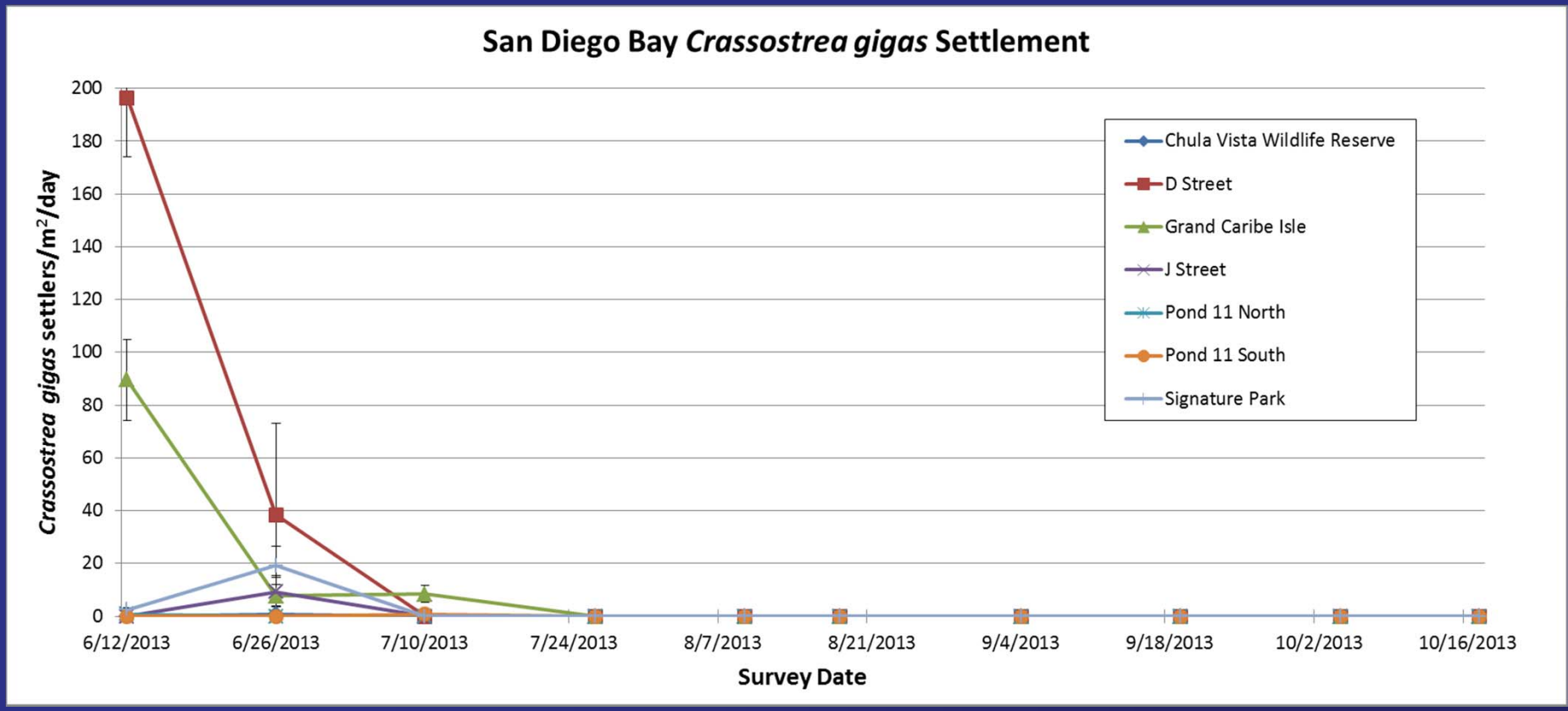
Oyster Settlement– RESULTS



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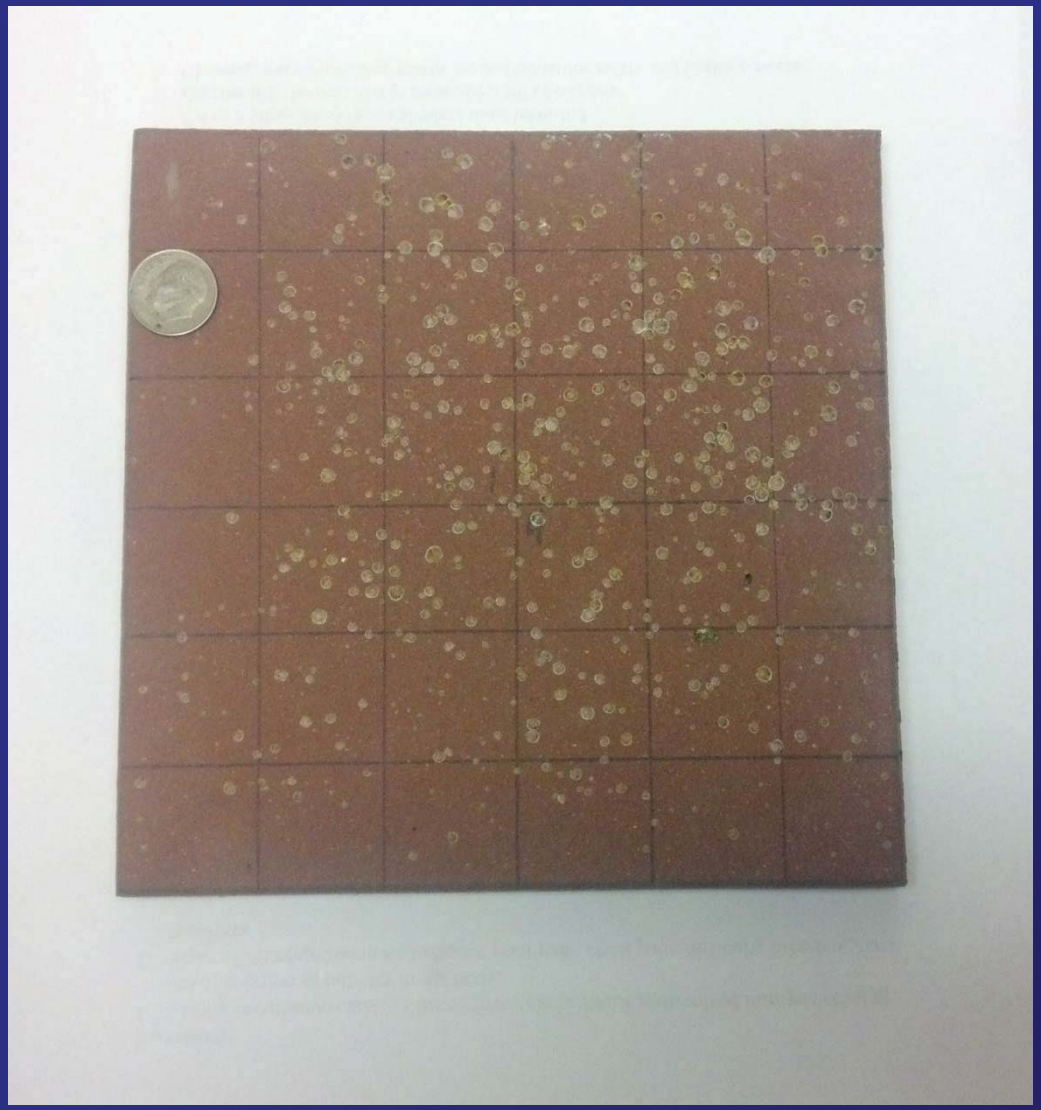
Oyster Settlement– RESULTS



Oyster Settlement– RESULTS

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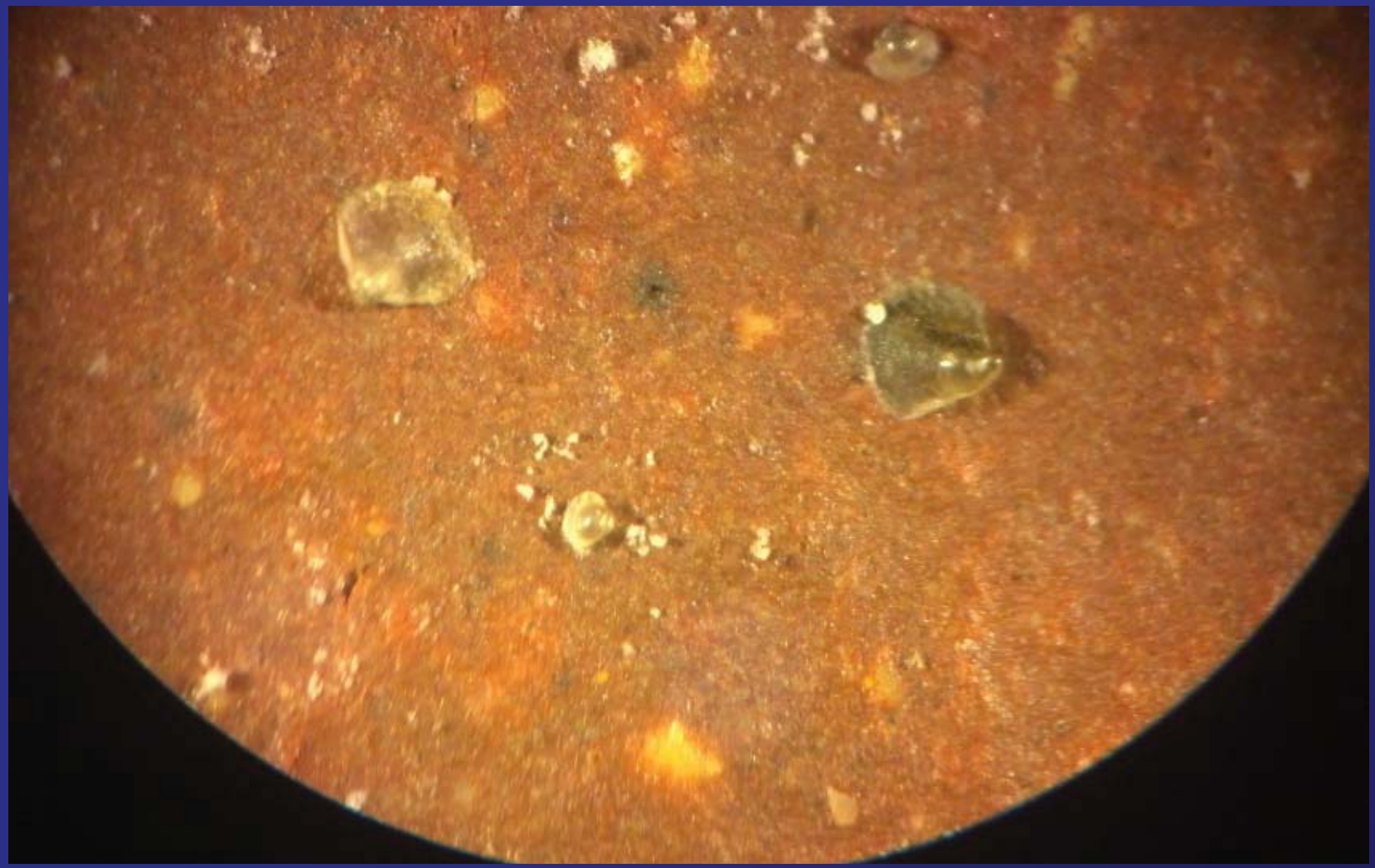
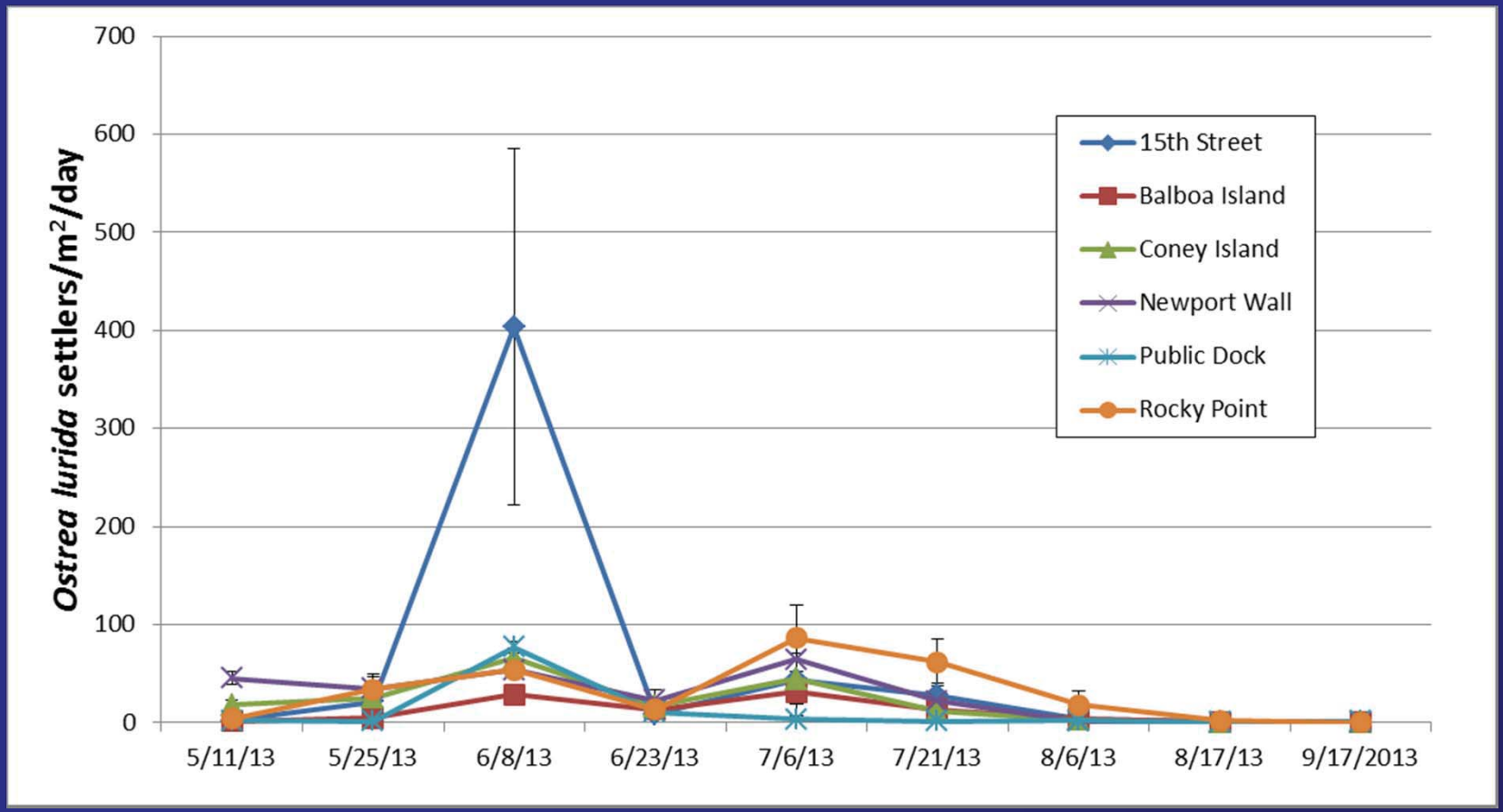


Oyster Settlement– RESULTS

Oyster Settlement in Newport Bay



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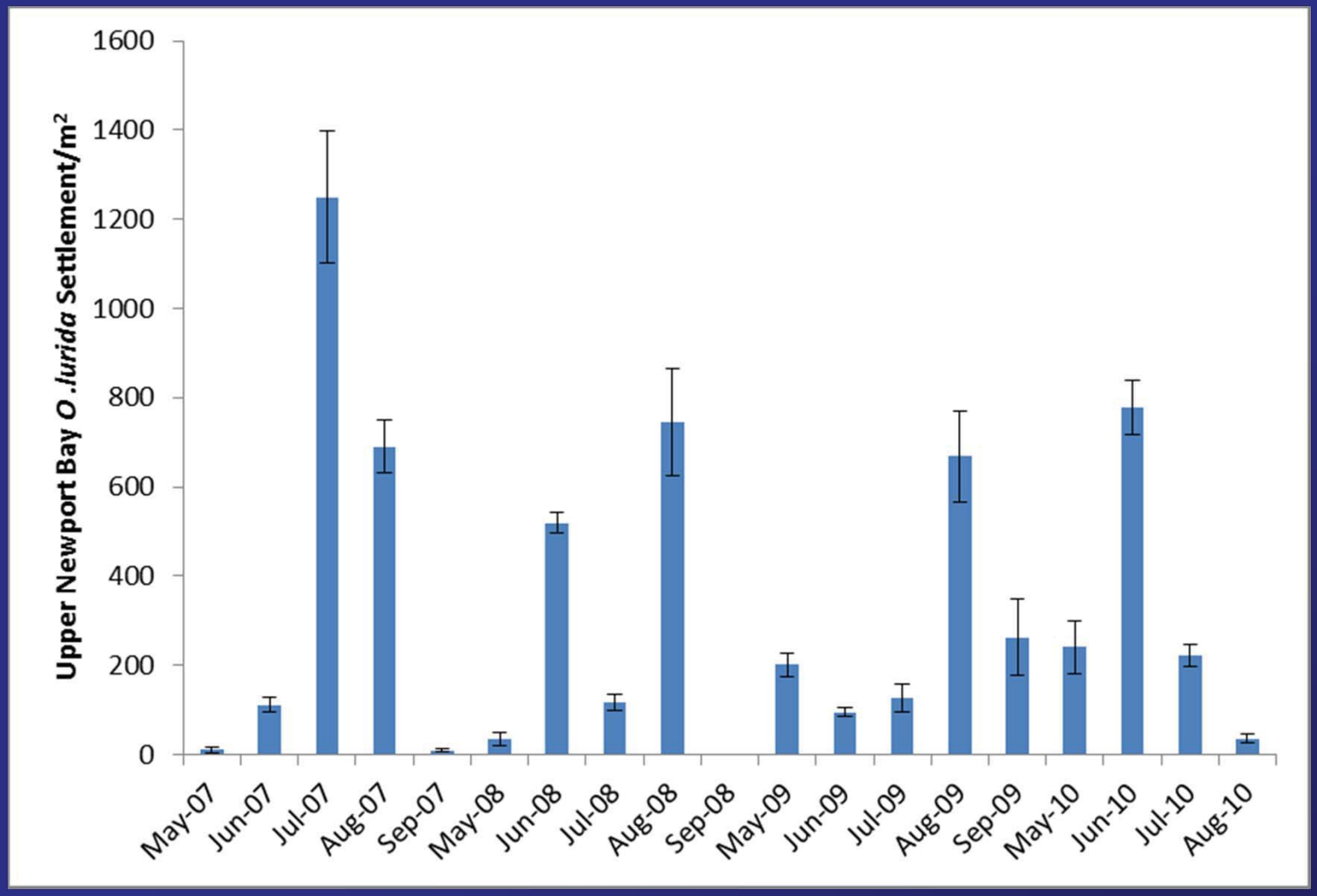
Oyster Settlement in Newport Bay



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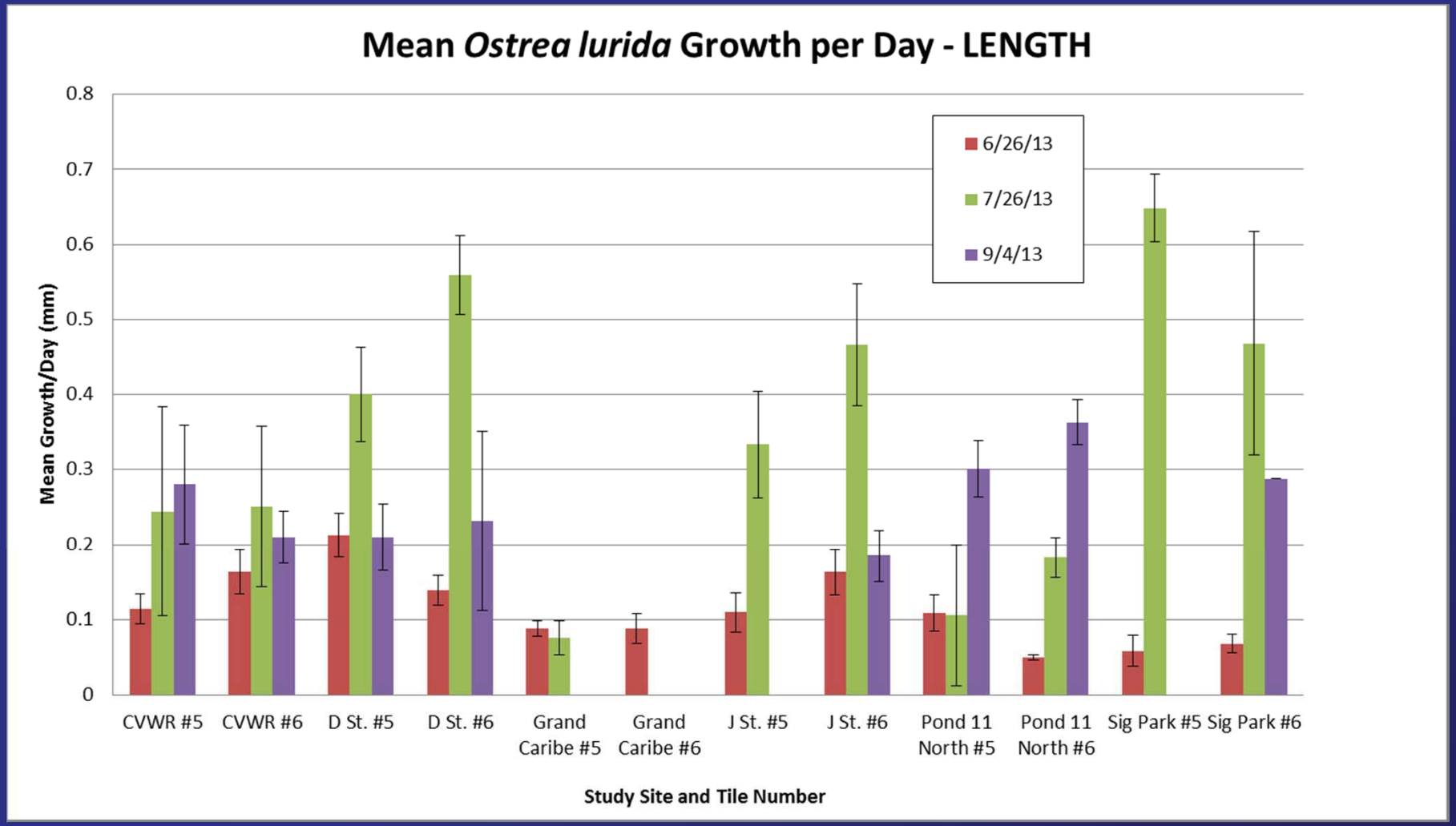
Oyster Growth - METHODS

- Study dates: May – October 2013
- Two PVC Ts with ceramic tiles placed at each site
- Tiles collected monthly
- Ten oysters per tile marked measured for growth
- Growth tiles then returned to field.

Oyster Growth – RESULTS



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Oyster Growth – RESULTS

Oyster Growth – RESULTS

Oyster Growth – RESULTS

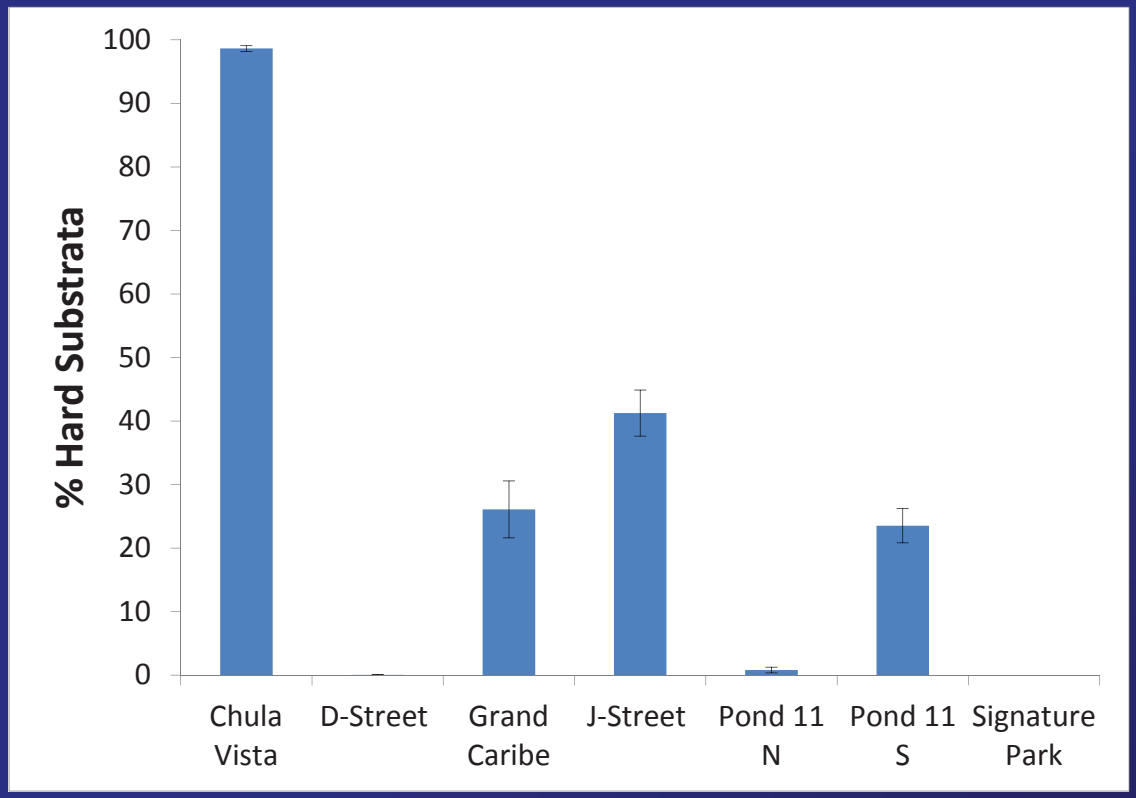
Oyster Settlement and Growth – Preliminary Conclusions

- None of the six sites appear settlement limited.
- Post-settlement processes are important.
- Based on 2013 data, all six sites could be viable restoration sites.

Oyster Distribution Studies - METHODS

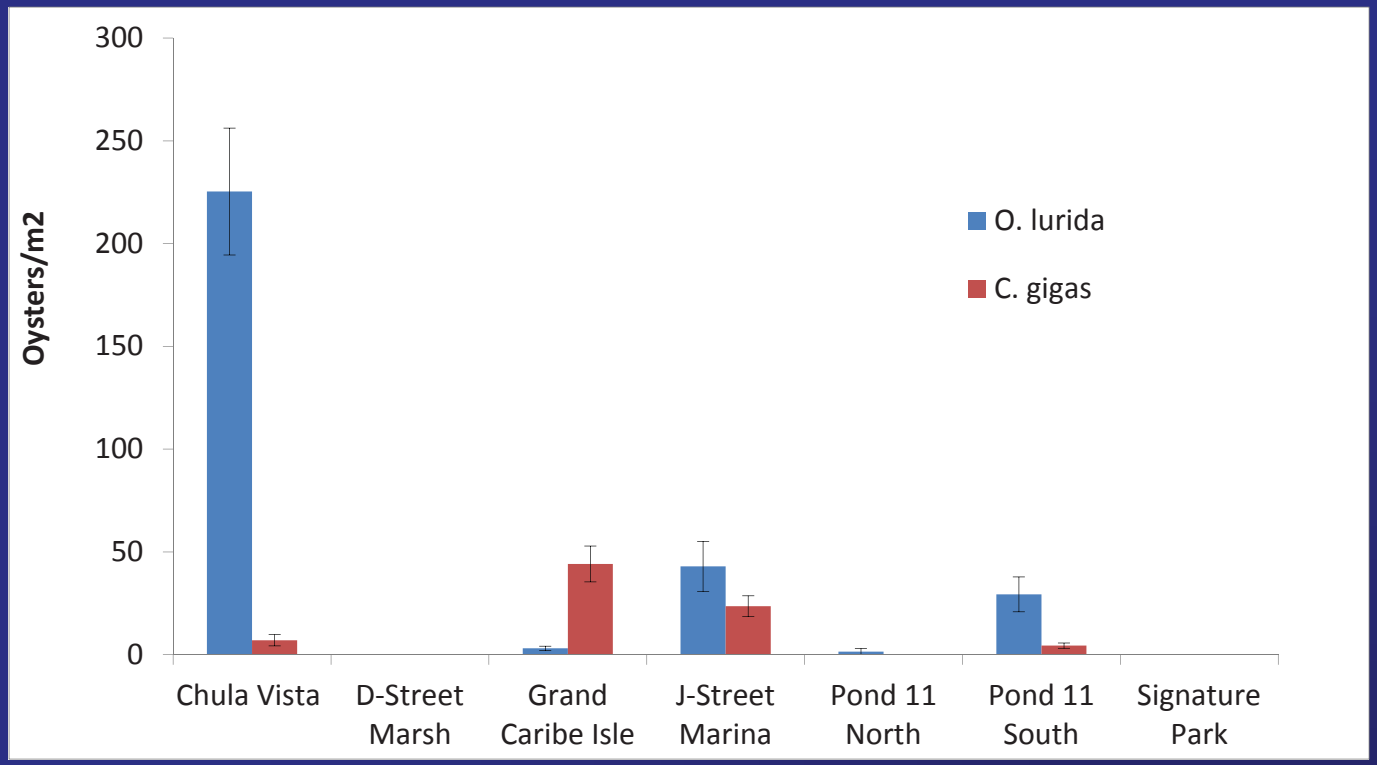
- Quantitative: Density and habitat % cover at six study sites
  - Laid out 50 m X 2 m transect at + 1.0 MLLW
  - Randomly placed 30 quadrats for point-contact and density counts of native and non-native oysters

Oyster Distribution Studies - RESULTS



- *% Hard substrate varied widely across sites at the tidal height surveyed*
- *At +1.0 MLLW, very different amounts of hard substrata available*

Oyster Distribution Studies - RESULTS



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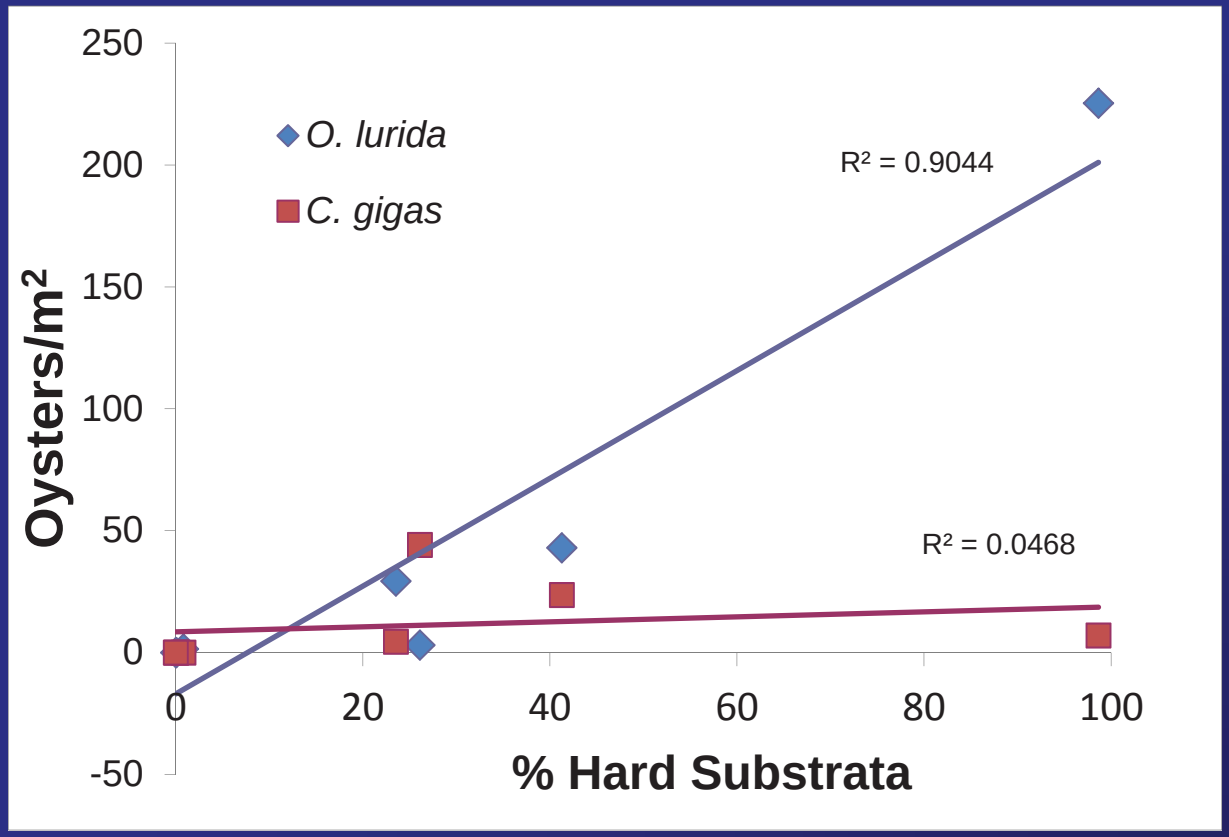
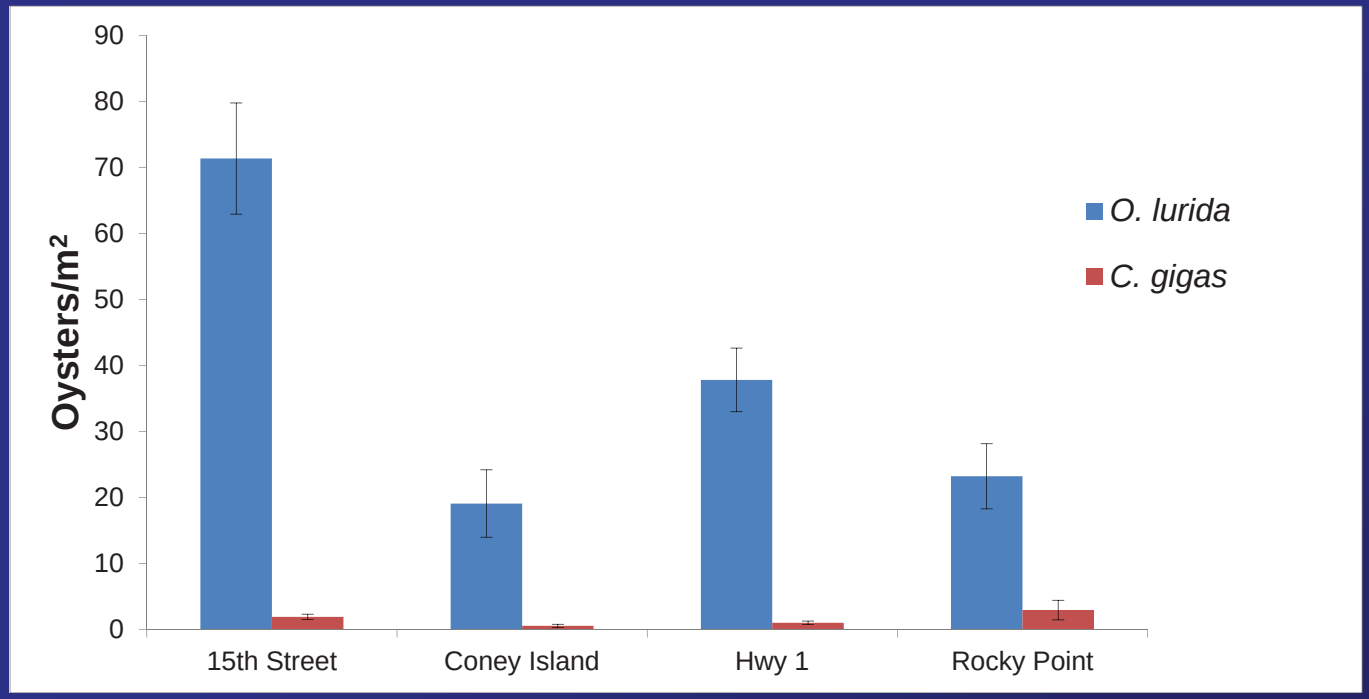
- *At +1.0 ft. MLLW, more natives than non-natives*
- *Both species of oysters were present at all sites*
- *Habitat differences – Chula Vista was cobble, D- street was mud, etc.*
- *Some sampling biases and an error*

Oyster Distribution Studies - RESULTS



Oyster Distribution Studies – Newport Bay (2010-2012)



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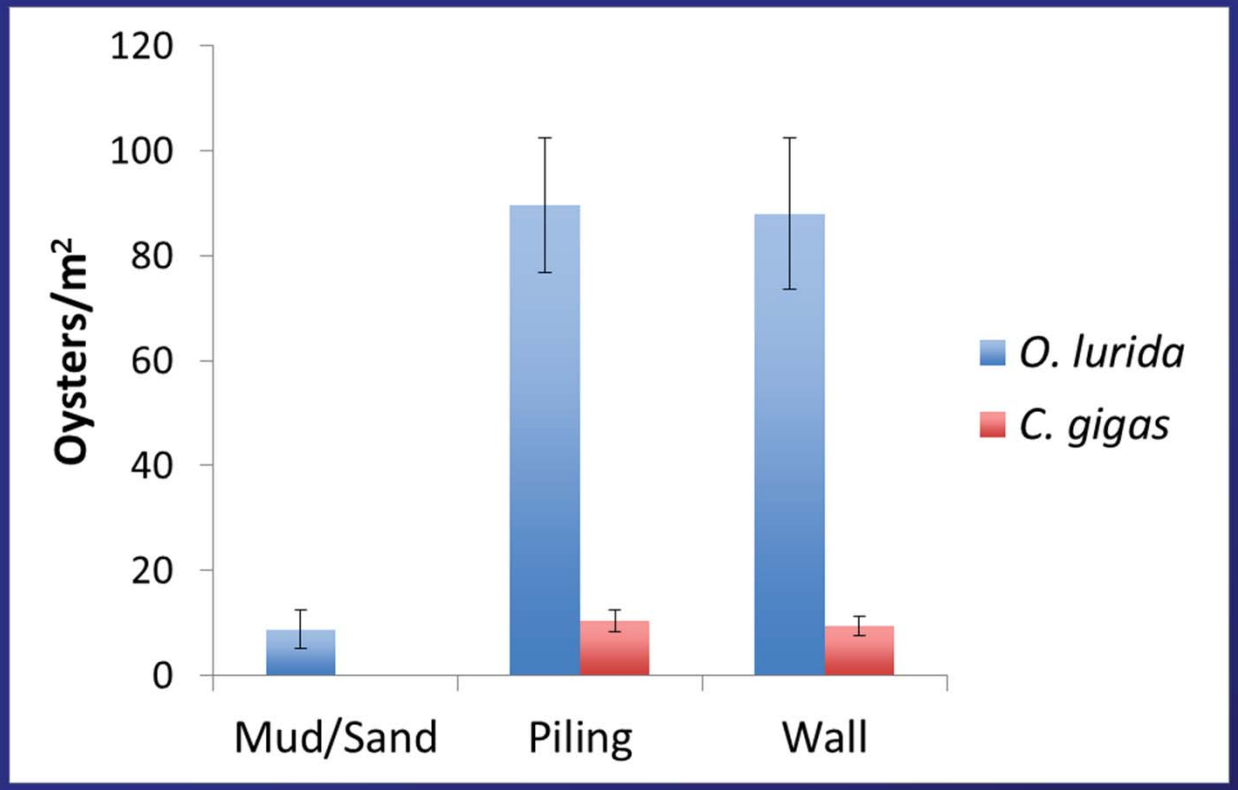
- *Native oyster density in San Diego Bay is comparable to Newport Bay, non-natives are more abundant in San Diego Bay than in Newport Bay*

Oyster Distribution Studies – Lido Island, Newport Bay (2011)



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Oyster Distribution Studies – Preliminary Conclusions

- Both native and non-native oysters are present at nearly all locations surveyed throughout the bay
- Densities of native oysters are comparable to Newport Bay, non-natives are more abundant in San Diego Bay than in Newport Bay
- Native oyster density is correlated with % hard substrata, non-native oyster density is not

Project Objectives

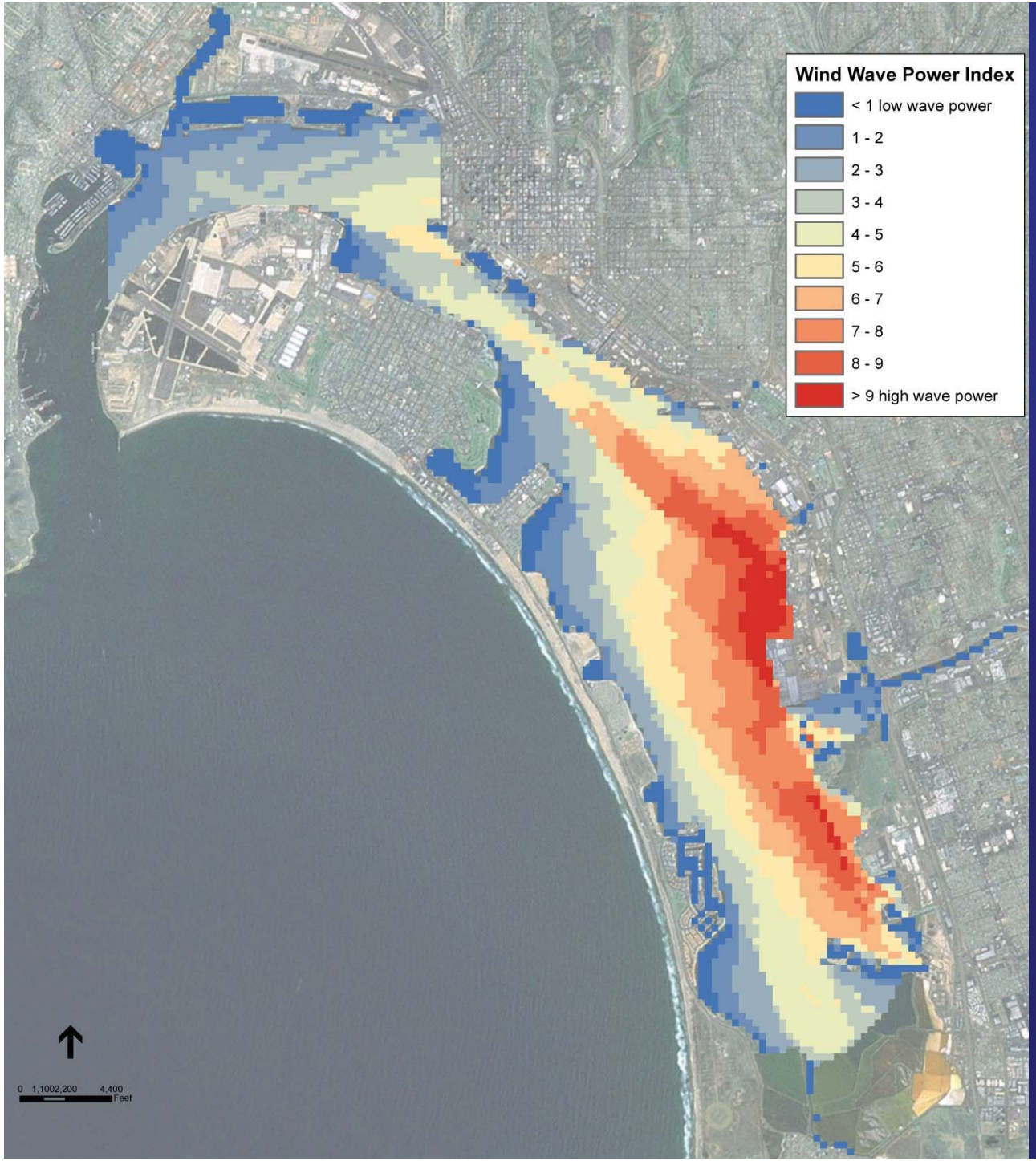
1. Evaluate existing and historical distribution of oysters in the Bay.
2. Determine suitable locations for oyster bed restoration, using existing and new data.
3. **Identify appropriate energy environments and sites in the Bay that could most benefit (in terms of erosion control and ecological function) from oyster bed creation.**
4. Use a pilot-scale approach to establish demonstration oyster beds.
5. Determine the extent to which oyster reefs enhance habitat for invertebrates, fish, and birds, relative to areas lacking structure and relative to pre-restoration conditions.
6. **Evaluate the potential for oyster beds to reduce water flow velocities, attenuate waves, reduce erosion, and promote sediment capture.**

Physical Studies - QUESTION

- Where are wave energies highest and lowest in the Bay?

Physical Studies – WIND WAVES

- Complete preliminary modeling of wave energies using existing data
  - The Hasselmann Method from the Shore Protection Manual calculates shallow water wave power from water depth, wind speed, and fetch length
    - The water depth was calculated as the difference between MHHW and the bathymetry (as a simplifying assumption)
    - Fetch length was calculated as the distance to a point above MHHW
    - Wind speed was from CIMIS station #184
  - Instantaneous wave power was calculated at each point in a grid for each wind speed and each direction
  - The wave power was weighted by the % occurrence of each wind speed and direction



Physical Studies - RESULTS

- High wave power along the southeastern shore
- Low wave power in the north and along the west shore

TAC Meeting Actions

- Determine potential oyster bed restoration sites
- Identify studies to fill gaps at potential restoration sites.

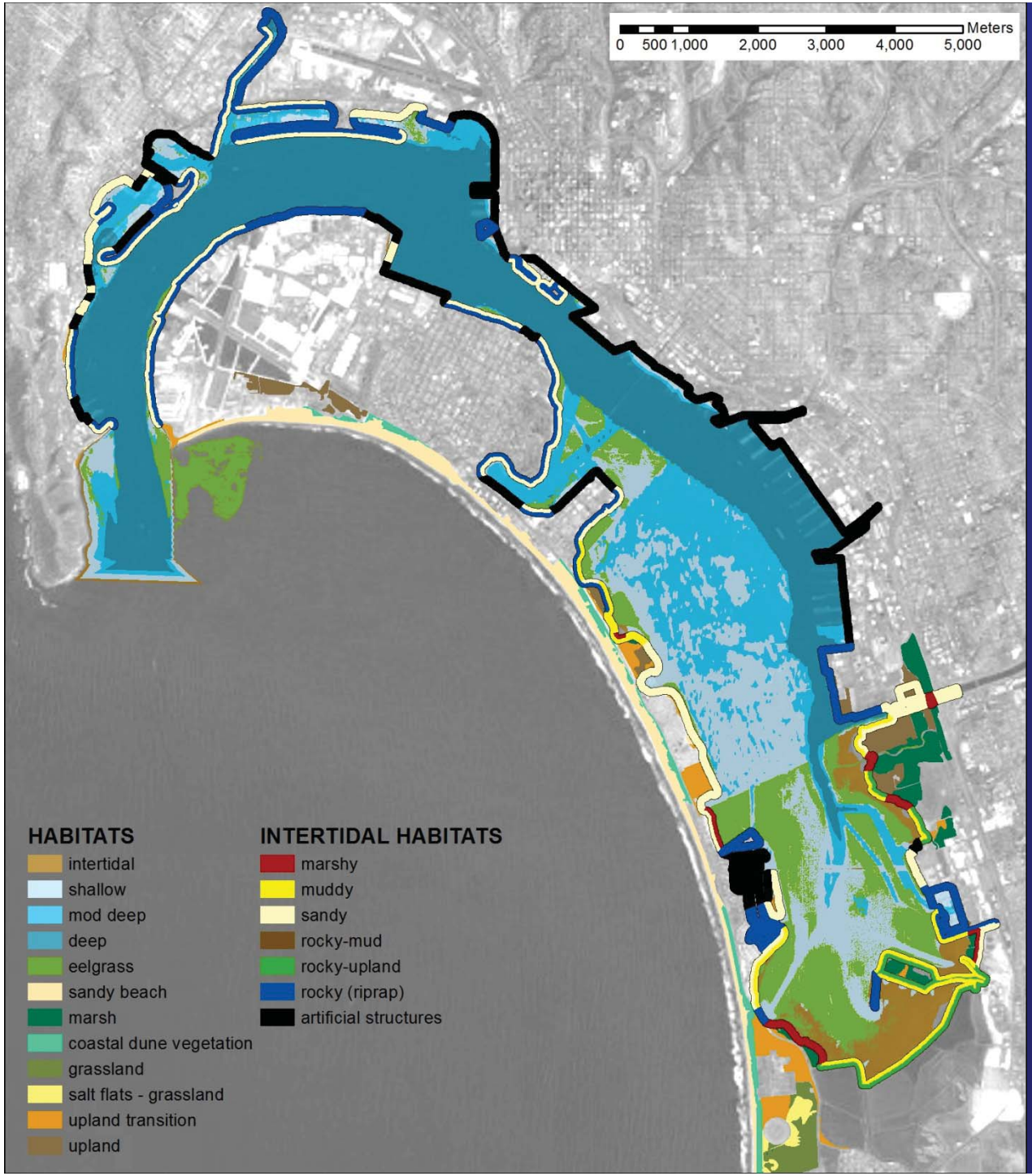
Next Steps

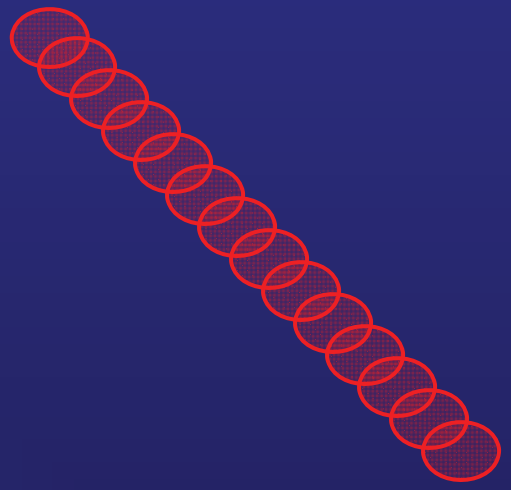
- Identify final site(s)
- Develop conceptual design
- Develop study plan
- Fund and implement second phase

Criteria for Potential Restoration Sites

- **TIER I: Criteria for all possible restoration sites:**
  - Bathymetry
  - Physiological parameters– salinity, turbidity, DO, temperature, water quality, nutrients, sediment type
  - Hydrologic regime (Energy environment, inundation/tidal elevation)
- **TIER II: Criteria for all sites that would help us learn something about effects of oyster bed restoration on wave energy:**
  - Not armored
  - Erosive sites
  - High wave energy
  - Offshore of marshes that we want to protect
- **TIER III: Criteria for sites that are feasible:**
  - Property ownership
  - Access

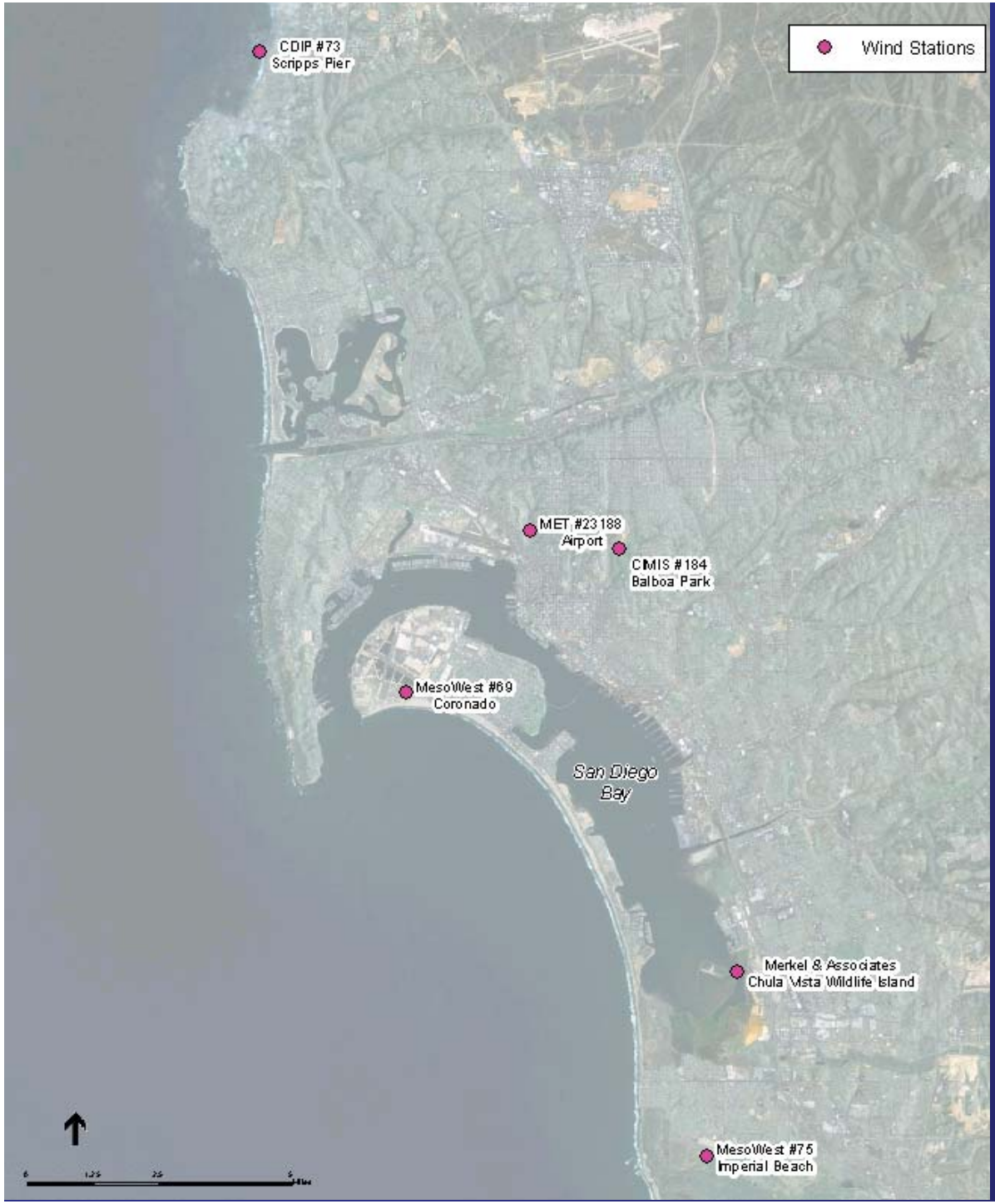
Potential Restoration Sites





Data Gaps

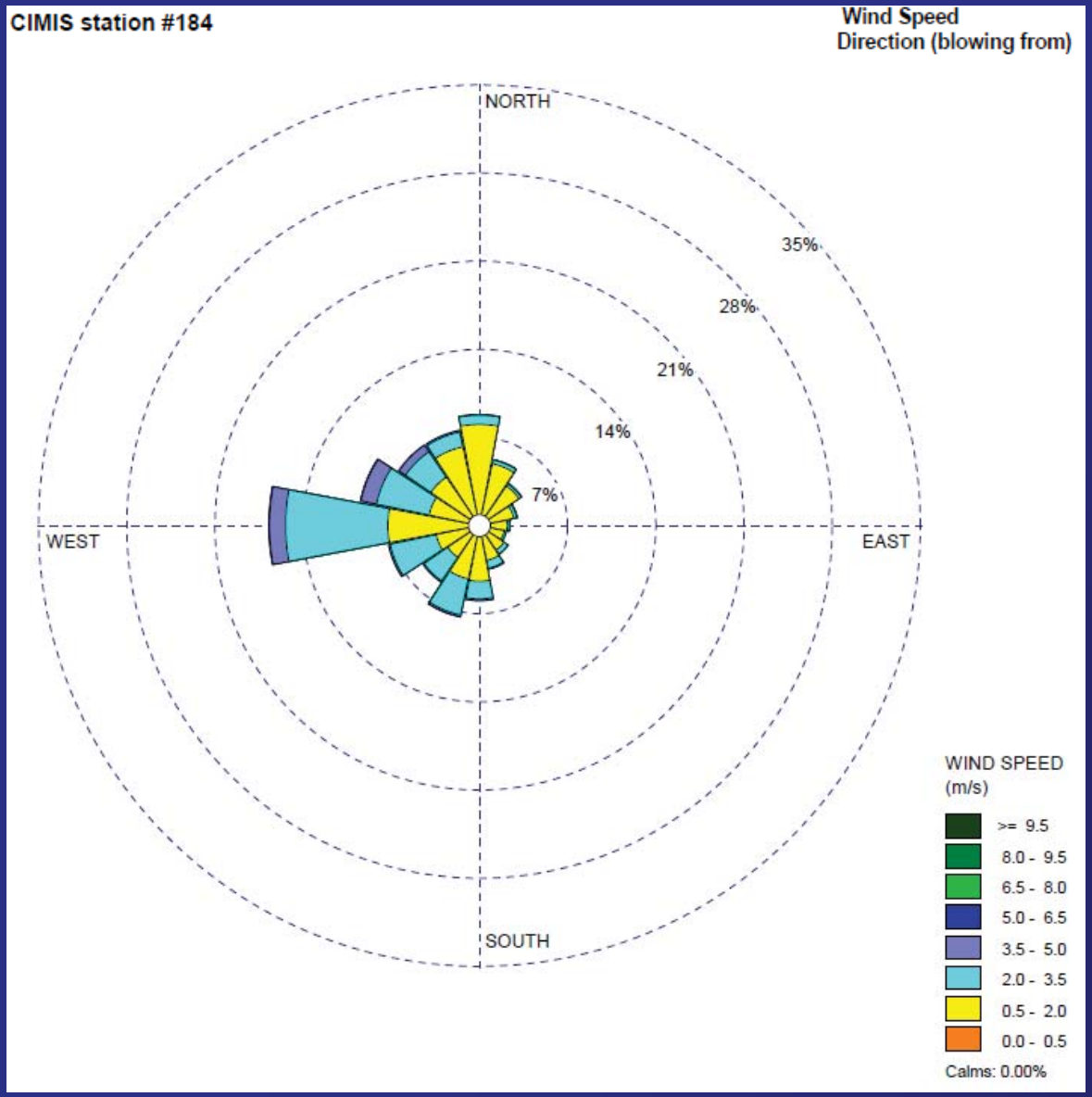
- **Physical Environment Data Needs**
  - Wave Energy and Shoreline Erosion
  - Sedimentation
  - Sediment Type at Restoration Site(s)
  - Water Quality
- **Biological Data Needs**
  - Settlement and growth for other species
  - Better growth data for native oysters
  - Causes of observed oyster species zonation



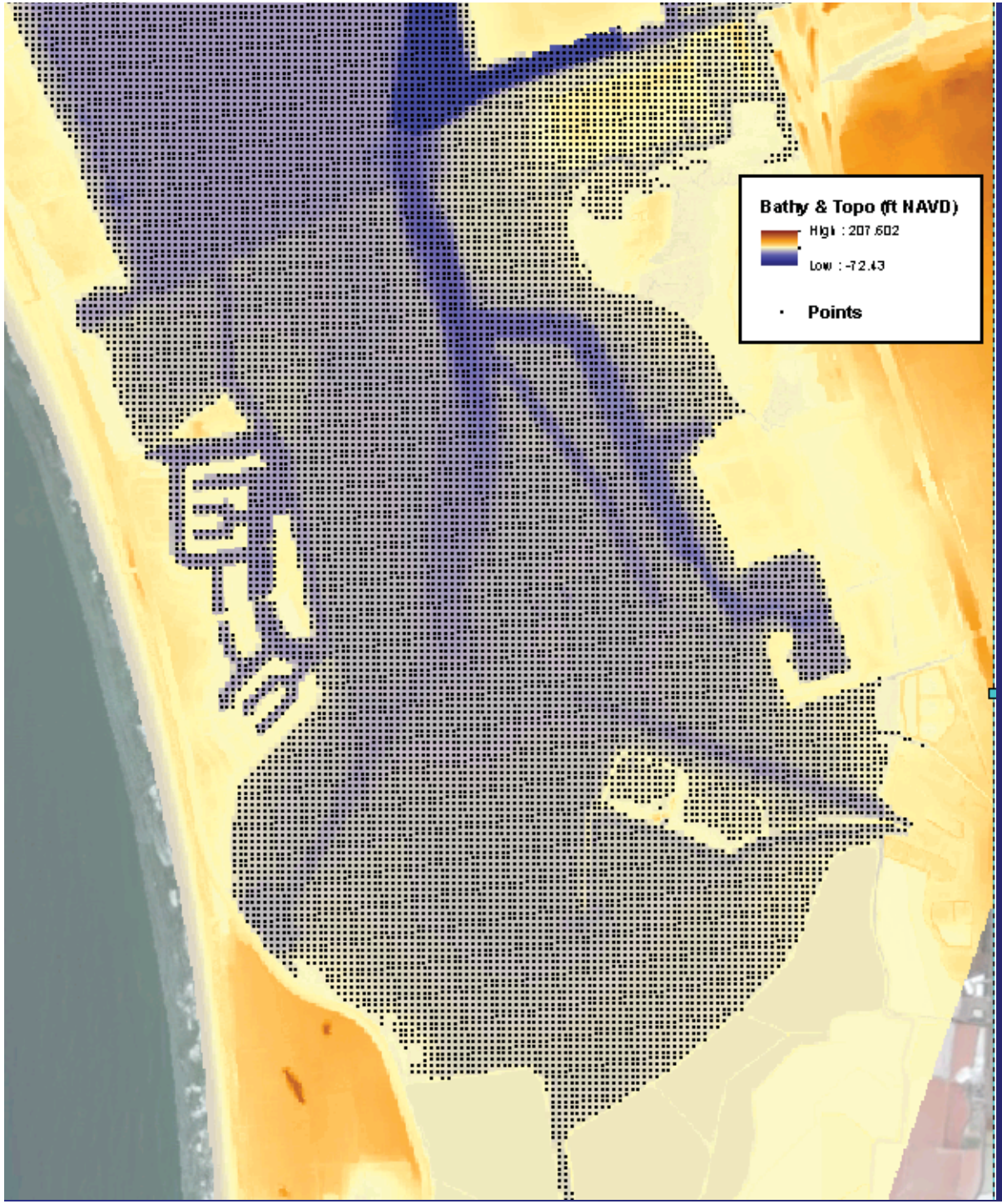
Physical Studies - WIND

- Wind data from CIMIS station #184 had the longest data set closest to the bay

Physical Studies - WIND

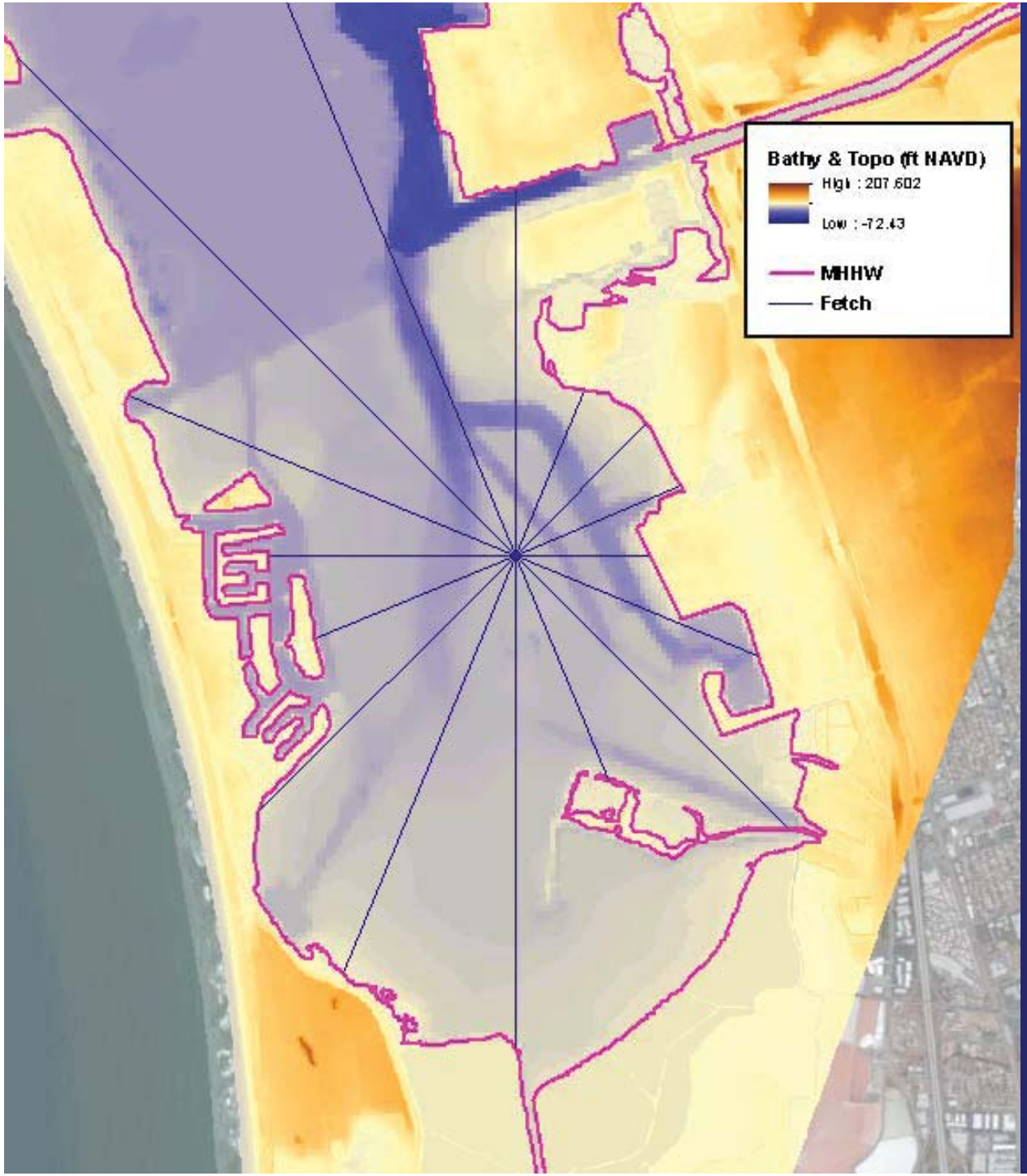


- Wind data from CIMIS station #184, located at Balboa Park, was used to generate a % occurrence table



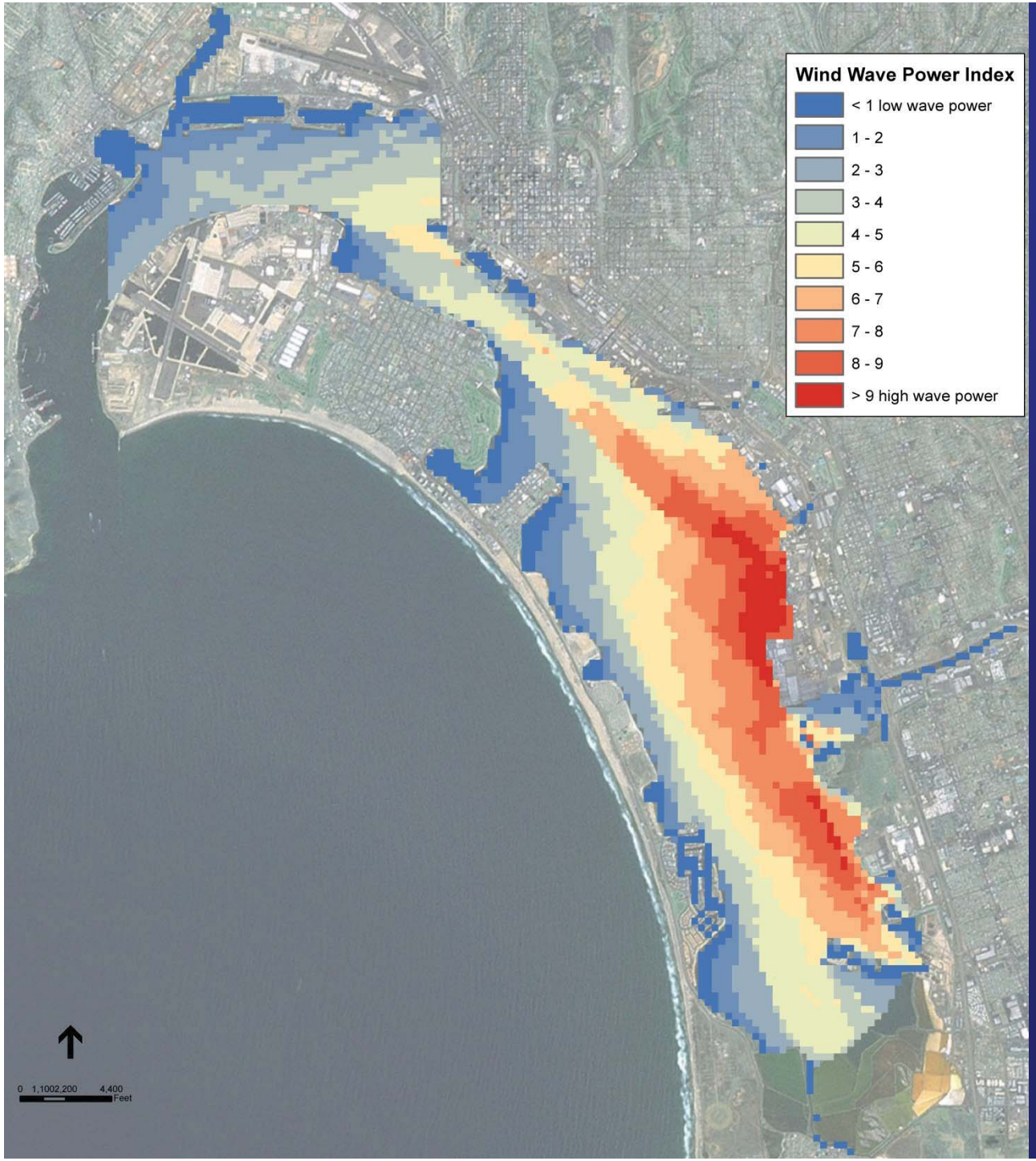
Physical Studies – WATER DEPTH

- Water depths were calculated at each point using the Merkel bathymetry



Physical Studies – WIND FETCH

- Fetch length was calculated from each point to the nearest point above MHHW in each direction
- Wave height, period, and power was calculated for each direction and a range of wind speeds

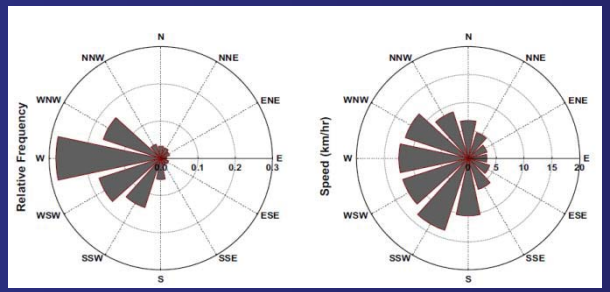


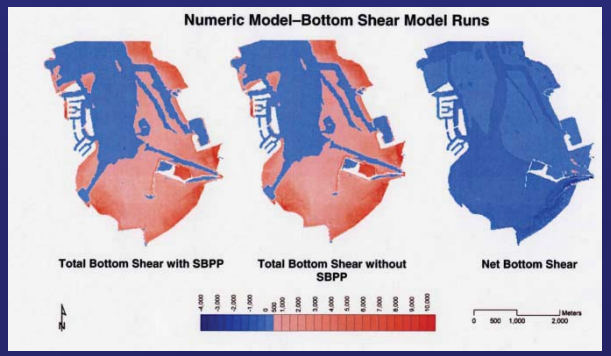
Physical Studies – WAVE POWER

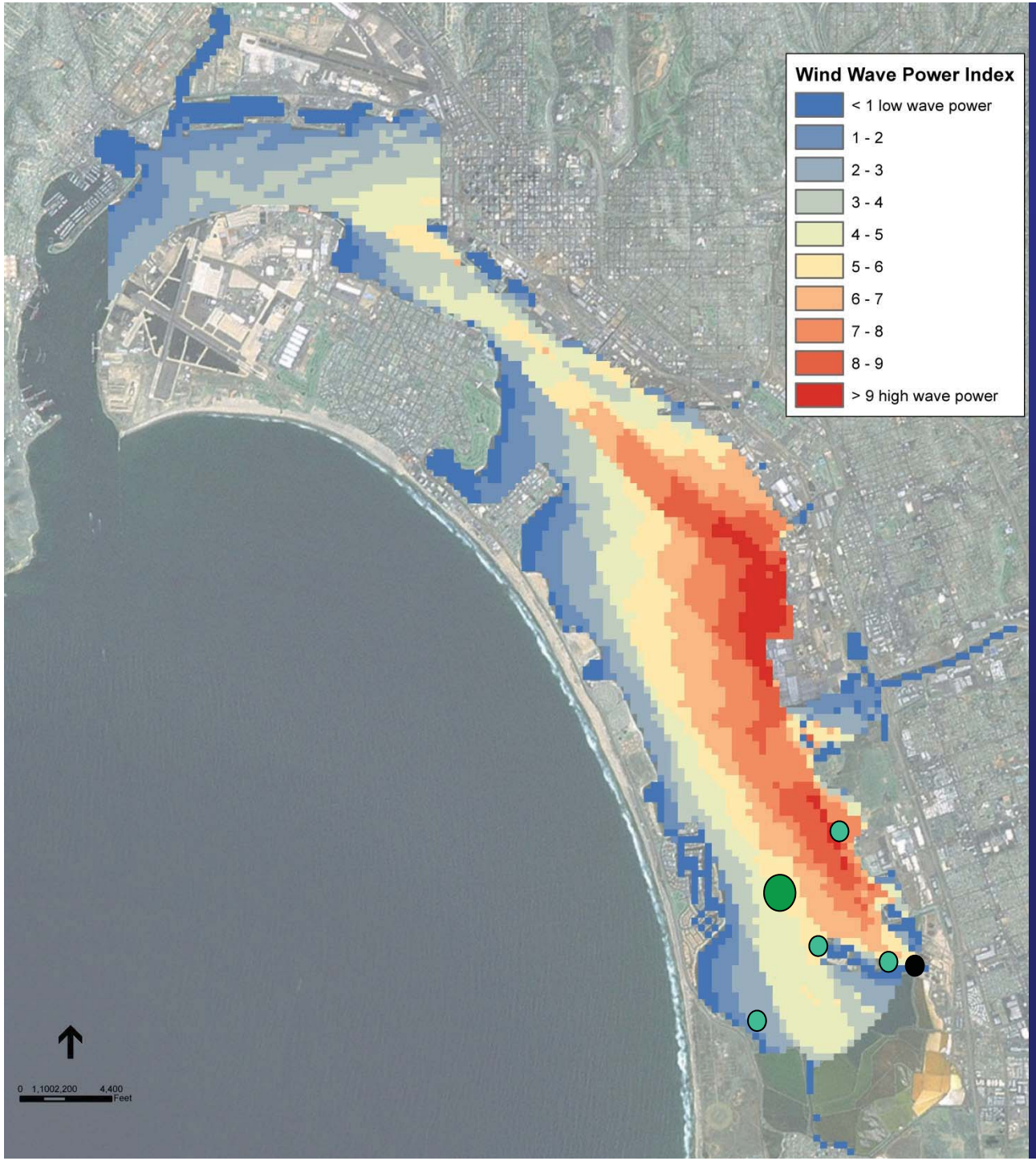
- Wave power for each direction and wind speed is weighted by % occurrence and summed to give a total average annual wave power index

Field Studies

- GIS data collection (bathymetry, tides, shoreline ownership, etc.)
- Weather station and wave gauges
- Water quality (temperature, salinity, turbidity, etc.)
- Modeling







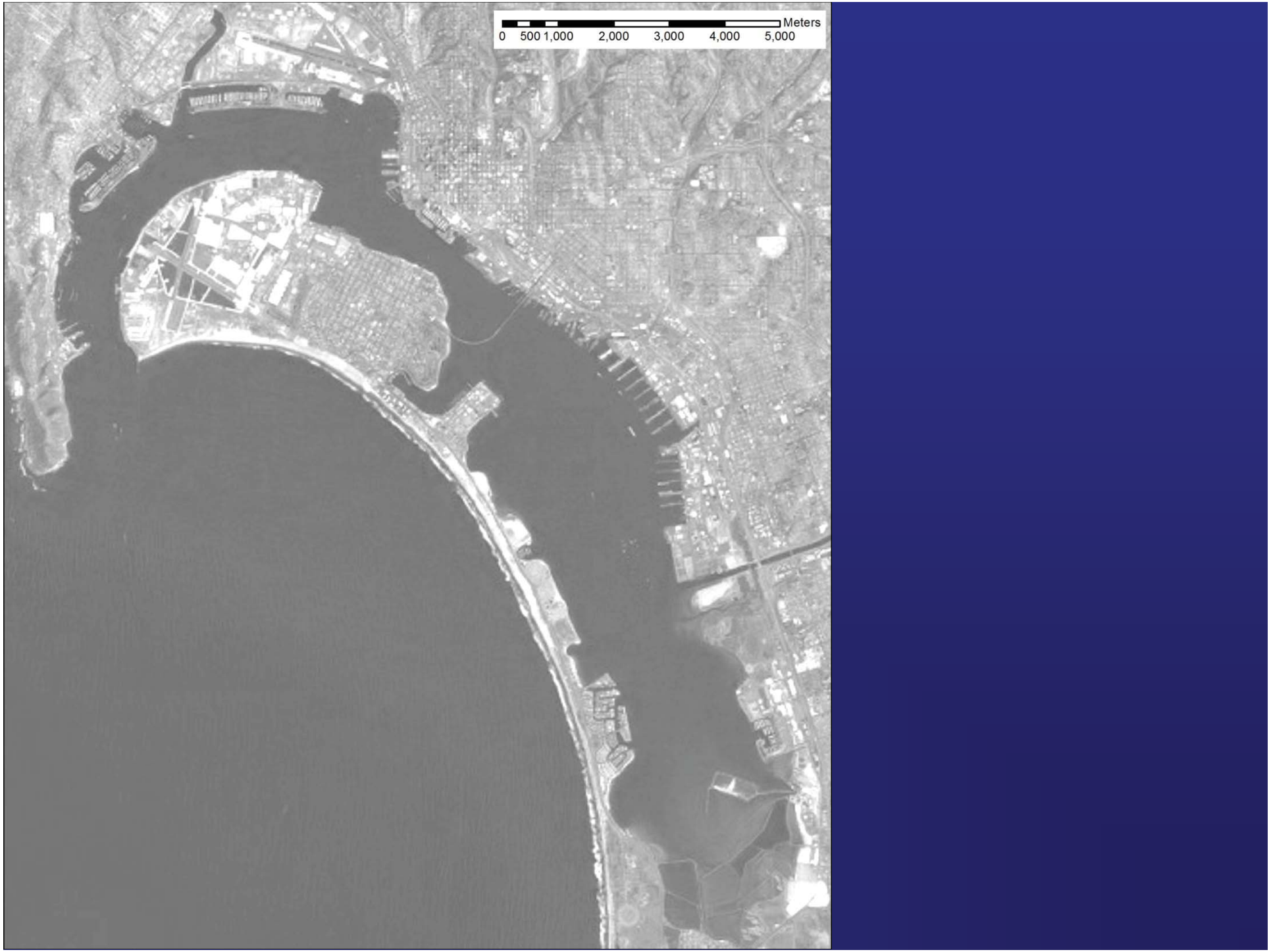
Physical Studies – DATA COLLECTION PLAN

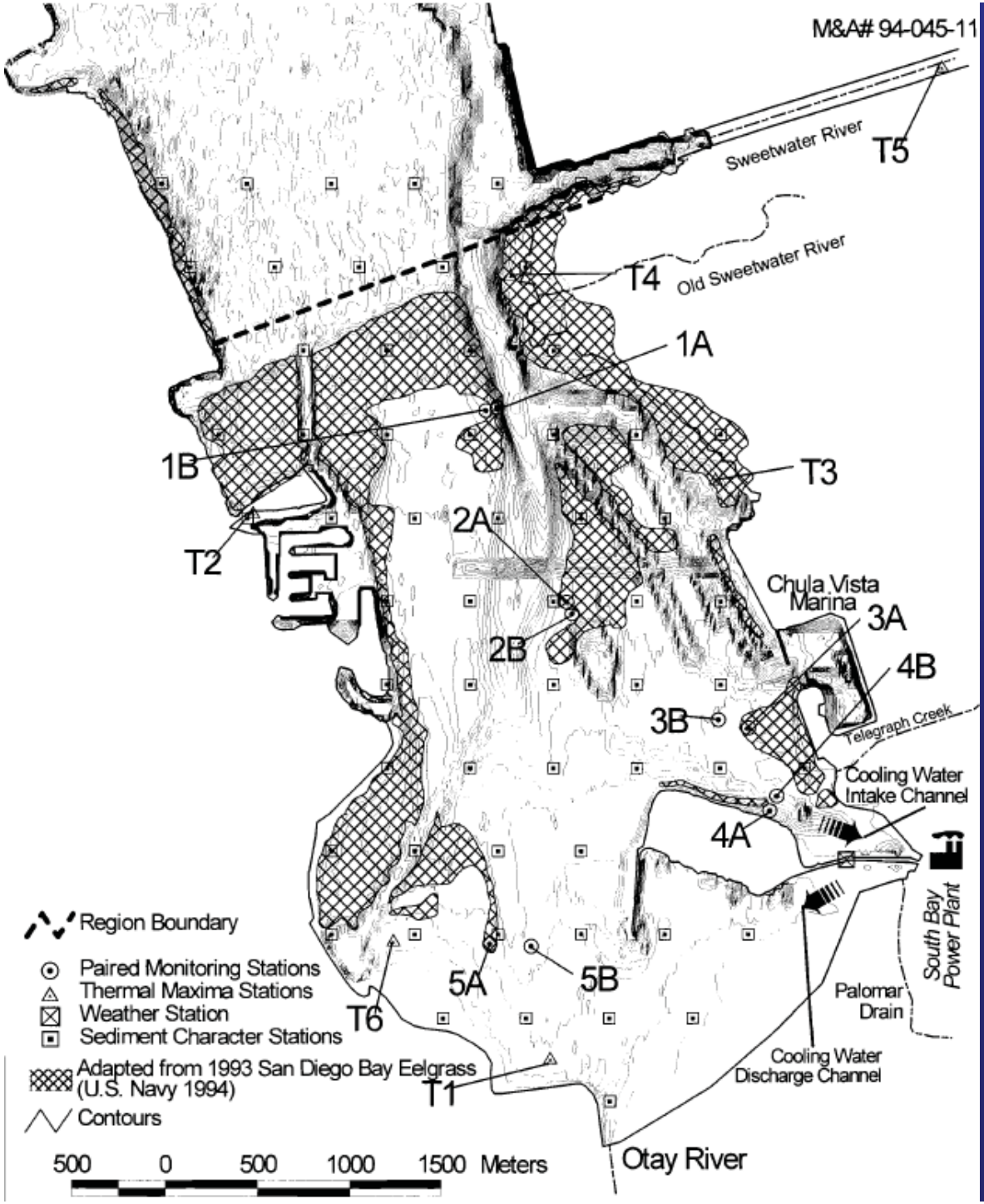
Goal:

- Confirm Bay wind and waves
- Establish erosion thresholds

Plan:

- Wind gage
- Directional wave gage (ADCP)
- Shoreline wave gages (pressure sensors)
  - Two eroding sites
  - Two stable sites


Meters
0 500 1,000 2,000 3,000 4,000 5,000

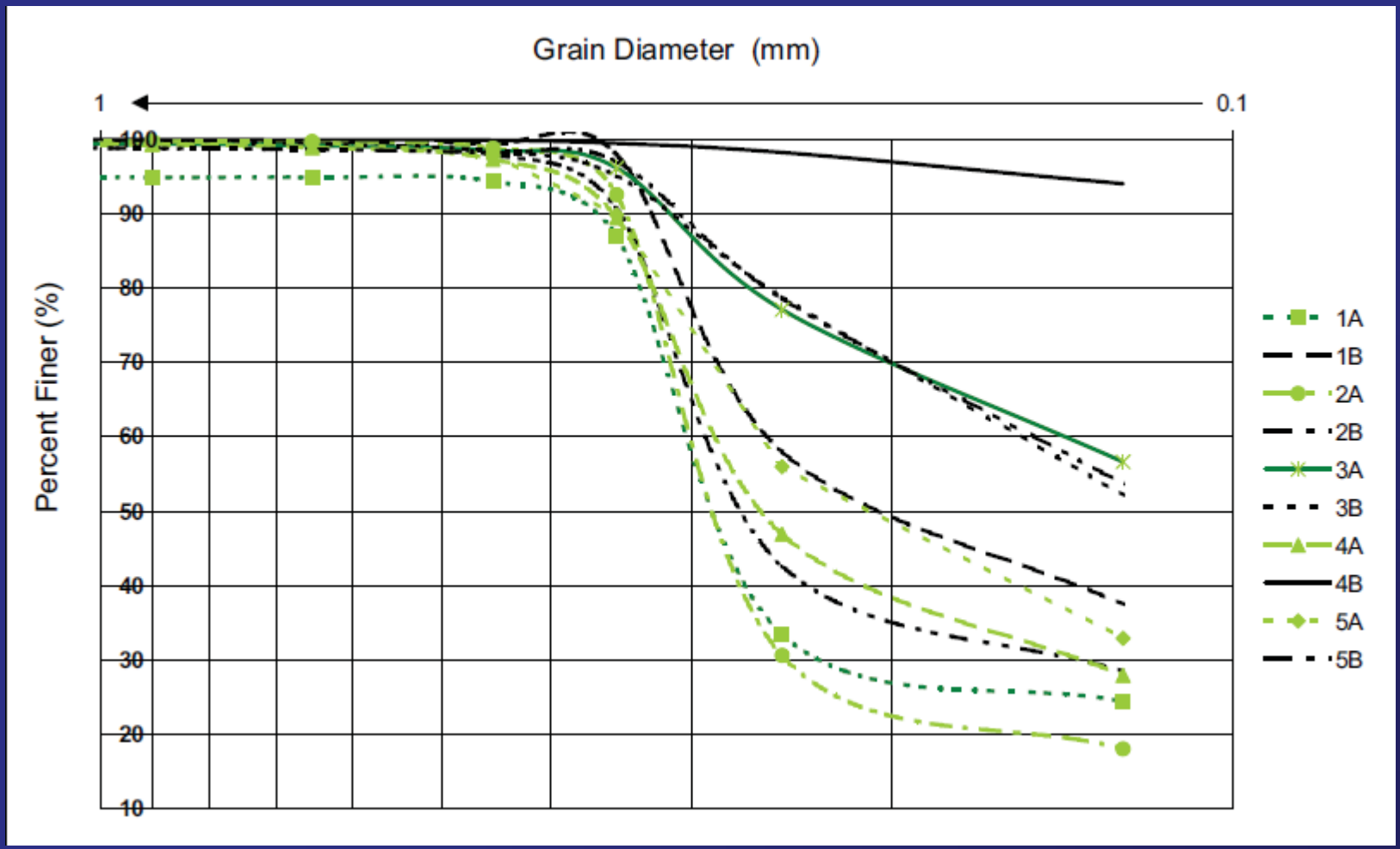


Physical Data - SEDIMENT

- Sampling locations for Merkel 2000 study

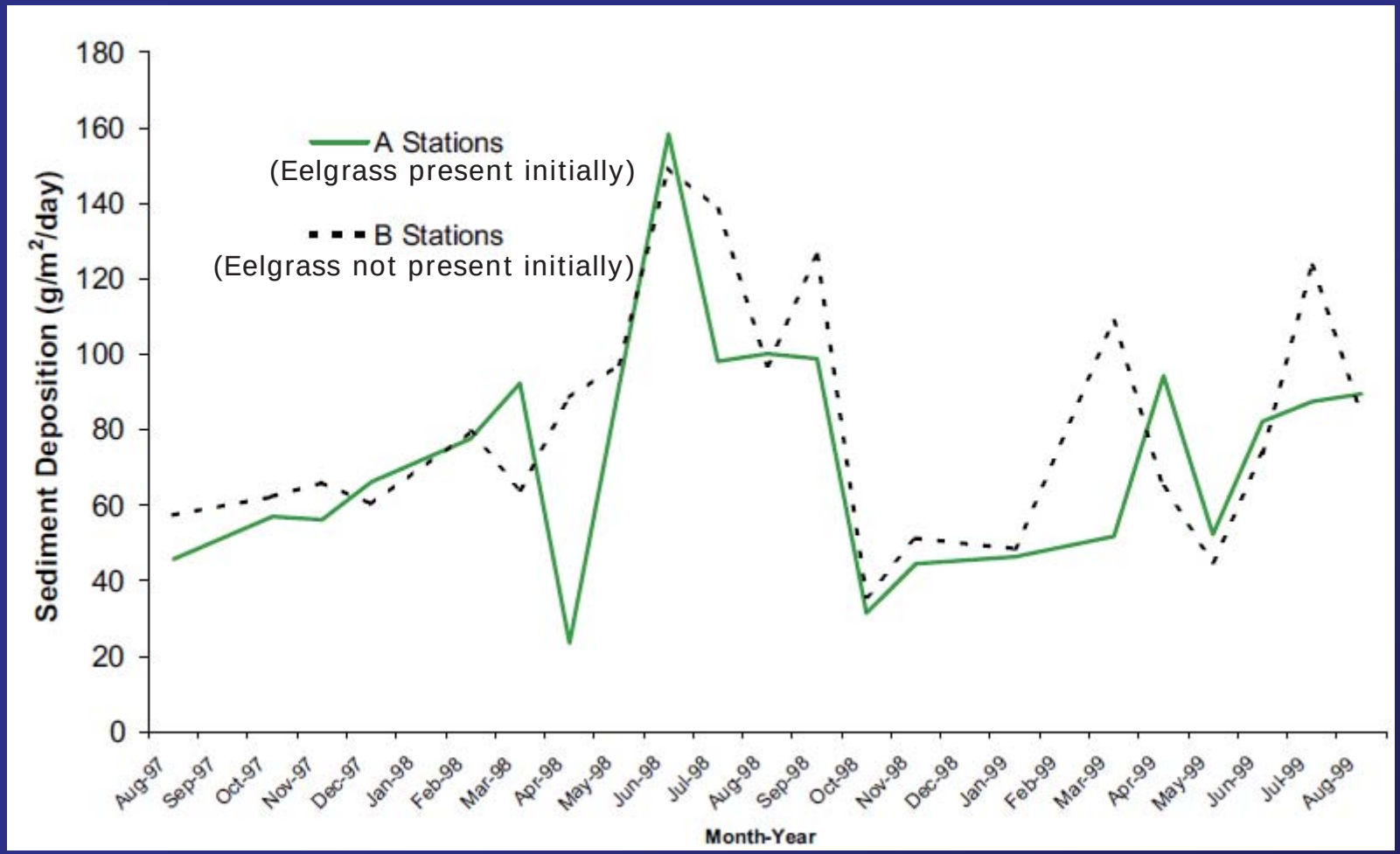
Physical Studies – Sediment Grain Size

- Grain Size Analysis (Merkel 2000)



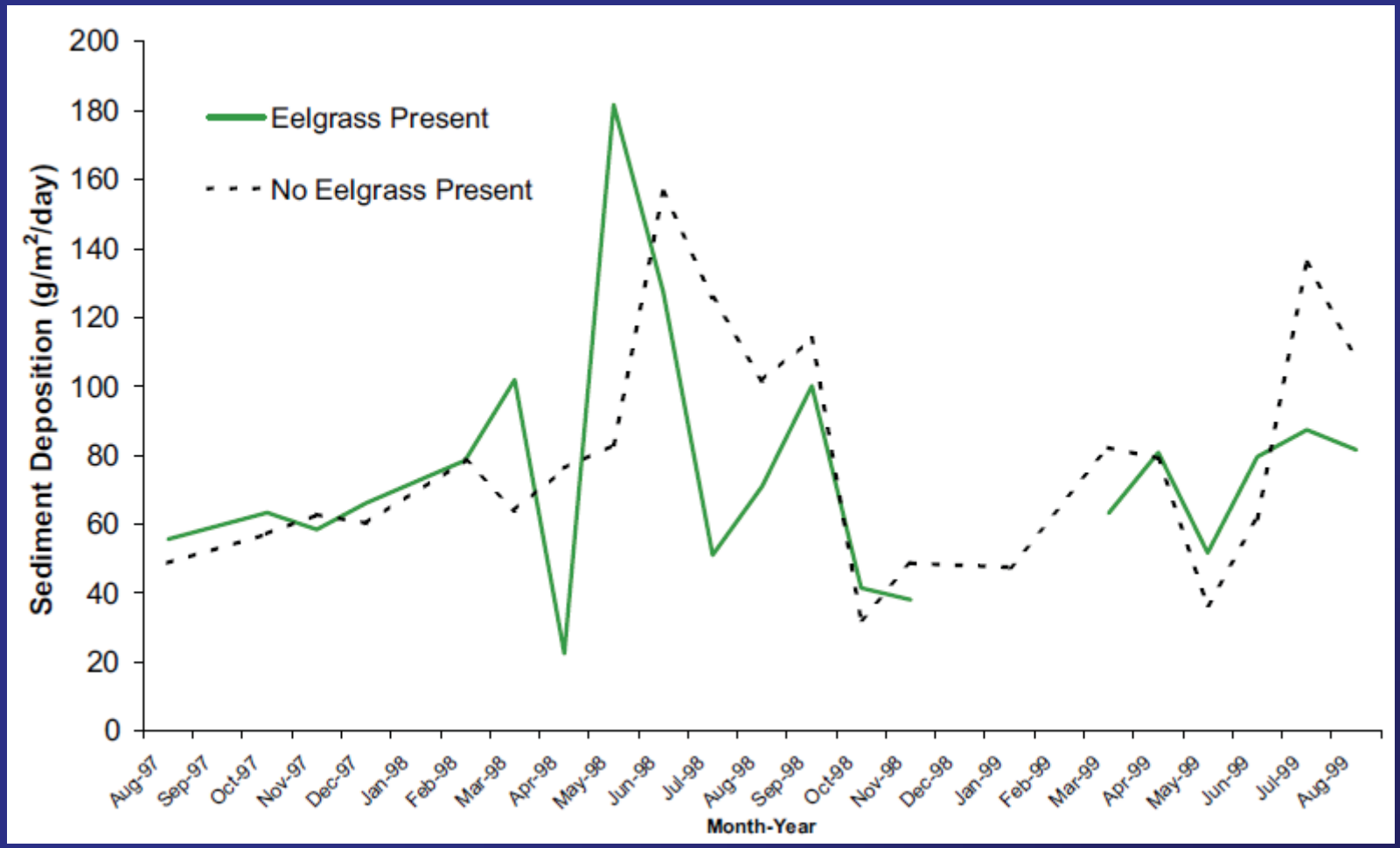
Physical Studies – Sediment Deposition

- Sediment Deposition (Merkel 2000)



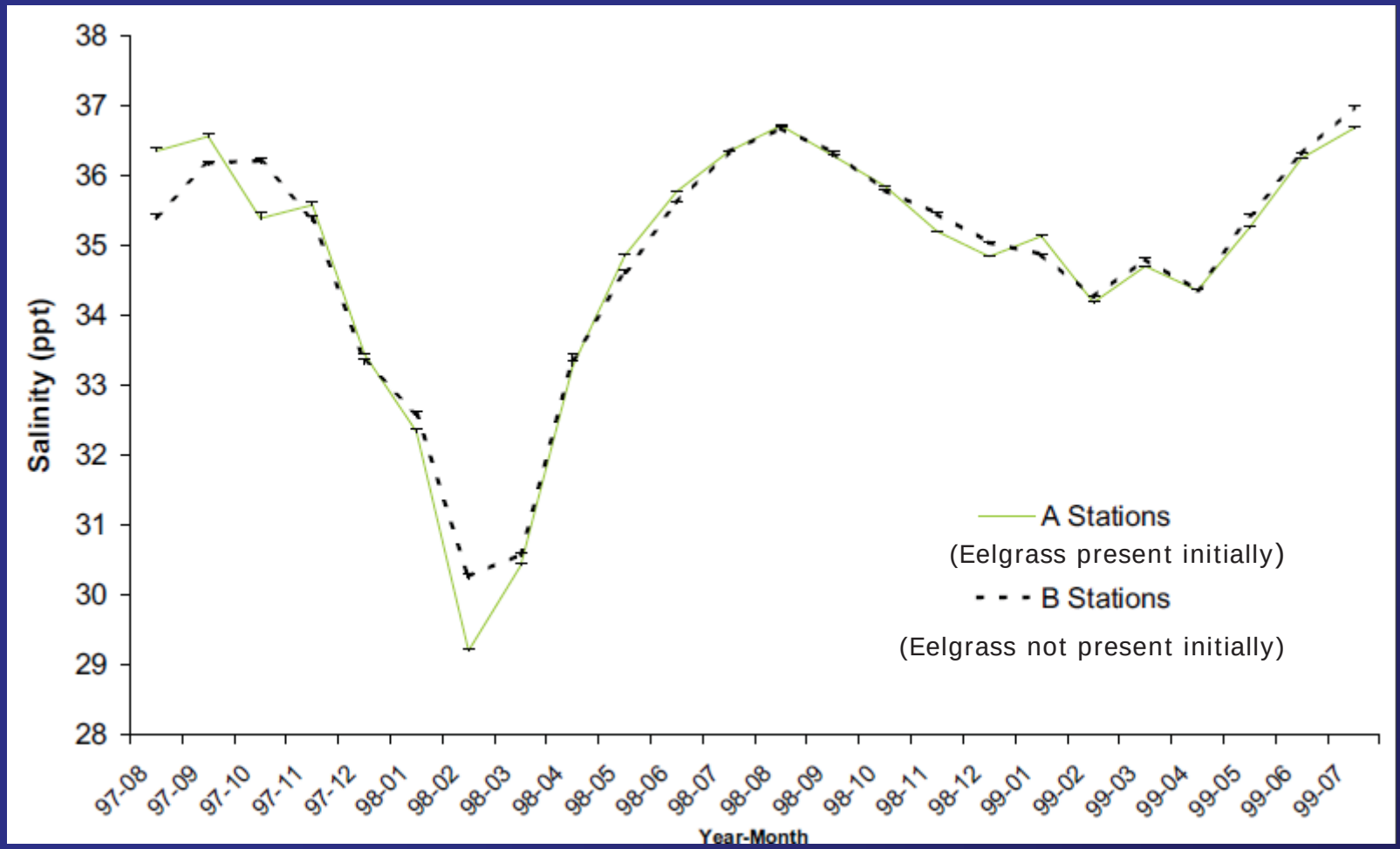
Physical Studies – Sediment Deposition

- Sediment Deposition (Merkel 2000)



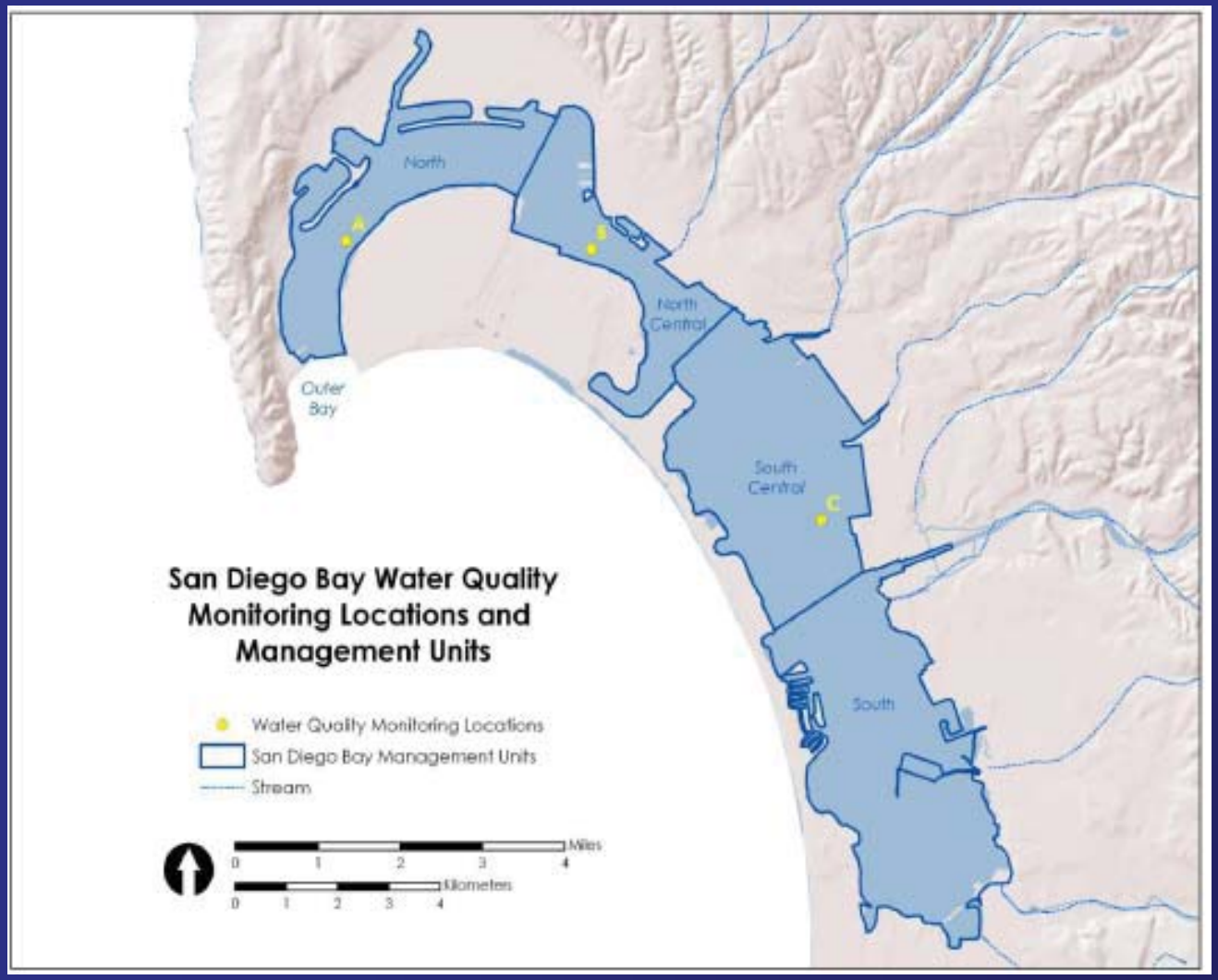
Physical Studies - Salinity

- Salinity (Merkel 2000)



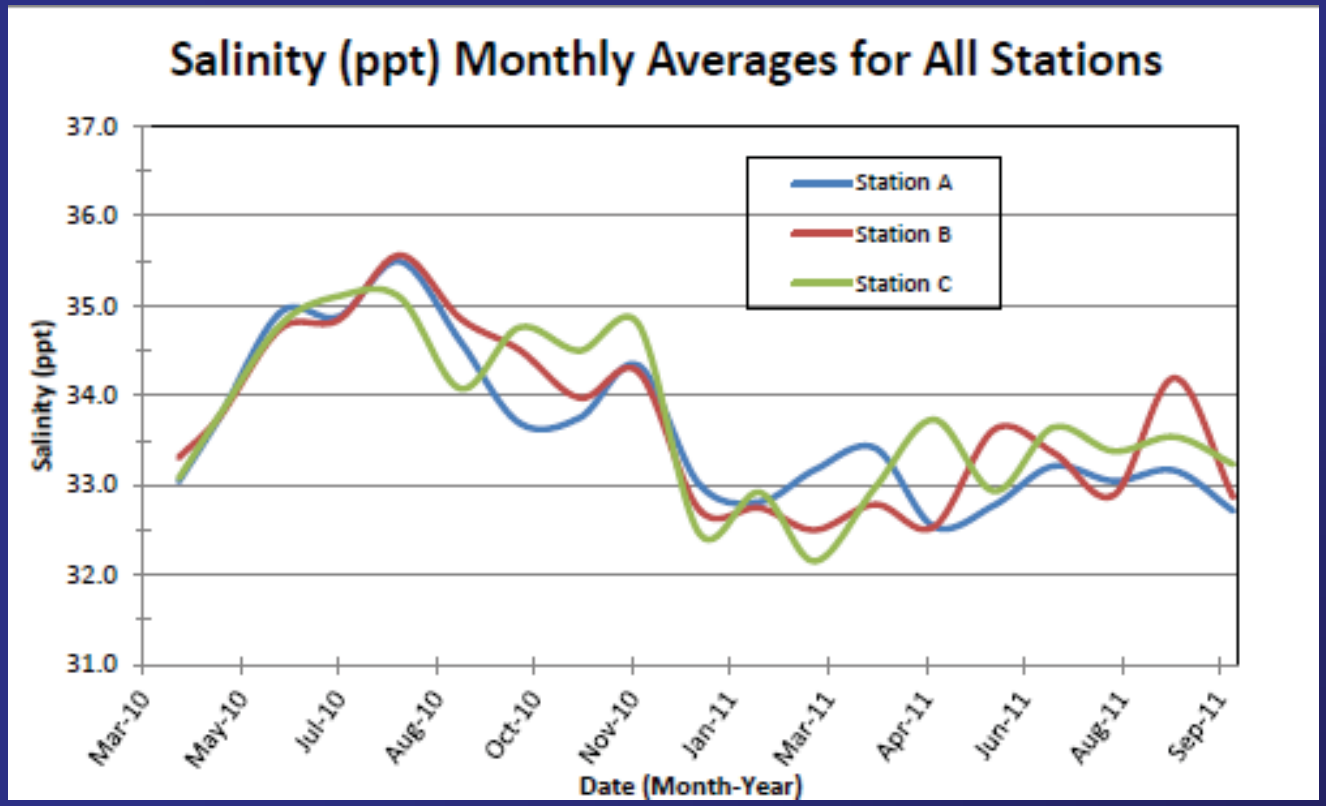
Physical Studies - DATA

- Salinity (Tierra Data 2012)

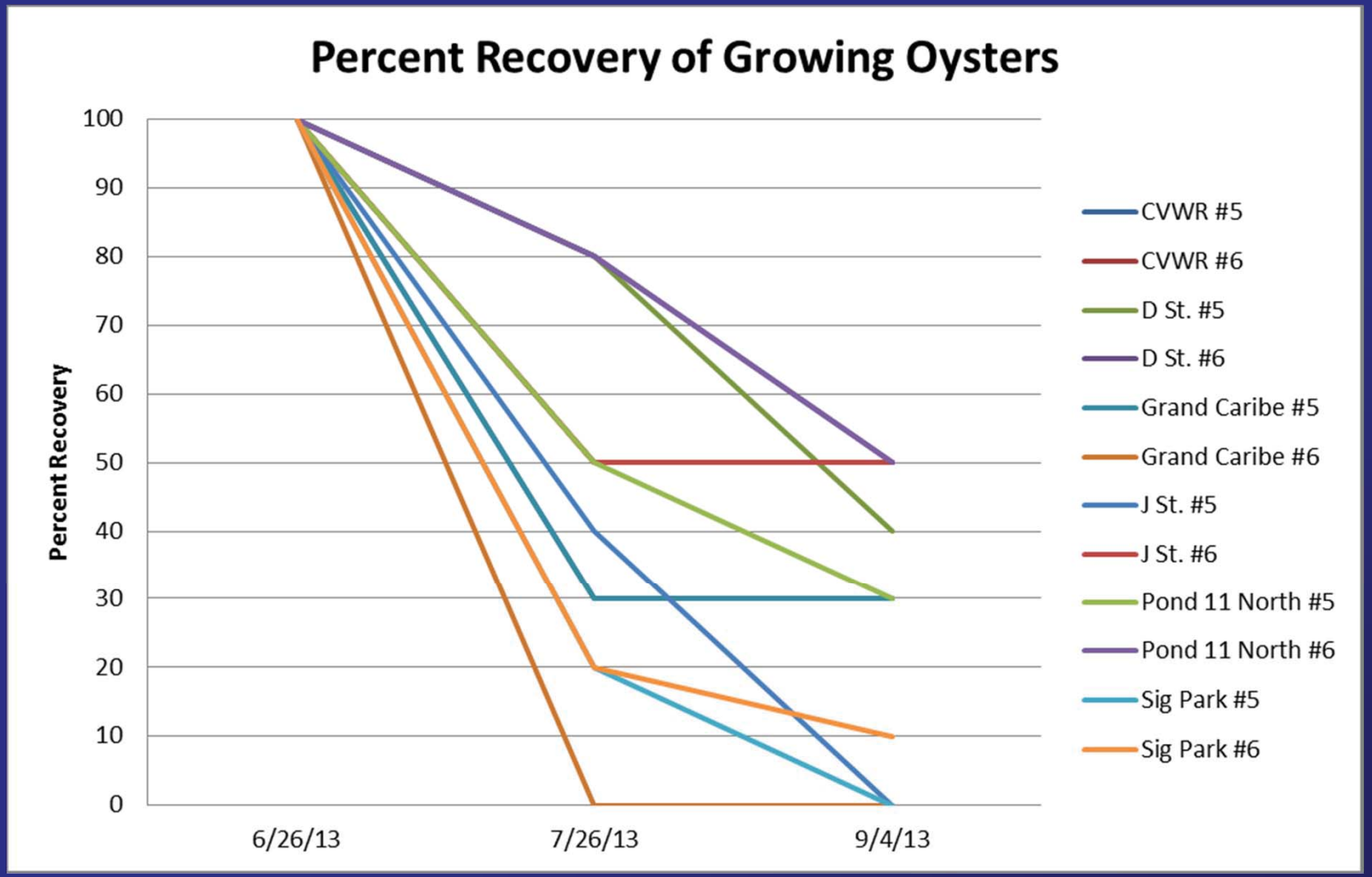


Physical Studies - DATA

- Salinity (Tierra Data 2012)



Percent Recovery



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e-mail: associates@merkelinc.com

Environmental Shoreline Erosion Protection
Demonstration Project Contract 55724
Quarterly Progress Report No. 12
Quarter ending August 31, 2012

DESCRIPTION OF WORK COMPLETED

- Final edits to Year 1 monitoring report

CUMULATIVE DOLLAR COSTS INCURRED

$106,964.49 (before 25% matching funds deduction. $80,223.36 of project budget)

ANTICIPATED WORK FOR NEXT QUARTER

- No additional work will occur until after the end of the tern breeding season (September 15).

PERCENTAGE OF WORK COMPLETE

41%

EXPECTED COMPLETION DATE FOR REMAINING WORK

All work, including Project Final Report, will be completed on or before August 31, 2014

PROBLEM AREAS/ISSUES THAT MAY AFFECT PROJECT COST AND/OR SCHEDULE

No issues thus far.

Keith W. Merkel
Principal Consultant

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e-mail: associates@merkelinc.com

Environmental Shoreline Erosion Protection
Demonstration Project Contract 55724
Quarterly Progress Report No. 13
Quarter ending November 30, 2012

DESCRIPTION OF WORK COMPLETED

- No work conducted during this quarter

CUMULATIVE DOLLAR COSTS INCURRED

$106,964.48 (before 25% matching funds deduction. $80,223.36 of project budget)

ANTICIPATED WORK FOR NEXT QUARTER

PERCENTAGE OF WORK COMPLETE

41%

EXPECTED COMPLETION DATE FOR REMAINING WORK

All work, including Project Final Report, will be completed on or before August 31, 2014

PROBLEM AREAS/ISSUES THAT MAY AFFECT PROJECT COST AND/OR SCHEDULE

No issues thus far.

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Environmental Shoreline Erosion Protection
Demonstration Project Contract 55724
Quarterly Progress Report No. 14
Quarter ending February 28, 2013

DESCRIPTION OF WORK COMPLETED

- Preparation for March monitoring work

CUMULATIVE DOLLAR COSTS INCURRED

$107,071.49 (before 25% matching funds deduction. $80,303.61 of project budget)

ANTICIPATED WORK FOR NEXT QUARTER

- Monitoring/assessment of treatments and plantings.

PERCENTAGE OF WORK COMPLETE

41%

EXPECTED COMPLETION DATE FOR REMAINING WORK

All work, including Project Final Report, will be completed on or before August 31, 2014

PROBLEM AREAS/ISSUES THAT MAY AFFECT PROJECT COST AND/OR SCHEDULE

No issues thus far.

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Environmental Shoreline Erosion Protection
Demonstration Project Contract 55724
Quarterly Progress Report No. 15
Quarter ending May 31, 2012

DESCRIPTION OF WORK COMPLETED

- Monitoring/assessment of treatments and plantings

CUMULATIVE DOLLAR COSTS INCURRED

$112,172.24 (before 25% matching funds deduction. $84,129.18 of project budget)

ANTICIPATED WORK FOR NEXT QUARTER

- Preparation of Year 2 monitoring report

PERCENTAGE OF WORK COMPLETE

44%

EXPECTED COMPLETION DATE FOR REMAINING WORK

All work, including Project Final Report, will be completed on or before August 31, 2014

PROBLEM AREAS/ISSUES THAT MAY AFFECT PROJECT COST AND/OR SCHEDULE

No issues thus far.

Keith W. Merkel
Principal Consultant

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Environmental Shoreline Erosion Protection
Demonstration Project Contract 55724
Quarterly Progress Report No. 16
Quarter ending August 31, 2013

DESCRIPTION OF WORK COMPLETED

- Preparation of Year 2 monitoring report
- Scope of contract changed to focus on living shoreline oyster reef
- Contract end date extended to August 31, 2015
- Oyster settlement, growth, and distribution sites implemented at six sites in South San Diego Bay
- Collection and analysis of historic oyster data for San Diego Bay

CUMULATIVE DOLLAR COSTS INCURRED

$142,320.65 (before 25% matching funds deduction. $106,740.49 of project budget)

ANTICIPATED WORK FOR NEXT QUARTER

- Address any comments to Year 2 monitoring report
- Analyze field data collected in oyster settlement, growth, and distribution studies
- Prepare 2-D model to predict wave energies in San Diego Bay

PERCENTAGE OF WORK COMPLETE

55%

EXPECTED COMPLETION DATE FOR REMAINING WORK

All work, including Project Final Report, will be completed on or before August 31, 2015

PROBLEM AREAS/ISSUES THAT MAY AFFECT PROJECT COST AND/OR SCHEDULE

No issues thus far.

Keith W. Merkel
Principal Consultant

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Environmental Shoreline Erosion Protection
Demonstration Project Contract 55724
Quarterly Progress Report No. 17
Quarter ending November 30, 2013

DESCRIPTION OF WORK COMPLETED

- Analyzed field data collected in oyster settlement, growth, and distribution studies
- Prepared 2-D model to predict wave energies in San Diego Bay

CUMULATIVE DOLLAR COSTS INCURRED

$133,280.73 of project budget

ANTICIPATED WORK FOR NEXT QUARTER

- Prepare for and conduct first Technical Advisory Committee (TAC) meeting. Data presented to include preliminary results from oyster settlement, growth, and distribution studies, as well as 2-D wave energy model and presentation of historic oyster distribution data
- Select potential oyster reef restoration sites
- Deploy wave gauges at potential restoration sites

PERCENTAGE OF WORK COMPLETE

69%

EXPECTED COMPLETION DATE FOR REMAINING WORK

All work, including Project Final Report, will be completed on or before August 31, 2015

PROBLEM AREAS/ISSUES THAT MAY AFFECT PROJECT COST AND/OR SCHEDULE

No issues thus far.

Keith W. Merkel
Principal Consultant