Compatibility of High-Fines Sediments with Beach Replenishment: Results of the Tijuana Estuary Sediment Fate and Transport Project

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Western Dredging Association
2010 Pacific Chapter Annual Conference
Monterey, California

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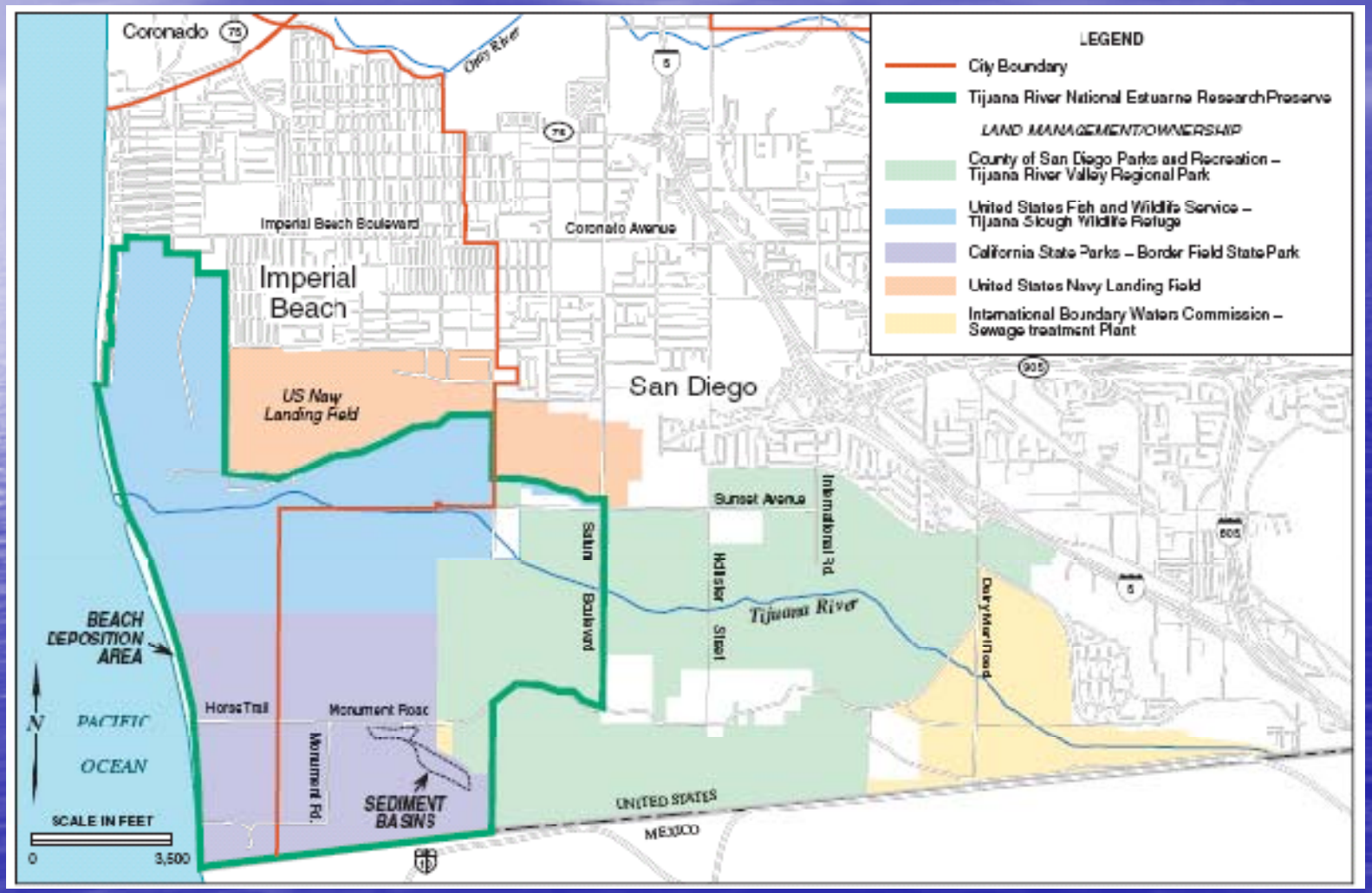
Tijuana River Watershed



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Project Partners

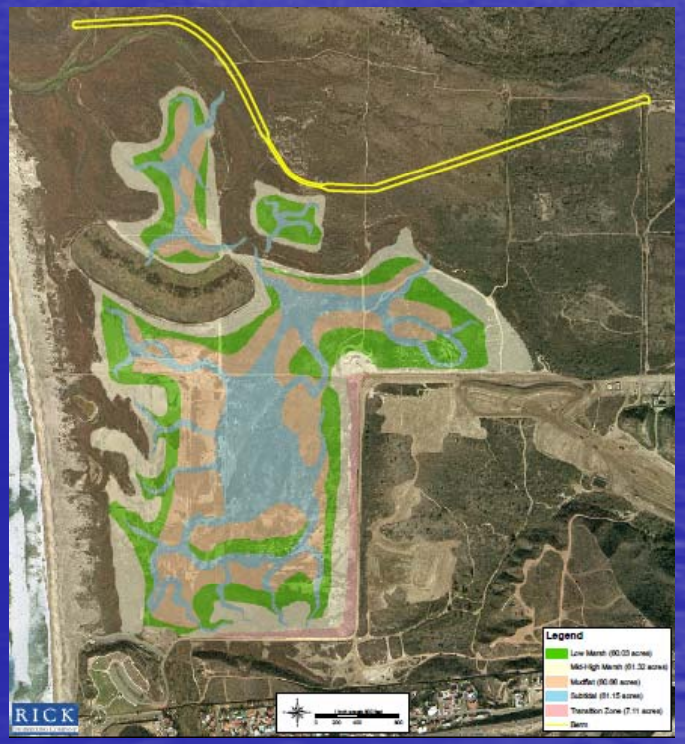
- **Government Agencies:**
  - California Coastal Conservancy
  - California Ocean Protection Council (OPC)
  - U.S. Geological Survey (USGS)
  - California Department of Boating and Waterways (DBW)
  - U.S. Army Corps of Engineers
  - California Sediment Management Workgroup (CSMW)
  - California State Parks - Border Field S.P.
  - NOAA Tijuana Estuary National Research Reserve
  - U.S. Environmental Protection Agency (EPA)
  - San Diego Regional Water Quality Control Board (RWQCB)
  - California Coastal Commission
  - U.S. Fish and Wildlife

- **Academic Partners/Collaborators**
  - Scripps Institute of Oceanography (SIO)
  - University of California, Santa Cruz (UCSC)

- **Private Sector and Non-Profits**:
  - Moffatt & Nichol Engineers
  - Southwest Wetlands Interpretive Association (SWIA)
  - Nordby Biological Consulting
  - AMEC Earth & Environmental
  - Diamond Lane Contractors
  - Ocean Imaging Corp.
  - CoastalCOMS
  - Deltares

Sources of Fines

- Tijuana River Discharge
- Border Canyon Flows (Smuggler's Gulch, Yogurt Canyon)
- Goat Canyon (with retention basins)
- Tijuana River Tidal Restoration Program



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Sediment Management: the Fate of Fines

- Association with Contaminants, Nutrients
- Turbidity Impacts
- Compatibility with Disposal Site Characteristics
- Constraint: the 80:20 ‘Rule of Thumb’
- Limited Quantitative Understanding of the Fate of Fines in the Environment

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Objective: A Comparison:

"Natural" Placement

Direct Placement

- What are the Pathways of Fine Sediment in the Nearshore?
- Are there Biological Impacts as a result of DP?

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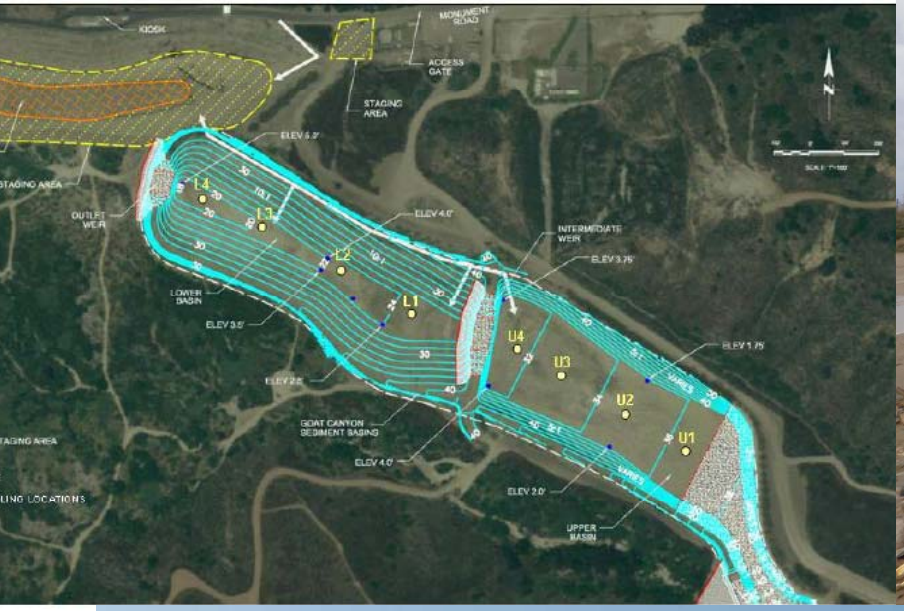

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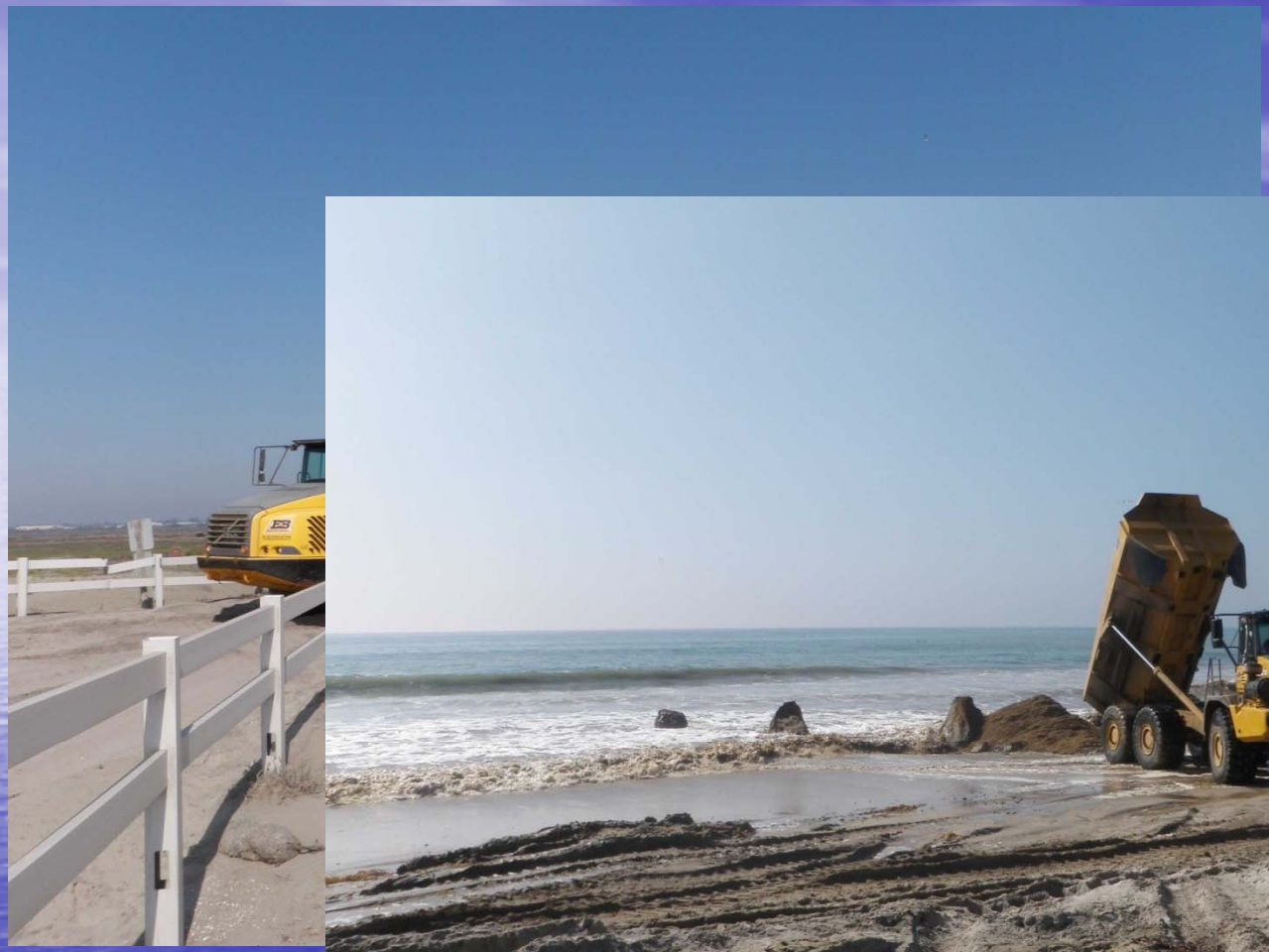

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Monitoring Components

- Sediment Quality (ITM)
- Environmental Quality (CEQA/NEPA)
- Construction Monitoring
- Water Quality Monitoring
- Biological Resource Monitoring

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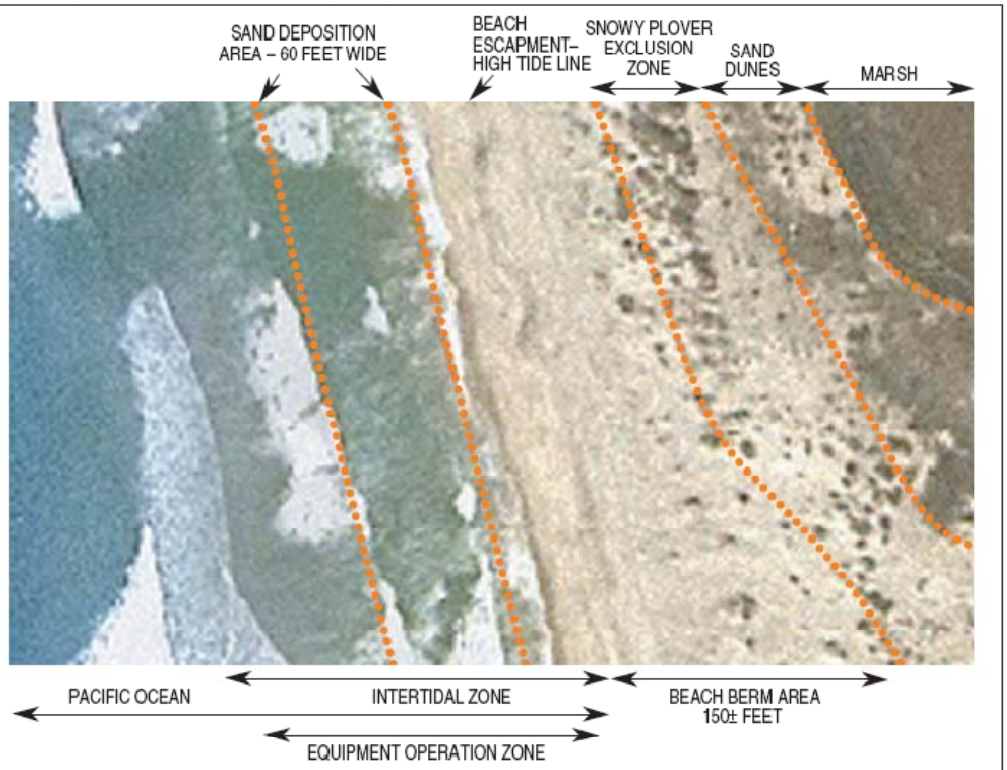

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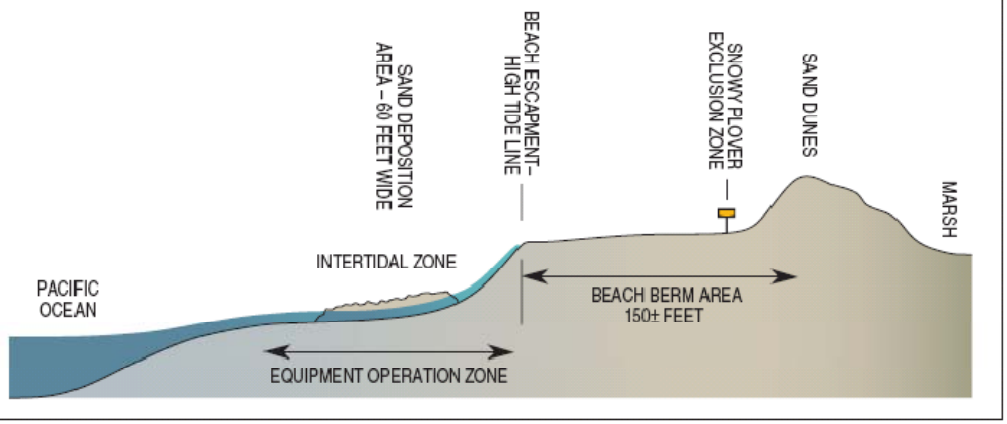

View to North (active placement)

View to South (24 hrs post-placement)

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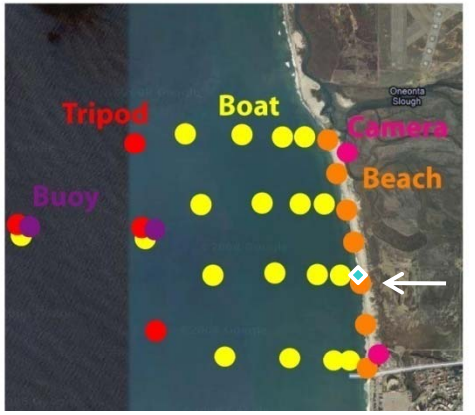
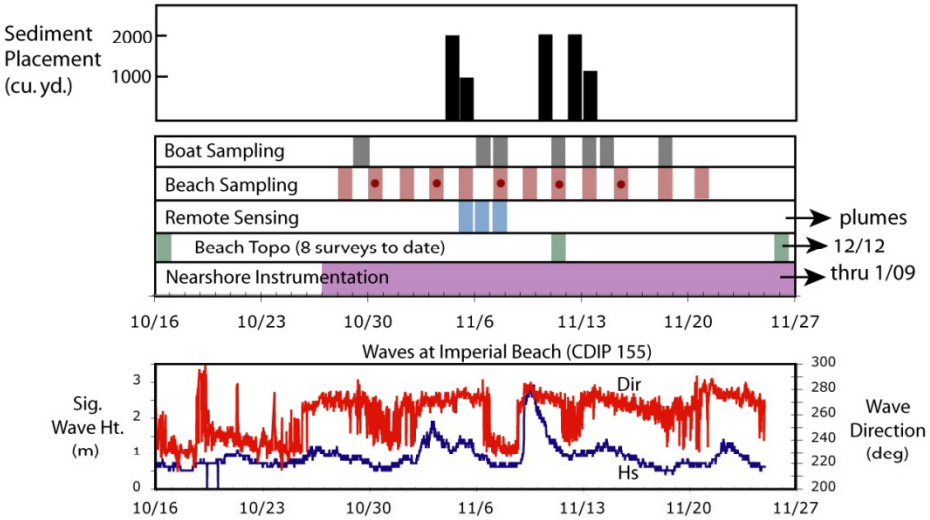
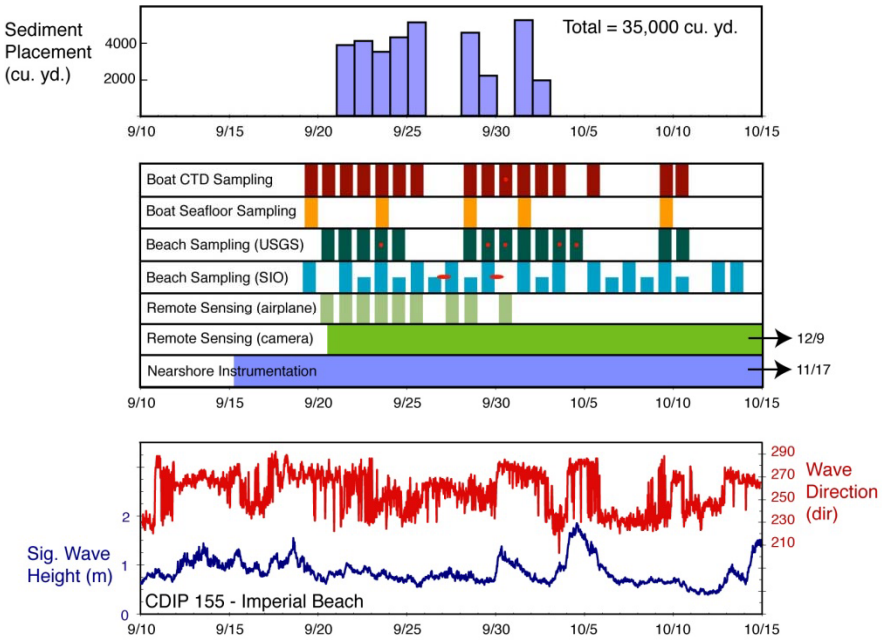
Water Quality Monitoring



2008 10,000 cubic yards



2009 35,000 cubic yards

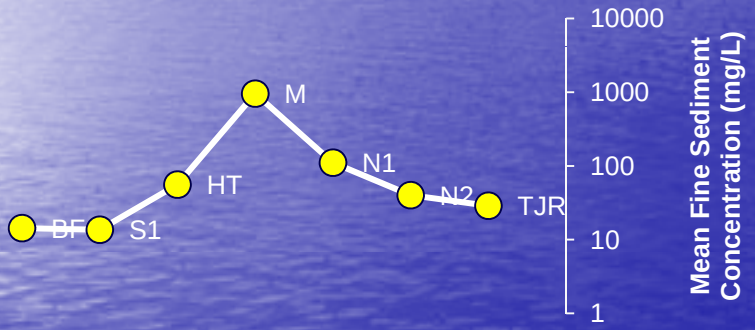


Surfzone Turbidity

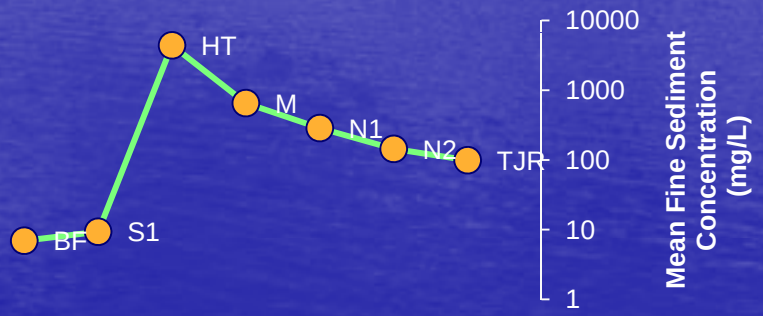
How turbid does the surfzone get?
How far does the turbidity extend?
How persistent is this turbidity?

SurfzoneTurbidity

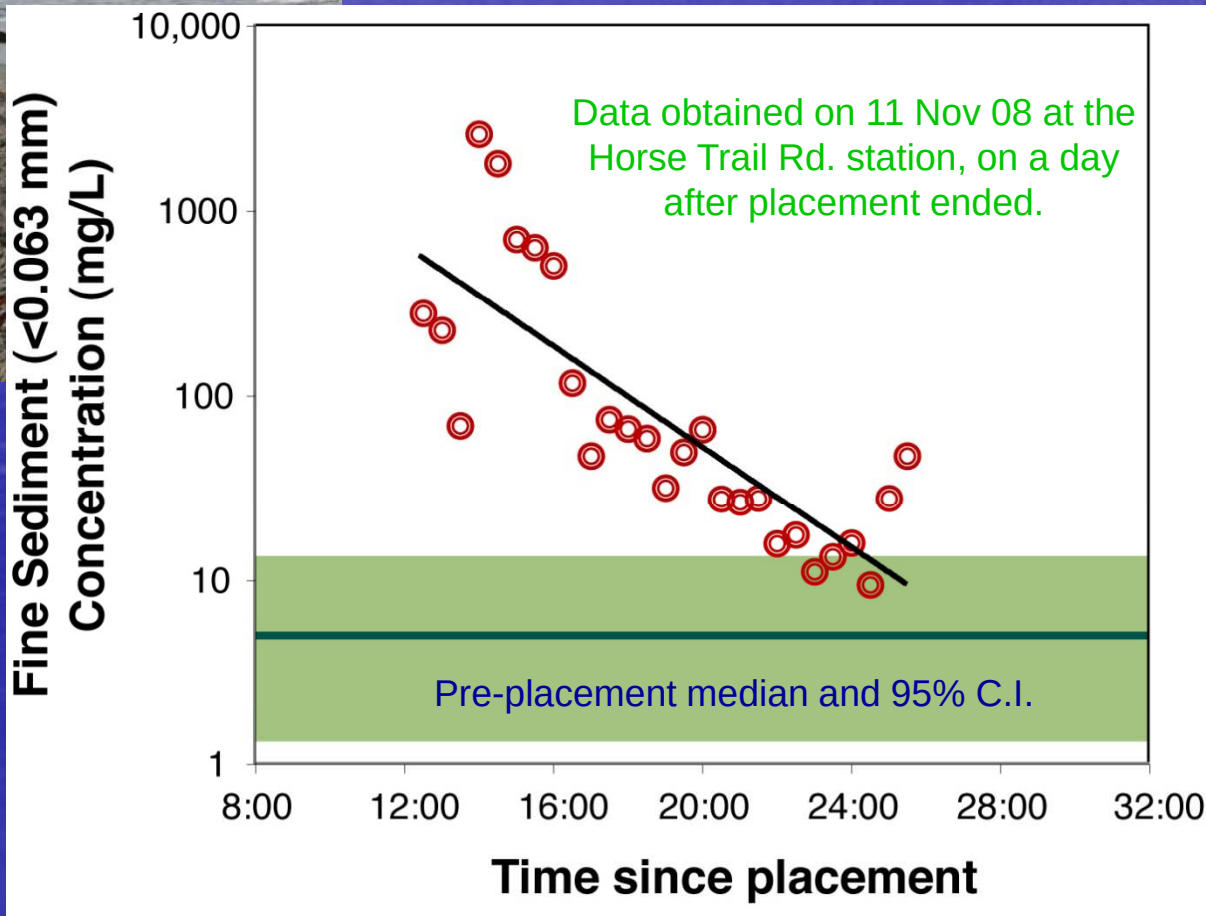
Mean Fine Css (mg/L)



Mean Fine Css (mg/L)



Surfzone Turbidity - Post Placement



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Nearshore Turbidity

Nearshore conditions measured with:
-Remote sensing imagery,
-Boat samples,
-Fixed oceanographic sensors

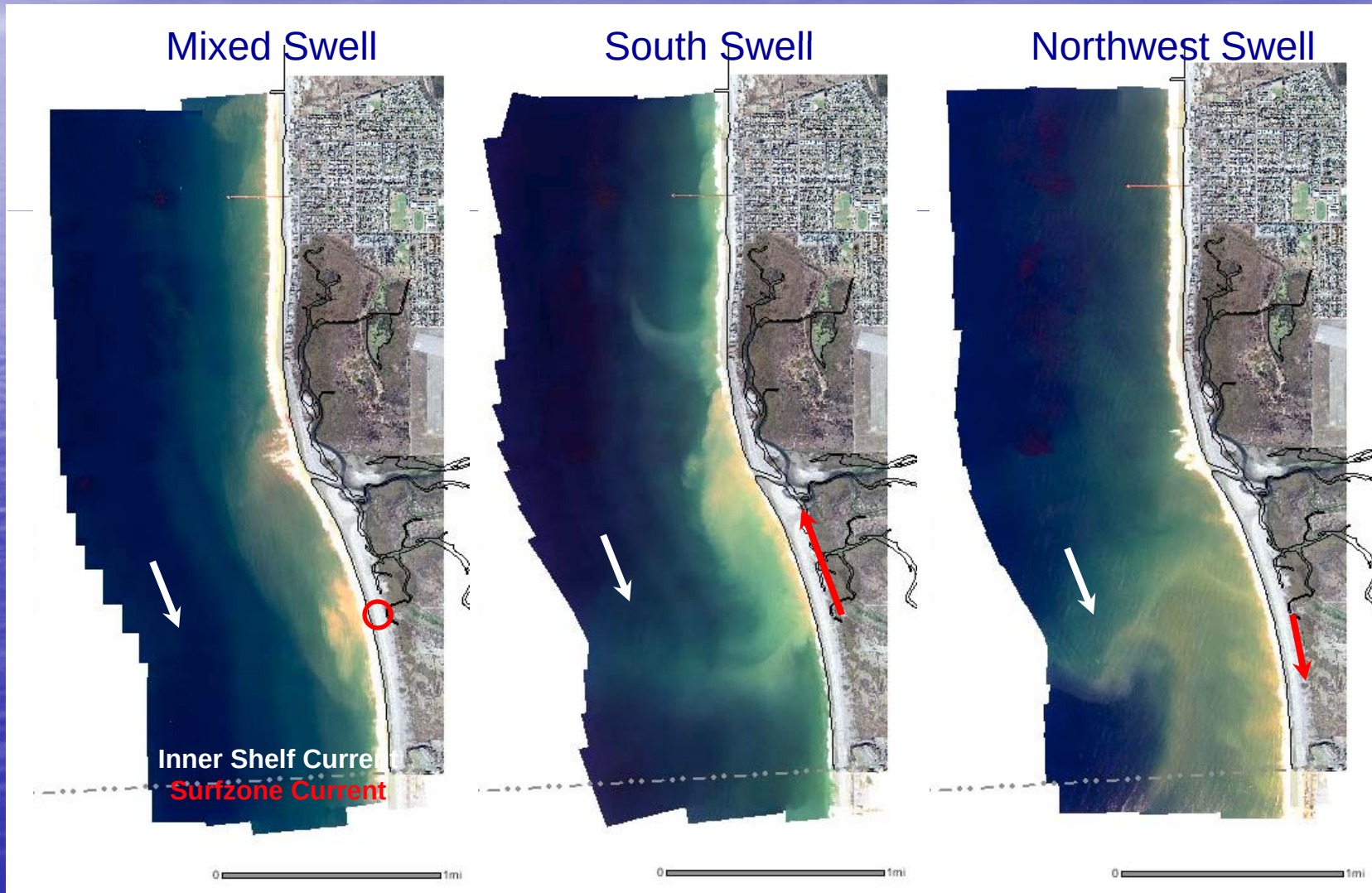
"Native" Turbidity from the Tijuana Estuary

Ocean Imaging

Remote sensing imagery from
Ocean Imaging Corp. on 20 Sept 2009
- one day BEFORE the sediment placement.

Nearshore Turbidity

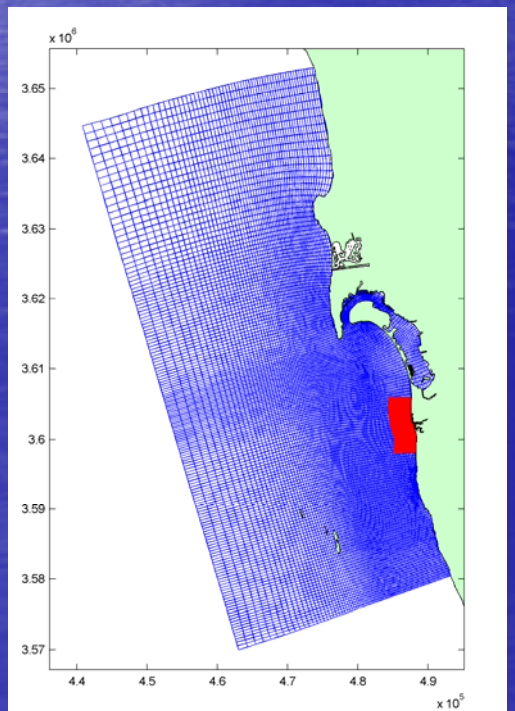
The influence of **wave direction** on the turbid plume during 2009 Tijuana Fate and Transport Project Remote Sensing by **Ocean Imaging Corp**.

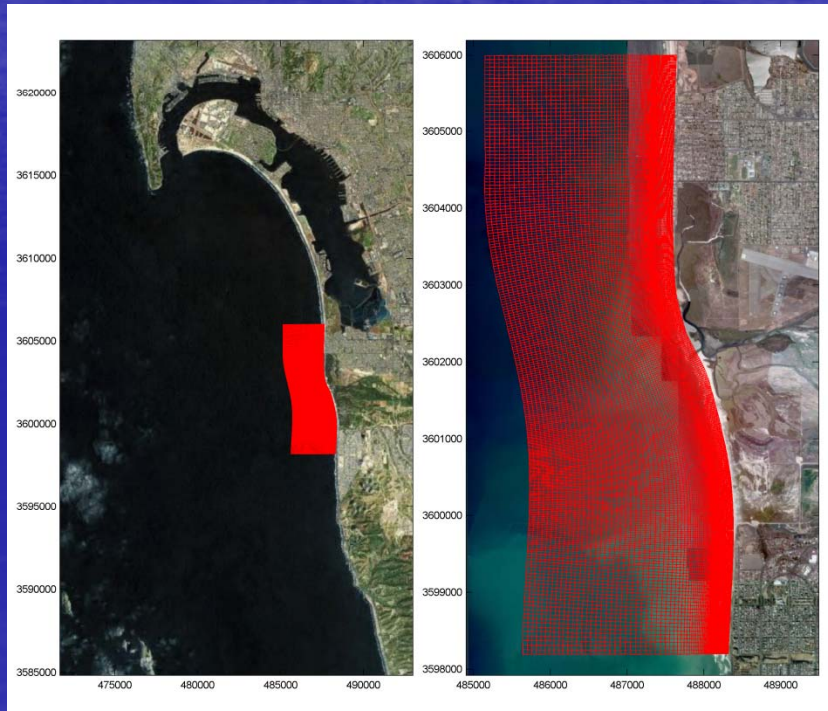


Collaborative numerical modeling with Deltares (Delft-3D model)

Primary Goal: How well can the numerical models reproduce the patterns observed during the TJ project?

Secondary Goal: What is the importance of grain size, placement rate, and physical setting on transport and fate of fine sediment?





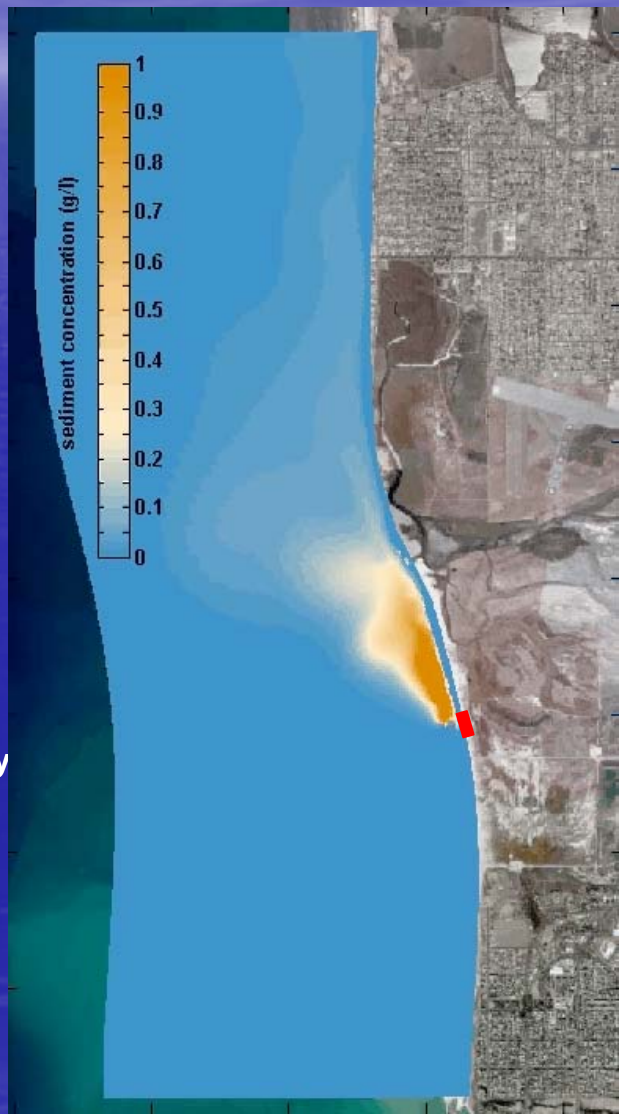
Collaborative numerical modeling with Deltares (Delft-3D model)

Here is what is included in the model:

2DH
Time varying fine sediment release at a point source
Fixed bed (no morphologic evolution, just transport of the released fines)
1 type of sediment (silt)
Time varying wave and wind (applied uniformly across the boundaries)
Astronomic tidal constituents on offshore boundary

This is what is being developed (fall 2010):

3D
Sensitivity Analyses
Estuarine pumping --> tidal/solar radiation/air temp
Heterogeneous sediment mixture
Fine sediment characteristics (density, wet-density, flocculation, settling velocity
Bed threshold thickness for transport
Infragravity motions (long waves)
Comparisons to ADCP data
Comparison to turbidity data



Comparison of Numerical Modeling and Remote Sensing

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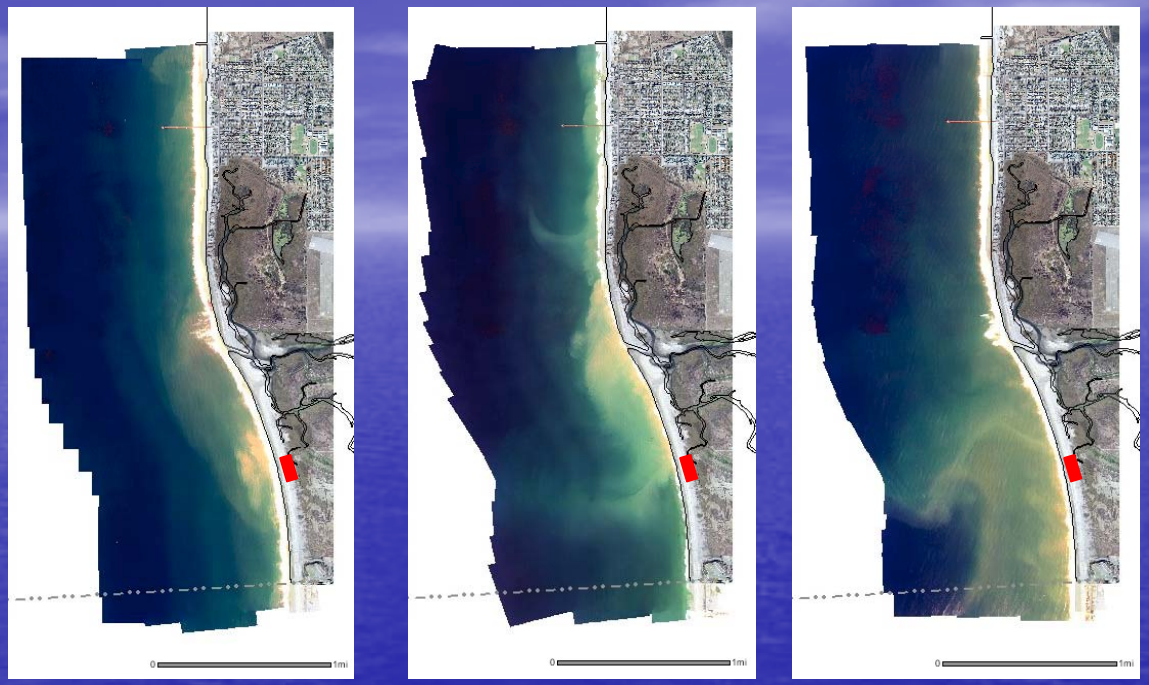
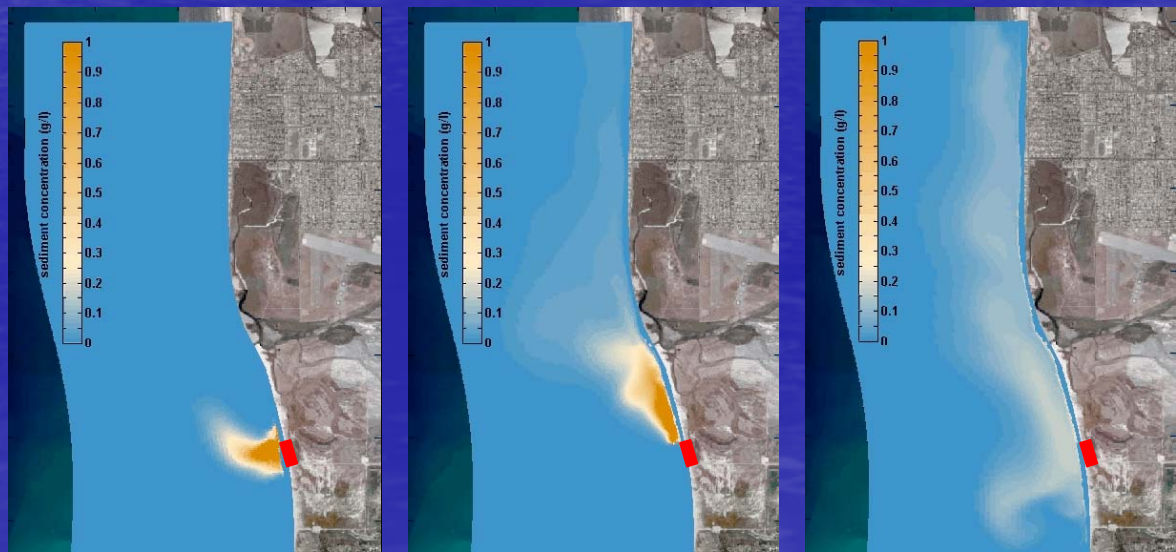
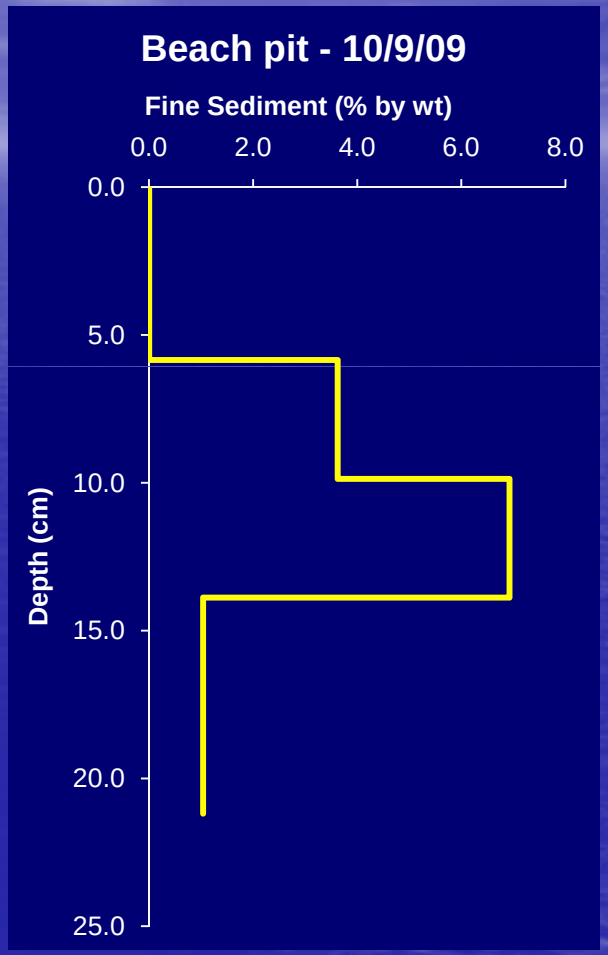
9.21.09 9.23.09 9.30.09





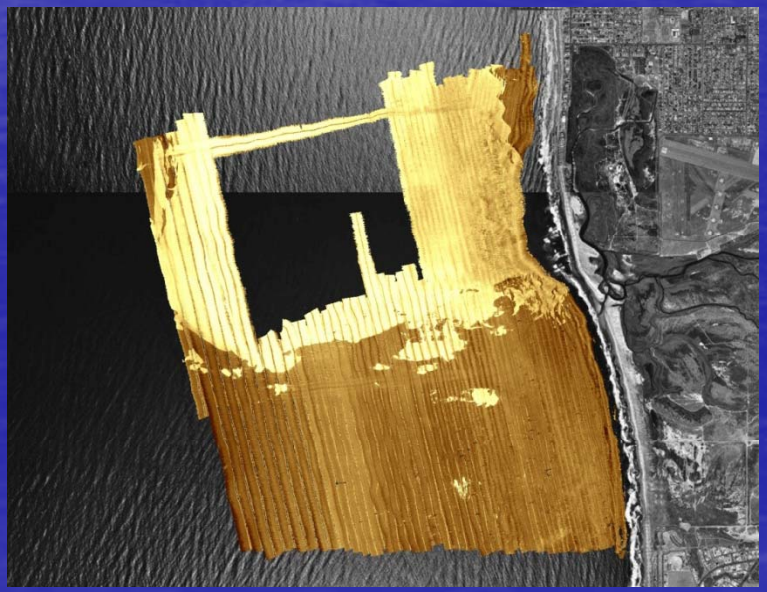
Post-Placement Beach



These fine sediment layers were **reworked** within 5 weeks after placement.

Biological Monitoring Objectives

- Are offshore sand dollar beds impacted by the sediment placement?
- Is the benthic macroinvertebrate fauna affected by sediment placement activities in the intertidal?



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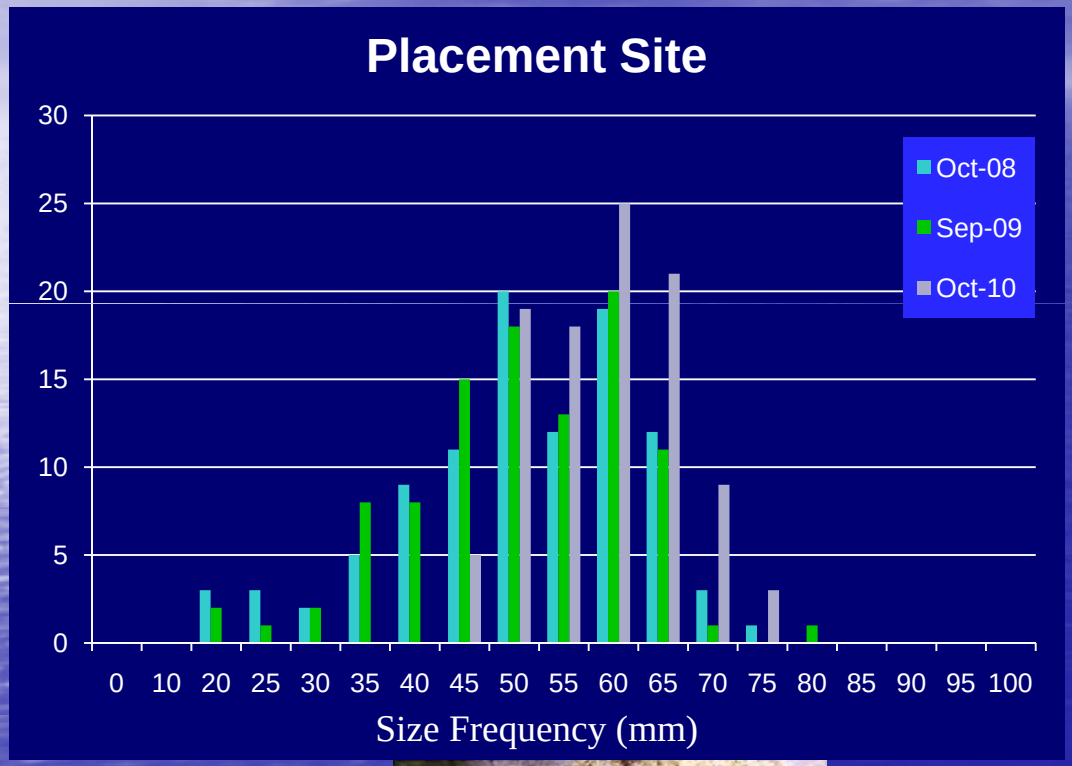
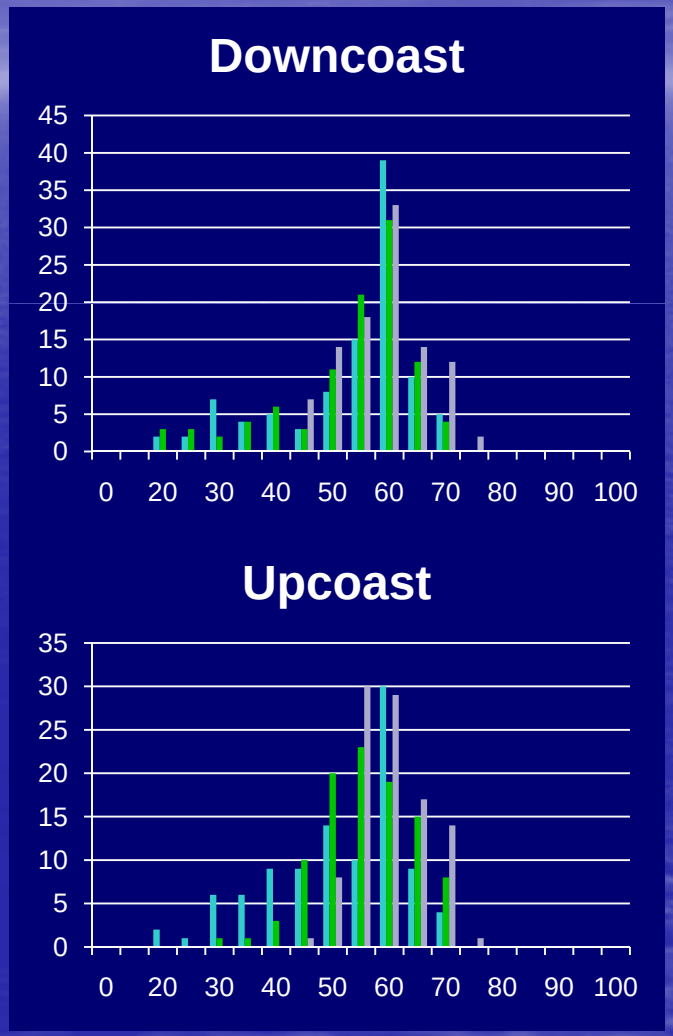
Sand Dollar Population





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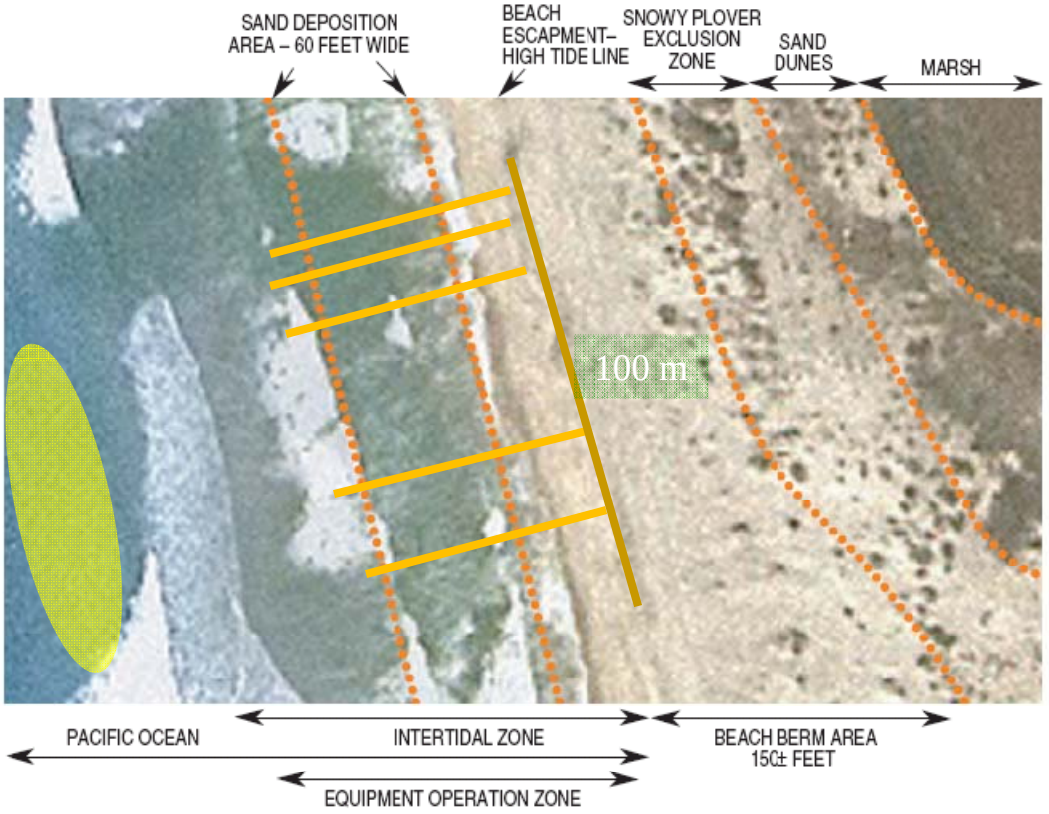

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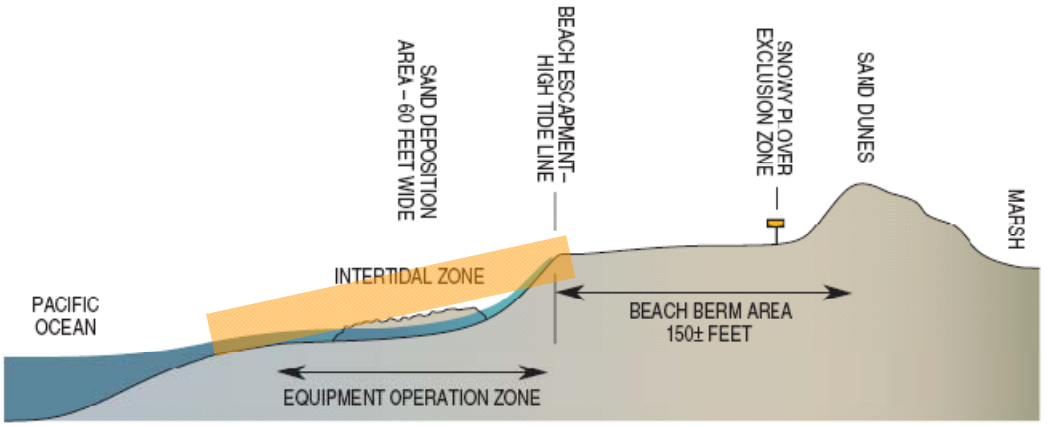

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Cool Vehicles on *Our* Beach

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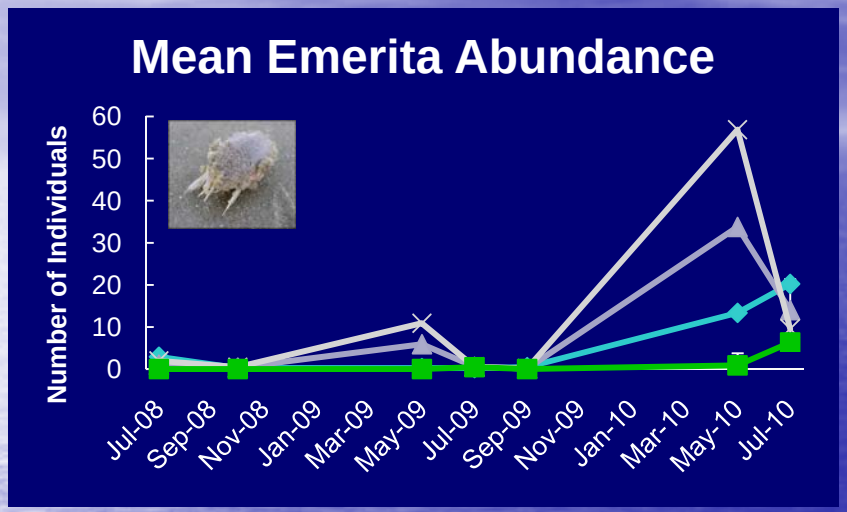
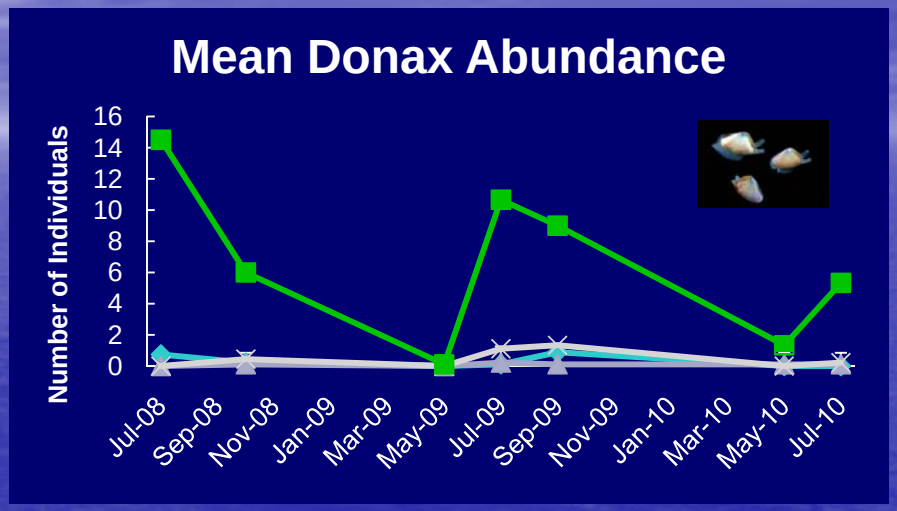
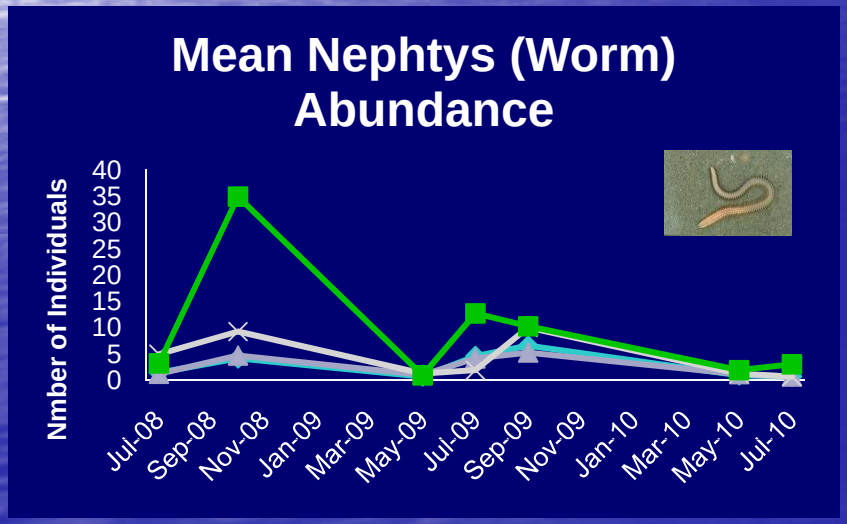
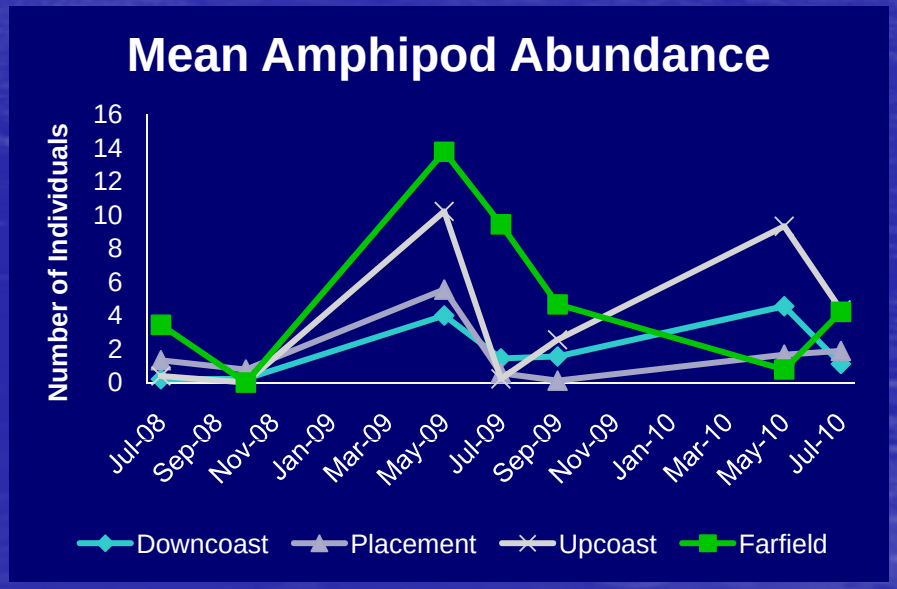
Intertidal Macroinvertebrates









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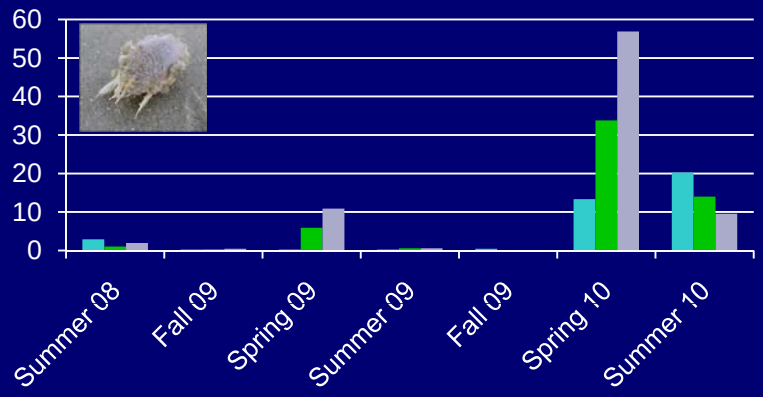
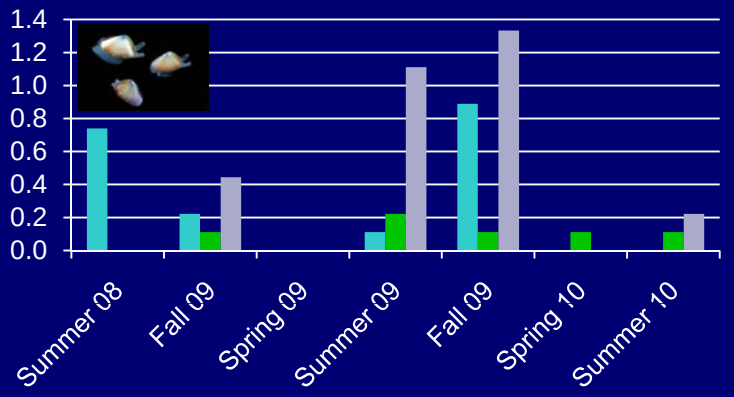
Intertidal Macroinvertebrates

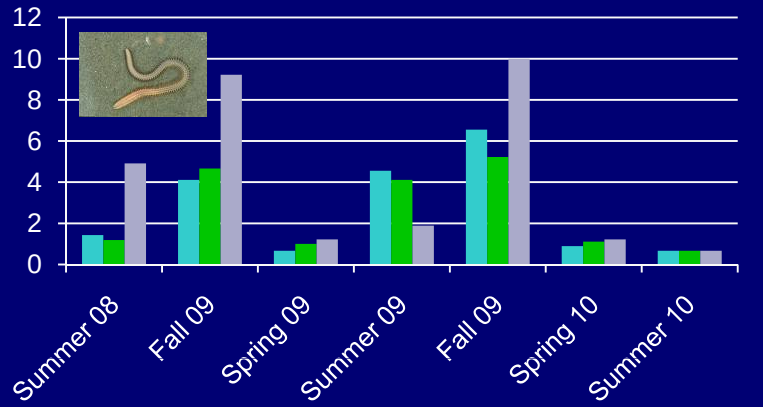
Emerita (Sand Crab)



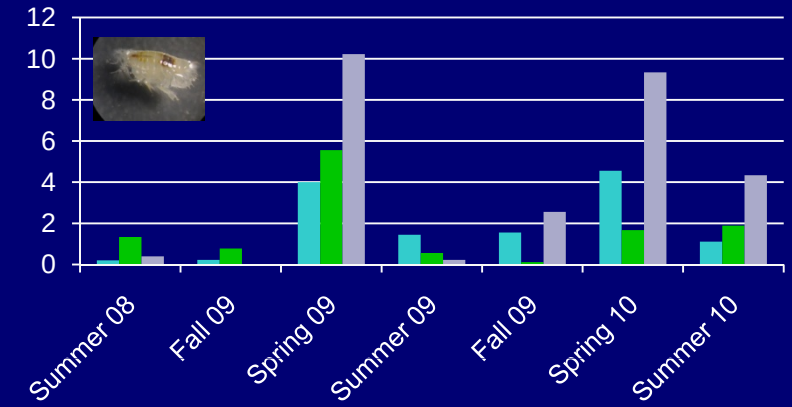
Donax (Bean Clam)



Nephtys (Shimmy Worm)



Amphipods (several spp.)



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Conclusions

1. Sediment dispersal related to physical conditions:

- Surfzone (initial) transport mimics **tracer** and is related to **waves** and **wave breaking angles**.
- Nearshore (secondary) transport is related to **sediment settling**, **coastal currents**, and **suspension by waves**.

2. Simple numerical model captures much of the dispersal patterns of fines.

3. Biological Resources do not appear to be affected by the project

- Likely due to **high natural variability** and resilience of the sandy intertidal community
- Subtidal communities studied also appear to be resilient to the addition of fines (within the limitations of the scope)

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Additional Efforts

1. **Additional Data Analysis using the Delft 3-D Model to identify deposition and persistence of fines on the seafloor.**

2. **Additional assessment of the intertidal invertebrate data to tease out potential factors affecting populations such as predominance of kelp wrack, particle size distributions, and tidal zonation.**

3. **Ongoing coordination with the California Sediment Management Workgroup to identify appropriate options for the disposal of high-fines sediments in the nearshore environment.**

4. **Need for additional studies!**

5. **Upcoming publications will encourage application of 'lessons learned' to similar projects.**

Thank You! Questions?

Natural Processes

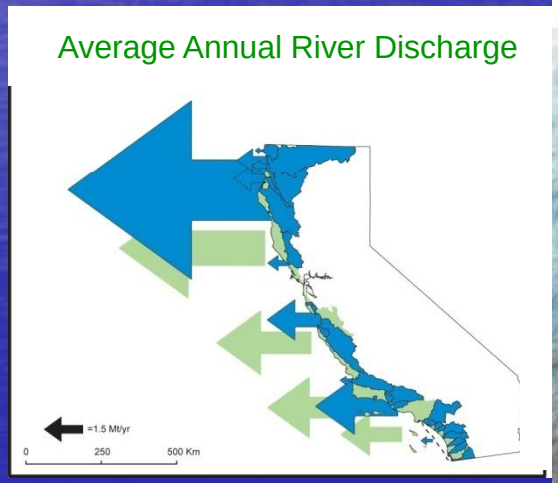
Annual Budget: 50 MCY

Sources of Coastal Sediments:

90% Rivers

9 % Coastal Erosion

1% Other



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