

# California Coastal Resilience Network Webinar: *Economic Impact of Climate Adaptation Strategies for Southern Monterey Bay*



MAY 26, 2016



PLEASE MUTE  
YOUR LINE!

INTERACTIVE  
WEBINAR –  
PLEASE  
PARTICIPATE

SPEAK OR TYPE  
QUESTIONS



PRESS \*6 TO MUTE

PRESS #6 TO UNMUTE

## What

## Time

### 1. Open & Updates

10:00 – 10:10

- Coastal Armoring Data
- Impacts of Desalination
- Network Website & Pledge

### 2. Presentation by:

10:10 – 11:00

- Kelly Leo, TNC
- Bob Battalio, ESA
- Dr. Walter Heady, TNC
- Dr. Phil King, SFSU

### 3. Discussion & Q&A

11:00 – 11:25

### 4. Next Webinar & Close

11:25 – 11:30

**RESOURCES**

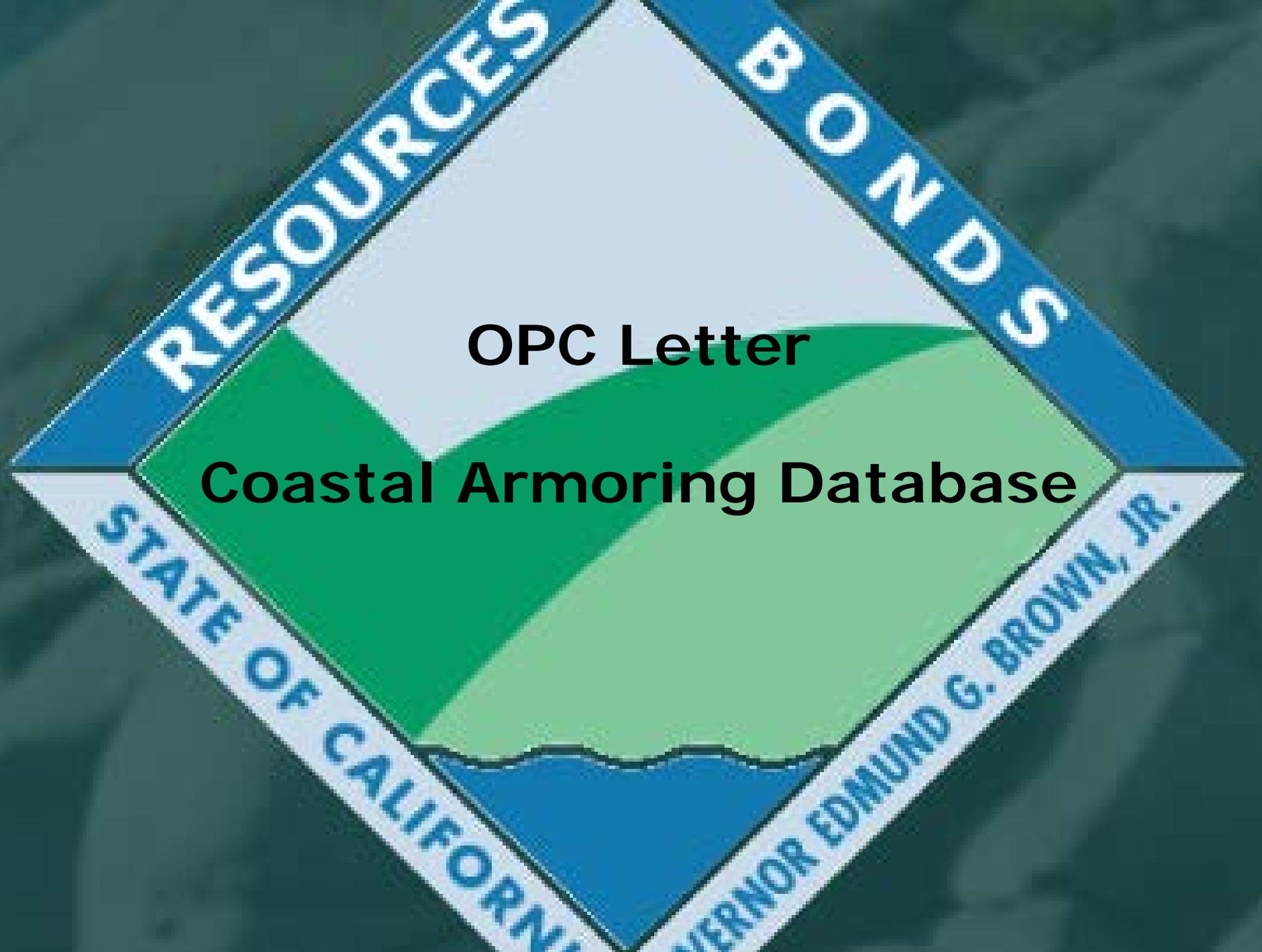
**BONDS**

**OPC Letter**

**Coastal Armoring Database**

**STATE OF CALIFORNIA**

**GVERNOR EDMUND G. BROWN, JR.**



How would an accurate coastal armoring data set be helpful for your work?



# Marine and Coastal Impacts of Ocean Desalination in California

Prepared by Water in the West, Center for Ocean Solutions, Monterey Bay Aquarium, The Nature Conservancy

May 2016





### CALIFORNIA

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## About

[BECOME A MEMBER](#)

### Mission

The California Coastal Resilience Network promotes knowledge exchange and policies that support adaptation solutions that strategically and comprehensively prepare California's coastal habitats and communities for climate induced impacts.

### Vision

The California Coastal Resilience Network envisions a resilient California coast, where habitats and communities are effectively prepared for adverse climate impacts through the coordinated action of an integrated network of coastal managers.

### What We Do

The Network is taking a coordinated approach to improving adaptation policies statewide for the protection and longevity of California's coastal habitats and communities.

To accomplish this, The California Network has identified the need for cross-cutting and coordinated policy action throughout California to facilitate the implementation of nature-based coastal climate change adaptation.

Network members recognize that they have diverse operational postures on policy: some groups can advocate, others can influence, and still others must be policy-neutral. However, they share several foundational goals in their coastal adaptation work and recognize that the Network would greatly benefit



## California Network

### CALIFORNIA

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## Events

See upcoming events. [See all events.](#)

MAY 26, 2016

Webinar: Economic Impacts of Climate Adaptation Strategies for Southern Monterey Bay

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JUN 15, 2016

Webinar: Social Vulnerability & Demographic Issues in Coastal Adaptation

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JUL 12, 2016

Webinar: City of Goleta's Coastal Hazards Vulnerability and Fiscal Impact Study

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[Archived Network Webinar Agendas, Recordings & Supplemental Materials](#)

# WEBINAR: SOCIAL VULNERABILITY & DEMOGRAPHIC ISSUES IN COASTAL ADAPTATION

**Jun 15, 2016**

The California Coastal Resilience Network will hear from two leading experts about how to best consider social vulnerability and demographics in coastal climate adaptation. Join us for a discussion of how best to incorporate these considerations into your climate adaptation work.

## Guest Speaker(s):



Nathan Wood, USGS



Susi Moser, Susanne Moser Research & Consulting

[Click here to download the Agenda](#)

WebEx Info:

[Join WebEx meeting](#)

<https://nethope.webex.com/nethope/j.php?MTID=m5011e6af0e9bbb7e784c93758e4aca95>

Meeting number: 828 162 940; Meeting password: Coastal123



## California Network

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## California

### CALIFORNIA COASTAL RESILIENCE NETWORK

[California Coastal Resilience Network Technical Report](#). 2014. The Nature Conservancy.

[Coastal Resilience Network California Adaptation Guidebook](#). 2015. The Nature Conservancy.

[Marine & Coastal Impacts of Ocean Desalination in California](#). 2016.

Szeptycki, L., E. Hartge, N. Ajami, A. Erickson, W. N. Heady, L. LaFeir, B. Meister, L. Verdone, and J.R. Koseff (2016). Marine and Coastal Impacts on Ocean Desalination in California. Dialogue report compiled by Water in the West, Center for Ocean Solutions, Monterey Bay Aquarium and The Nature Conservancy, Monterey, CA.

#### **Webinar Summaries & Related Resources:**

##### **2016**

May 26, 2016. CA CR Network Webinar: Economics of Climate Adaptation Strategies for Southern Monterey Bay

[Agenda](#).

[See Full Report](#).

June 15, 2016. CA CR Network Webinar: Social Vulnerability & Demographic Issues in Coastal Adaptation

[Agenda](#).

July 12, 2016. CA CR Network Webinar: City of Goleta, Coastal Hazard Vulnerability Assessment & Fiscal Impact Study

[Agenda](#).

[See Full Report](#).

August 17, 2016. CA CR Network Webinar: Using FEMA Hazard Mitigation Funding for Coastal Climate Adaptation.

[Agenda](#).

See Report: [Aligning Natural Resource Conservation and Flood Hazard Mitigation in CA](#) (Calil et al. 2015)

See Report: Stanford Policy Lab White Papers: [Nature Based Flood Solutions](#).

##### **2015**

July 2015. CA CR Network Transportation & the Coastal Habitat Squeeze Presentation. Summary.



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# Membership

## CA Coastal Resilience Network Learning Exchange Membership

Individuals or organizations can become a Learning Exchange Member by subscribing to the CA Coastal Resilience Network electronic email list. Learning Exchange members receive notifications about Network activities and can participate on monthly Network webinars. Network webinar topics are selected by Network members and feature experts presenting cutting-edge work on coastal adaptation in California, followed by informal discussion, Q&A and brainstorming sessions for collaborative problem-solving and action.

## CA Coastal Resilience Network Action Membership

Organizations formalize their membership by signing the [Coastal Resilience Network Membership Pledge](#) and submitting it to the [CA CRN Project Manager](#). Government Departments or large institutions for whom it is not legally feasible to sign a pledge may instead request the CA Coastal Resilience Network to commit to a mutual Memorandum of Understanding (MoU).

Sign the CA Coastal Resilience Network Membership Pledge

[Download The Pledge](#) & send to [CACoastalResilience.org](http://CACoastalResilience.org)

[Get Involved](#)

**California Coastal Resilience Network Pledge**  
**Commitment by Members to the California Coastal Resilience Network**

**Mission:** *The California Coastal Resilience Network promotes knowledge exchange and policies that support adaptation solutions that strategically and comprehensively prepare California's coastal habitats and communities for climate induced impacts.*

**Vision:** *The California Coastal Resilience Network envisions a resilient California coast, where habitats and communities are effectively prepared for adverse climate impacts through the coordinated action of an integrated network of coastal managers.*

**We/I hereby commit ourselves/myself to upholding the mission and vision of the California Coastal Resilience Network as a (please check one):**

- Network Learning Exchange Member** (participate in monthly learning exchange webinars)
- Network Action Member** (participate in monthly learning exchange webinars AND work together with other Action Members to advocate for coastal adaptation policy improvements in California)

**We/I undertake to contribute to achieving the agreed objectives of the Network, which are to:**

- Promote knowledge sharing and partnerships among coastal climate adaptation practitioners throughout California, promoting nature-based, multi-benefit adaptation alternatives wherever possible;
- Actively participate in Network calls and activities as my/our schedule allows, with the understanding that my/our experience(s) and questions are of great value to other Network members;
- Through my actions and participation, ensure an informal, safe space to brainstorm creative solutions, develop new partnerships and approaches, and support regional and cross-geography nature-based, multi-benefit adaptation solutions;
- Support the development of a Coastal Adaptation Platform for the Network aimed at improving California policy to better facilitate the implementation of nature-based, multi-benefit coastal climate change adaptation approaches;
- Promote activities that build communities' capacity to innovate and adapt to coastal climate change;
- Where feasible, given my organizations' limitations on policy engagement, support the implementation of the Coastal Adaptation Platform and relevant initiatives that fund nature-based, multi-benefit adaptation activities;
- Be a Network ambassador: I will share what I have learned and invite others who might benefit to join the Network.

We/ I further undertake to actively contribute to the Network's work and be solution-oriented. In the case of individuals nominated to represent our organization in the Network, we undertake to provide them with the necessary organizational backing to play an effective role within the Network and to contribute effectively to its activities.

Name of individual: \_\_\_\_\_ Signature: \_\_\_\_\_

Organization (optional): \_\_\_\_\_ Date: \_\_\_\_/\_\_\_\_/2016

Please sign, scan, and email to: [CACoastalResilienceNetwork@tnc.org](mailto:CACoastalResilienceNetwork@tnc.org)

YES, please add my/our logo to the list of members on the [Network's Membership webpage](#)  
 Please email your company logo (<2MB), along with your Pledge, to: [CACoastalResilienceNetwork@tnc.org](mailto:CACoastalResilienceNetwork@tnc.org)

What other features  
would you like to see on  
the website?

# Economic Impact of Climate Adaptation Strategies for southern Monterey Bay



**Kelly Leo**, The Nature Conservancy

**Bob Battalio**, Environmental Science Associates (ESA)

**Dr. Walter Heady**, The Nature Conservancy

**Dr. Philip King**, Economist, SFSU



# INTRODUCTION

Kelly Leo, The Nature  
Conservancy

UNITED STATES OF AMERICA 20

IN SOIL  
WE TRUST



TWENTY DOLLARS



PEOPLE

+

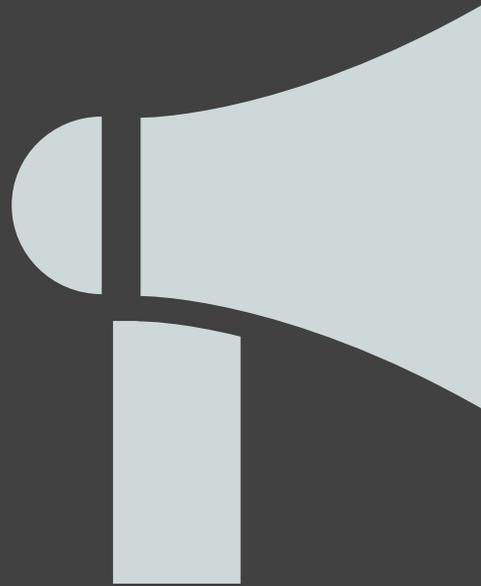


NATURE

+



MONEY



This is BIG news,  
spread the word!



# Shoreline erosion high, study says

By WILL HOUSTON, Herald Correspondent

POSTED: 08/26/13, 12:01 AM PDT

0 COMMENTS

The shores of Monterey Bay are known for their beauty, but some of it is being slowly washed away. A 2006 U.S. Geological Survey found that the Monterey Bay shoreline has the **highest** average erosion rate in California, narrowing the beaches by about 2 feet a year.



National Assessment of Shoreline Change Part 3:  
Historical Shoreline Change and Associated  
Coastal Land Loss Along Sandy Shorelines of the  
California Coast

Cheryl J. Hapke, David Reid, Bruce M. Richmond, Peter Ruggiero and Jeff List

Open-File Report 2006-1219  
U.S. Department of the Interior  
U.S. Geological Survey



# Step 1: Stakeholder Engagement



# Step 2: Physical Modeling



## Step 2: Physical Modeling



Photo credit: Doug Smith

# Step 2: Physical Modeling



Photo credit: Dan Hill

# Step 2: Physical Modeling



# Step 3: Beach Ecosystem Index



# Step 3: Beach Ecosystem Index



## Step 4: Economic Analysis



# Step 5: CoastalResilience.org

**CALIFORNIA** GET STARTED TOUR GO TO ▼ The Nature Conservancy

in Monterey

**Flood and Sea Level Rise**

Choose a Region Selected Region: Monterey

- Rising Tide
- Aggregated Rising Tide
- Coastal Storm Flood
- Aggregated Coastal Storm Flood
- Dune Erosion
- Aggregated Dune Erosion
- Cliff Erosion
- Aggregated Cliff Erosion

**2. Select the time and amount of sea level rise**

Year

Layer Properties: [Search Icon]

Opaque Transparent

Download Data View Technical Report View Overview

**Map Legend**

**Flood Inundation 2100 Combined**

- 1 Hazard
- 2 Hazard
- 3 Hazard

**Infrastructure**

- Airport
- Community

Any questions so far?



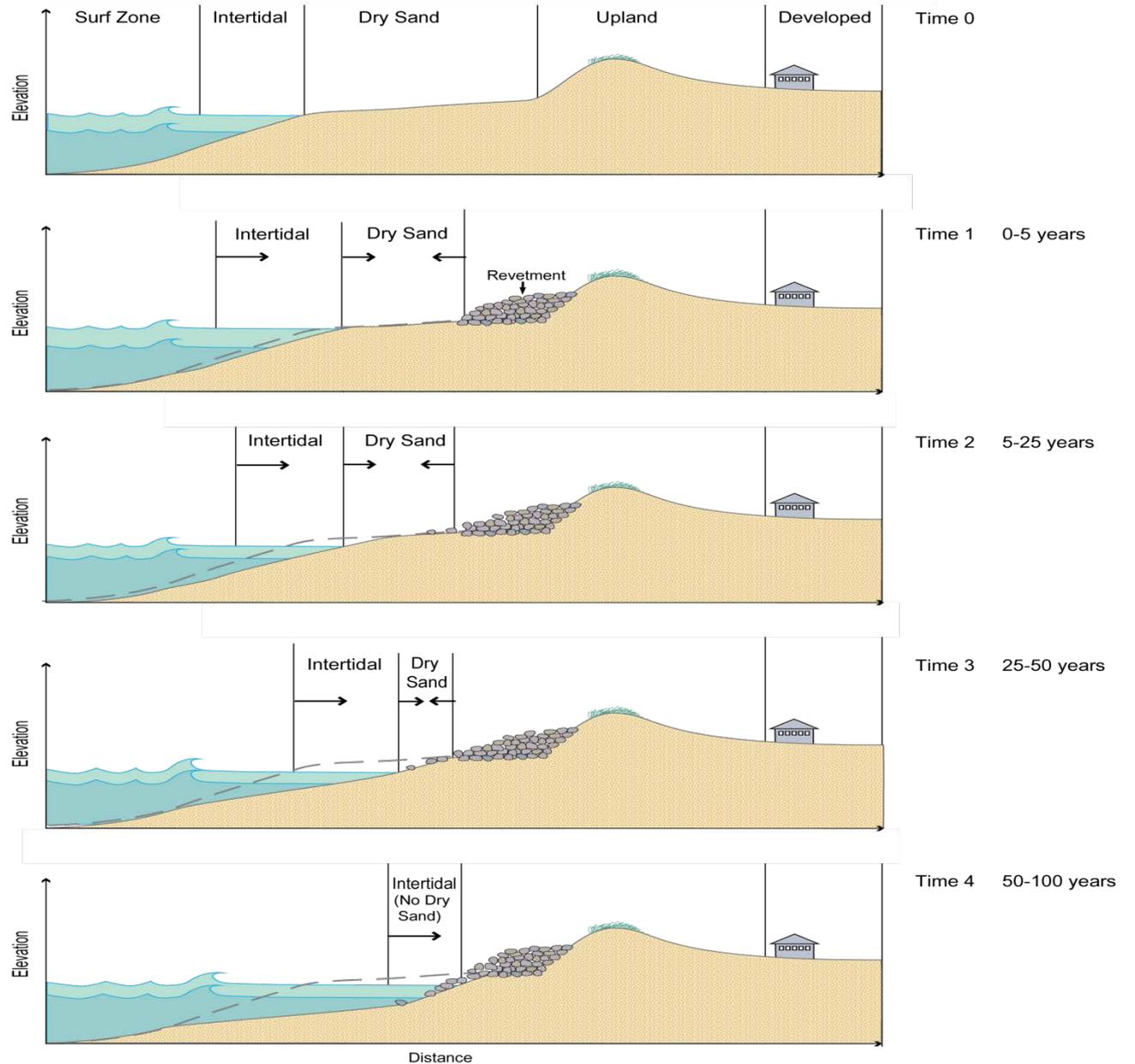
# SHORE RESPONSE TO SLR & ADAPTATION APPROACHES

Bob Battalio, ESA

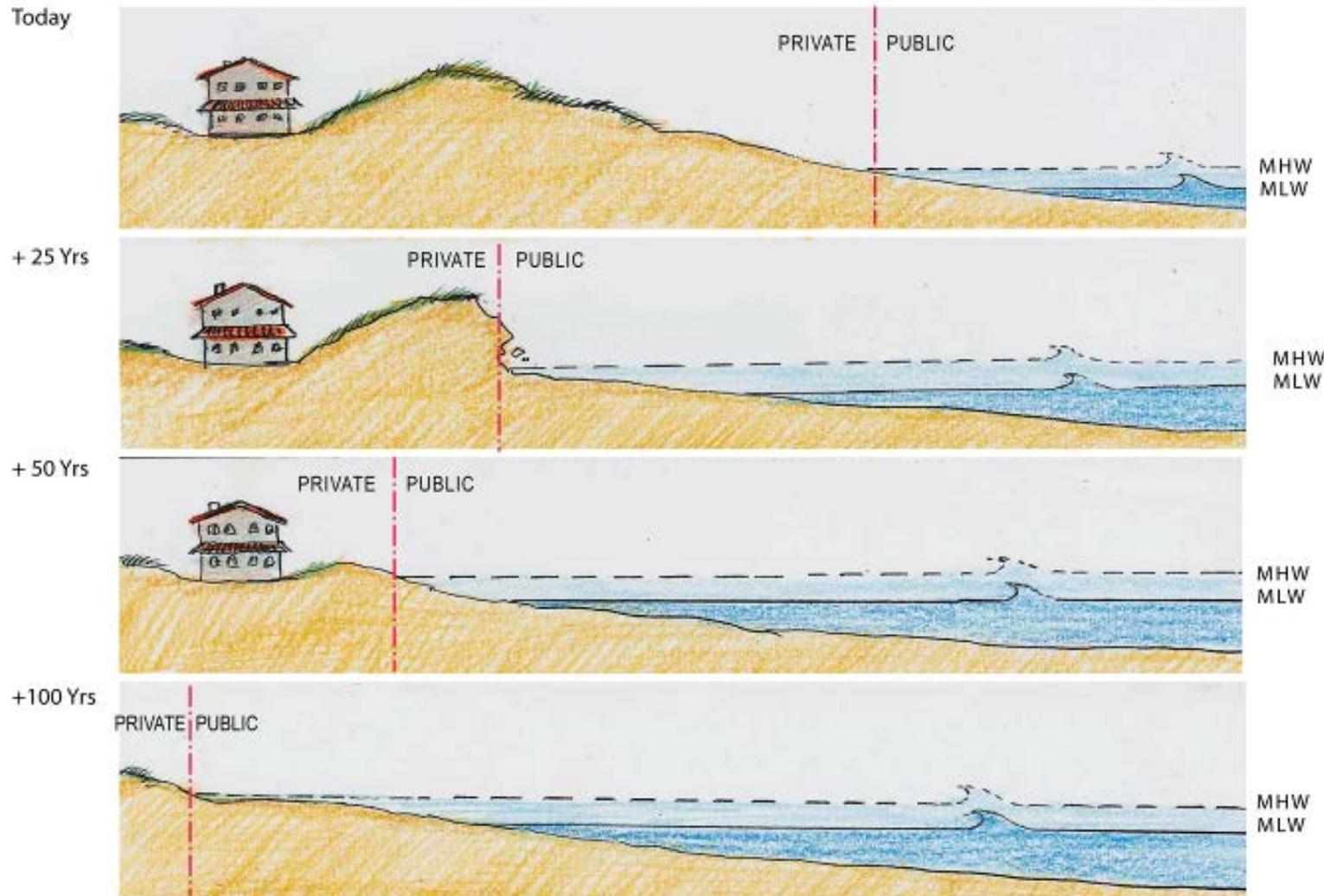
# Reaches



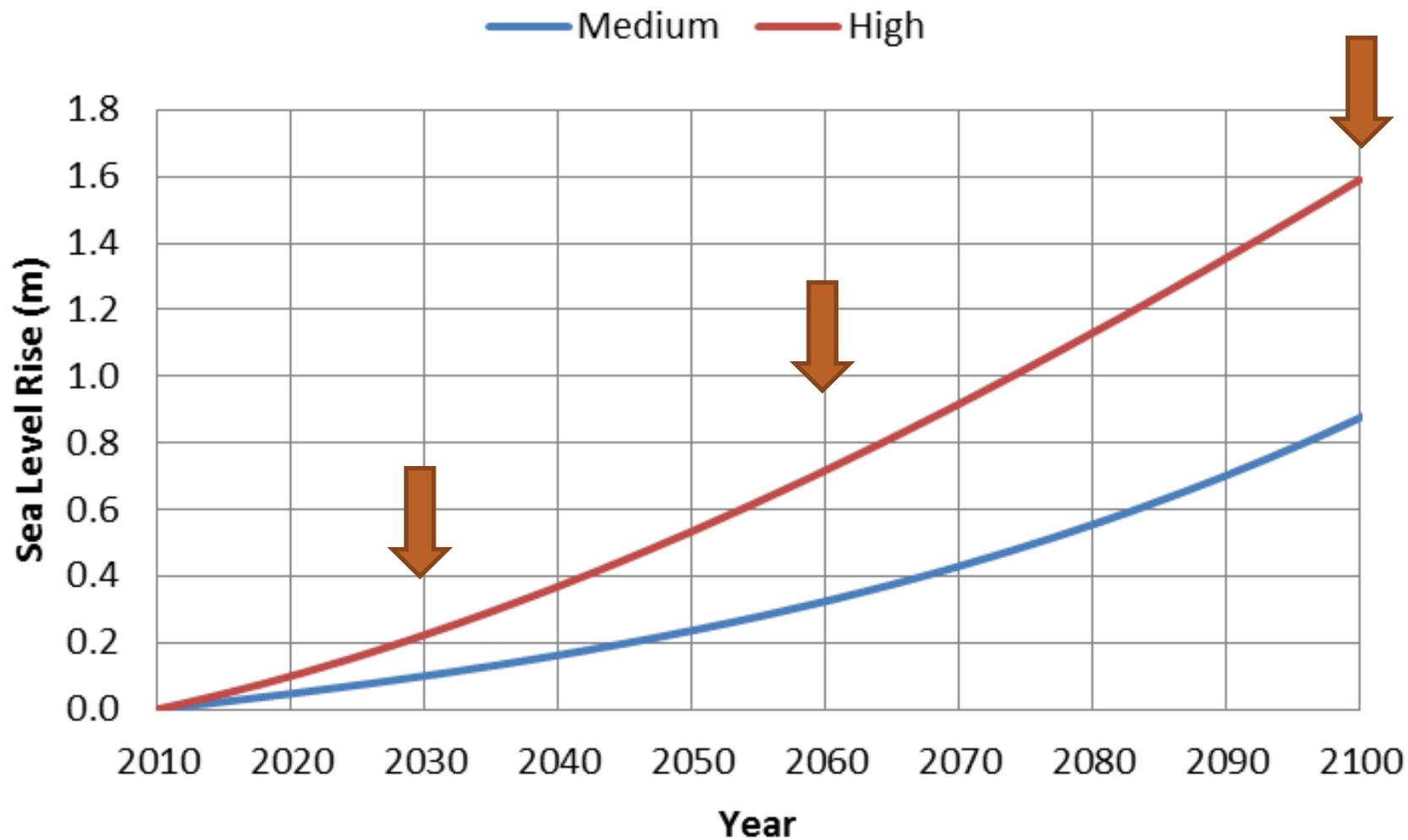
# Shoreline Response – Hold the Line



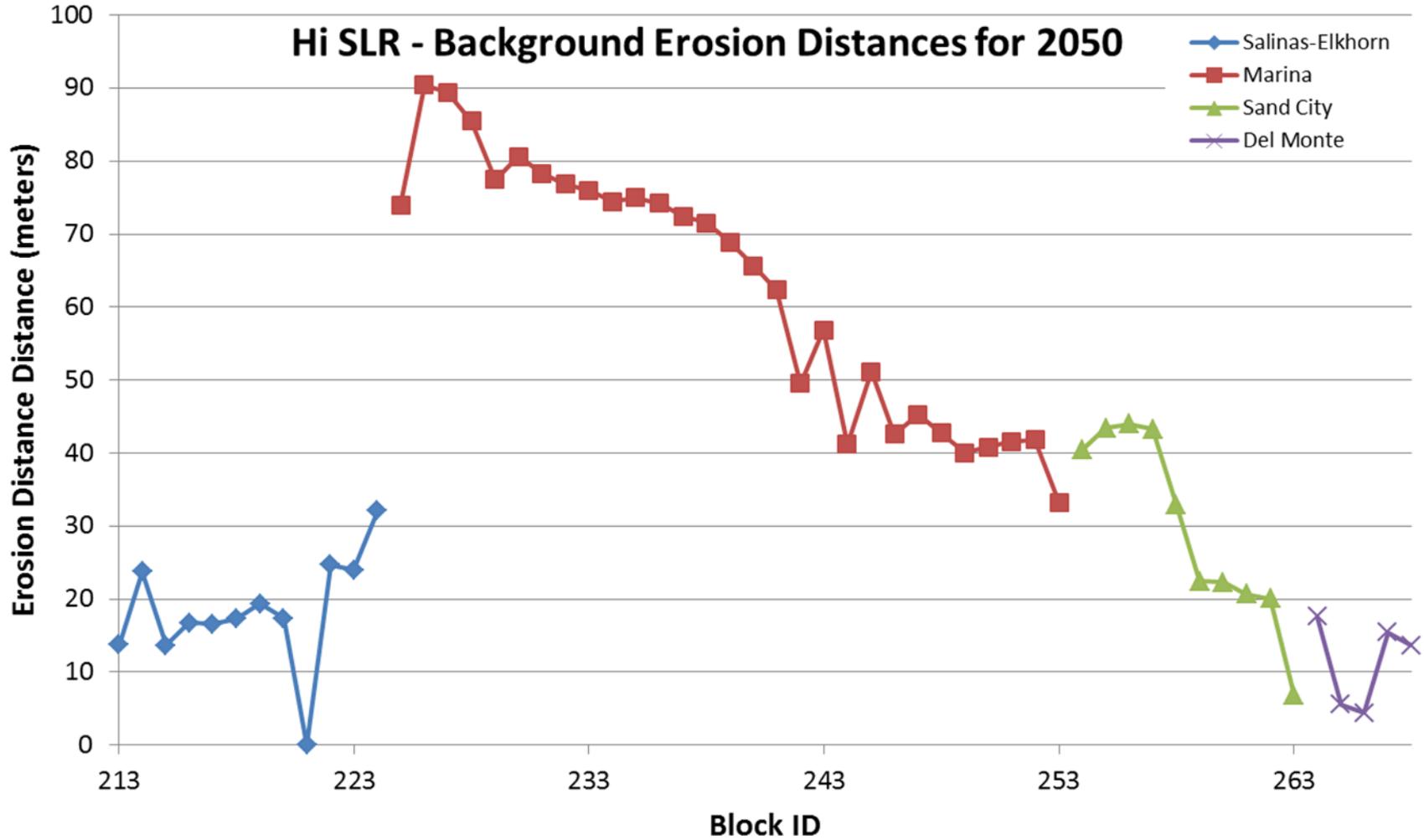
# Shoreline Response – Allow Erosion



# Sea level rise scenarios



# Potential Erosion by 2050



# Scenario Modeling Del Monte – Monterey

Figure 1e. Reach Summary

## Del Monte (High Sea Level Rise)

The Del Monte reach includes two types of beach nourishment scenarios, with the following inputs and outputs:

### Beach Nourishment (Set Schedule)

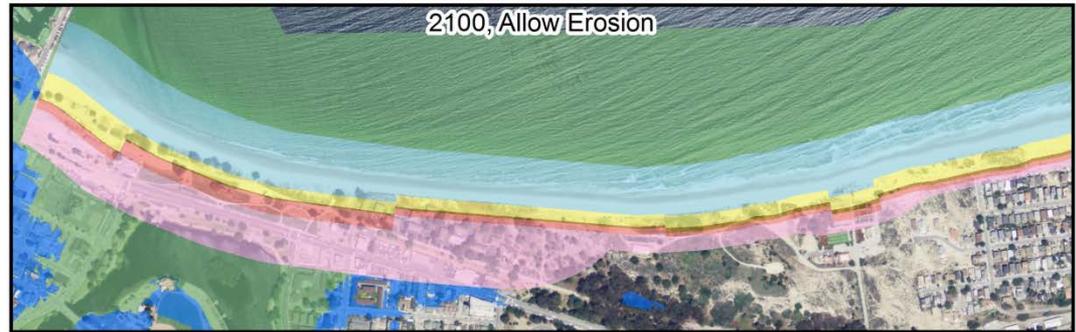
Nourishment volume: 50,000 CY  
Nourishment years before 2100: 2010, 2020, 2030, 2040,  
2050, 2060, 2070, 2080,

### Beach Nourishment (As Needed) + Groins

Nourishment volume: 400,000 CY  
Nourishment years before 2100: 2010, 2051



# Scenario Results for 2100 with high sea level rise projections



# Scenario Modeling: Del Monte

## Long-Term Coastal Evolution Results

Scenario	Average Beach Width (m)										Long Term Backshore Erosion (m)*									
	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
Allow Erosion	29	29	29	29	29	29	29	29	29	29	0	3	6	9	12	16	20	24	28	33
Hold the Line	21	20	17	13	10	6	1	0	0	0	-8	-8	-8	-8	-8	-8	-8	-8	-8	-8
Beach Nourishment (Set Schedule)	32	32	34	35	37	38	38	38	37	36	0	2	5	7	10	12	15	18	21	24
Beach Nourishment (As Needed)	<i>This adaptation action is not a scenario for this reach.</i>																			
Beach Nourishment (As Needed) + Groins	51	50	48	47	45	62	61	57	53	50	0	1	2	4	6	6	7	8	9	10

\*Hold the line scenario produces negative backshore erosion due to the encroachment of the revetment onto the beach.

Scenario	Storm-Induced Erosion Distance (m)**										Intertidal Width (m)									
	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
Allow Erosion	17	17	17	17	17	17	17	17	17	17	38	38	38	38	38	38	38	38	38	38
Hold the Line	0	0	0	0	0	0	0	0	0	0	38	38	38	38	38	38	27	10	6	6
Beach Nourishment (Set Schedule)	14	14	12	10	9	8	7	8	9	9	38	38	38	38	38	38	38	38	38	38
Beach Nourishment (As Needed)	<i>This adaptation action is not a scenario for this reach.</i>																			
Beach Nourishment (As Needed) + Groins	17	17	19	21	23	6	7	11	15	18	38	38	38	38	38	38	38	38	38	38

\*\*Hold the line scenario assumes no erosion past structure. However, high velocity run-up can still occur over structure (see flood maps).

# Del Monte

Maps, ecology and economics based on modeling of shore changes in terms of

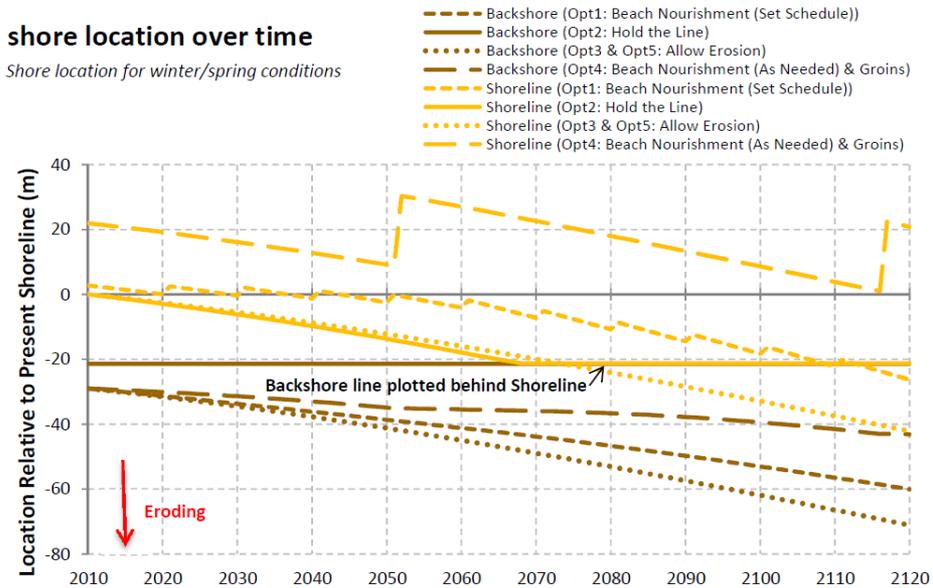
Location of shore and backshore

Beach width

Intertidal width

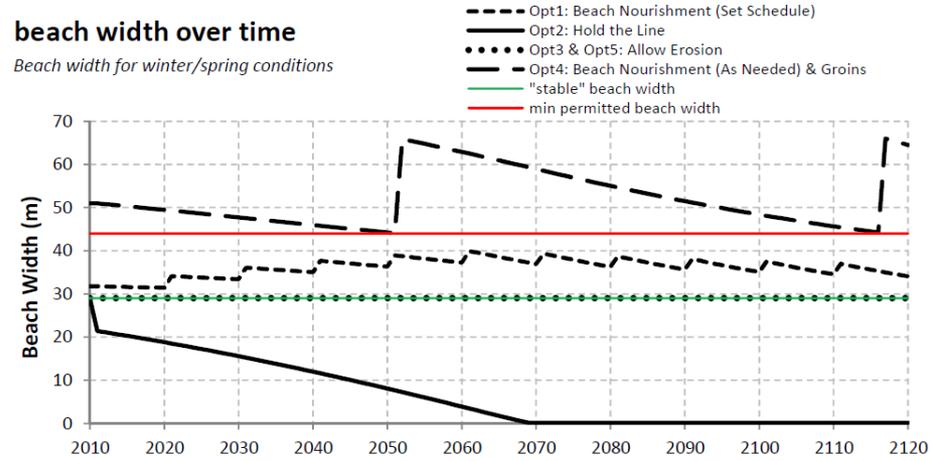
## shore location over time

Shore location for winter/spring conditions

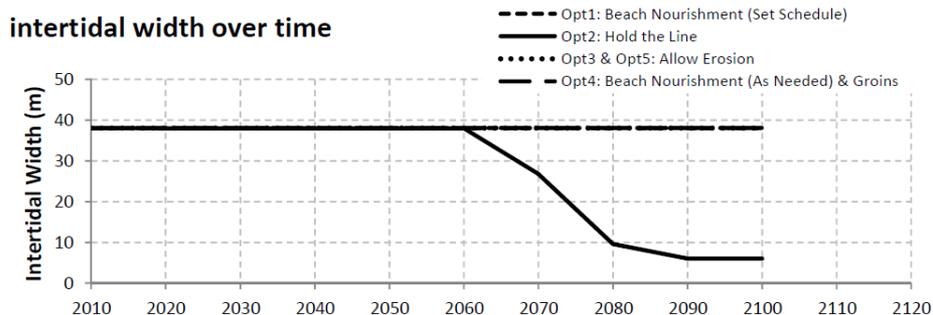


## beach width over time

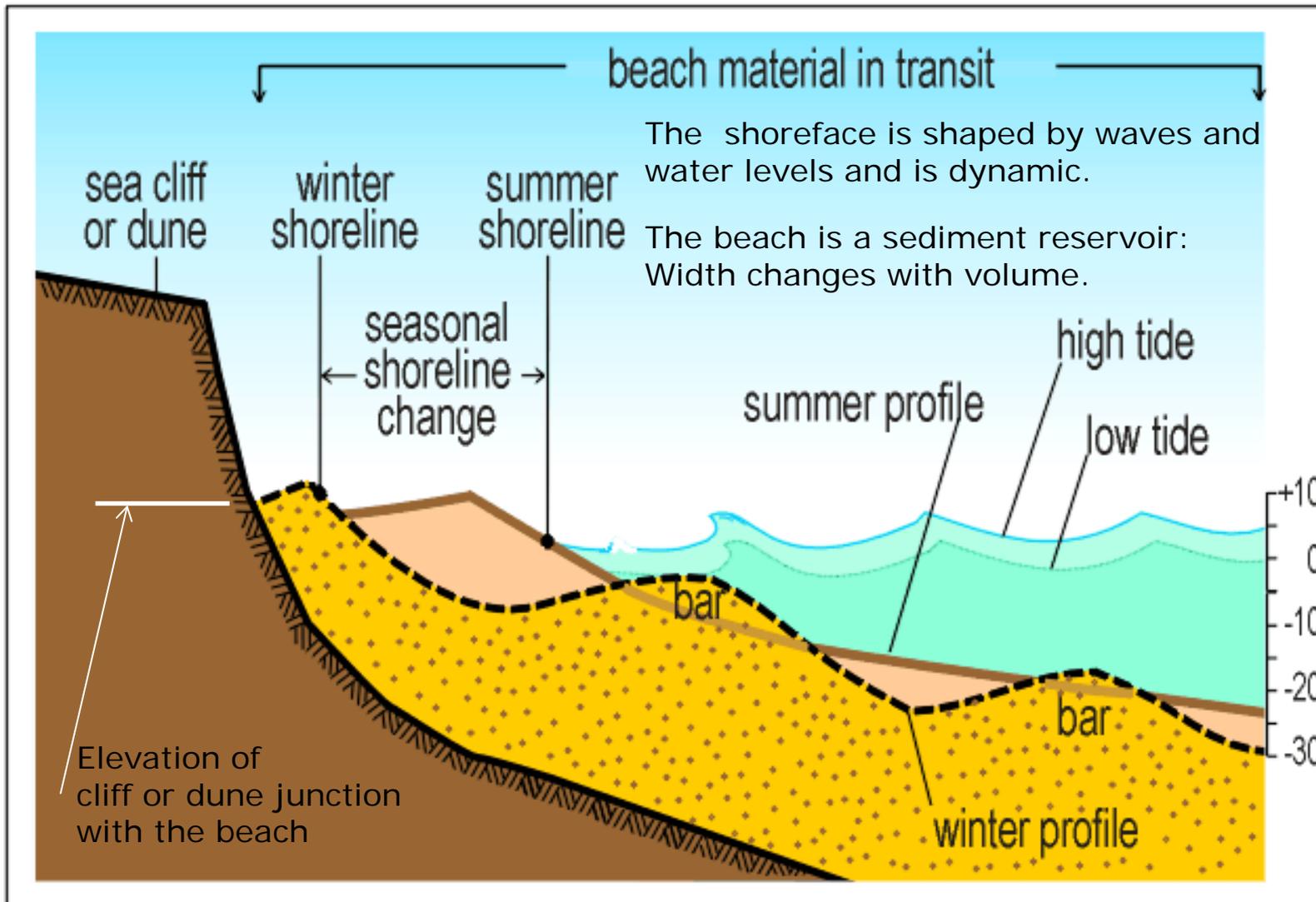
Beach width for winter/spring conditions



## intertidal width over time

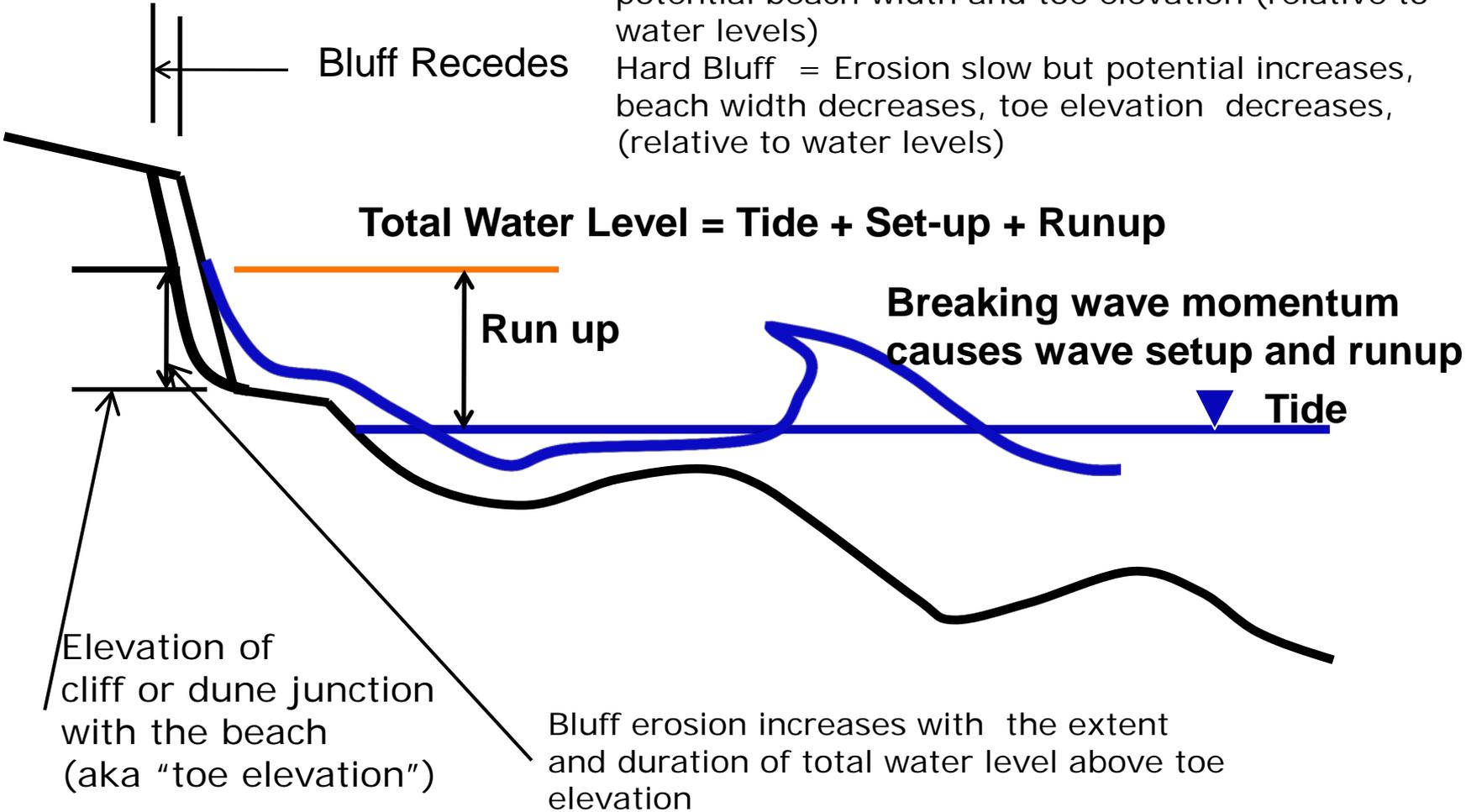


# Shore Face Morphology



# Conceptual Model of Bluff Erosion

Soft Bluff = Bluff recedes rapidly, little change in potential beach width and toe elevation (relative to water levels)  
Hard Bluff = Erosion slow but potential increases, beach width decreases, toe elevation decreases, (relative to water levels)





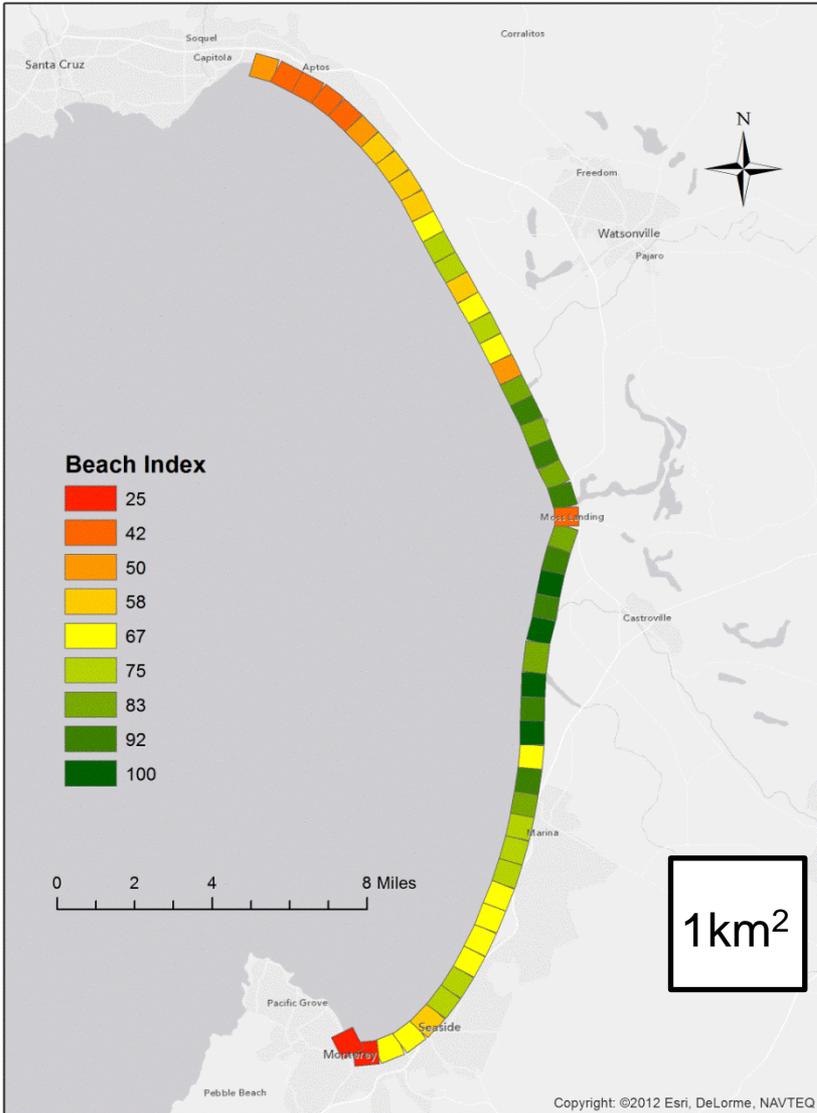
Any questions for Bob?



# BEACH ECOSYSTEM INDEX

Dr. Walter Heady

# Beach Ecosystem Index Score



# Beach Ecosystem Index Score

Average of 3 components:

$$\bullet \text{ BI} = (\text{PC} + \text{BC} + \text{HI}) / 3$$

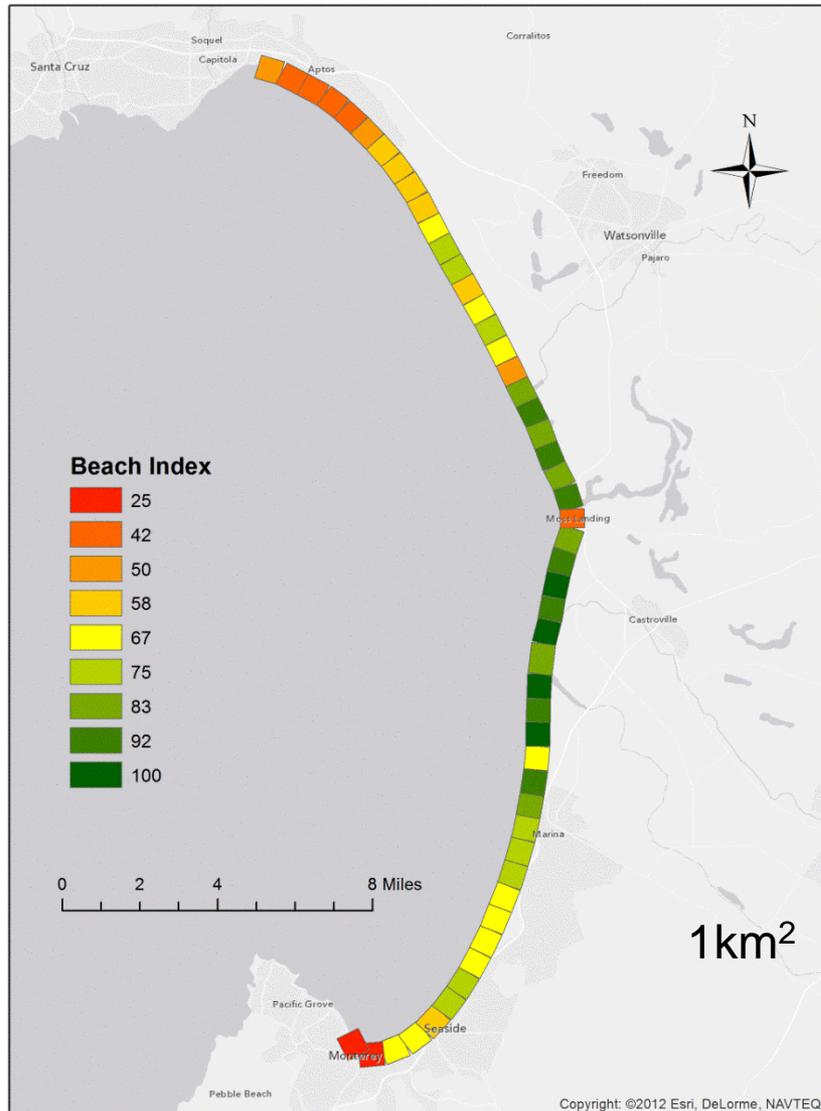
1. PC – Physical



2. BC – Biotic

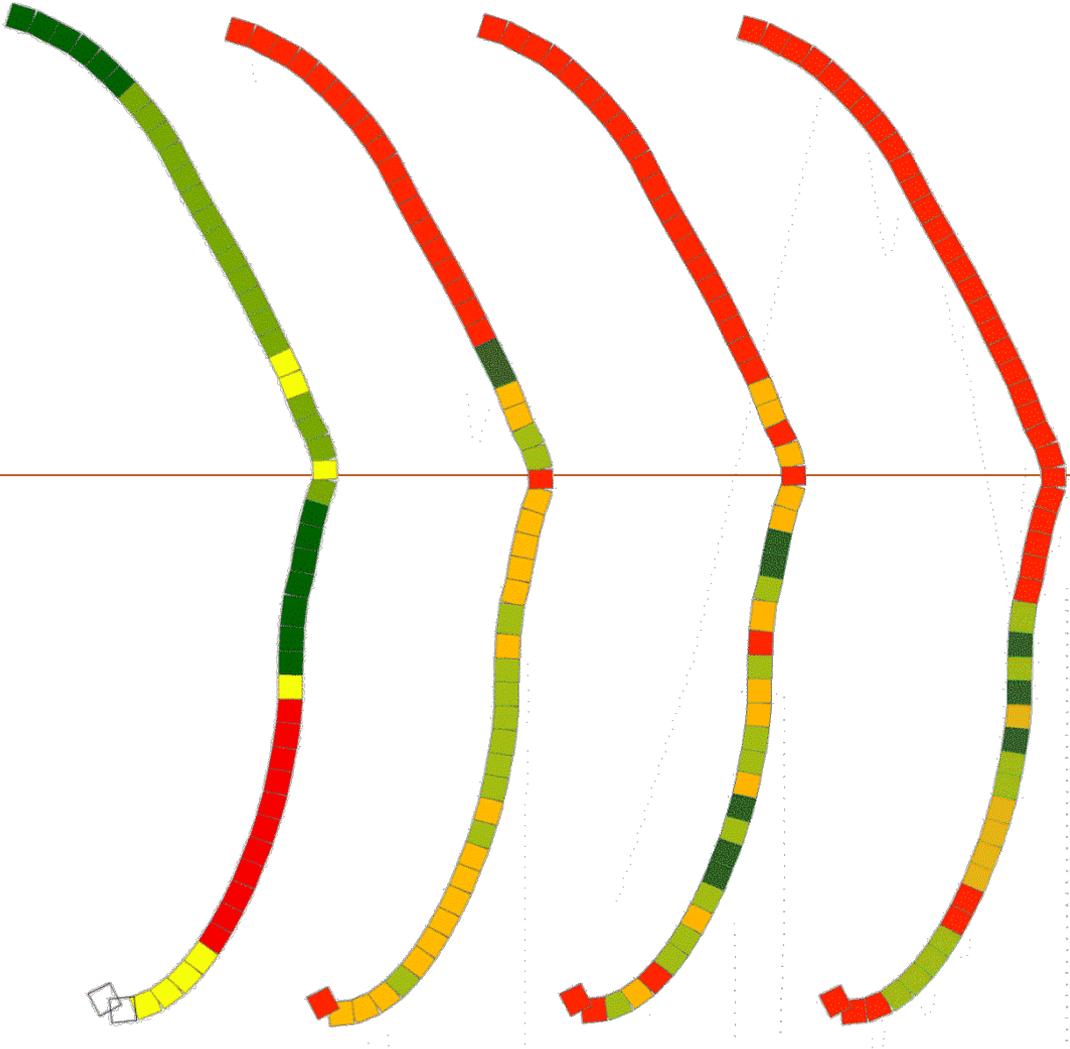
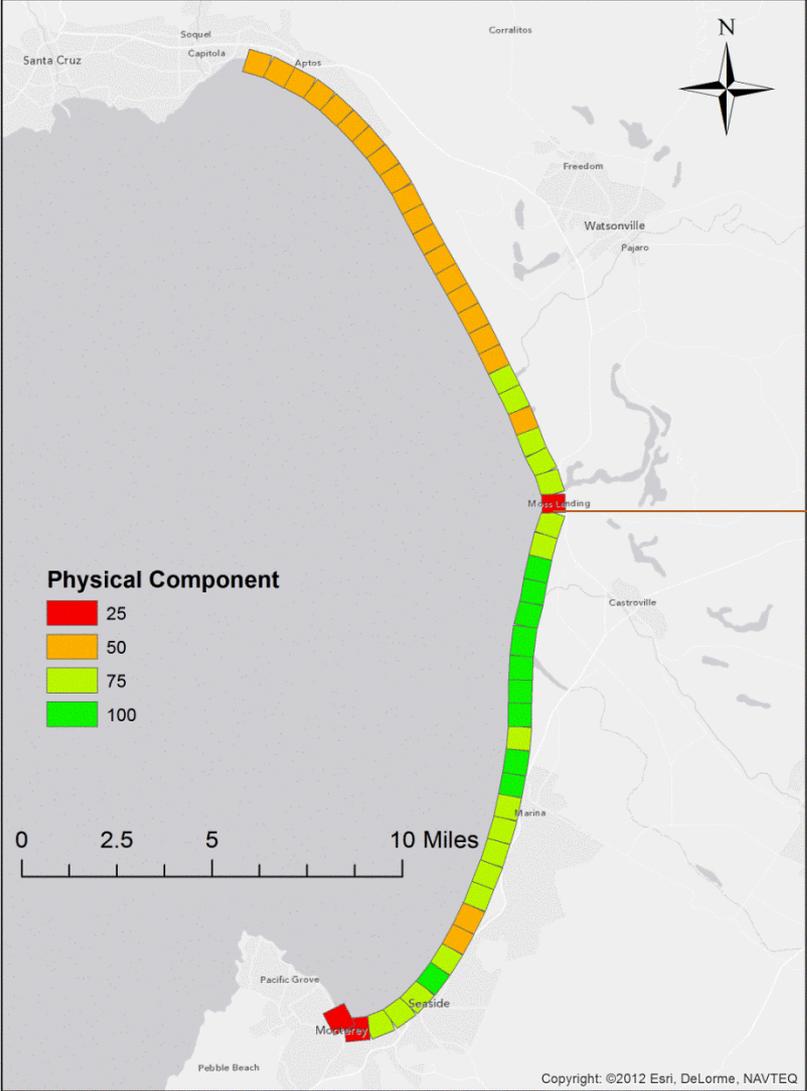


3. HI – Human Impact



# Physical Component

Long-Term Erosion Rates Beach Vegetated Dunes Dunes

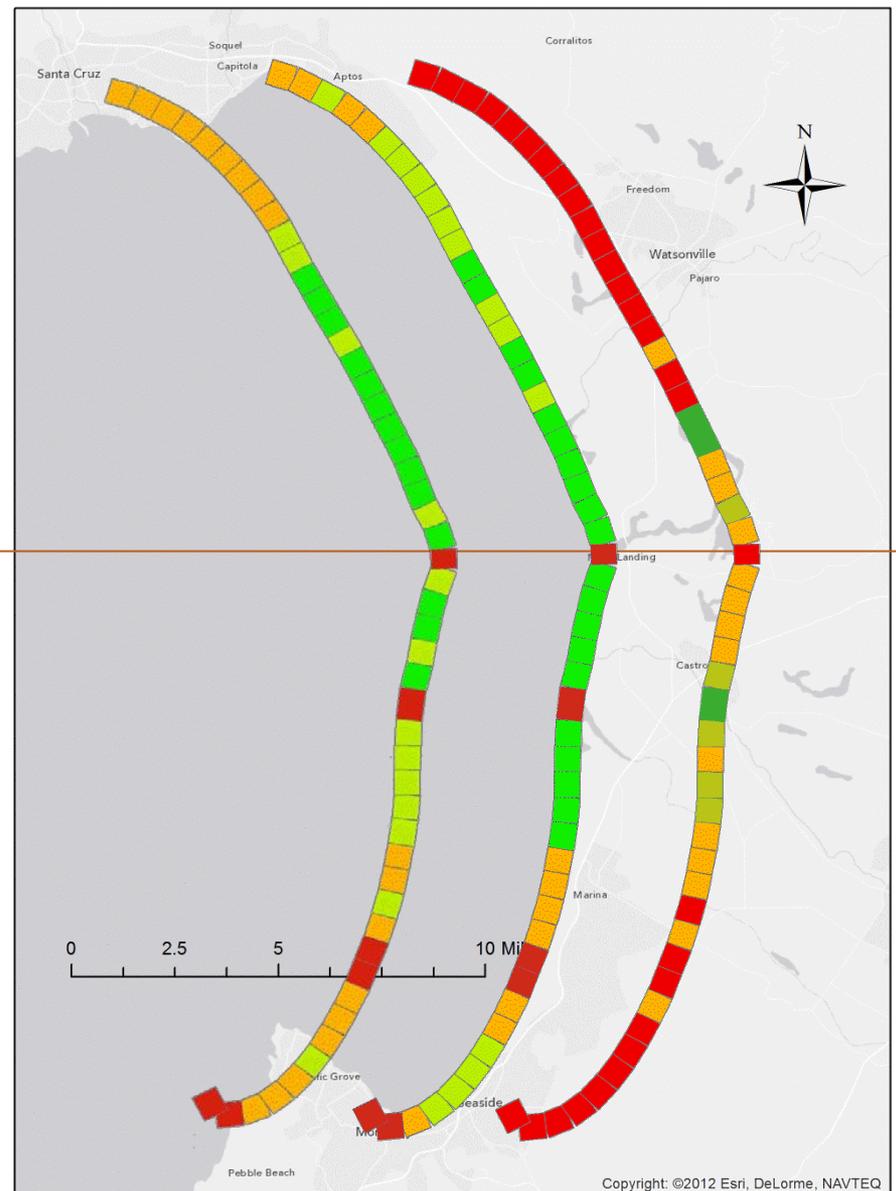
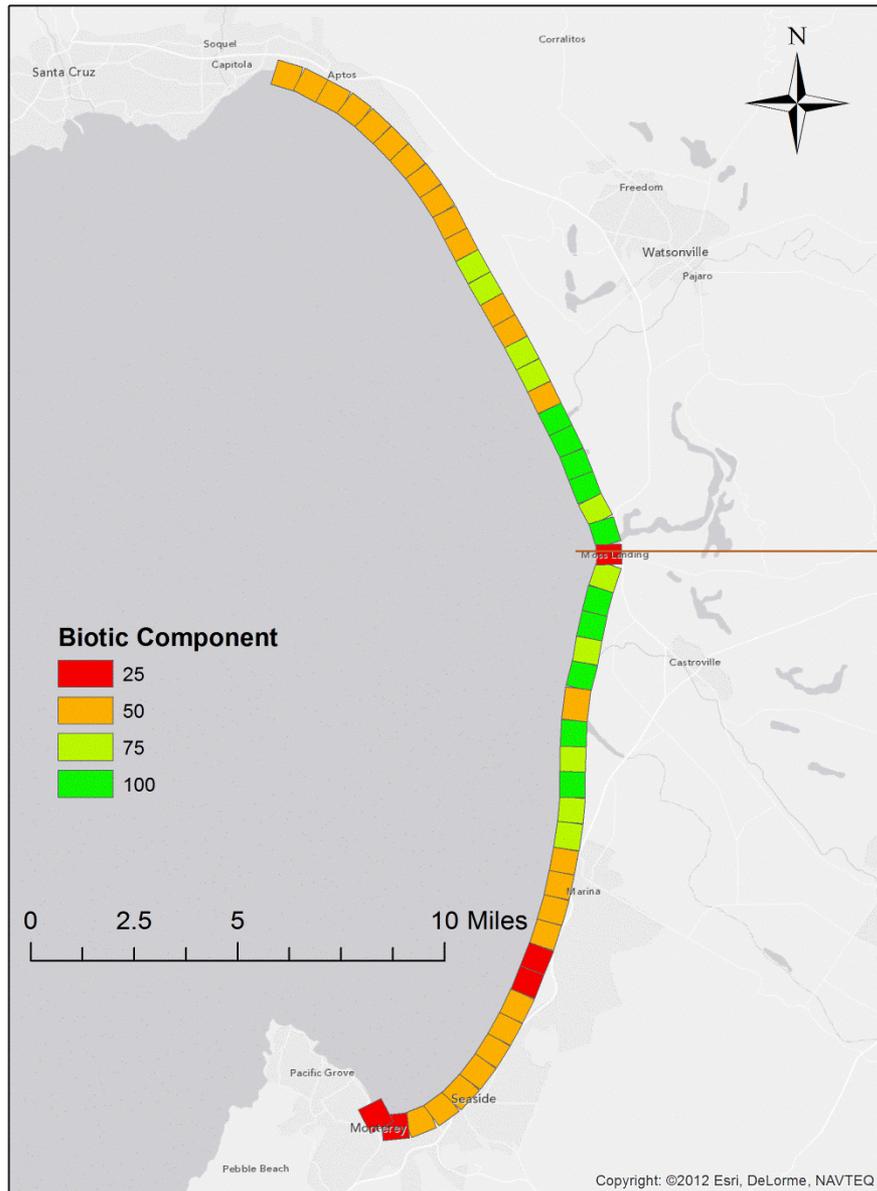


# Biotic Component

Birds  
Abundance

Bird  
Richness

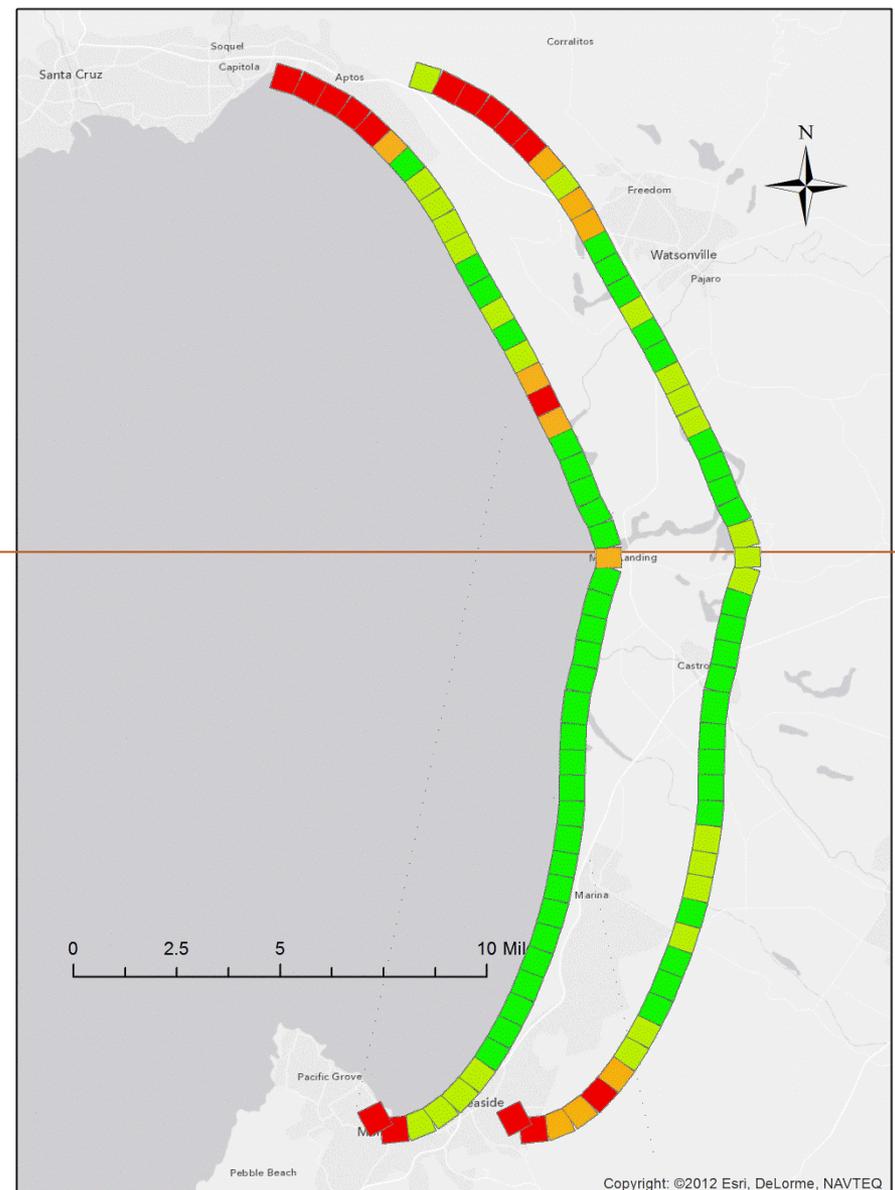
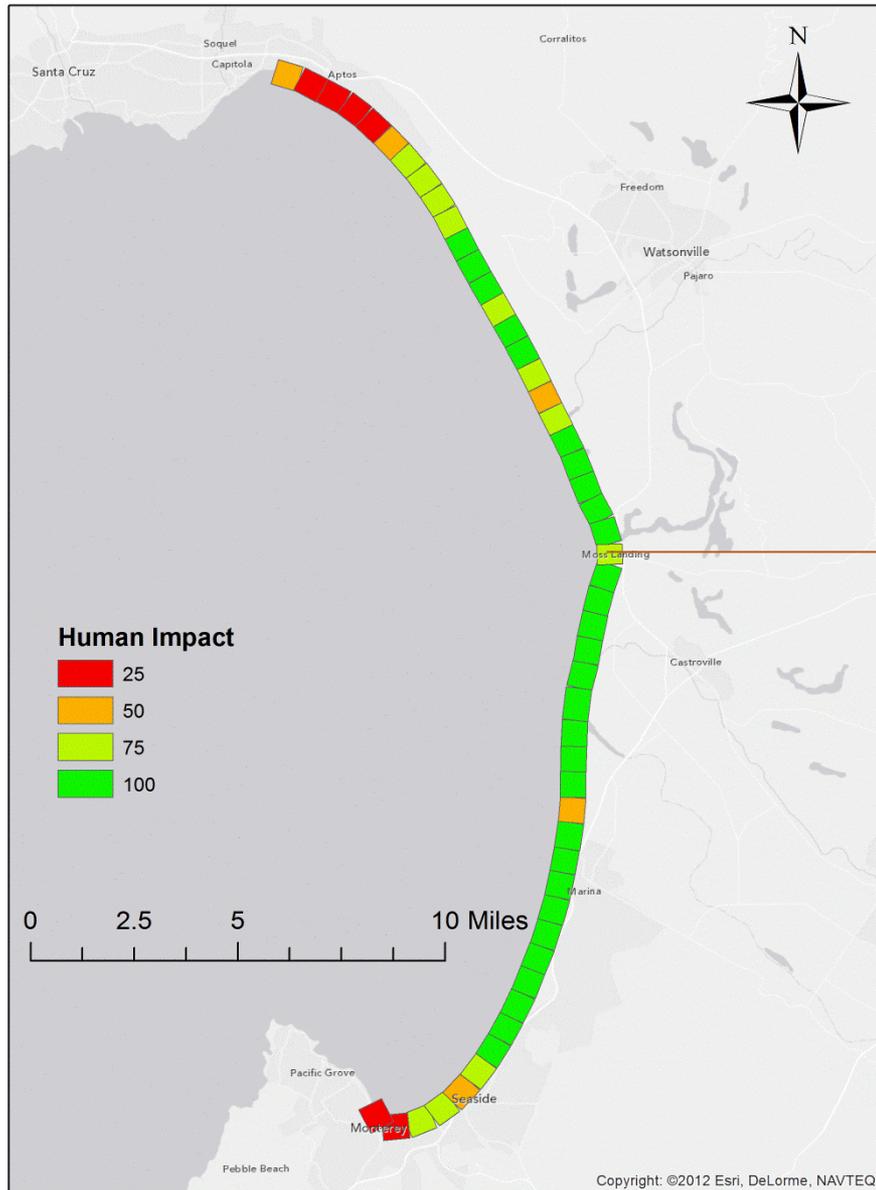
Snowy plover  
nest counts



# Human Impact Component

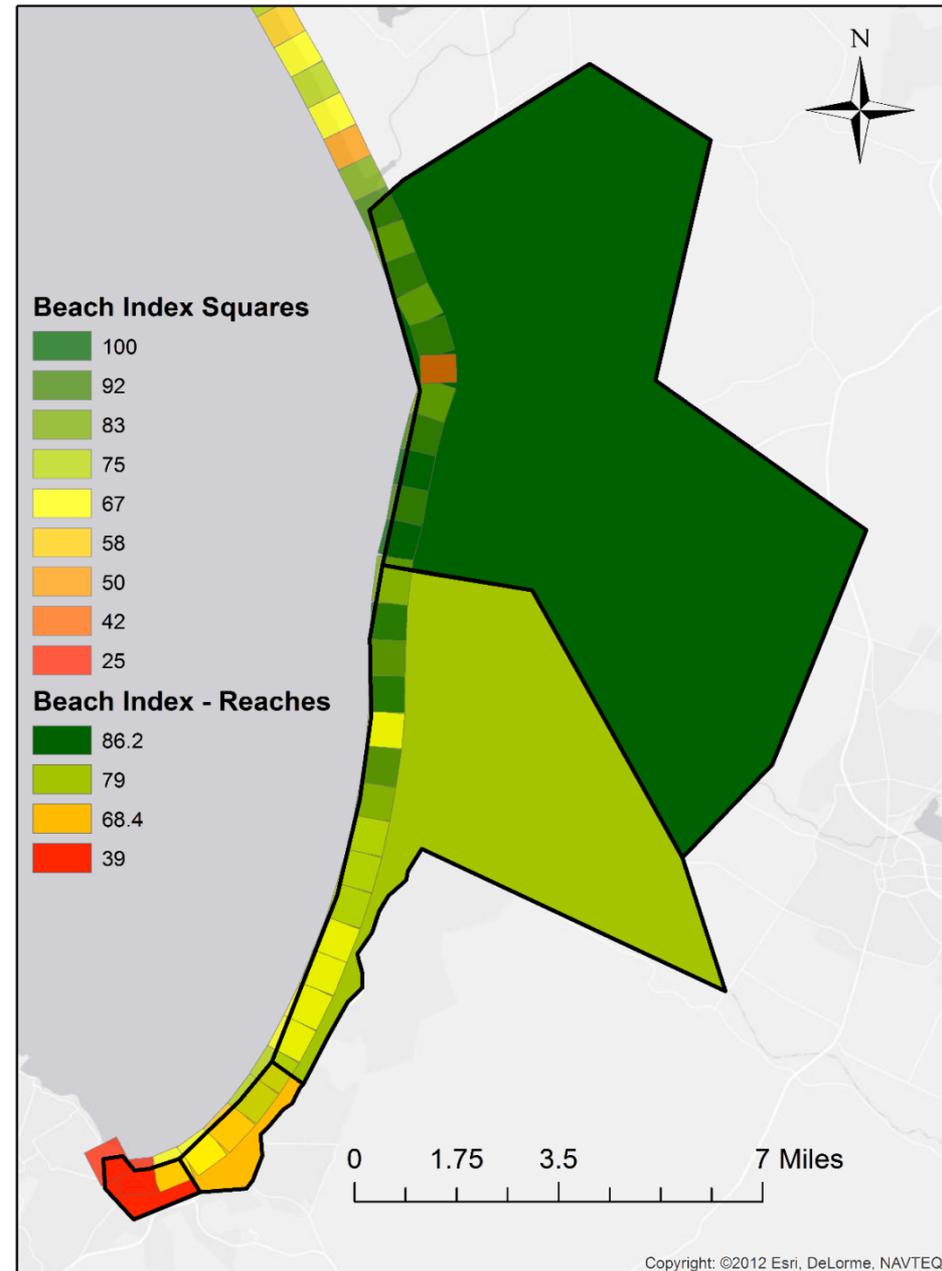
Armor

Urbanization

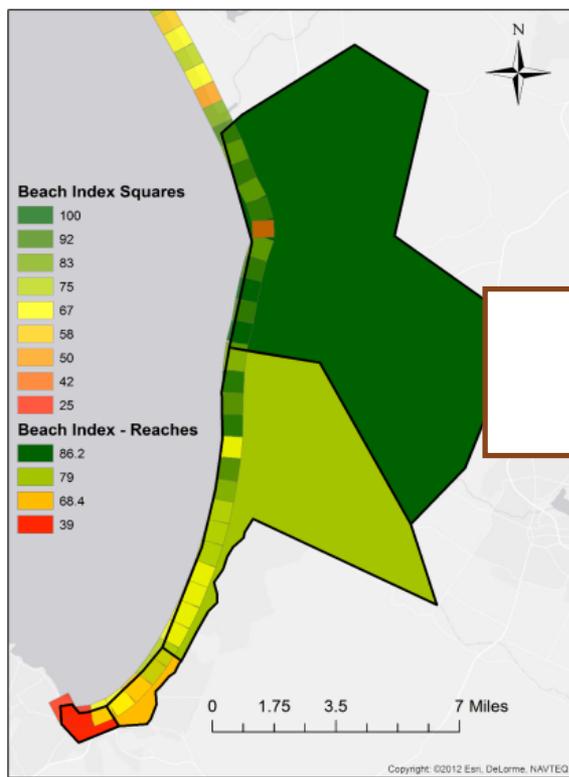


# Beach Ecosystem Index Score for each reach

- $BI = (PC + BC + HI) / 3$
- PC – Physical
- BC – Biotic
- HI – Human Impact

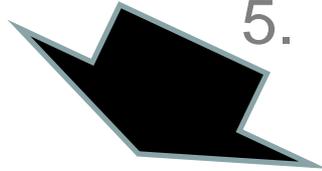
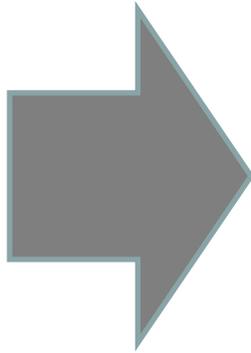
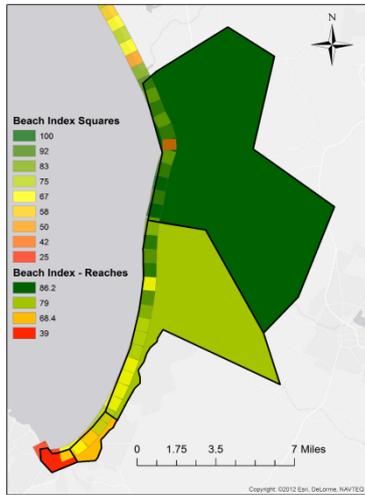


# Ecosystem Indices for each Adaptation Strategy



1. Hold the line
2. Beach nourishment (set schedule)
3. Beach nourishment (as needed) groins
4. Beach nourishment (large)
5. Allow erosion

# Ecosystem Indices for each Adaptation Strategy

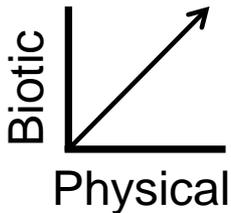


1. Hold the line
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4. Beach nourishment (large)
5. Allow erosion

## Physical Component - changed:

- Beach area
- Dune area
- Vegetated dune area

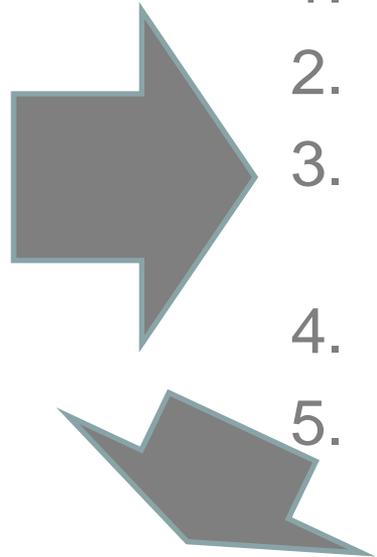
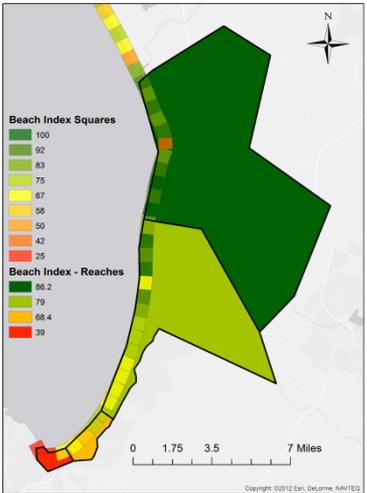
## Biotic Component - used:



## Human Impact - unchanged

# Ecosystem Indices for each Adaptation Strategy

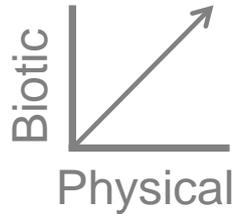
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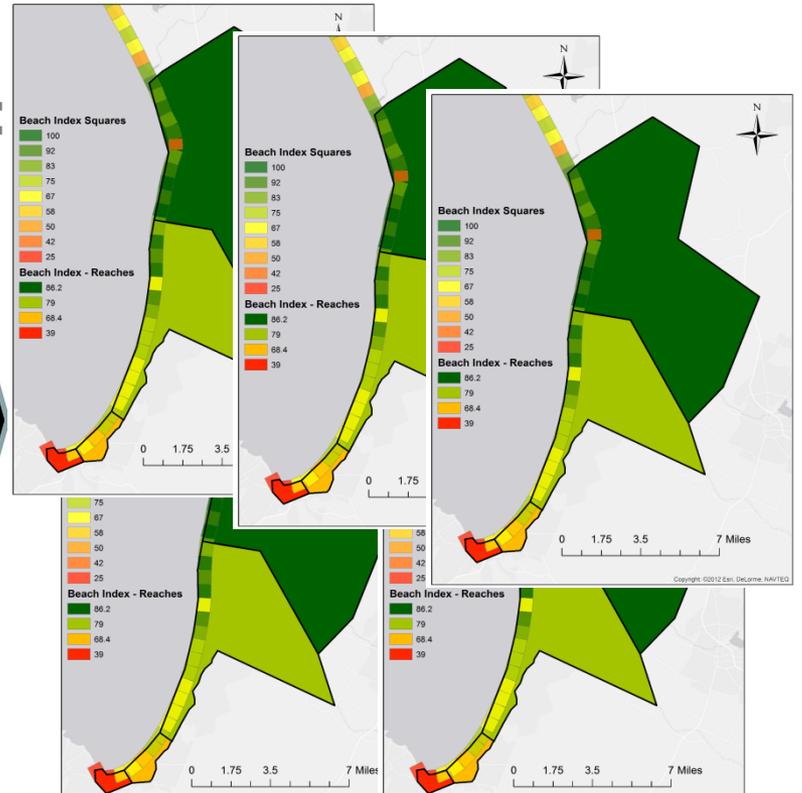
## Physical Component - changed:

- Beach area
- Dune area
- Vegetated dune area

## Biotic Component - used:

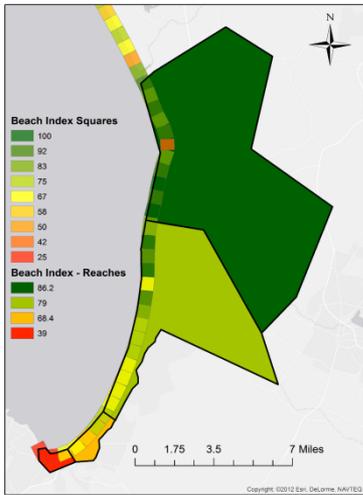


## Human Impact - unchanged



# Ecosystem Indices for each Adaptation Strategy

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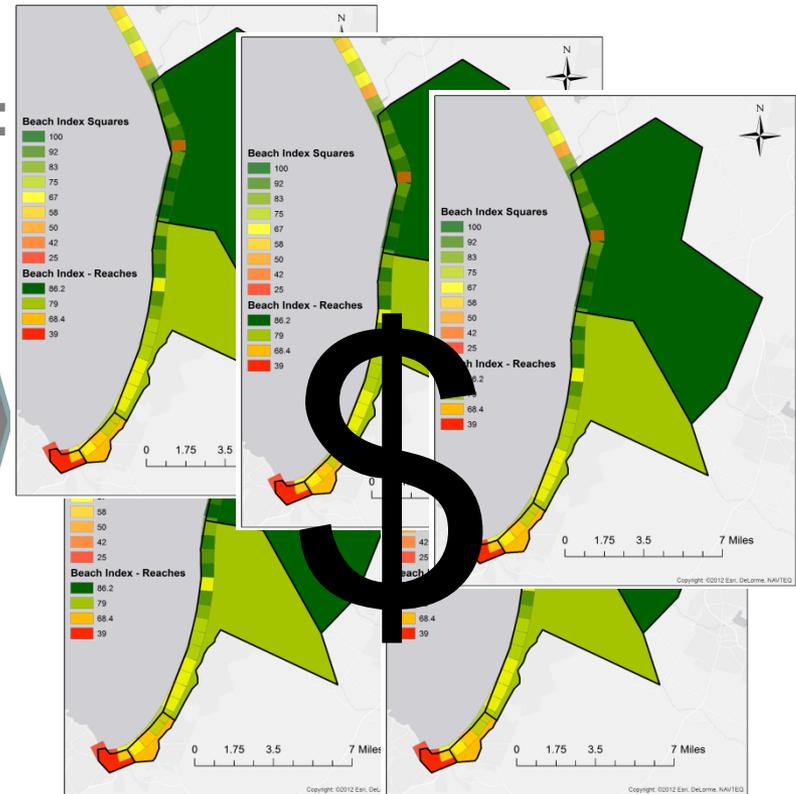
## Physical Component - changed:

- Beach area
- Dune area
- Vegetated dune area

## Biotic Component - used:



## Human Impact - unchanged



Any questions for  
Walter?

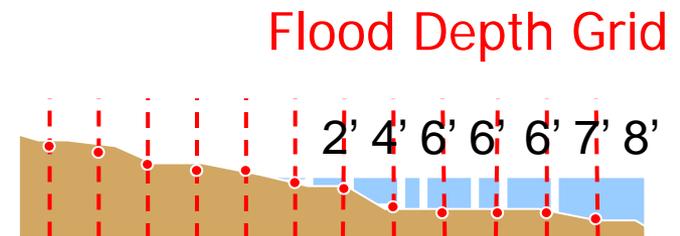


# ECONOMIC ANALYSIS

Dr. Philip King, SFSU

# Economic Benefits/Impacts

- Recreational Benefits
- Loss of Land/Property
- Ecological Losses/Benefits

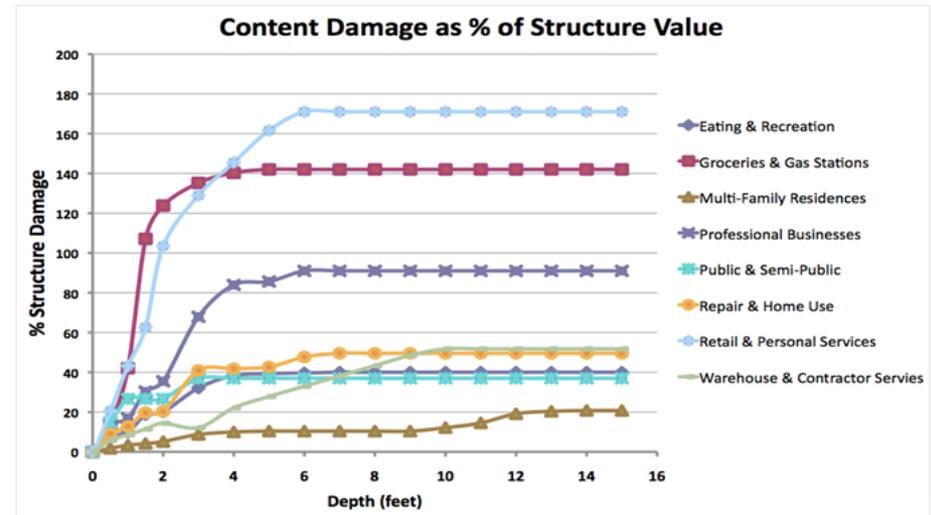
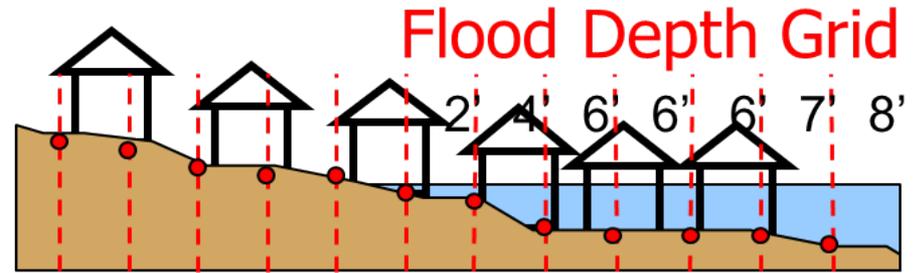
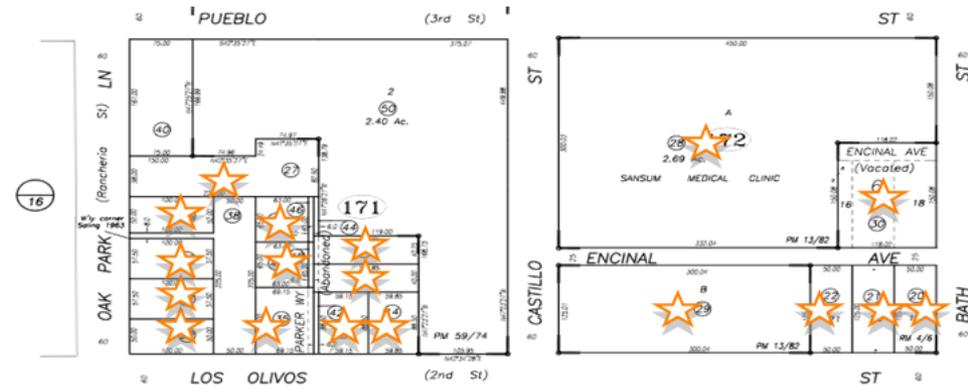


# Recreational Benefits

- As part of the study we:
- Surveyed Visitors
- Conducted Periodic Counts
- Applied "Benefits Transfer" from other beach studies in California
- Estimated the recreational Value of each Reach
- CSBAT model incorporates Beach Width as an amenity

# Loss of Land / Property

- Parcel-by-parcel analysis
- Updated County Parcel Data to reflect market values
- Estimated Cost of Building Replacement
- Evaluate flood depth
- Used USACE Depth Damage Curves



# Valuing Coastal Ecosystems

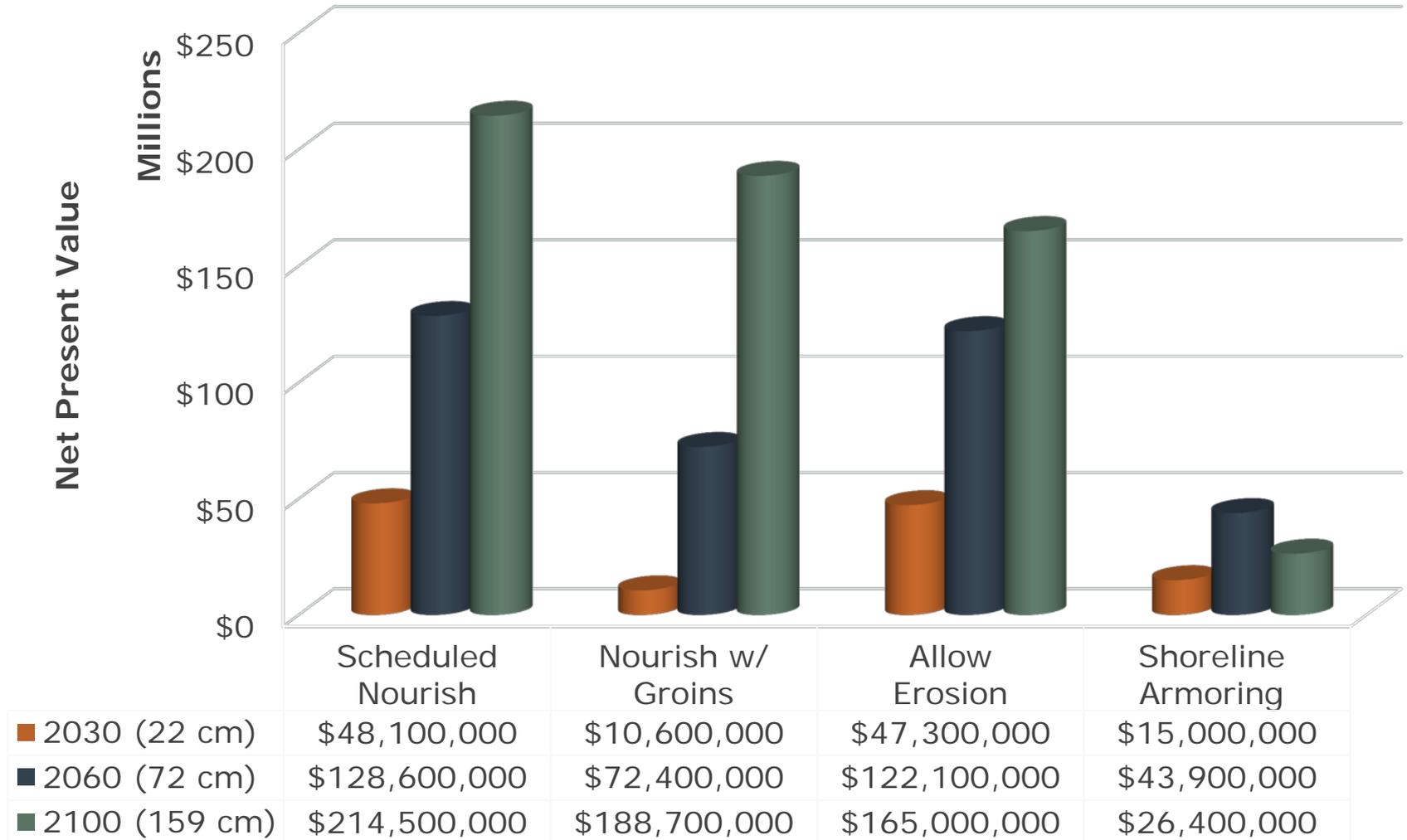
- Used 3:1 Offset Ratio
- Calibrated using beach ecosystem index score
- Used Average Cost of Beach Restoration



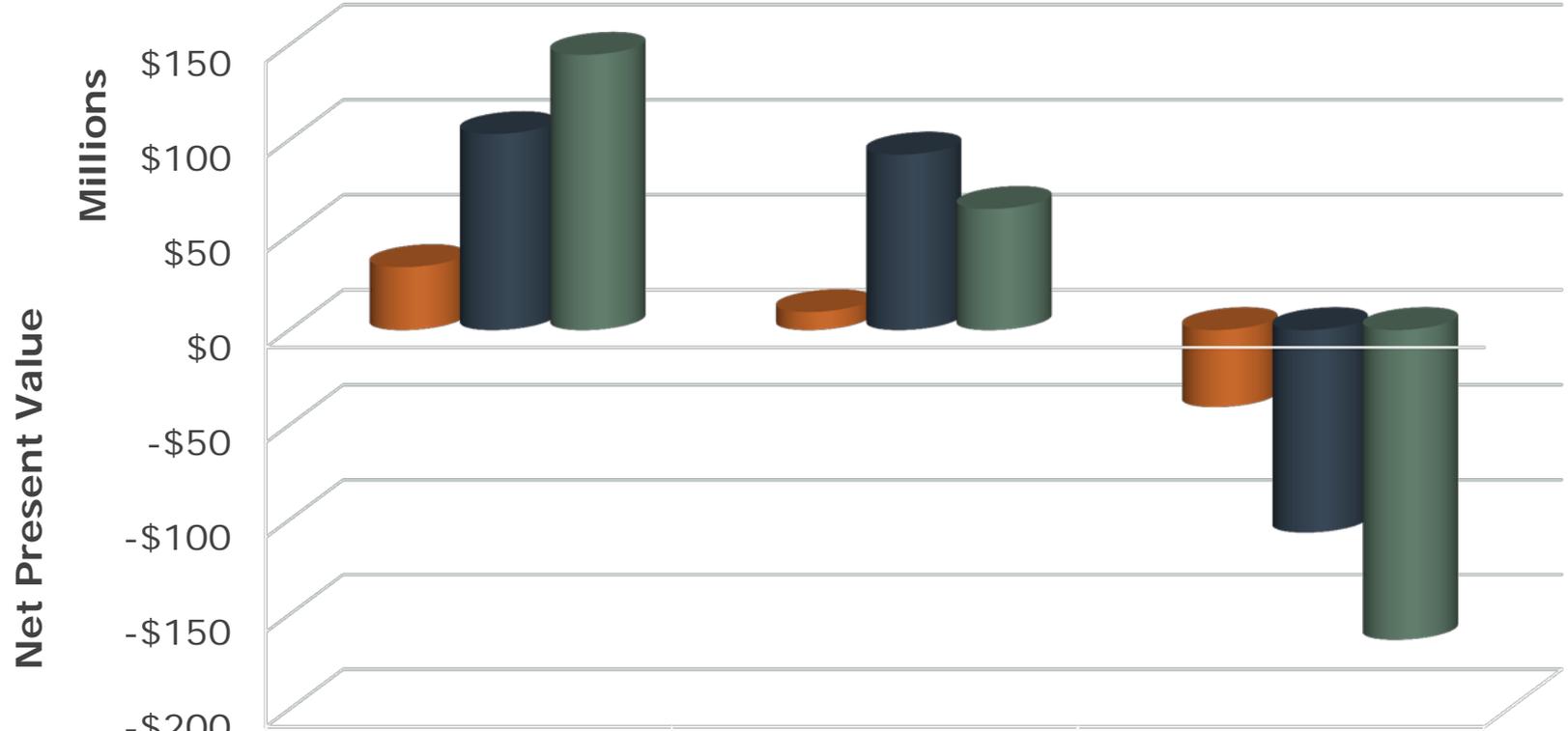
# Summary of Methods

<b>Item</b>	<b>Method for Estimating</b>	<b>Final Metric</b>
Beach Recreation	CSBAT	Recreational Value for given Beach Width
Ecological Value	Beach ecological index score	Cost of Replacement
Land	Commercial Data	Market Value
Buildings	FEMA	Replacement Cost
Flood Damages	USACE	Depth Damage Curves
Water Infrastructure	ESA	Replacement Cost
Roads	ESA	Replacement Cost
Nourishment	ESA	Cost of Hopper Dredge, etc.
Revetments	ESA	Construction Cost

# Del Monte

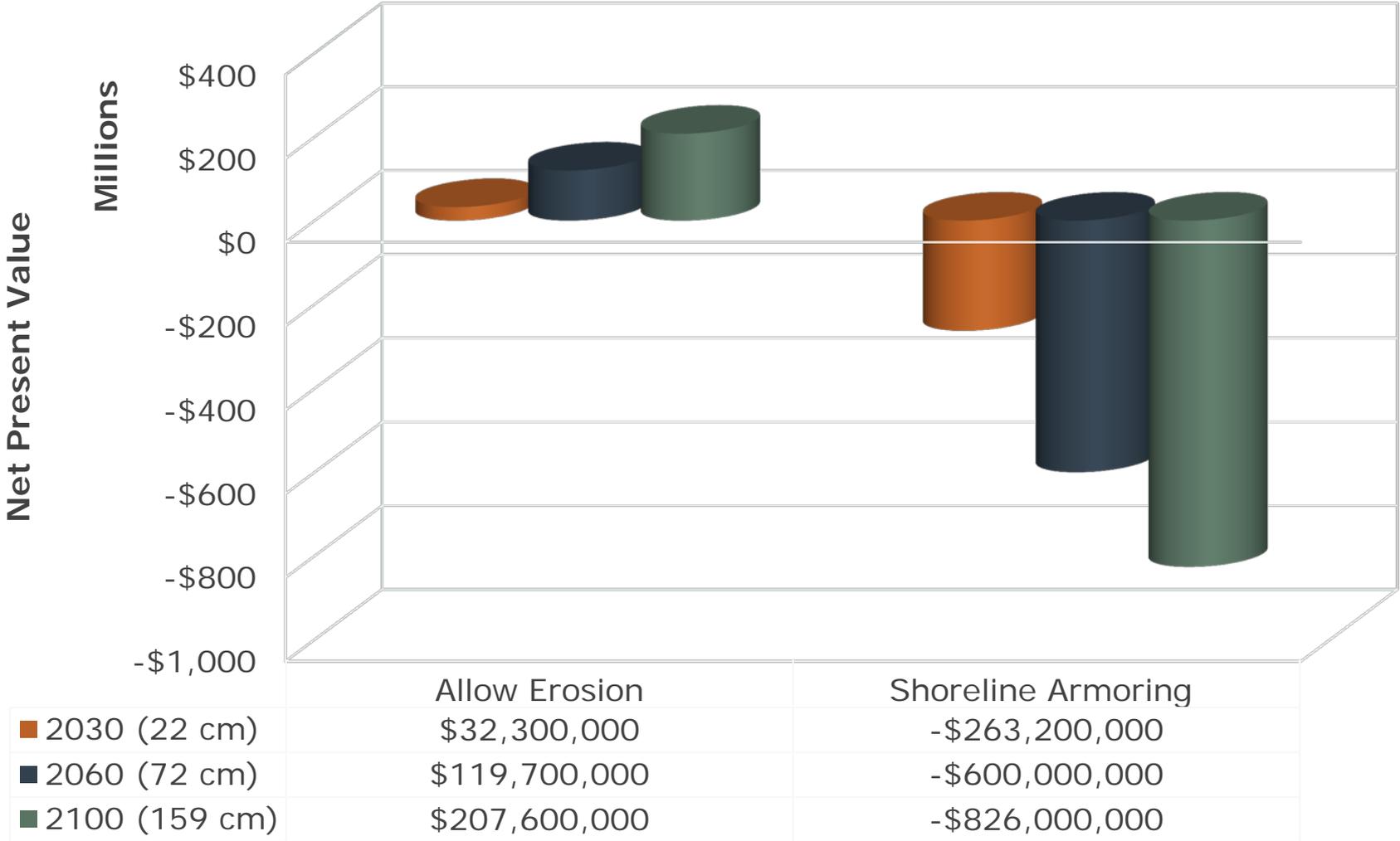


# Sand City

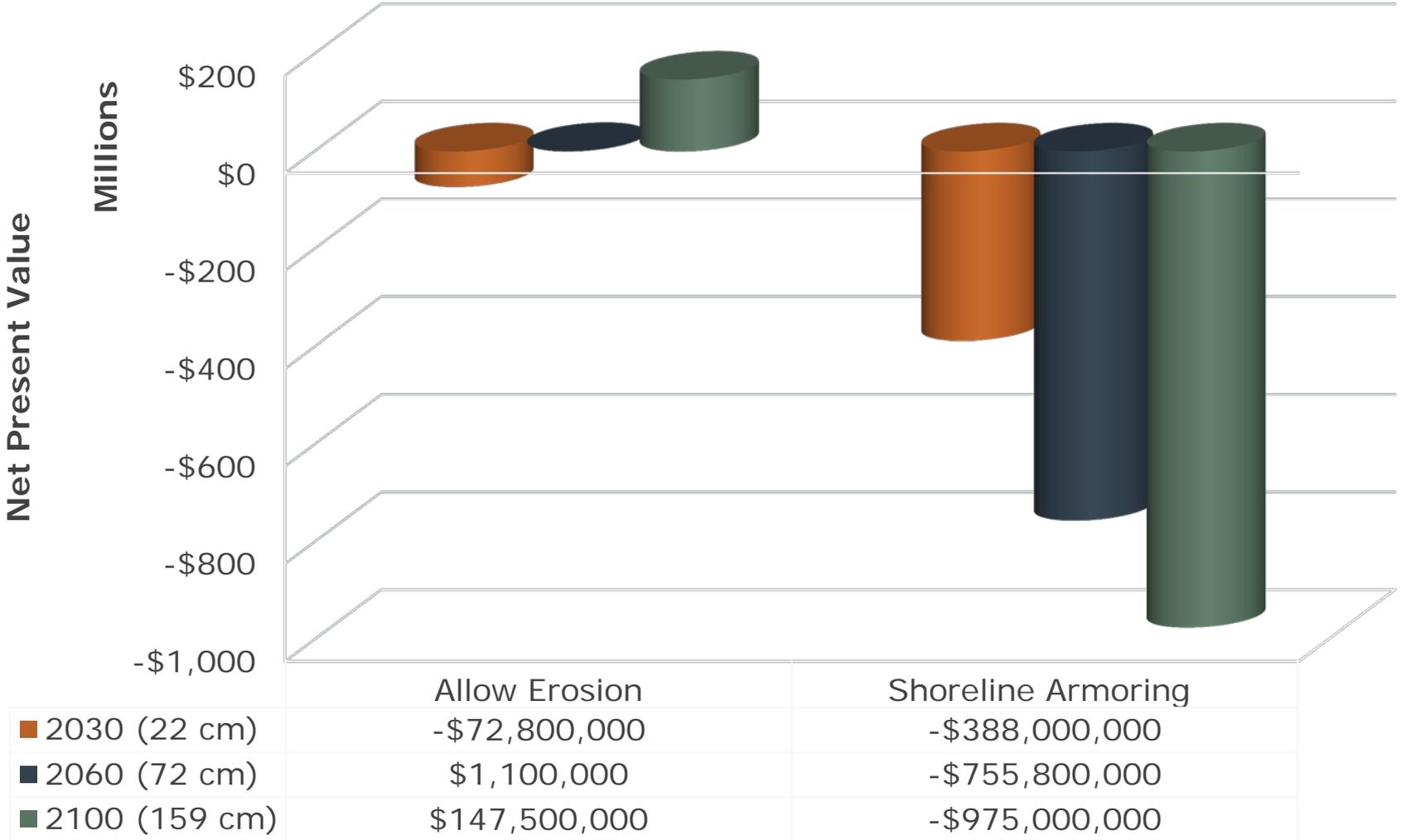


	Allow Erosion	Nourish as Needed	Shoreline Armoring
■ 2030 (22 cm)	\$33,100,000	\$9,500,000	-\$40,500,000
■ 2060 (72 cm)	\$103,100,000	\$92,300,000	-\$106,600,000
■ 2100 (159 cm)	\$144,800,000	\$63,700,000	-\$163,200,000

# Marina



# Moss Landing



# Sensitivity/ Robustness

- We changed the Value of Key Parameters to see if it would change our results
- For every reach except Del Monte, Shoreline Armoring had Lowest NPV under a wide variety of Assumptions
- Nourish w Groins sometimes Lowest in Del Monte



Any questions for Phil?



## TAKE-AWAYS & NEXT STEPS

Kelly Leo, The Nature  
Conservancy

# NON-ARMORING & NATURE-BASED SOLUTIONS ECONOMICALLY OUTPERFORM SHORELINE ARMORING



BEACH NOURISHMENT YIELDS BENEFITS  
FOR SOME LOCATIONS, IF SAND IS  
AVAILABLE & AFFORDABLE



# MANAGED RETREAT IS AN ECONOMICALLY **SMART** STRATEGY



# PLANNING AHEAD IS REALLY IMPORTANT





PEOPLE

+



NATURE

+



MONEY



# DISCUSSION



**Kelly Leo**, The Nature Conservancy

**Bob Battalio**, Environmental Science Associates (ESA)

**Dr. Philip King**, Economist, SFSU

**Dr. Walter Heady**, The Nature Conservancy

# SOCIAL VULNERABILITY & DEMOGRAPHIC ISSUES IN COASTAL ADAPTATION



Photo credit: OxFam

**Nate Wood, USGS**

**Susi Moser, Susanne Moser Research & Consulting**

**June 15, 2016**

**10:30AM – 12:00**

THANK YOU!