Reexamination of sediment management in Newport Bay under accelerating sea-level rise

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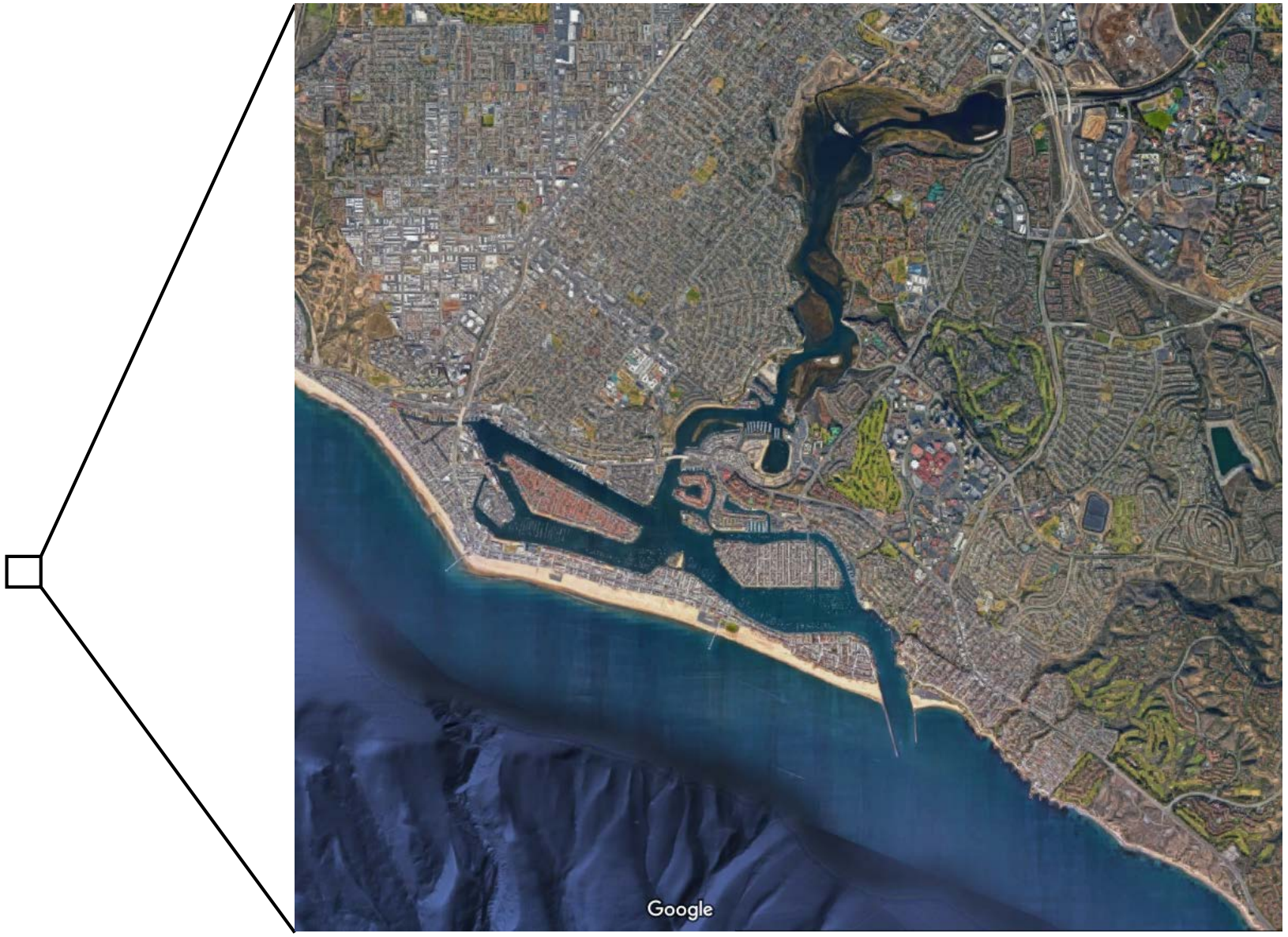
Where and What is Newport Bay?



Sources: Google Maps

Where and What is Newport Bay?

Motivation

- Newport Bay relies on sediment management to preserve critical habitat, sustain recreational activities and maintain federal navigational channels.
  - Sediment basins requiring periodic dredging
  - Watershed control measures

- Predictions of future change are needed to plan/adapt management of the system and require a coupled natural-human system modeling approach capable of accounting for major uncertainties.
  - Natural processes: stormwater inputs, tidal currents
  - Human activities: dredging, watershed controls of sediment loads

Historical Context

Impacts of Significant Human Intervention

1896

1932

1952

1970

1980

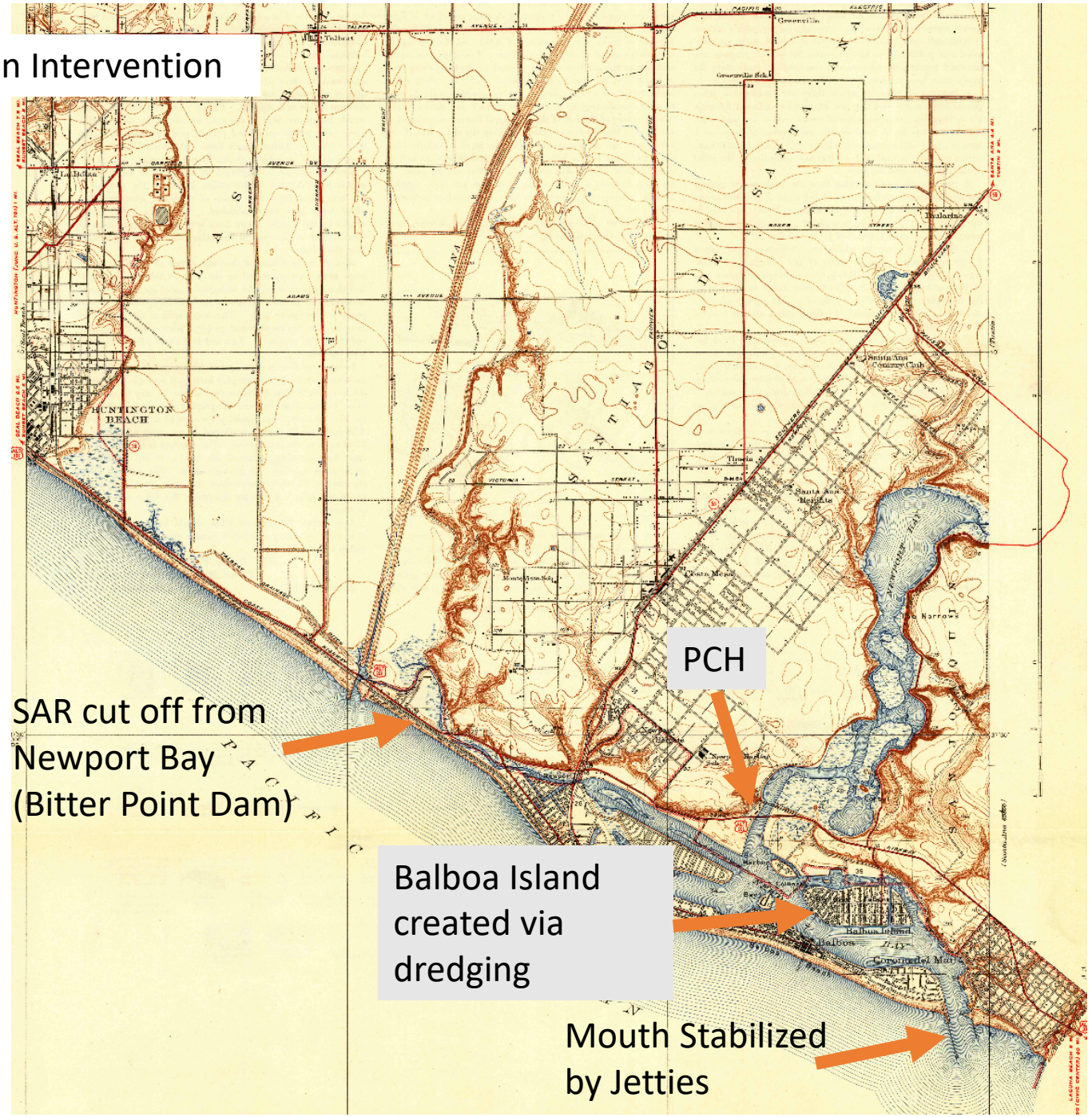
1990

2018

2100

Source: USGS T-Sheet

Impacts of Significant Human Intervention



1896
1932
1952
1970
1980
1990
2018
2100

Source: USGS T-Sheet

Impacts of Extreme Events

1896

1932

1952

1970

1980

1990

2018

2100

Source: County of Orange, Historical Ariel Imagery, ESRI

Impacts of Human Intervention and Excessive Sedimentation

1896

1932

1952

1970

1980

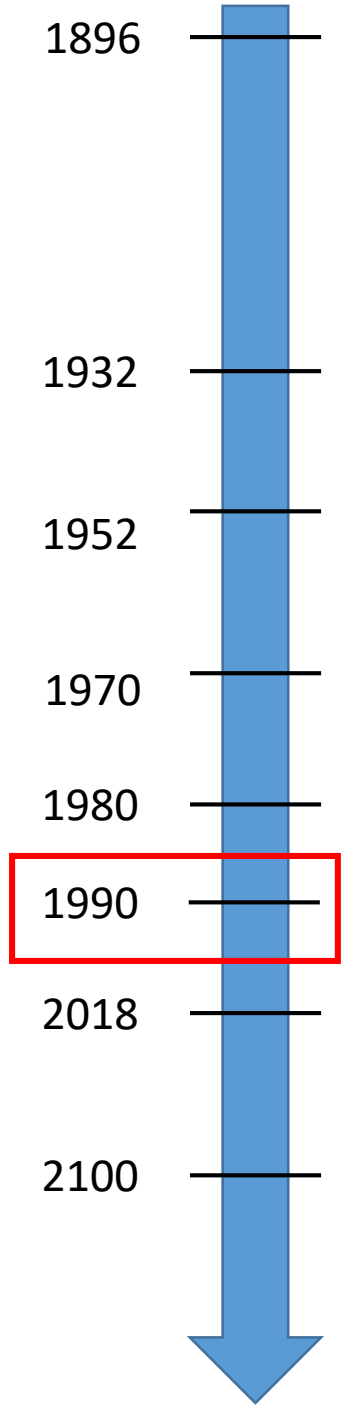
1990

2018

2100

Source: County of Orange, Historical Ariel Imagery, ESRI

Impacts of Human Intervention and Excessive Sedimentation



Source: County of Orange, Historical Ariel Imagery, ESRI

Impacts of Human Intervention

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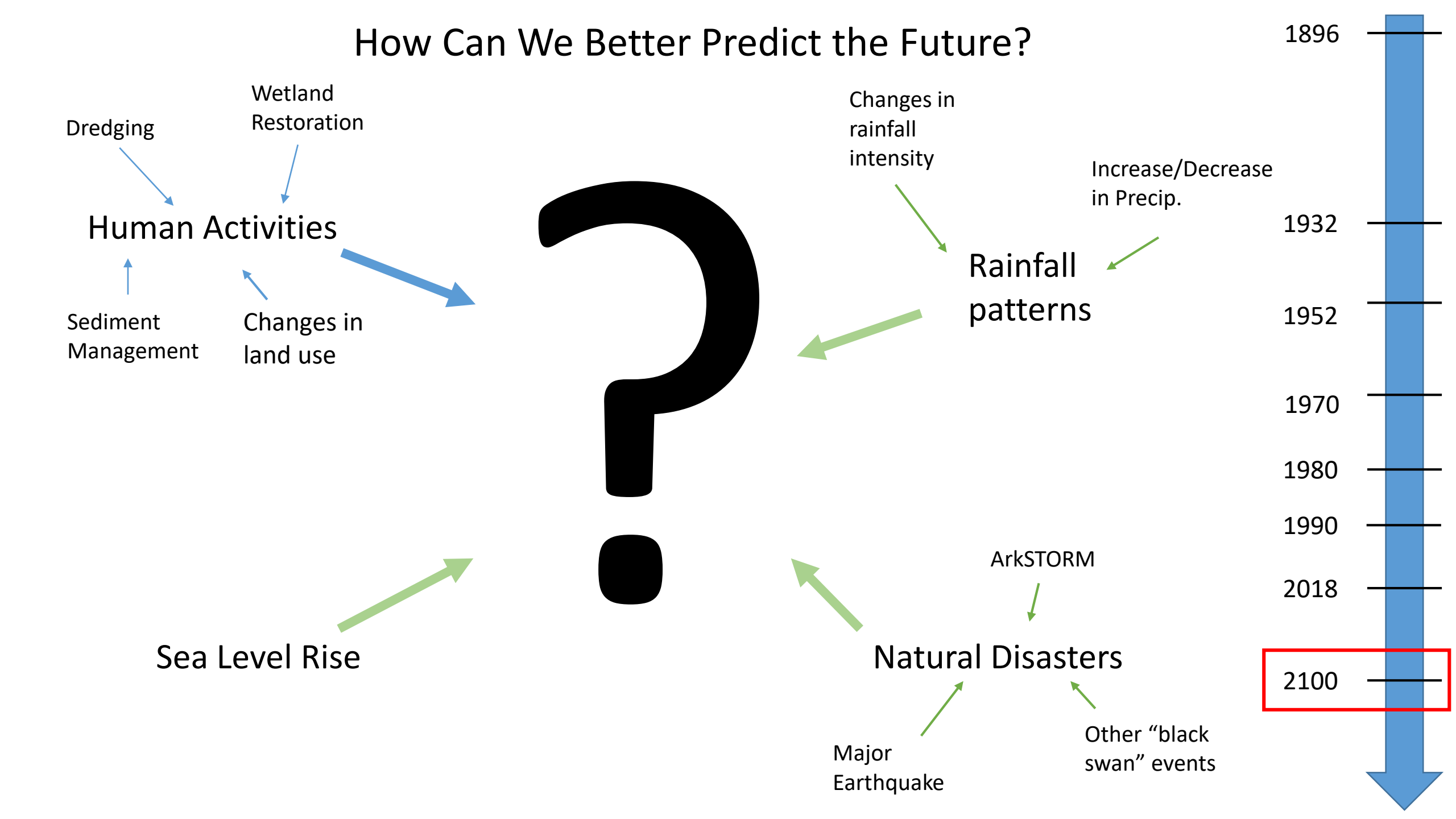
Source: Google

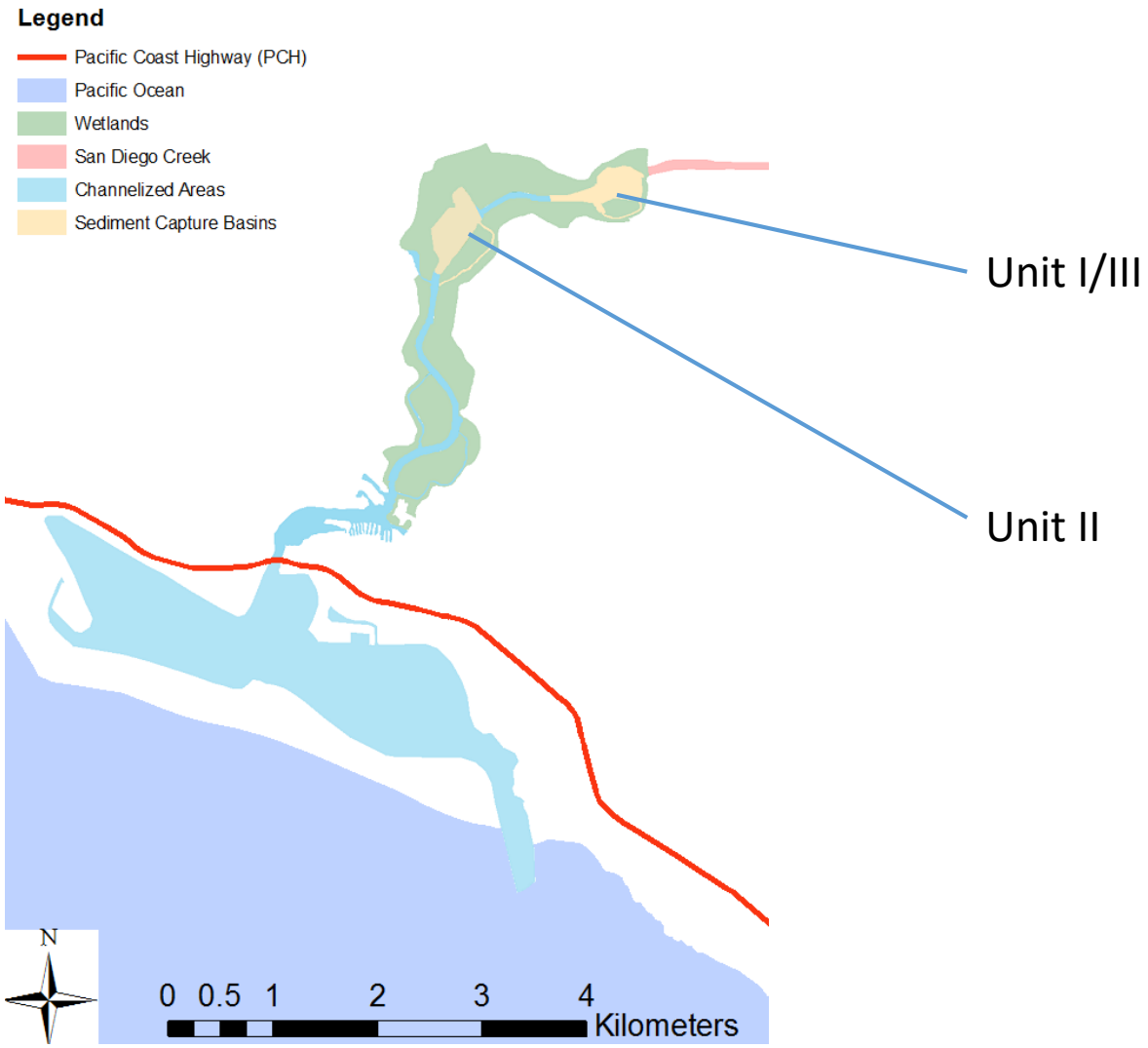
How Can We Better Predict the Future?



Systems Modeling Approach

- In this presentation we present a probabilistic, systems modeling approach focused on sediment basin management – how often will dredging be required considering:
  - Watershed control measures
  - Sea level rise
  - Basin dredging trigger point

Systems Modeling Approach: Three Steps



1. Physical modeling of basins was completed with Delft3D, a high resolution, 3D hydromorphodynamic modeling package

2. Delft3D was then used to inform a lower resolution "surrogate model" which at the expense of a loss of accuracy, is significantly more efficient

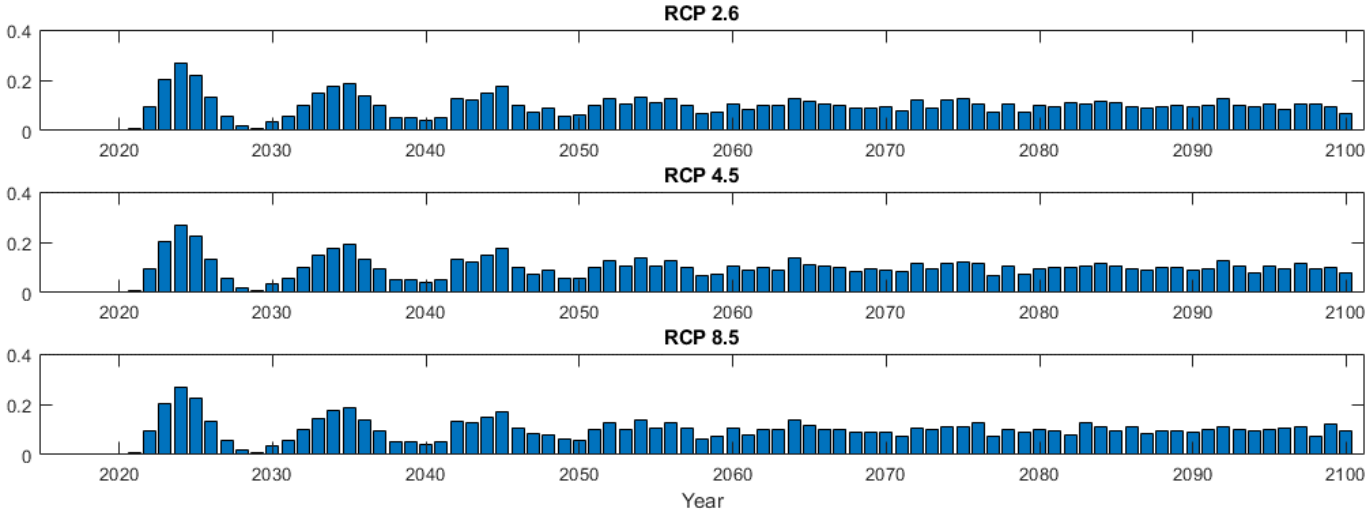
3. We run many simulations to capture variability in possible sea level rise and storm input scenarios and measure required dredging based on "trigger point" requirement.

Question 1

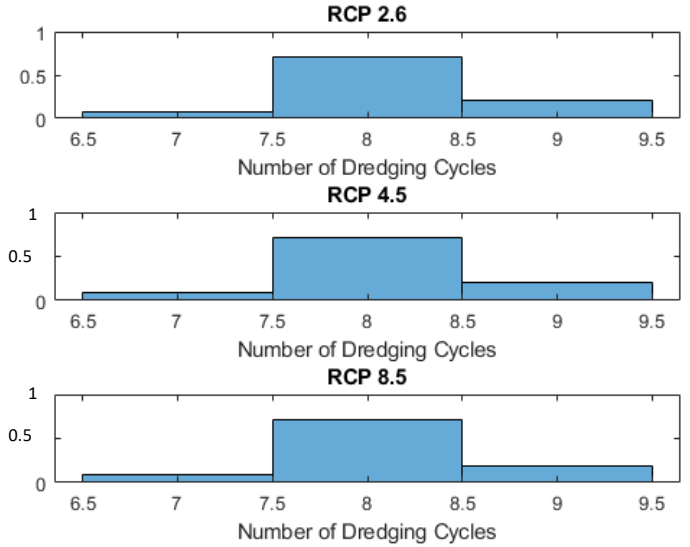
How many dredging cycles are needed to maintain basin elevations through 2100 based on pre- and post-TMDL loading rates?

Pre-TMDL Loading Rates

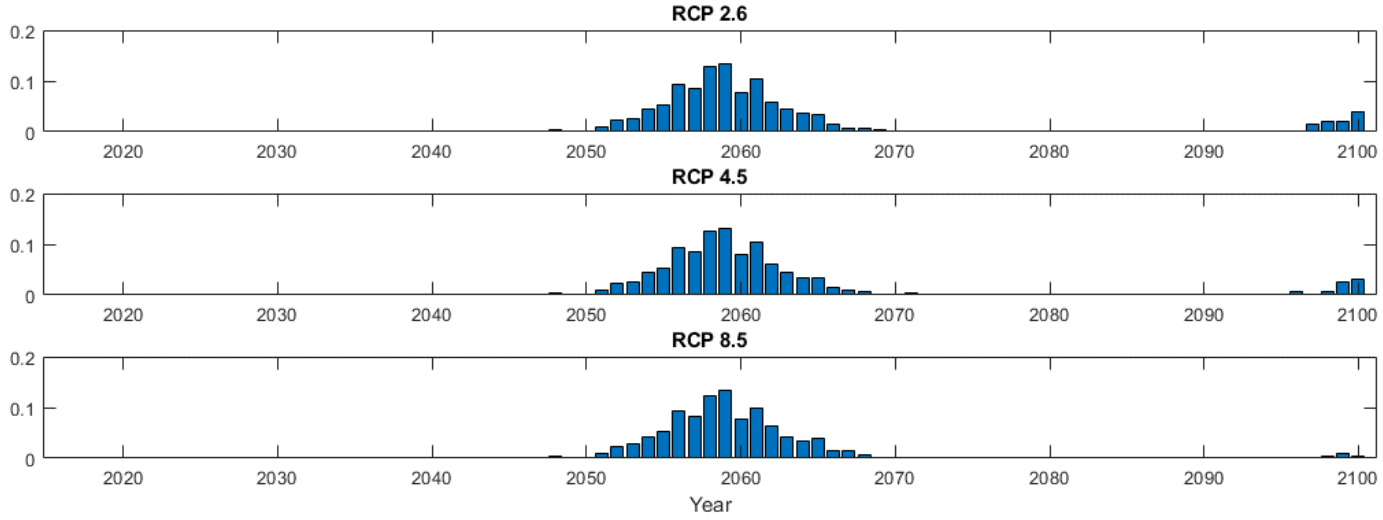
Probability of Dredging in a Given Year

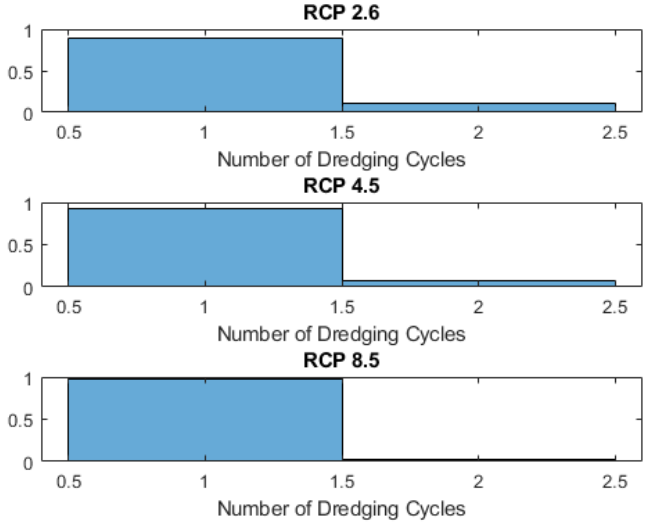


Probability of Number of Dredging Cycles Through 2100



Post-TMDL Loading Rates

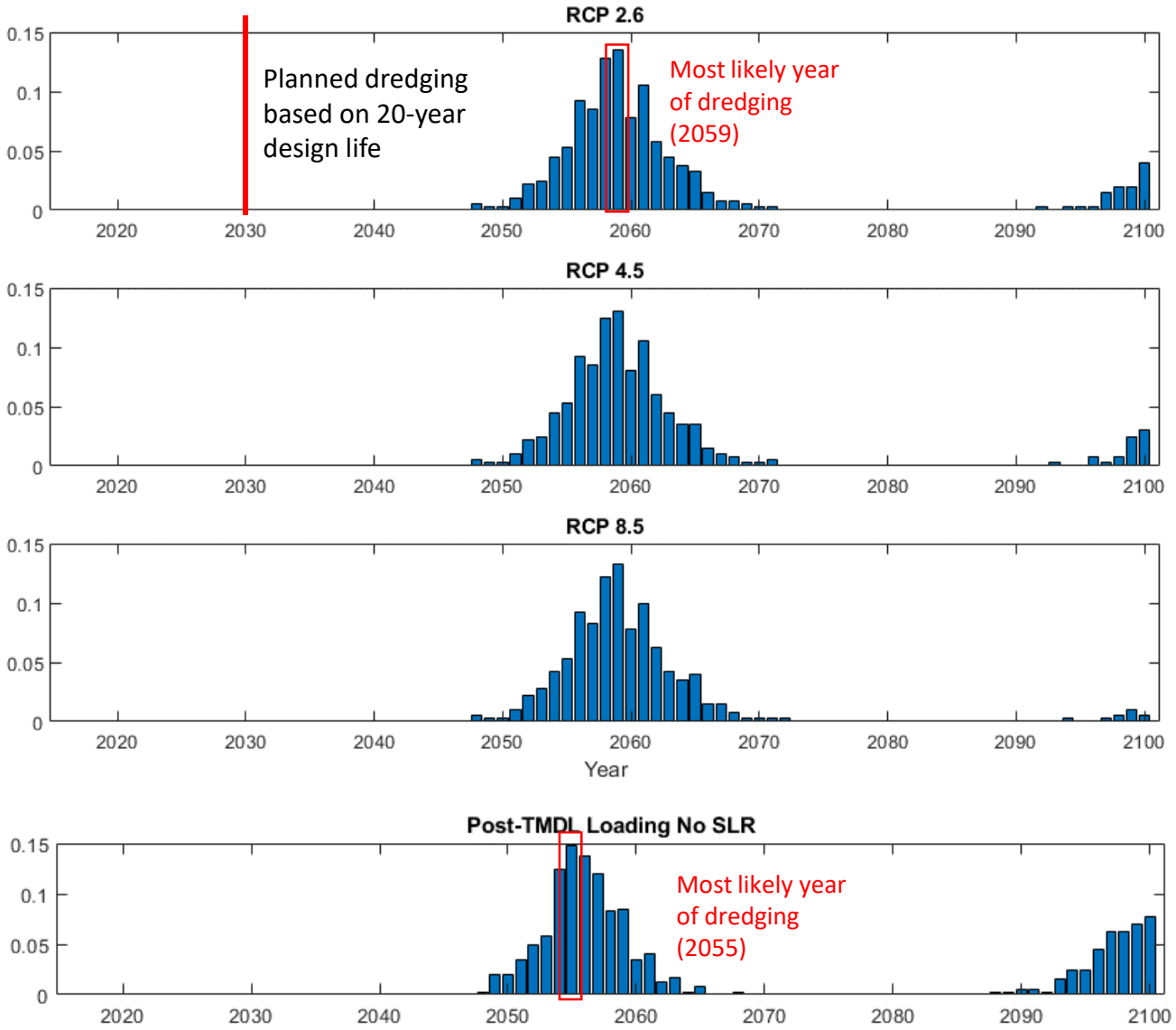




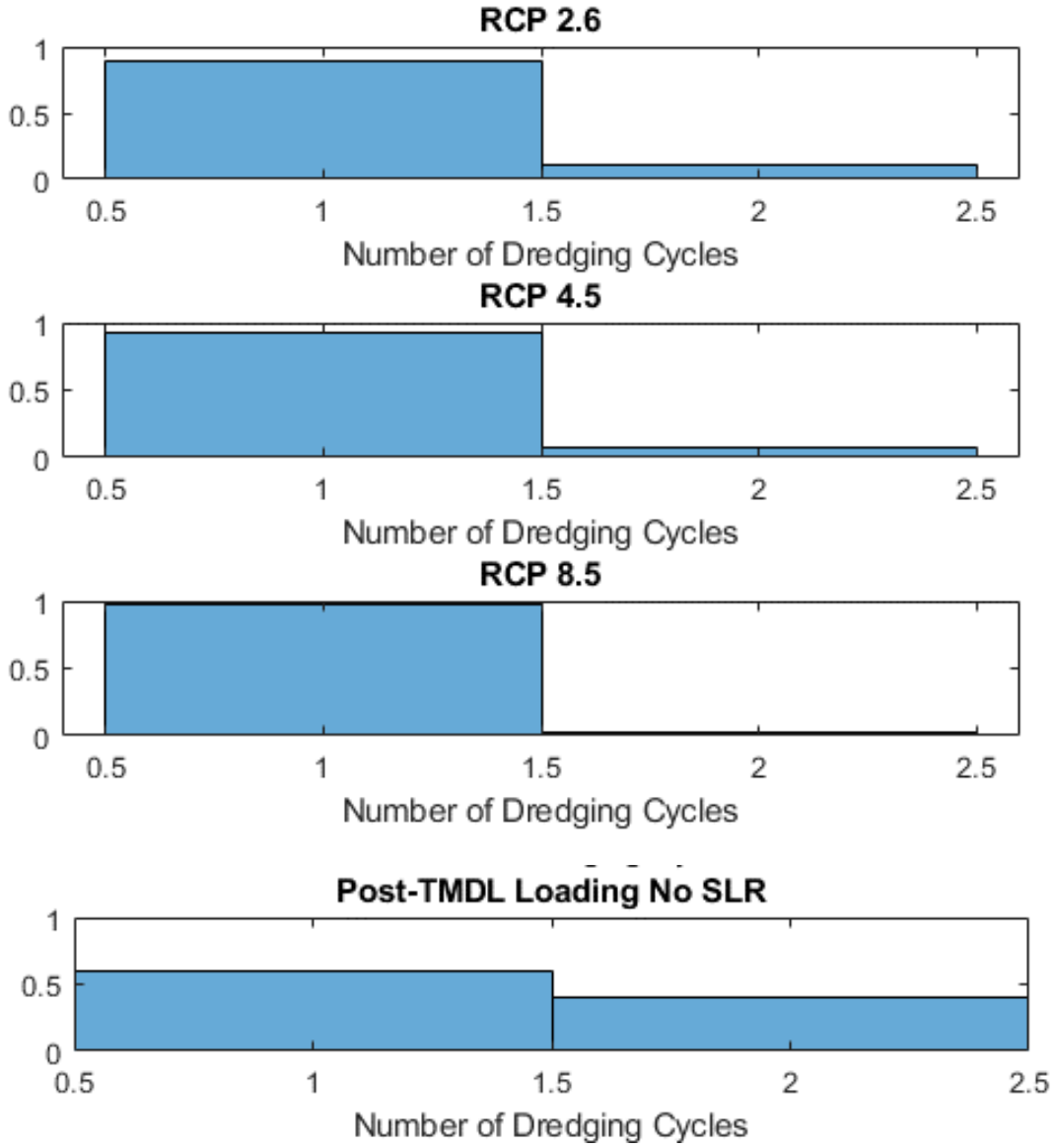
Question 2

How important are SLR scenarios (e.g. RCP 4.5 vs 8.5) to the amount of required dredging cycles?

Probability of Dredging in a Given Year



Number of Dredging Cycles Through 2100

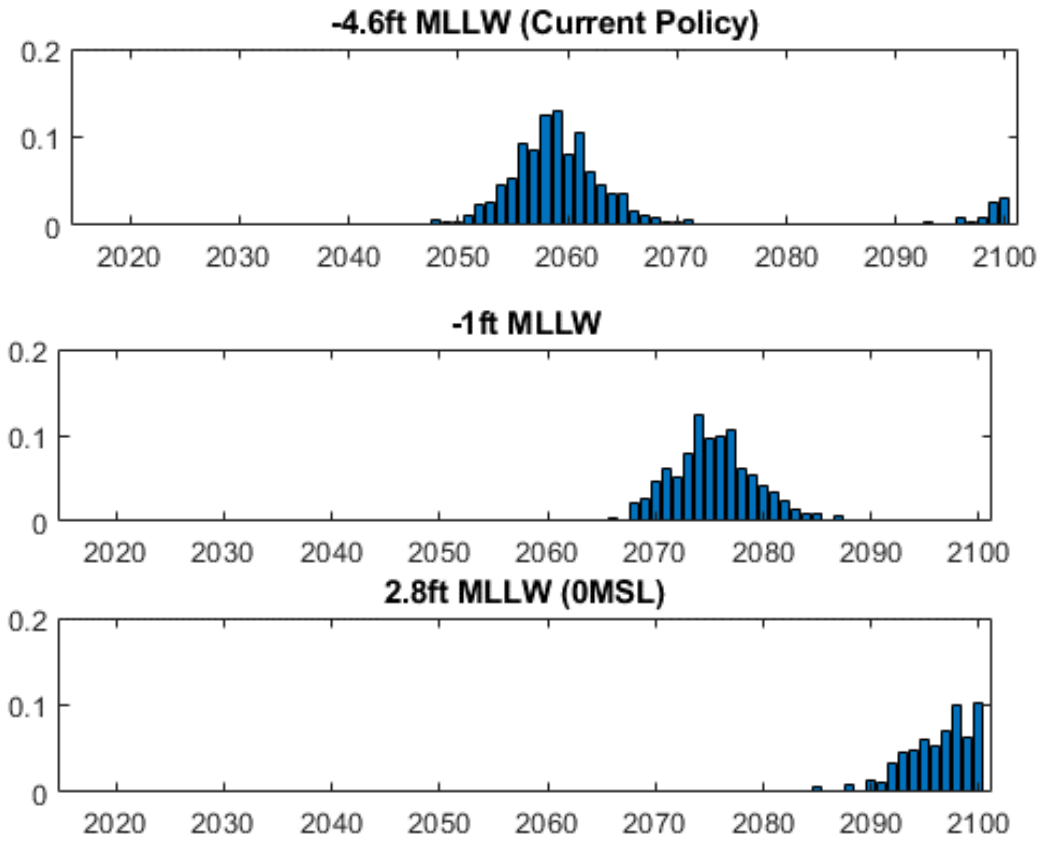


Question 3

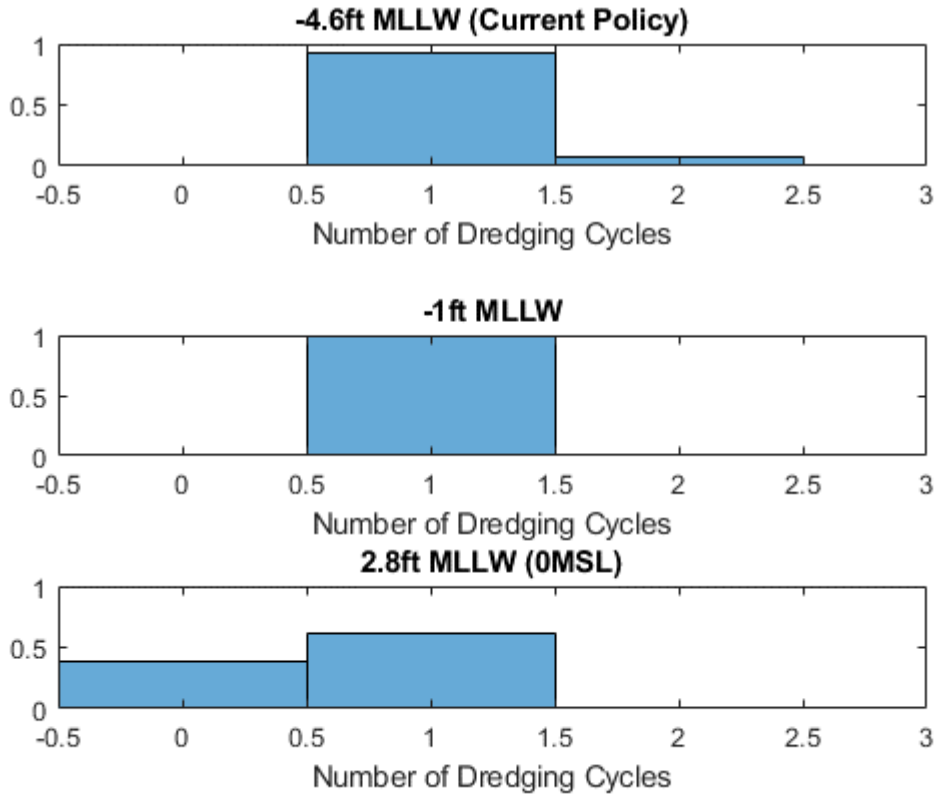
How does modification of the dredging “trigger elevation” affect the number of required dredging cycles?

Effect of “trigger elevation”

Probability of Dredging in a Given Year



Probability of Number of Dredging Cycles Through 2100



Conclusions

- Reduction of sediment loads resulting from TMDL reduces the number of dredging cycles for 2015-2100 from eight to one to two.
- Trigger elevation for dredging could vary the number of dredging cycles for 2015-2100 from 1-2 to potentially zero.
- Through 2050, sea level rise will have minimal impact on in-basin sediment management compared to upstream sediment management policies and storm flows.
- Past 2050, through 2100, sea level rise will have a significant impact on in-basin management, and the SLR trajectory will play a significant role in probability of dredging.

Acknowledgments