Changes in Tidal Hydraulics at Crims Island in Response to Restoration Activities

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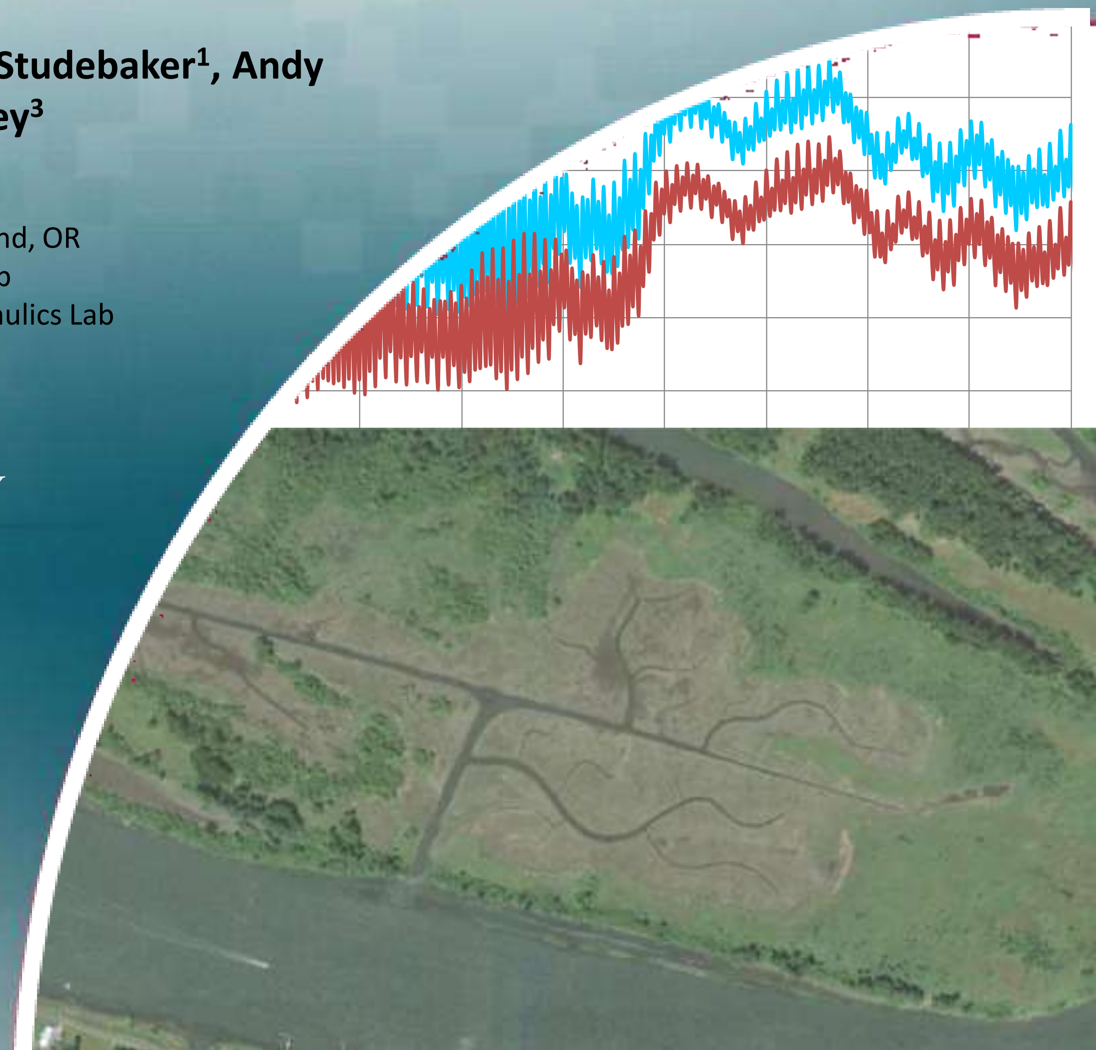


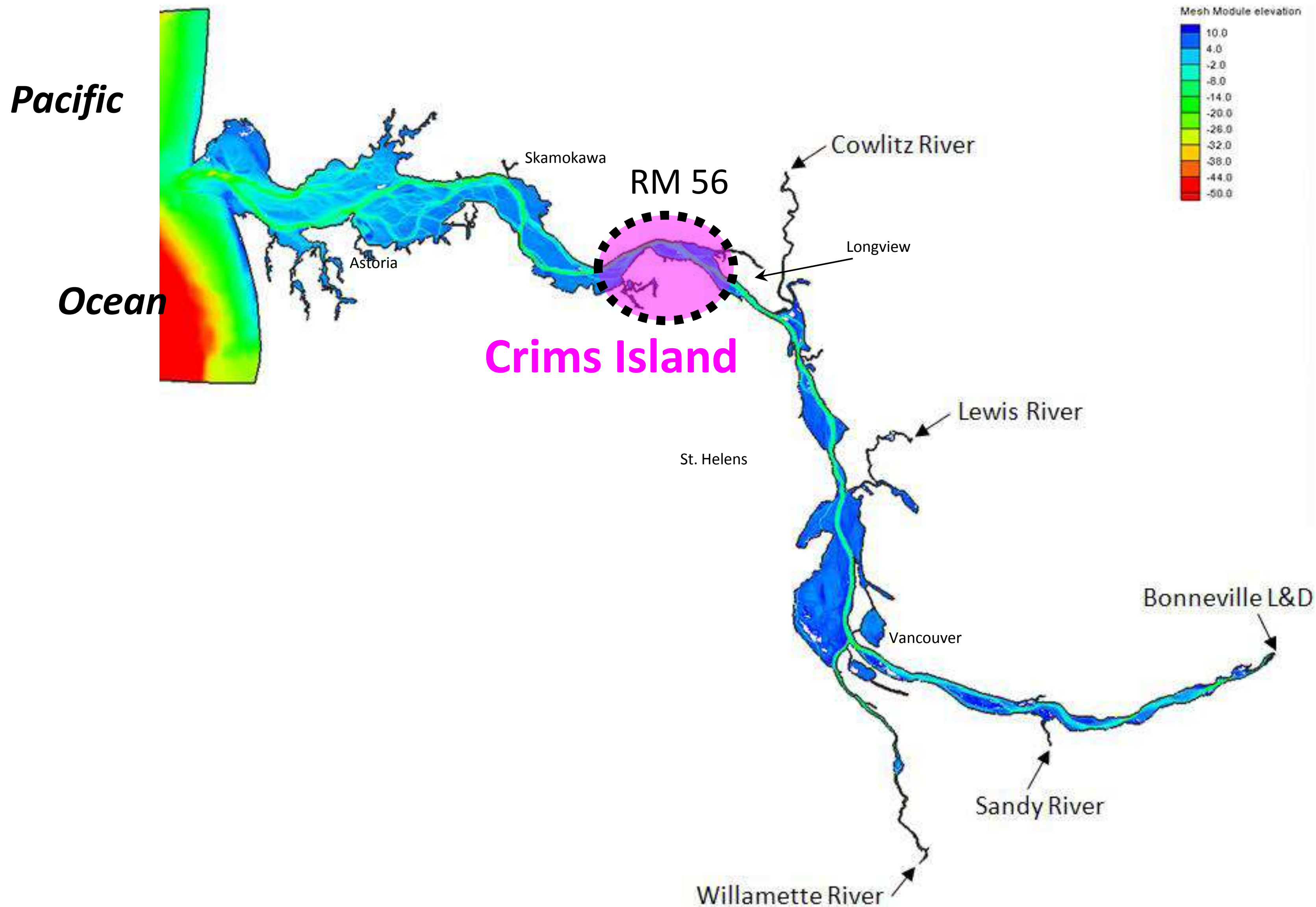
2014 Columbia River Estuary Workshop:
Forging Links in the Columbia River Estuary

PRESENTATION OUTLINE

1) Highlight Implementation of Crims Island Restoration.

2) Summarize AdH model development at Crims Island

3) Investigate Changes in tidal hydraulics due to Restoration



AdH Model Domain for the Lower Columbia River (147 miles)

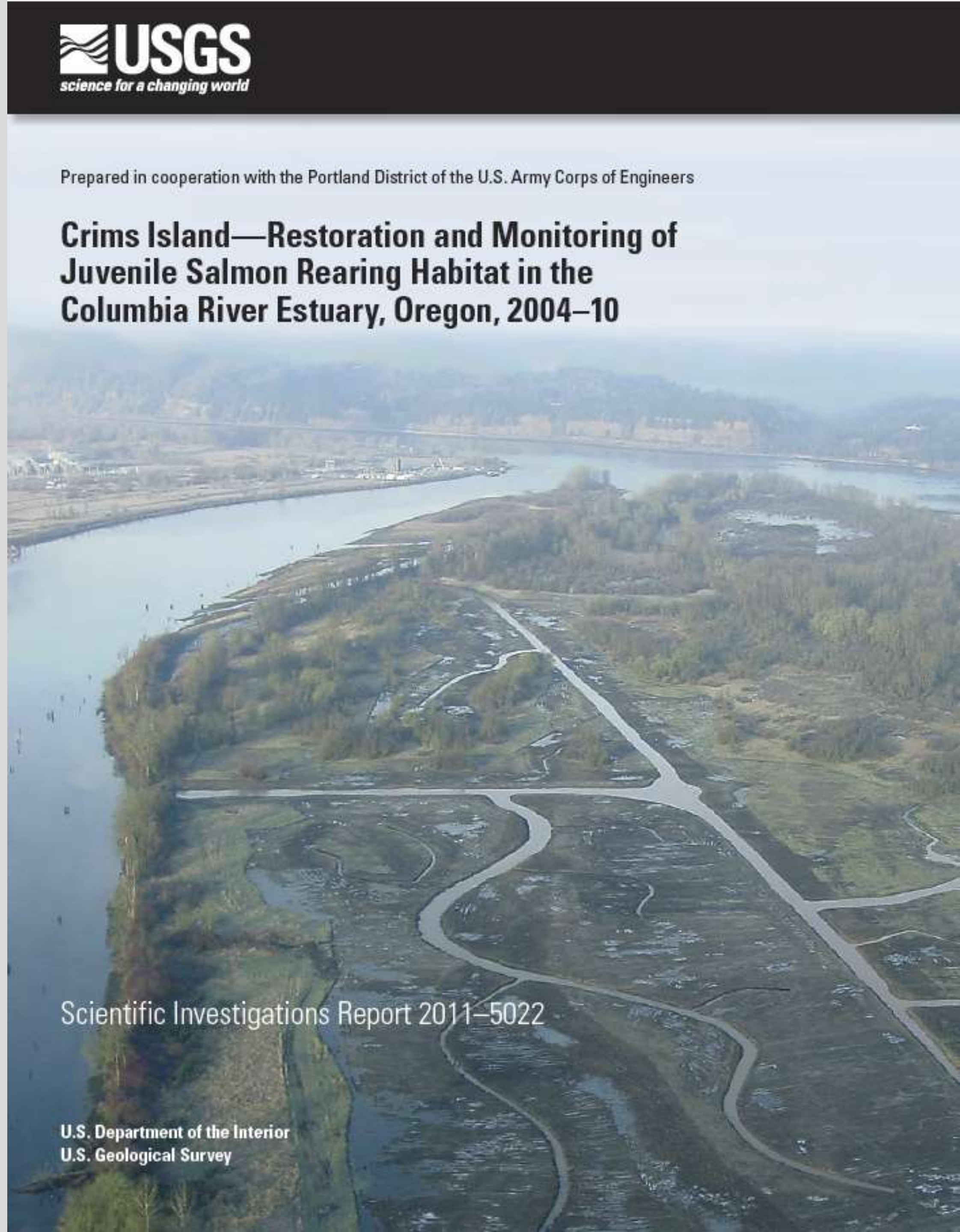
AdH = adaptive hydraulics – developed by USACE-ERDC-CHL

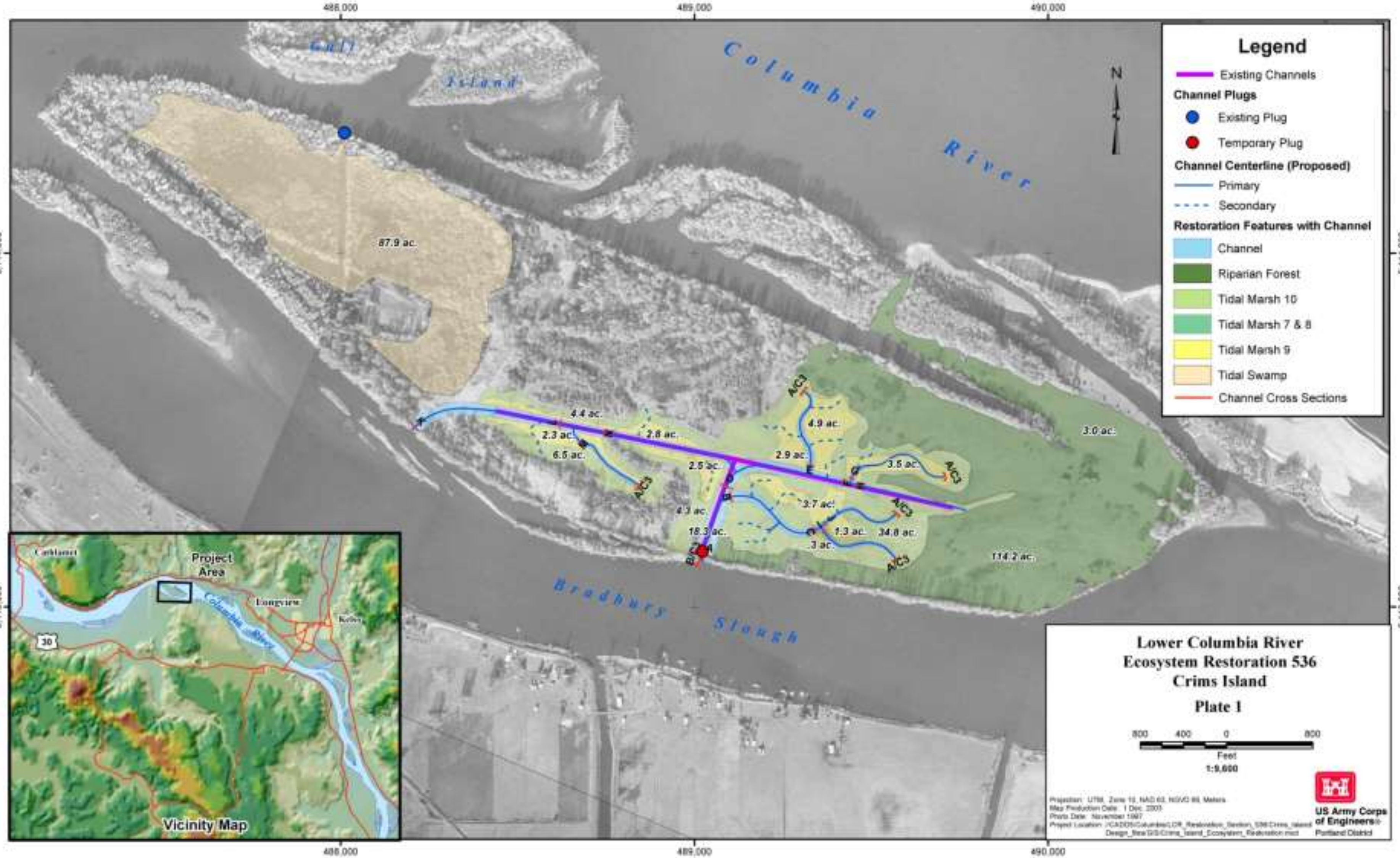
An Excellent reference for documenting *Crims Island* restoration activities in terms of:

1) Rationale,

2) Implementation,

3) Monitoring





Excavation plan and tidal channel layout for Crims Island restoration, USACE.

Restoration design developed through Chris Nygaard et al in EC-HY

Construction Activities - Crims Island Restoration

2005

Cut deeper channels initially---

To allow post-construction adjustment .

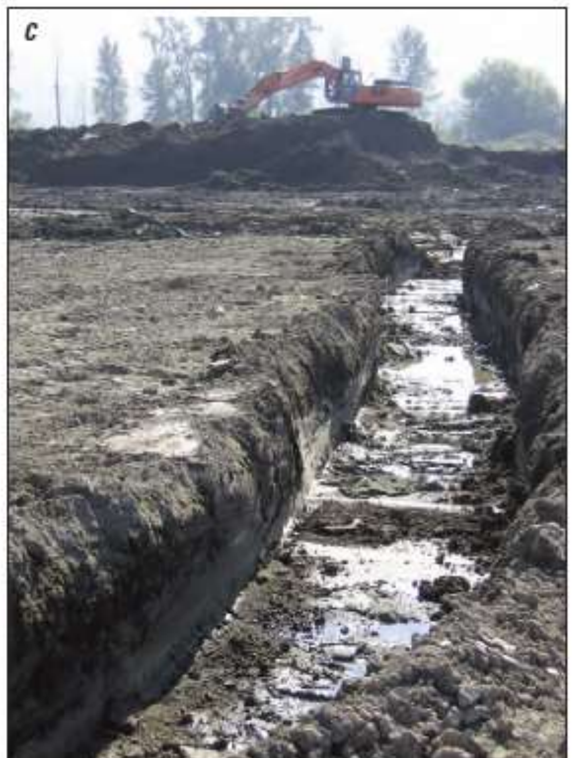
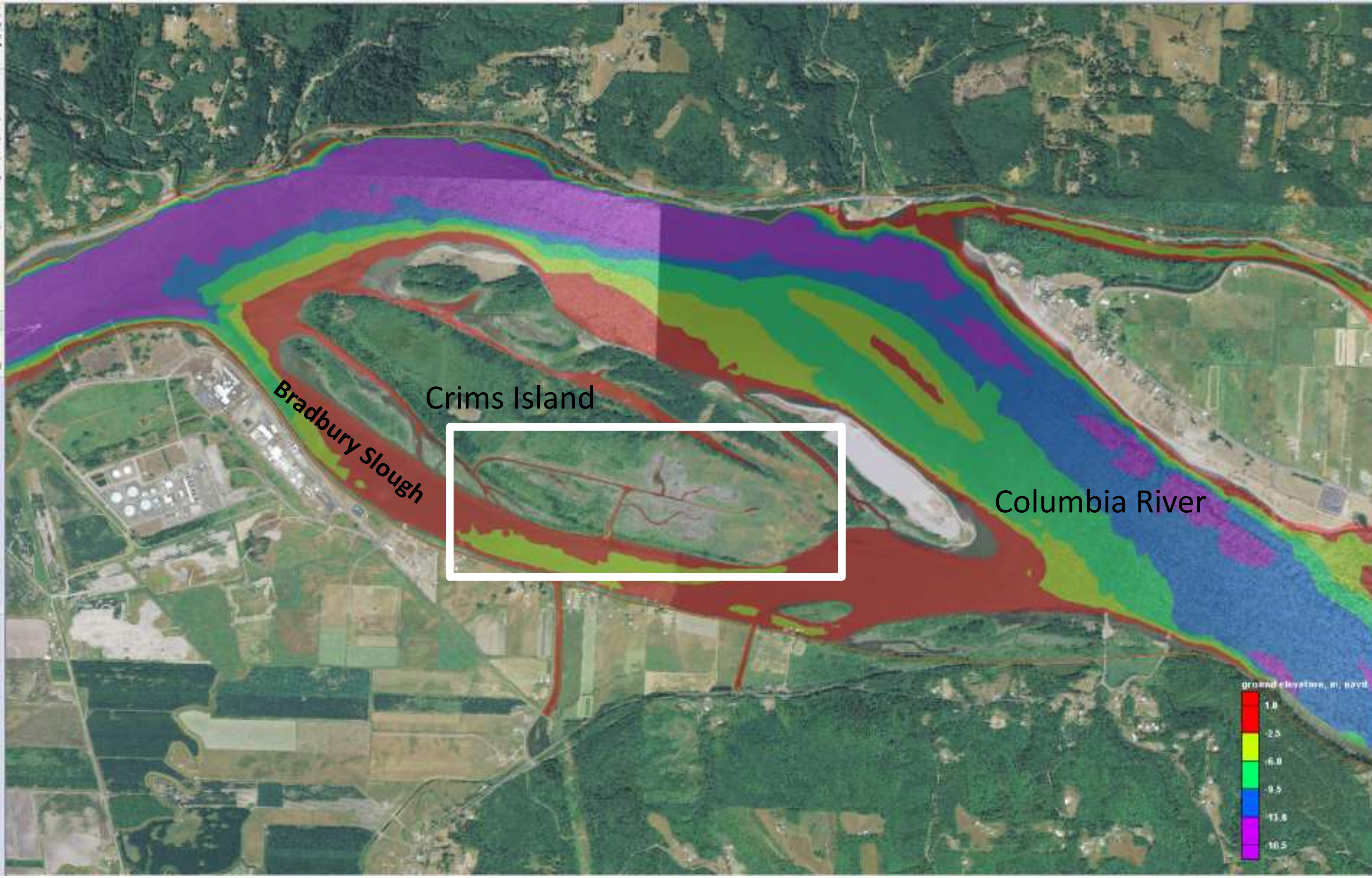


Figure 3. Excavation at Crims Island, Columbia River, Oregon, 2005. (Photographs taken by Craig Haskell and Ken Tiffan, U.S. Geological Survey, October 17, 2005).

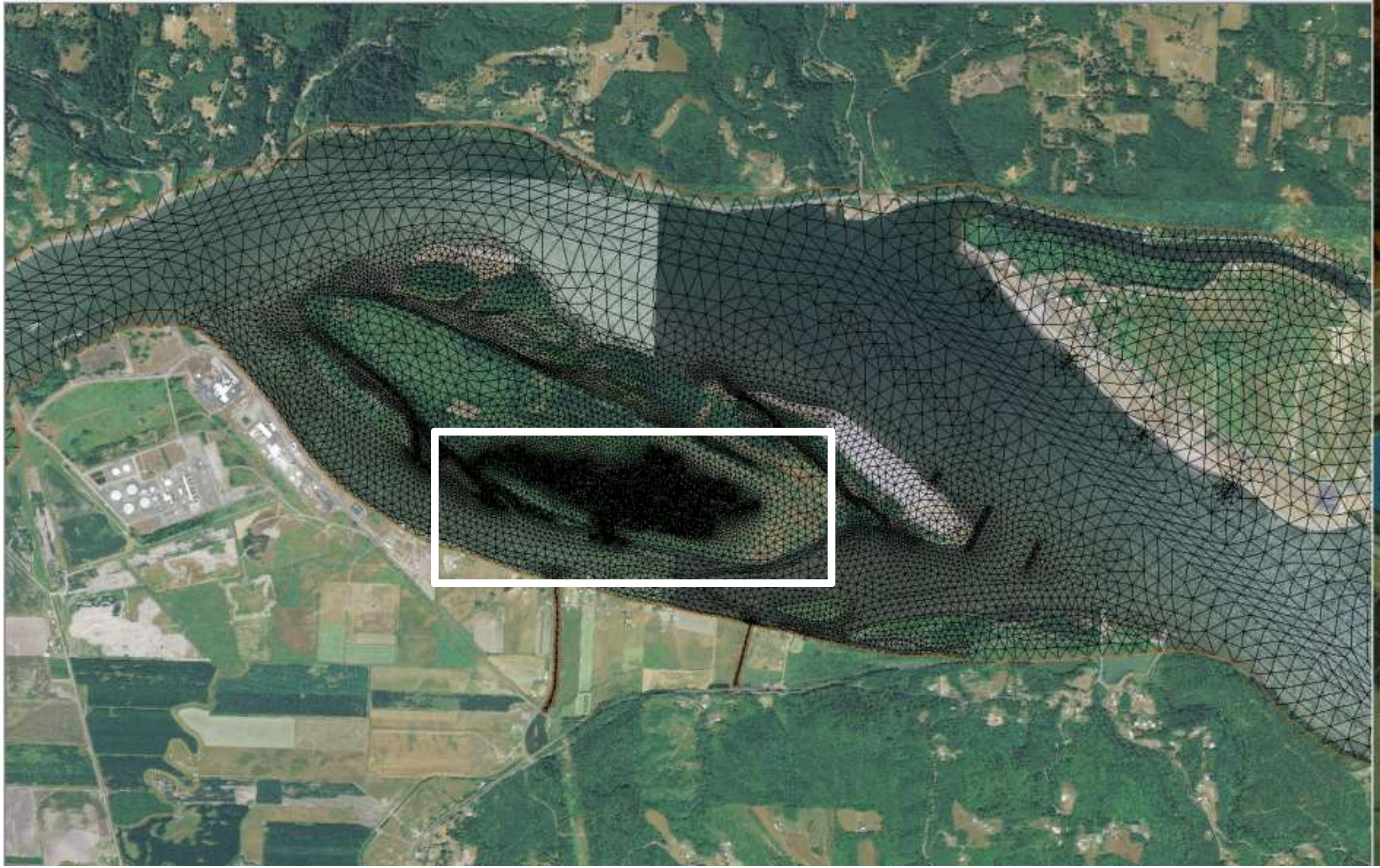
Figure 2. Habitat at Crims Island in 2004 prior to restoration, Columbia River estuary, Oregon. (Photographs taken by Craig Haskell, U.S. Geological Survey, January 16, 2004)

TOP: Crims Island on 17 AUG 2003, Prior to restoration improvement. Note presence of tidal T-channel and adjacent lowland area which would be inundated during high water level events.

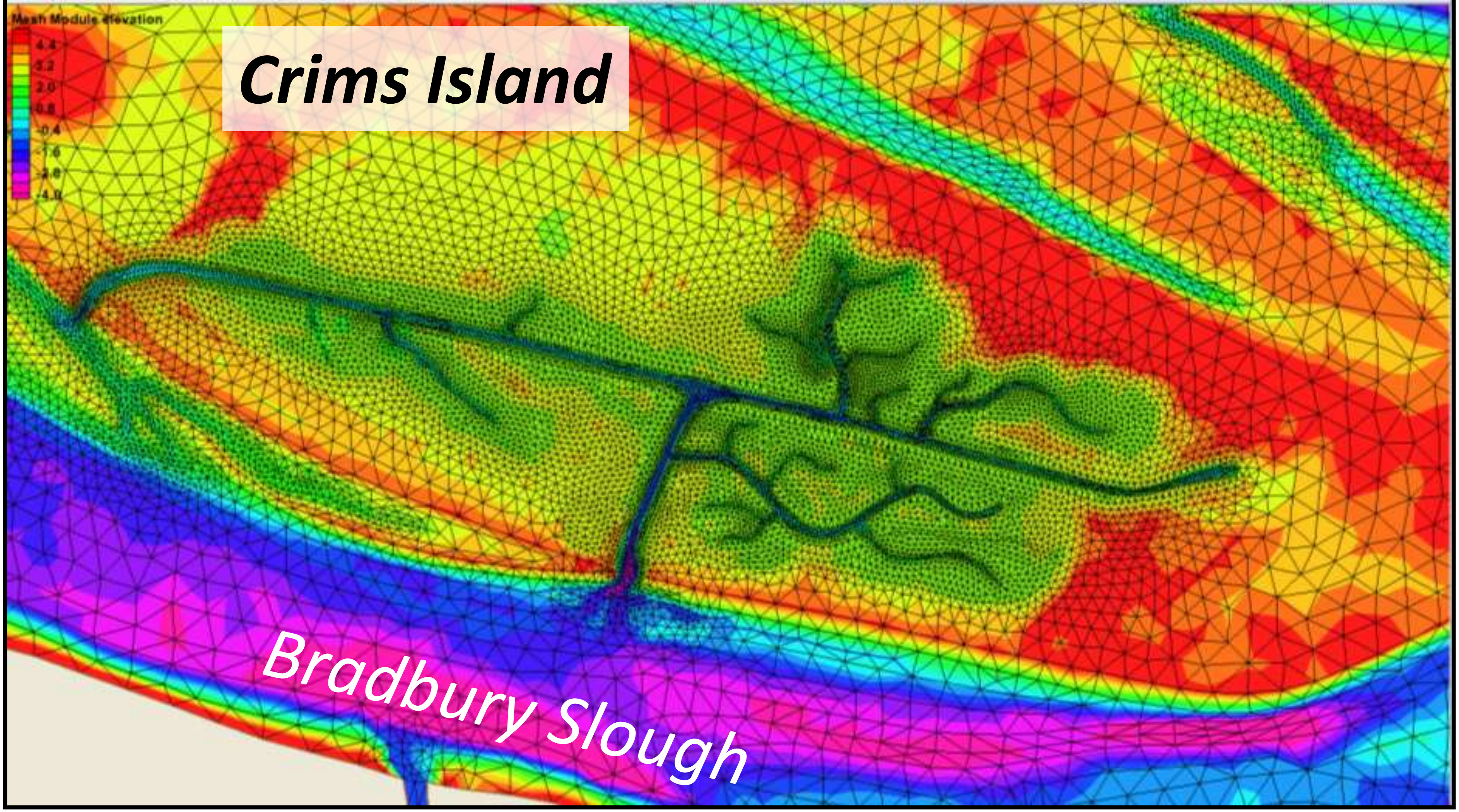
BOTTOM: Crims Island on 5 JUL 2012, After restoration improvement to excavate a 0.6-meter layer of soil, enhance the tidal T-tidal, and dig peripheral tidal channels in the interior of the island.   The affected area (denoted by the clearing of vegetation) is subjected to enhanced inundation and tidal complexity as compared to the "before restoration condition". Note that the improved T-channel now has two hydraulic connection points to Bradbury Slough.



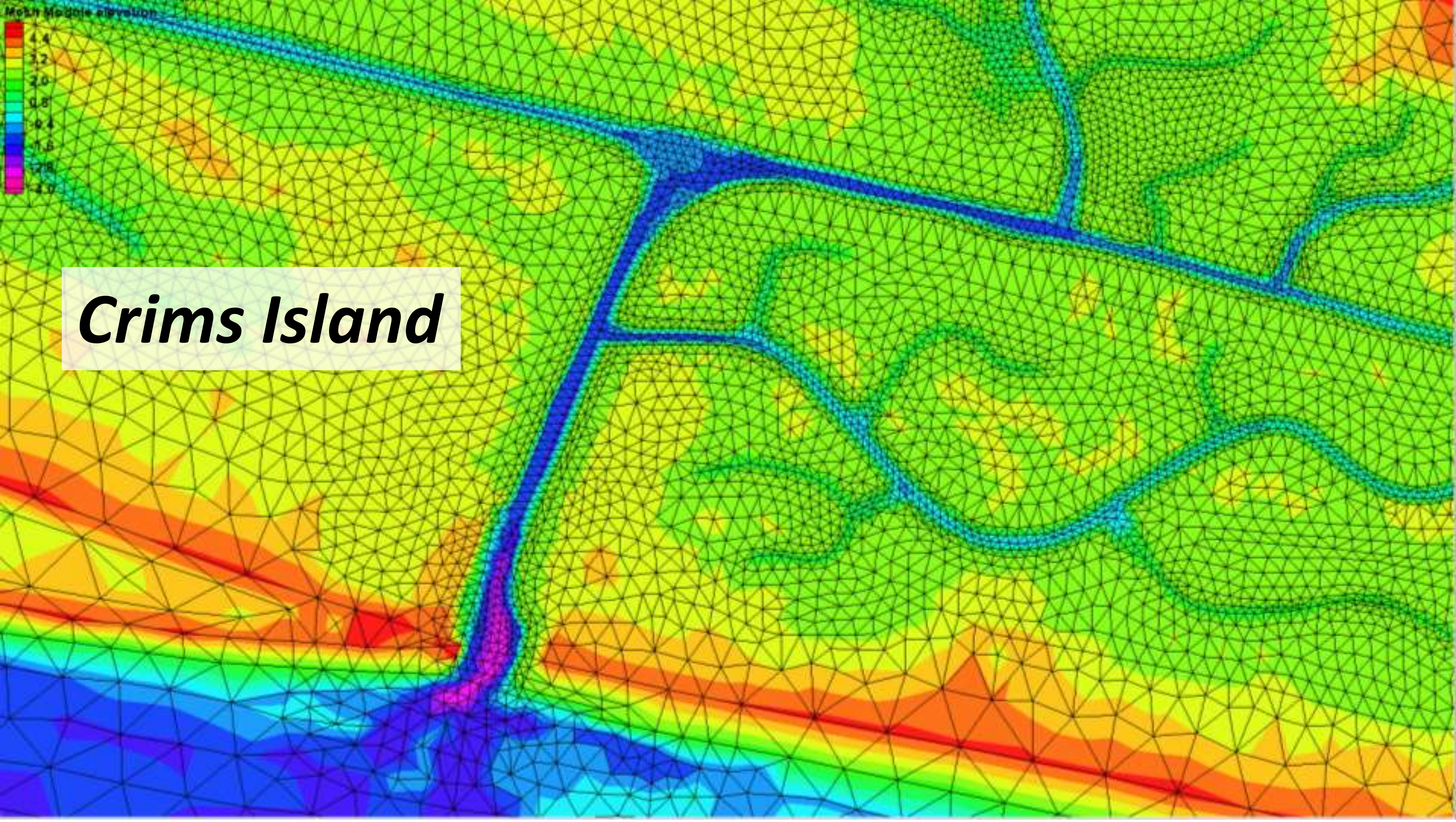
Post restoration condition for Crims Island as represented by the composition of LIDAR and conventional topographic/bathymetric surveys, restoration area is outlined by the "box". The above morphology was reproduced in a hydrodynamic model (AdH).



Finite element mesh used to emulate Crims Island within a 2-dimensional hydrodynamic model (AdH). The model was used to compare the tidal hydraulics for pre-restoration condition to post-restoration conditions. Habitat improvement associated with the post-restoration condition was assessed using the AdH hydraulic forcing within the framework of the Habitat Evaluation Model.

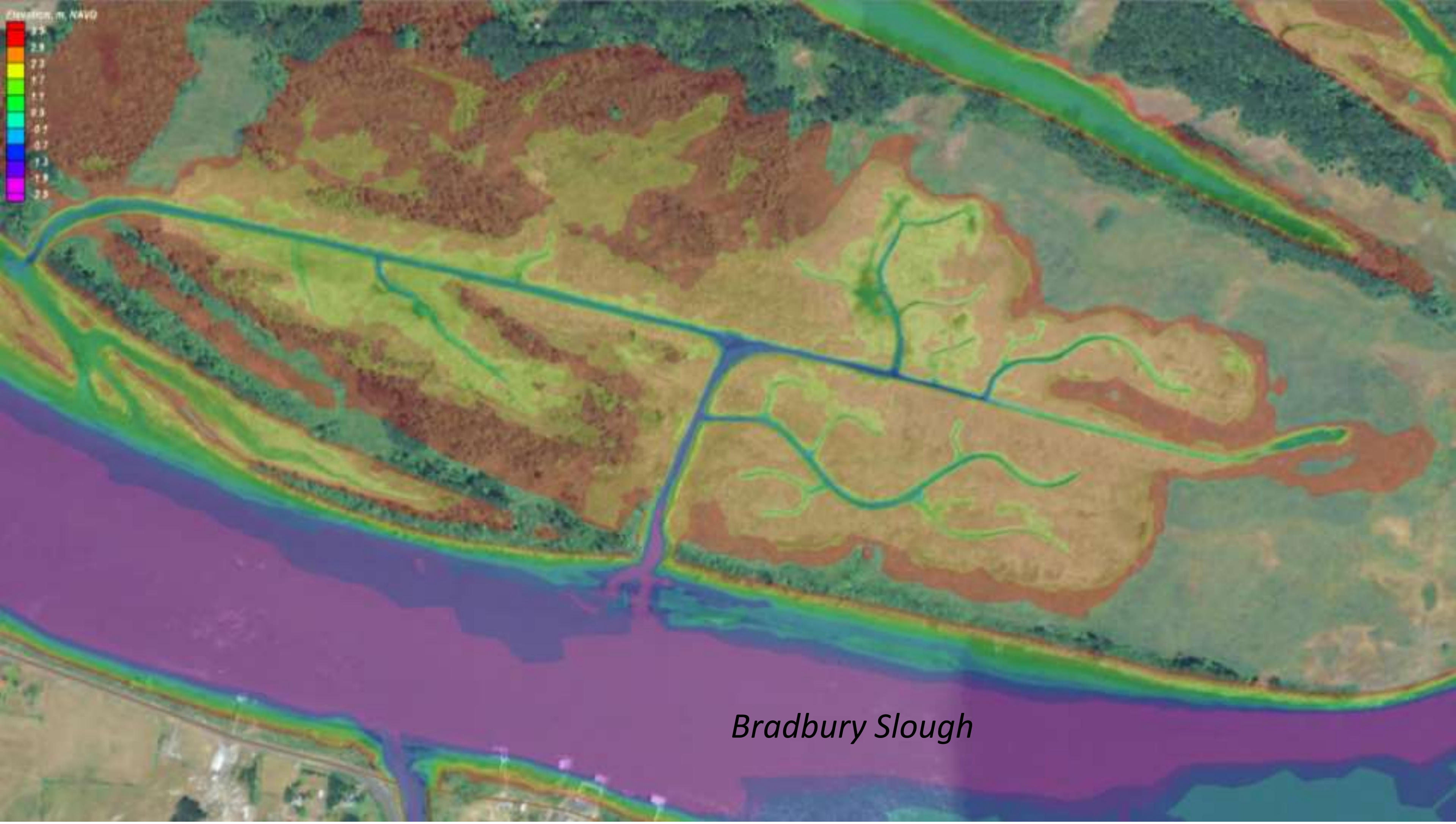


AdH Finite Element Model Mesh at Crims Island
Showing full resolution of 'restored' tidal channels

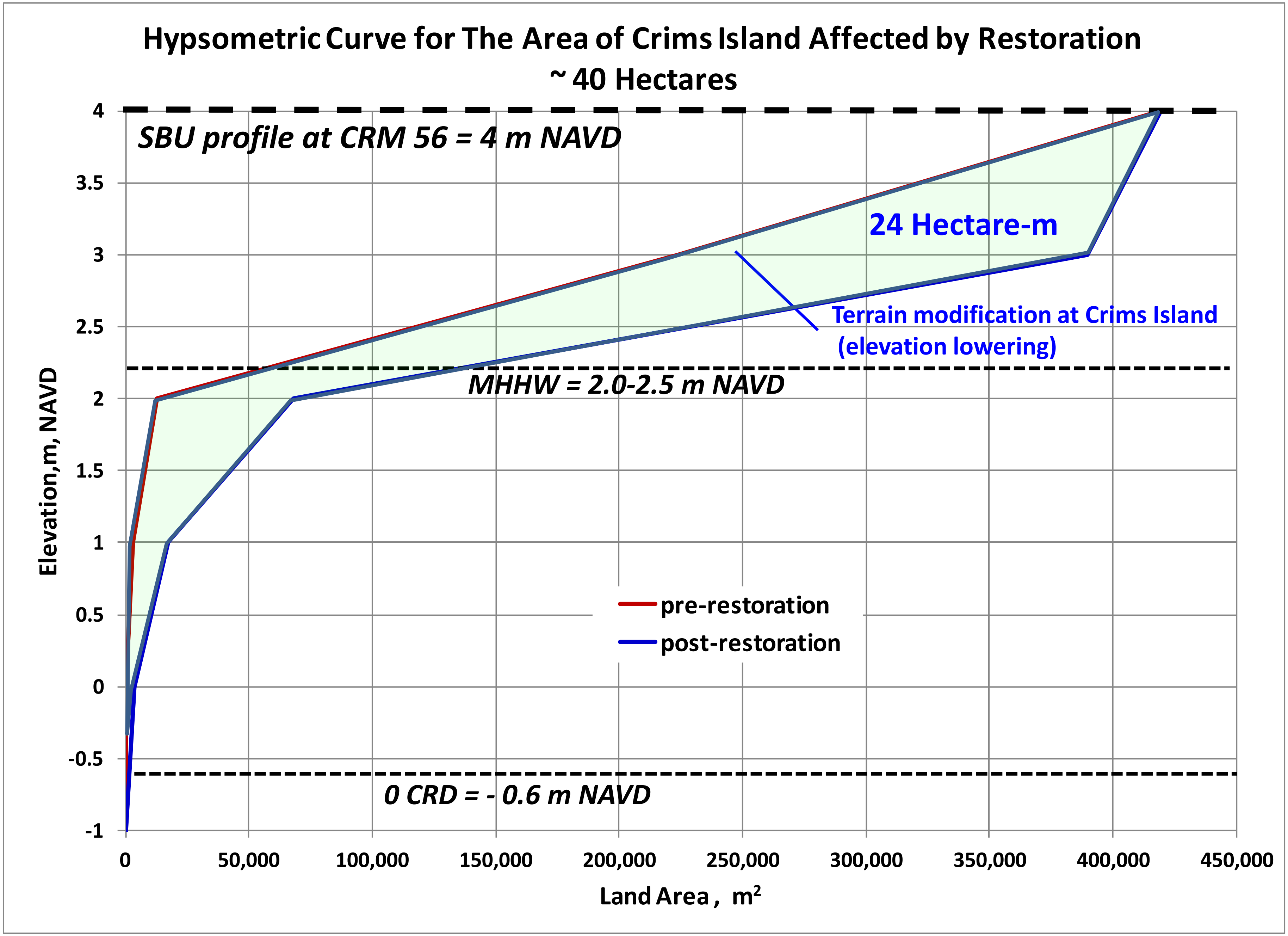


AdH Finite Element Model Mesh at Crims Island
Showing full resolution of ‘restored’ tidal channels

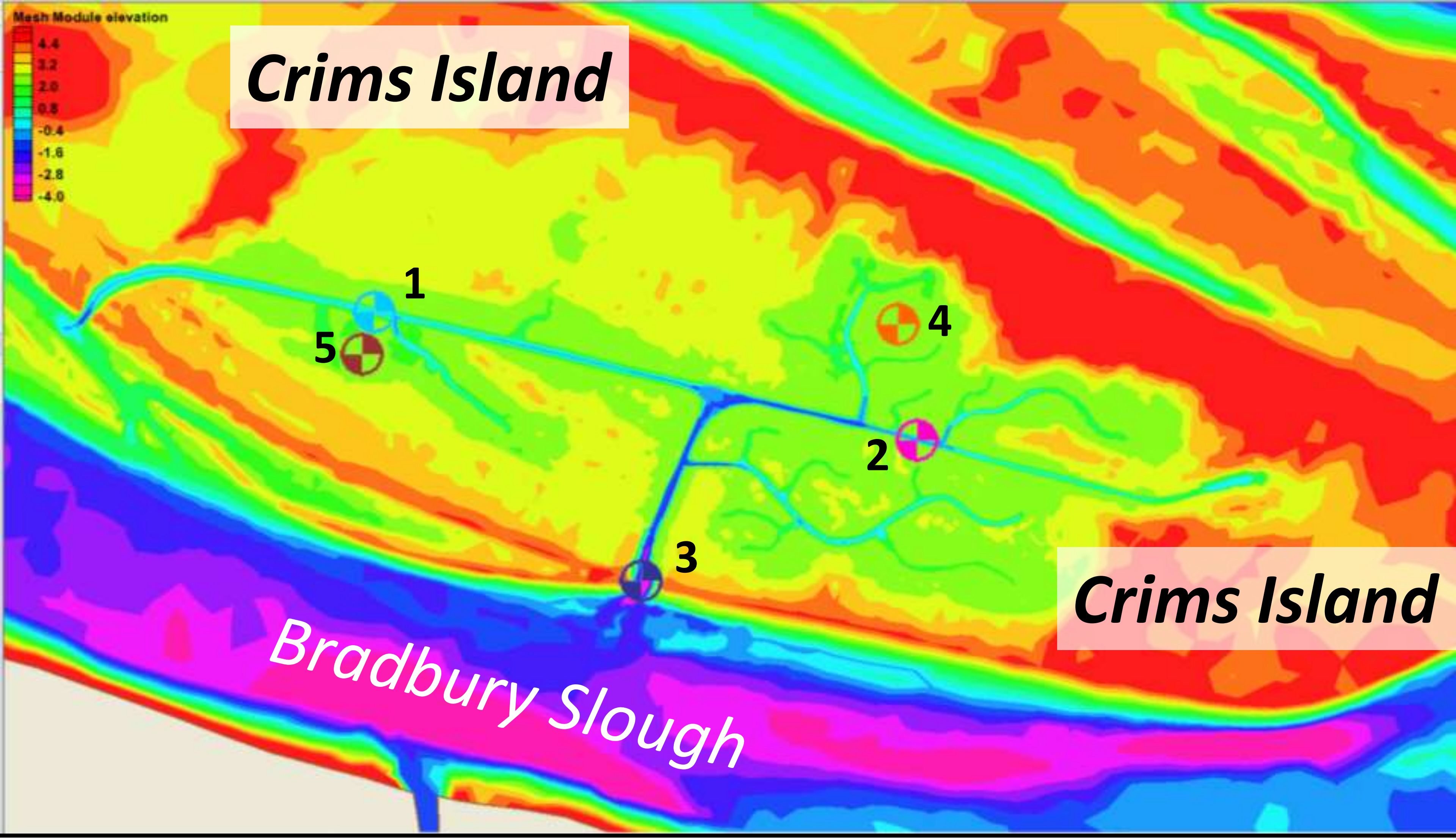
PRE-restoration topographic condition for Crims Island as represented by the composition of LIDAR and conventional topographic/bathymetric surveys, restoration area is outlined by the "box". The above morphology was reproduced in a hydrodynamic model (AdH).



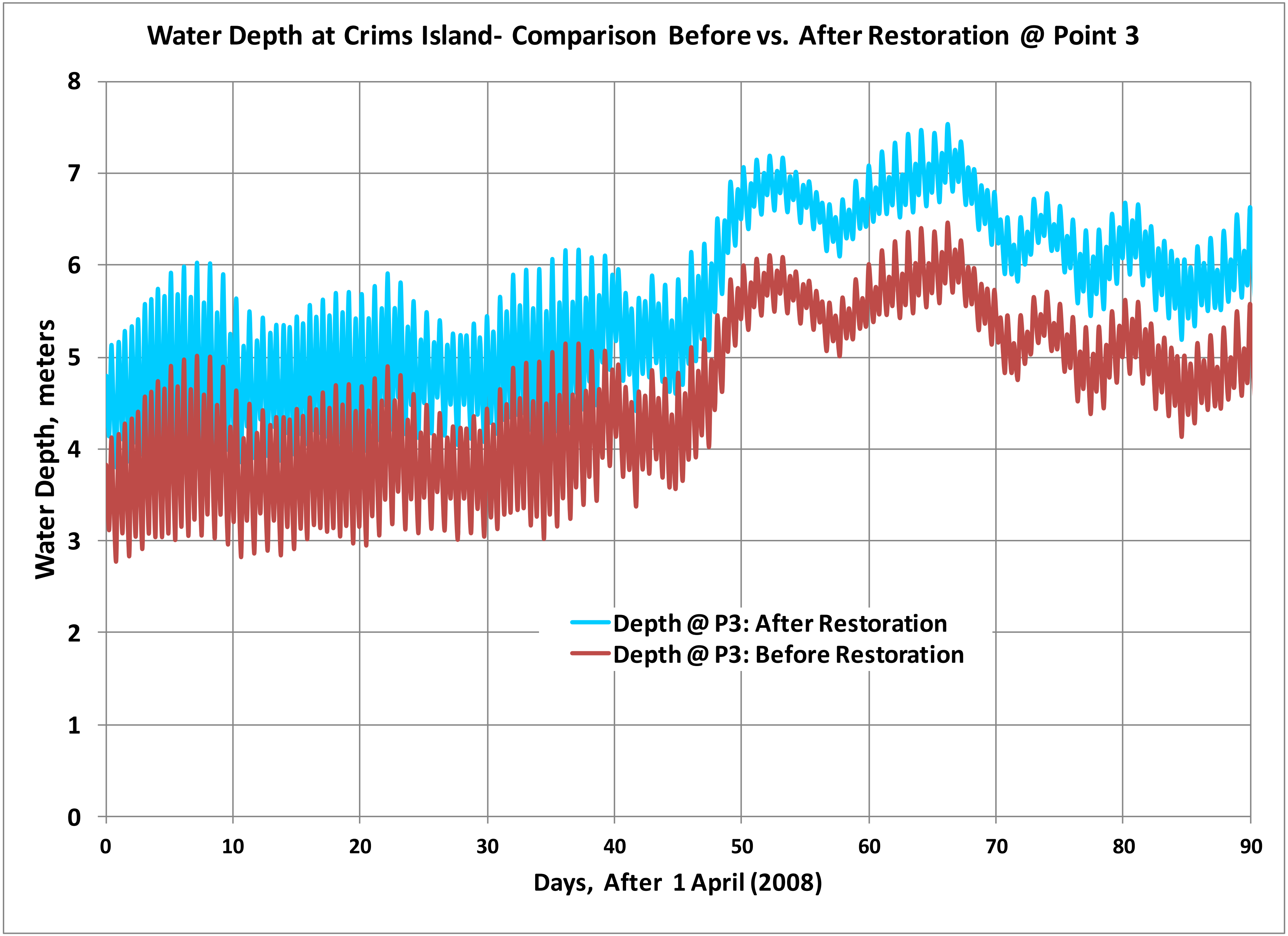
POST restoration topographic condition for Crims Island as represented by the composition of LIDAR and conventional topographic/bathymetric surveys, restoration area is outlined by the “box”. The above morphology was reproduced in a hydrodynamic model (AdH).



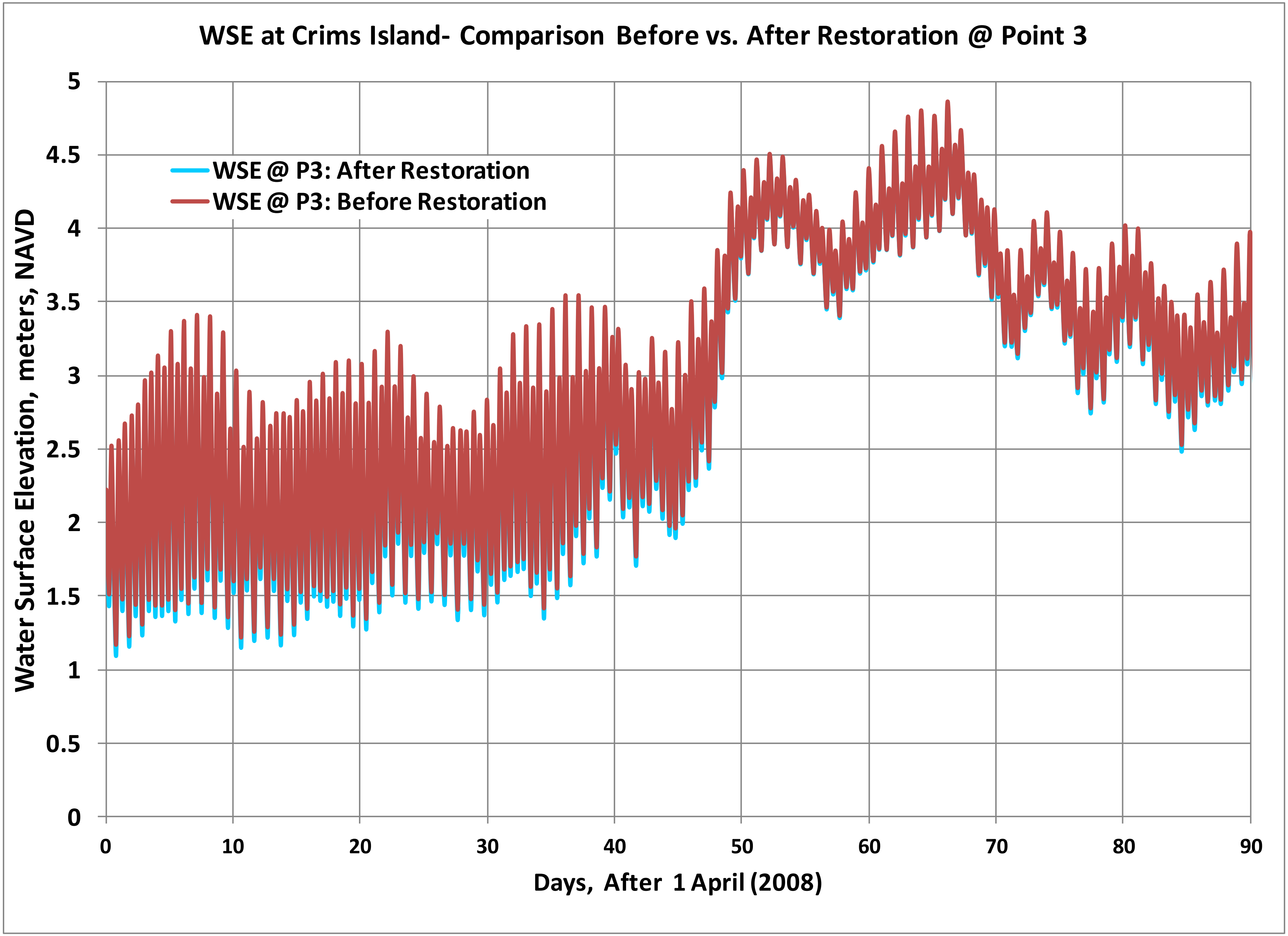
Hypsometric Curve for The Area of Crims Island Affected by Restoration
~ 40 Hectares
SBU profile at CRM 56 = 4 m NAVD
24 Hectare-m
Terrain modification at Crims Island
(elevation lowering)
MHHW = 2.0-2.5 m NAVD
pre-restoration
post-restoration
0 CRD = - 0.6 m NAVD
Elevation, m, NAVD
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
0
50,000
100,000
150,000
200,000
250,000
300,000
350,000
400,000
450,000
Land Area, m²

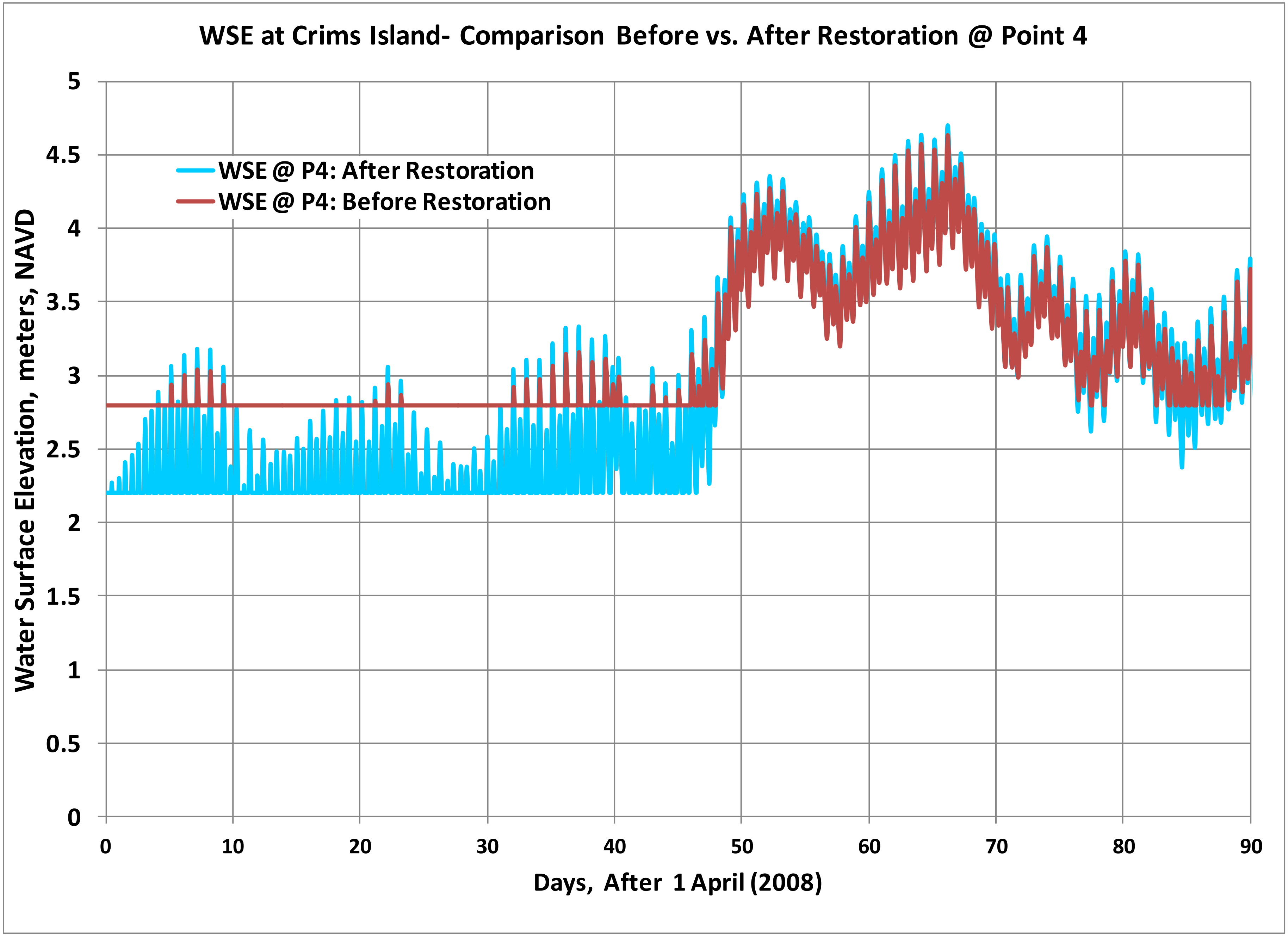


Five "model observation points" to compare tidal aspects for:
pre-restoration **vs.** ***post-restoration*** **conditions at Crims Island**

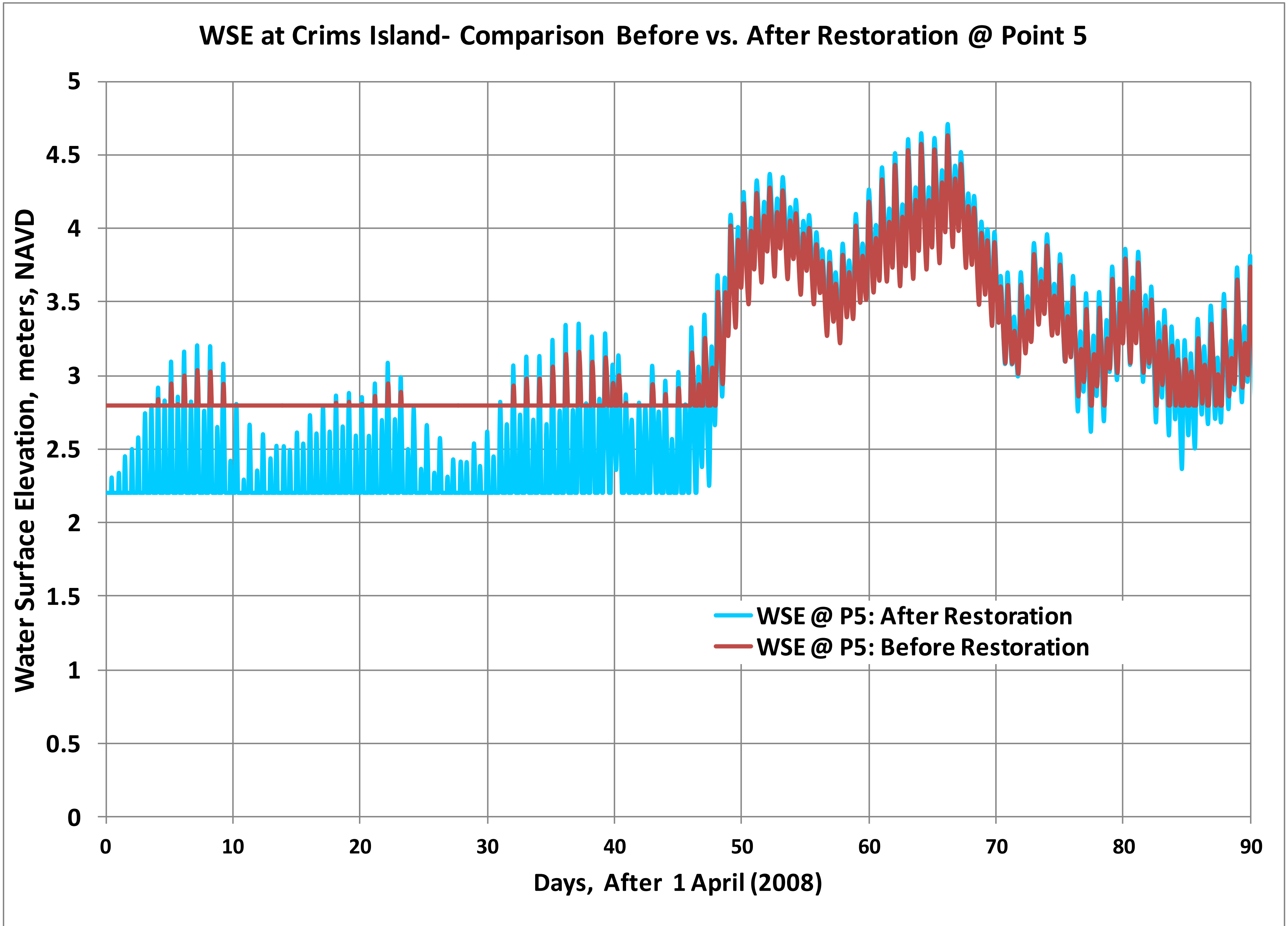


Water Depth at Crims Island- Comparison Before vs. After Restoration @ Point 3
Water Depth, meters
Days, After 1 April (2008)
Depth @ P3: After Restoration
Depth @ P3: Before Restoration
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90

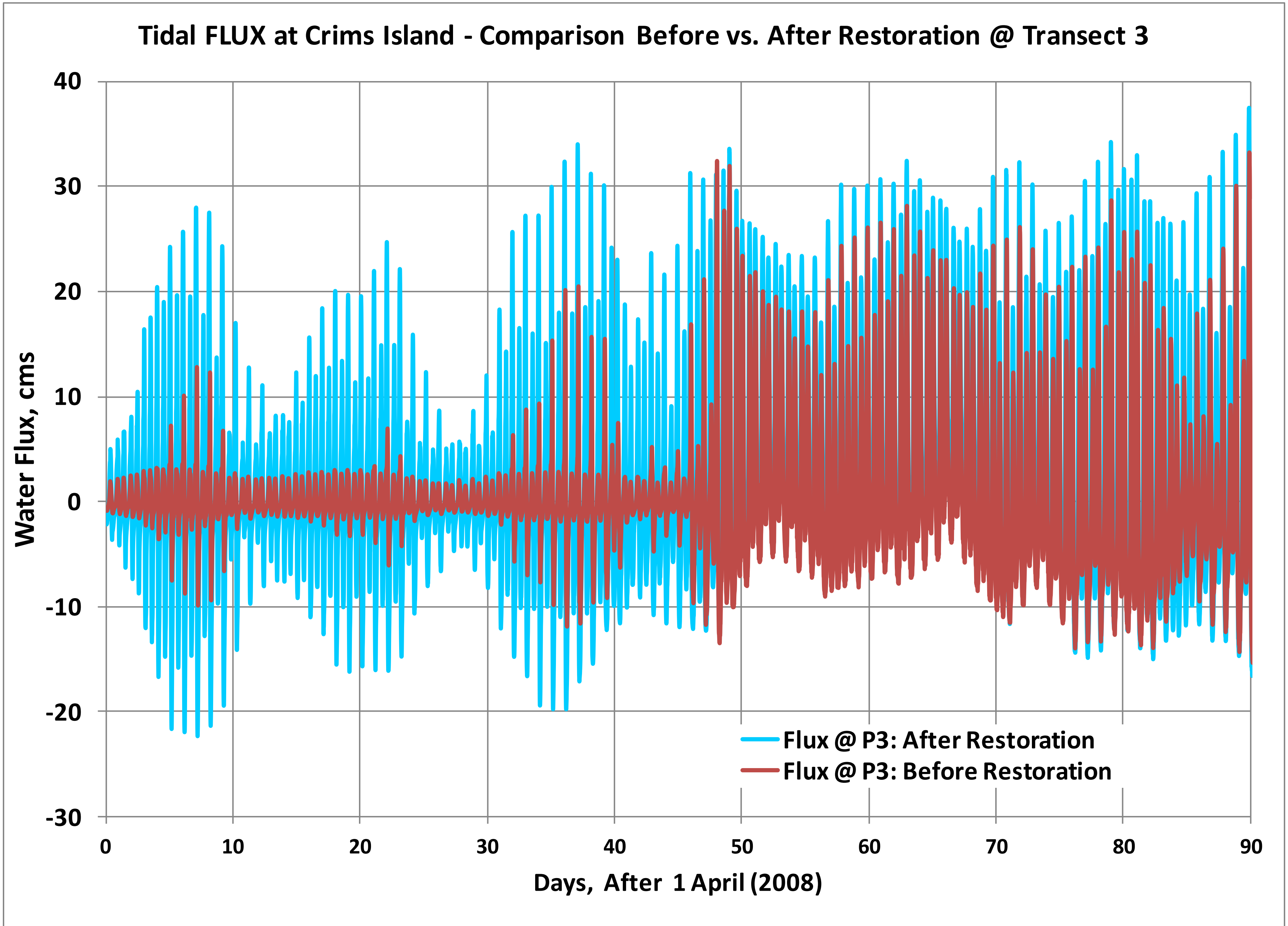

WSE at Crims Island- Comparison Before vs. After Restoration @ Point 3
WSE @ P3: After Restoration
WSE @ P3: Before Restoration
Water Surface Elevation, meters, NAVD
Days, After 1 April (2008)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90



WSE at Crims Island- Comparison Before vs. After Restoration @ Point 4
WSE @ P4: After Restoration
WSE @ P4: Before Restoration
Water Surface Elevation, meters, NAVD
Days, After 1 April (2008)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90

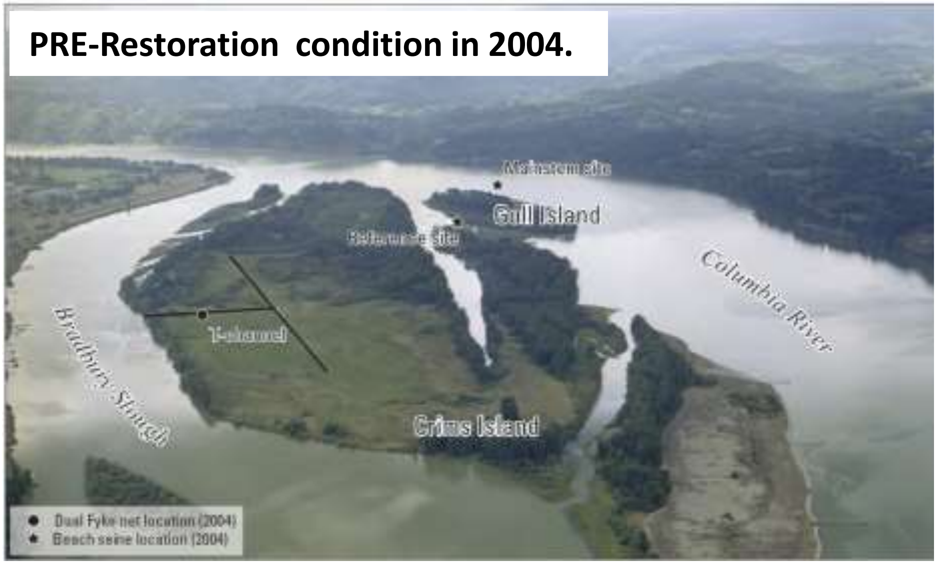


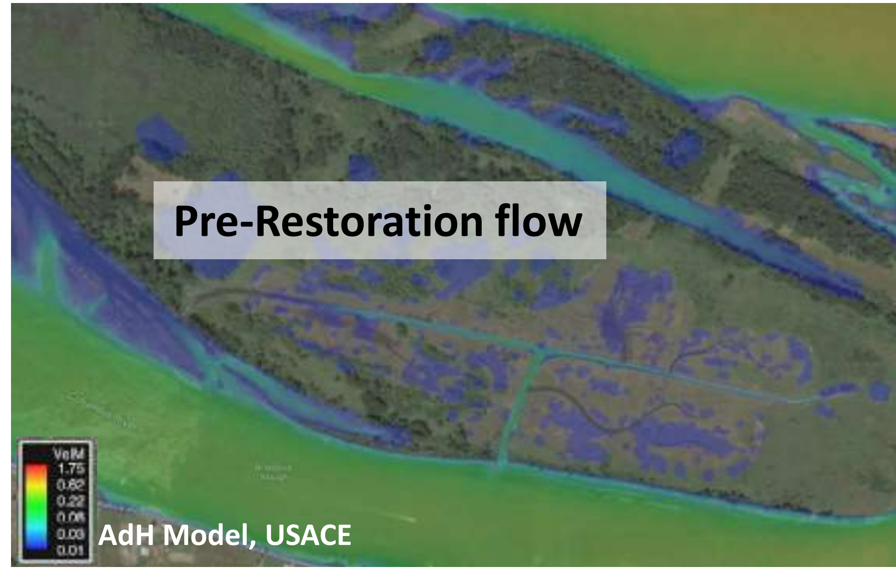
WSE at Crims Island- Comparison Before vs. After Restoration @ Point 5
Water Surface Elevation, meters, NAVD
Days, After 1 April (2008)
WSE @ P5: After Restoration
WSE @ P5: Before Restoration
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90

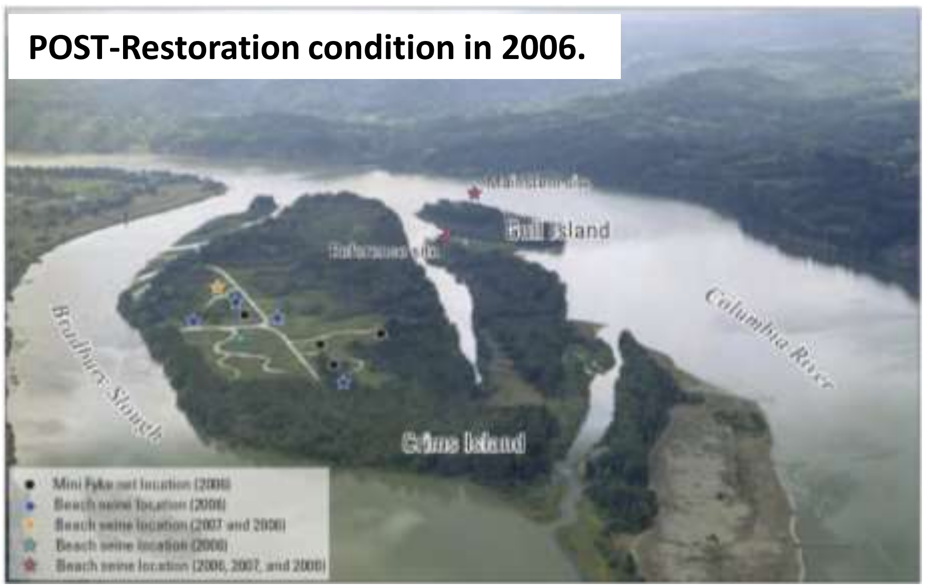


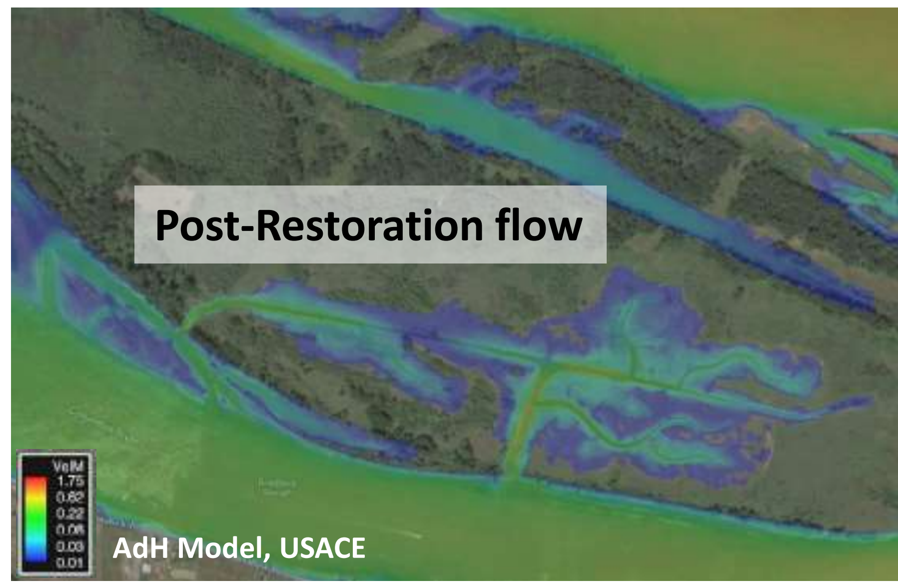
Tidal FLUX at Crims Island - Comparison Before vs. After Restoration @ Transect 3
40
30
20
10
0
-10
-20
-30
Water Flux, cms
0
10
20
30
40
50
60
70
80
90
Days, After 1 April (2008)
Flux @ P3: After Restoration
Flux @ P3: Before Restoration

Crims Island Ecosystem Restoration in Columbia River Estuary









Restoration of Crims Island near Longview, Washington, re-established 38.1 hectares of marsh and swamp in the tidal freshwater portion of the Columbia River Estuary and a 95-percent increase in available juvenile salmon rearing habitat at Crims Island. View toward downstream.

Changes in Tidal Hydraulics at Crims Island in Response to Restoration Activities

Detailed resolution (in conformance with morphology) is required to properly model small-scale features like tidal channels….unstructured grid meets the need.

The tidal flux increase into/out of Crims Island is vastly increased by the restored condition; especially for non-flood stage (non-freshet) river flow.

Smart move to lower terrain by 0.6 m (establish marsh-like terrain) and implement many primary and secondary tidal channels, accounting for channel evolution.

Essential to have two-way connectivity for the T-channel (restoration implemented additional outlet to Bradbury Slough)—allows full tidal prism exchange