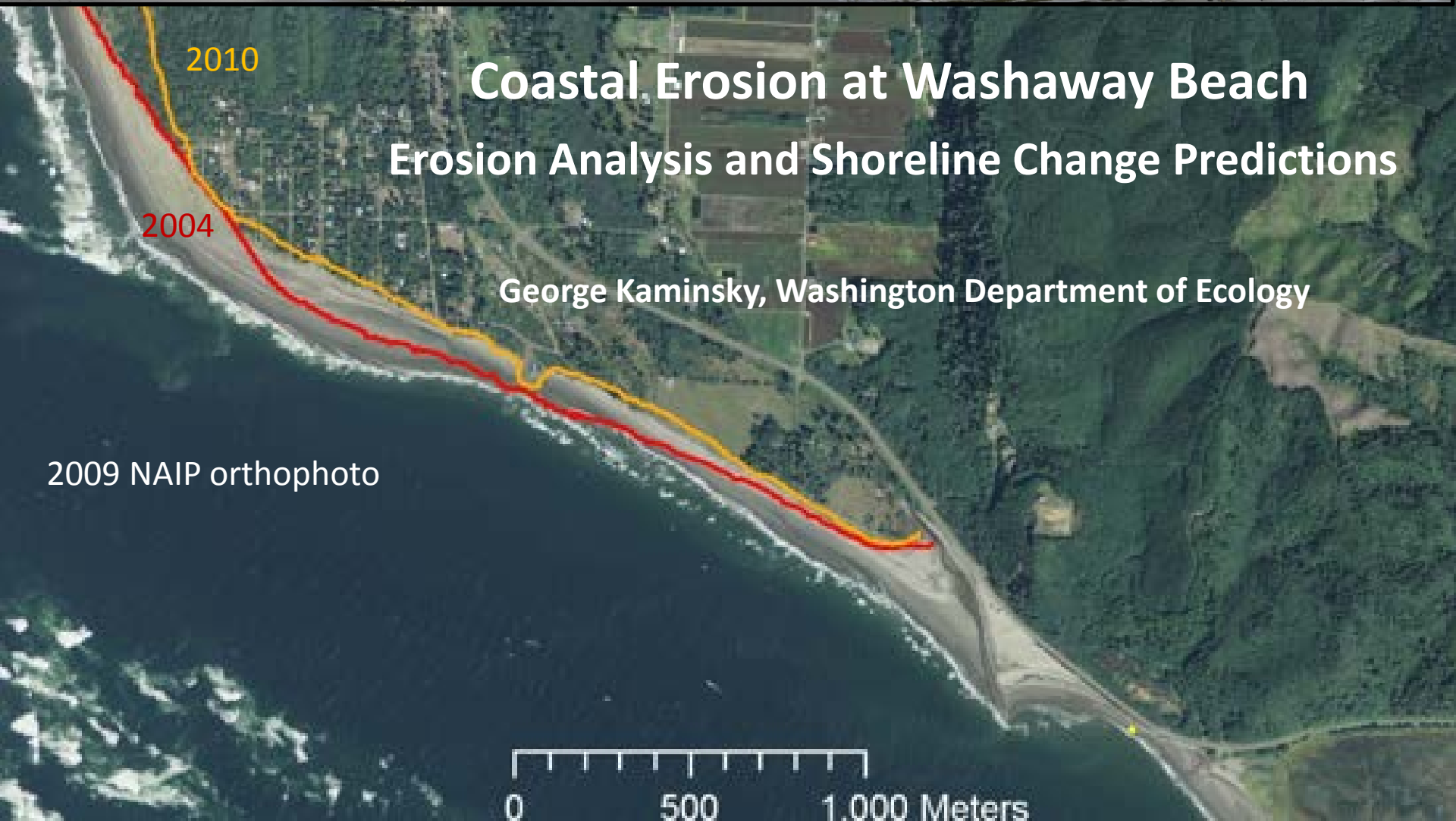
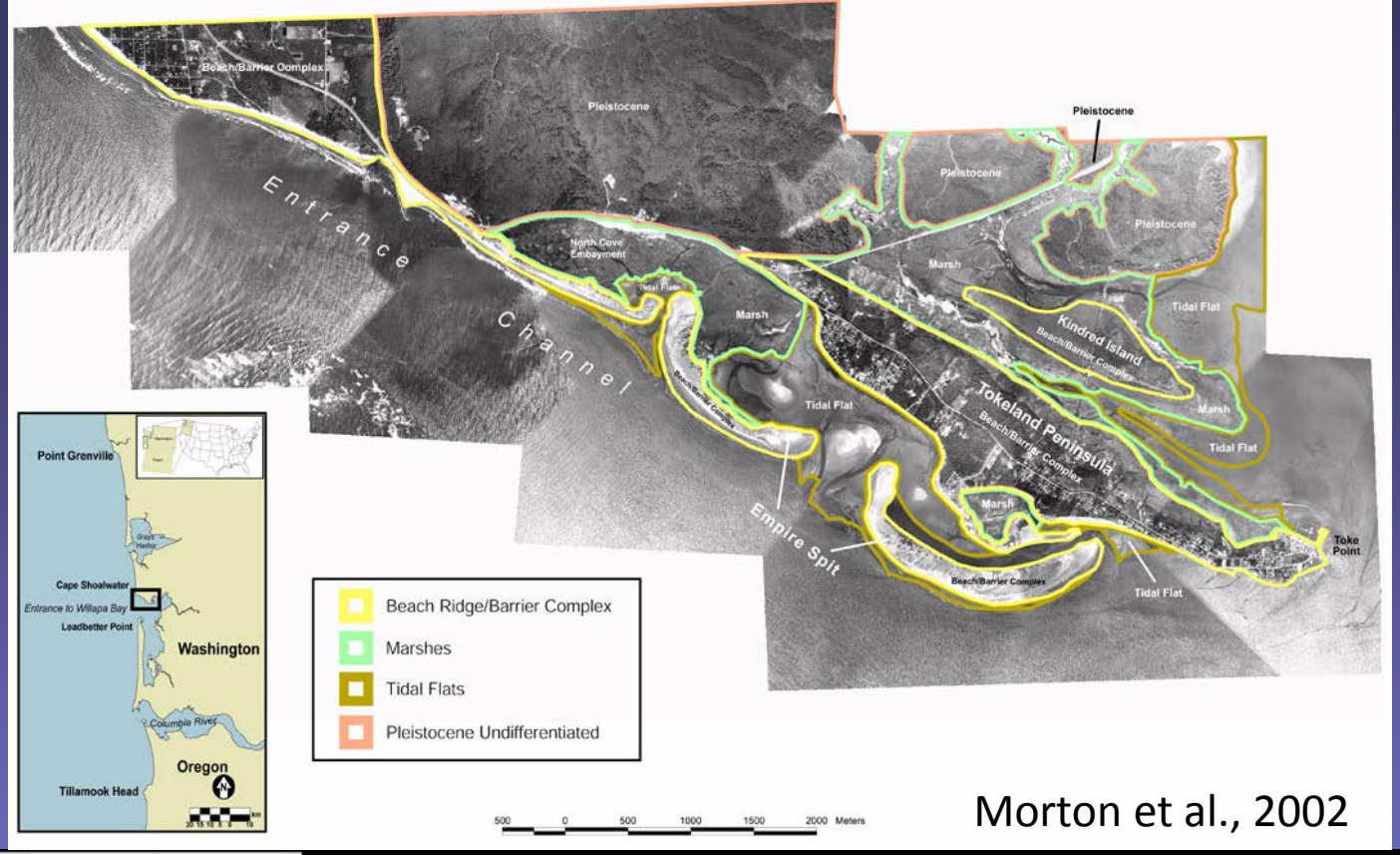
Coastal Erosion at Washaway Beach

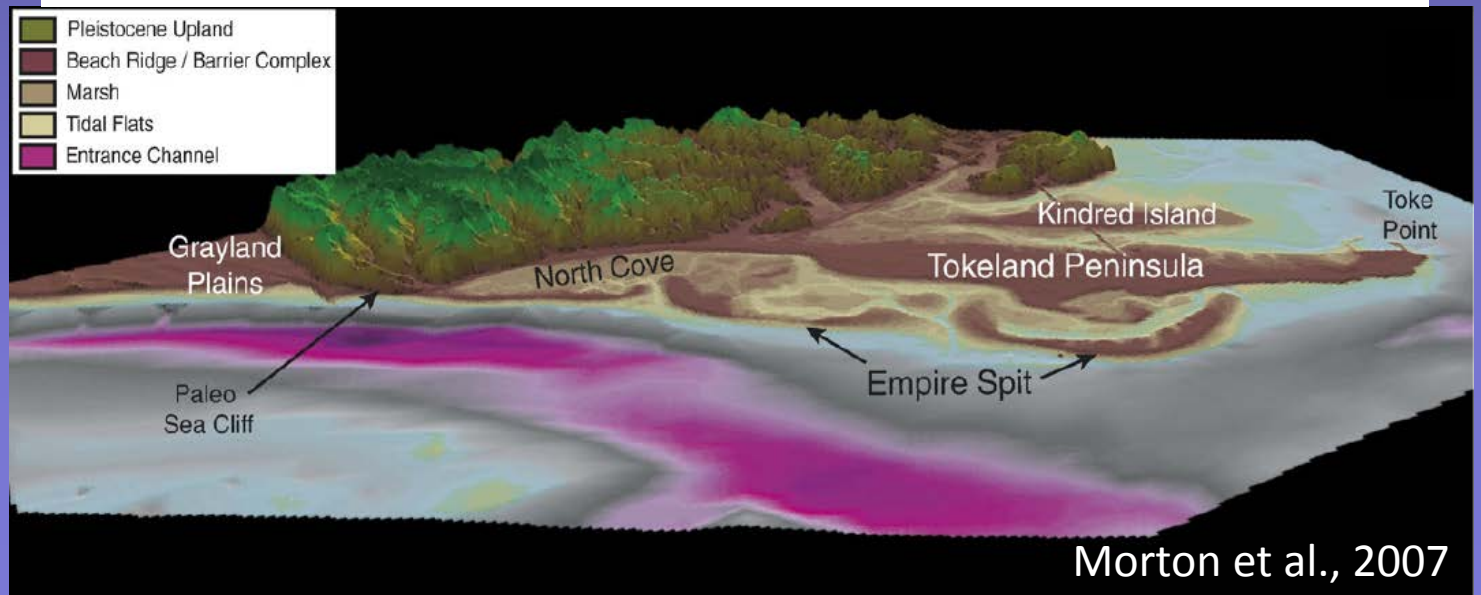
Erosion Analysis and Shoreline Change Predictions

George Kaminsky, Washington Department of Ecology



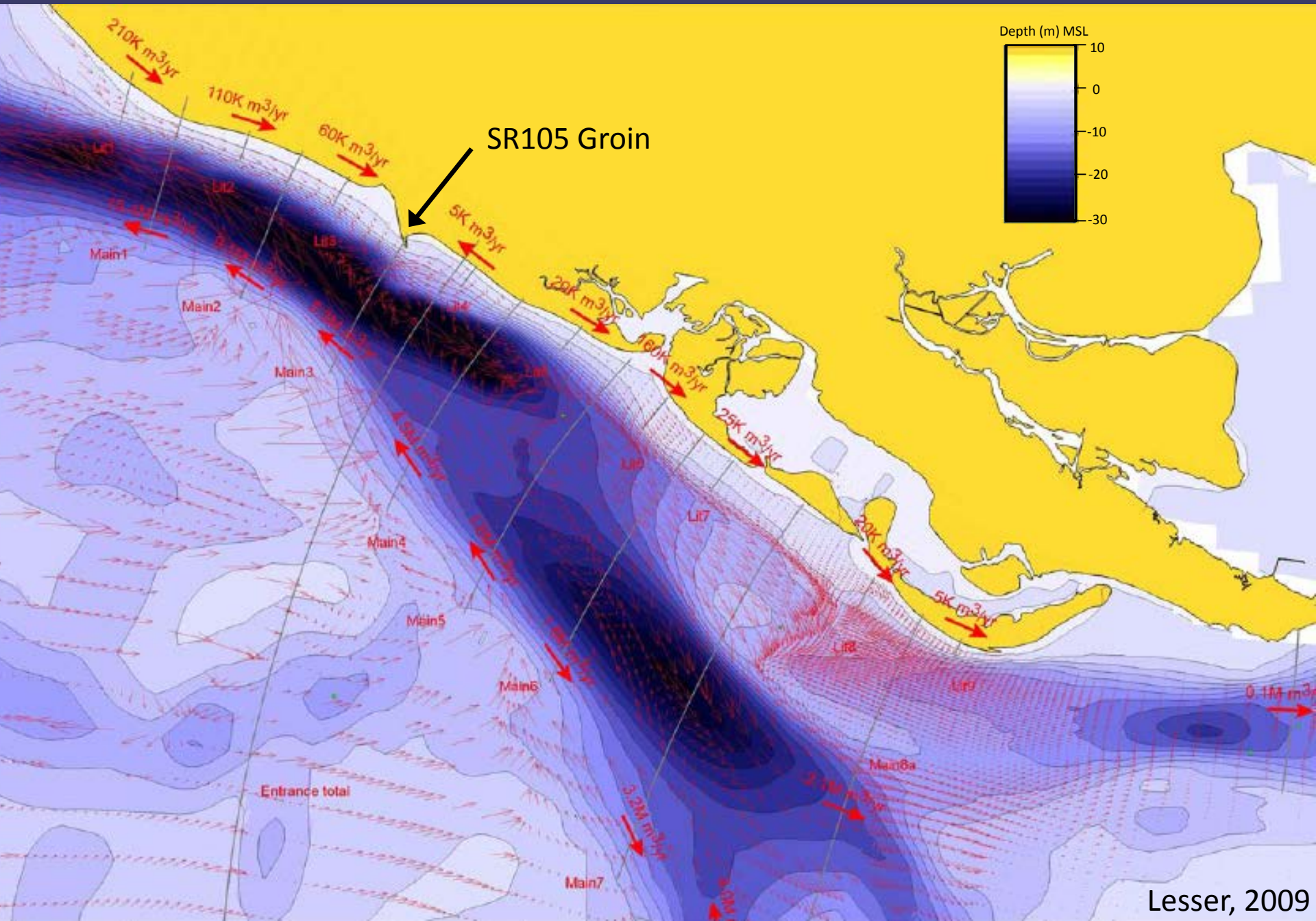


Morton et al., 2002



Morton et al., 2007

Modeled net sand transport on 2003 bathymetry



Lesser, 2009

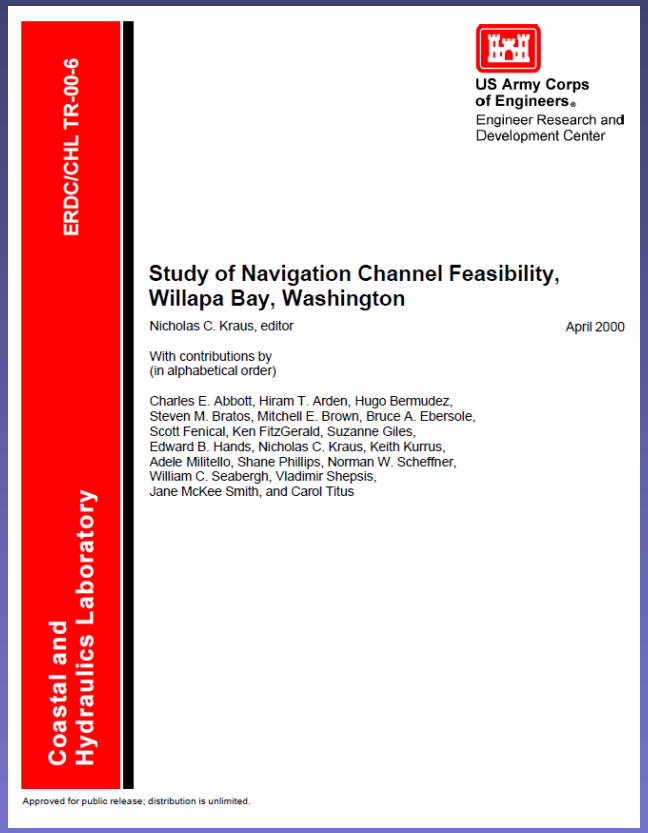
2006 NAIP photography
1/2 mile ticks
1/2 mile ticks
1 km ticks
1 km ticks

2009 NAIP photography
1/2 mile ticks
1/2 mile ticks
1 km ticks
1 km ticks

1/2 mile ticks
2013 NAIP photography
1/2 mile ticks
1 km ticks
1 km ticks

1/2 mile ticks
2015 NAIP photography
1/2 mile ticks
1 km ticks
1 km ticks

Twenty-year sequence illustrating two channel-spit cycles (USACE, 2000)



ERDC/CHL TR-00-6

Coastal and Hydraulics Laboratory

US Army Corps of Engineers®
Engineer Research and Development Center

Study of Navigation Channel Feasibility, Willapa Bay, Washington

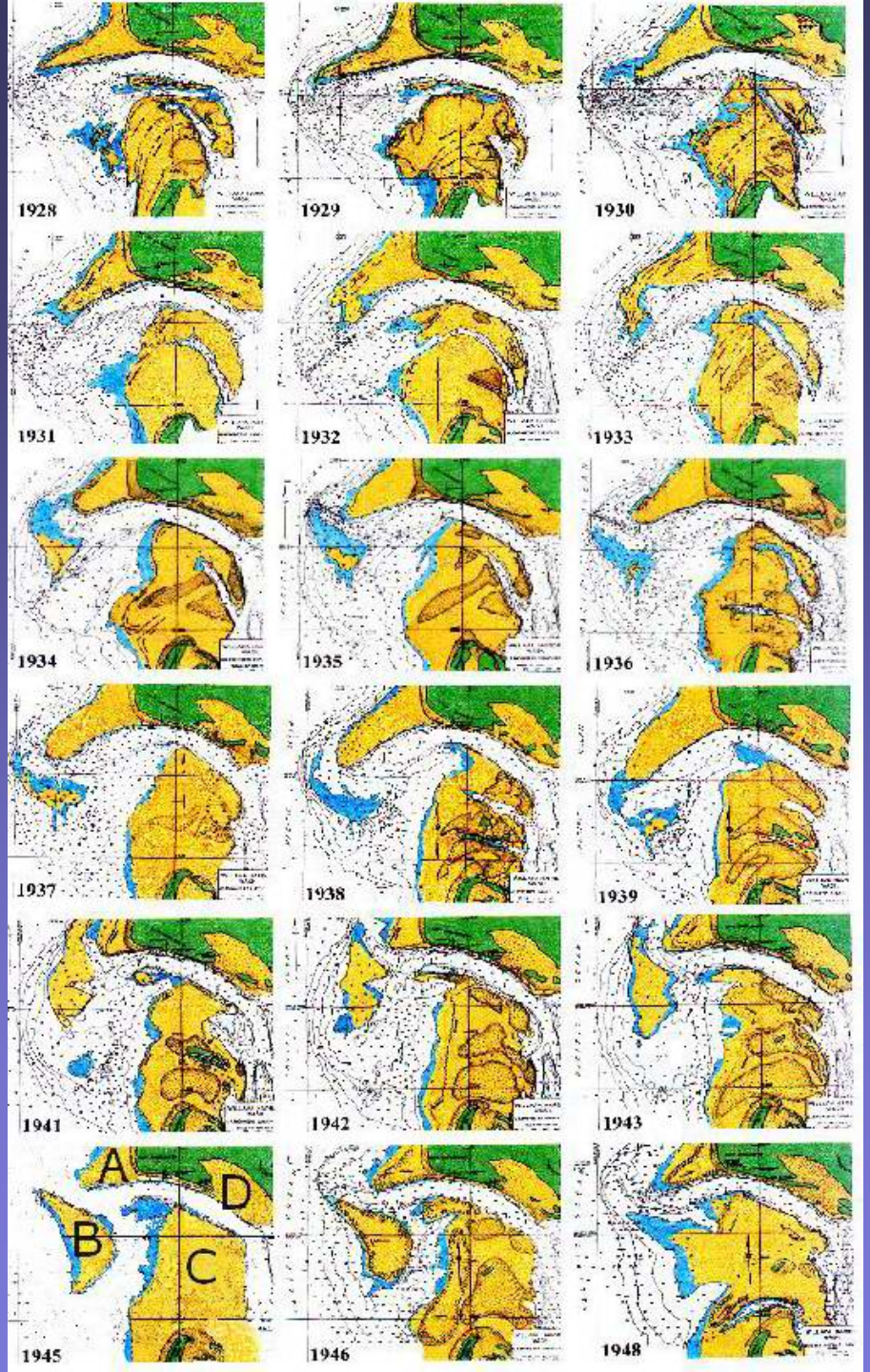
Nicholas C. Kraus, editor

April 2000

With contributions by
(in alphabetical order)

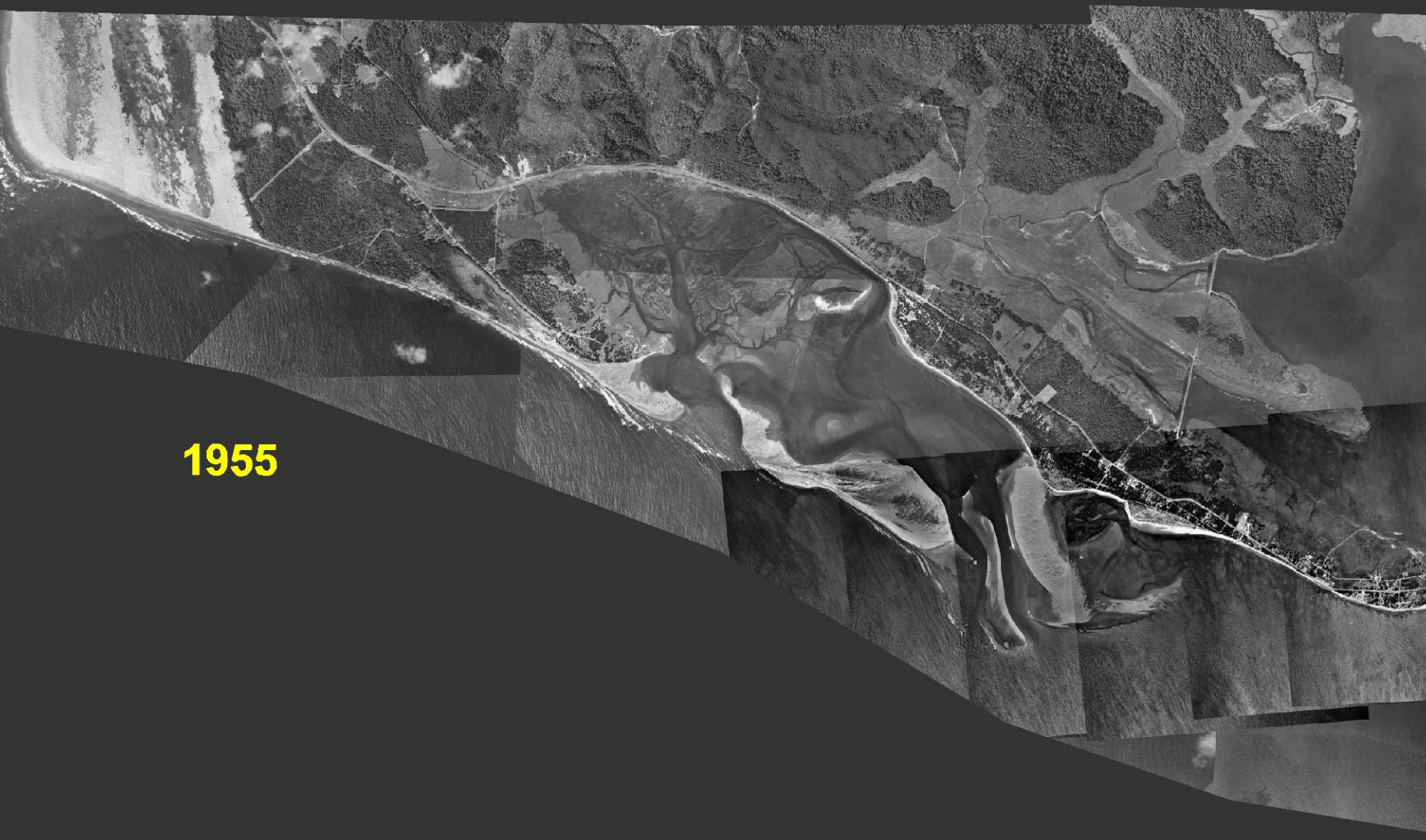
Charles E. Abbott, Hiram T. Arden, Hugo Bermudez, Steven M. Bratos, Mitchell E. Brown, Bruce A. Ebersole, Scott Fenical, Ken FitzGerald, Suzanne Giles, Edward B. Hands, Nicholas C. Kraus, Keith Kurrus, Adele Militello, Shane Phillips, Norman W. Scheffner, William C. Seabergh, Vladimir Shepsis, Jane McKee Smith, and Carol Titus

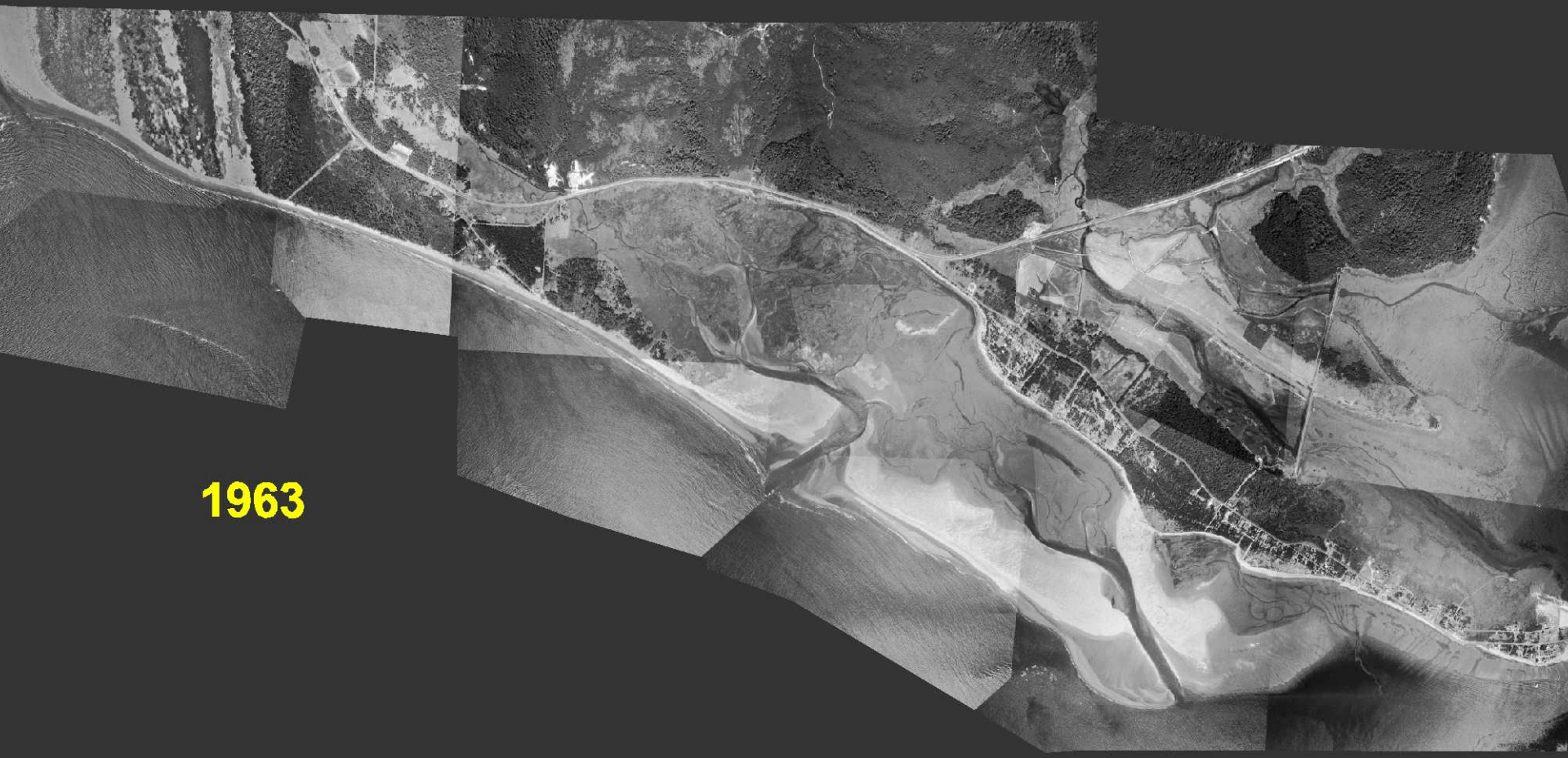
Approved for public release; distribution is unlimited.



New bar channels dissect a submerged spit (A in lowest panel on left) creating a dynamic shoal (B) that migrates rapidly eastward to merge with other entrance shoals (C) near North Cove (D) in the 1945 panel.

Cape S
Shoalwate
Reserv
1945


1955

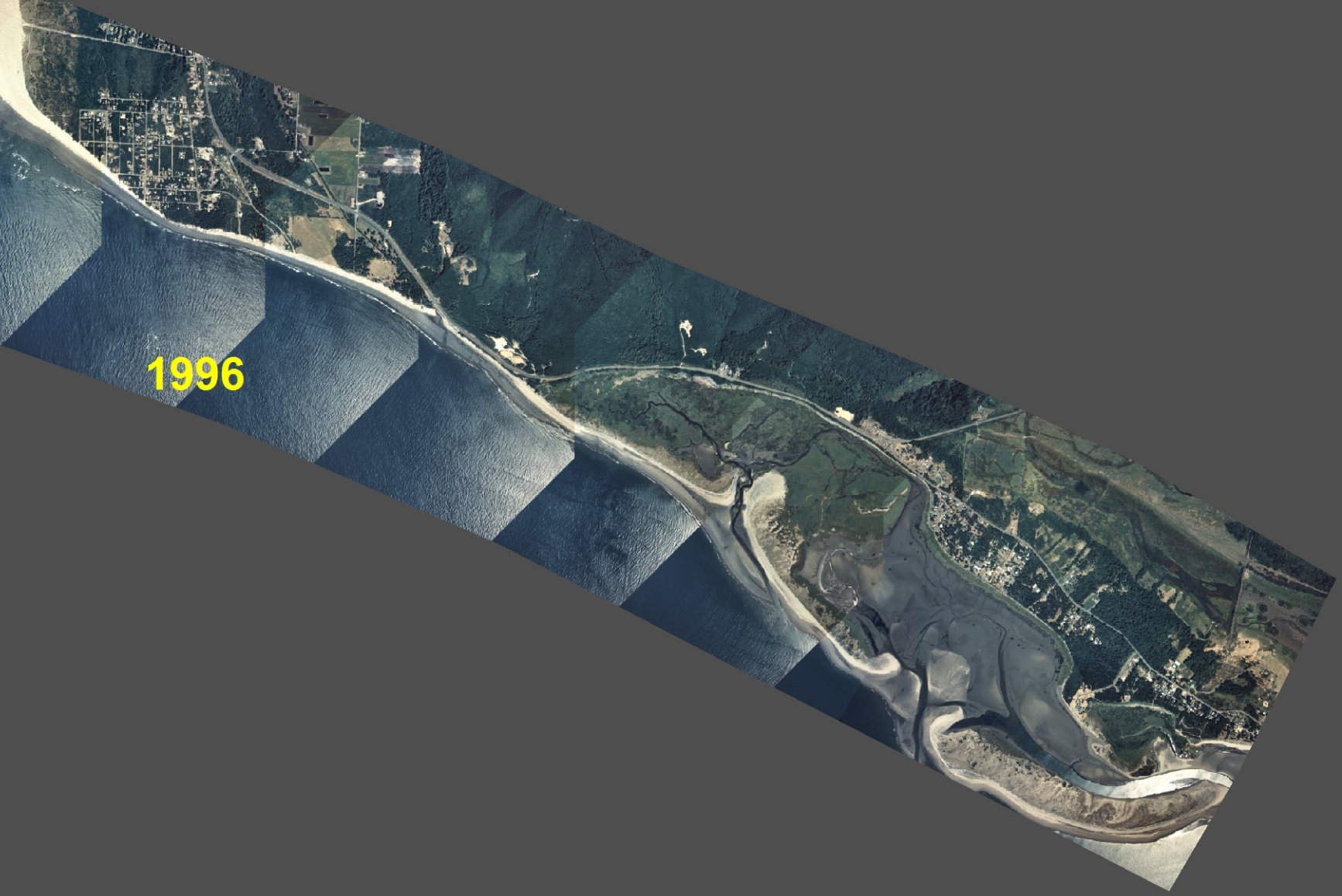

1963

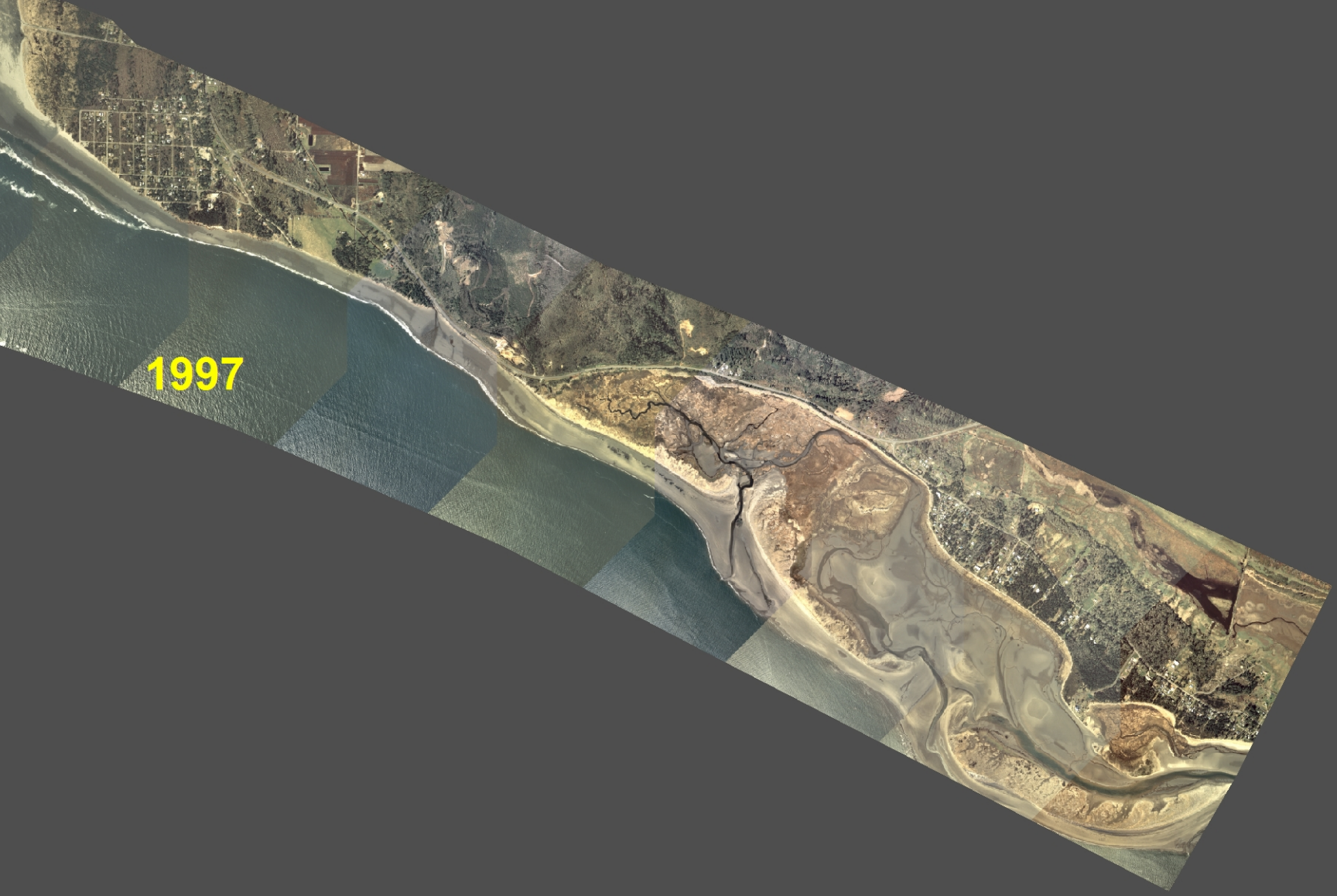
1970

1974

1985

1990


1996


1997

1998

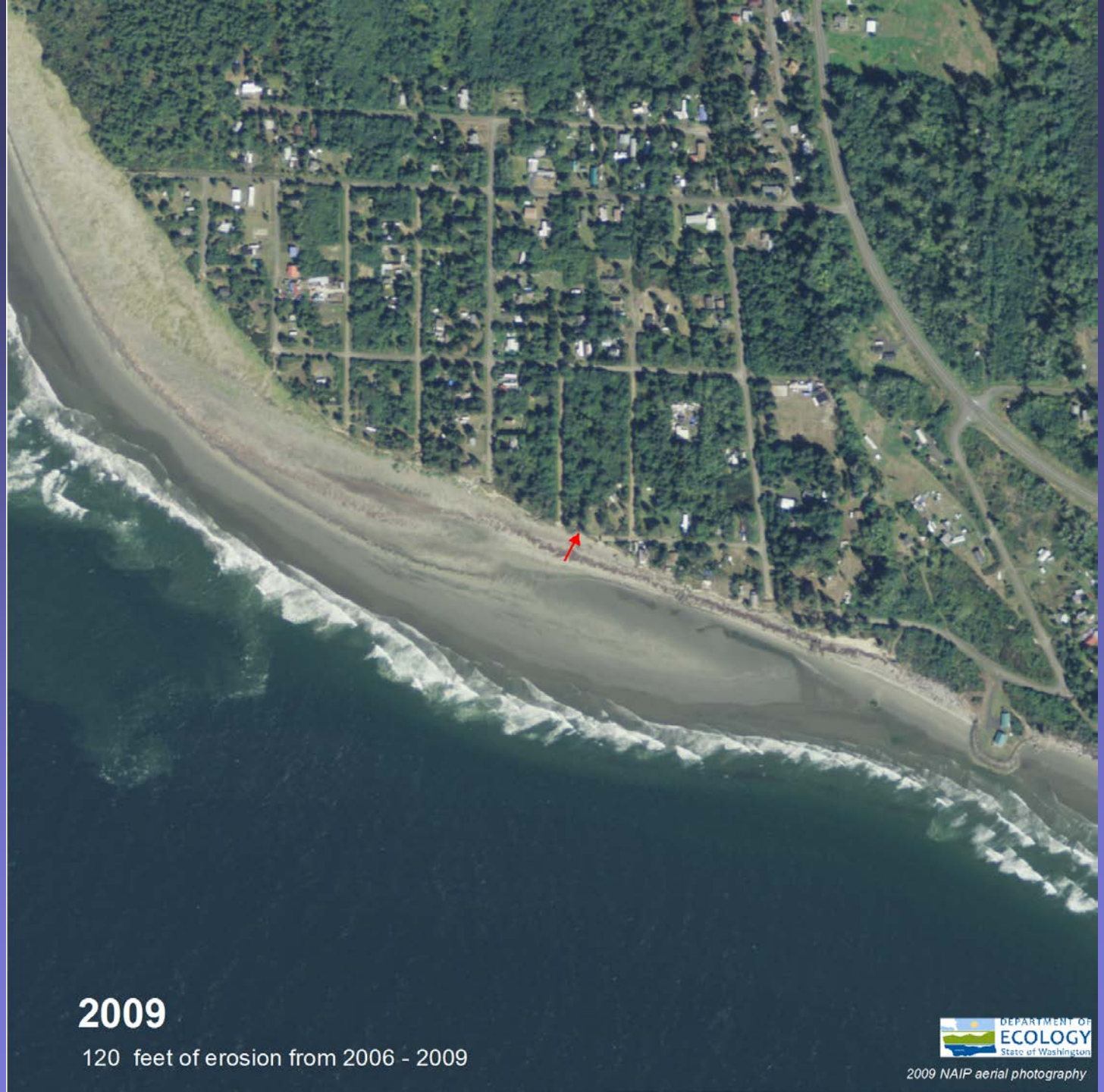
0.3
1974
Town of North Cove
DEPARTMENT OF
ECOLOGY
State of Washington
1974 Dept. of Natural Resources aerial photography

1989
Town of North Cove

1997
970 feet of erosion from 1989 - 1997
DEPARTMENT OF
ECOLOGY
State of Washington
1997 Dept. of Natural Resources aerial photography

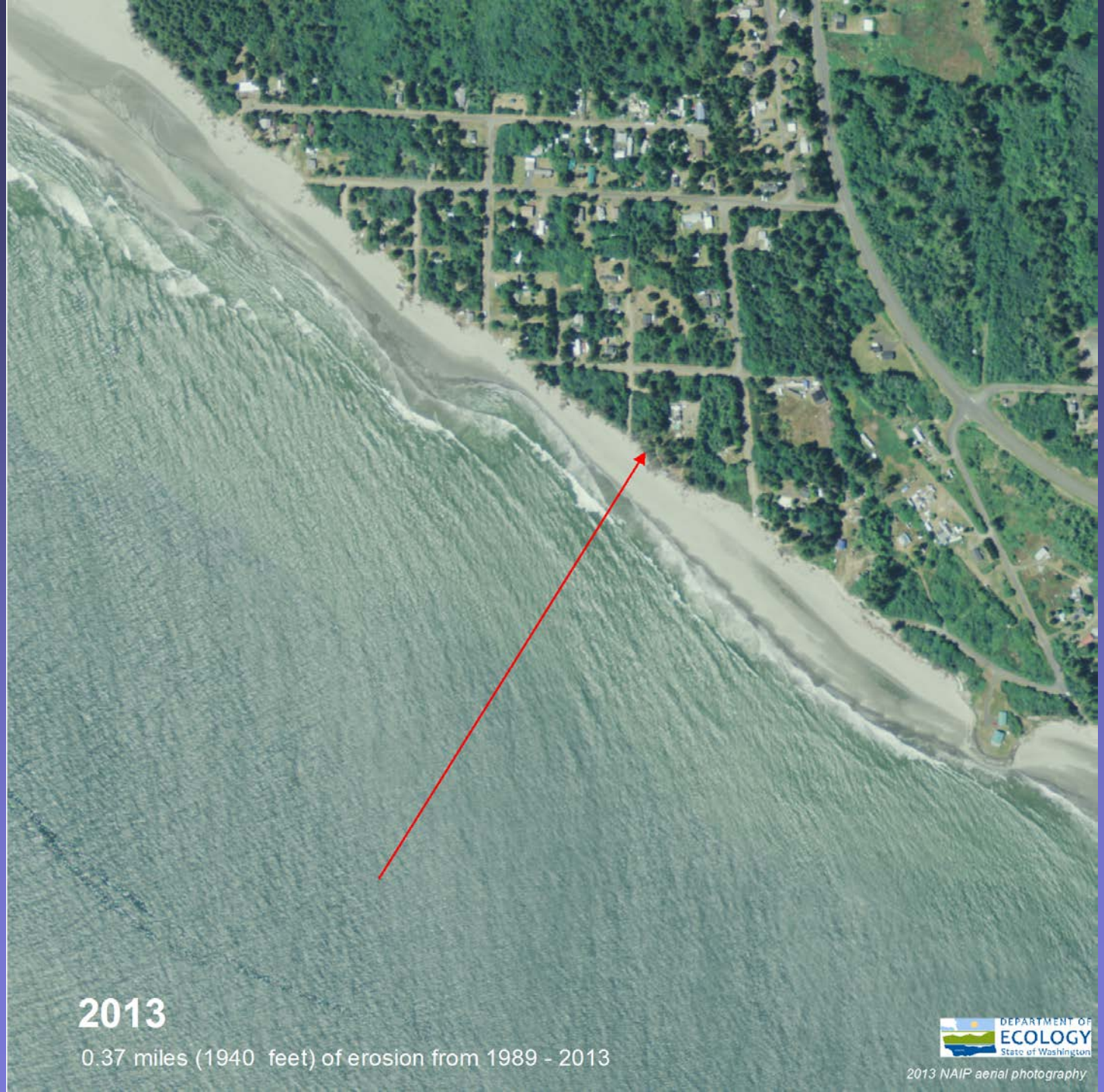
2000
250 feet of erosion from 1997 - 2000
DEPARTMENT OF
ECOLOGY
State of Washington
2000 Earth Data aerial photography

2006
190 feet of erosion from 2000 - 2006
DEPARTMENT OF
ECOLOGY
State of Washington
2006 NAIP aerial photography


2009
120 feet of erosion from 2006 - 2009
DEPARTMENT OF
ECOLOGY
State of Washington
2009 NAIP aerial photography

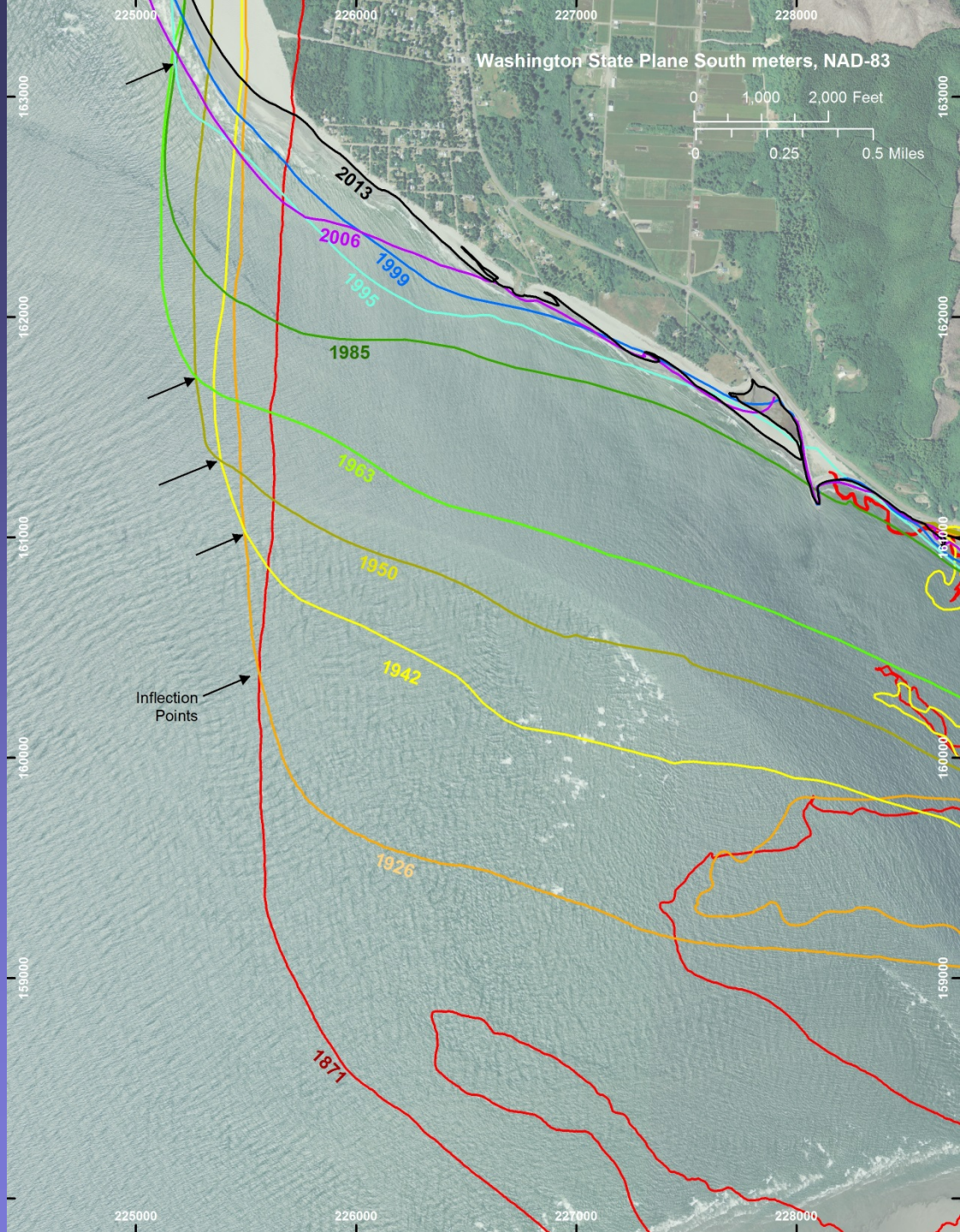
2011
170 feet of erosion from 2009 - 2011
DEPARTMENT OF
ECOLOGY
State of Washington
2011 NAIP aerial photography

2013
230 feet of erosion from 2011 - 2013
DEPARTMENT OF
ECOLOGY
State of Washington
2013 NAIP aerial photography

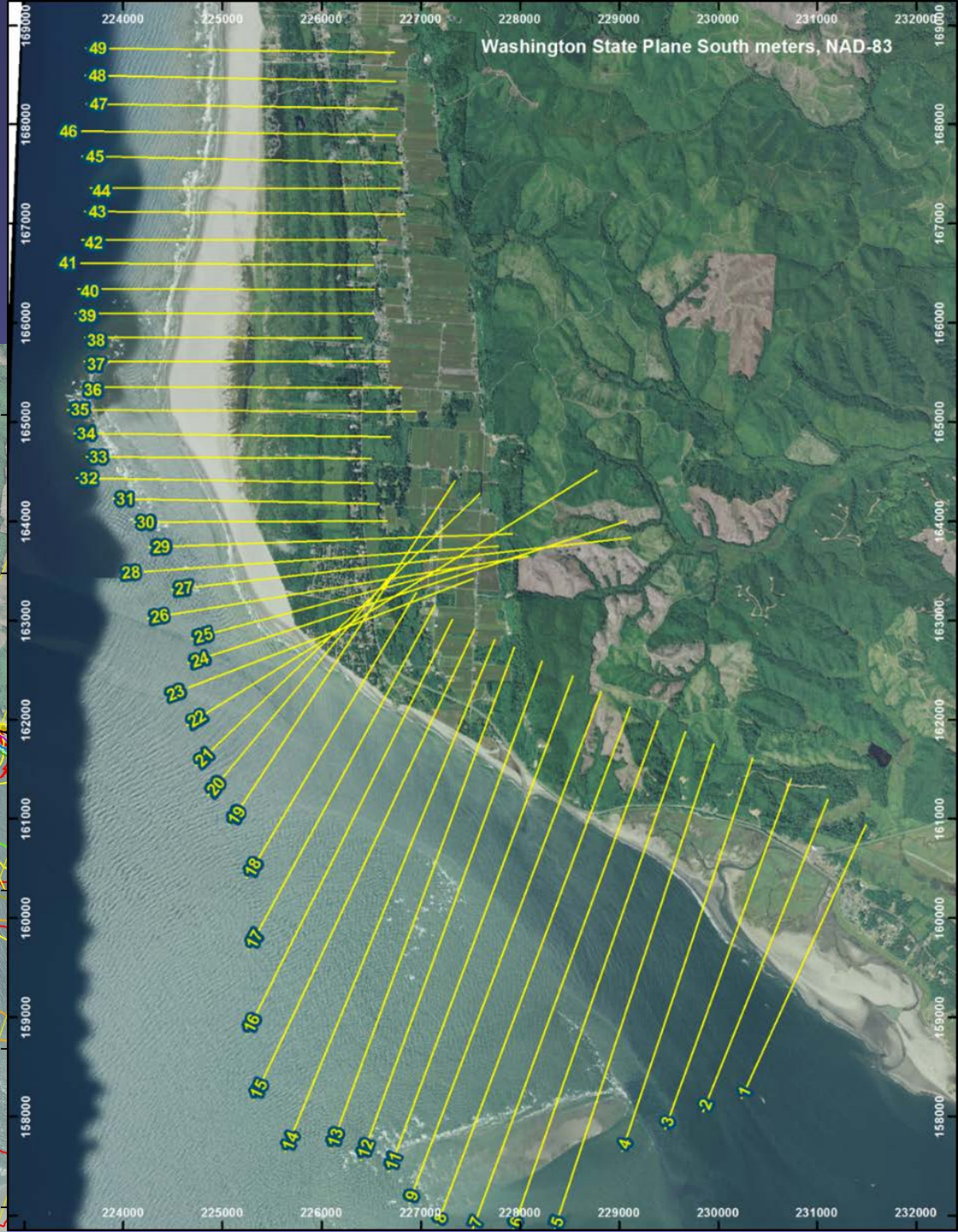

2013
0.37 miles (1940 feet) of erosion from 1989 - 2013
DEPARTMENT OF
ECOLOGY
State of Washington
2013 NAIP aerial photography

Historical Shoreline Change Analysis

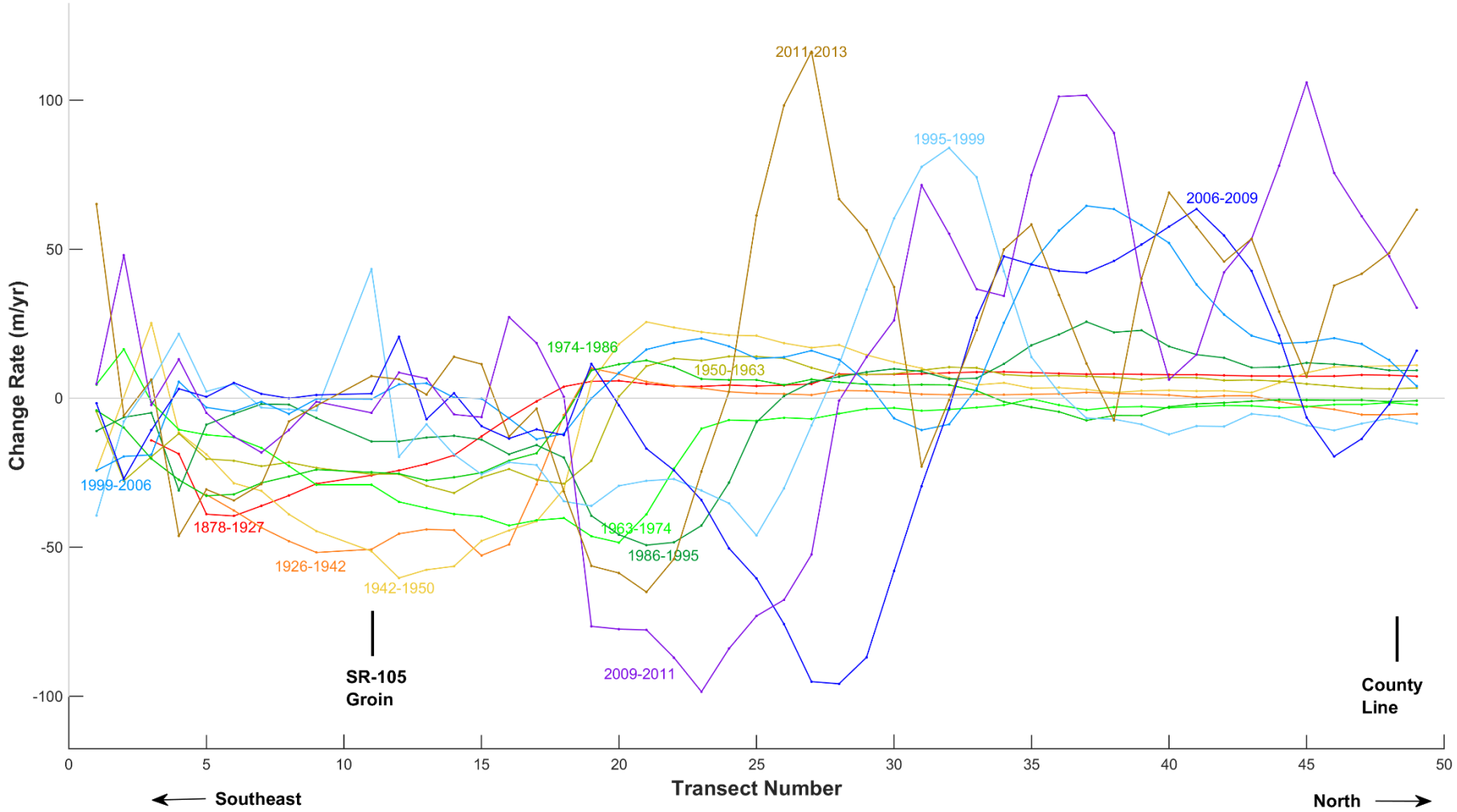
Type of Dataset	Year	Source
T-Sheet	**1871**	U.S. Coast & Geodetic Survey
T-Sheet	**1911**	US Coast Survey T-sheet
T-Sheet	**1926**	NOS T-sheet
Aerial Photo	**1942**	U.S. Army
Aerial Photo	**1945**	U.S. Army Corps of Engineers (USACE)
T-Sheet	**1950**	NOS T-sheet
Aerial Photo	**1963**	WADNR
Aerial Photo	**1970**	WADNR
Aerial Photo	**1974**	WADNR
Aerial Photo	**1985**	USACE
Aerial Photo	**1990**	Walker & Associates / USACE
Aerial Photo	**1995**	NOAA
Aerial Photo	**1996**	USACE
Aerial Photo	**1997**	USACE
Aerial Photo	**1999**	WADNR
Aerial Photo	**2001**	Spencer B. Gross
Aerial Photo	**2006**	National Agricultural Imagery Program
Aerial Photo	**2009**	National Agricultural Imagery Program
Aerial Photo	**2011**	National Agricultural Imagery Program
Aerial Photo	**2013**	National Agricultural Imagery Program



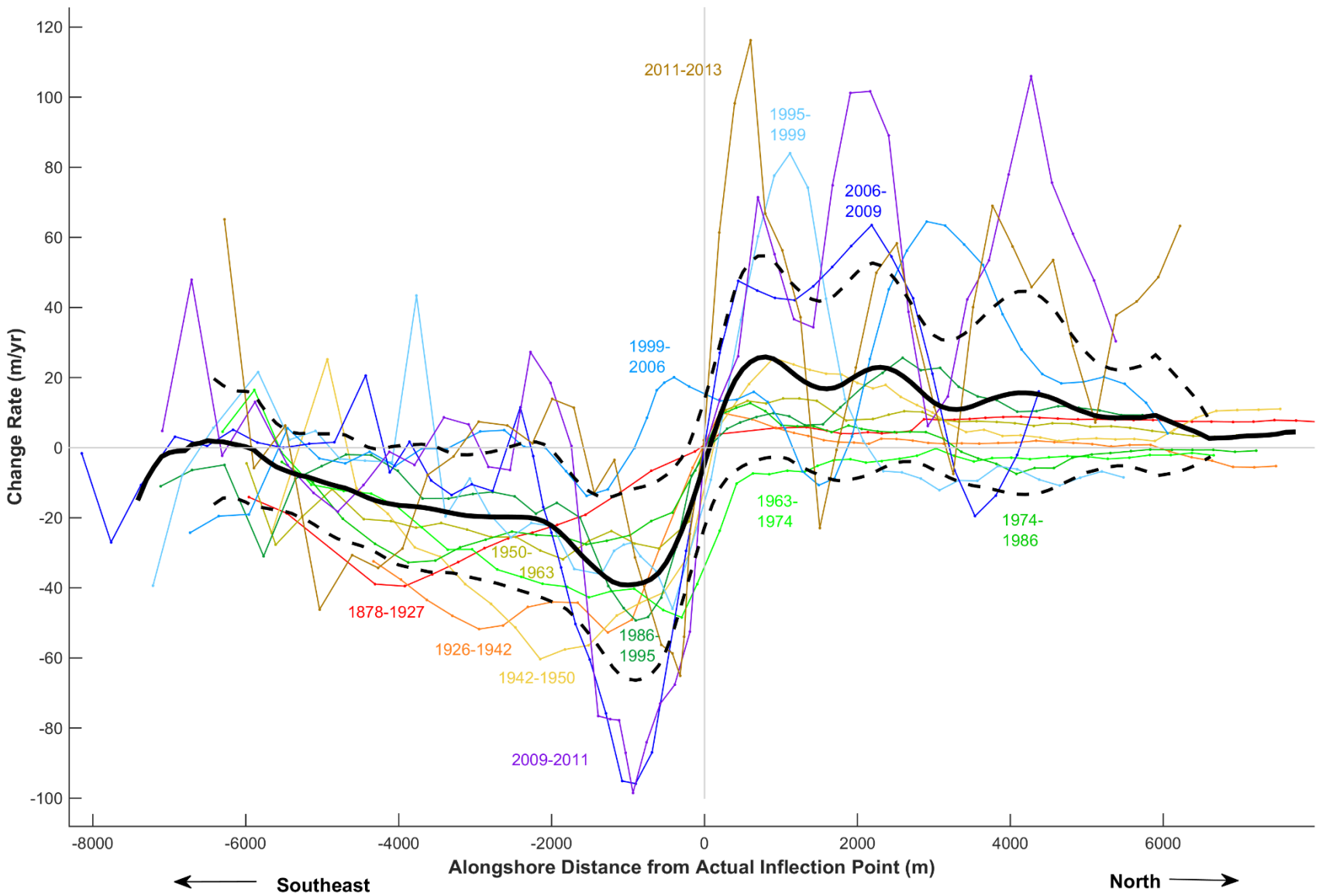
Cross-shore Transects



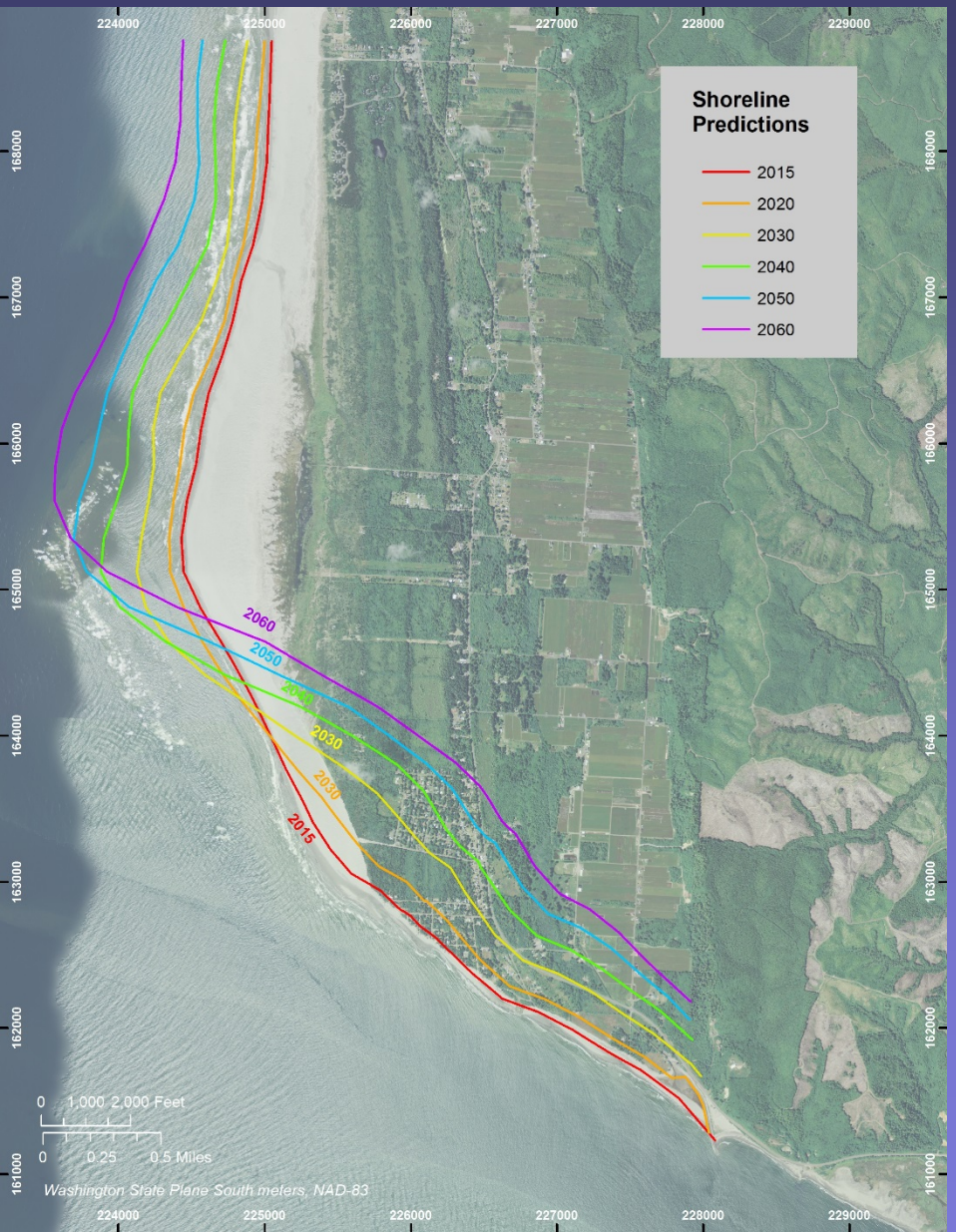
Historical Shoreline Change Rates at each Transect

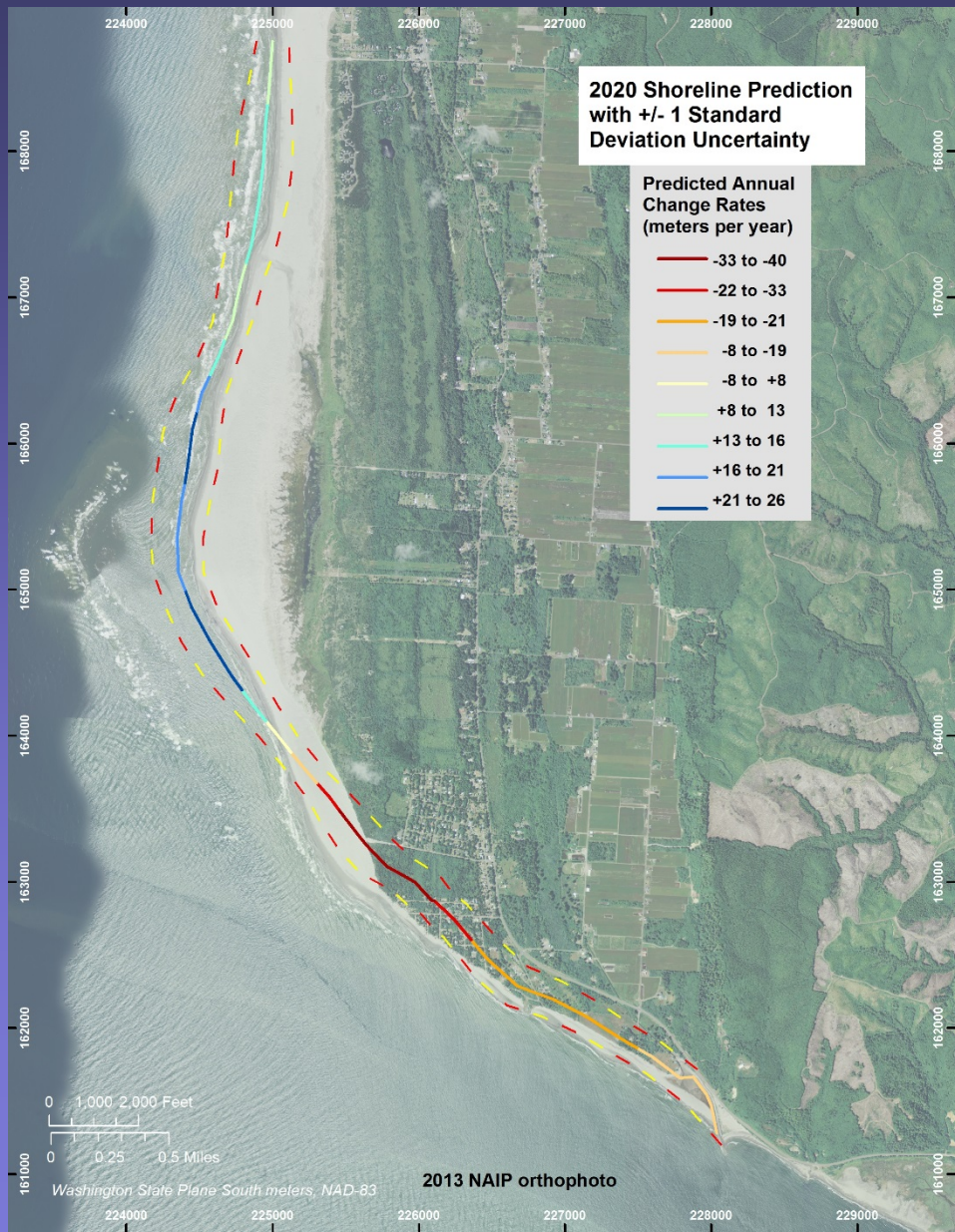


Historical Shoreline Change Rates relative to Inflection Point

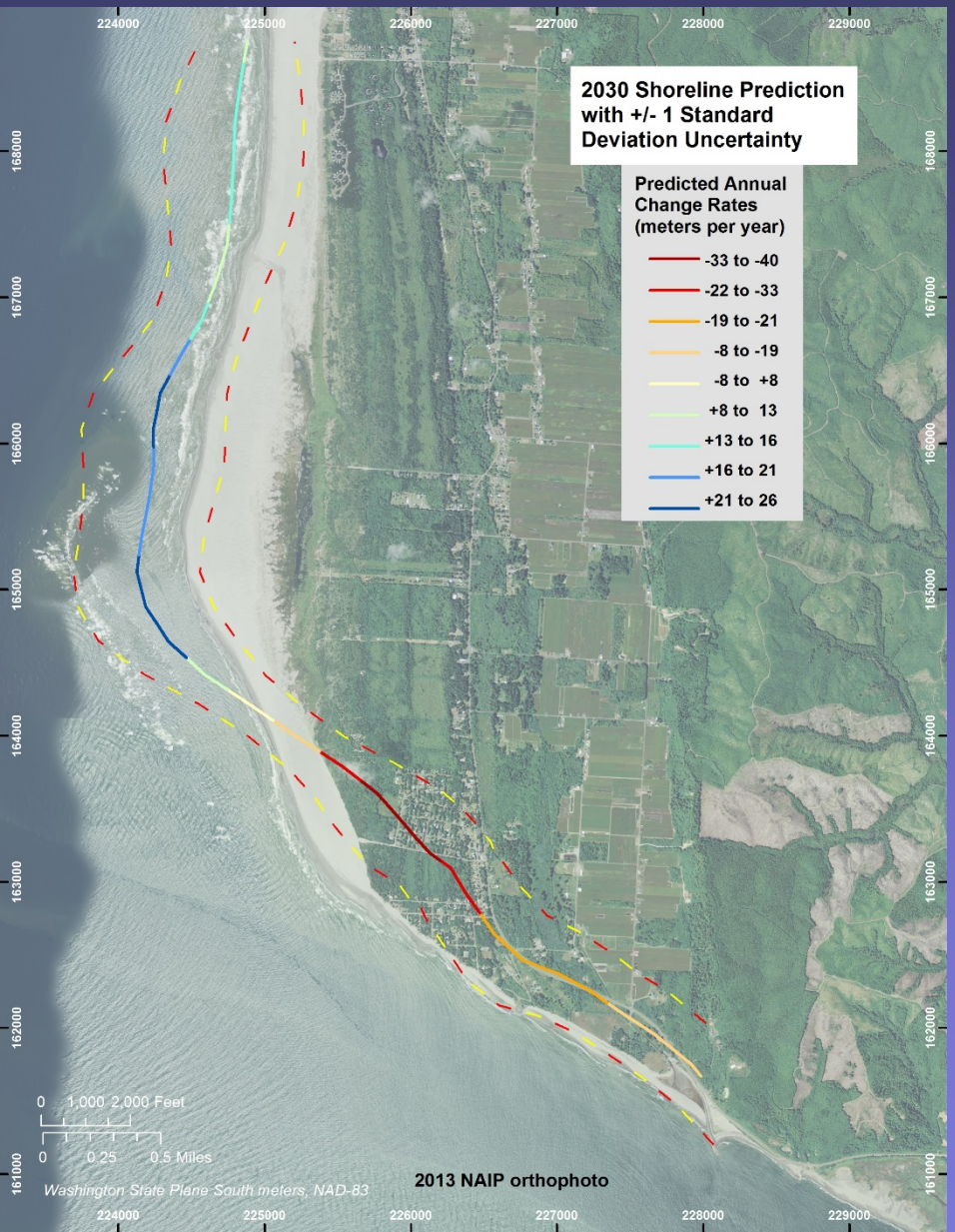


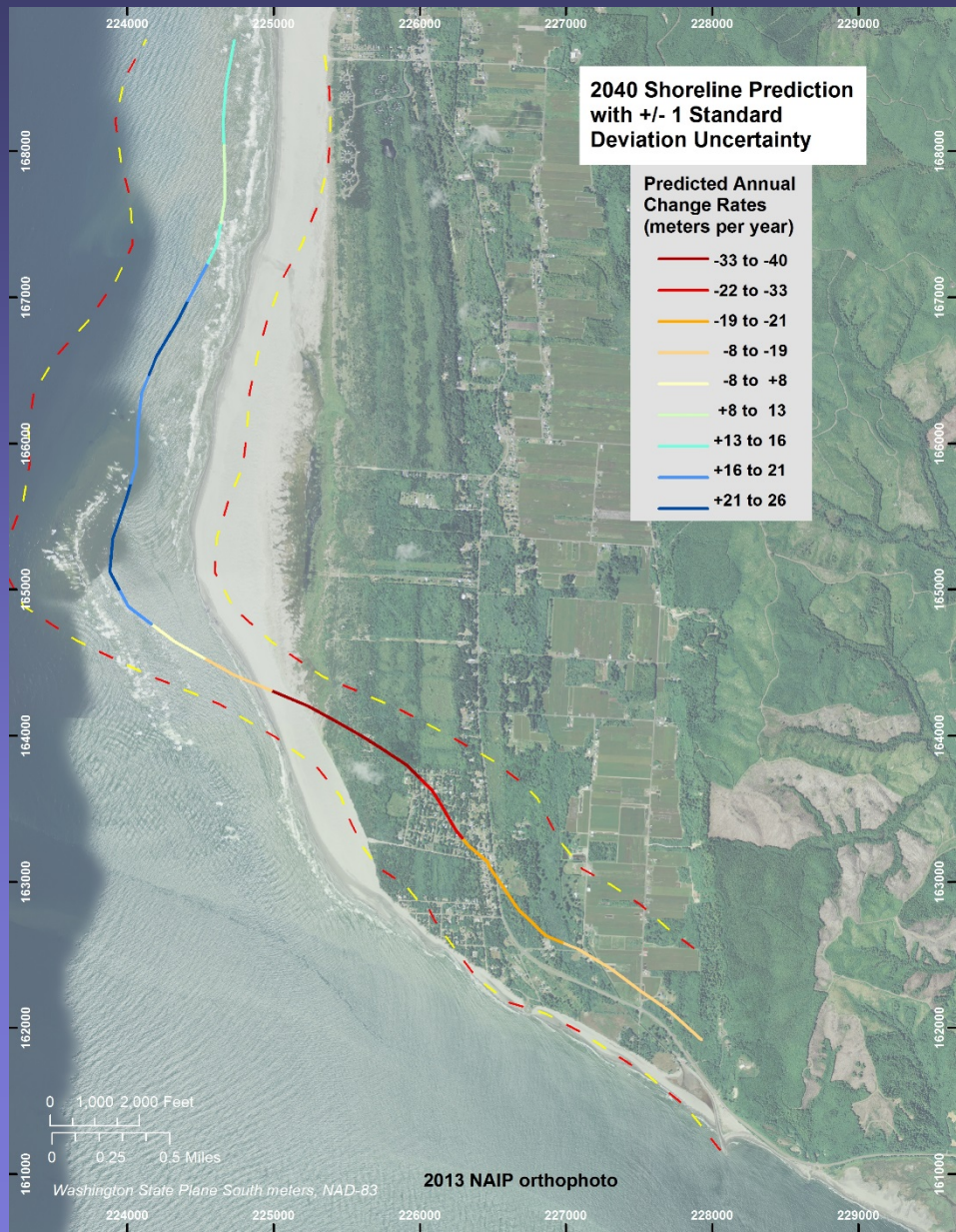
Shoreline Predictions



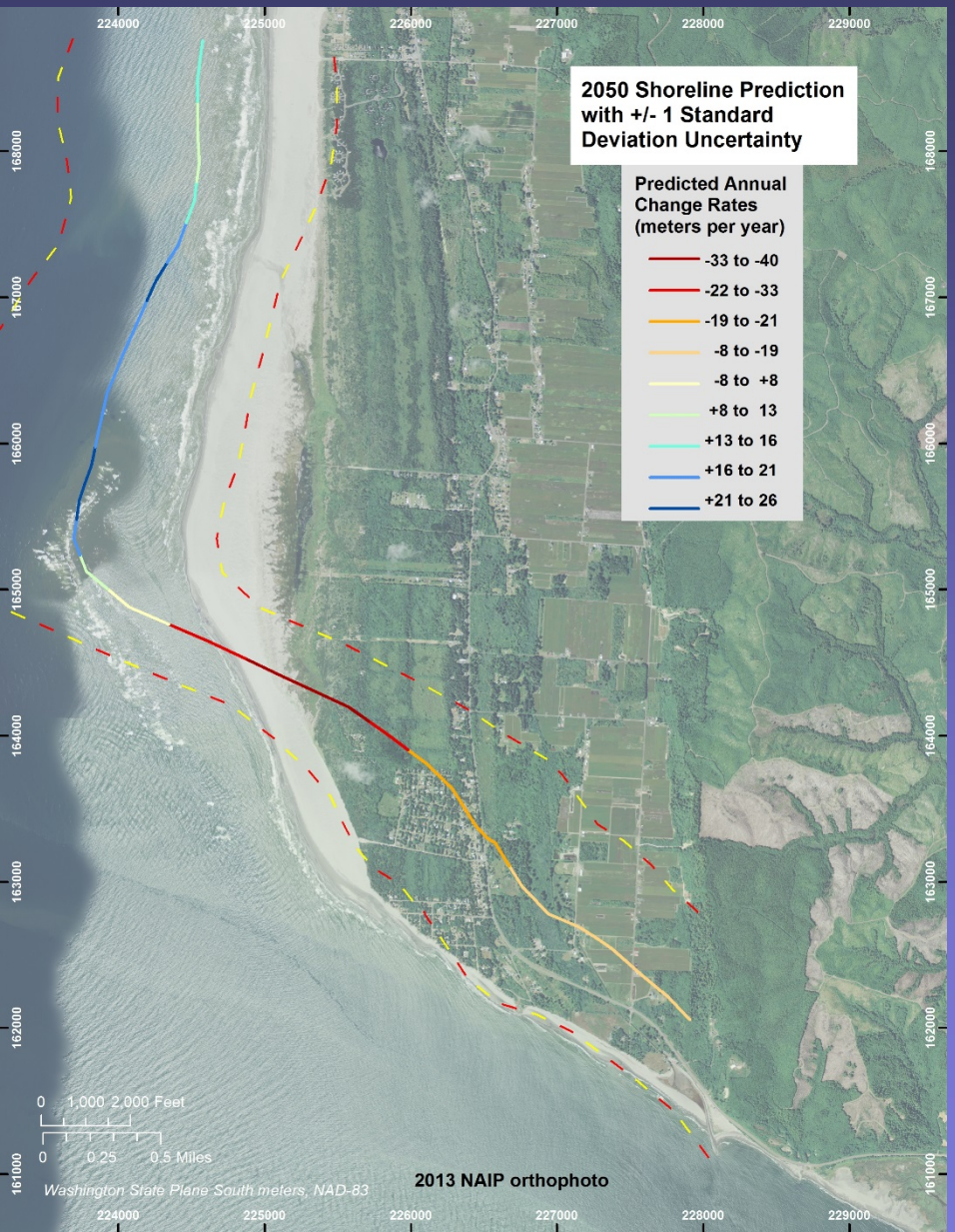


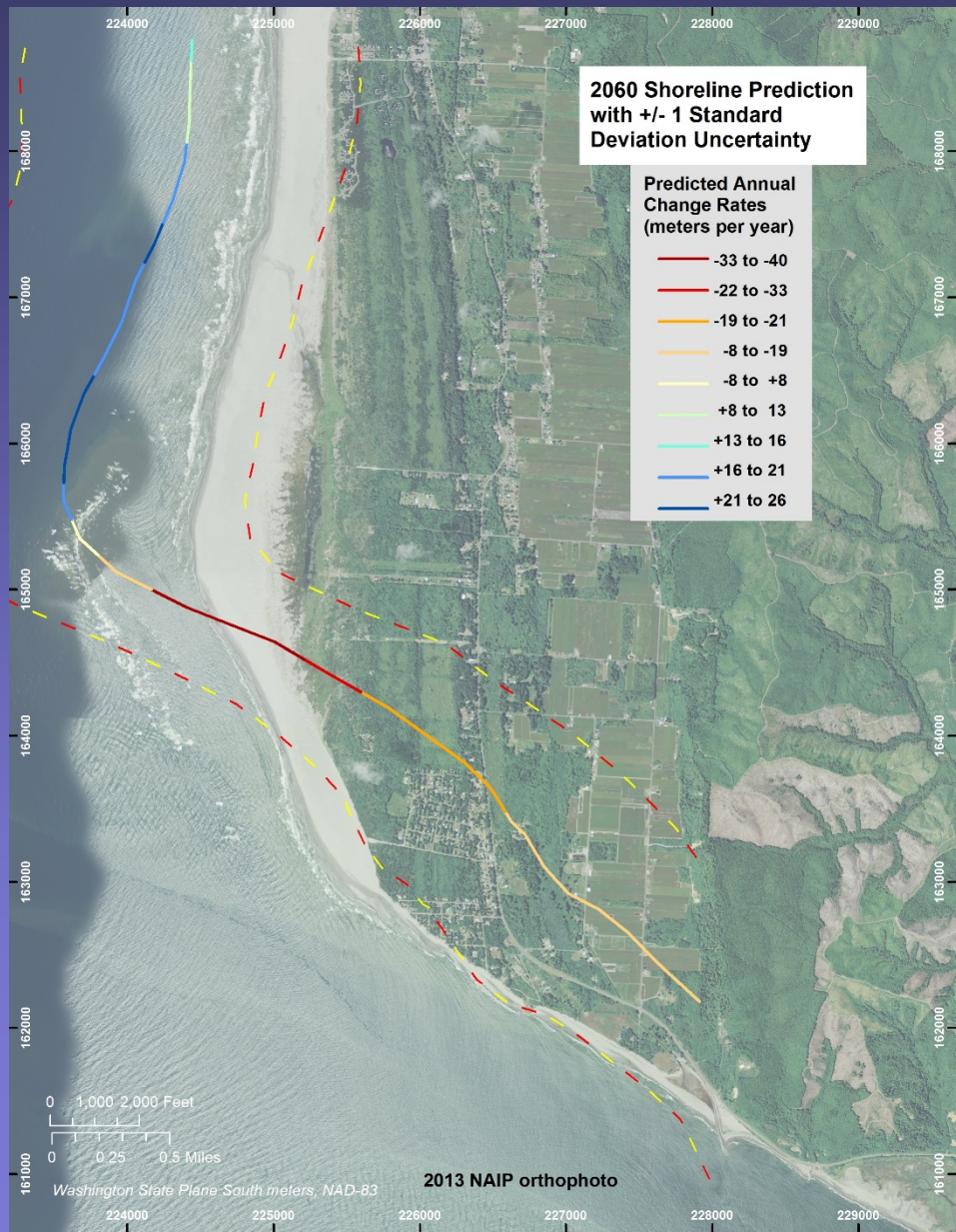
Shoreline Predictions



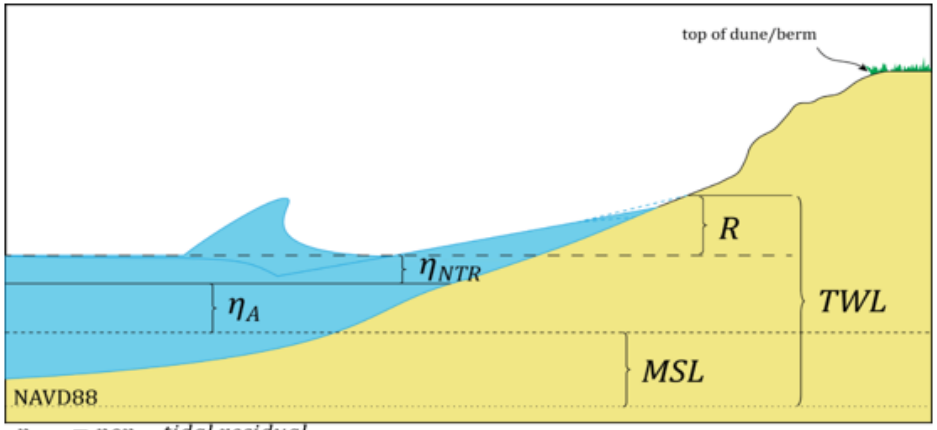


Shoreline Predictions





Total Water Level Model (Ruggiero et al., OSU)



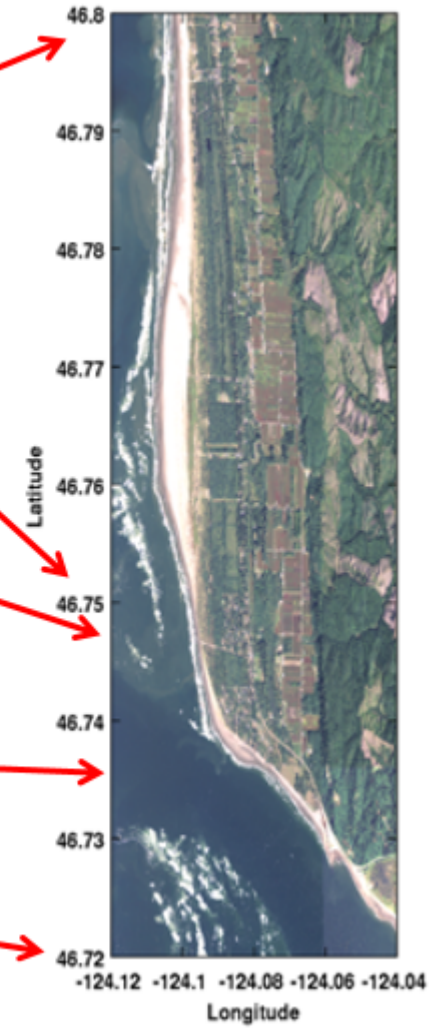
$\eta_{NTR} = non-tidal\ residual$
$\eta_A = astronomical\ tide$
$MSL = mean\ sea\ level$
$R = runup$

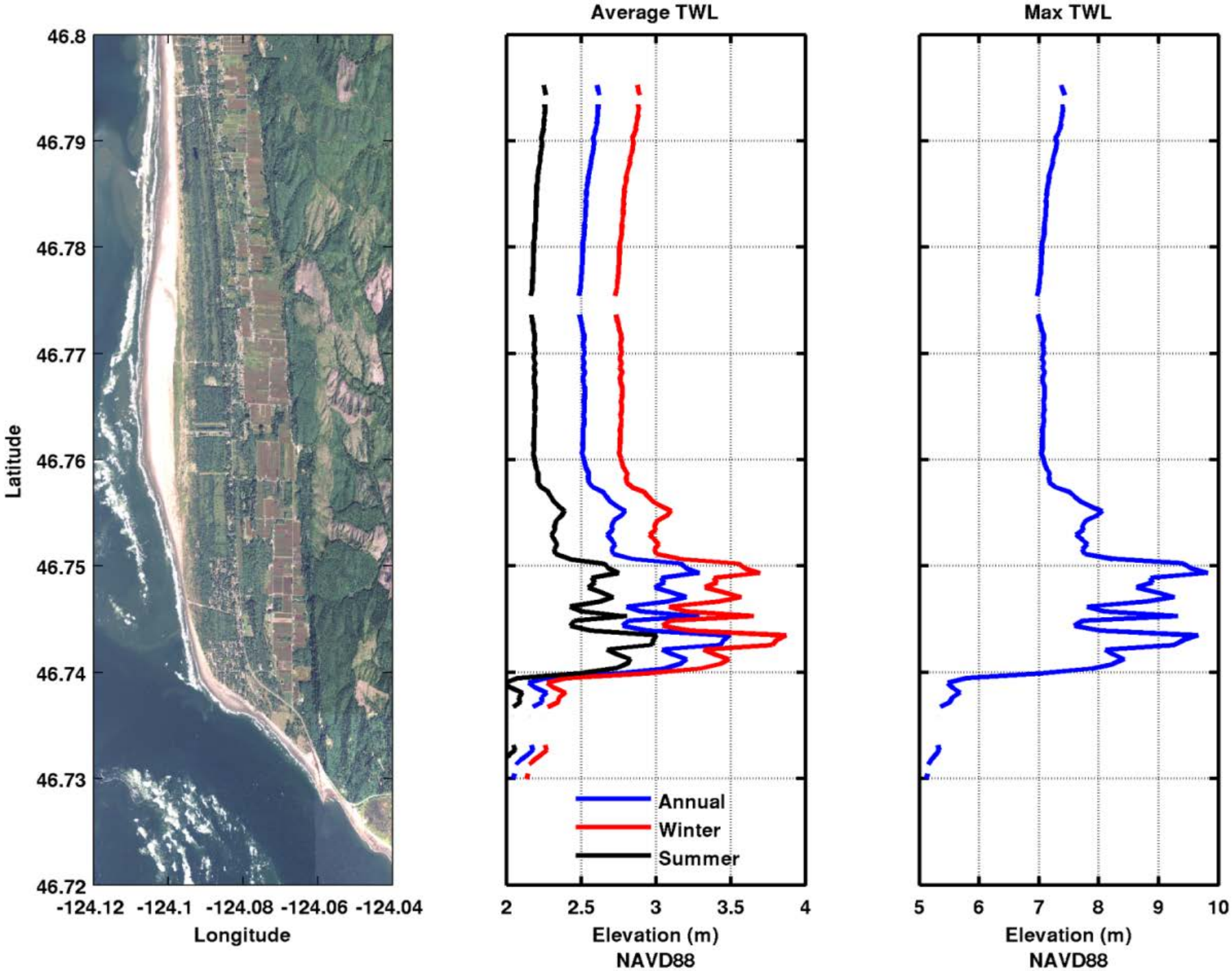
$\eta_{NTR} + \eta_A + MSL = measured\ tide\ gauge$
$R2\% = Stockdon\ 2006\ f(\beta, H_0, L_0)$

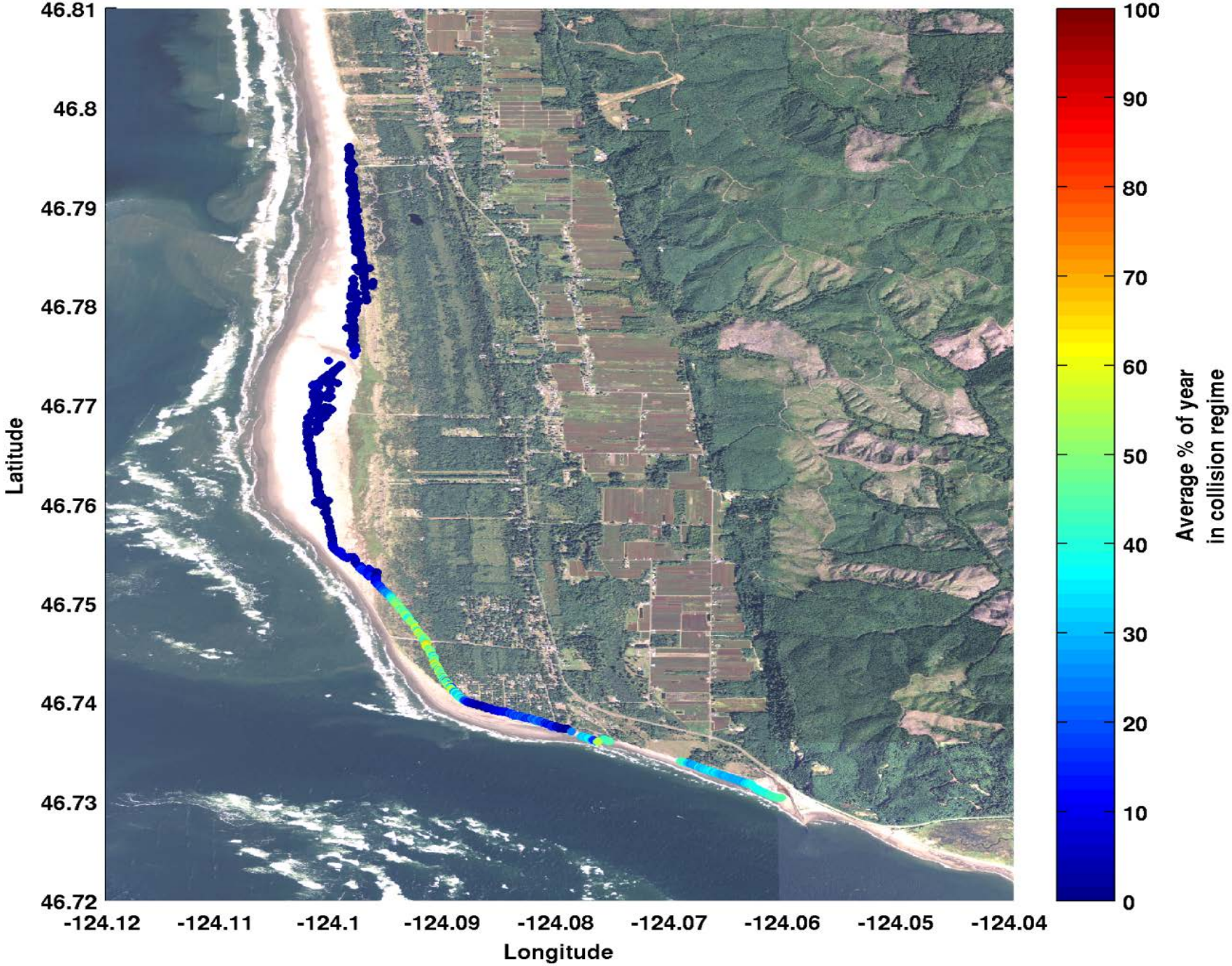
TWLs on the "open coast" were computed using waves from the combined water level time series

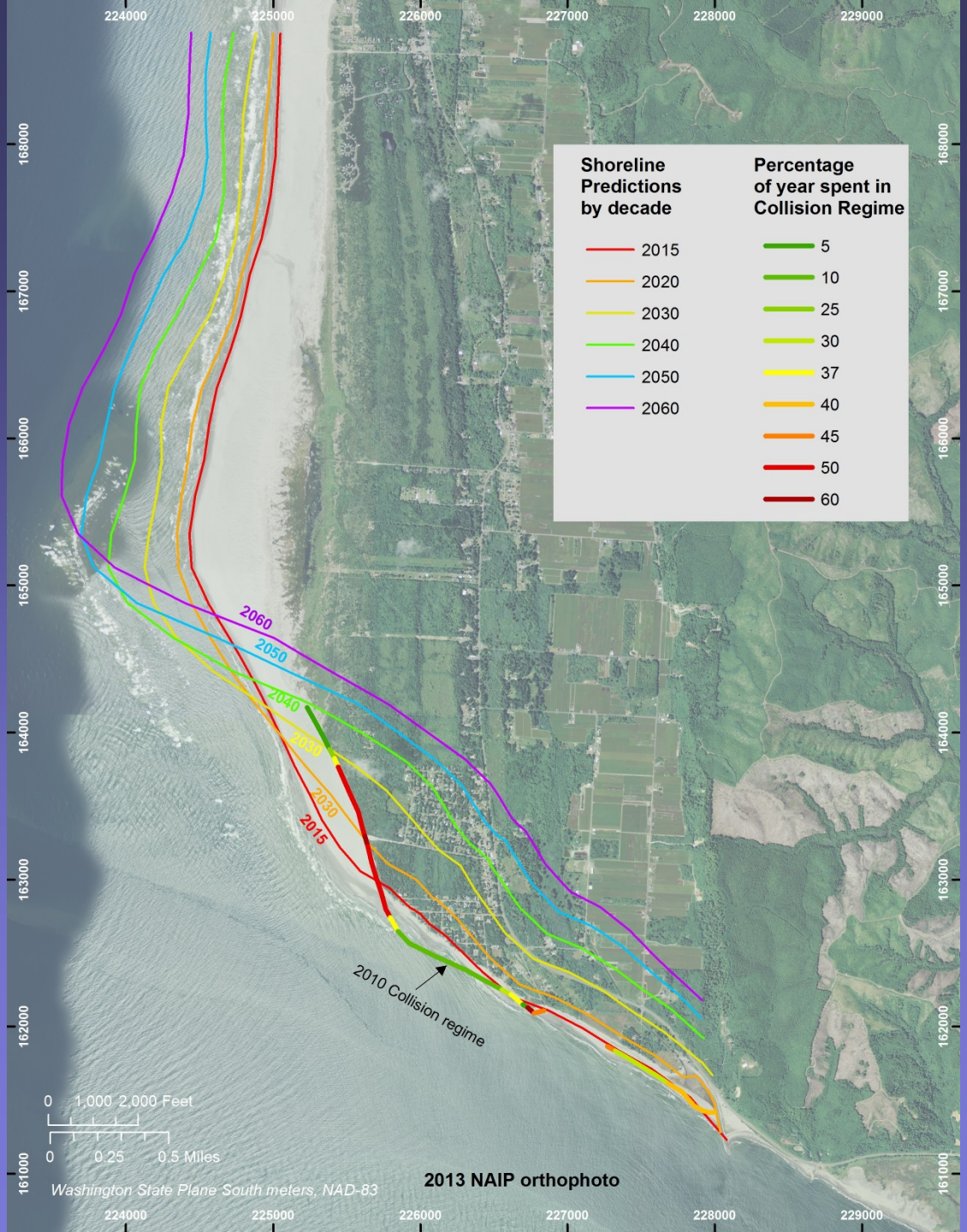
The open coast (OC) and Willapa Bay model (WB) were weighted in this transition area using a linear weighting function (wf)
[WB+(OC-WB)*wf]

TWLs in this region were computed using transfer functions for both wave height and wave period determined from a 2002 field experiment




Average TWL
Max TWL
Latitude
46.8
46.79
46.78
46.77
46.76
46.75
46.74
46.73
46.72
-124.12
-124.1
-124.08
-124.06
-124.04
Longitude
Annual
Winter
Summer
2
2.5
3
3.5
4
Elevation (m)
NAVD88
5
6
7
8
9
10
Elevation (m)
NAVD88


46.81
46.8
46.79
46.78
46.77
46.76
46.75
46.74
46.73
46.72
Latitude
-124.12
-124.11
-124.1
-124.09
-124.08
-124.07
-124.06
-124.05
-124.04
Longitude
100
90
80
70
60
50
40
30
20
10
0
Average % of year
in collision regime


Shoreline Predictions by decade
2015
2020
2030
2040
2050
2060
Percentage of year spent in Collision Regime
5
10
25
30
37
40
45
50
60
2060
2050
2040
2030
2020
2015
2010 Collision regime
0 1,000 2,000 Feet
0 0.25 0.5 Miles
Washington State Plane South meters, NAD-83
2013 NAIP orthophoto
224000
225000
226000
227000
228000
229000
168000
167000
166000
165000
164000
163000
162000
161000

Summary

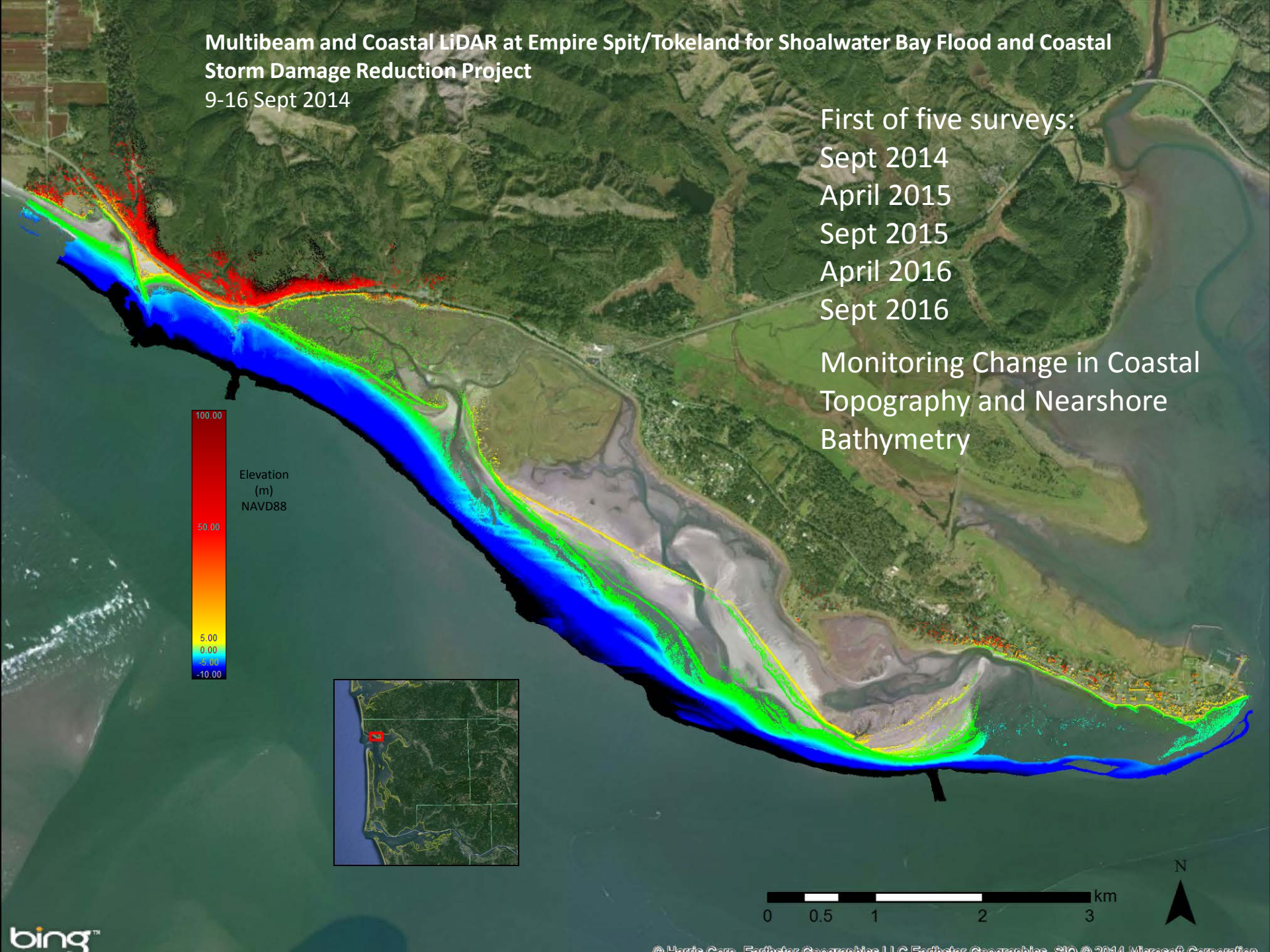
- The shoreline is expected to continue to erode in a similar pattern over the next few decades.
- The locus of highest erosion is projected to shift toward the northwest.
- The highest impact at present and over the long-term centers on an area in the vicinity of the Warrenton Cannery Road.
- The Pleistocene geology in the vicinity of the SR105 groin is assumed to prevent significant channel migration locally.
- The entrance channel position and alignment may eventually start to stabilize (post 2060).

Multibeam and Coastal LiDAR at Empire Spit/Tokeland for Shoalwater Bay Flood and Coastal Storm Damage Reduction Project

9-16 Sept 2014

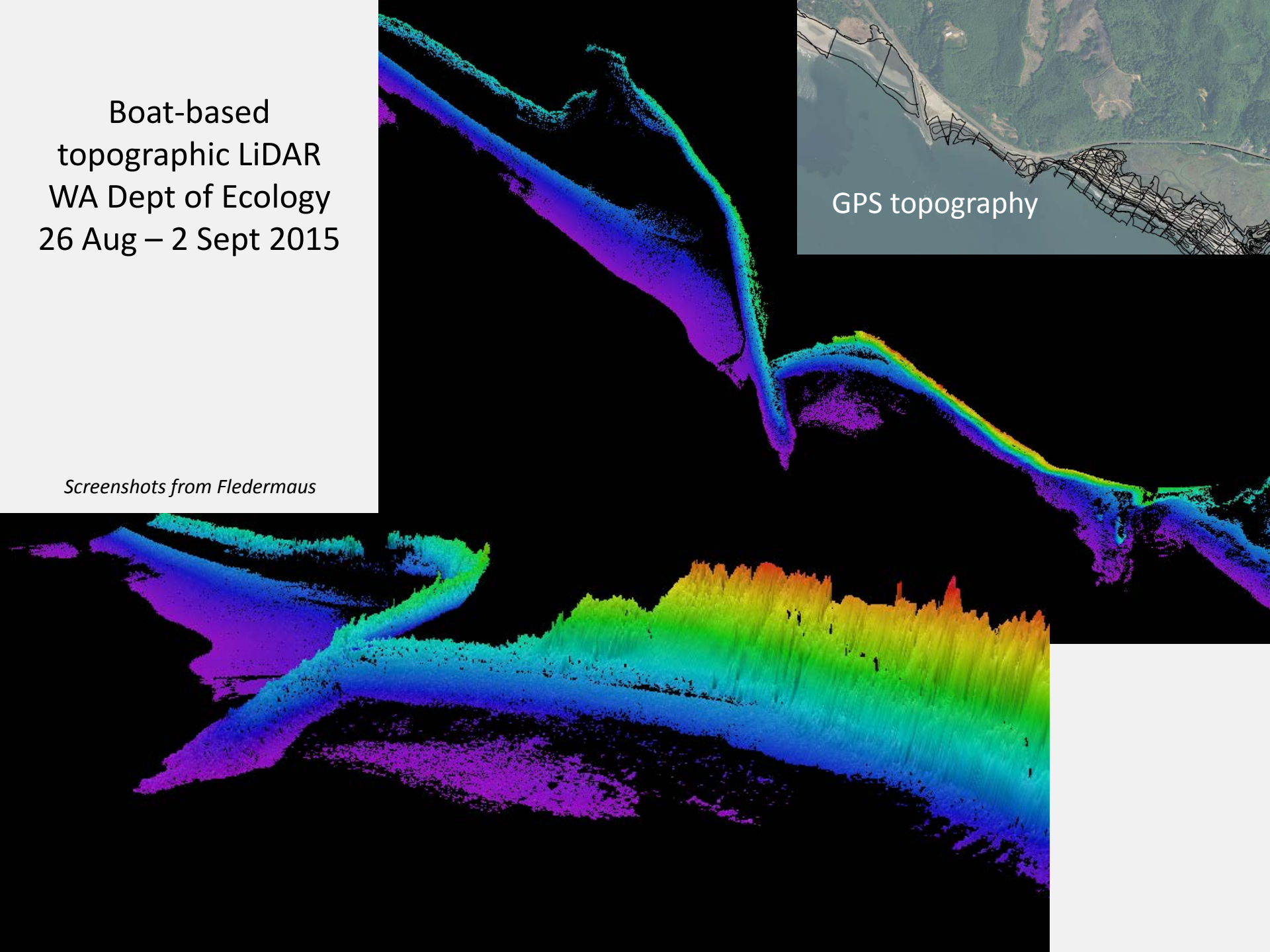
First of five surveys:
Sept 2014
April 2015
Sept 2015
April 2016
Sept 2016

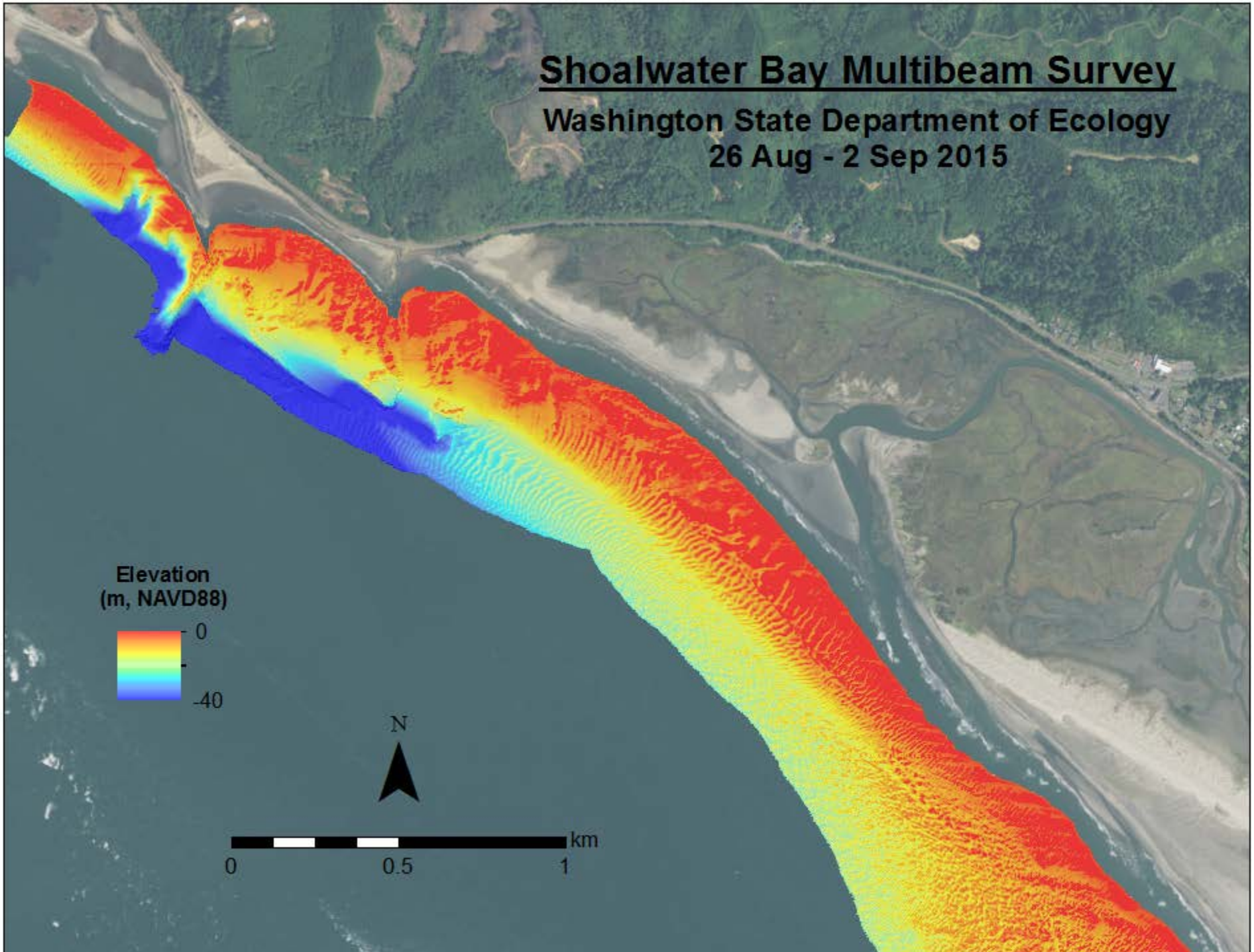
Monitoring Change in Coastal Topography and Nearshore Bathymetry

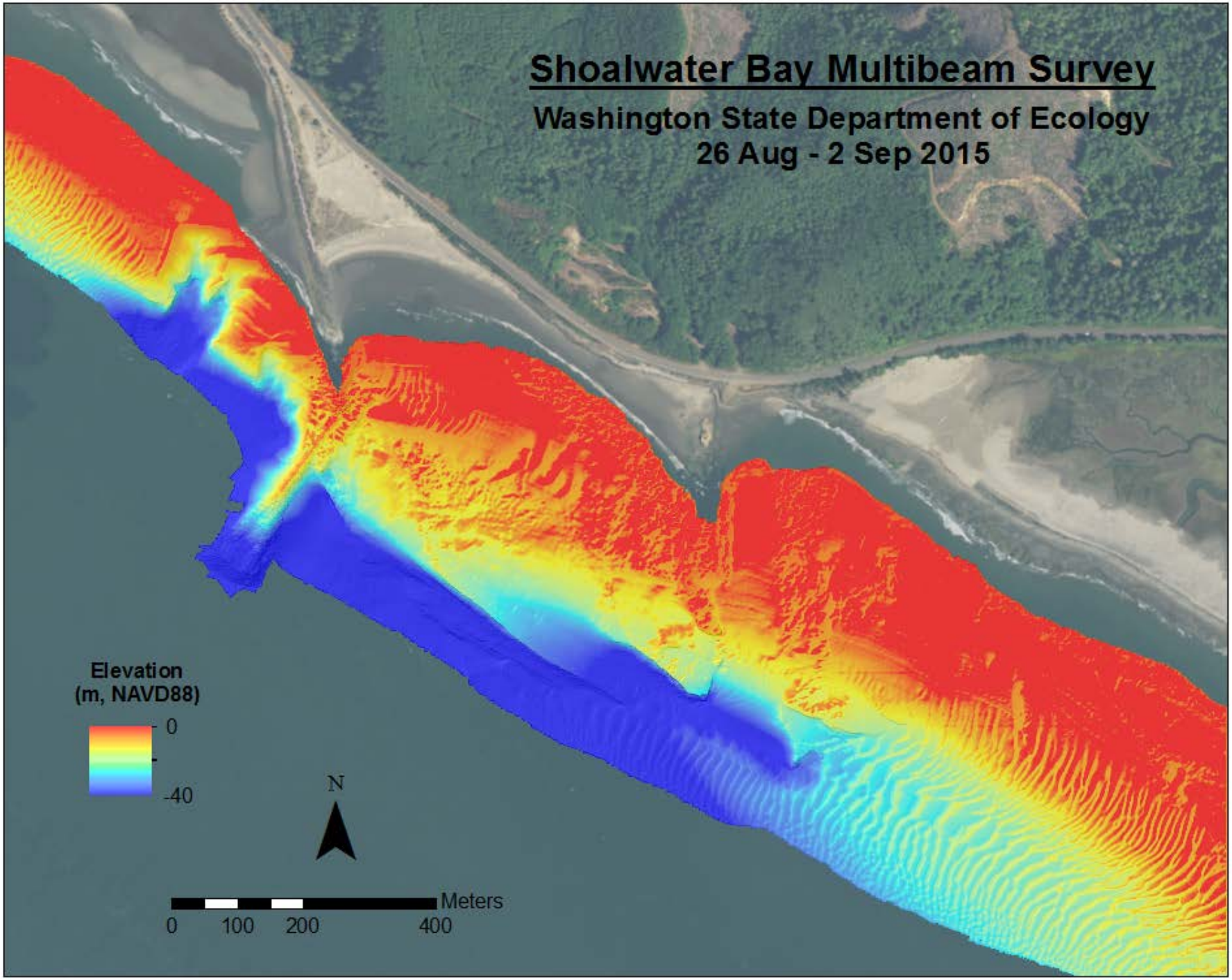


Boat-based
topographic LiDAR
WA Dept of Ecology
26 Aug – 2 Sept 2015

Screenshots from Fledermaus

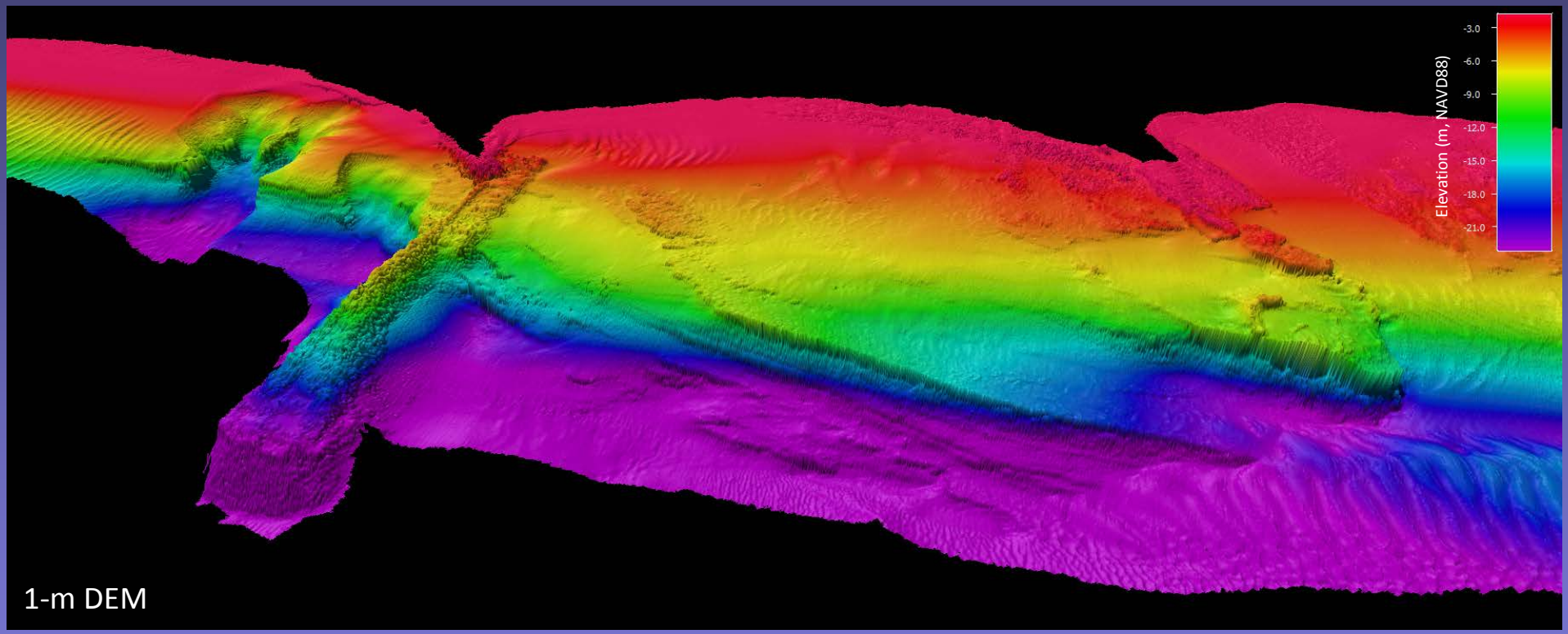



Shoalwater Bay Multibeam Survey
Washington State Department of Ecology
26 Aug - 2 Sep 2015
Elevation
(m, NAVD88)
0
-40
N
km
0
0.5
1


Shoalwater Bay Multibeam Survey
Washington State Department of Ecology
26 Aug - 2 Sep 2015
Elevation
(m, NAVD88)
0
-40
N
Meters
0
100
200
400

Shoalwater Bay Multibeam Survey

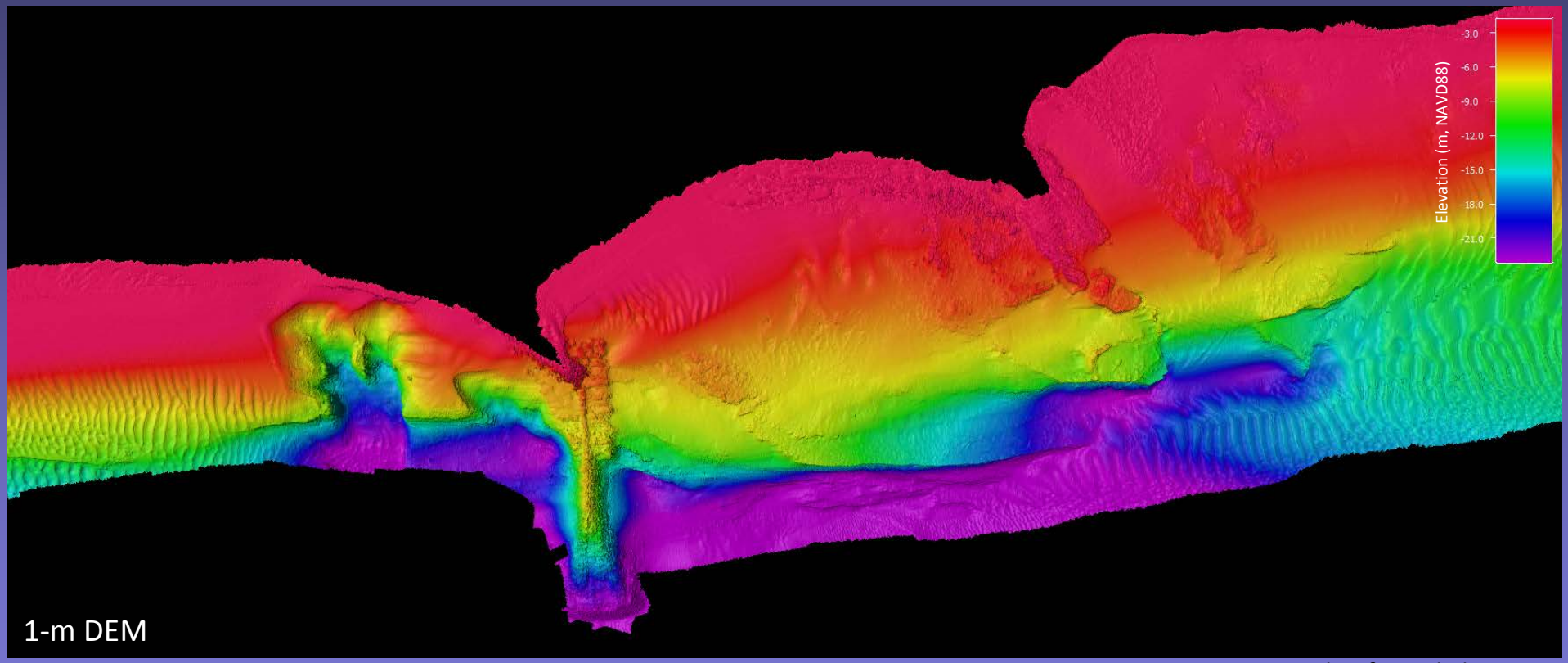
Washington Department of Ecology
26 Aug - 2 Sep 2015



Screenshot from Fledermaus

Shoalwater Bay Multibeam Survey

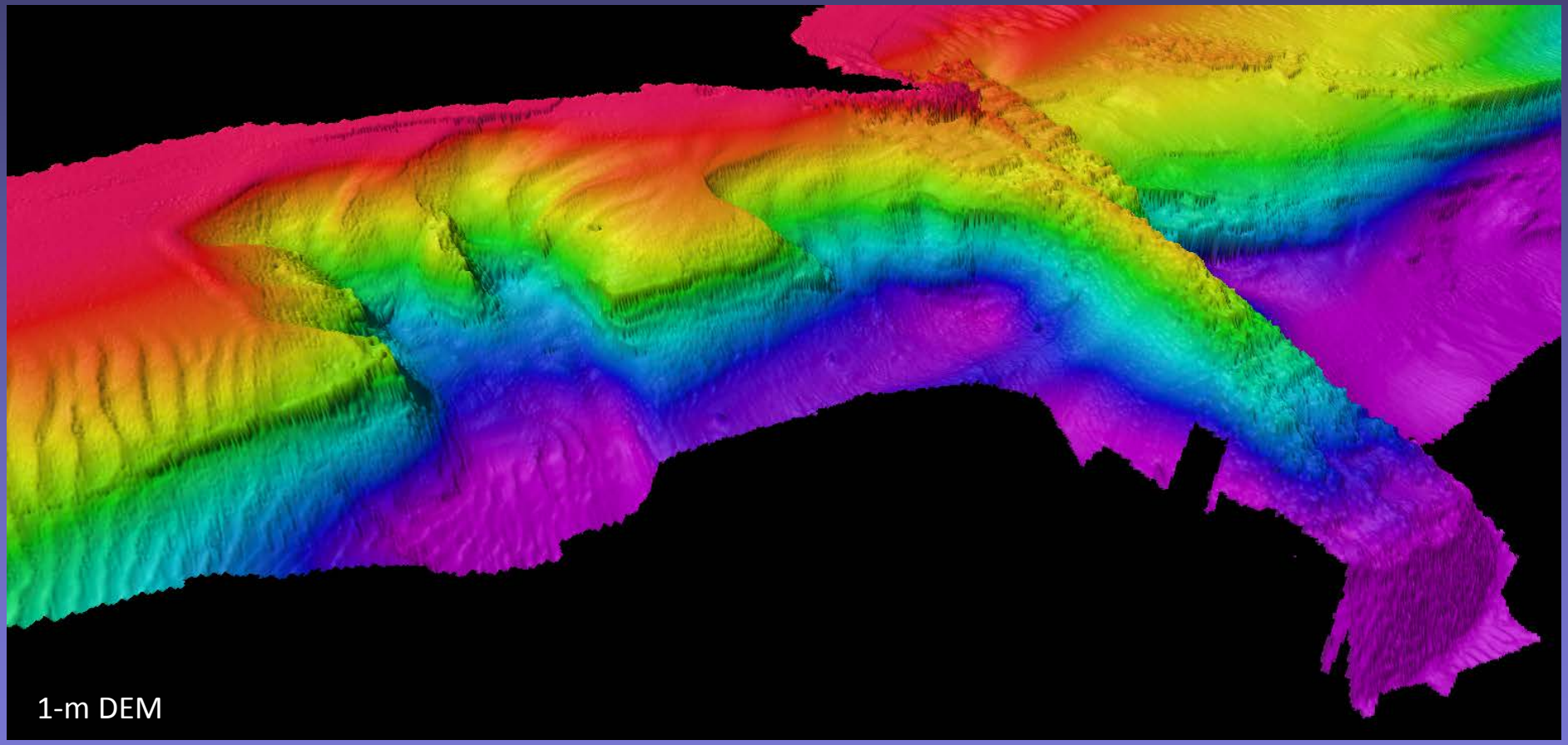
Washington Department of Ecology
26 Aug - 2 Sep 2015



Screenshot from Fledermaus

Shoalwater Bay Multibeam Survey

Washington Department of Ecology
26 Aug - 2 Sep 2015



Screenshot from Fledermaus

Questions

- How has the entrance channel migrated since 2003?
- Has the channel deepened in the vicinity of the SR105 groin?
- How has the nearshore morphology changed since 2003?
- How much Pleistocene geology is exposed?
- Will the Pleistocene geology prevent further landward migration of the channel near the SR105 groin?
- Is the Pleistocene geology sufficiently resistant to erosion?
- Can SR105 be relocated along the base of the Pleistocene geology toward the north?
- Can the SR105 groin be modified to facilitate sediment transport and bypassing from west to east?