Regional Municipal Approaches to Sea Level Rise and Increased Storm Surges: The SLAWG Approach

Gulf of Maine Council on the Environment Working Group Meeting

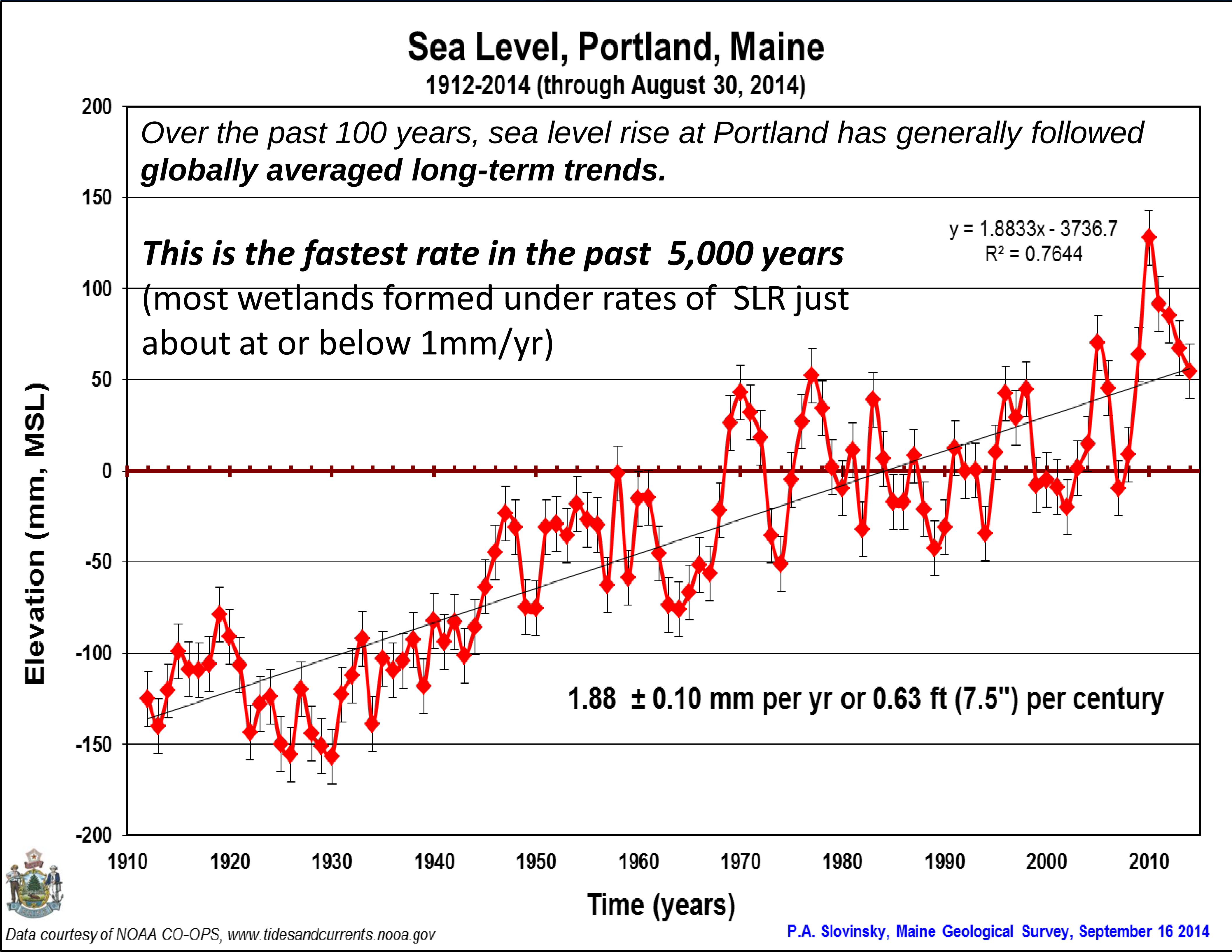
October 16, 2014

Work funded by:

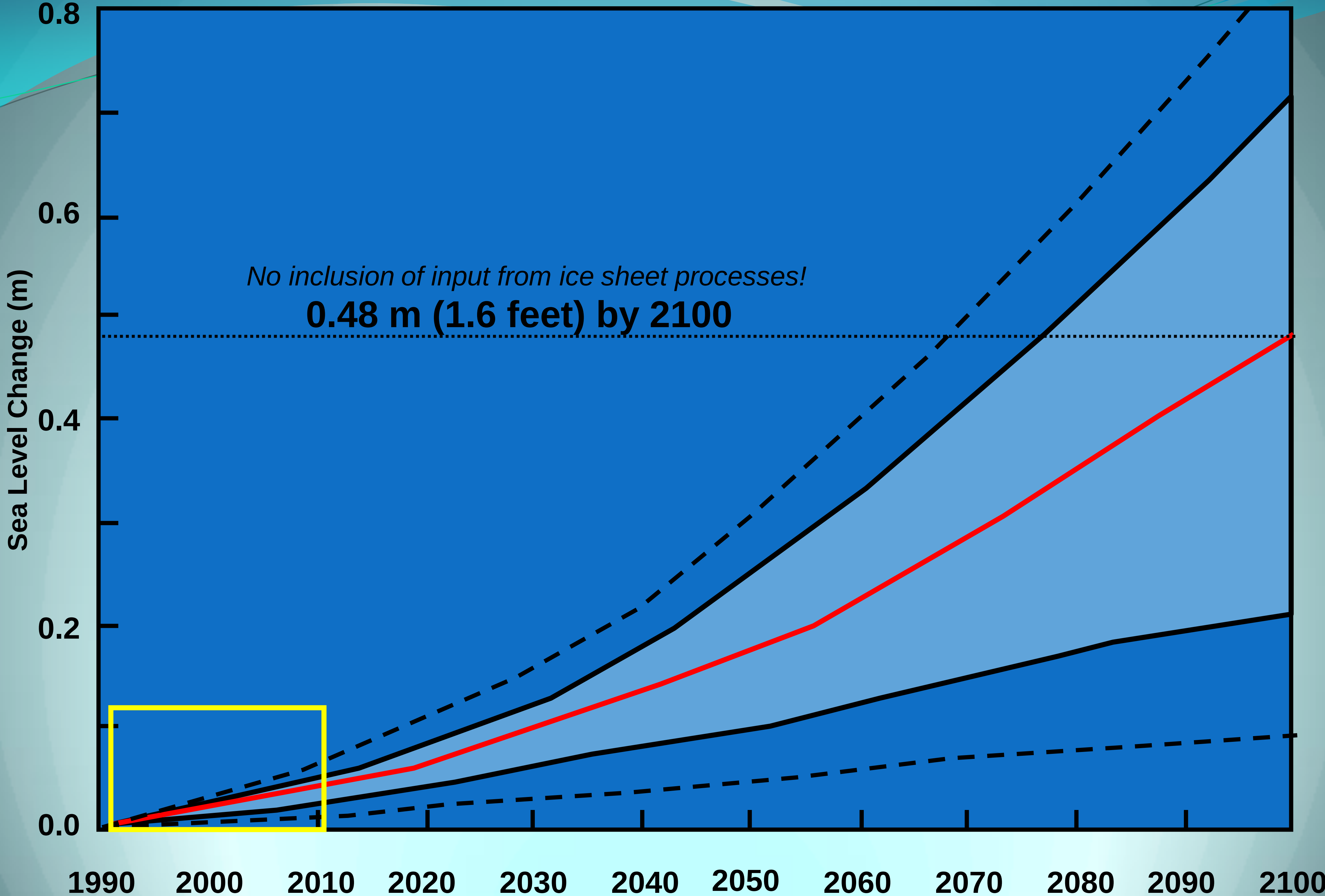
Peter A. Slovinsky, Marine Geologist
Maine Geological Survey
Department of Agriculture, Conservation and Forestry

I'll cover….

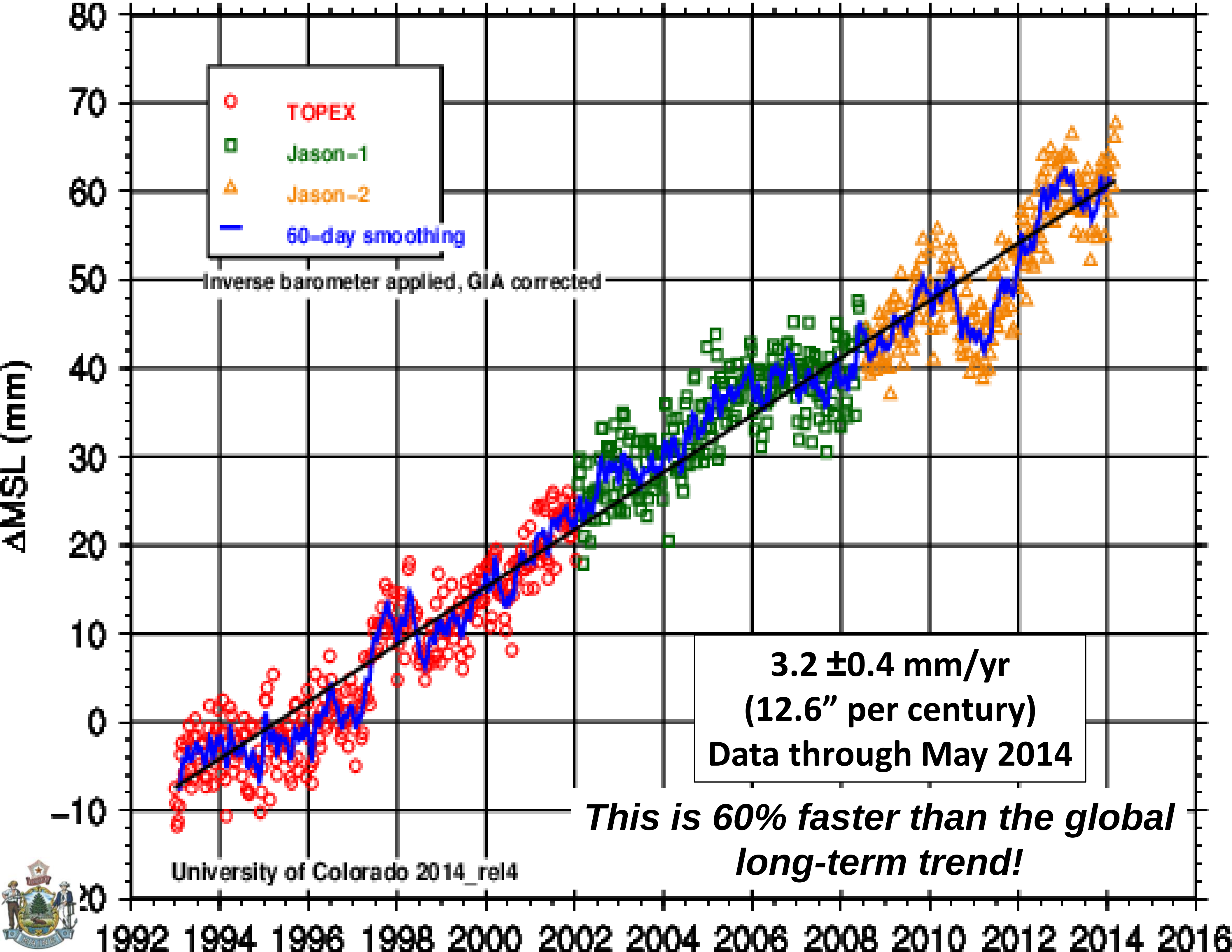
- Setting the stage: *a very quick* summary on the latest sea level rise trends and historical storm surge data in Maine
- Impacts of sea level rise on "nuisance flooding"
- Maine's NOAA-funded Coastal Hazard Resiliency Tools Project
- The Saco Bay **Sea Level Adaptation Working Group**
- SLAWG's transferability to other efforts in Maine



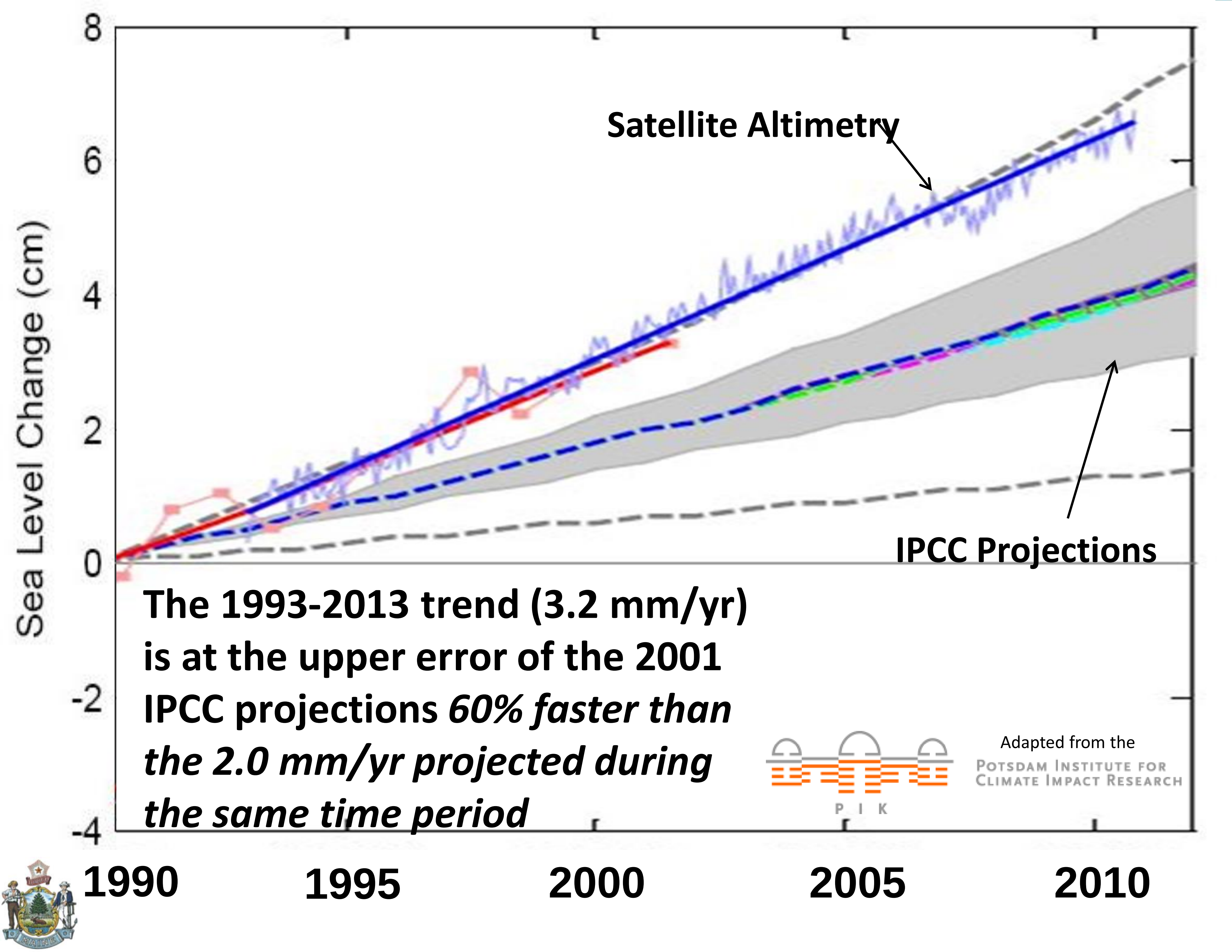
Sea Level, Portland, Maine
1912-2014 (through August 30, 2014)
Over the past 100 years, sea level rise at Portland has generally followed **globally averaged long-term trends.**
This is the fastest rate in the past 5,000 years
(most wetlands formed under rates of SLR just about at or below 1mm/yr)
y = 1.8833x - 3736.7
R² = 0.7644
1.88 ± 0.10 mm per yr or 0.63 ft (7.5") per century
Elevation (mm, MSL)
200
150
100
50
0
-50
-100
-150
-200
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Time (years)
Data courtesy of NOAA CO-OPS, www.tidesandcurrents.noaa.gov
P.A. Slovinsky, Maine Geological Survey, September 16 2014

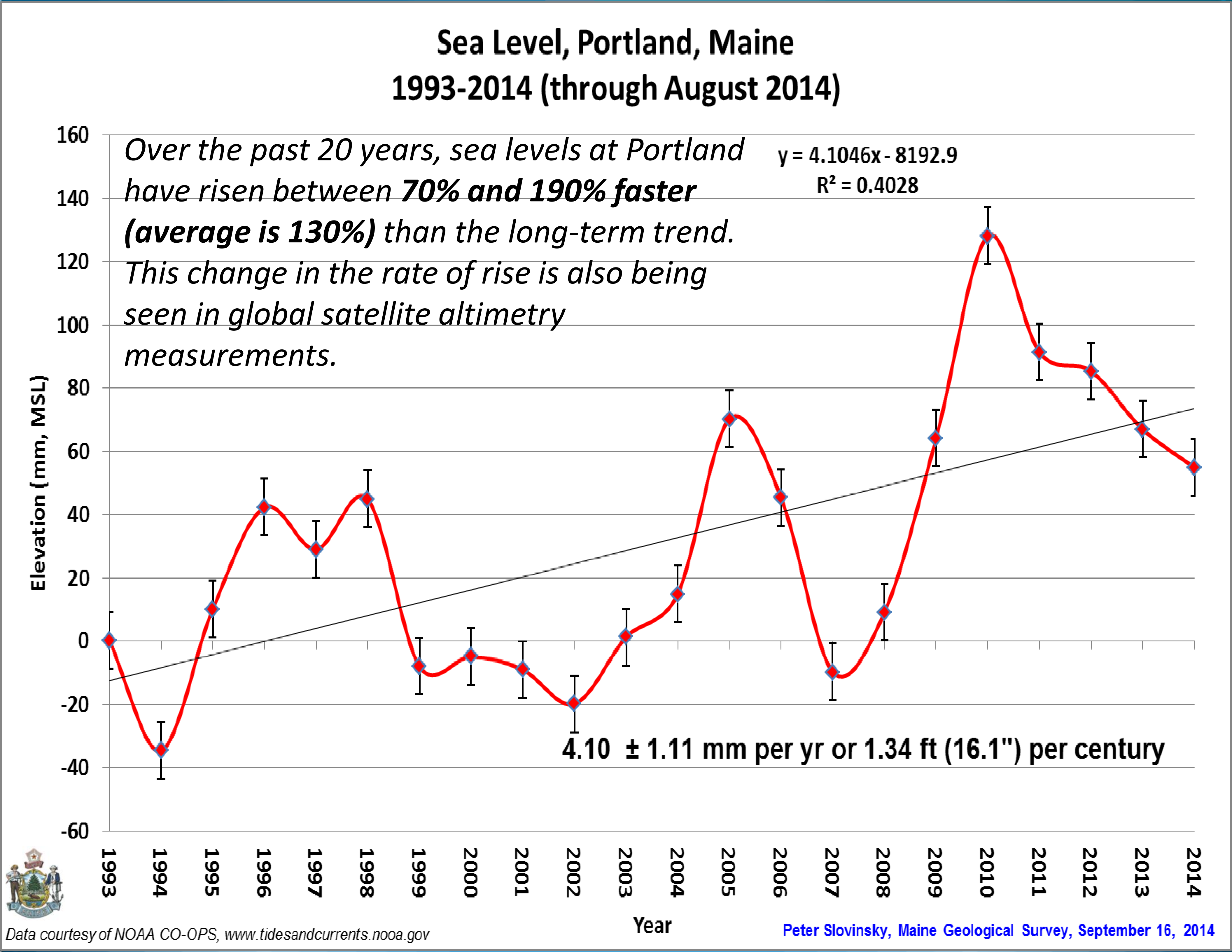


Adapted from the IPCC 3rd Assessment (Tech. Summary of Working Group I Report, Fig. 24, p. 74., 2001)



TOPEX
Jason-1
Jason-2
60-day smoothing
Inverse barometer applied, GIA corrected
ΔMSL (mm)
80
70
60
50
40
30
20
10
0
-10
-20
1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
University of Colorado 2014_rel4
3.2 ±0.4 mm/yr
(12.6” per century)
Data through May 2014
This is 60% faster than the global long-term trend!


Sea Level Change (cm)
8
6
4
2
0
-2
-4
1990
1995
2000
2005
2010
Satellite Altimetry
IPCC Projections
The 1993-2013 trend (3.2 mm/yr) is at the upper error of the 2001 IPCC projections *60% faster than the 2.0 mm/yr projected during the same time period*
Adapted from the
Potsdam Institute for Climate Impact Research
P I K

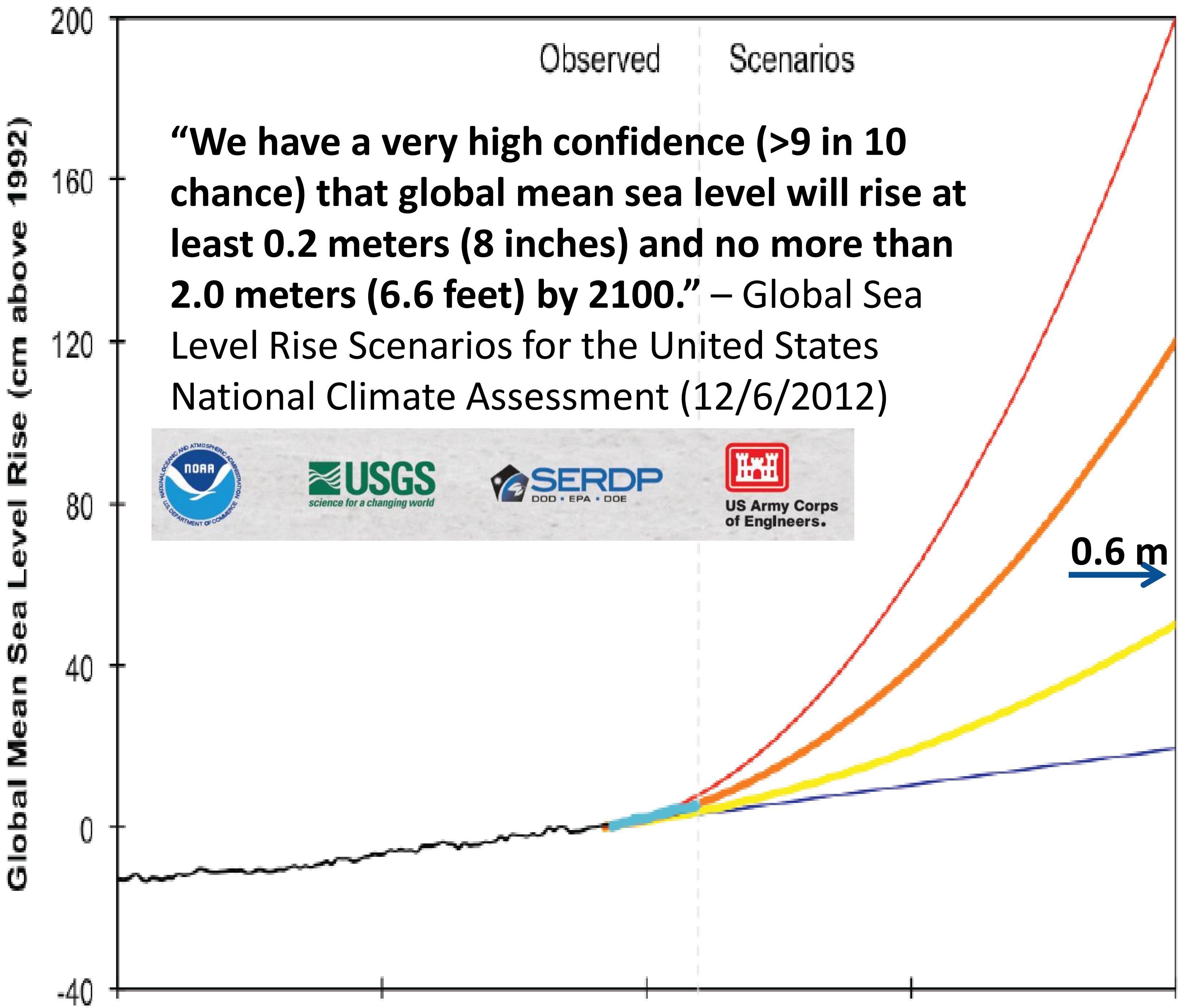

Sea Level, Portland, Maine
1993-2014 (through August 2014)
Over the past 20 years, sea levels at Portland have risen between 70% and 190% faster (average is 130%) than the long-term trend. This change in the rate of rise is also being seen in global satellite altimetry measurements.
y = 4.1046x - 8192.9
R² = 0.4028
4.10 ± 1.11 mm per yr or 1.34 ft (16.1") per century
Elevation (mm, MSL)
160
140
120
100
80
60
40
20
0
-20
-40
-60
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Year
Data courtesy of NOAA CO-OPS, www.tidesandcurrents.noaa.gov
Peter Slovinsky, Maine Geological Survey, September 16, 2014

…if current [Antarctic and Greenland] ice sheet melting rates continue for the next four decades, their cumulative loss could raise sea level by 15 centimeters (5.9 inches) by 2050. When this is added to the predicted sea level contribution of 8 centimeters (3.1 inches) from glacial ice caps and 9 centimeters (3.5 inches) from ocean thermal expansion, total sea level rise could reach 32 centimeters **(12.6 inches) by the year 2050**.

Rignot and others, March 2011

http://www.agu.org/news/press/pr_archives/2011/2011-09.shtml

Image from www.swisseduc.ch



"We have a very high confidence (>9 in 10 chance) that global mean sea level will rise at least 0.2 meters (8 inches) and no more than 2.0 meters (6.6 feet) by 2100." – Global Sea Level Rise Scenarios for the United States National Climate Assessment (12/6/2012)

US Army Corps of Engineers.

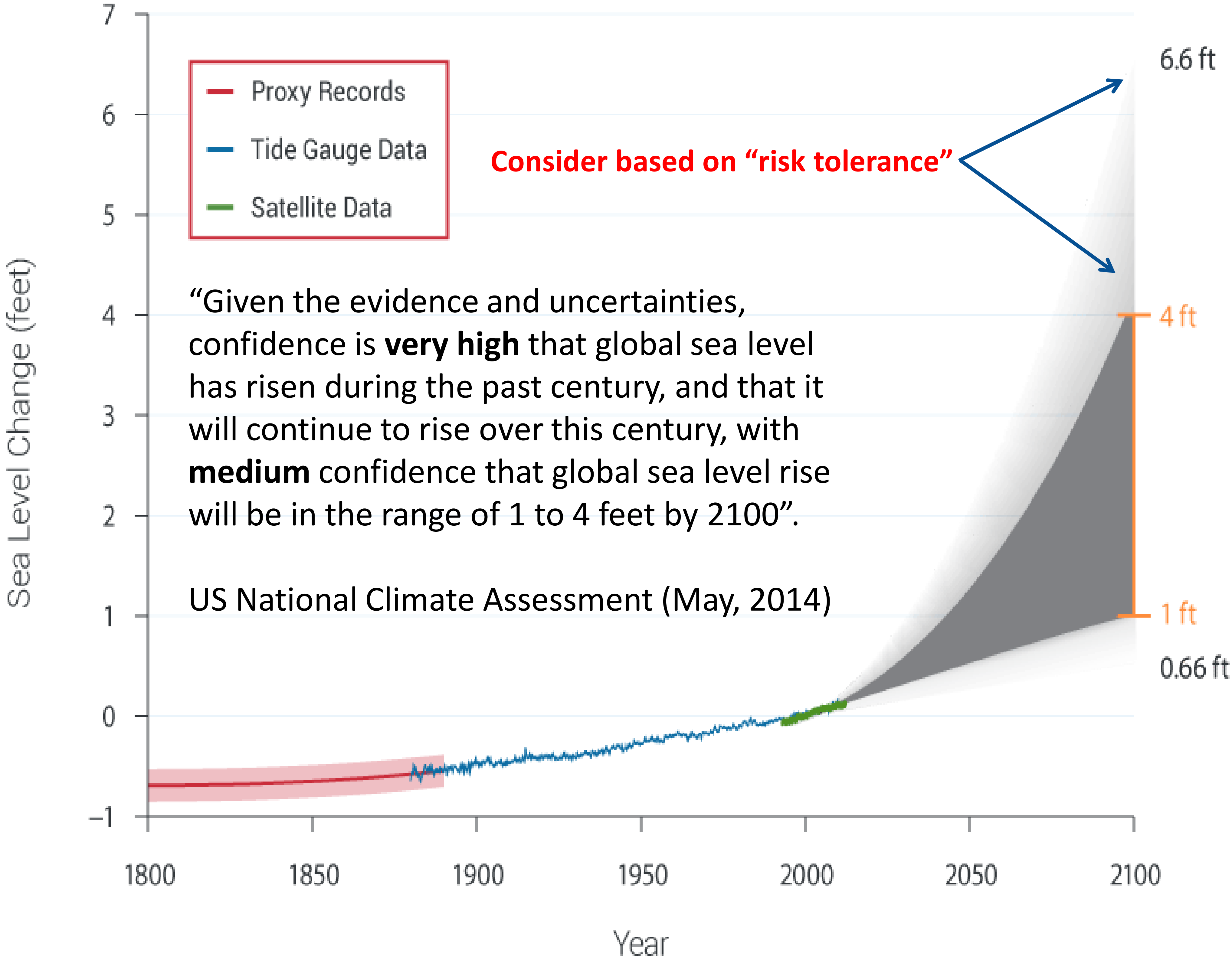
Highest
(2.0 m, 6.6 ft)
***Combines maximum warming, thermal expansion, and possible ice sheet loss from semi-empirical models.**

Intermediate-High
(1.2 m, 3.9 ft)
***Average of high end global predictions, combines recent ice sheet loss and thermal expansion**

Intermediate-Low
(0.5 m, 1.6 ft)
***Includes only thermal expansion from warming from IPCC AR4.**

Lowest
(0.2 m, 0.7 ft)
*** Historical trend continued; no additional thermal expansion from warming**

Recommend using a "Scenario" Based Approach

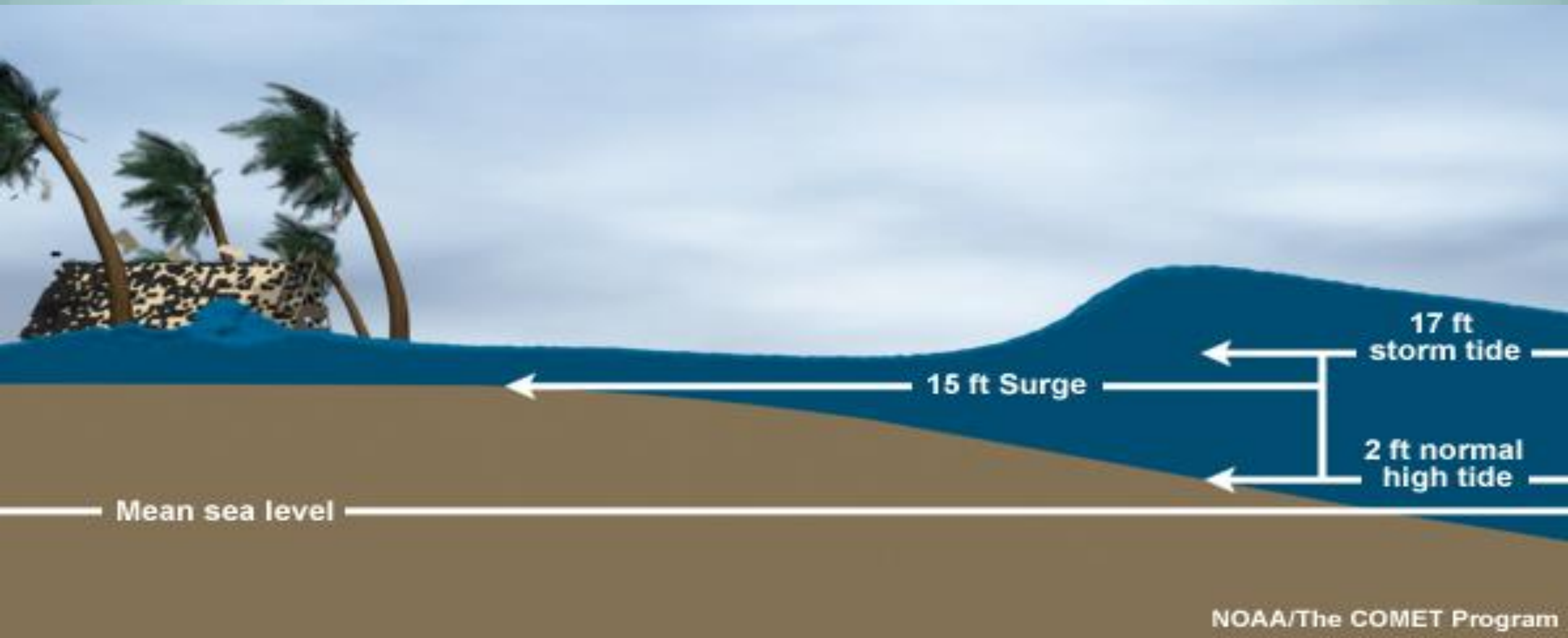


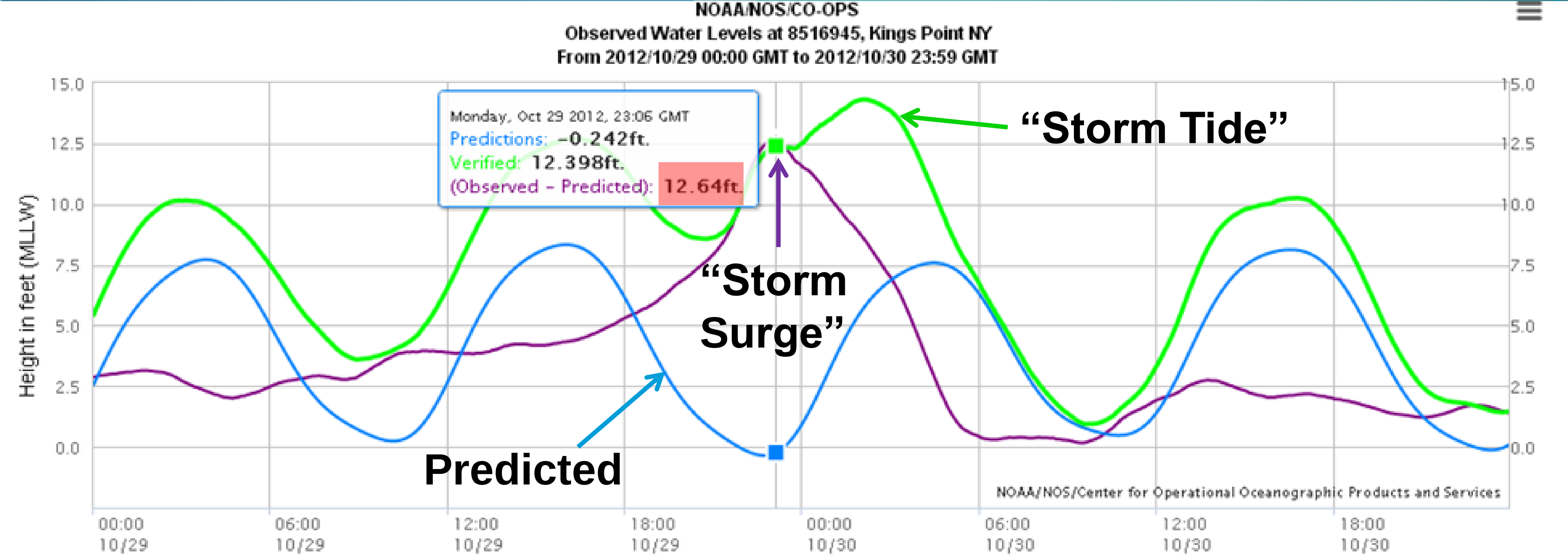
Proxy Records
Tide Gauge Data
Satellite Data
Consider based on "risk tolerance"
6.6 ft
4 ft
1 ft
0.66 ft
"Given the evidence and uncertainties, confidence is **very high** that global sea level has risen during the past century, and that it will continue to rise over this century, with **medium** confidence that global sea level rise will be in the range of 1 to 4 feet by 2100".
US National Climate Assessment (May, 2014)
Sea Level Change (feet)
7
6
5
4
3
2
1
0
−1
1800
1850
1900
1950
2000
2050
2100
Year

What about storm tides and storm surges?

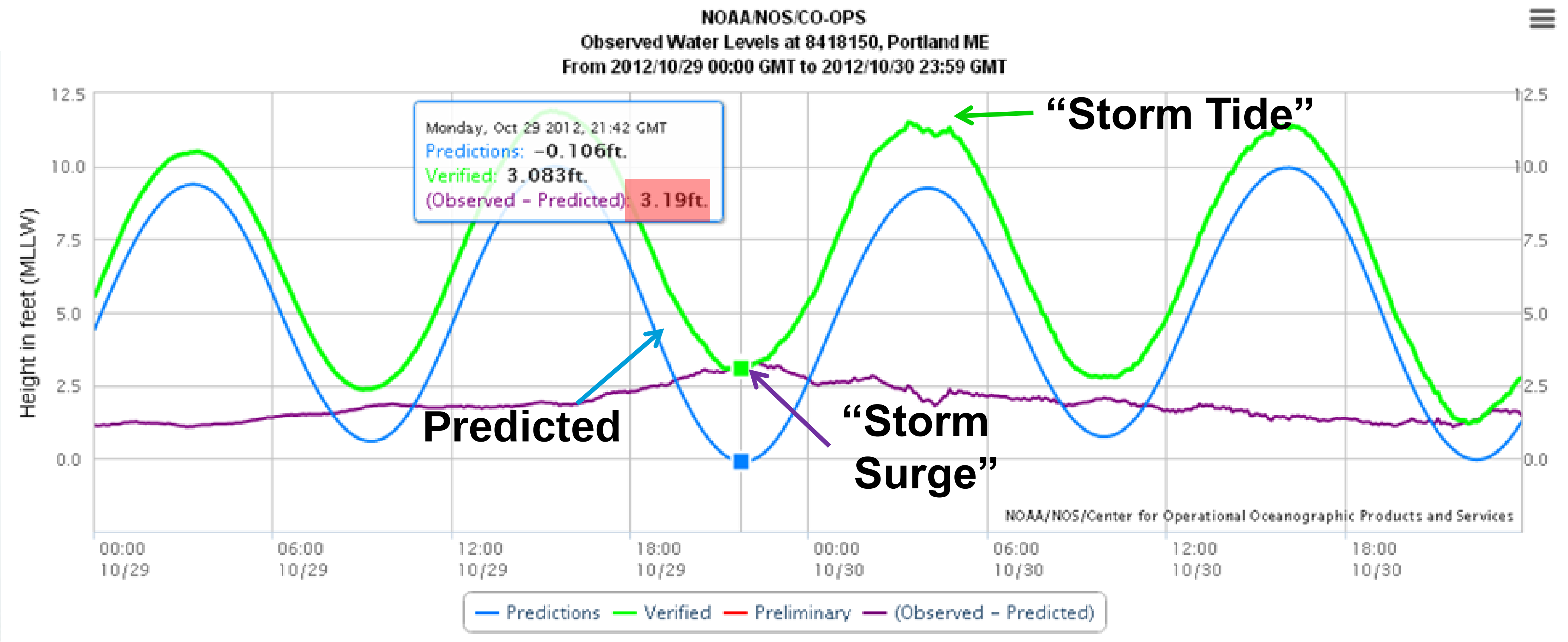
So what is storm surge?

Storm surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tides. Storm surge should not be confused with storm tide, which is defined as the water level rise due to the combination of storm surge and the astronomical tide (National Hurricane Center)





NOAA/NOS/CO-OPS
Observed Water Levels at 8516945, Kings Point NY
From 2012/10/29 00:00 GMT to 2012/10/30 23:59 GMT
Height in feet (MLLW)
Monday, Oct 29 2012, 23:06 GMT
Predictions: -0.242ft.
Verified: 12.398ft.
(Observed - Predicted): 12.64ft.
"Storm Tide"
"Storm Surge"
Predicted
NOAA/NOS/Center for Operational Oceanographic Products and Services



NOAA/NOS/CO-OPS
Observed Water Levels at 8418150, Portland ME
From 2012/10/29 00:00 GMT to 2012/10/30 23:59 GMT
Height in feet (MLLW)
Monday, Oct 29 2012, 21:42 GMT
Predictions: -0.106ft.
Verified: 3.083ft.
(Observed - Predicted): 3.19ft.
"Storm Tide"
"Storm Surge"
Predicted
NOAA/NOS/Center for Operational Oceanographic Products and Services
Predictions
Verified
Preliminary
(Observed - Predicted)

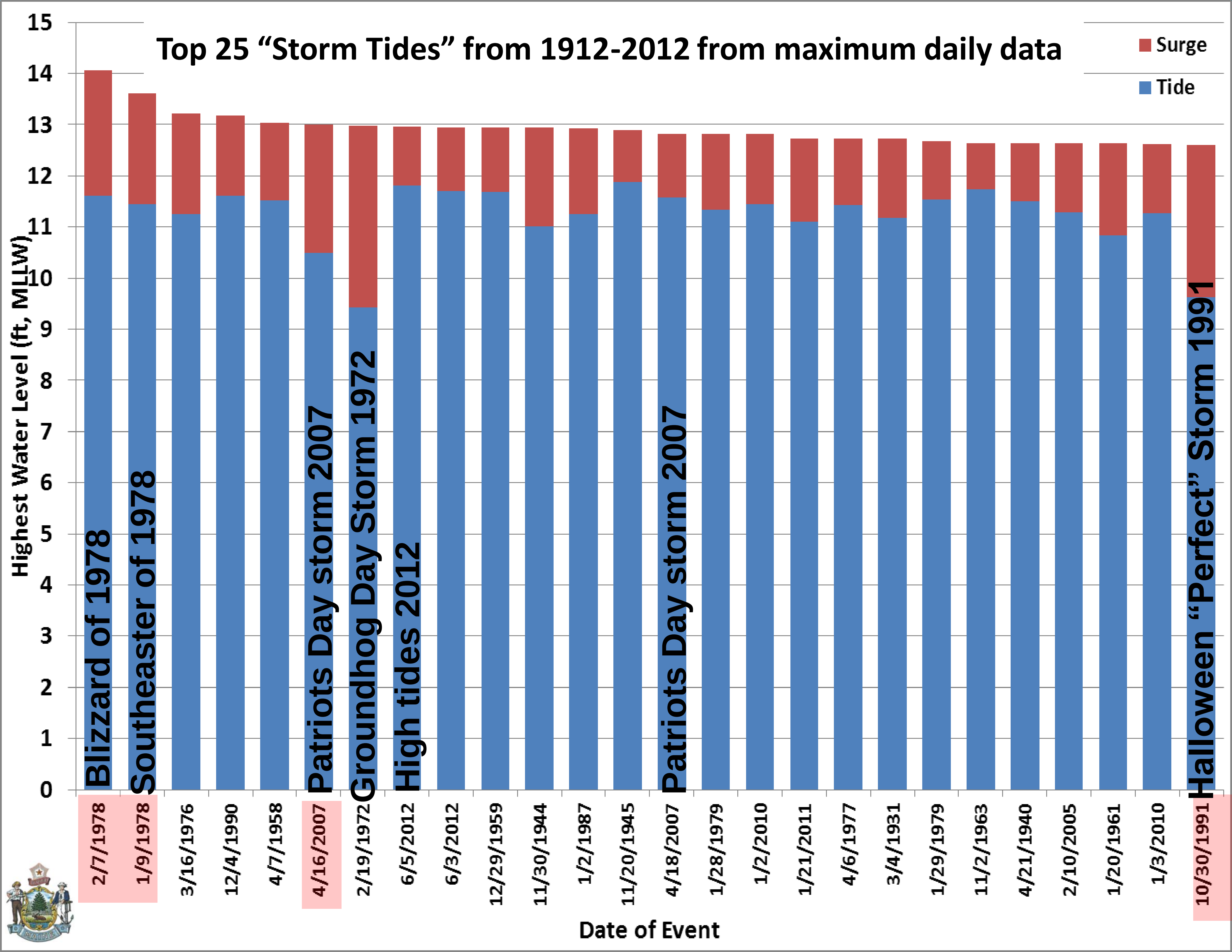
Portland Storm Surges, any tide (1912-2012)

Time Interval (years)	Surge Height (feet)
1 (100 %)	1.8
2 (50%)	2.4
5 (20%)	3.3
10 (10 %)	4.0
20 (5%)	4.7
25 (4 %)	4.9
50 (2 %)	5.6
75 (1.3 %)	6.0
100 (1%)	6.3

*These numbers correlate **relatively well with overall longer term sea level rise planning!***

P.A. Slovinsky, MGS

Because of Maine’s tidal variation, it’s *the combination of astronomical tide and “storm surge” that are of concern* (NHC calls this overall water level the **“storm tide”**)



Top 25 “Storm Tides” from 1912-2012 from maximum daily data
Surge
Tide
Highest Water Level (ft, MLLW)
Date of Event
Blizzard of 1978
Southeaster of 1978
Patriots Day storm 2007
Groundhog Day Storm 1972
High tides 2012
Patriots Day storm 2007
Halloween “Perfect” Storm 1991
2/7/1978
1/9/1978
3/16/1976
12/4/1990
4/7/1958
4/16/2007
2/19/1972
6/5/2012
6/3/2012
12/29/1959
11/30/1944
1/2/1987
11/20/1945
4/18/2007
1/28/1979
1/2/2010
1/21/2011
4/6/1977
3/4/1931
1/29/1979
11/2/1963
4/21/1940
2/10/2005
1/20/1961
1/3/2010
10/30/1991

Portland "Storm Tides", 1912-2012

Interval (yrs)	"Storm Tide" Level (ft, MLLW)
1 (100 %)	11.7
5 (20%)	12.6
10 (10 %)	12.9
25 (4 %)	13.4
50 (2 %)	13.7
100 (1 %)	14.1

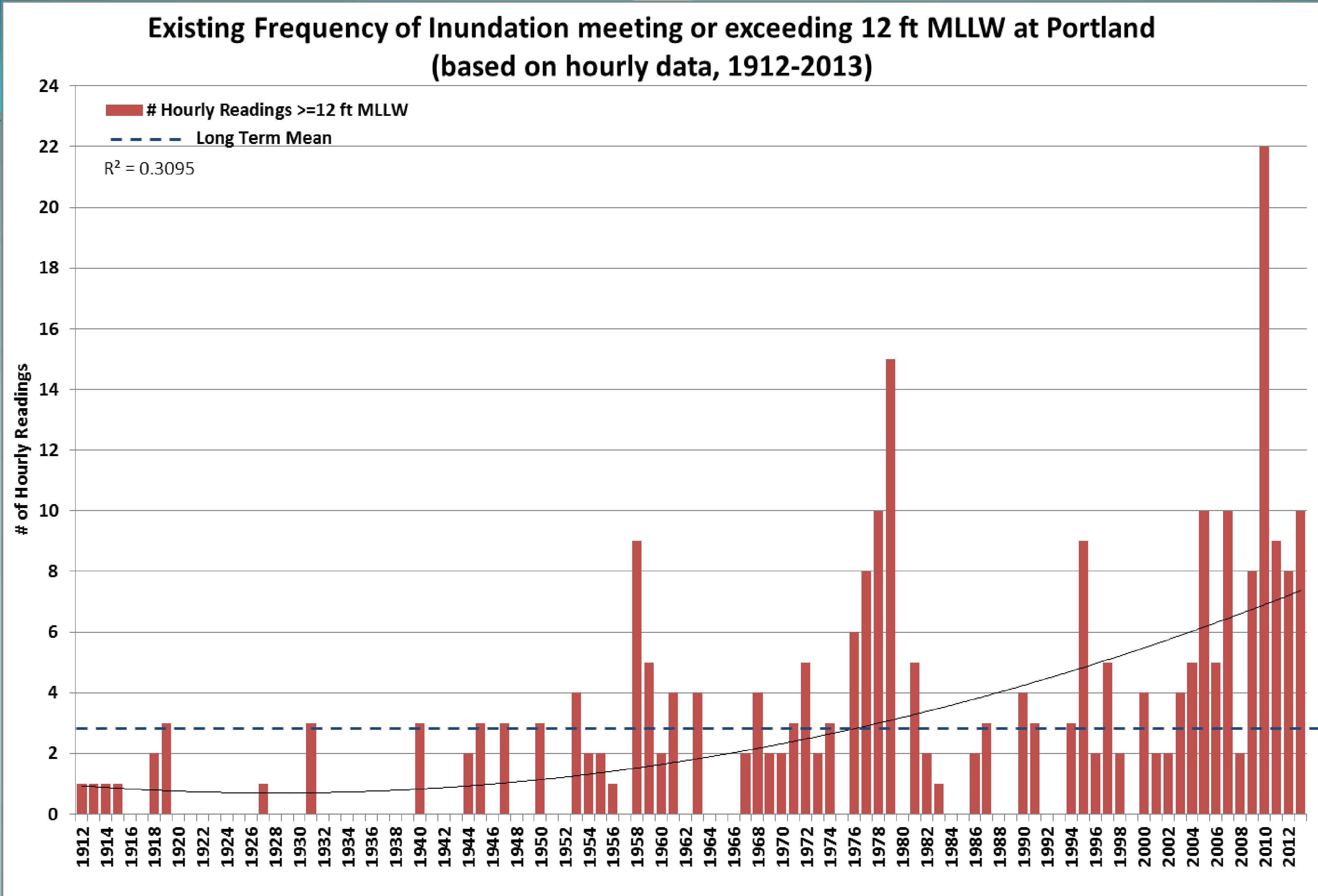
Portland "Storm Tides", 1912-2012

Interval (yrs)	"Storm Tide" Level (ft, MLLW)
1 (100 %)	11.7
5 (20%)	12.6
10 (10 %)	12.9
25 (4 %)	13.4
50 (2 %)	13.7
100 (1 %)	14.1

1 foot difference!

What about "nuisance" flooding, and how might SLR impact it?

"King Tide" 12:15 pm, October 9, 2014
Cameron Adams, MGS



Existing Conditions (flood stage = 12 ft MLLW)
Historic Mean Trend (1912-2013) = 2.6 readings/year
Last Decade Trend (2003-2013) = 8.5 readings/year

Data from NOAA COOPS

Portland, ME
Changes in Flooding Frequency with SLR
(using 2013 as a “representative” year)

Scenario	Flood Stage (ft, MLLW)	# times inundated	% of high tides	Duration, hrs
Existing Flood	12.0	8	1.1%	8.6
+1 ft SLR	11.0	87	12.4%	121.8
+2 ft SLR	10.0	312	44.4%	575.3
+3.3 ft SLR	8.7	616	87.6%	1748.5
+6 ft SLR	6.0	702	99.9%	3816.3

based on 2013 Portland tidal station data from the NOAA Inundation Analysis Tool

Based on this, there would potentially be **a *tenfold increase in the frequency of flooding* with one foot of sea level rise.**

Similar types of analyses can be completed using the Inundation Analysis Tool or longer-term hourly datasets for almost **any critical infrastructure as long as the flood elevation is known, and tidal prediction data exists proximal to the site.**

Sea Level and Storm Surge Summaries

- Latest scientific predictions for SLR:
    - Short Term: approximately 1 ft by 2050
    - Long Term: 2-4 ft *but potentially more* by 2100;
    - the **State of Maine has adopted 2 feet by the year 2100 for areas with regulated Coastal Sand Dunes**.
- Along the Maine coast, there is only about a <u>one foot difference</u> between the “10 year” event and the “100 year” event ; **a one-foot rise in sea level by 2050 would lower the “100 year” event recurrence interval to about 10 years.**
- Sea level rise increases both the **frequency and duration of annual tidal and storm-driven flood events.**
- We suggest examining scenarios of **1 foot, 2 feet, 3.3 feet, and 6 feet** on top of the highest annual tide (HAT). These scenarios relate to the National Climate Assessment, and also **correspond well with evaluating potential impacts from storm surges that may coincide with higher tides today.**

Sea Level Rise Planning in Maine…

United States Environmental Protection Agency

Policy, Planning, And Evaluation (2122)

EPA-230-R-95-900 September 1995

Anticipatory Planning For Sea-Level Rise Along The Coast of Maine

This report a joint effort in cooperation with State of Maine's State Planning Office.

On the right track… in 1995!

But it was never <u>engaged at the local level</u>

So it ended up shelved in the archives.

Even More recently…

Working Groups:

Built Environment
Coastal Environment
Natural Environment
Social Environment

- Year-long Stakeholder Process led to the production of a report in early 2010.
- Major recommendations related to ***bringing tools, models, and technical data to the local decision-making level relating to sea level rise planning.***

Resolves, Chapter 16, LD 460, "Resolve, To Evaluate Climate Change Adaptation Options for the State"

Bringing it down to the local level

Proactive Engagement

Coastal Hazard and Resiliency Tools (CHRT) Project

Regional Planning Organizations

SMPDC
SOUTHERN MAINE PLANNING & DEVELOPMENT COMMISSION

GPCOG

Lincoln County Regional Planning Commission

Municipal Planning Assistance Program

Local Municipal Partners

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Federal Funding
(CZMA Section 309)

Maine Coastal Program

State Funding

Maine Geological Survey

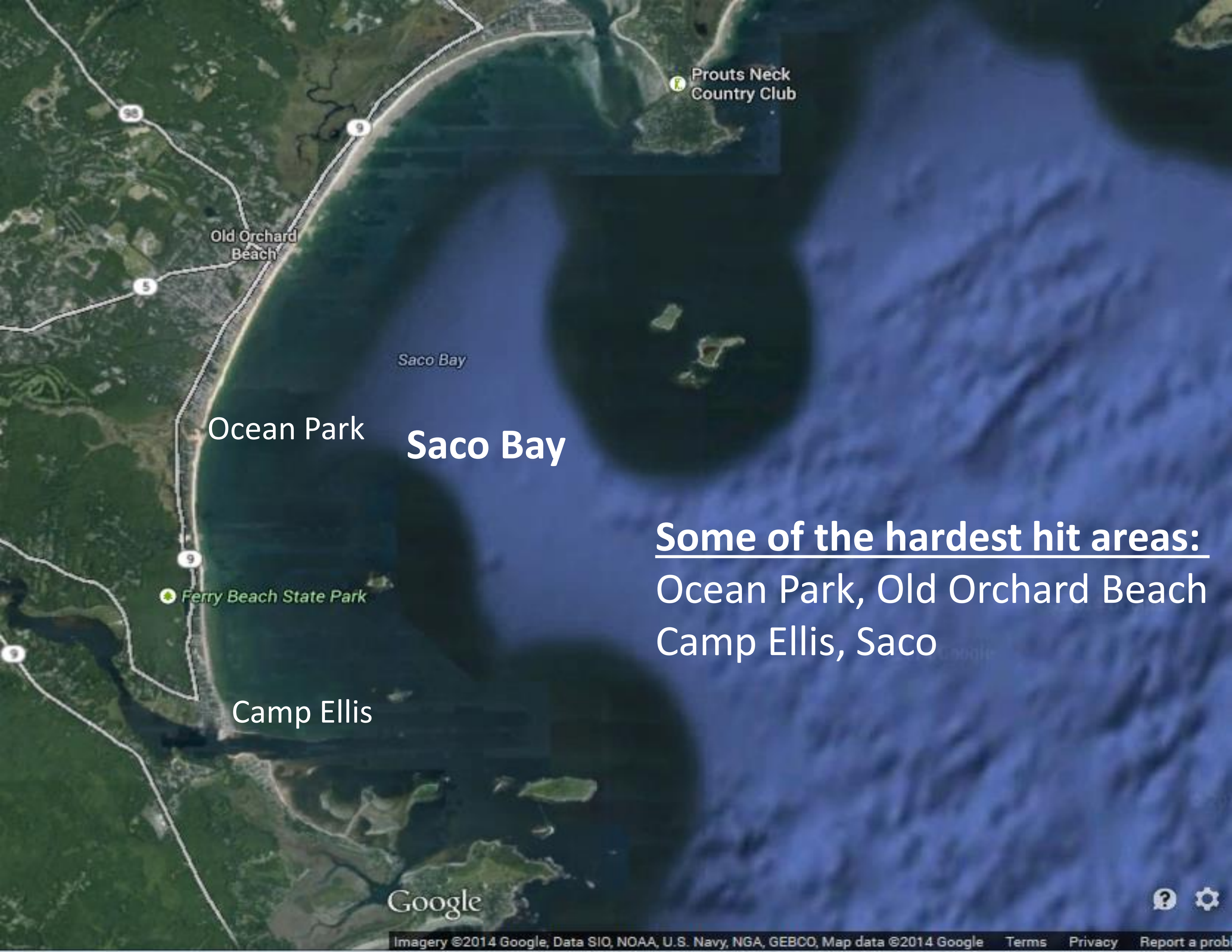
State Science
Technical Support

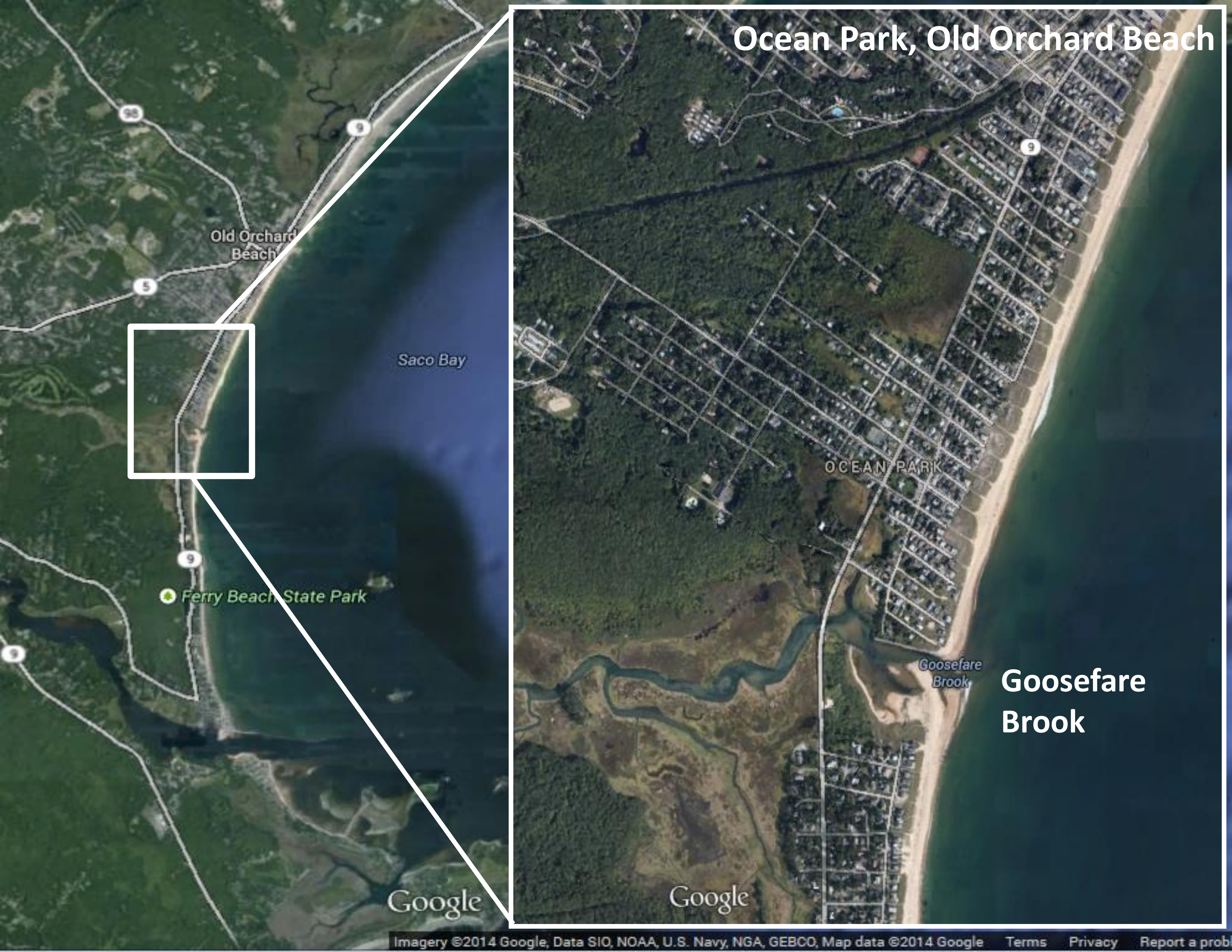
Private partners
(as needed)

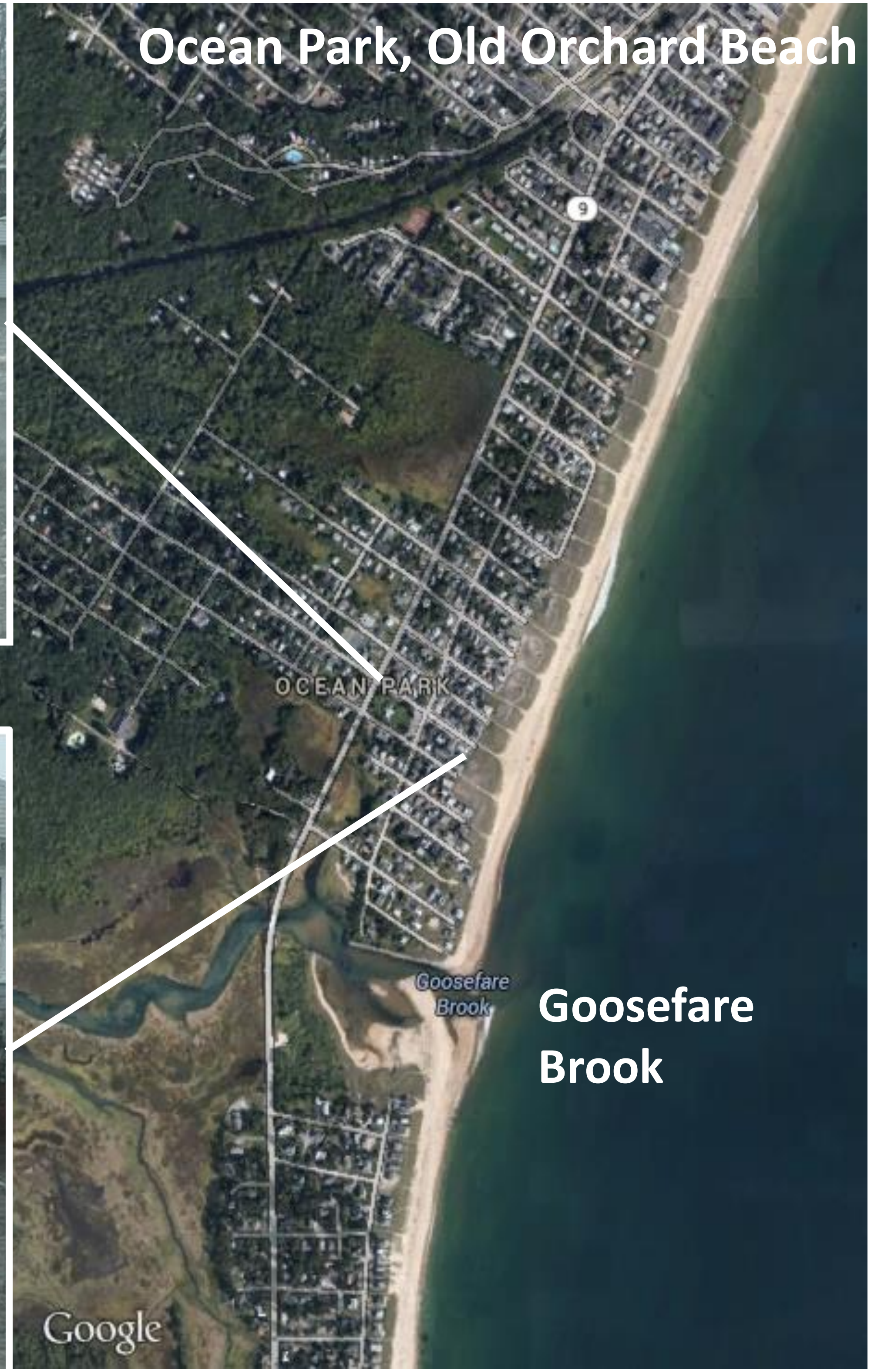
The Saco Bay Sea Level Adaptation Working Group (SLAWG) Approach to Resiliency

2007 Patriots' Day Storm

- April 16 to April 17, 2007
- Winds of 40-60 mph
- 30 foot waves offshore
- Hit during higher astronomical tides
- Storm Tide was over 12 ft MLLW for 7 tidal cycles (in Portland)
- 14th Highest Water Level ever recorded at Portland, ME (since 1912)
- Precipitation on average between 4-6 inches of during storm event


Prouts Neck
Country Club
98
9
Old Orchard
Beach
5
Saco Bay
Ocean Park
Saco Bay
Some of the hardest hit areas:
Ocean Park, Old Orchard Beach
Camp Ellis, Saco
9
Ferry Beach State Park
9
Camp Ellis
Google
Imagery ©2014 Google, Data SIO, NOAA, U.S. Navy, NGA, GEBCO, Map data ©2014 Google
Terms
Privacy


Ocean Park, Old Orchard Beach
Old Orchard Beach
Saco Bay
Ferry Beach State Park
OCEAN PARK
Goosefare Brook
Goosefare Brook
Google
Google
Imagery ©2014 Google, Data SIO, NOAA, U.S. Navy, NGA, GEBCO, Map data ©2014 Google
Terms
Privacy

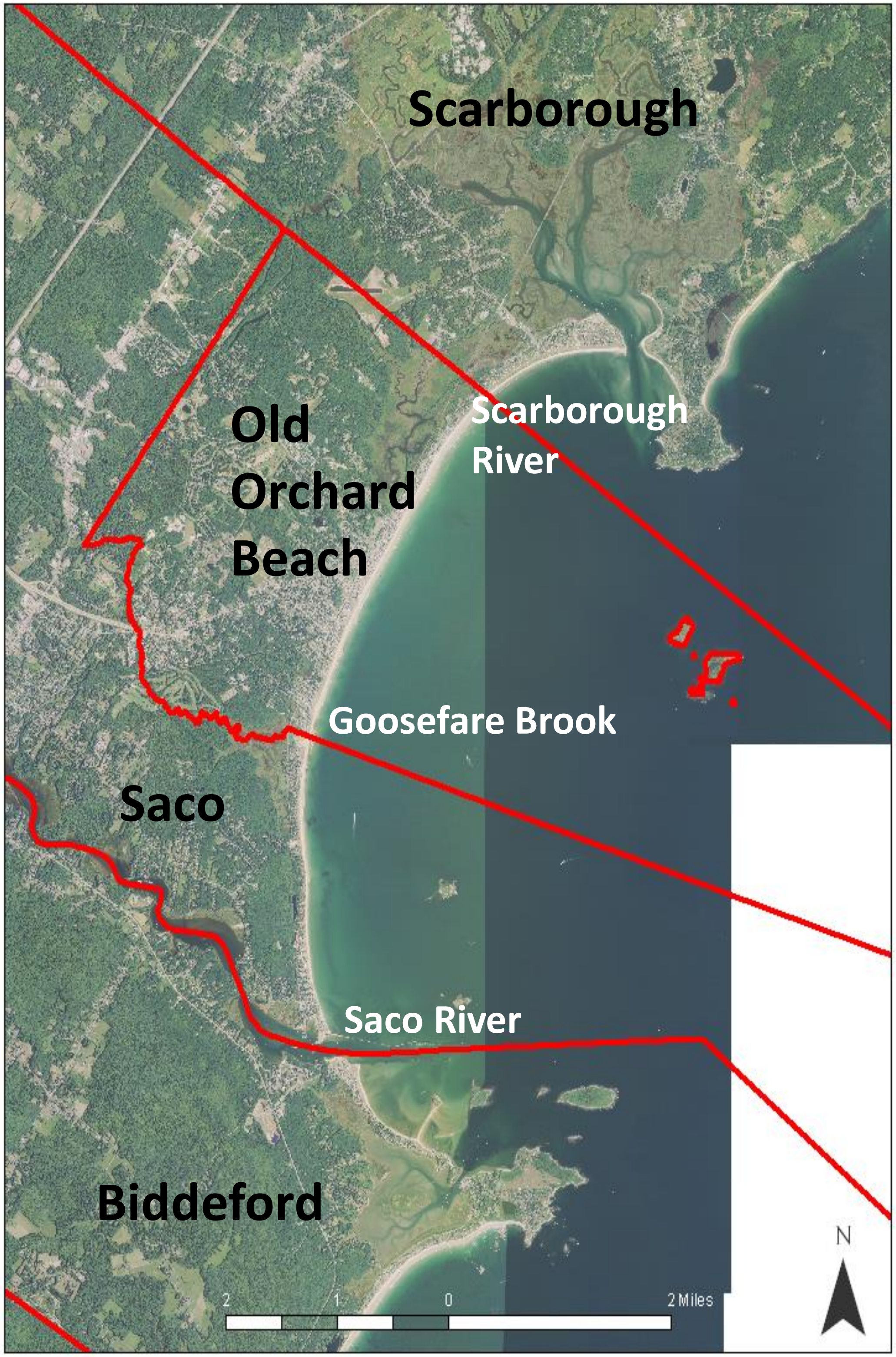


Images courtesy of Bill Edwards

Camp Ellis, Saco
Old Orchard Beach
Saco Bay
Ferry Beach State Park
Ferry Beach Ecology School
Morris Ave
Eagle Ave
Fairhaven Ave
Surf St
Landing Rd
Beacon Ave
Sunrise Ave
Sunset Ave
Camp Ellis Ave
West Ave
Main Ave
Riverside Ave
North Ave
Eastern Ave
Bay Ave
Saco River
Google
Imagery ©2014 Google, Map data ©2014 Google Terms Privacy
Imagery ©2014 Google, Data SIO, NOAA, U.S. Navy, NGA, GEBCO, Map data ©2014 Google Terms Privacy Report a probl

Camp Ellis, Saco

Images courtesy of Stephen Dickson, MGS



Saco Bay Sea Level Adaptation Working Group

Local Participation:

Planning, Science, Technical Support:

SMPDC
SOUTHERN MAINE PLANNING & DEVELOPMENT COMMISSION

Maine Geological Survey

Additional Support Funding:

Maine Coastal Program

Sea Level Adaptation Working Group

The Process to Legitimacy…

<u>Formation of a Steering Committee (2008-2010)</u>

• Developed an ***Interlocal Agreement*** outlining the creation of a Working Group and its potential duties and action plan.

• Received approval from each municipal council.

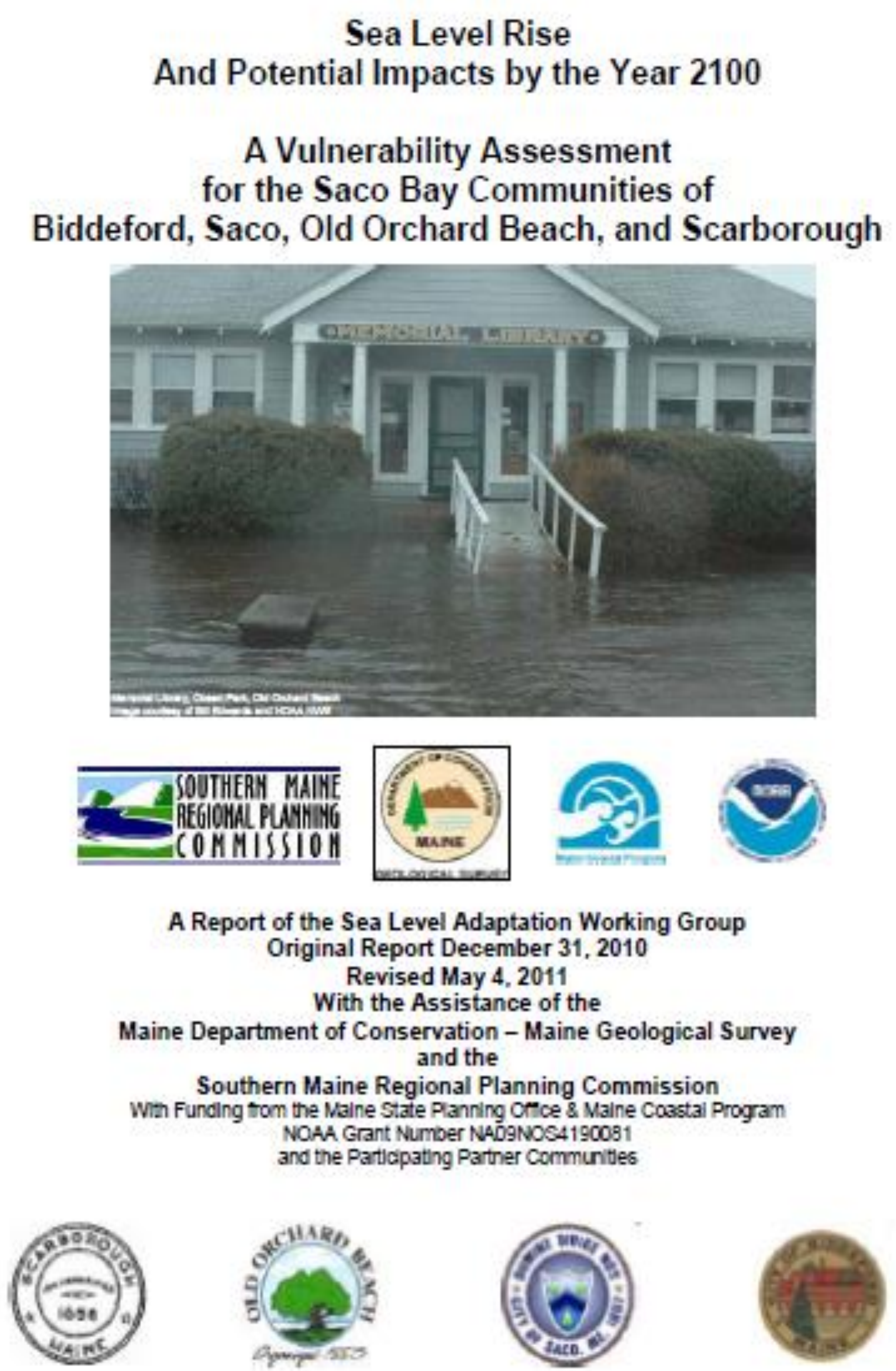
•*This took nine months to achieve.*

• Funded by state Regional Challenge Grant (MCP) and local matches

<u>Working Group (2010-current)</u>

• Comprised of municipal planners and an assigned citizen-at-large member from each community; an SMRPC planner and technical support from MGS.

• Completed a ***Vulnerability Assessment*** and ***Action Plan*** that were submitted to municipal councils for approval.


Sea Level Rise
And Potential Impacts by the Year 2100

A Vulnerability Assessment
for the Saco Bay Communities of
Biddeford, Saco, Old Orchard Beach, and Scarborough

SOUTHERN MAINE REGIONAL PLANNING COMMISSION

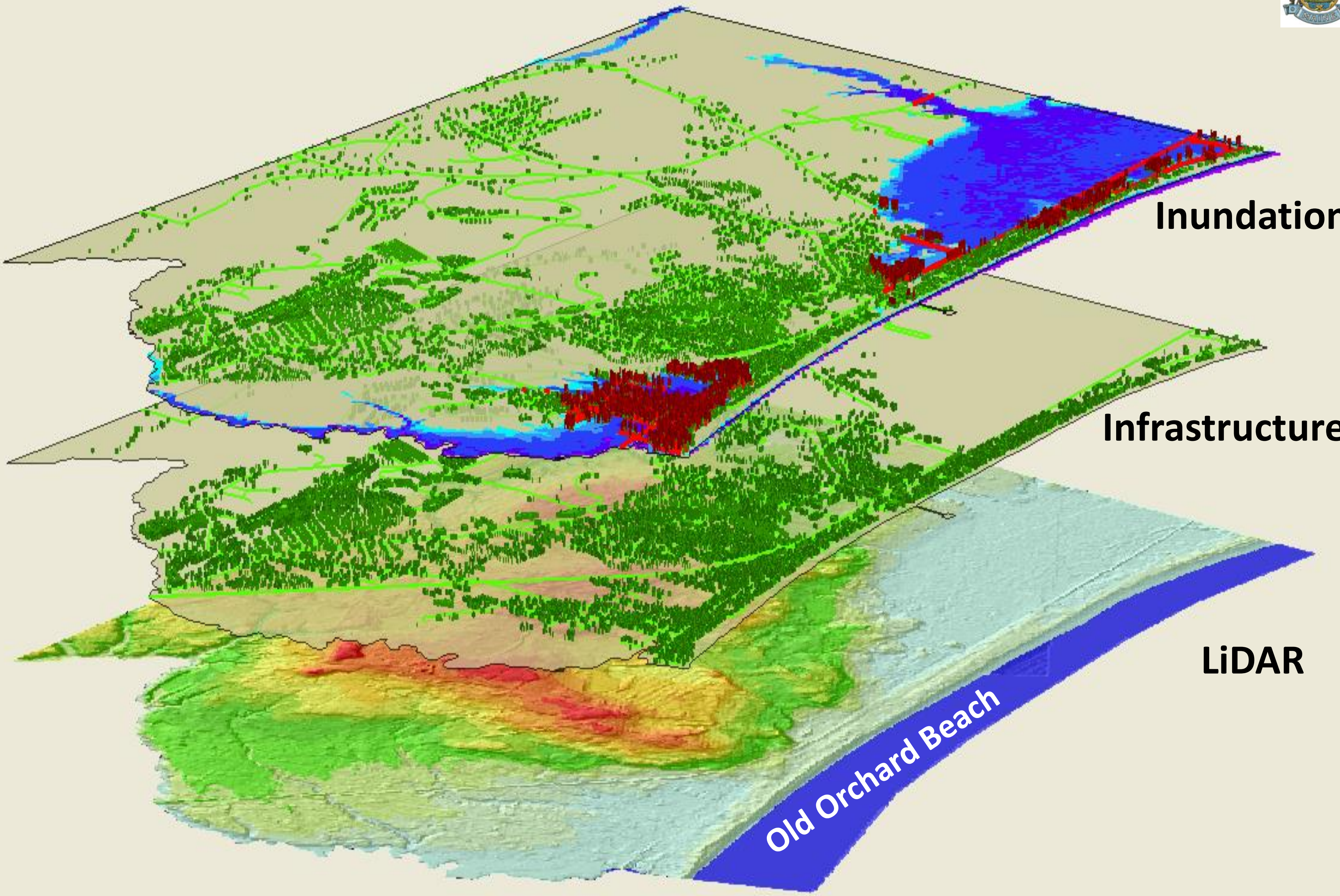
A Report of the Sea Level Adaptation Working Group
Original Report December 31, 2010
Revised May 4, 2011
With the Assistance of the
Maine Department of Conservation – Maine Geological Survey
and the
Southern Maine Regional Planning Commission
With Funding from the Maine State Planning Office & Maine Coastal Program
NOAA Grant Number NA09NOS4190081
and the Participating Partner Communities

The first effort: SLAWG Assessment 2010

Vulnerability Assessment of the built and natural environments to <u>2 feet of SLR</u> (agreed upon by the Group) on top of the Highest Annual Tide (HAT) and the historic 1% ("100-year") storm event (February 7, 1978 storm) for each community in Saco Bay.

Identified potentially <u>vulnerable buildings</u>, transportation infrastructure, and wetland migration areas.

Focus: GIS-based visualizations



Data and tools *critical to communicating coastal vulnerability*

First, some "Assumptions"

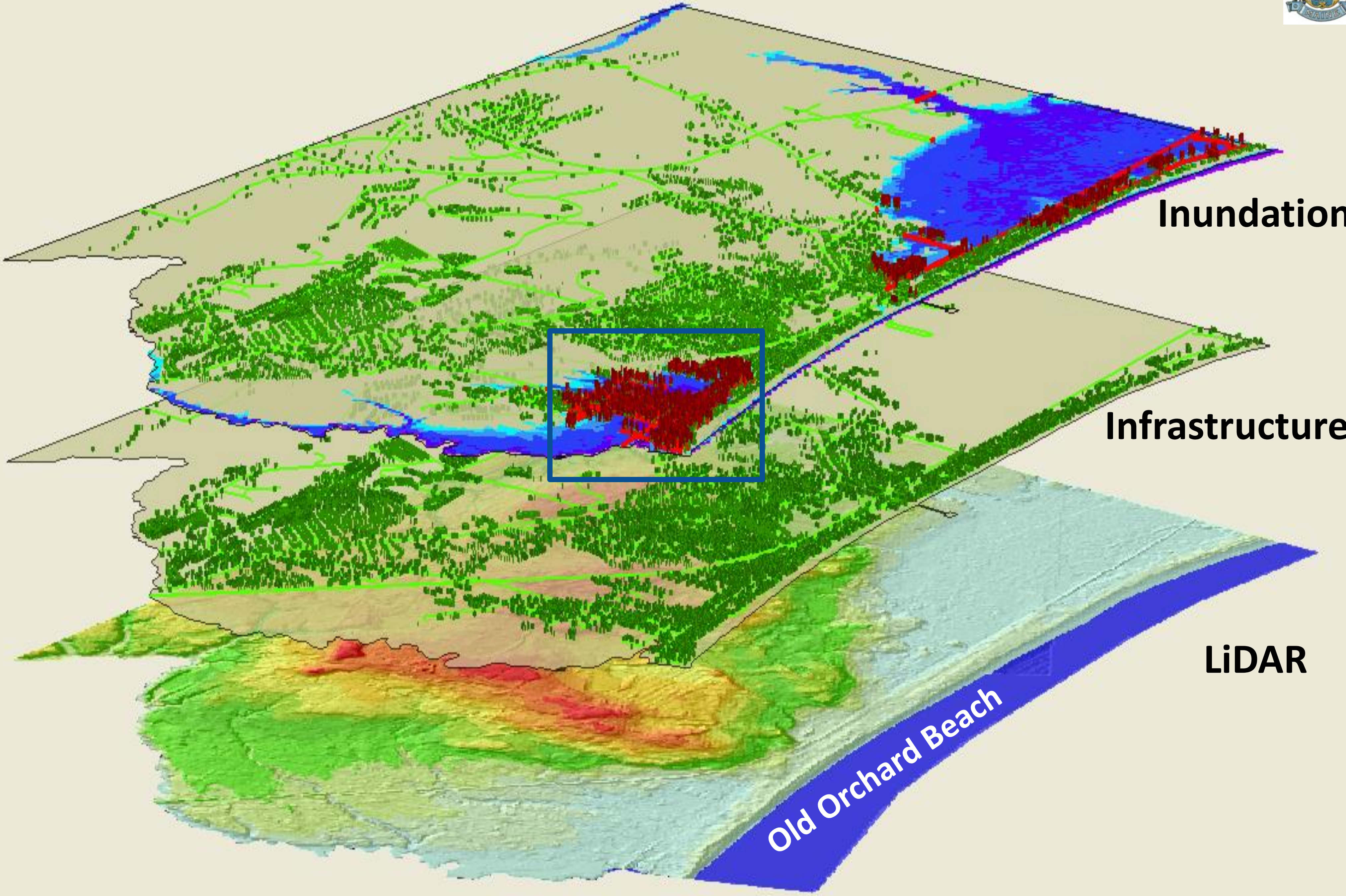
- Topography stays static – we are using 2006/2010 LiDAR data that represent a "snapshot" of topography that may have changed

- Simulations use a "bathtub" approach that assumes that the topography stays the same, i.e., it doesn't account for erosion, accretion, or dynamic processes like waves.

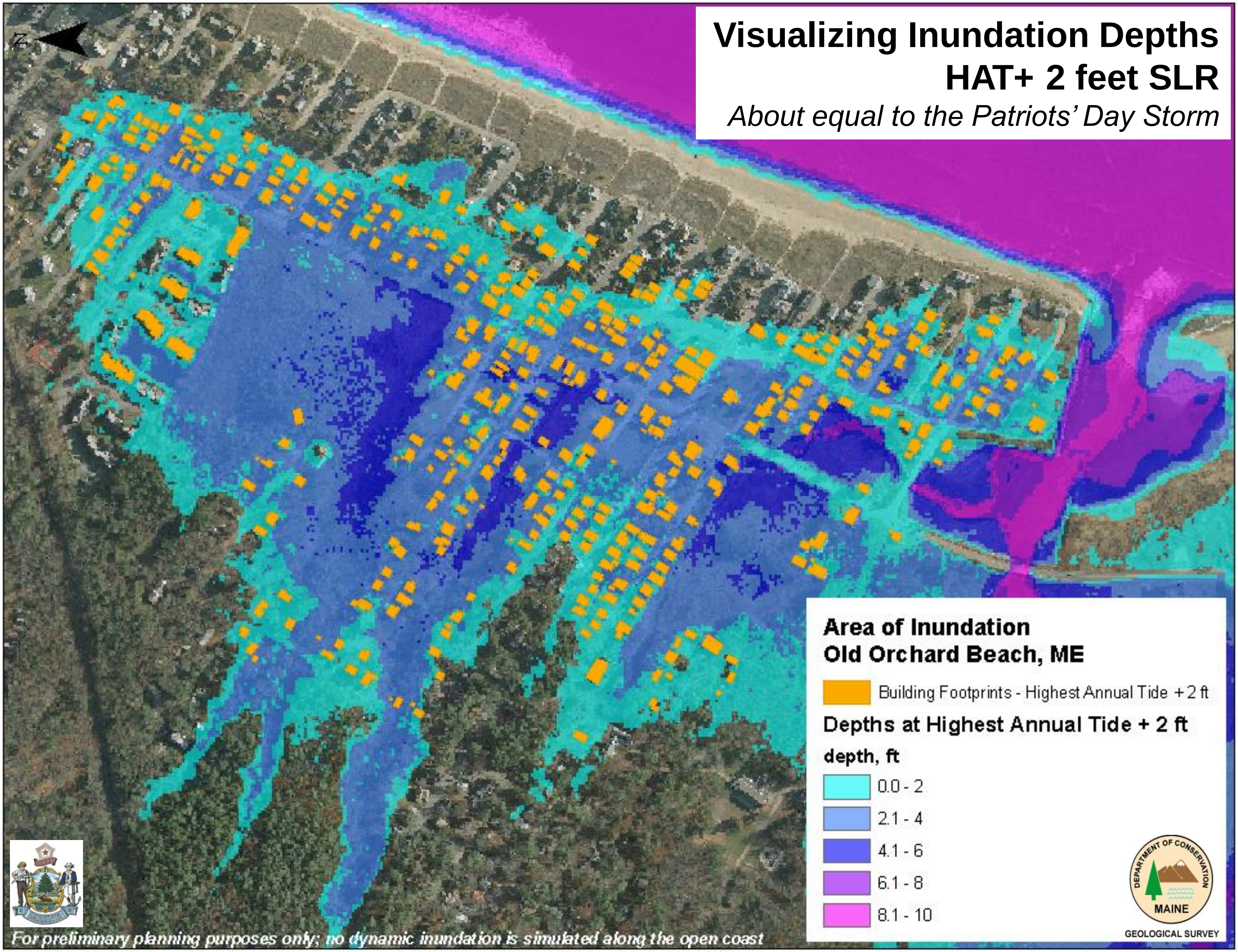
- We use tidal elevations such as the Highest Annual Tide (HAT) as a proxy for the upper boundary of coastal wetlands – can't account for changes in tides due to tidal restrictions such as roads, etc.

- "Impacted" infrastructure simply means the inundation scenario intersects with a polygon feature.

Focus: GIS-based visualizations



Data and tools *critical to communicating coastal vulnerability*



Visualizing Inundation Depths
HAT+ 2 feet SLR
About equal to the Patriots' Day Storm
N
Area of Inundation
Old Orchard Beach, ME
Building Footprints - Highest Annual Tide + 2 ft
Depths at Highest Annual Tide + 2 ft
depth, ft
0.0 - 2
2.1 - 4
4.1 - 6
6.1 - 8
8.1 - 10
DEPARTMENT OF CONSERVATION
MAINE
GEOLOGICAL SURVEY
For preliminary planning purposes only; no dynamic inundation is simulated along the open coast

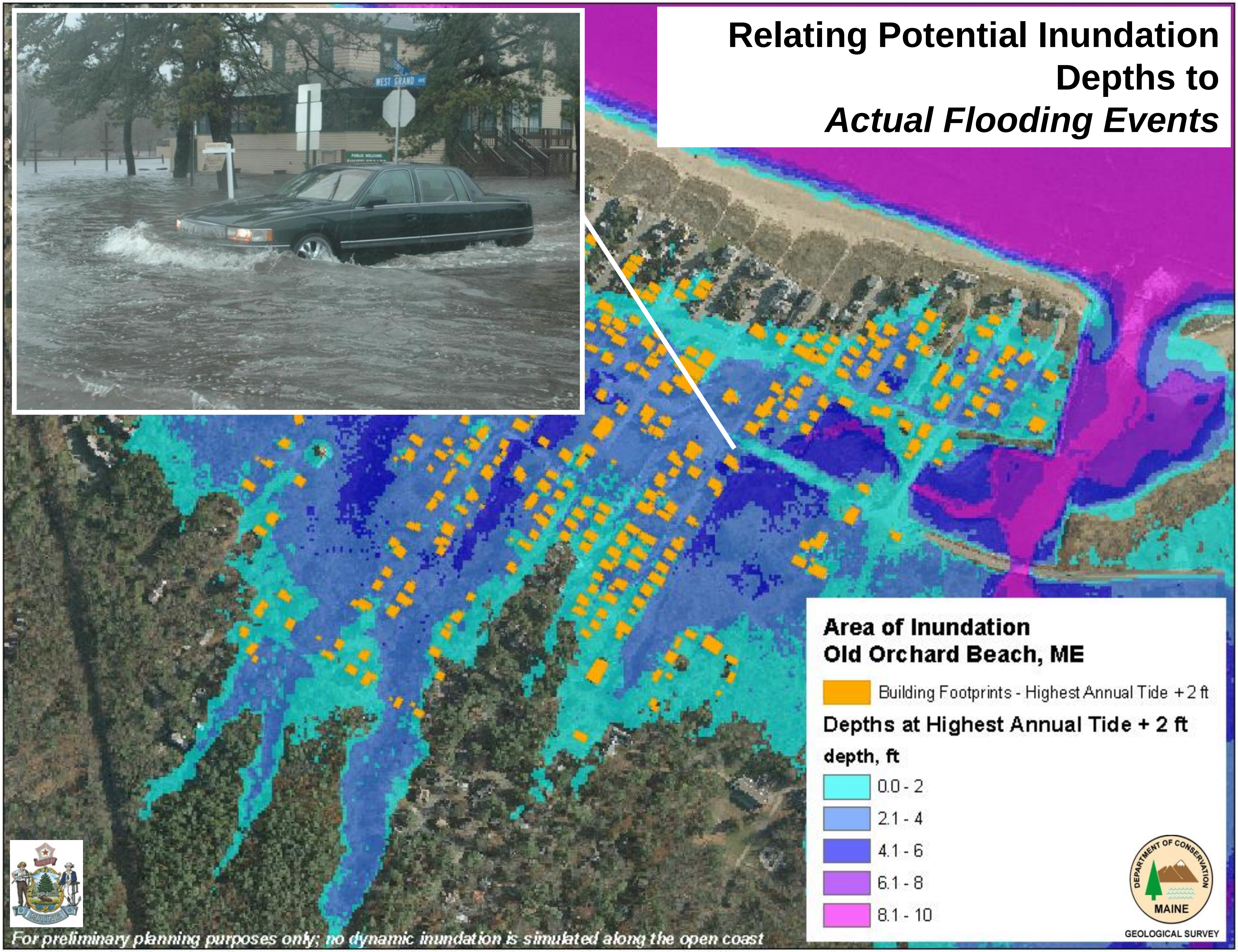


Image courtesy of Bill Edwards

Using Visualization Tools to Help Communicate Potential Future Inundation Scenarios

Visualization Techniques (CanVis2.3)

Patriots' Day 2007

1 – 2 ft inundation

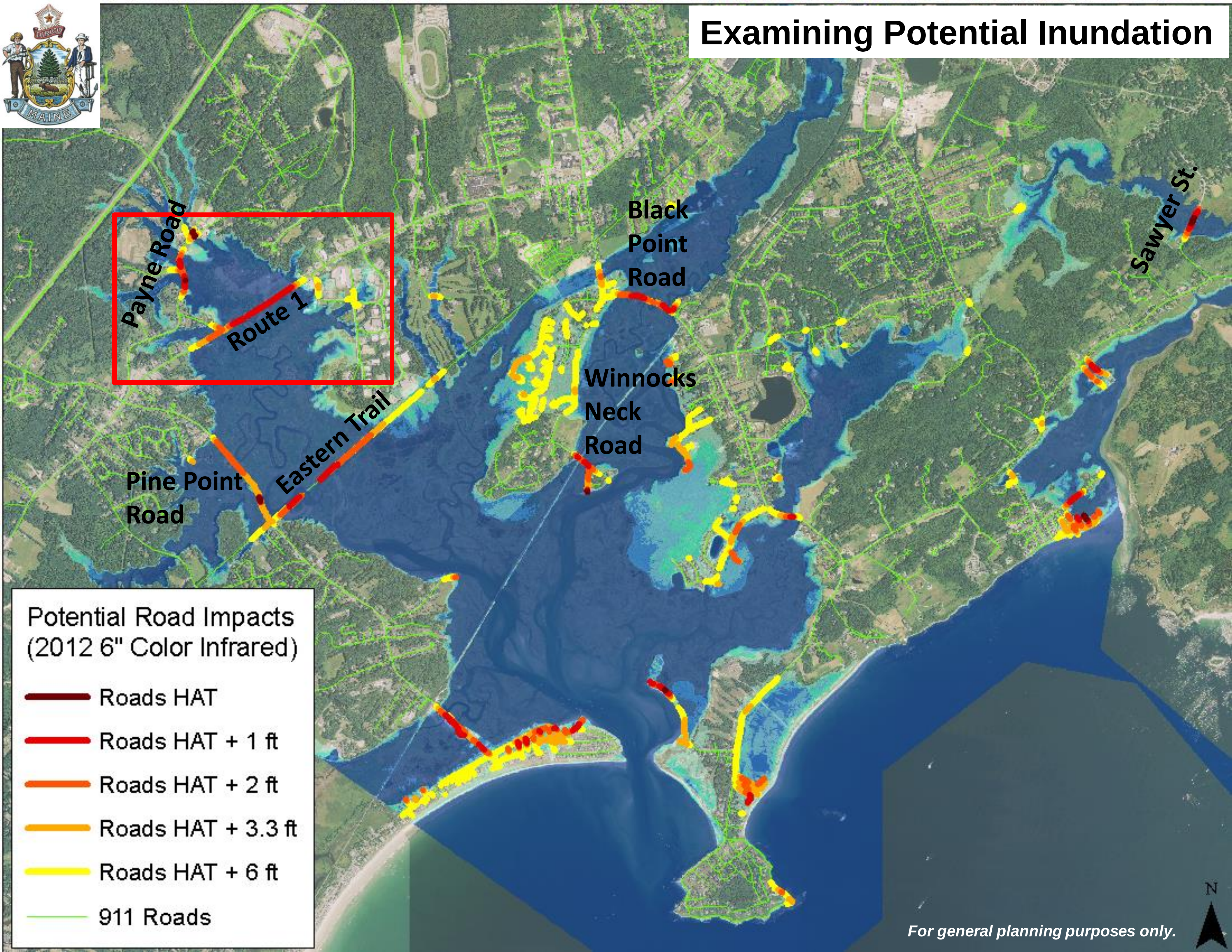
Patriots' Day 2007 + 2 ft SLR

3 – 4 ft inundation

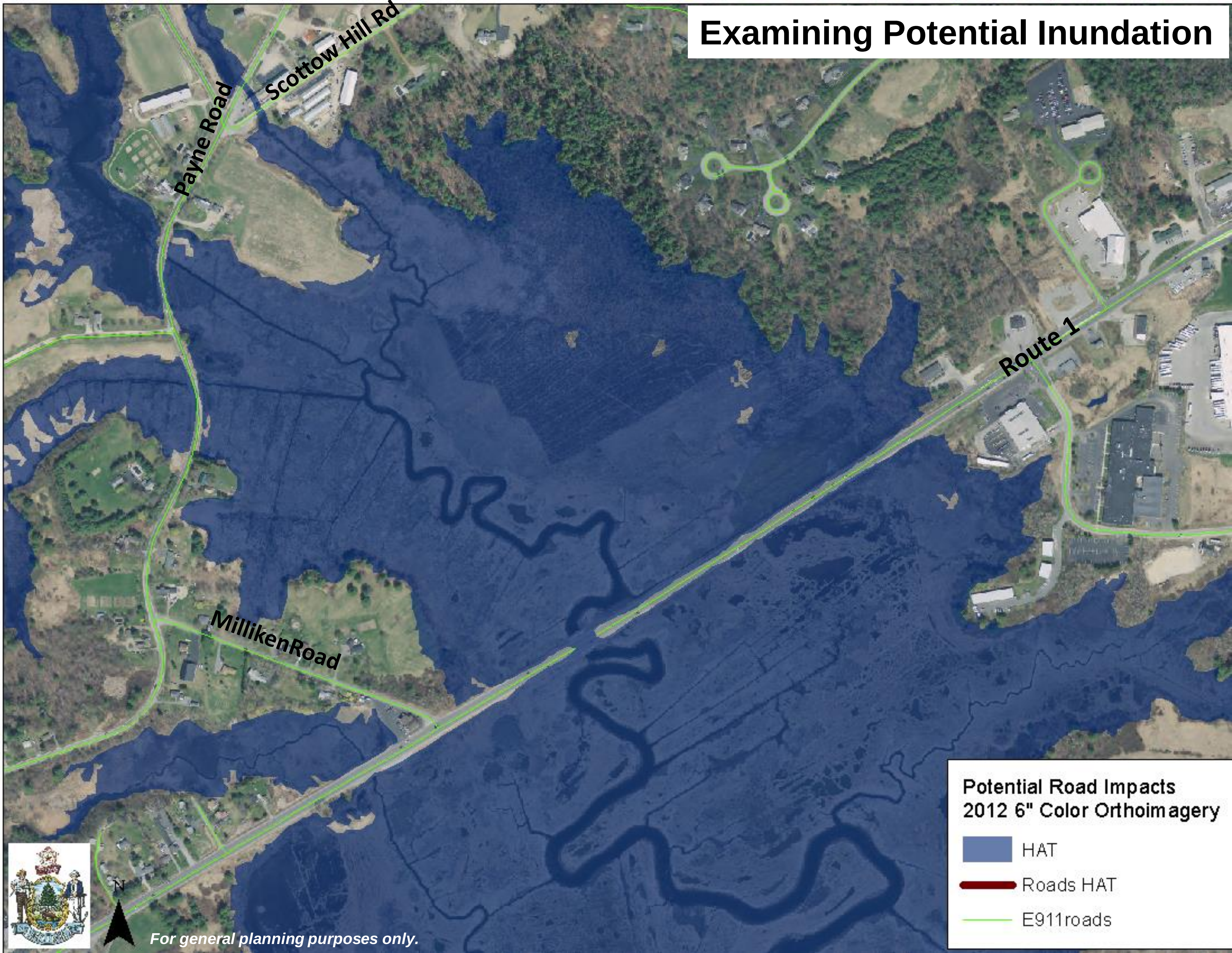
Image courtesy of Bill Edwards


Analyzing Potential Impacts to Transportation Infrastructure
Assumption: “impacted” = flooded
P.A. Slovinsky

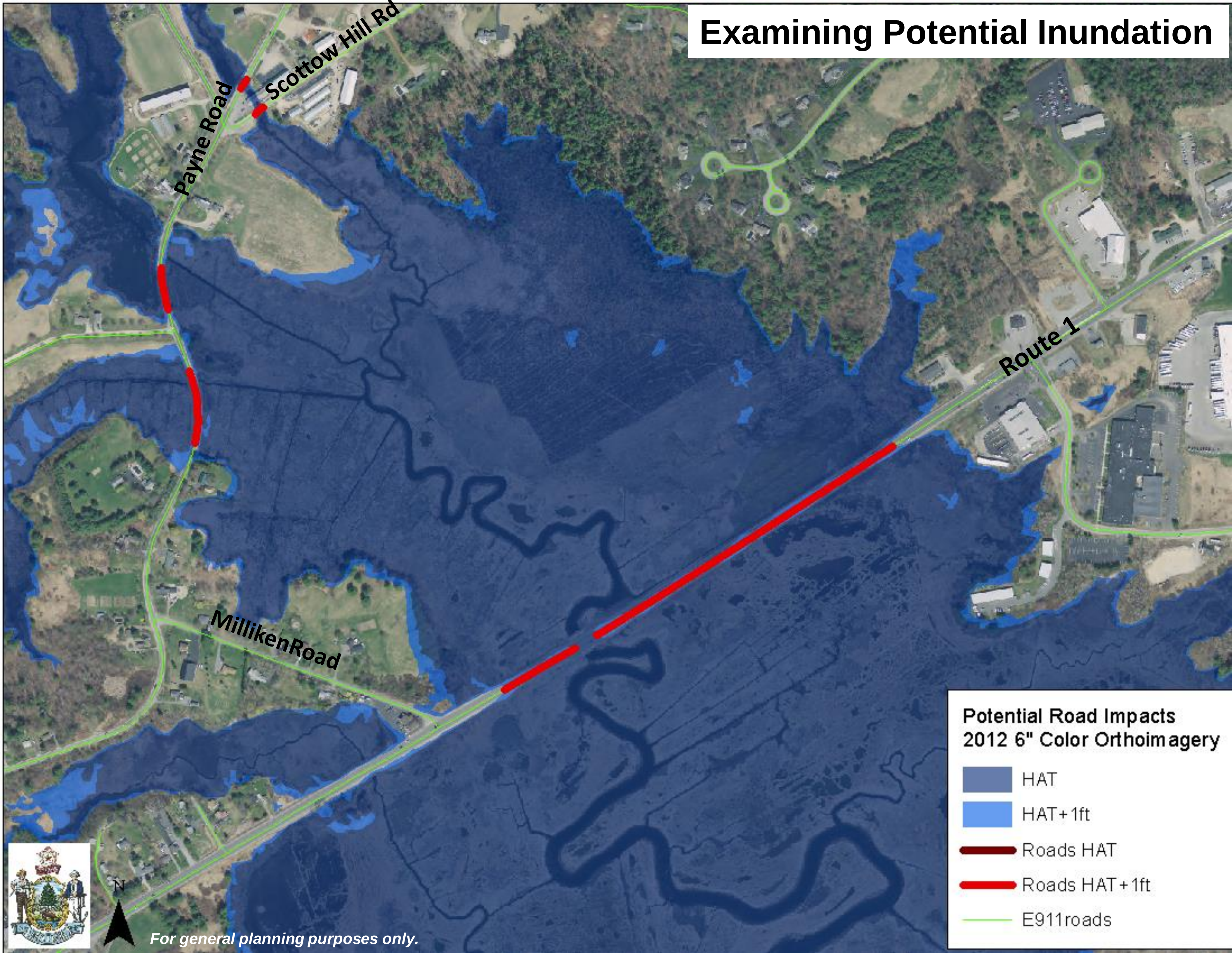
Examining Potential Inundation



Examining Potential Inundation

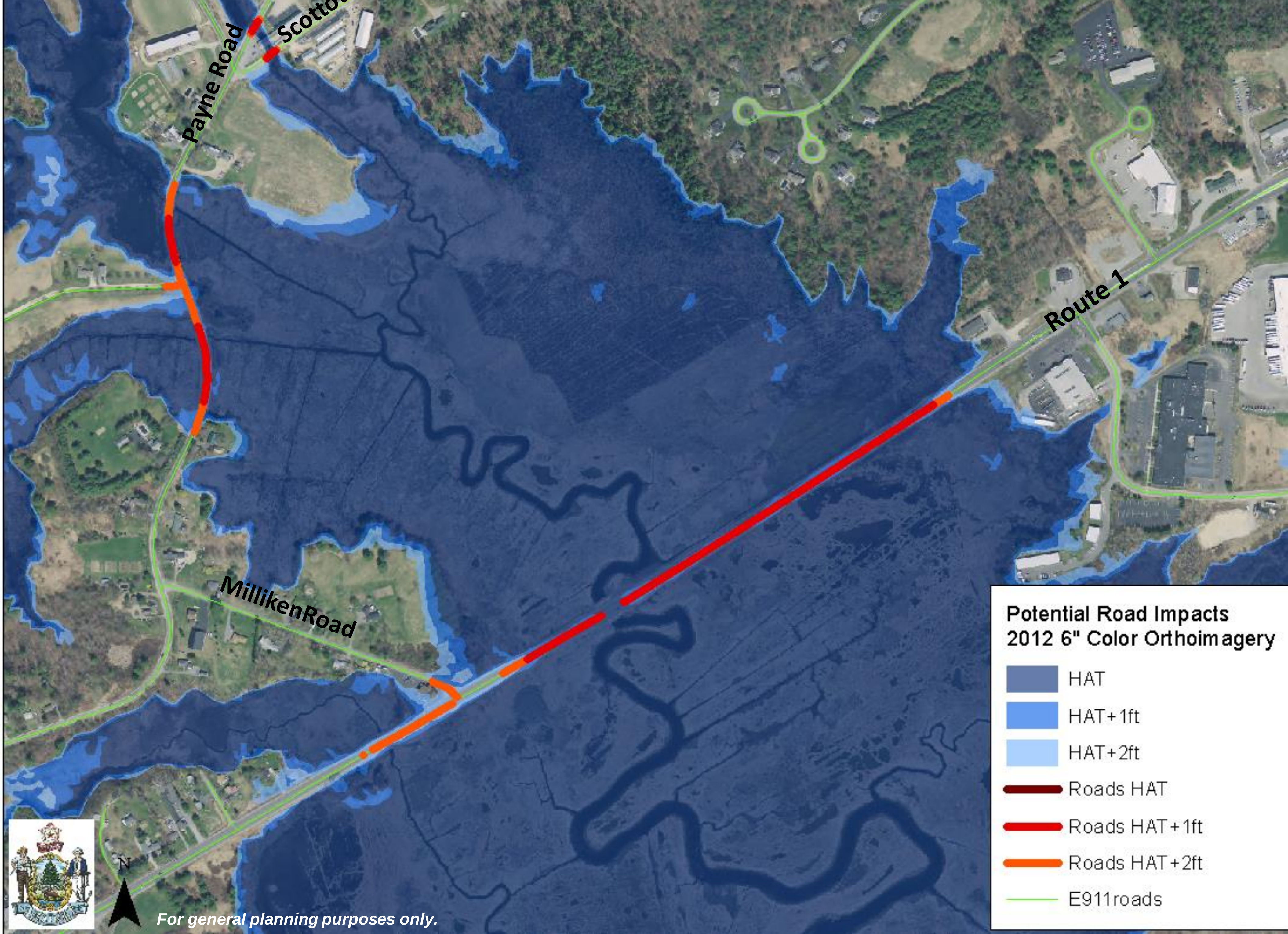


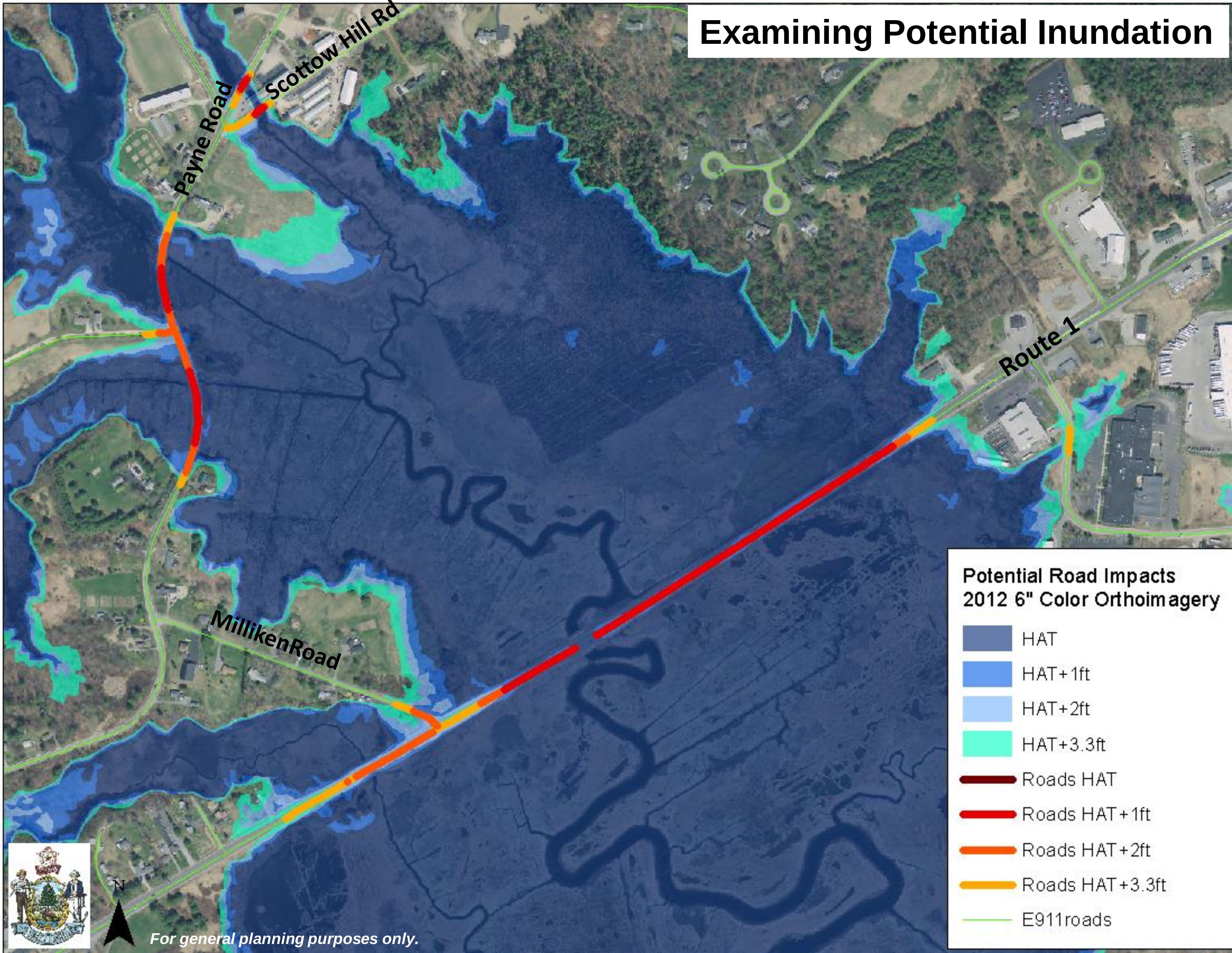
Examining Potential Inundation



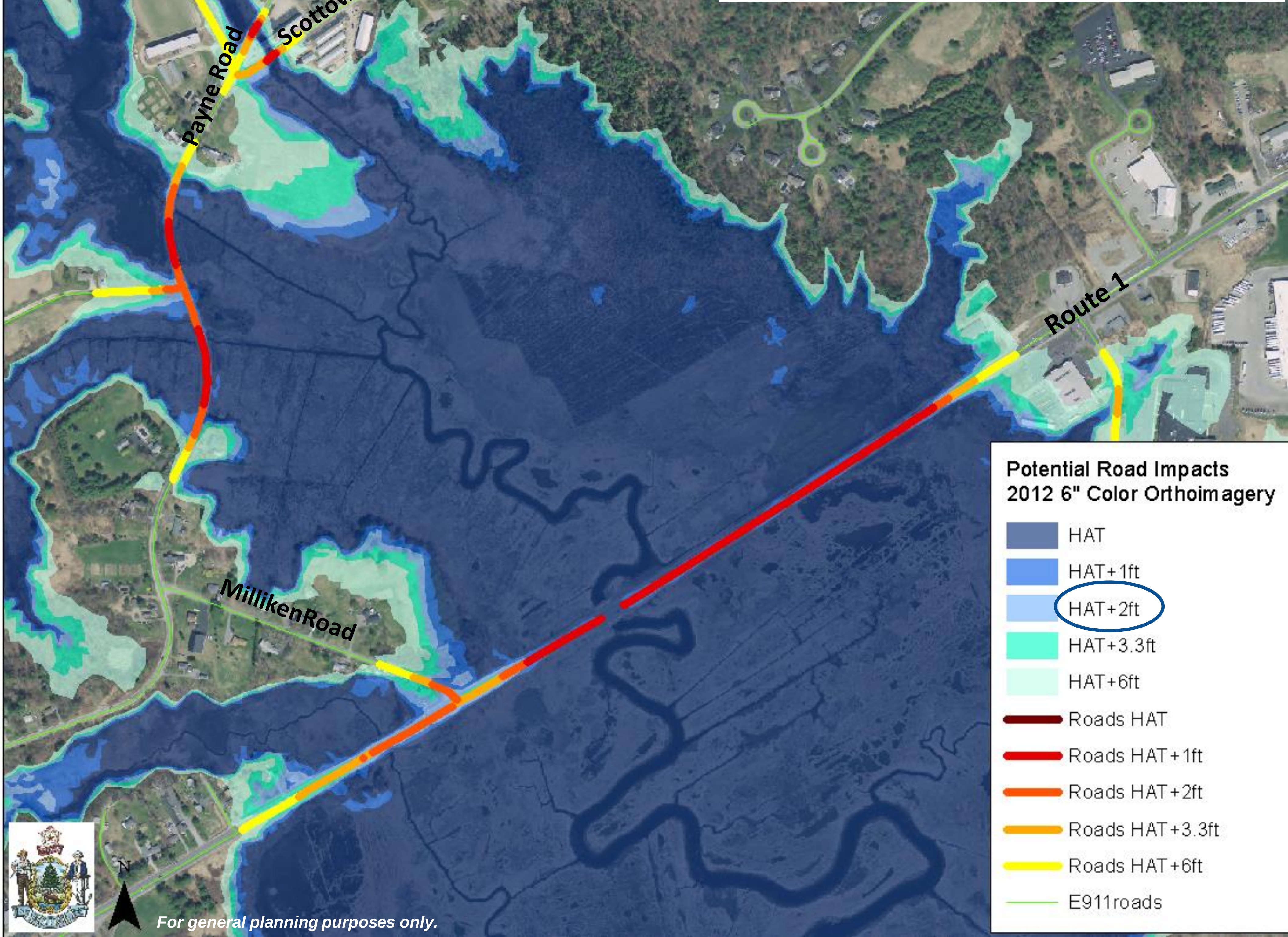
For general planning purposes only.

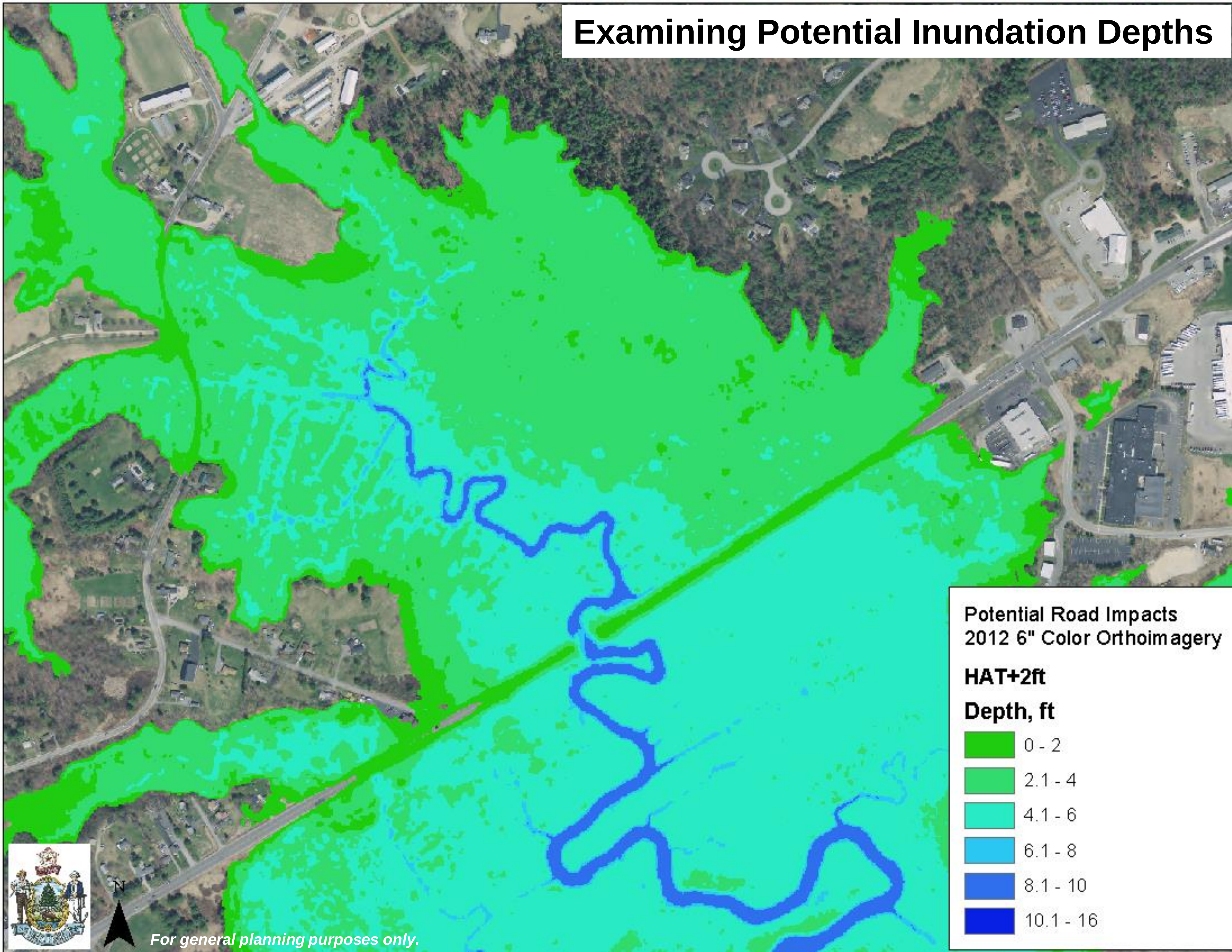
Examining Potential Inundation



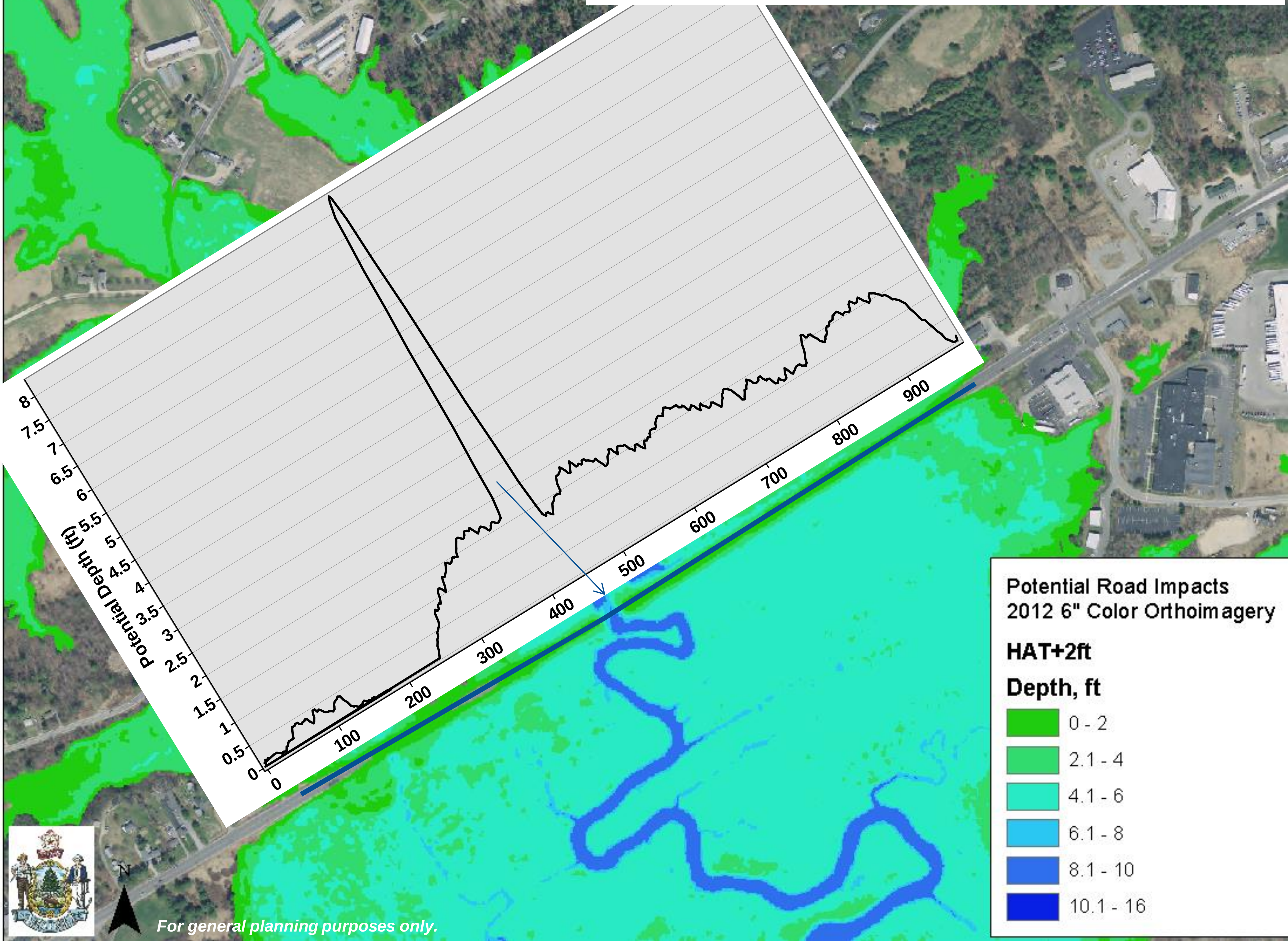

Examining Potential Inundation
Scottow Hill Rd
Payne Road
Route 1
MillikenRoad
Potential Road Impacts
2012 6" Color Orthoimagery
HAT
HAT+1ft
HAT+2ft
HAT+3.3ft
Roads HAT
Roads HAT+1ft
Roads HAT+2ft
Roads HAT+3.3ft
E911roads
N
For general planning purposes only.

Examining Potential Inundation




Examining Potential Inundation Depths
Potential Road Impacts
2012 6" Color Orthoimagery
HAT+2ft
Depth, ft
0 - 2
2.1 - 4
4.1 - 6
6.1 - 8
8.1 - 10
10.1 - 16
N
For general planning purposes only.

Examining Potential Inundation Depths



What about simulating potential marsh migration in response to SLR?

Coastal wetlands

"Coastal wetlands" means all tidal and subtidal lands; all areas with vegetation present that is tolerant of salt water and occurs primarily in salt water or estuarine habitat; and any swamp, marsh, bog, beach, flat or other contiguous lowland that is subject to tidal action during the ***highest tide level for each year*** in which an activity is proposed as identified in tide tables published by the National Ocean Service. Coastal wetlands may include portions of coastal sand dunes.

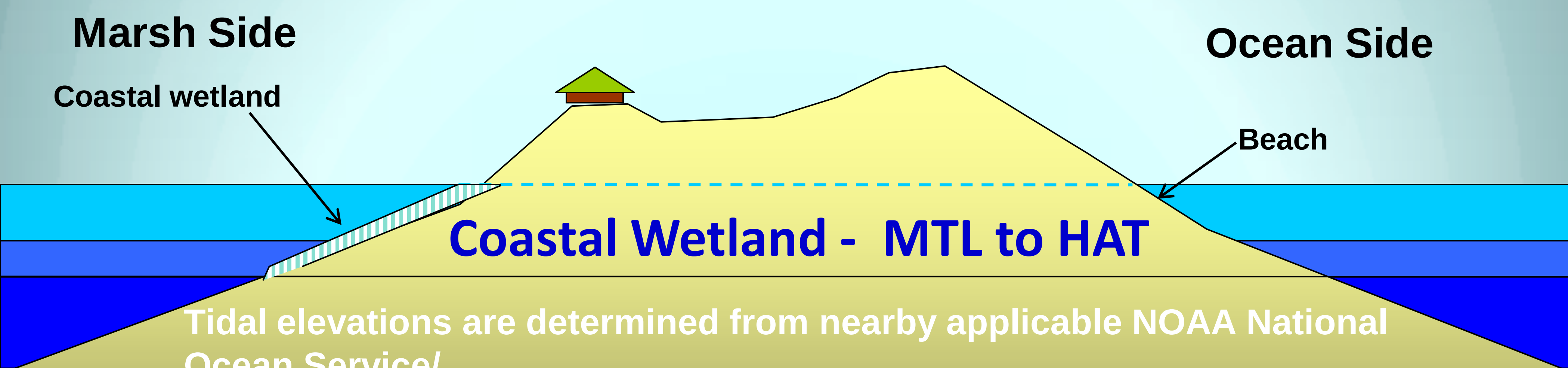
Required in Maine's Municipal Shoreland Zoning

P.A. Slovinsky, MGS

Using Tidal Elevations as Proxies for the Marsh…

Highest Annual Tide (HAT) - "spring" tide, the highest predicted water level for any given year but is reached within several inches numerous tides a year

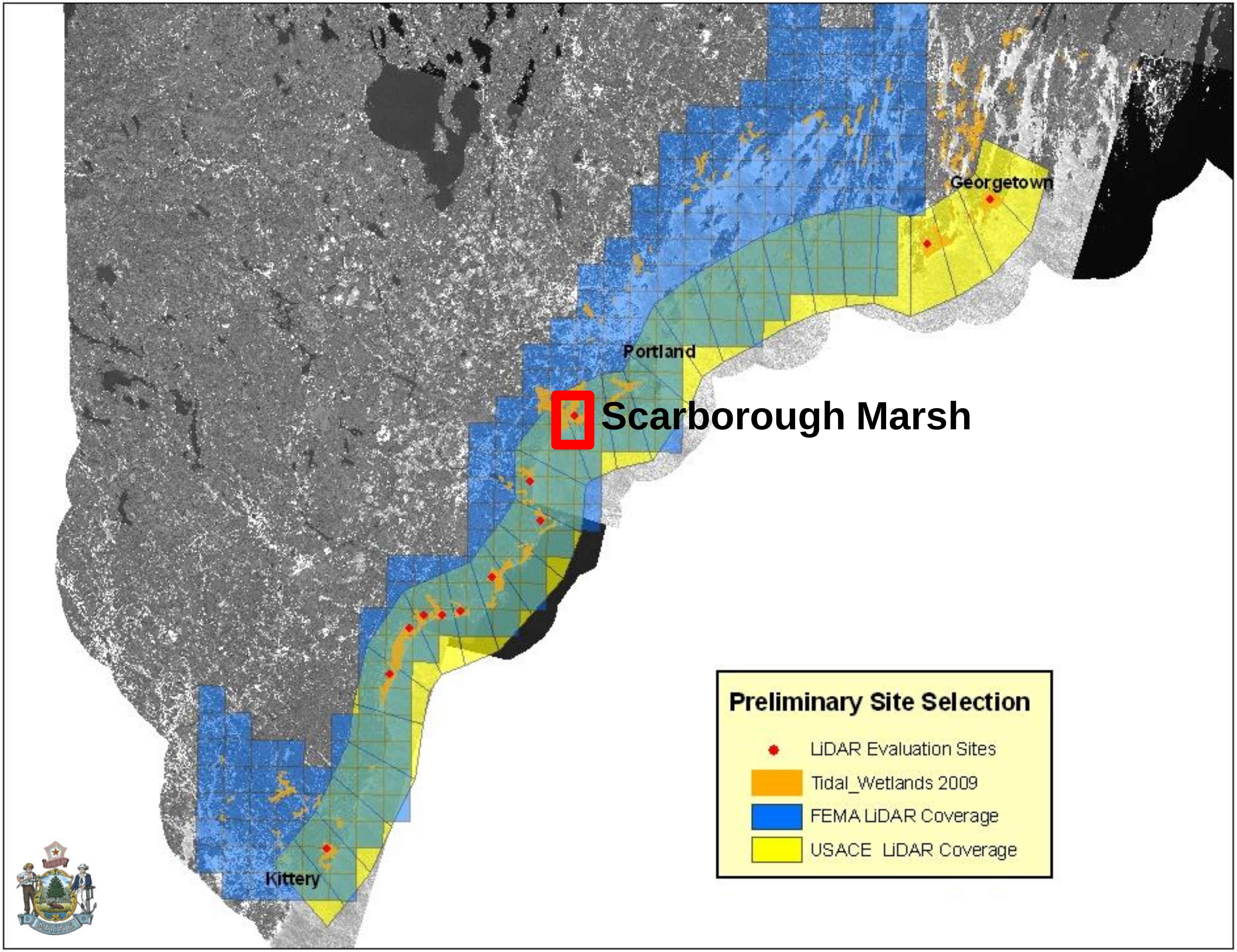
Mean Tide Level (MTL) = average height of the ocean's surface (between mean high and mean low tide).



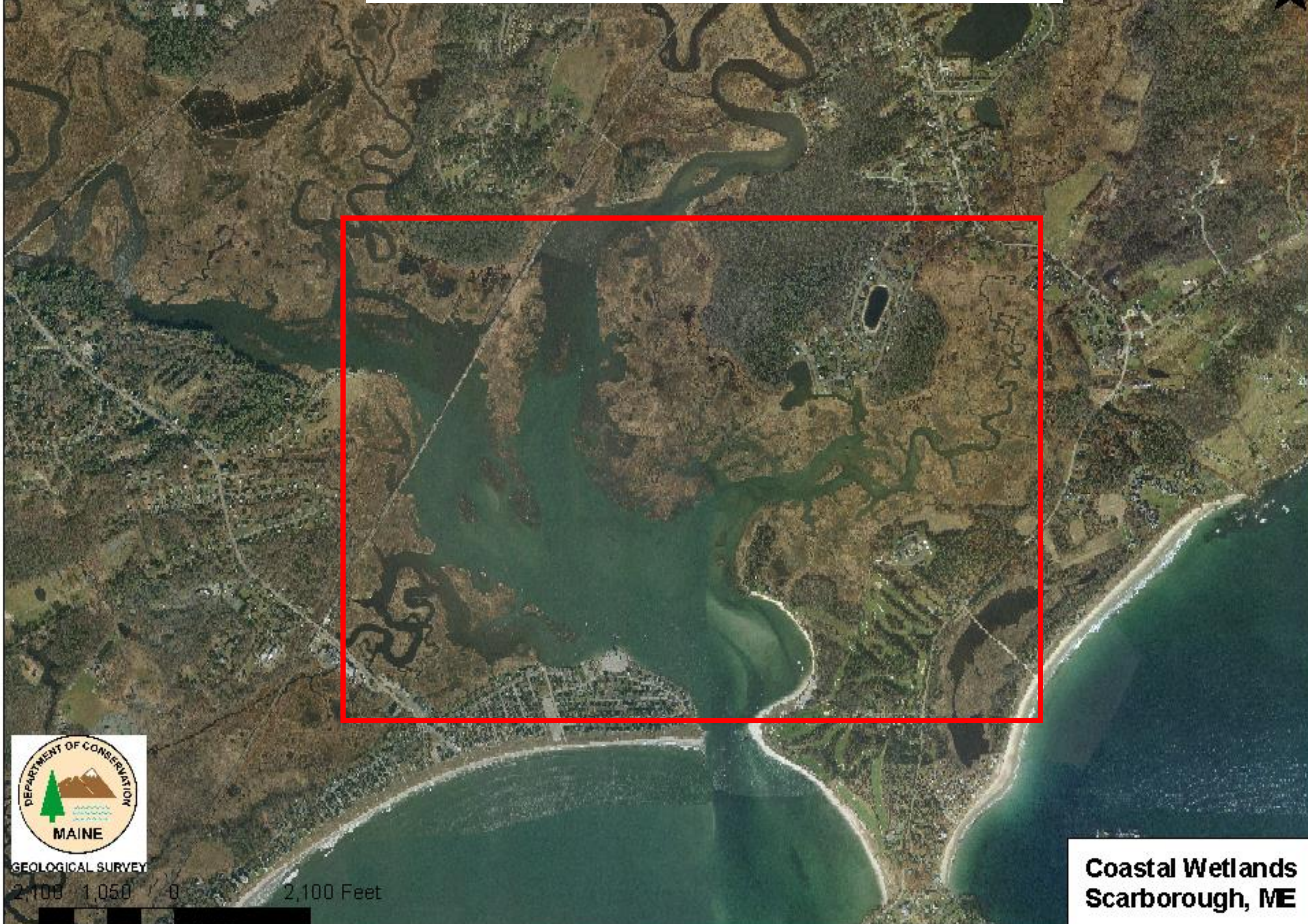
Tidal elevations are determined from nearby applicable NOAA National Ocean Service/
CO-OPs tidal prediction stations
http://tidesandcurrents.noaa.gov

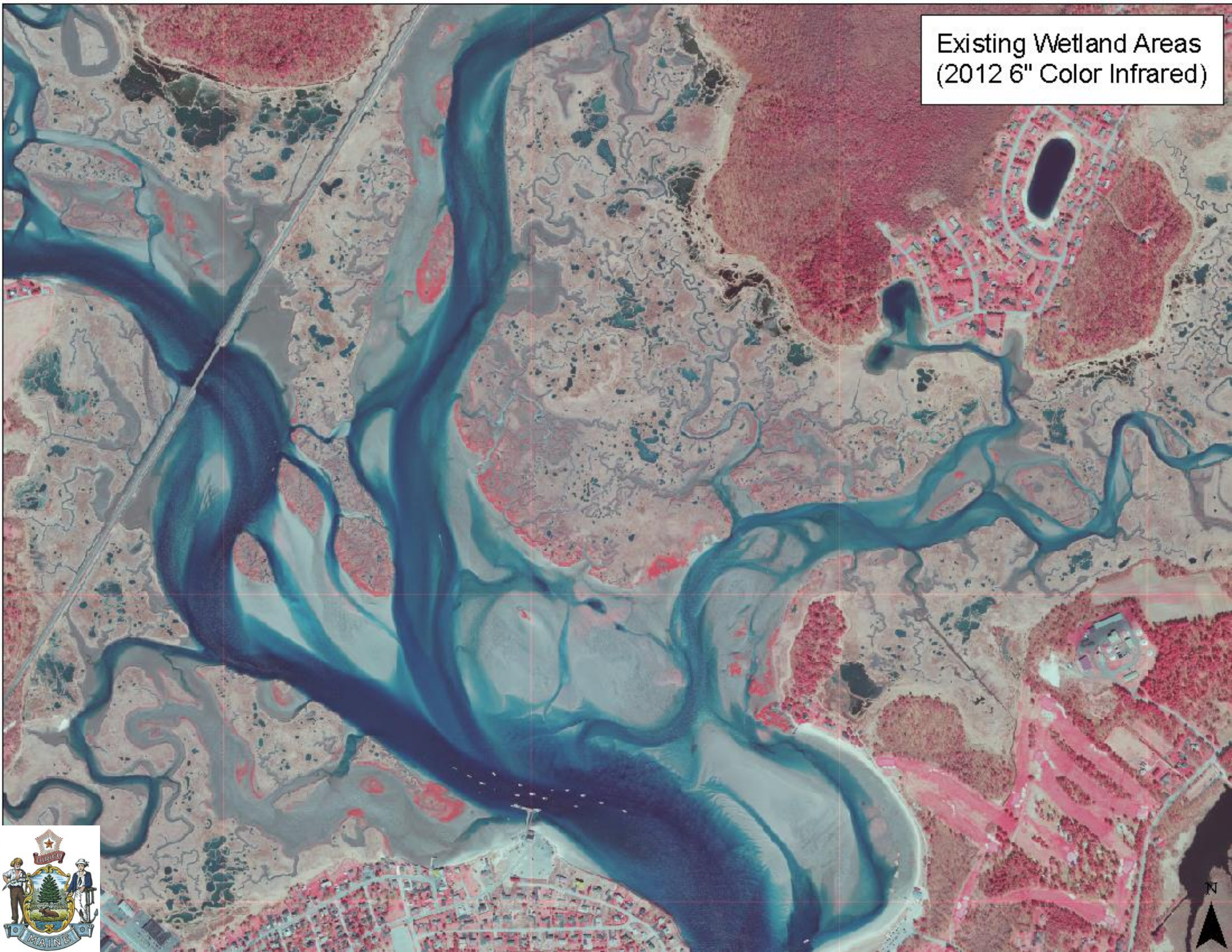
MGS also creates a "HAT" table based on predictions for tidal stations for each year in support of the Shoreland Zoning Program

P.A. Slovinsky, MGS

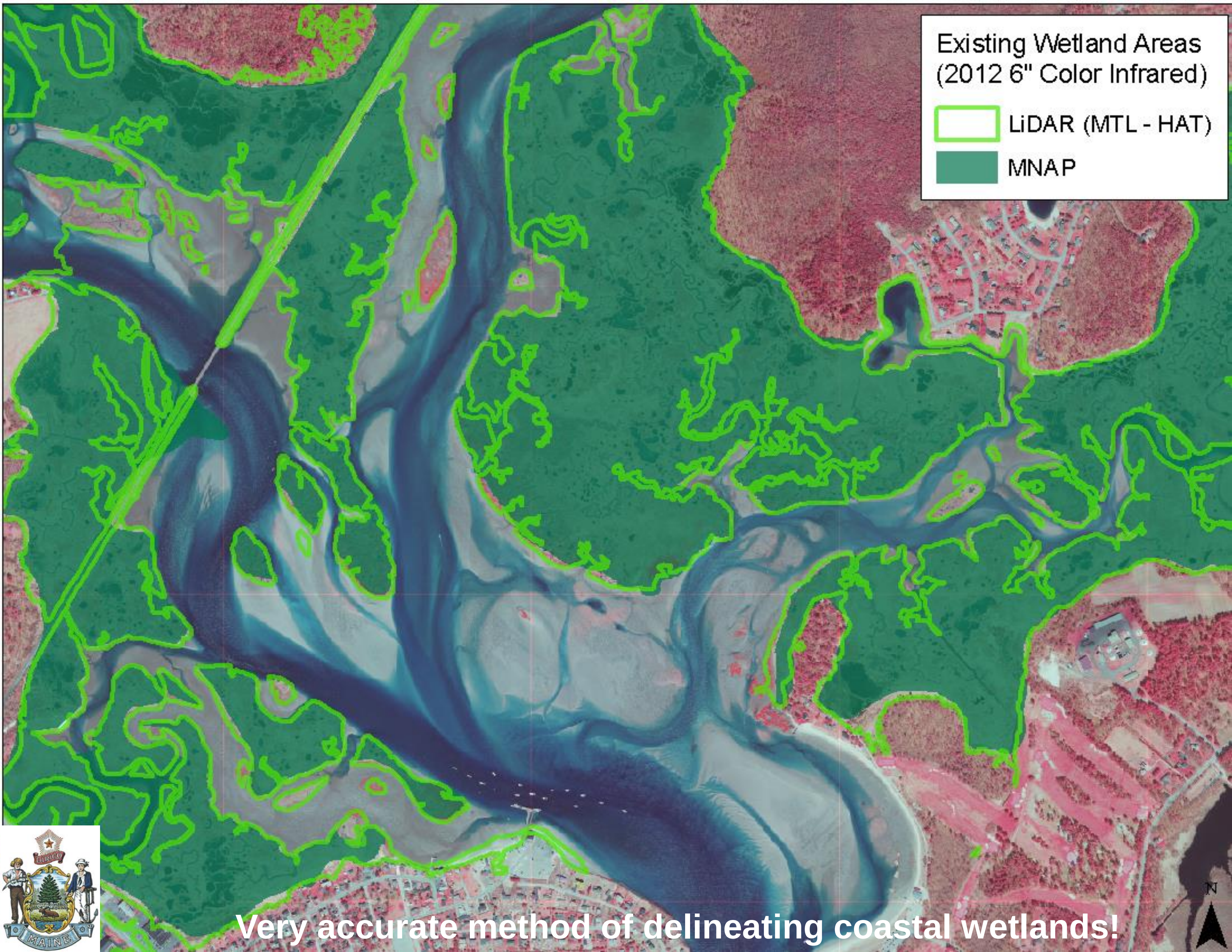

Georgetown
Portland
Scarborough Marsh
Kittery
Preliminary Site Selection
LiDAR Evaluation Sites
Tidal_Wetlands 2009
FEMA LiDAR Coverage
USACE LiDAR Coverage

Simulate Existing Conditions



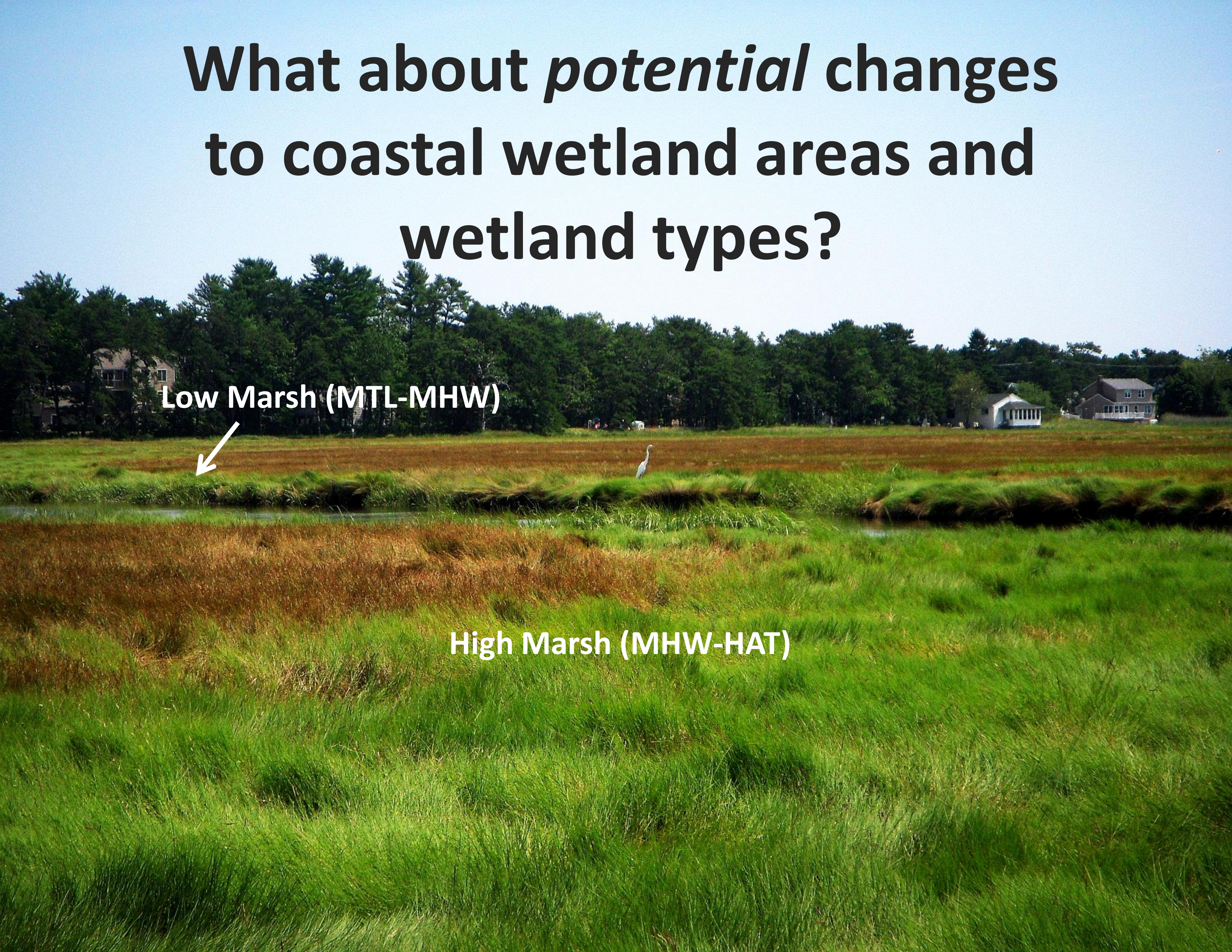

Existing Wetland Areas
(2012 6" Color Infrared)
N

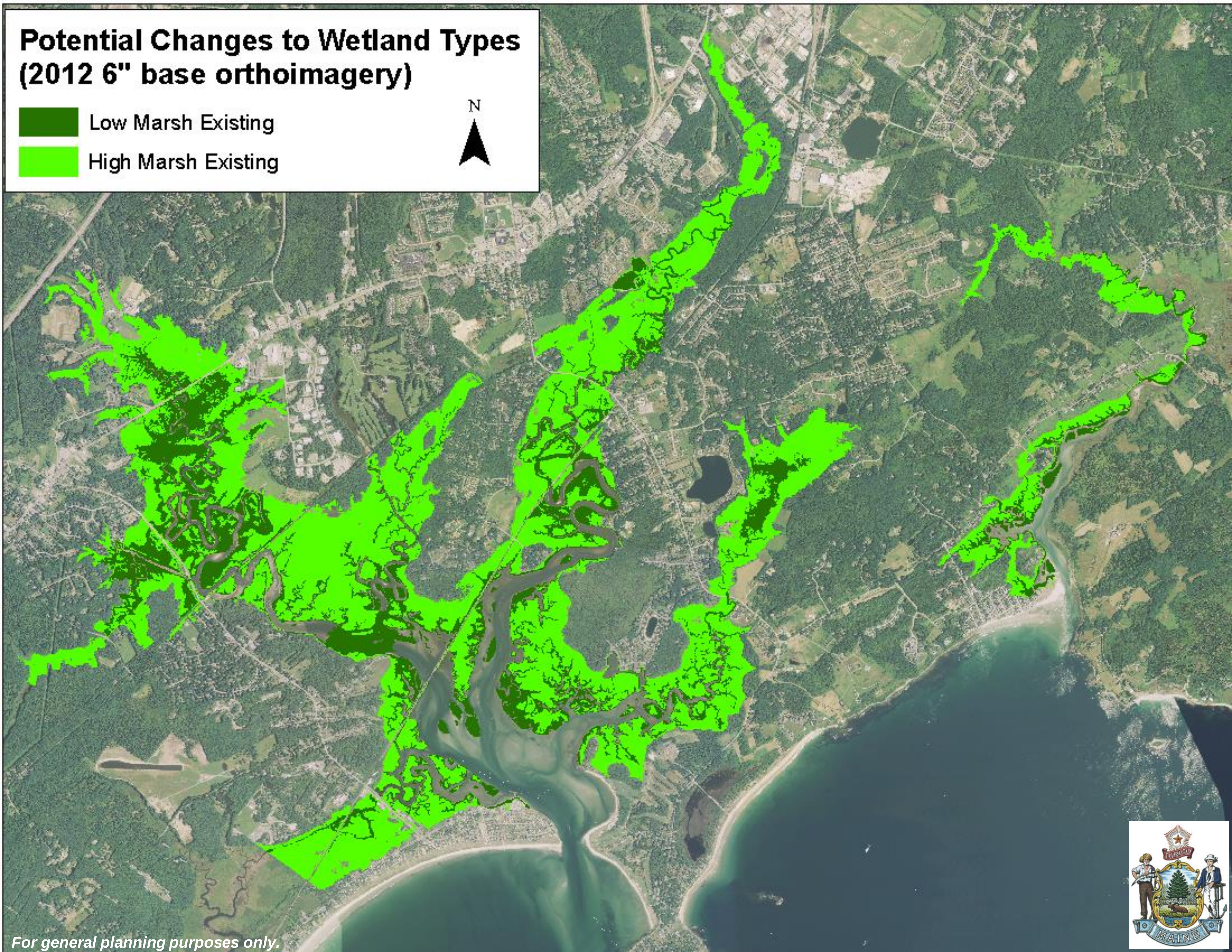

Existing Wetland Areas
(2012 6" Color Infrared)
MNAP
N
MAINE

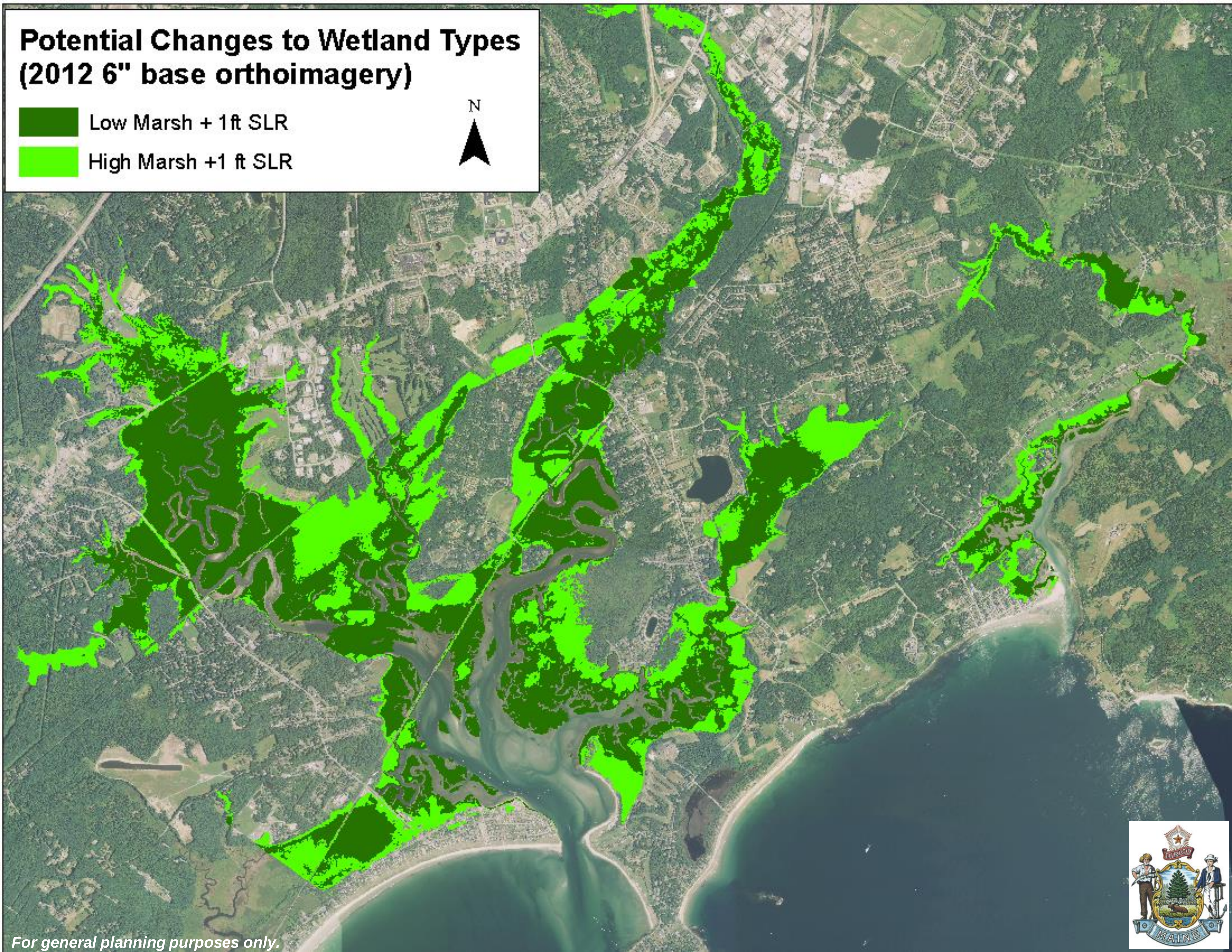


Very accurate method of delineating coastal wetlands!

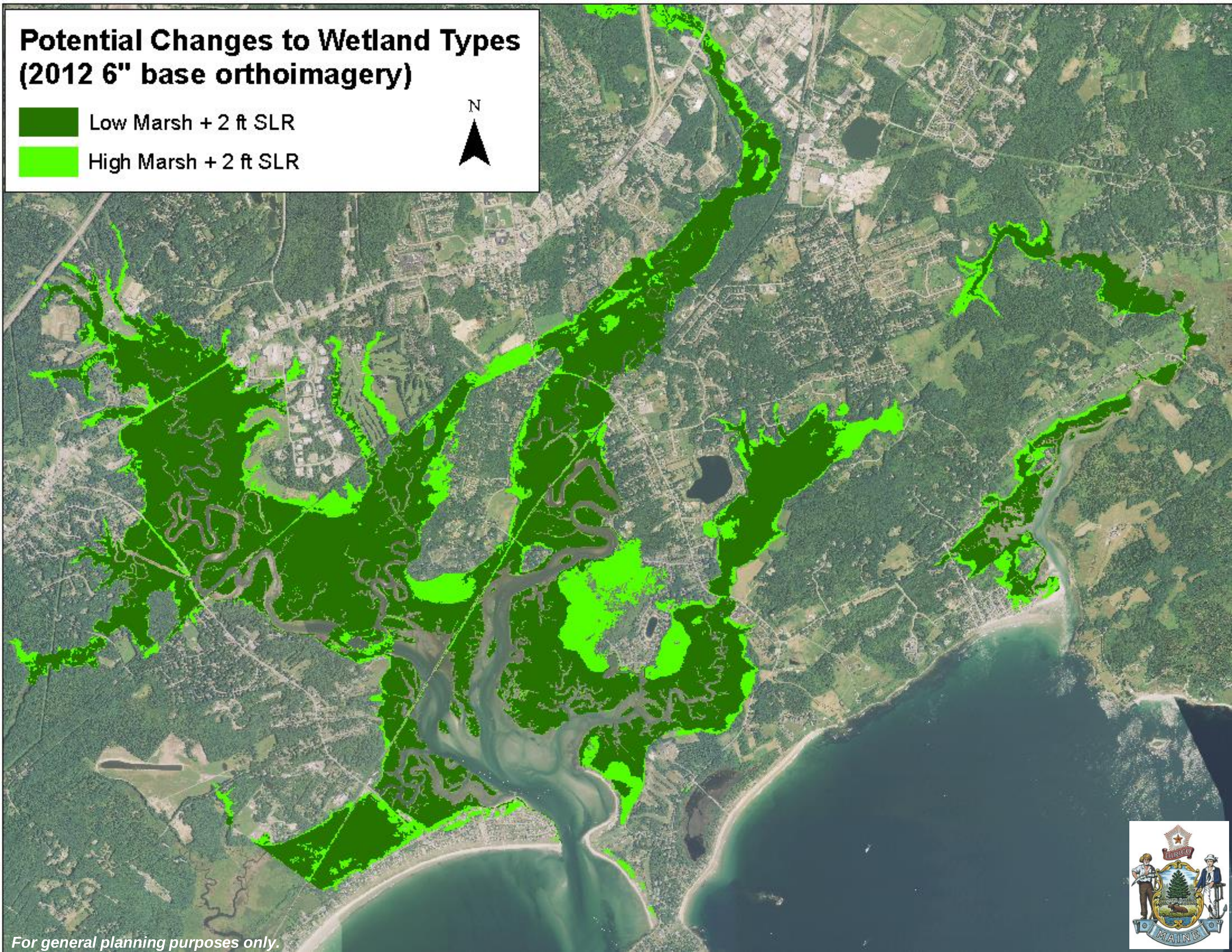
What about *potential* changes to coastal wetland areas and wetland types?

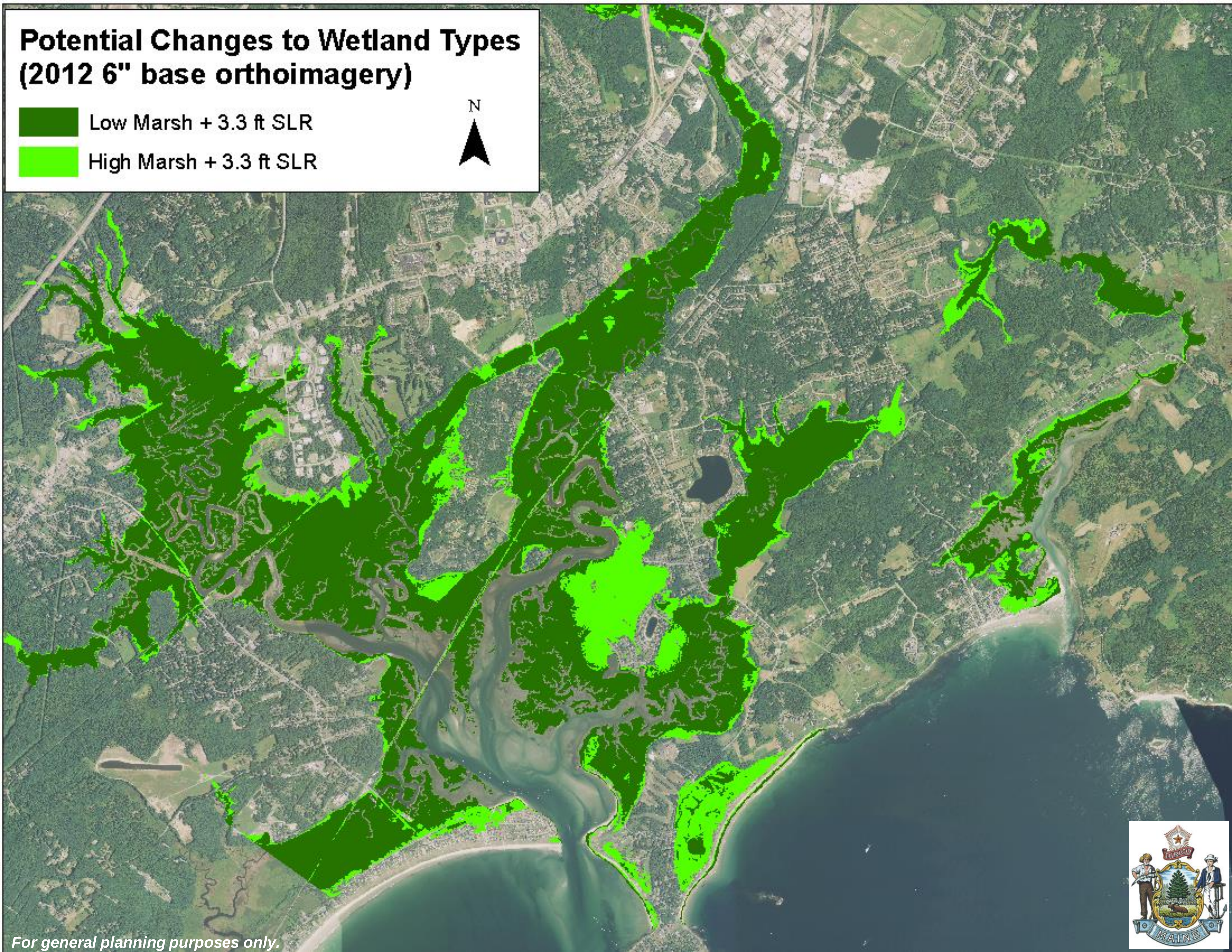


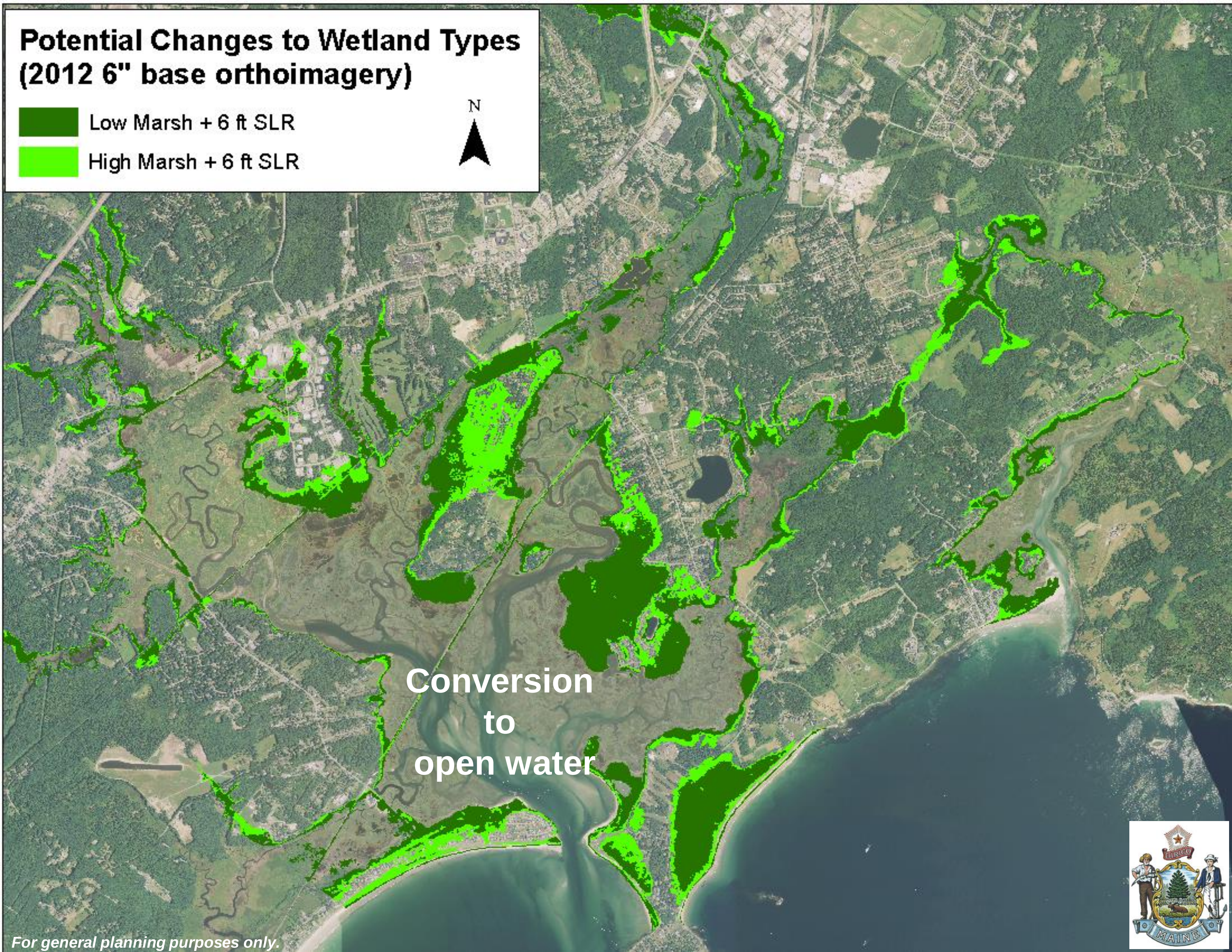

Potential Changes to Wetland Types
(2012 6" base orthoimagery)
Low Marsh Existing
High Marsh Existing
N
For general planning purposes only.
DIRIGO
MAINE



Potential Changes to Wetland Types
(2012 6" base orthoimagery)
Low Marsh + 1ft SLR
High Marsh +1 ft SLR
N
MAINE
For general planning purposes only.


Potential Changes to Wetland Types
(2012 6" base orthoimagery)
Low Marsh + 2 ft SLR
High Marsh + 2 ft SLR
N
For general planning purposes only.
MAINE


Potential Changes to Wetland Types
(2012 6" base orthoimagery)
Low Marsh + 3.3 ft SLR
High Marsh + 3.3 ft SLR
N
MAINE
For general planning purposes only.


Potential Changes to Wetland Types
(2012 6" base orthoimagery)
Low Marsh + 6 ft SLR
High Marsh + 6 ft SLR
N
Conversion
to
open water
For general planning purposes only.
DIRIGO
MAINE

Summary Table – Potential Overall Changes to Coastal Wetlands

Scenario	Coastal Wetland (MTL - HAT)	Coastal Wetland Difference	% change (from previous scenario)	% change (from existing)
Existing Conditions	3,187	0	0.0%	0.0%
0.3 m (1 foot) SLR	3,605	418	13.1%	13.1%
0.6 m (2 feet) SLR	3,785	180	5.0%	18.8%
1.0 m (3.3 feet) SLR	4,046	261	6.9%	27.0%
1.8 m (6.0 feet) SLR	2,207	-1839	-45.5%	-30.7%

*** as delineated using LiDAR topographic data and tidal elevations from the NOS Tidal Station*

includes some areas along the open coast that are not currently "coastal wetlands" by vegetation types

Take home point: Wetlands do have some room to expand based on existing topography and tidal elevations. *The largest expansion is under a 1 foot scenario.* Significant amounts of wetlands may be lost in highest scenario and converted to "open water".

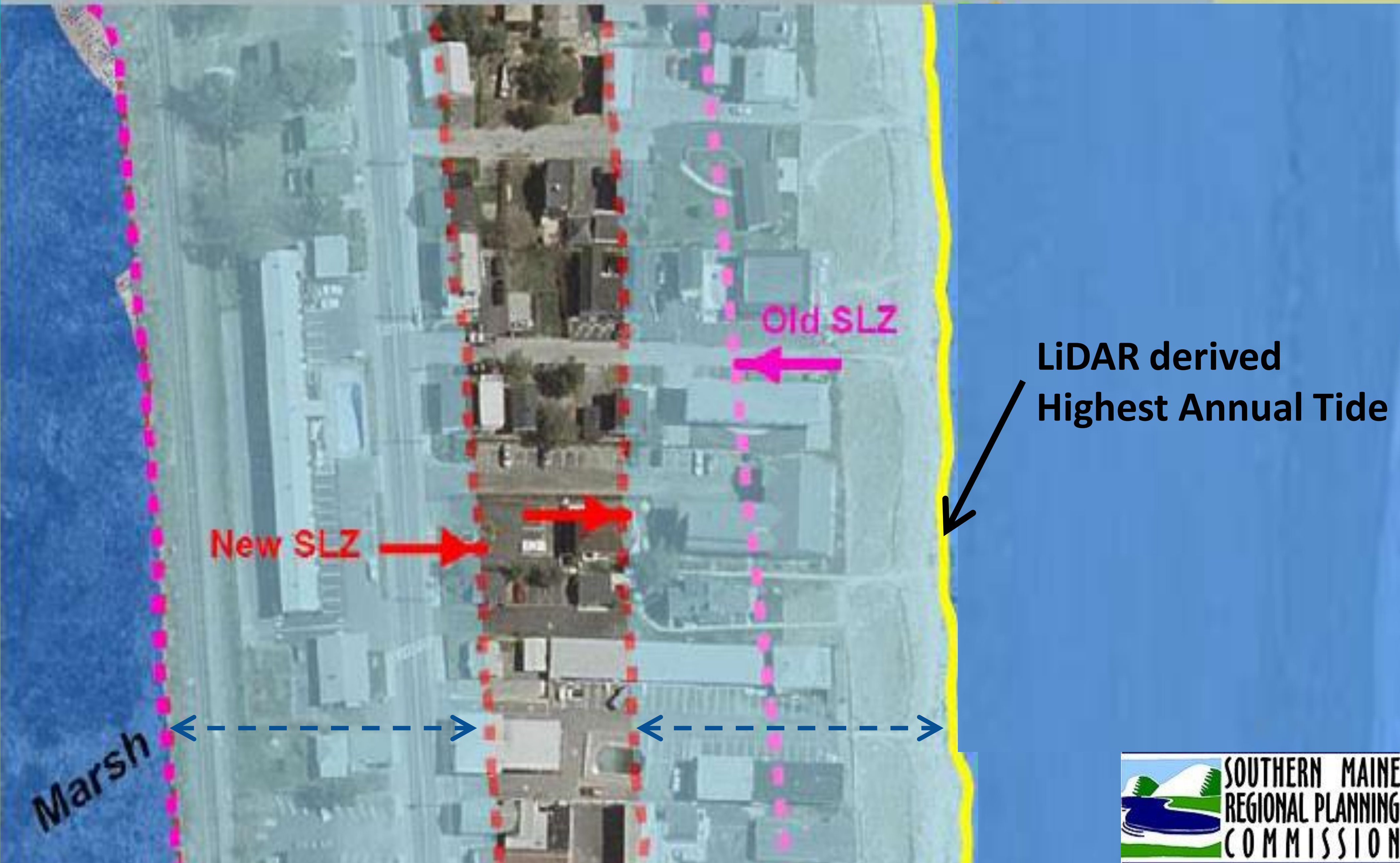
Summary Table – Potential Changes to Coastal Wetland Types

Scenario	"Low Marsh" (MTL - MHW)	Difference (acres)	% change (from previous scenario)	% change (from existing)
Existing Conditions	857	0	0.0%	0.0%
0.3 m (1 foot) SLR	2080	1223	142.7%	142.7%
0.6 m (2 feet) SLR	2869	789	37.9%	234.8%
1.0 m (3.3 feet) SLR	3168	299	10.4%	269.7%
1.8 m (6.0 feet) SLR	1447	-1721	-54.3%	68.8%
Scenario	**"High Marsh" (MHW - HAT)**	**Difference (acres)**	**% change (from previous scenario)**	**% change (from existing)**
Existing Conditions	2395	0	0.0%	0.0%
0.3 m (1 foot) SLR	1525	-870	-36.3%	-36.3%
0.6 m (2 feet) SLR	916	-609	-39.9%	-61.8%
1.0 m (3.3 feet) SLR	878	-38	-4.1%	-63.3%
1.8 m (6.0 feet) SLR	760	-118	-13.4%	-68.3%

Take home point: Wetlands will likely convert to a low-marsh dominated system and we will lose marsh to open water.

Some transferable *low hanging fruit* adaptation and ordinance strategies developed and being implemented by some of the SLAWG communities

Old Orchard Beach – East Grand Avenue Area

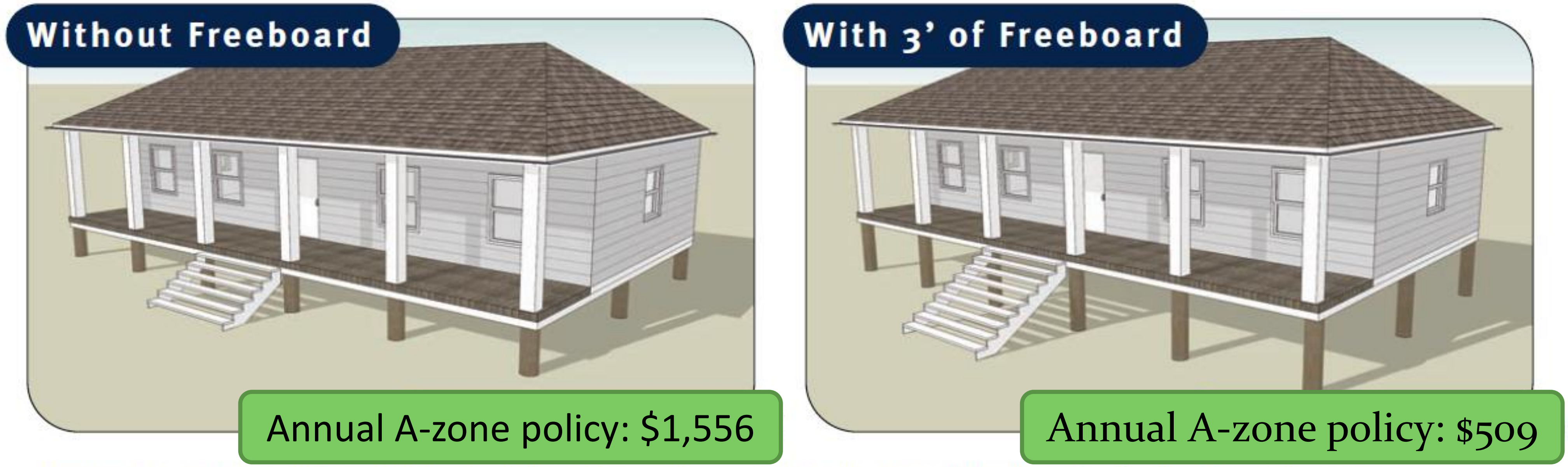


Strategy: Use LiDAR to more accurately define the Highest Annual Tide to create better Shoreland Zoning maps (OOB and Saco; Cape Elizabeth)

Strategy: Incorporating more freeboard into municipal floodplain ordinances to account for SLR or storms

The City of Saco made ordinance changes to increase freeboard to <u>three feet</u> above the 100-year Base Flood Elevation (BFE). Also done in South Berwick.

"Low Hanging Fruit" : Flood Insurance Premium Benefits



Elevating a home a few feet above legally mandated heights has very little effect on its overall look, yet it can lead to substantial reductions in flood insurance, substantially decrease the chances the home will be damaged by storms and flooding, and help protect against sea level rise.

Scenario	V-zone			A-zone		
	Annual Policy	Savings (%)	30-year savings	Annual Policy	Savings (%)	30-year savings
No Freeboard	$7,747	$0 (0%)	$0	$1,556	$0 (0%)	$0
1 ft freeboard	$5,331	$2,416 (31%)	$72,480	$799	$757 (49%)	$22,710
2 ft freeboard	$3,648	$4,099 (53%)	$122,970	$574	$982(63%)	$29,460
3 ft freeboard	$2,635	$5,112 (66%)	$153,360	$509	$1,047(67%)	$31,410

Based on 2012 rates for a one-floor residential structure, no basement, post-FIRM, $1,000 deductible with $250,000 coverage and $100,000 contents.

Flood policy rating quotes graciously provided to Maine Floodplain Management Program by Chalmers Insurance Group, www.chalmersinsurancegroup.com

Why increase freeboard?

- Is a **simple cost-effective means to protect buildings** from existing ocean storms and surges and accommodate for potential future sea level rise

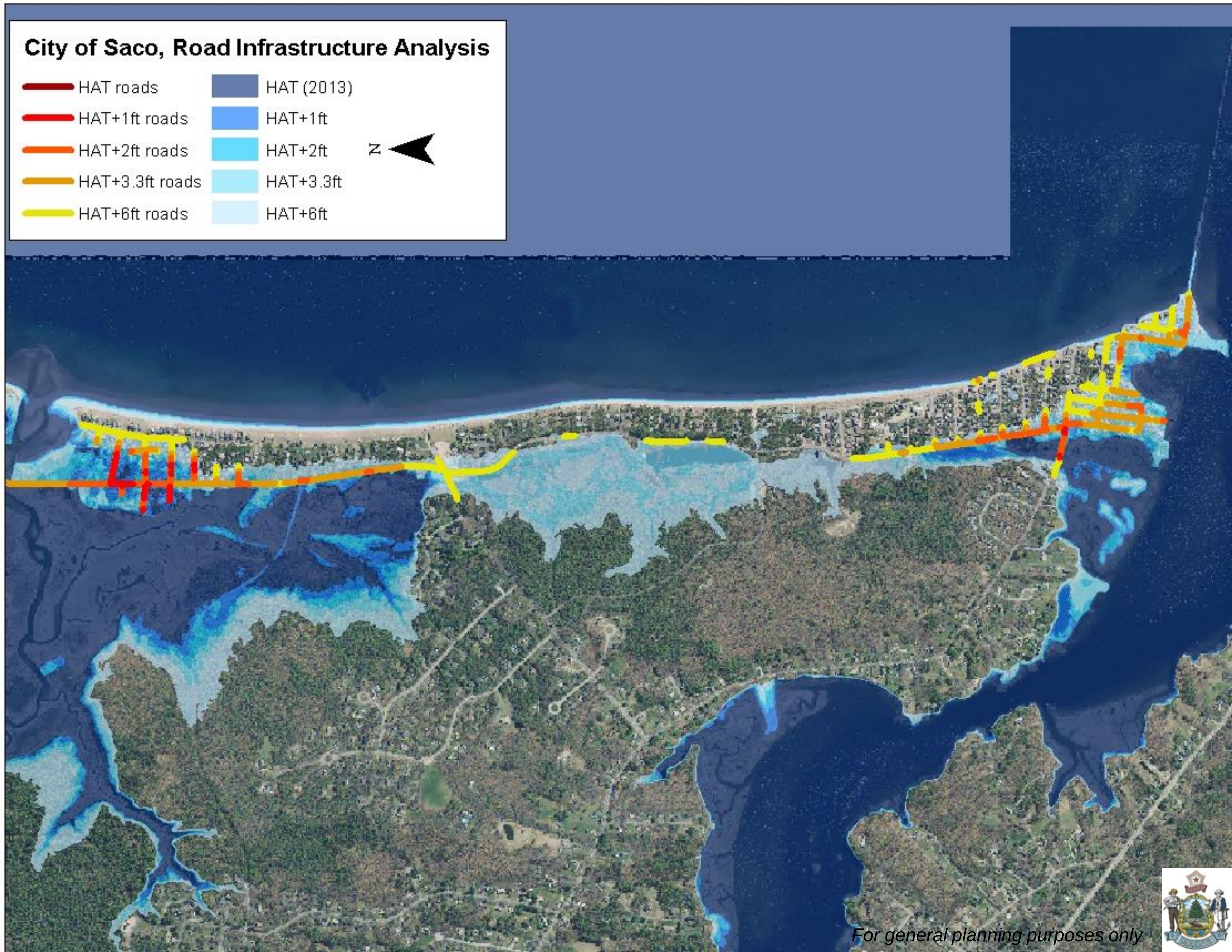
- Is **only triggered by substantial improvement, new construction, or damage threshold requirements <u>that already exist</u>** and will only impact structures that **would already need to meet minimum freeboard requirements**

- Will **not substantially increase the costs of elevating a structure** (three feet vs. one foot, 0.25-1.25% of cost!)

- **Reduces flood insurance costs.**

So what is SLAWG doing now?

- Using a "scenario based approach" Vulnerability Assessment results in conjunction with an **infrastructure criticality matrix to pinpoint critical transportation impacts** in each community
- Engaging with **community DPWs** to get a better handle on viable adaptation strategies for identified critical roads
- Working to start the conversation on how to address **identified regional issues** between Towns and private and state parties (i.e., Scarborough and Old Orchard from the 2007 Milone & MacBroom Report)


City of Saco, Road Infrastructure Analysis
HAT roads
HAT+1ft roads
HAT+2ft roads
HAT+3.3ft roads
HAT+6ft roads
HAT (2013)
HAT+1ft
HAT+2ft
HAT+3.3ft
HAT+6ft
N
For general planning purposes only

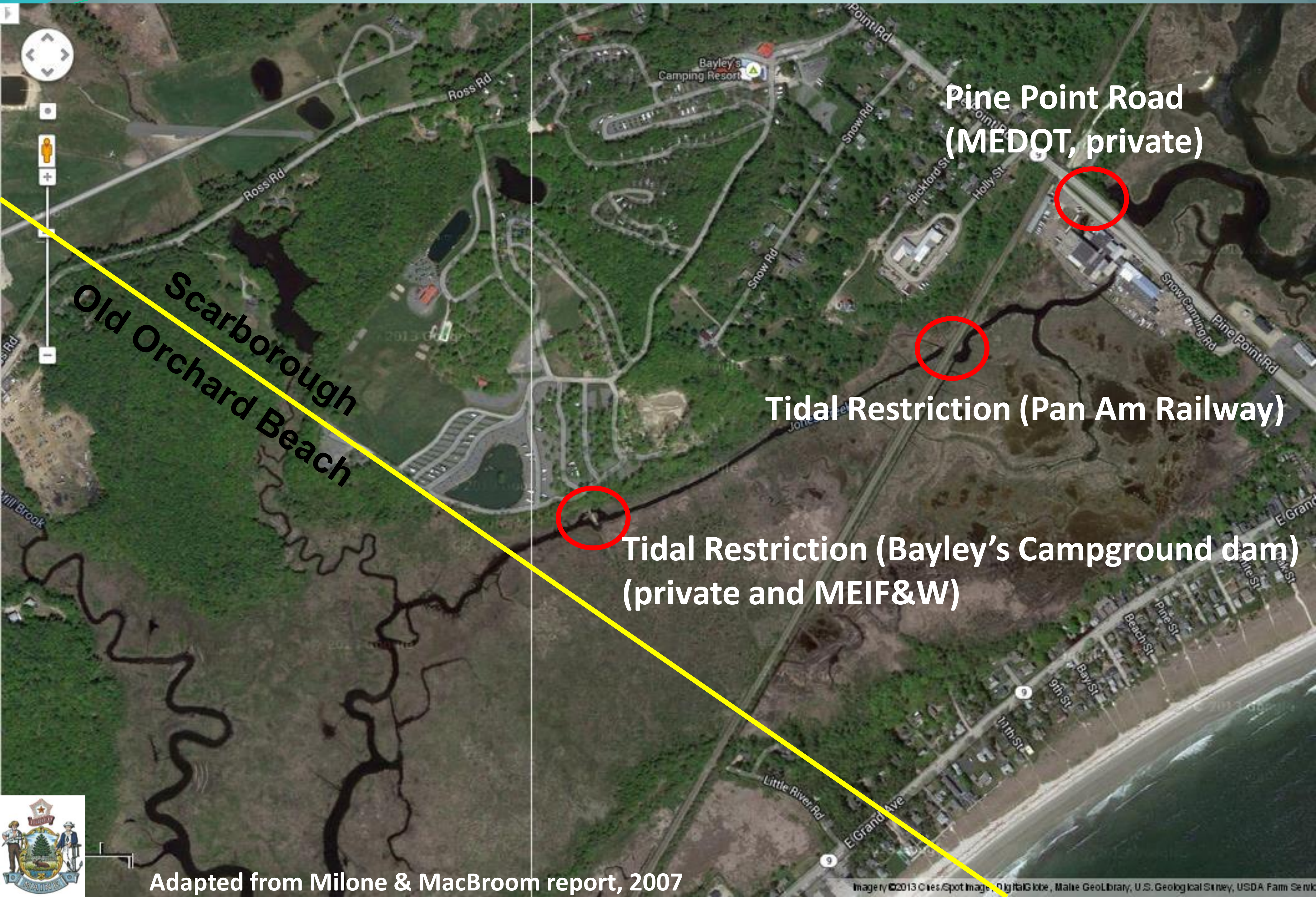
No to some impact	Moderate Impact	Major Impact	Severe Impact
0-50 ft	50-100 ft	100-500 ft	500+ ft

** or entire road*

Assessment of Potential Impacts to Roads: City of Saco

Road Name	Road Class	Highest Annual Tide (+ SLR in feet)					1% Storm Event (+ SLR in feet)					Hurricane	
		HAT	HAT+1	HAT+2	HAT+3.3	HAT+6	1%	1%+1	1%+2	1%+3.3	1%+6	Cat1	Cat2
ABBY LN	Local												238
ATLANTIC WY	Local												79
BAY AV	Local			95	378	430	323	380	405	430	430	430	430
BAY VIEW RD	Local					160			91	145	205	157	380
BAYVIEW RD	Major/urb collector					646			372	594	776	602	1277
BEACH AV	Local				86	364	7	87	216	347	364	351	364
BEACON AV	Local			32	66	102	39	66	77	96	419	97	504
CAMP ELLIS AV	Local			183	754	917	222	807	916	916	916	916	916
COTTAGE AV	Local				49	165		52	93	165	165	165	165
COURTLYNN CIR	Local												436
COVE AV	Local				273	594		271	422	559	709	549	709
CURTIS AV	Local				56	187		63	98	167	303	179	335
DUNE AV	Local		43	217	298	347	246	303	328	342	459	347	459
EAGLE AV	Local				26	53		26	38	51	148	54	465
EASTERN AV	Local			54	110	475	63	110	407	458	631	461	631
FAIRHAVEN AV	Local			12	47	177	21	42	65	104	515	87	628
FERRY LN	Local										16		425
FERRY PARK AV	Local					33				25	404	12	595
FERRY RD	Major/urb collector		53	311	313	496	313	311	327	472	823	453	1729
FRONT ST	Local				247	445		211	308	396	490	482	599
HARRIMAN FARM	Local												149
ISLAND VIEW AV	Local					90			69	84	276	84	331
ISLAND VIEW ST	Local					111				37	350	40	455
KING AV	Local										174		365
LANDING RD	Local												1103
LIGHTHOUSE LN	Local										46		221
LOWER BEACH RD	Local			79	135	365	98	140	186	355	632	346	877

A Regional Approach to Tidal Restrictions?



Adapted from Milone & MacBroom report, 2007

So what Tools or Strategies have evolved from SLAWG?

- Developed a **sound, transferable methodology for engaging at the municipal level** with technical and planning resources
- **Tailored engagement** to each community's needs
- Developed **transferable municipally-determined adaptation strategies**
- **Developed a GIS-based Highest Annual Tide mapping tool** that allows coast-wide inundation mapping and potential marsh migration mapping

What has happened since SLAWG?

- Engagement of **38 coastal municipalities in 4 different counties** through either municipal or regional resiliency approaches based on the SLAWG model
- Implementation of locally-derived and driven adaptation strategies:
  - **Elevating roads (Kennebunkport)**
  - **Adapting critical infrastructure (Ogunquit)**
  - **Adapting historic infrastructure (Damariscotta)**
  - **Increasing floodplain ordinance (Saco)**
  - **Using LiDAR to derive Shoreland Zoning (Saco, OOB; soon all)**
  - **Changing Shoreland Zoning (3 ft above HAT, Cape Elizabeth)**
  - **Comprehensive Plans (York, Bowdoinham, South Portland; underway in Biddeford, Old Orchard Beach)**
  - **Beach Management Plan (Saco)**
  - **Community Climate Change Adaptation Plan (Georgetown)**
  - **Hurricane Planning (Lincoln County)**

Final thoughts on Municipal Adaptation

- Impacts from existing storms and SLR will be felt most at the local level, regardless of what happens at the State or Federal government levels. Preparation needs to start with the **"ground zero" of potential impacts, <u>the municipalities</u>**

- Multiple-level project partnerships bring **resources** to the table that **are not currently available at the local level**.

- **Each municipality is different;** engage the right players, and understand that each approach needs to be tailored to each municipality

Final thoughts on Municipal Adaptation

- **Develop regional working groups** to pool resources, create parallel regulations, and leverage funding for capital improvements

- Use a “Scenario Based Approach” to build on the concept of “no regrets actions” and **cover a range of scientific predictions and manageable planning horizons**

- Use **existing regulatory mechanisms** for incorporating sea level rise and storm surge planning . You don’t have to recreate the wheel.

Final thoughts on Municipal Adaptation

- Expect unforeseen delays (FEMA FIRMs!) and to **work on municipal time frames** - *expect to take your time!*

- **Bring planning time horizons and goals down to realistic levels**…you don't have to tackle it all at once!

- Shoot for the **"low hanging fruit"** in terms of planning or ordinance changes – something that has a definitive benefit in terms of creating resiliency for the "**storms of today and potential tides of tomorrow**"

- Resiliency efforts have been mainly focused on the coast and potential impacts from sea level rise. ***The gaping hole is inland communities and potential changes in precipitation and resulting impacts on engineering infrastructure.***

Thank you!

Washingtonpost.com

Regional Municipal Approaches to Sea Level Rise and Increased Storm Surges: The SLAWG Approach

Peter A. Slovinsky, Marine Geologist

Maine Geological Survey, Department of Agriculture, Conservation,and Forestry

peter.a.slovinsky@maine.gov