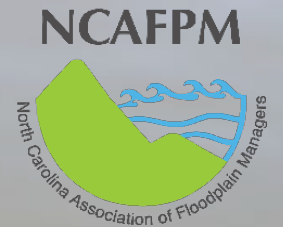




# Community Involvement with the Monitoring of Water Levels and King Tide Events

Daniel M. Tomczak, CFM  
Jacobs Engineering Group

Association of State Floodplain Managers Annual Conference  
Cleveland, Ohio  
May 22, 2019



**JACOBS**



# What is meant by “high tide flood events”?

## High Tide Flood Events Are Significantly Increasing Around the U.S.

### What is high tide flooding?

Flooding which causes public inconvenience.

### What are the impacts of high tide flooding?

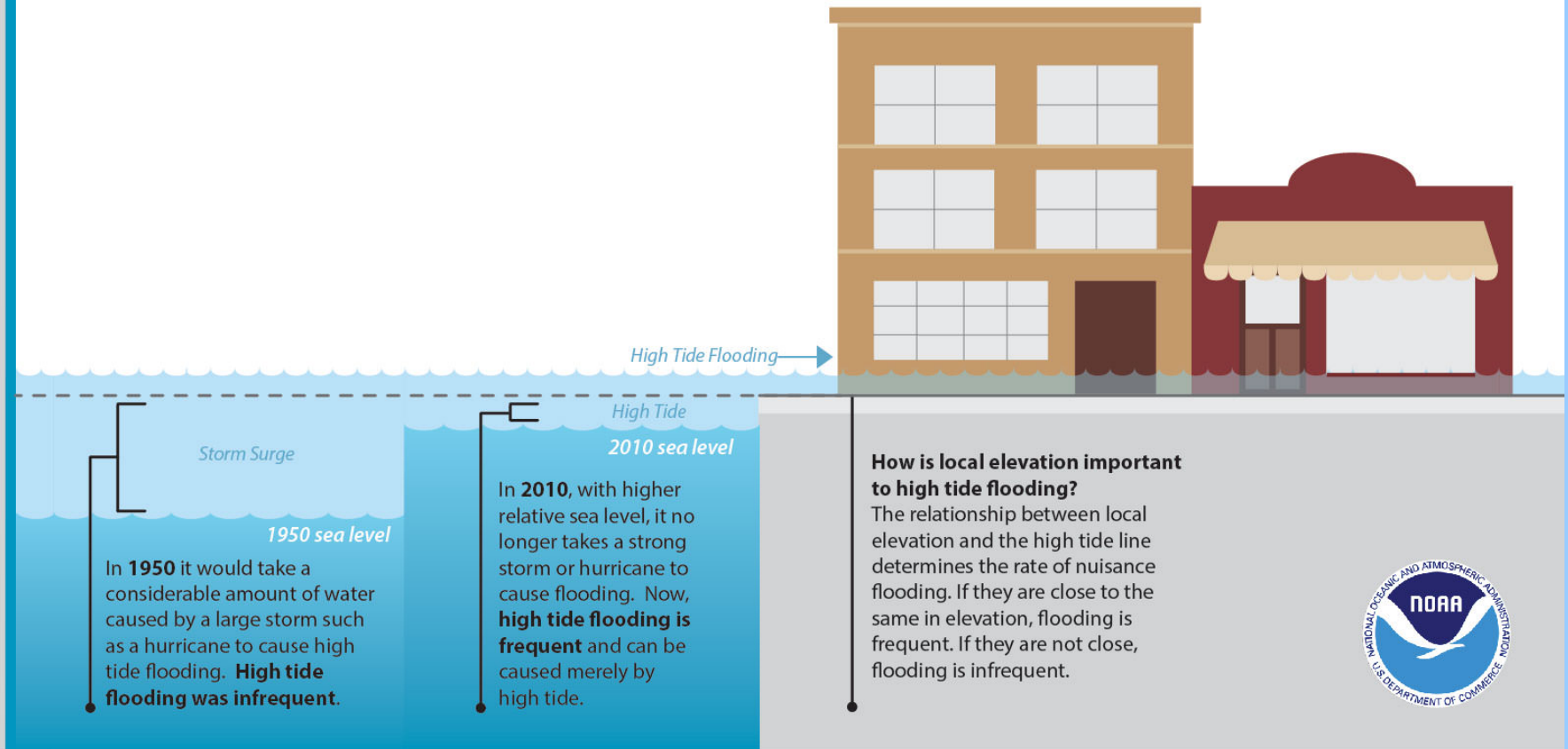
Frequent road closures, overwhelmed storm drains, and deterioration of infrastructure such as roads and rail.

### Where is this happening?

High tide flooding is increasing around the coastal U.S., with more rapid acceleration along the East and Gulf Coasts.

### Why is this happening?

High tide flooding is increasing due to climate-related sea level rise and land subsidence (sinking) combined with loss of natural coastal barriers.







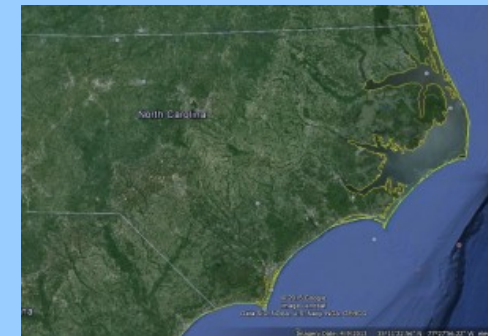
# North Carolina King Tide Project

## Snap the shore *See the future*

Local project was started by Prof. Christine Voss of the University of North Carolina – Institute of Marine Sciences, Morehead City, North Carolina



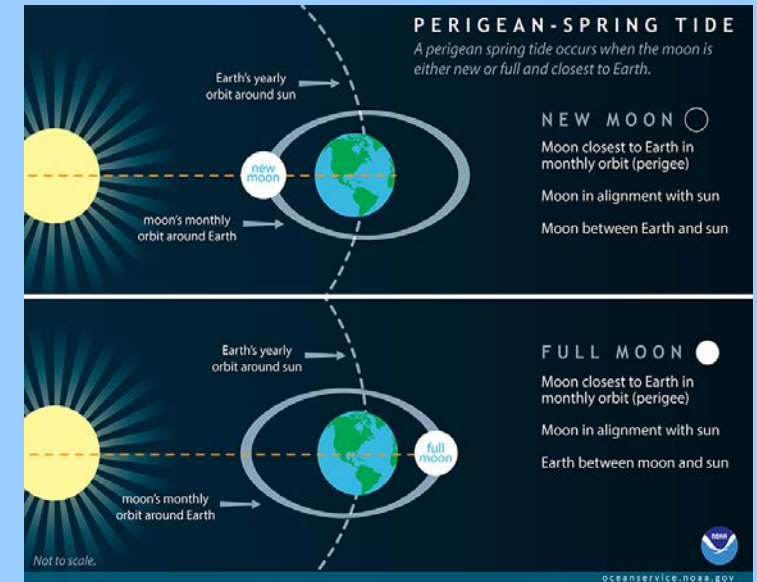
The screenshot shows the website for the North Carolina King Tides Project. The header features the project logo and the slogan "Snap the shore See the future". Below the header is a navigation menu with links: Home, Get Involved!, Water Level Gauges, Learn More, Educational Tools, Selected Photos, Water Level Data Download, Blog, and Contact Us!. The main content area has a large heading: "The King Tides Project helps people all over the world understand how sea-level rise will impact their lives." Below this heading is a blue button that says "Submit a Photo or Report". To the right of this button is a green button that says "Sign Up for our Mailing List". Below the heading, there is a section titled "What is the King Tides Project?" with a bulleted list: "The King Tides Project is an international initiative to document extreme high tide events using photos", "These photos can help us visualize how 'normal' high tides could look in the future due to sea-level rise", "From these images we can create a record of how our shoreline looks today and track future changes.", and "By visualizing these higher tide events we can start to understand how rising sea-levels will impact local resources and community investments". Below this list is a section titled "What are king tides?" with a bulleted list: "King tides are the highest high and lowest low tide events of the year". To the right of this section is a box titled "Upcoming High Water-Level Events!" with the dates "April 17 - 22" and "July 1 - 5". At the bottom of the page, there is a link that says "Click Here for the 2019". The website is displayed in a web browser window with the address bar showing "http://nckingtides.web.unc.edu/". The browser's taskbar at the bottom shows various application icons and the system clock indicating 3:25 AM on 5/5/2019.





# What is a King Tide?

- The “king tide” is a *non-scientific term* used to describe the highest high-tide and lowest low-tide events of the year.
- A king tide occurs when the full or new moon co-occur with the moon being closest to earth in its elliptical orbit.
- Due to their astronomical nature, king tides are regular and predictable events, reoccurring multiple times a year.



<https://oceanservice.noaa.gov/facts/perigean-spring-tide.html>







# What is the King Tide Project?

- The “king tide” project is an international initiative to photo-document extreme high water-level events (started in 2009 in Australia)
- These flooding events can be very helpful for scientists because they provide a glimpse of what “normal” high tides might look like in the future due to sea-level rise
- Benefits the coastal communities by helping inform and influence proactive planning and policy decisions





# North Carolina King Tides Project

Nuisance flooding has become more common in waterfront communities along the coast of North Carolina over the past few decades.

Photos can help us to:

- better understand storm-, tidal-, and wind-driven flooding in our area
- visualize what sea levels might look like in the future
- help improve community planning



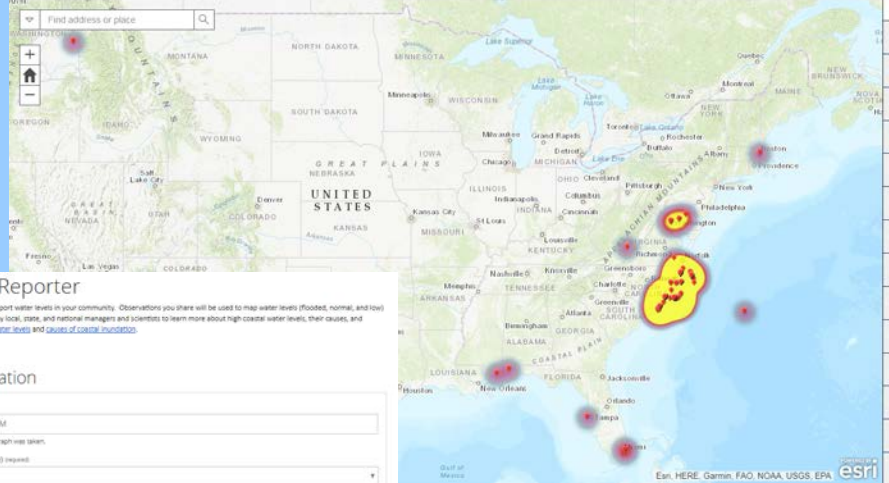


# Water Level Reporter WebApp NOAA-NCCOS

- Citizen science application to report meteorological, tidal, and flooding conditions
- Spatially-organized, interactive summary map hosts real-time and historical record of water-level data and photographs
- Inundation dashboard merges water levels with representative photos and real-time data being collected by National Ocean Service gauges

**What's your water level?**  
Water level reports are submitted and summarized here. Observations you share will be used to map water levels (flooded, normal, and low) regionally. Your contributions will be used by local, state, and national managers and scientists to learn more about high coastal water levels, their causes, and impacts.

[All Contributions](#) [Make a Report](#) [Reports by Month](#) [Learn More: King Tides](#) [Learn More: Nuisance Flooding](#) [Inundation Dashboard](#)



Date
April 16, 2018
April 16, 2018
April 16, 2018
April 15, 2018
April 15, 2018
April 14, 2018
April 14, 2018
April 13, 2018
April 13, 2018
April 13, 2018
April 12, 2018
April 12, 2018
April 11, 2018

### Water Level Reporter

Please enter information below to report water levels in your community. Observations you share will be used to map water levels (flooded, normal, and low) regionally. Your inputs will be used by local, state, and national managers and scientists to learn more about high coastal water levels, their causes, and impacts. [More on observing water levels and causes of coastal inundation.](#)

#### 1. Enter Information

Date and Time of Photo:   
Select the date and time the photograph was taken.

What is affected by the water? (if any)   
Select...

Water levels are elevated. Identify the primary structure or area affected by the water. If any, if nothing is affected, select nothing.

Cause of observed water level?   
Select...

Describe what you suspect to be the cause of the observed water level in your photograph.

Keyword describing conditions:   
Select...

What keyword best describes the conditions displayed in your photograph.

Water Depth (in inches):   
Add depth in inches here.

If you are documenting a gauge or meter, please report the water depth (in inches).

Picture URL:

Provide a brief title for your photograph and report.

Additional details:

Provide any additional information here that you feel will help inform your local managers or scientist about the water level you observed.

Upload photograph:

In addition to following the NOAA Privacy Policy, reports are collected "anonymously". We do not collect personally identifiable information, including your name, email address, or your device's unique identification number. By submitting your report you are allowing NOAA to use your photograph for non-commercial purposes, such as presentations.





# Citizen Science Water-Level Monitoring



In Fall 2017, the North Carolina King Tide Program received a grant from *Carolinas Integrated Sciences and Assessments* (CISA) to expand the project to include water-level monitoring conducted by trained citizen scientists using gauging stations.

- ***UNC Institute of Marine Sciences***: furnishes and installs stations, provides training and continued support for participants, and serves as a conduit facilitating information exchange between citizen scientists, coastal zone managers, and researchers
- ***North Carolina Association of Floodplain Managers***: provide guidance on where records of water levels are most needed



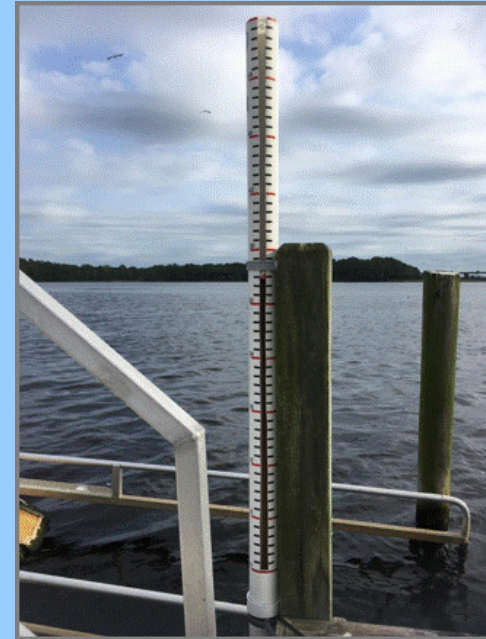
# Citizen Science Water-Level Monitoring

**WHAT:** Trained citizen scientists will collect water level data using gauging stations

**WHO:** Any coastal resident with access to a vertically stable structure (dock, piling, bulkhead, etc.) that captures the full tidal range

**WHERE:** Estuarine waters along the NC coast (rivers, sounds, bays, canals, ICW, etc.)

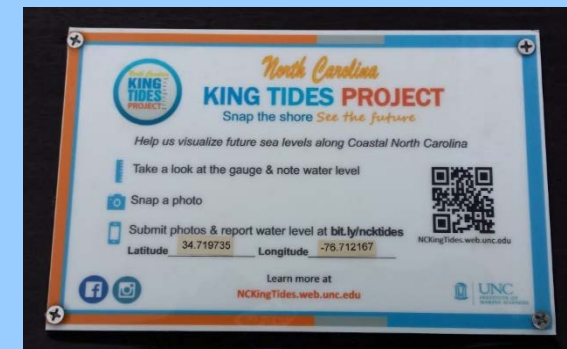
**WHEN:** Citizens collect at least one reading a week, preferably one a day



Floating Dowel



Staff





# Photo Documentation for the NC King Tide Project

- There have been over 670 entries to the *Water Level Reporter* WebApp in NC since May 2017
- These photos have documented flooding caused by hurricanes, nor'easters, king tides, wind events, prolonged rain events, etc.







# NC King Tide Water Level Gauges

20 stations installed

19 actively reporting

5 recent inquiries from public  
and private locations:

Dare County:

- Southern Shores
- NC Aquarium - Roanoke Island

New Hanover County:

- Wrightsville Beach (Banks Channel)

Brunswick County:

- Ocean Isle Beach







# Installation of NC King Tide Water Level Gauges





# NC King Tide Program Goals

- Create photographic and data records of how the NC shoreline looks today and track future changes
- Verify model predictions and support scientific research
- Gain a more holistic understanding of coastal water level patterns in North Carolina driven by tides, wind, and storms
- Spread awareness of the effects of sea-level rise and its effects on local infrastructure and communities
- Engage citizens, teachers, students, planners, town managers, etc. in an active effort to proactively plan for higher water levels and increased nuisance flooding





# Community Involvement with NC King Tide Carolina Beach, North Carolina







# Tidal Flooding along Canal Drive Carolina Beach

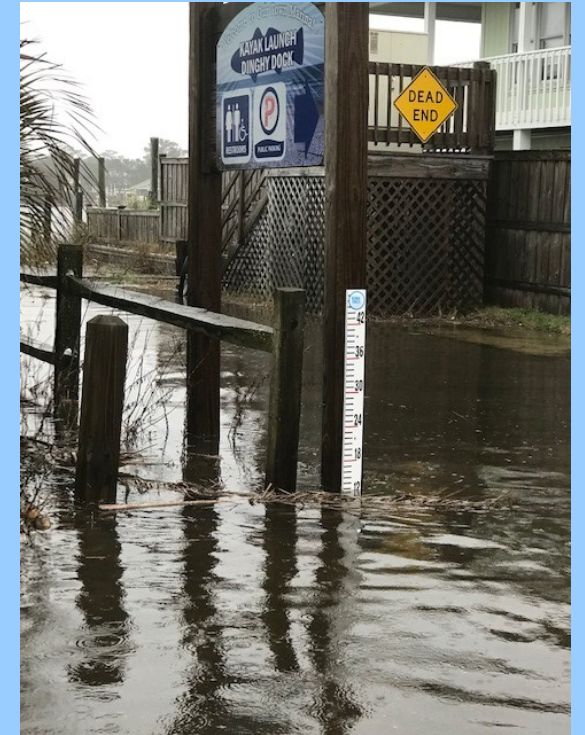






# Installation of Water Level Gauges NC King Tide Project

- Street level gauge – monitoring road flooding
- Town Marina – monitoring tidal flooding

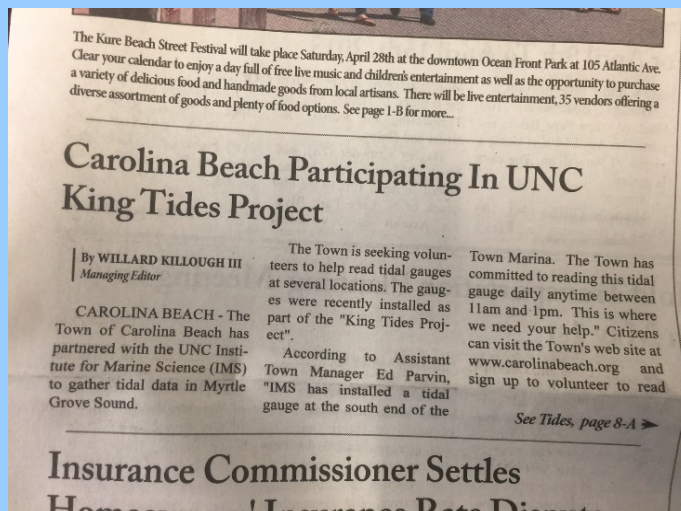






# Communication and Promotion

## NC King Tide Project



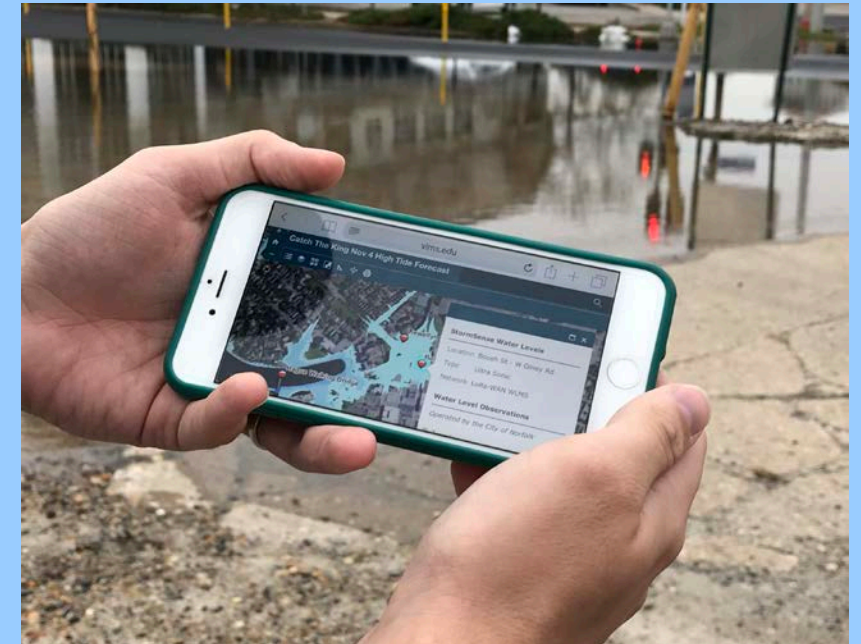


# Virginia “Catch the King Tide”



Jon Derek Loftis

Assistant Research Scientist  
Virginia Institute of Marine Science  
Gloucester Point, VA 23062






# Virginia “Catch the King Tide”



- VIMS identified **VOLUNTEERS** to assist with collecting high water data
- Conducted 35 separate volunteer training events around the Hampton Roads area
- **MEDIA PARTNERS** that assisted with promoting “Catch the King Tide”:
  - The Virginian-Pilot
  - Daily Press
  - WHRO Public Media
  - WVEC-TV
  - Commonwealth Center for Recurrent Flooding Resiliency

 <b>“Catch the King” Geospatial Participation Statistics by Locality</b> (ranked by # of GPS High Water Marks)				
<b>KING TIDE</b> <small>NOV. 5, 2017   LET'S TRACK HOW FAR IT REACHES</small>		<small>*Please note, only KT-regions designated in the Sea Level Rise App are represented in these #'s</small>		
Rank	Locality	Participants	GPS Data Points	Geotagged Pictures
1	Norfolk	156	20601	389
2	Virginia Beach	166	17040	355
3	Hampton	35	4179	67
4	York Co. / Poquoson	31	3709	84
5	Chesapeake	45	3063	105
6	Portsmouth	29	1632	63
7	Gloucester	14	1124	16
8	Newport News	16	923	29
9	Williamsburg / James City Co	4	334	12
10	Suffolk	9	249	16
11	Outside HR	5	152	2
<b>Total</b>	-	<b>510</b>	<b>53006</b>	<b>1126</b>

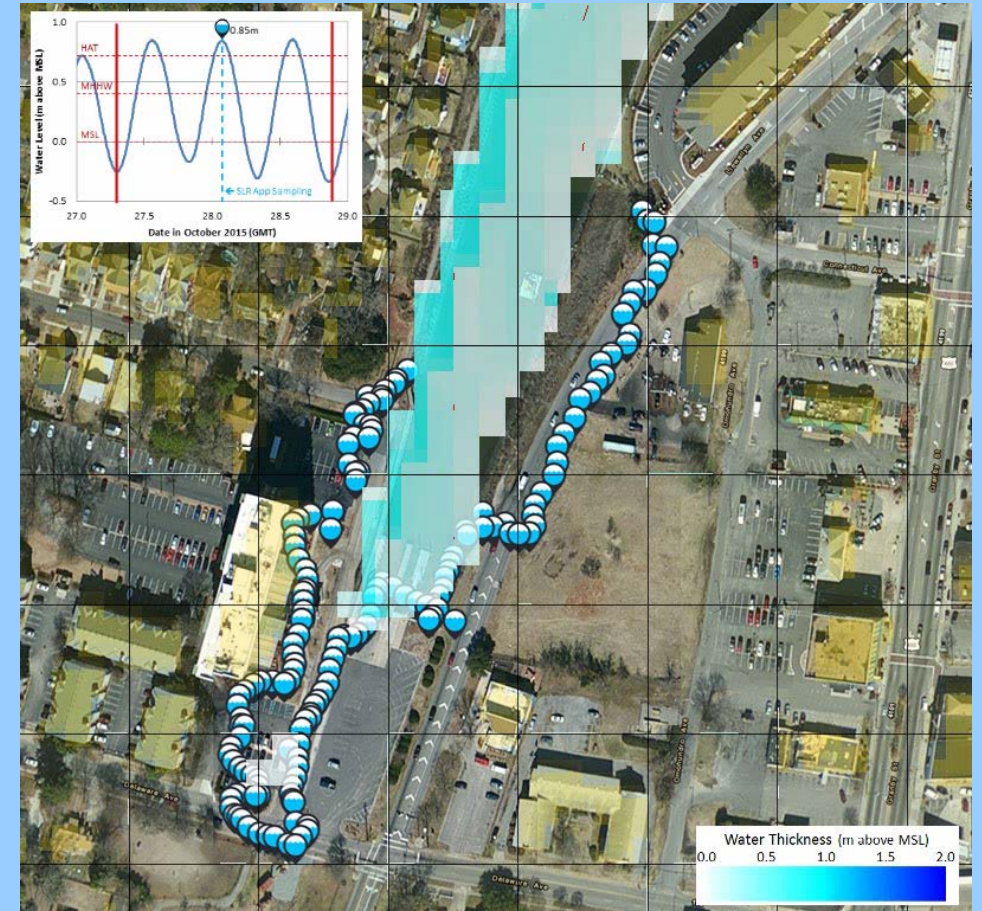




# Virginia “Catch the King Tide”

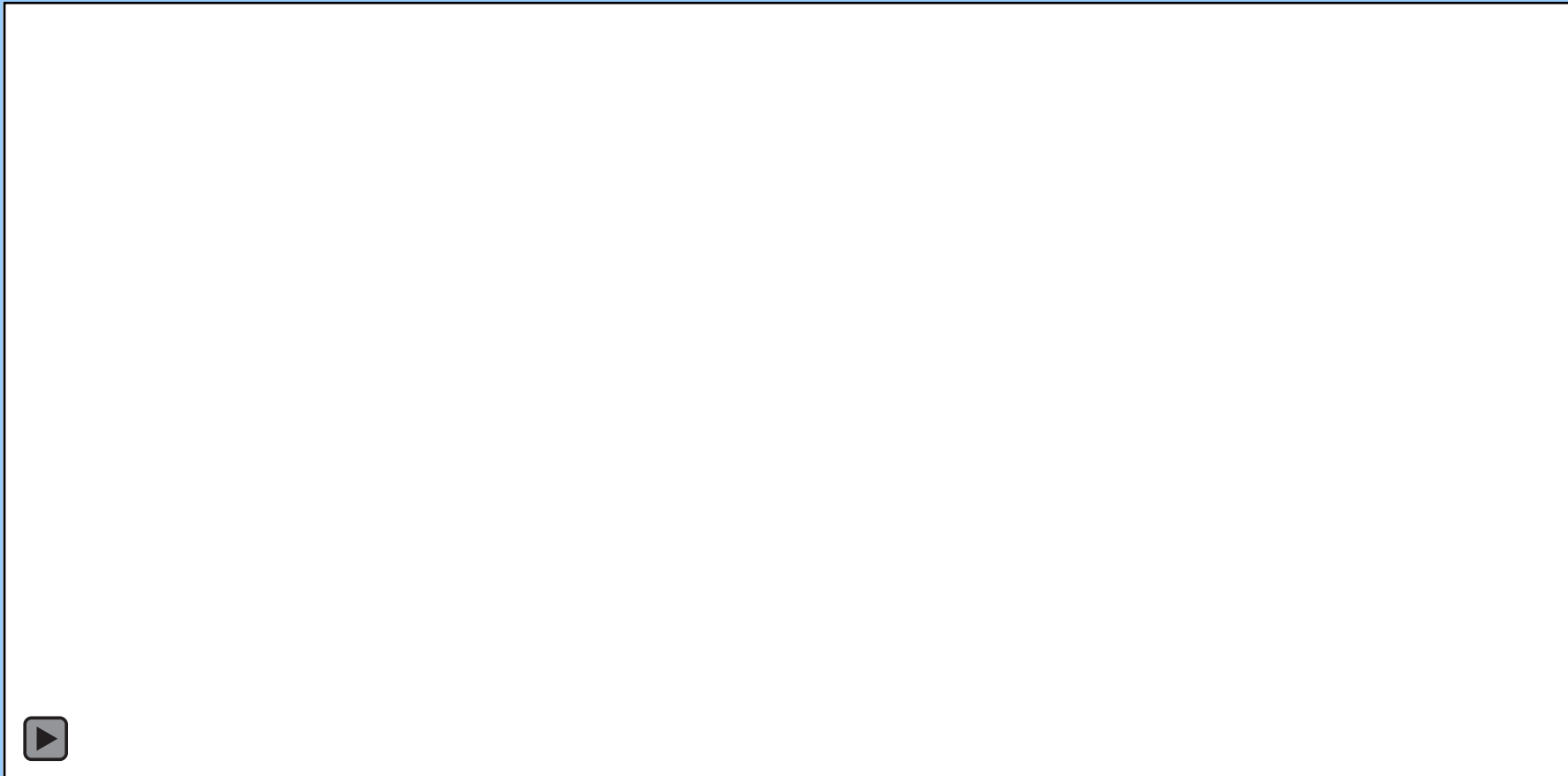


- Volunteers collect GPS data points in the SLR App to effectively “breadcrumb” or trace the high water line while walking along the water’s edge
- “Real-time” water level data collected from NOAA, USGS, VIMS, and StormSense networks
- Data could be used to validate (“ground truth”) VIMS predictive hydrodynamic models for future inundation forecasts
- Example: forecast model extents at Llewellyn Ave as compared with SLR App data collection





# Virginia “Catch the King Tide”



November 5, 2017 “Catch the King Tide” Data web map



# Virginia “Catch the King Tide”



General take-aways from the “Catch the King Tide” project:

- Tidal flooding or “blue sky” events are inundating many low-lying areas more frequently
- Crowd sourcing and ground-truthing are valuable to help validate the hydrodynamic models
- The general public can assist in better understanding tidal flooding
- Recognized by the Guinness World Records for having the **most contributions to an environmental survey** with 722 individual volunteers directly collecting 59,718 GPS-reported high water marks

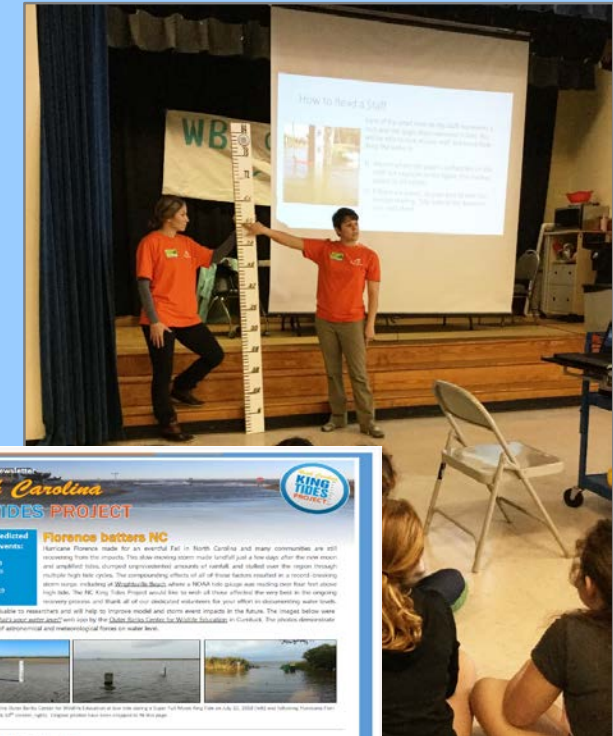






# Public Outreach and Education

- Interviews with local television and radio stations
- Presentations at local town resilience committee, planning board, and operations meetings
- Participation in K-12 educational events ([lesson plans](#))
- Informing the public of upcoming high water-level events via social media, [email list](#) and [quarterly e-newsletter](#)
- Presentation to Southeastern NC and OBX CRS Users Group meeting to potentially help reduce NFIP rates for participating communities





# King Tide Webinar

- Webinar speakers included Marygrace Rowe (UNC), Dr. Derek Loftis (VIMS), and Jeremy Hardison (Town of Carolina Beach)
- Over 60 attendees from Pennsylvania down to Florida
- Uploaded onto YouTube with 119 views ([https://youtu.be/x1M3\\_vhIr7E](https://youtu.be/x1M3_vhIr7E))
- CFMs that attended the webinar were able to receive CECs

The poster is for a webinar titled "Community Involvement in Monitoring King Tide Events". It features the "North Carolina King Tides Project" logo in the top left and right corners. The text "Webinar" is centered at the top. Below the title, a paragraph invites participants to join a webinar hosted by the NC Association of Floodplain Managers, discussing how communities can get involved with monitoring high water-level events for better flood-risk planning. The date and time are listed as "Thursday, May 10, 2018 from 1PM - 2PM EST". A section titled "Webinar speakers will include:" lists three speakers: Marygrace Rowe (Research technician at UNC's Institute of Marine Sciences), Dr. Derek Loftis (Assistant Research Professor at the Virginia Institute of Marine Science), and Jeremy Hardison (CZO, CFM - Senior Planner for the Town of Carolina Beach). Each speaker's name is followed by their title and a brief description of their role in the project. Below the speaker list, it mentions "Continuing Education Credits (CECs) available for CFMs". At the bottom, there is a call to action "Snap the shore See the future" and contact information for Dan Tomczak. The NCAFP logo is in the bottom right corner, and the Jacobs logo is in the bottom right corner of the slide.

Webinar

## Community Involvement in Monitoring King Tide Events

Please join us for a webinar hosted by the NC Association of Floodplain Managers that will discuss how communities are getting involved with monitoring high water-level events for better flood-risk planning.

**Thursday, May 10, 2018 from 1PM - 2PM EST**

Webinar speakers will include:

**Marygrace Rowe** - Research technician at UNC's Institute of Marine Sciences working on the North Carolina King Tides Project's citizen science water-level monitoring initiative  
Project Website: <http://nckingtides.web.unc.edu/>

**Dr. Derek Loftis** - Assistant Research Professor at the Virginia Institute of Marine Science on mapping flooding extents during "Catch the King" events in Hampton Roads, VA  
Project Website: <https://bit.ly/2ac57Ba>

**Jeremy Hardison, CZO, CFM** - Senior Planner for the Town of Carolina Beach; Regional Representative for NCAFP

Continuing Education Credits (CECs) available for CFMs

Snap the shore *See the future*

If you're interested in joining the webinar, please contact Dan Tomczak ([daniel.tomczak@jacobs.com](mailto:daniel.tomczak@jacobs.com)) for details

**NCAFP**  
North Carolina Association of Floodplain Managers

**JACOBS**

# Questions??

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[NCKingTides.web.unc.edu](http://NCKingTides.web.unc.edu)