

The Power of Observations for...

**...improved decision making in support
of public health and economic vitality:**

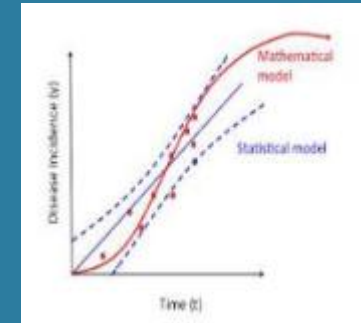
Gathering Alligators, Taking Observations, Realizing Solutions (GATORS)

Dwayne E. Porter*

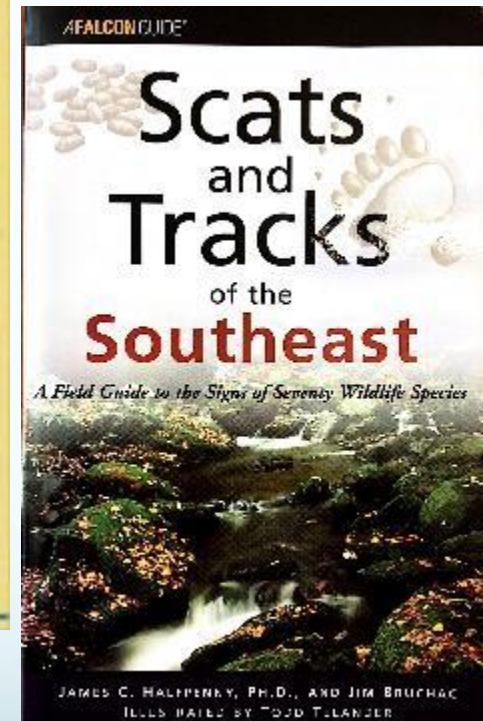
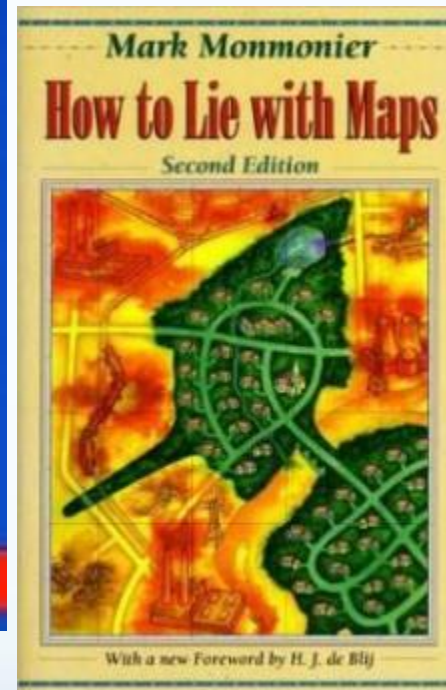
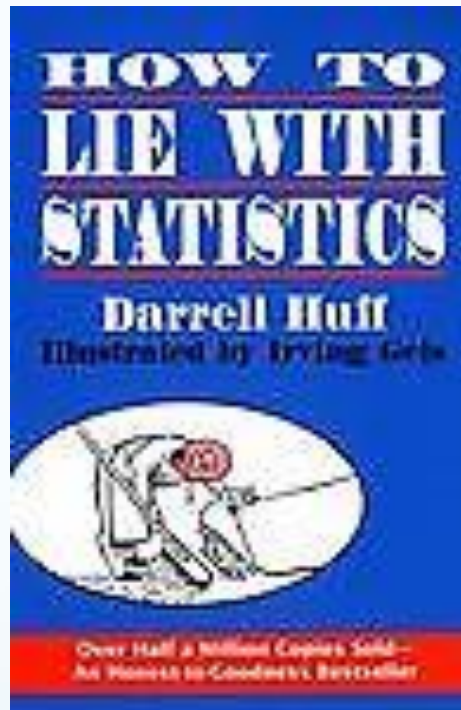
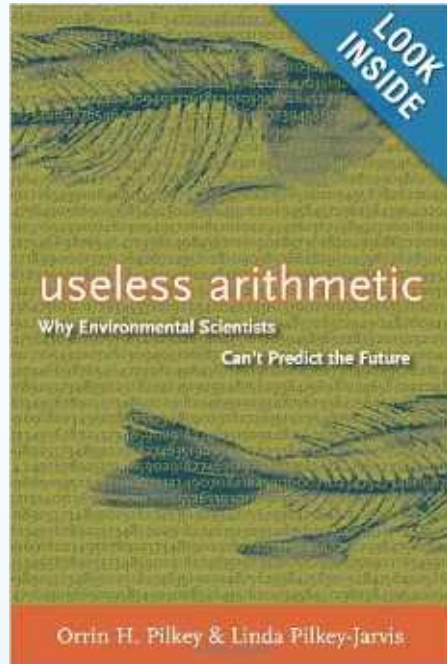
Arnold School of Public Health, University of South Carolina
and the NOAA National Estuarine Research Reserve System

*** And a host of others who actually do the work including:**

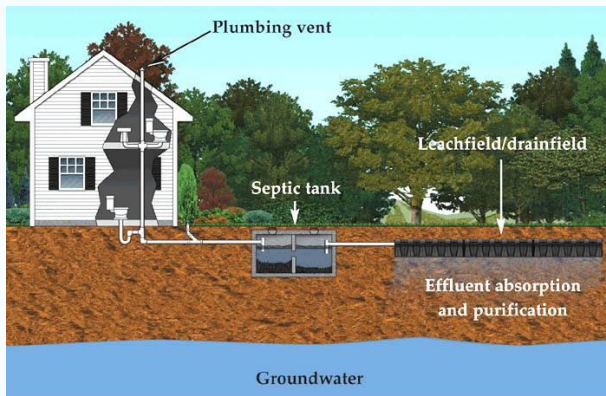




But before we begin ...



So take it all with a grain of salt...



Usual anthropogenic culprits ...



... along with farm animals, wildlife and pets ...



G A T O R S

... and some we did not realize!



GATORS



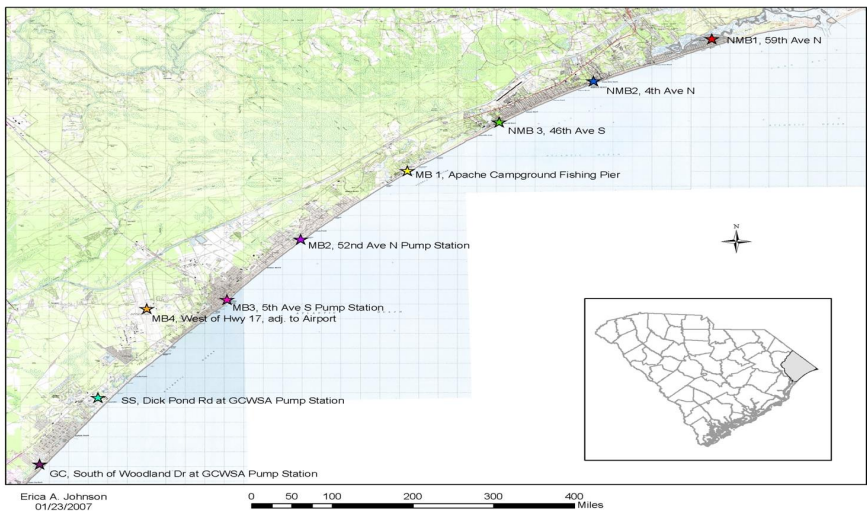
GATORS



Species	Fecal Coliform (density/g [wet wt] feces)	Source
Alligator	8.0×10^9	Johnston et al. 2010
	3.0×10^9	Current Study
	1.6×10^{10}	
Duck	3.3×10^7	Schueler and Holland, 2000
	8.1×10^3	Cox et al. 2005
Human	1.3×10^7	Schueler and Holland, 2000
	2.3×10^7	Schueler and Holland, 2000
Dog	3.1×10^7	Cox et al. 2005
	1.6×10^6	Harwood et al., 1999
Cow	2.3×10^5	Schueler and Holland, 2000
	1.8×10^5	Cox et al. 2005

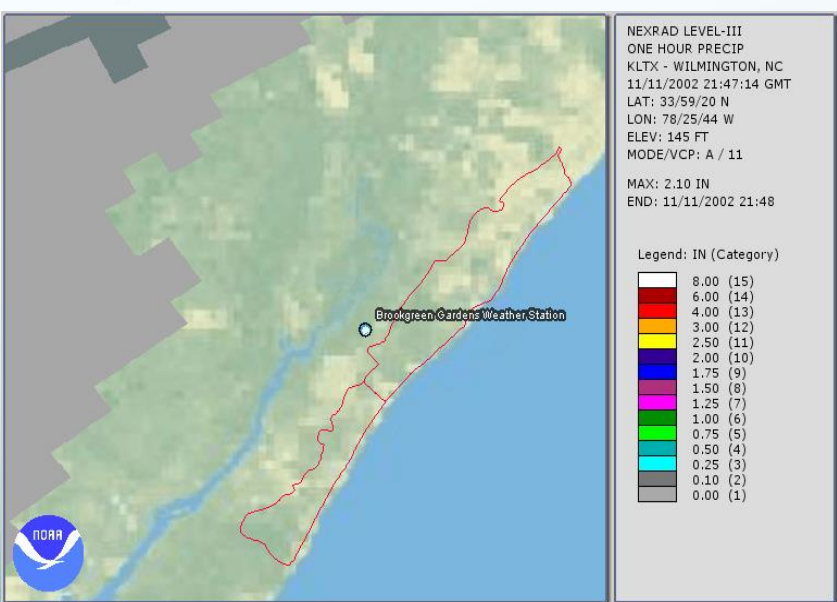
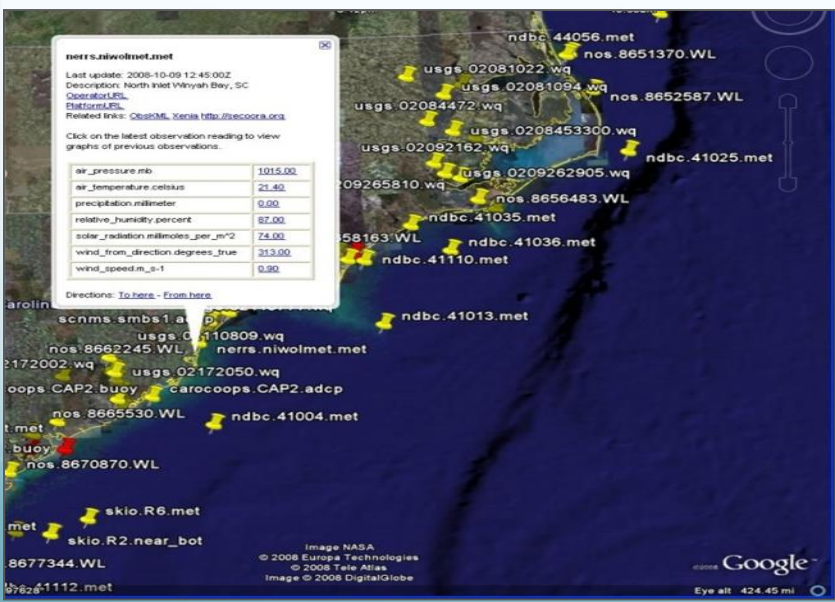
Source	Bacteria	No. Isolates	No. Isolates	Total No. of Isolates
Alligator	<i>Aeromonas hydrophila</i>	24	7	31
	<i>Aeromonas punctata</i>	1	0	1
	<i>Aeromonas veronii</i>	23	1	24
	<i>Citrobacter freundii</i>	47	45	92
	<i>E. coli</i>	21	20	41
	<i>Edwardsiella tarda</i>	0	12	12
	<i>Enterobacter aerogenes</i>	0	3	3
	<i>Enterobacter cloacae</i>	16	5	21
	<i>Klebsiella planticola</i>	3	2	5
	<i>Klebsiella pneumoniae</i>	2	8	10
	<i>Plesiomonas shigelloides</i>	64	14	78
	<i>Salmonella enterica</i>	6	1	7
	Total	207	118	325

Observations? ... Data? ...



Underwhelming!

Unknown and/or overwhelming!



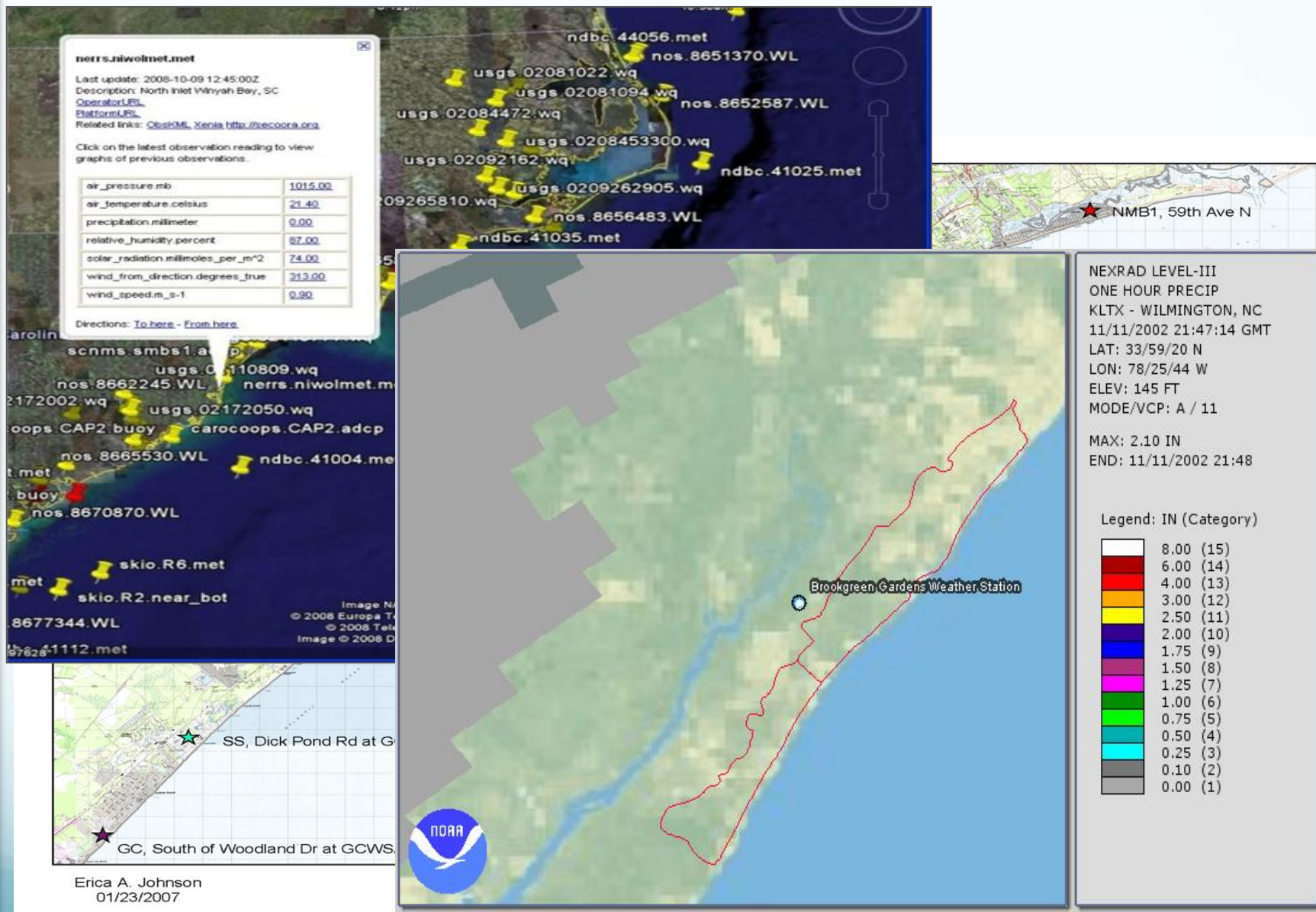
G A T O R S

Explanatory variables available from coastal real-time monitoring programs include:

- Meteorological
 - Rainfall
 - Wind
 - Weather
- Physical/Chemical
 - Current
 - Salinity
- Tidal Conditions
 - Tide Range
 - Lunar Phase

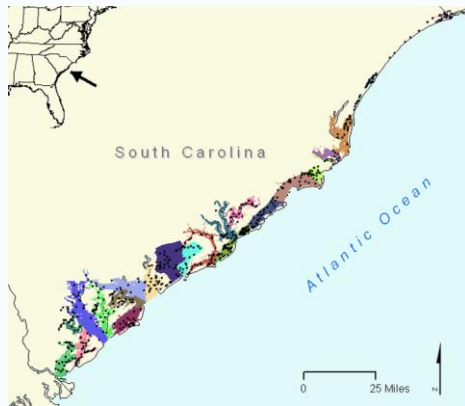


The real value is in integrating observing systems!



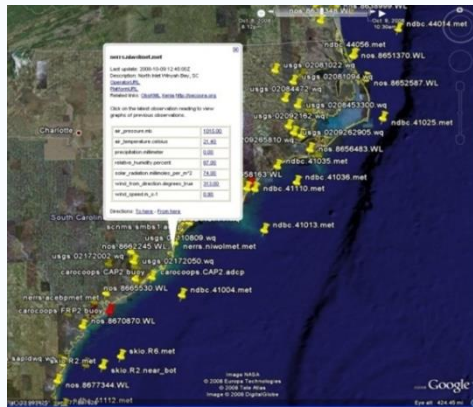
Data assimilation and integration from multiple monitoring sources including:

Field programs



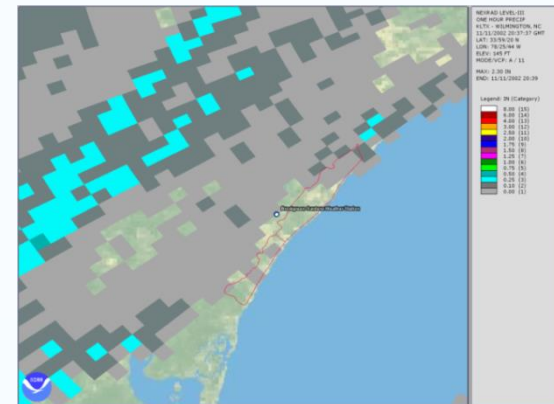
- Bacteria density
- Salinity
- Air/water temp
- Tide
- Weather

Observing systems



- Rainfall
- Currents
- Salinity
- Wind

Remote sensing / Models



- Salinity
- Air/water temp
- Rainfall
- Currents
- Wave activity

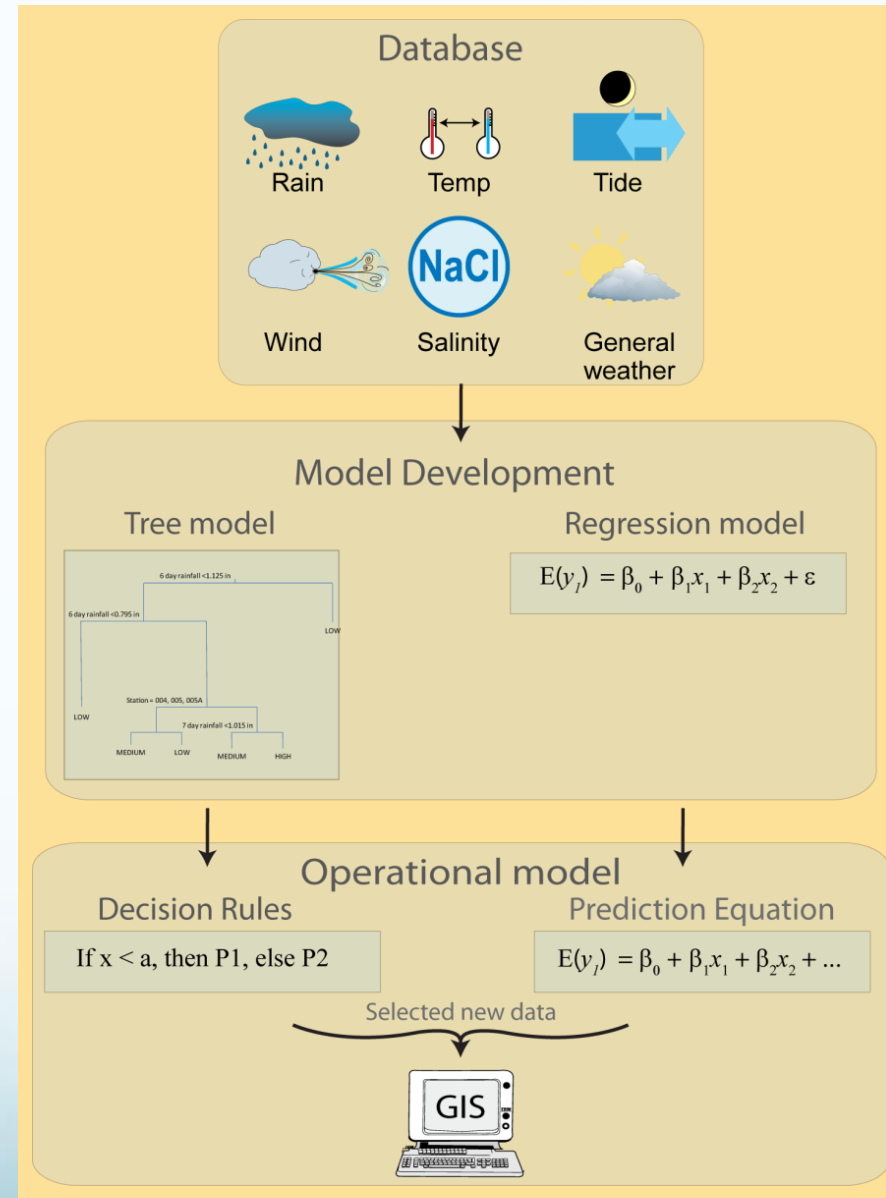
Data collection, assimilation and integration

Data assimilation  Data integration



G A T O R S

Models have to be accurate, reliable, understandable and implementable!



Partly cloudy
High 75
Low 58
DETAILS, 8B

NEWS

others 1C

May 4, 1999 © Copyright 1999, SUN PUBLISHING Co.

Officials still advise swimmers to stay out of ocean



Erika Kelly, 2, walks with her cousin Christopher Smith, 4, in tide pools along the ocean at Third Avenue South in Myrtle Beach.

People ignore warning of high bacteria

By Charlotte Le Balle
The city of Myrtle Beach, S.C., is warning swimmers to stay out of the ocean at several areas from Georgetown to Briarcliffe Acres in North Myrtle Beach.

en, Andrews and Waccamaw Neck

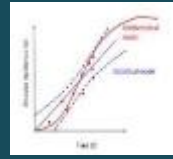
Still Only 25c

Bacteria level in surf draws DHEC warning

By Scott Harper

Last week's coastal storm did more than just soak the area. It is being blamed for high levels of bacteria in the ocean, and a warning to stay out of the surf. According to Georgetown County Communications Director Thomas Williams, the number of bacteria in the water jumped more than 6,000 times on the county's Thursday and Saturday. The South Carolina Department of Health and Environmental Control (DHEC) reported that the bacteria levels were "unusually high" and that the water was "unsafe for swimming."

According to Ron Tata, DHEC's district director, because the heavy rains followed an extended dry period, more bacteria than normal was drained into the ocean via stormwater. "The public is especially advised against swimming in the general area of storm drains," Tata said. DHEC conducted bacteria tests throughout the weekend and will lift the advisory when conditions improve.



Angeles Times

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Number of beach closures due to pollution rose last year, report says

Closures were up to their second-highest level in 20 years, the Natural Resources Defense Council study said, partly because of the Gulf of Mexico oil spill and heavy rains.



Golden Beach is one of three beaches where swimmers were being warned July 18, 2018, to stay out of the water because of high levels of fecal matter. Pedro Portal - pportal@miamiherald.com

MIAMI-DADE COUNTY

High levels of poop lead to swimming advisory at three South Florida beaches

BY CARLI TEPROFF
cteproff@miamiherald.com

July 18, 2018 07:15 PM
Updated July 18, 2018 07:23 PM

The Florida Department of Health in Miami-Dade County is warning people to think twice before swimming at three South Florida Beaches — Golden Beach, Crandon Beach North and Crandon Beach South.

That's because water samples show that there's too much fecal matter.

CAUTION

A SWIMMING ADVISORY HAS BEEN ISSUED FOR THIS SECTION OF THE BEACH BY THE SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL. HIGH BACTERIA LEVELS HAVE BEEN DETECTED IN THIS BEACH AREA AND

SWIMMING IS NOT ADVISED

UNTIL BACTERIA LEVELS RETURN TO NORMAL. WADING, FISHING, AND SHELL COLLECTING DO NOT PRESENT A RISK.



FOR INFORMATION ABOUT THIS ADVISORY CONTACT YOUR LOCAL DHEC EQC OFFICE OR CALL (803) 898-4015

CAUTION: WATER QUALITY ADVISORY



FOR YOUR SAFETY

- Swim at your own risk
- Do not ingest lake water
- Shower after swimming
- Wash hands before eating
- Do not swim if you are ill

*Increased risk of illness may be present
Based on recent monitoring for E. coli bacteria*

FOR MORE INFORMATION:

1-800-441-4636 ext. 1500

www.wibeaches.us

SWIMMING ADVISORY

BEACH
CLOSED

CAUTION

Xin Luru Ý! CUIDADO 小心

NO SWIMMING

NO WADING

Cấm Bơi Prohibido Nadar 不許游泳

Cấm Lội Prohibido Bañarse 不許涉水



A health advisory has been posted based on monitoring results. The current conditions at this beach are not suitable for recreational water activities. Small children and chronically ill people are at higher risk for increased illness.

360-407-6543 or the Web at: www.doh.wa.gov/beach

GATORS



- Clean swimming waters –
- Mom and dad happy!
 - Chambers of Commerce happy!

Exposure to bacterial-laden swimming waters –

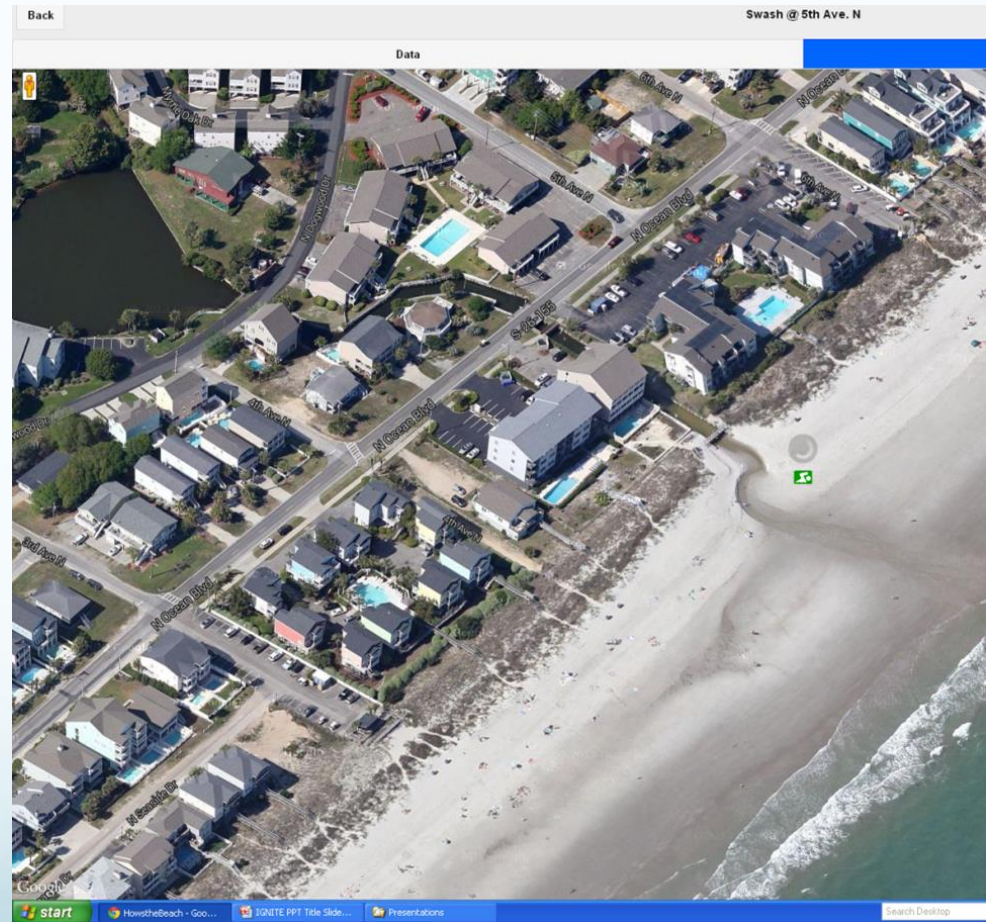
- ~~Mom and dad happy!~~
- ~~Chambers of Commerce happy!~~

Tain't no one happy!!!



In response to water quality concerns and associated public health concerns

- State health agency routinely (weekly, post rain event, repeat) samples water quality at ocean beaches
- Results used to inform public of potential health risk



Swimming advisories are issued if *Enterococcus* levels

- >500 MPN/100mL
 - Issue advisory
- >104 MPN/100mL
 - Resample

So ... today's advisory is based on yesterday's water quality!

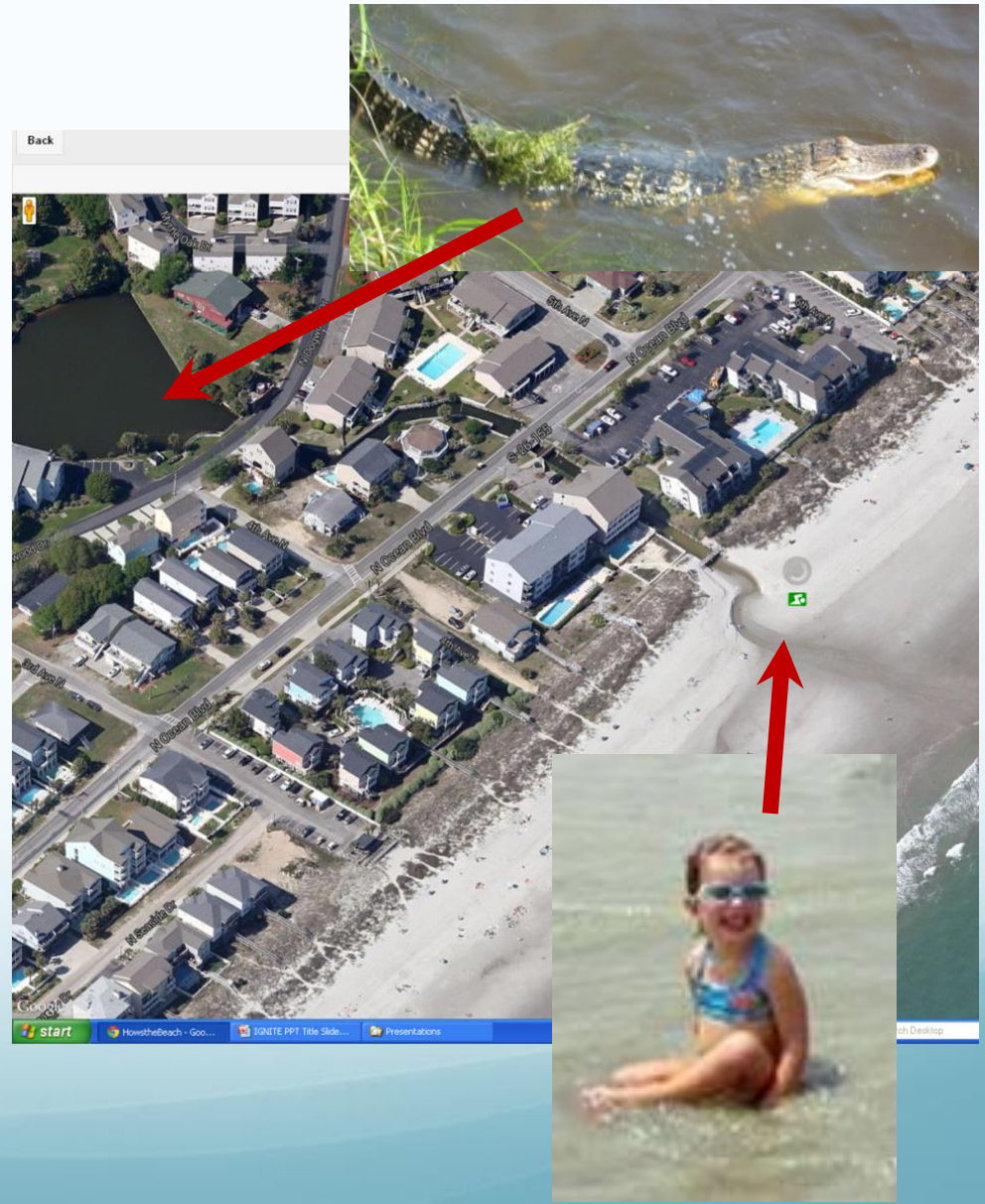
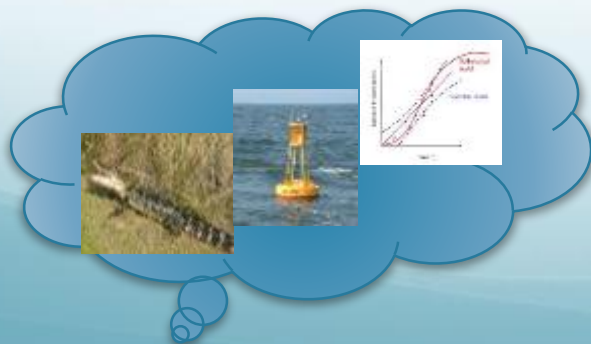


CAUTION
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SWIMMING IS NOT ADVISED
UNTIL BACTERIA LEVELS RETURN TO NORMAL. WADING, FISHING, AND SHELL COLLECTING DO NOT PRESENT A RISK.
FOR INFORMATION ABOUT THIS ADVISORY CONTACT YOUR LOCAL REGION 7 DHEC EQC OFFICE AT (843) 953-6150 OR CALL (803) 898-3541.

PRECAUCIÓN
UN AVISO SOBRE NADAR EN ESTA SECCIÓN DE LA PLAYA HA SIDO HECHO PÚBLICO POR EL DEPARTAMENTO DE SALUD Y CONTROL AMBIENTAL DE CAROLINA DEL SUR. ALTOS NIVELES DE BACTERIAS HAN SIDO DETECTADOS EN ESTA ÁREA DE LA PLAYA Y
NO SE ACONSEJA NADAR
HASTA QUE LOS NIVELES DE LA BACTERIA VUELVAN A LA NORMALIDAD. NO PRESENTA UN RIESGO EL CAMINAR, PESCAR Y RECOLECTAR CONCHAS.
PARA MÁS INFORMACIÓN SOBRE ESTE AVISO CONTACTE A LA OFICINA LOCAL DE LA REGIÓN 7 DE DHEC EQC AL (843) 953-6150 O AL (803) 898-3541.

A potential improvement offered up to public health officials was that

- Bacterial levels can be predicted with an accuracy adequate to assist decision-makers in the preemptive advisory process










Bacterial levels are driven by multiple inputs and varied forcing functions



LOADING

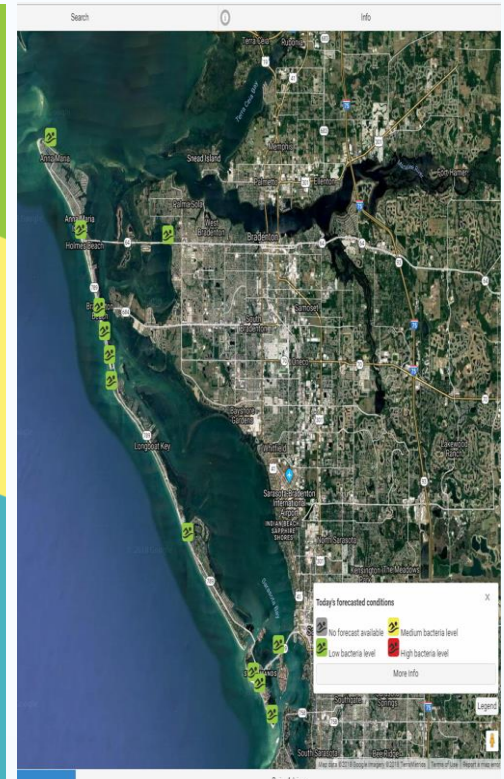
-  Precipitation
-  Animal waste
-  Fertilizer application
-  Bacterial input
-  Failed septic systems

SURVIVABILITY

-  Sedimentation
-  Solar inactivation
-  Temperature
-  Tidal flushing
-  Salinity
-  Wind
-  Deposition/resuspension

Building on (student) efforts supported by state beach, shellfish and public health managers, NOAA (SECOORA / IOOS) and EPA, new models from integrated data and simple statistical techniques include:

- Multiple Linear Regression (MLR)
- Classification and Regression Trees (CART)
- Ensemble Modeling integrated with EPA's VB





Office of Water
EPA 823 R 18 001
May 2018

2017 Five-Year Review of the 2012 Recreational Water Quality Criteria



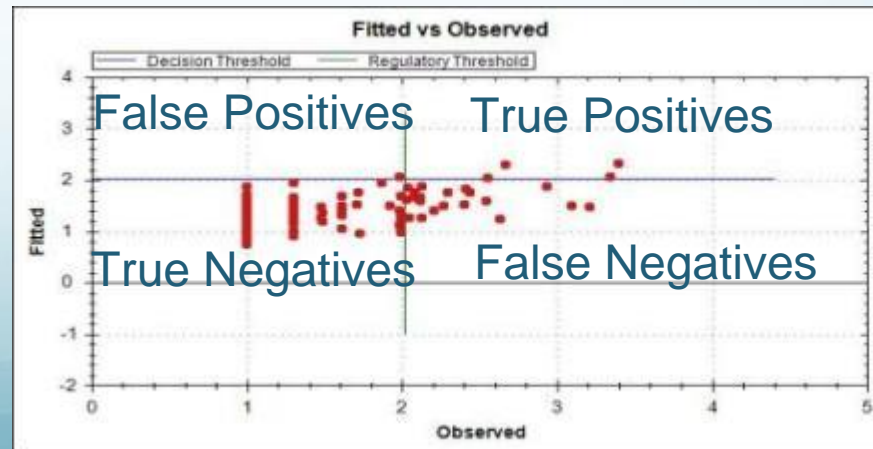
U.S. Environmental Protection Agency
Office of Water Office of Science and Technology
Washington, D.C.

G A T O R S

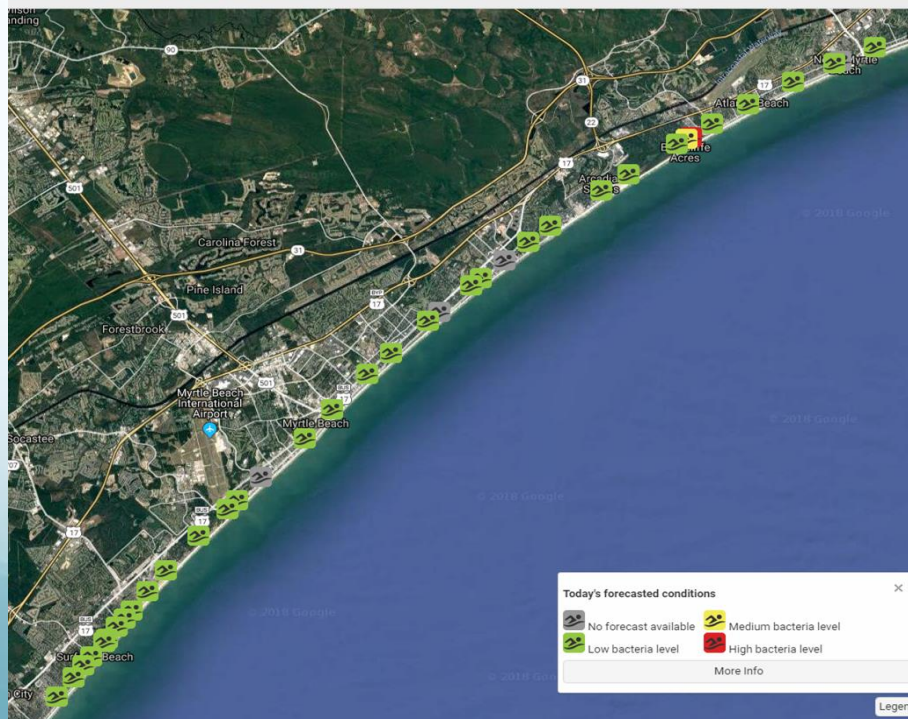
Model complexity is dependent upon

- Location
- Availability of data
- Acceptable error
- **Errors of omission**
 - Fail to issue advisory when water quality is poor
 - Public health risk
- **Errors of commission**
 - Issue advisory when water quality is good
 - Poor image / revenue loss (i.e. the Chamber of Commerce is not happy)

Level 1	Level 2	Level 3
Cumulative Rainfall Rain Intensity Preceding Dry Days Weather Tidal Range Lunar Phase Station	Cumulative Rainfall Rain Intensity Preceding Dry Days Weather Tidal Range Lunar Phase Station Wind Speed Wind Direction	Cumulative Rainfall Rain Intensity Preceding Dry Days Weather Tidal Range Lunar Phase Station Wind Speed Wind Direction Current Salinity

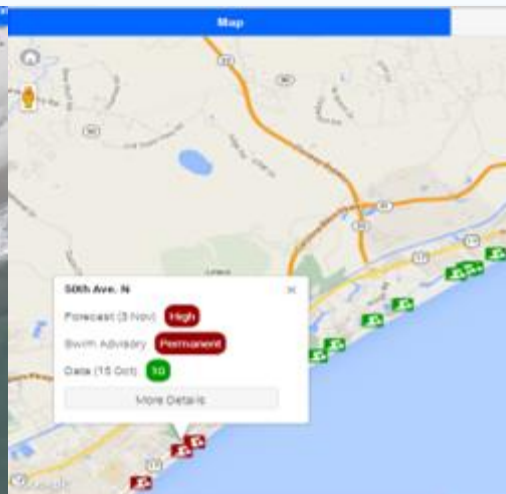
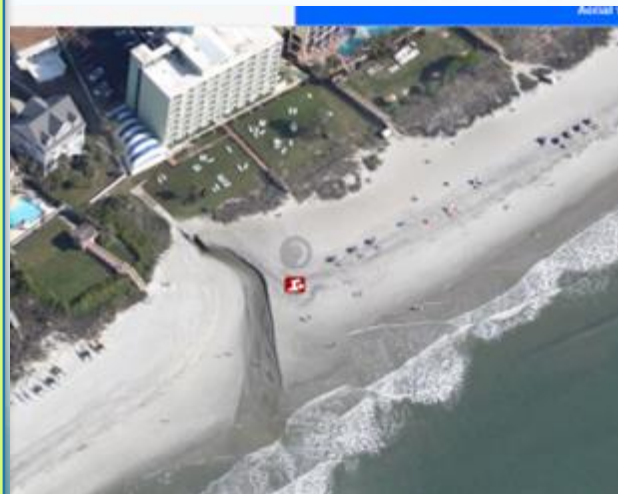
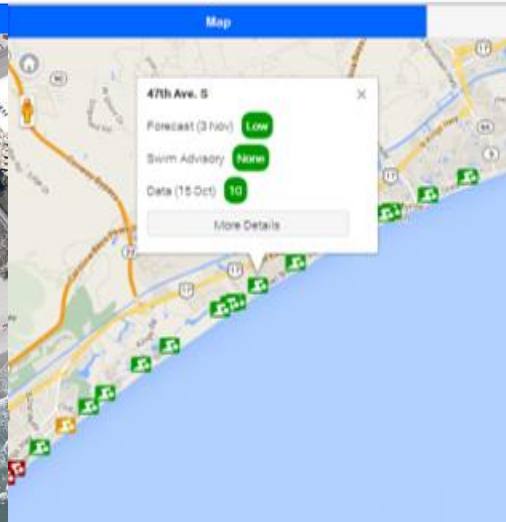
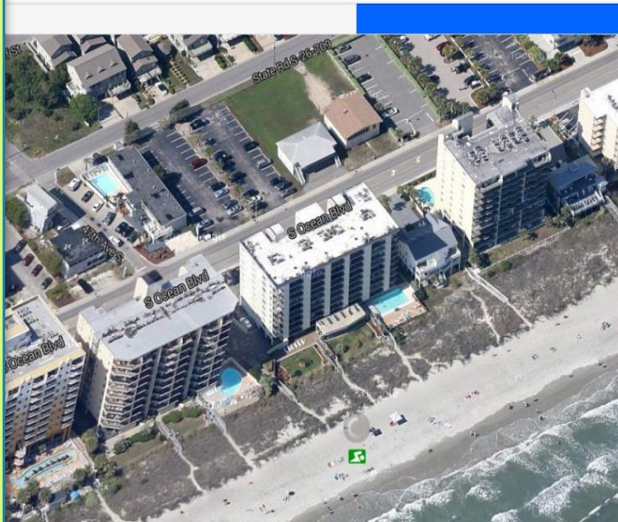


GATOR



End result is a decision-support tool available at your fingertips for public health, economic and personal decision making resulting in...

... a win – win situation for *public health* and *economic vitality*!



GATORS

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