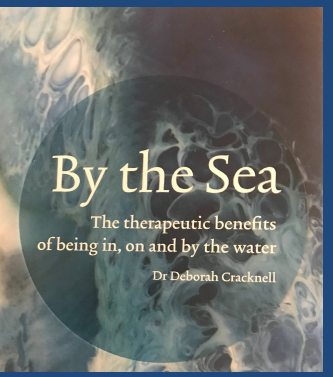
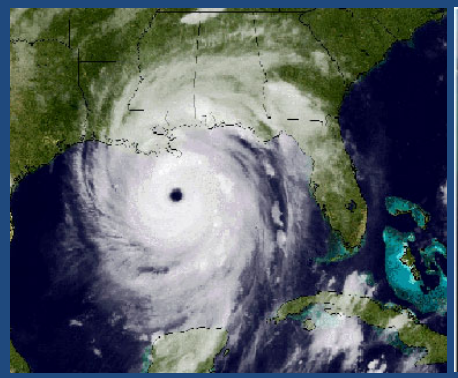
Getting Ahead of the Curve:
Augmenting Coastal Ocean Observing Systems to Better Enable Predictions of Coastal Health Threats and Benefits

Paul A. Sandifer, Ph.D.



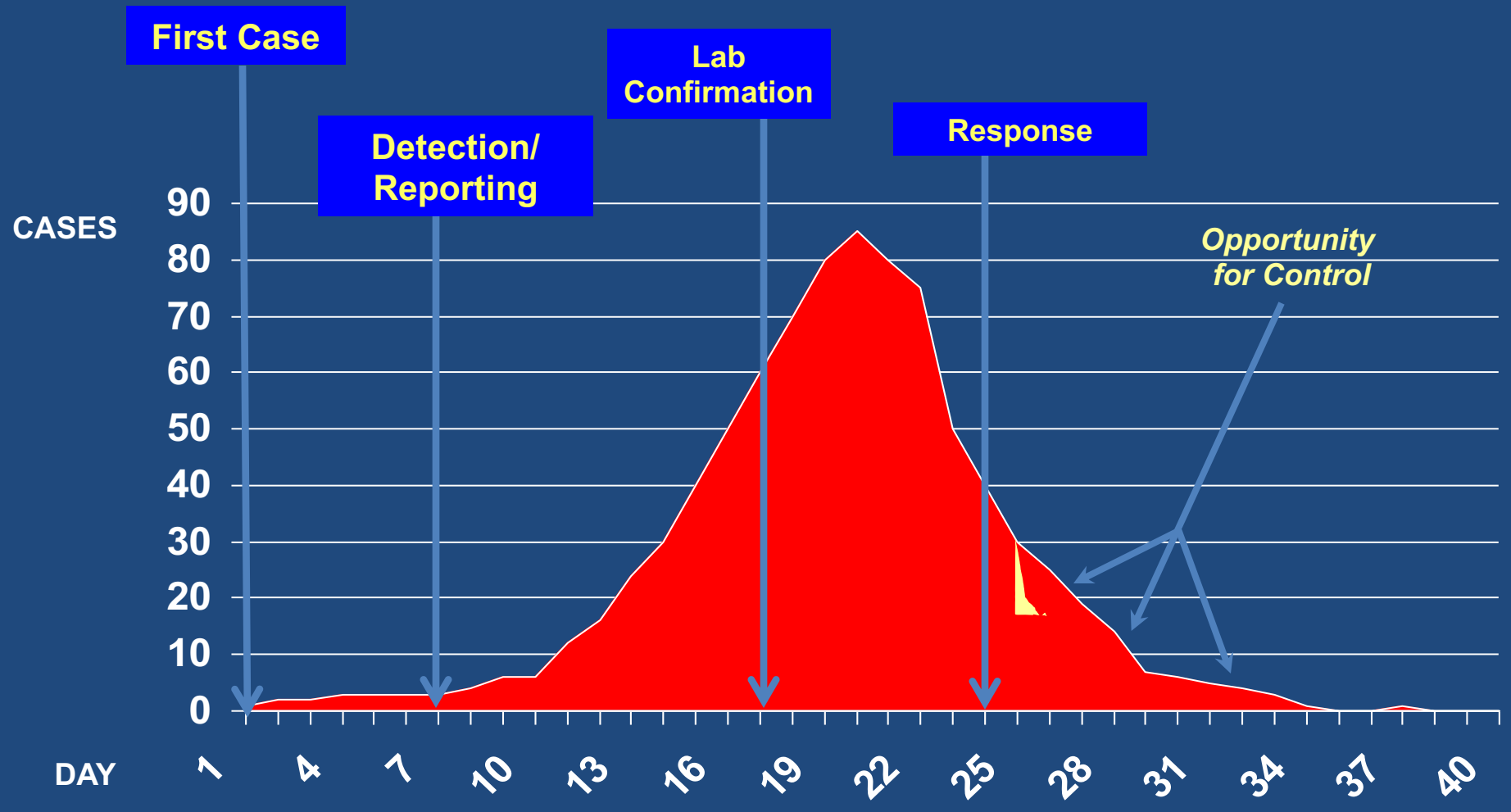



My Two Hats


1770
COLLEGE of CHARLESTON
CENTER FOR COASTAL
ENVIRONMENTAL & HUMAN HEALTH

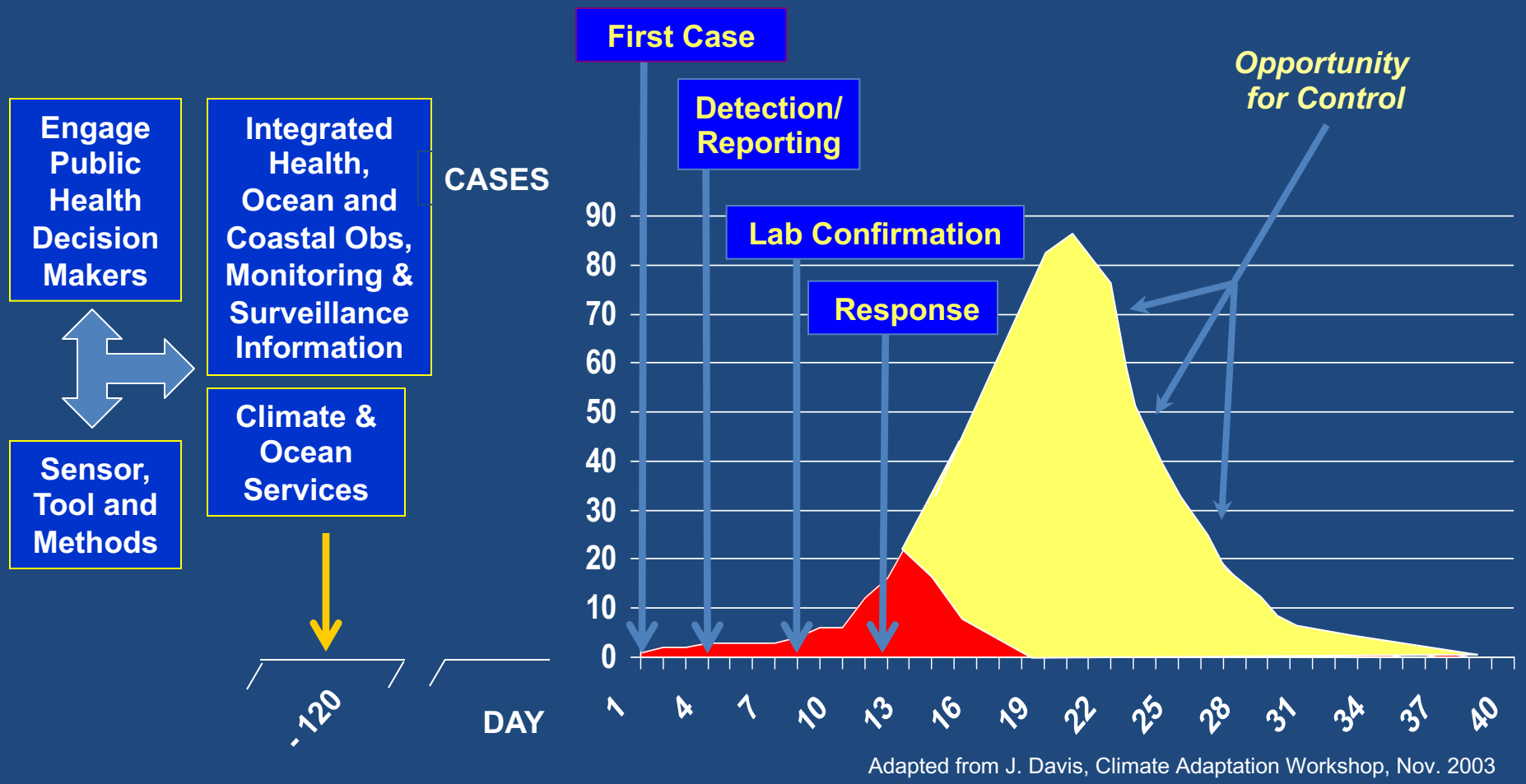

OHC2I
NIEHS Center for Oceans and Human Health and
Climate Change Interactions at the University of SC

Current Epidemic Detection and Response Curve



Adapted from J. Davis, Climate Adaptation Workshop, Nov. 2003

Getting ahead of the Curve: Integrating Ocean, Climate and Public Health Information



Adapted from J. Davis, Climate Adaptation Workshop, Nov. 2003

Enhancing Public Health Engagement, Outreach, and Feedback throughout

Fleming et al. 2019. Fostering human health through ocean sustainability in the 21st century. People and Nature. DOI: 10.1092/pan3.10038.

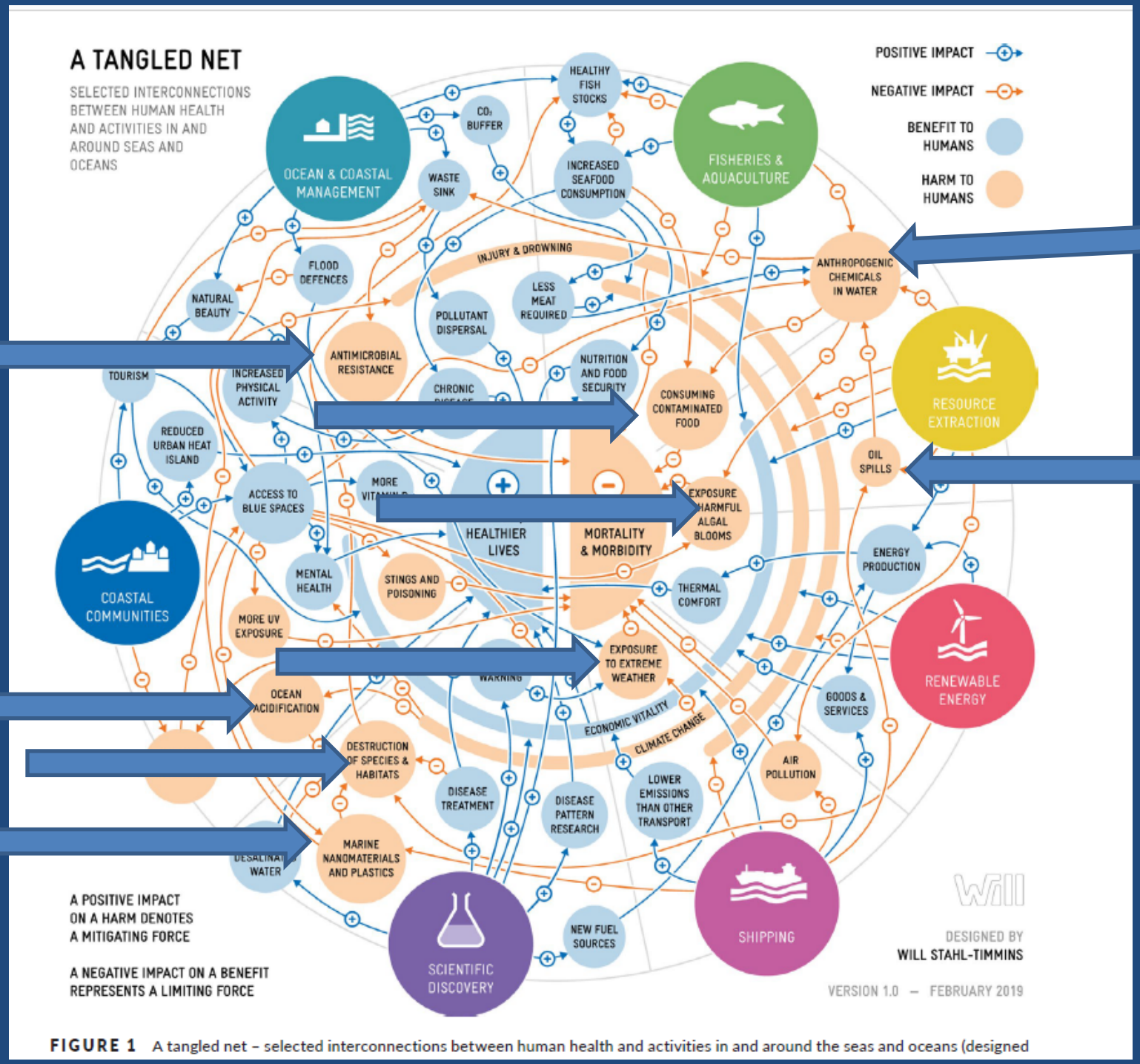
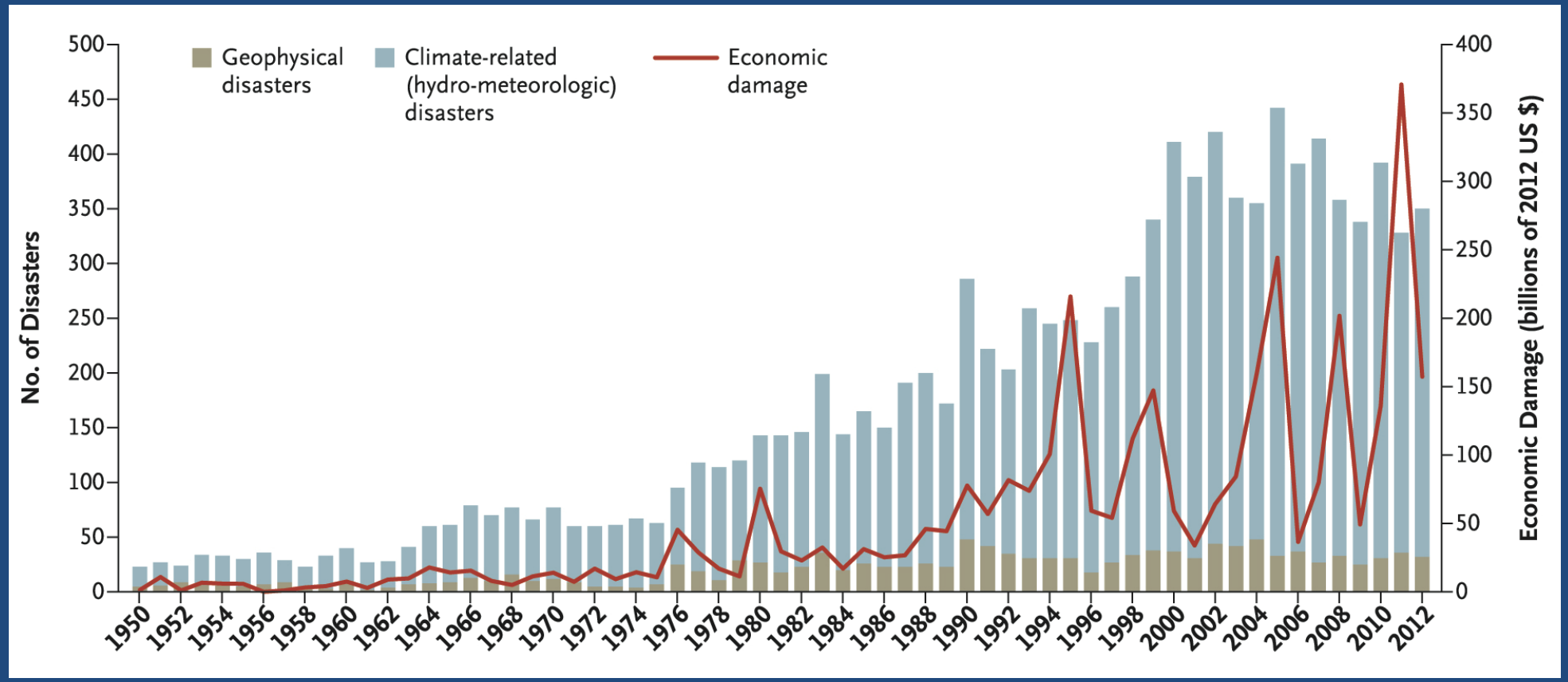


FIGURE 1 A tangled net – selected interconnections between human health and activities in and around the seas and oceans (designed

Source: World Economic Forum Global Risks Perception Survey, 2018-2019. WEF. 2019

Numbers and Types of Natural Disasters, 1950-2012



(From Learning & Guha-Sapir, 2013 with permission)

Recent US Disaster History (Selected Chapters)

1980-2018: 230 > $1B climate/weather disasters

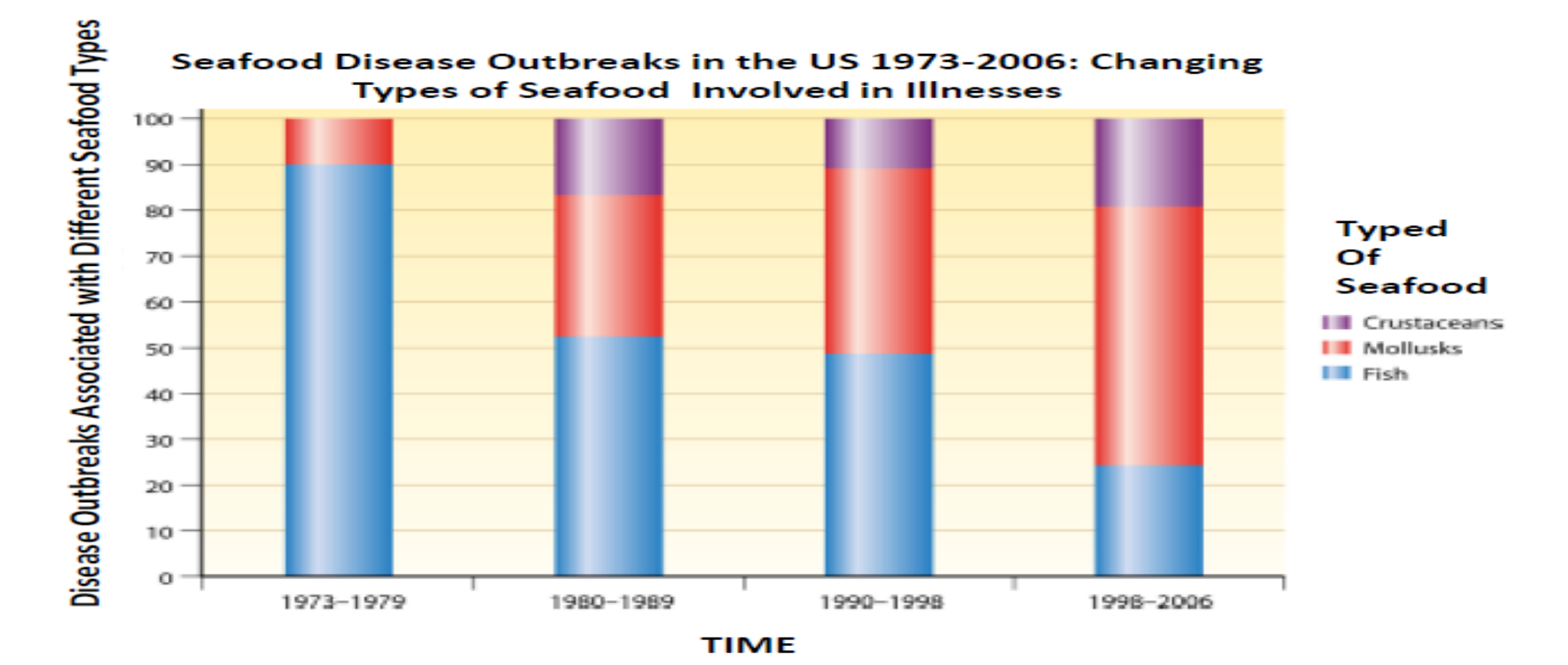
2005: ~$160 B in disaster costs, $85B from Hurricane Katrina alone

2010: ~$62 B from the Deepwater Horizon catastrophe

2012: ~$110B including Hurricane Sandy

2017: ~$306 B from 16 >$1B events, including Hurricanes Harvey, Irma and Maria

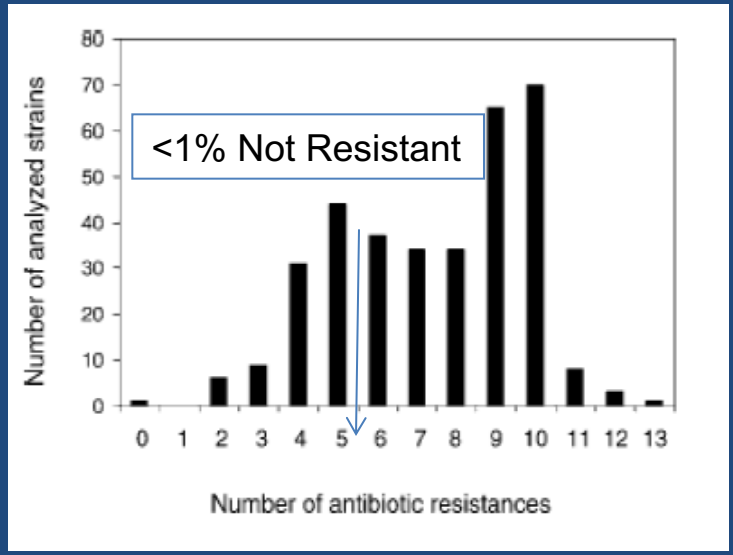
Changing Nature of Seafood Illness in the US: 1973-2006



Microbiology

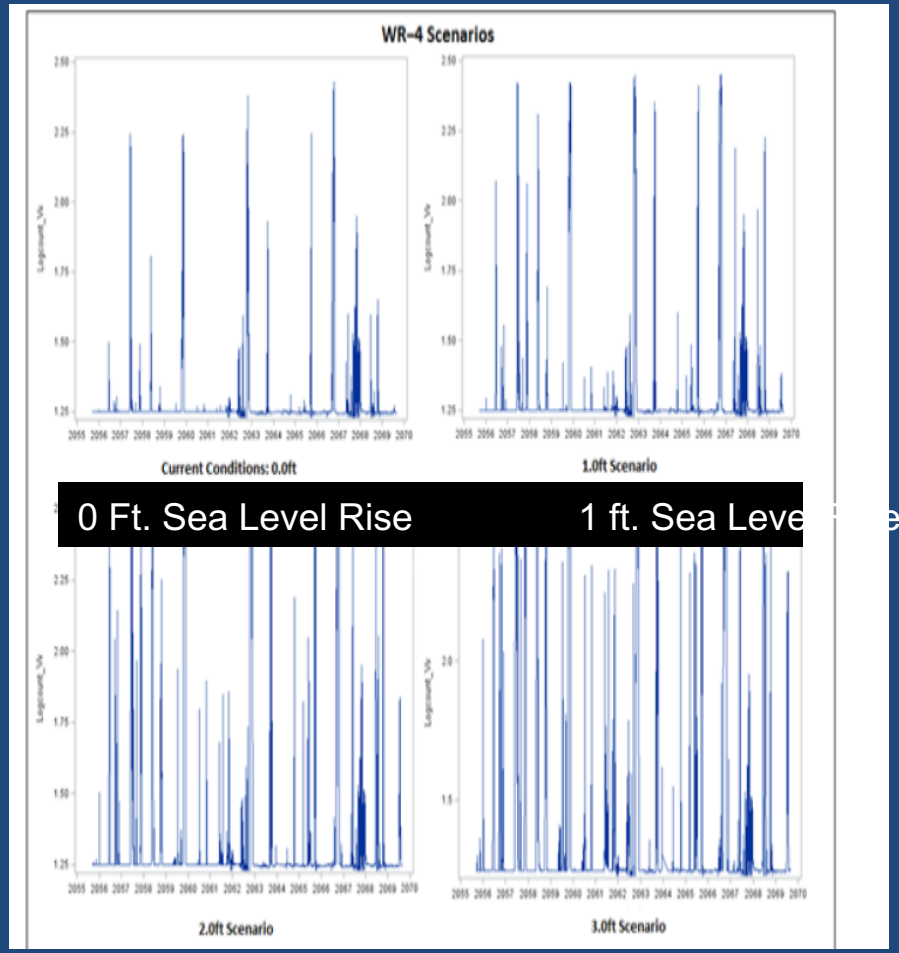
- **Vibrio Bacteria** – Leading Cause of illness/mortality in seafood & wound infections- highly antibiotic resistance -Multi Factorial Experiments → Forecasts

 # Of Vp In SC



Number of Antibiotics

Vibrio Forecasting SC Coast



0 Ft. Sea Level Rise

1 ft. Sea Leve

2 Ft. Sea Level Rise

3 Ft. Sea Level Rise

250% Increase in Optimum Growth by 2050

Cost of Water Recreation Related Illnesses
=
$2.9 Billion per Year in the USA

90 million cases of **gastrointestinal, respiratory, ear, eye and skin-related illnesses per year** in the U.S. are associated to **swimming, paddling, boating and fishing**

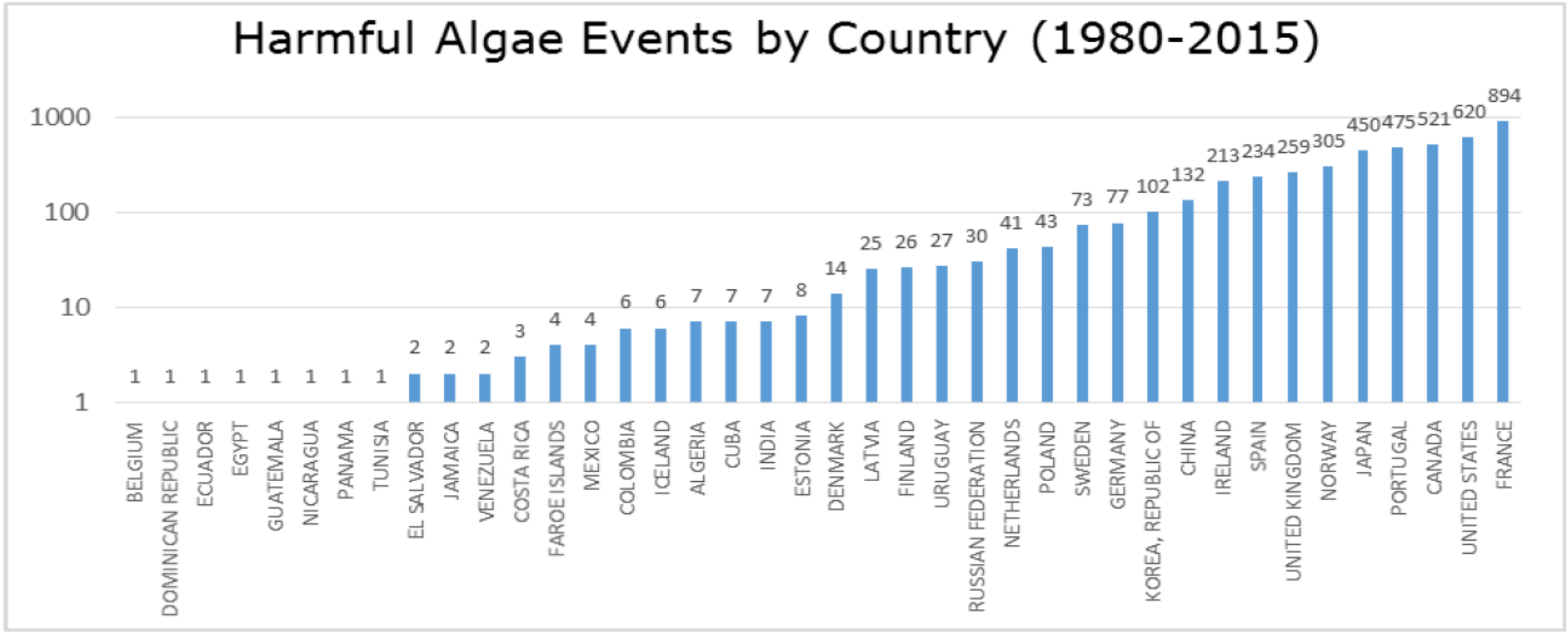
The cost for recreational water related illness
per case **$9.5** to **$303,000**
(**mild illness** to **the most severe illnesses**)

Only **$10 million** per year allocated for beach protection

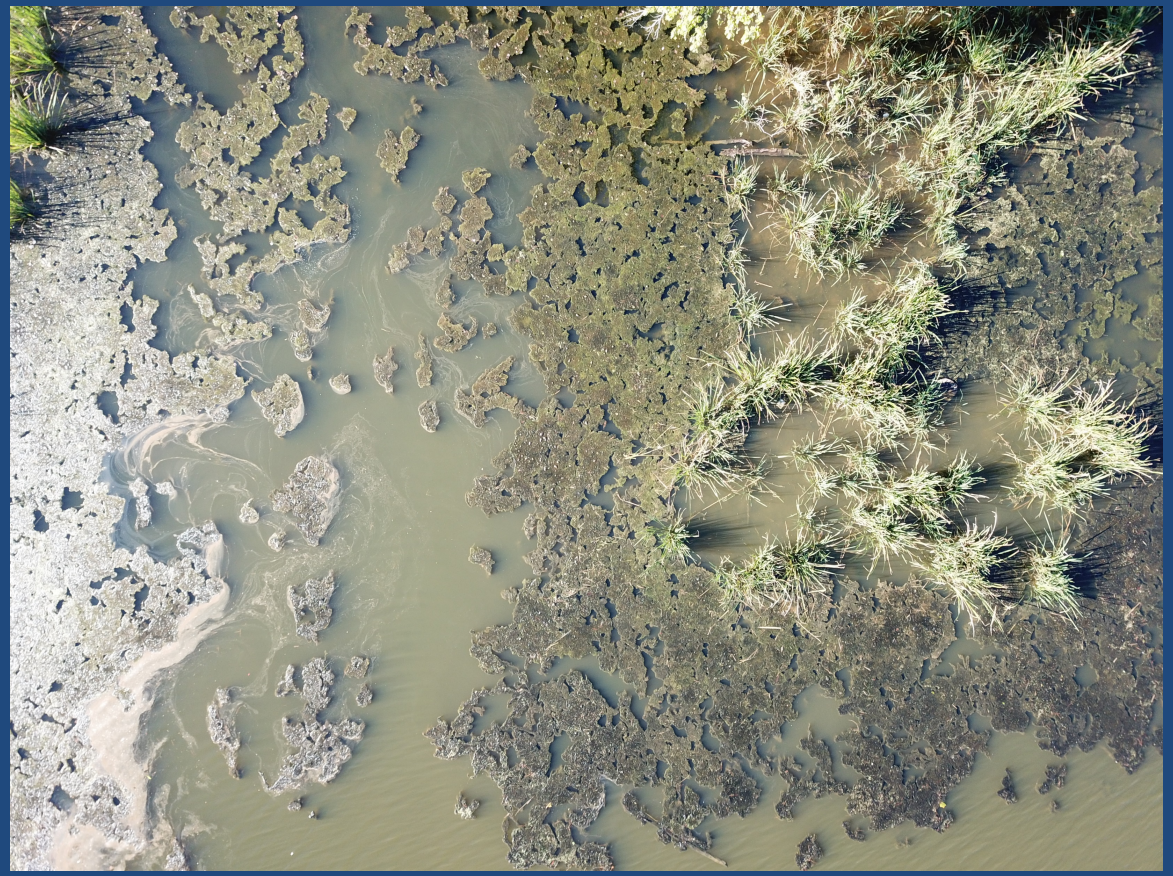
https://today.uic.edu/illnesses-caused-by-recreation-on-the-water-costs-2-9-billion-annually-in-the-us

Source: DeFlorio-Barker et al. 2018

Harmful Algal Events Dataset (HAEDAT)



Freshwater HABs



In This Issue:

ET&C FOCUS

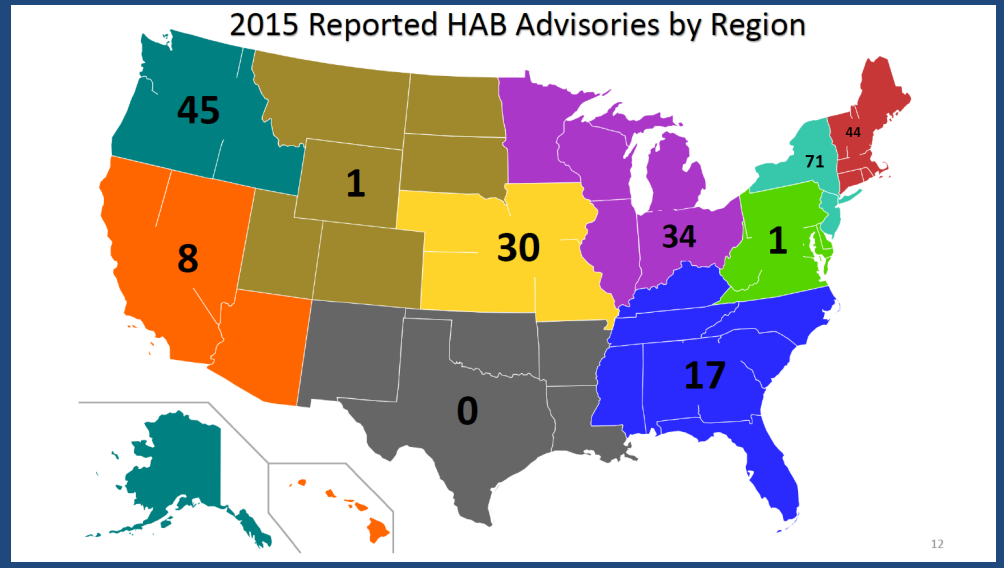
Focus articles are part of a regular series intended to sharpen understanding of current and emerging topics of interest to the scientific community.

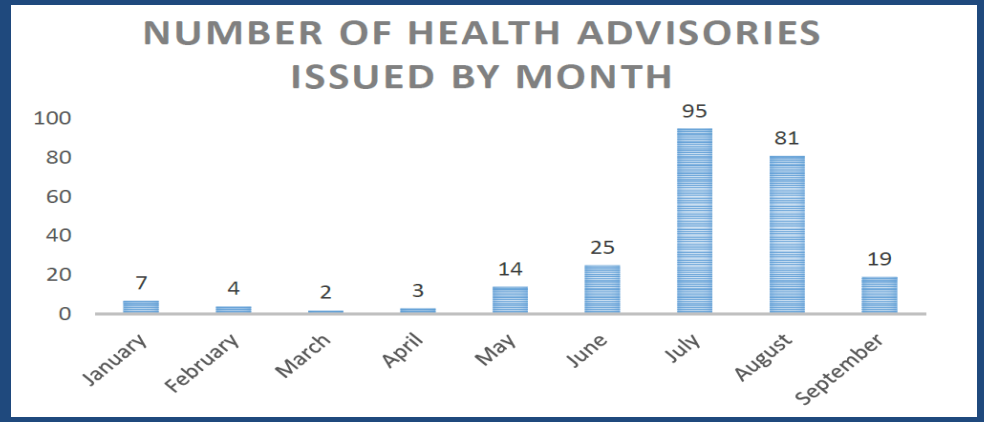
Are Harmful Algal Blooms Becoming the Greatest Inland Water Quality Threat to Public Health and Aquatic Ecosystems?

Bryan W. Brooks,*† James M. Lazorchak,‡ Meredith D.A. Howard,§ Mari-Vaughn V. Johnson,‖ Steve L. Morton,# Dawn A.K. Perkins,†† Euan D. Reavie,‡‡ Geoffrey I. Scott,§§ Stephanie A. Smith,‖‖ and Jeffery A. Steevens##

Toxin	Water Type				
	Fresh	Brackish	Marine	Unknown	Total (%)
Anatoxin	243	2	0	1	246 (7)
Azaspiracid	0	0	1	0	1 (<1)
Brevetoxoins	0	3	0	0	3 (<1)
Cylindrospermopsin	4	0	0	0	4 (<1)
Domoic Acid	0	0	31	0	31 (1)
Karlotoxins	0	3	1	0	4 (<1)
Microcytins Total	2629	35	2	10	2676 (81)
Microcytsin LR	21	0	0	0	21 (1)
Okadaic Acid	1	2	0	0	3 (<1)
Saxitoxins	296	1	11	3	311 (9)
Unidentified Toxin	0	1	0	0	1 (<1)
Total	3194	47	46	14	3301

96.7% of HABs occur in Freshwater



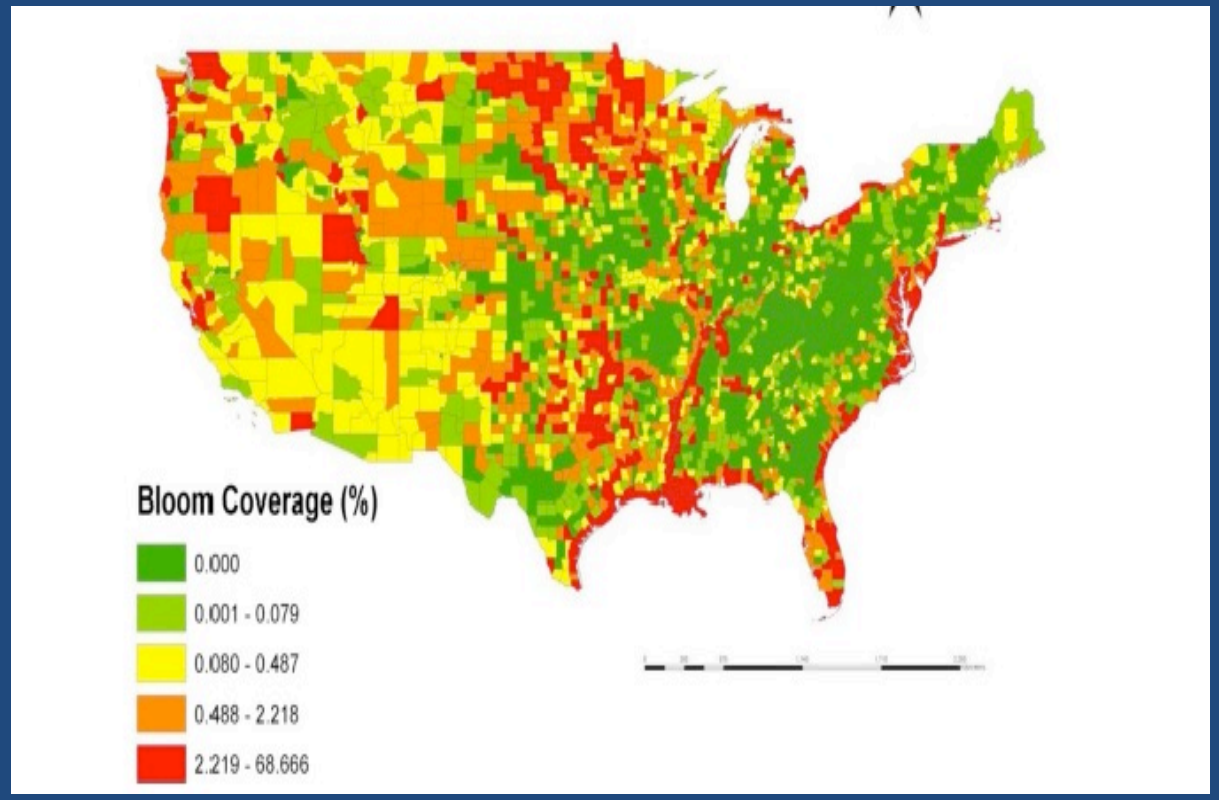


(Sources: Brooks et al. 2015. ETC; Ravencroft, J. 2016. Update on Development of Recreational WQC for Cyanotoxins. EPA Office of Water)

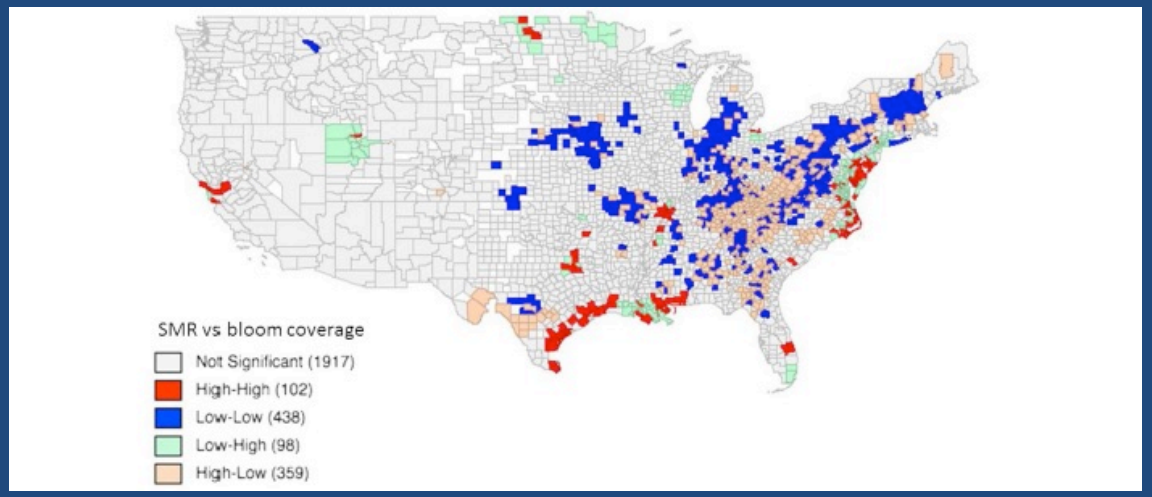
Correlation Between CHAB Blooms and Non-Alcoholic Fatty Liver Disease

(61% of US Counties Have CHABs and for Every 1% increase in CHABs Results in a 0.3% Increase in Non-Alcoholic Fatty Liver Disease)

CHAB Bloom Coverage

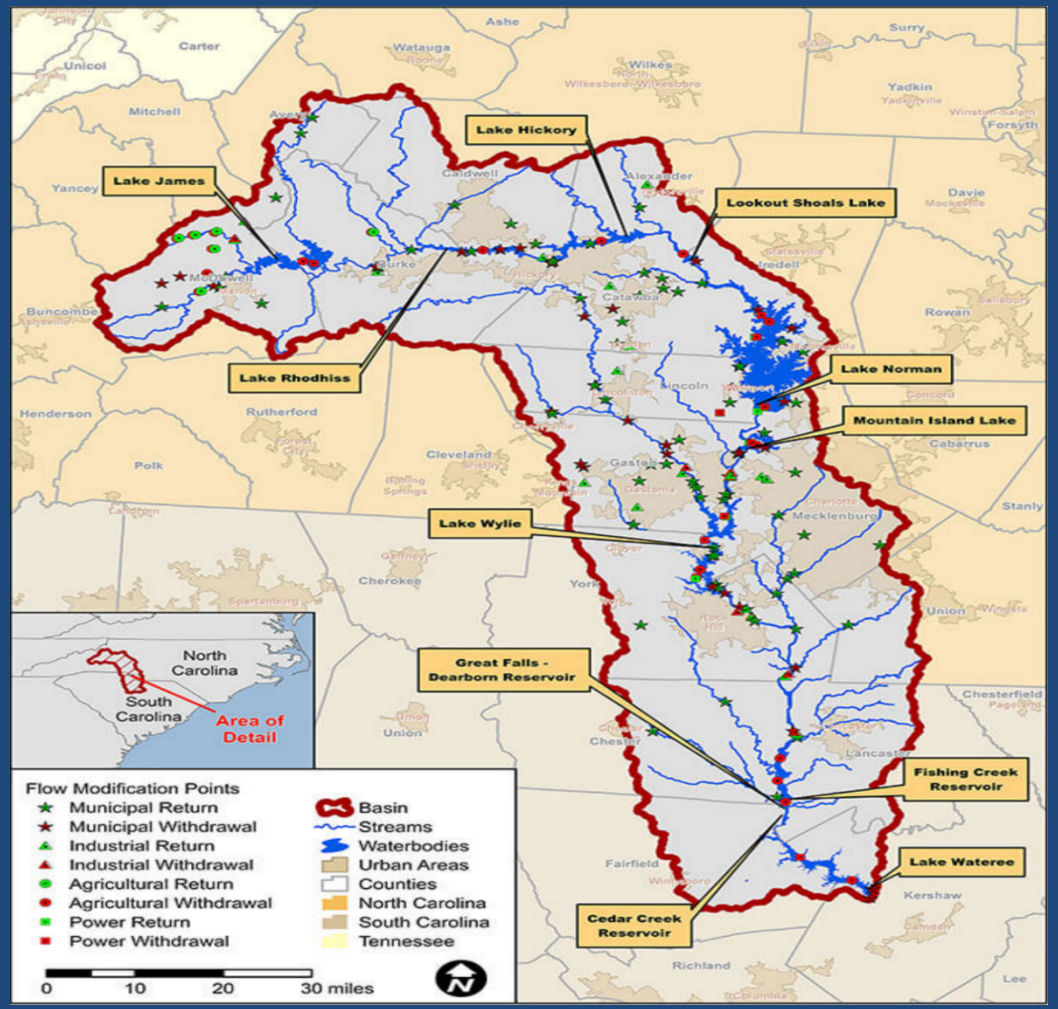


Fatty Liver Disease & CHABs



(**Source:** Zhang et al. 2015. Env. Health 14: 41-52)

Catawba River Basin and Lake Wateree



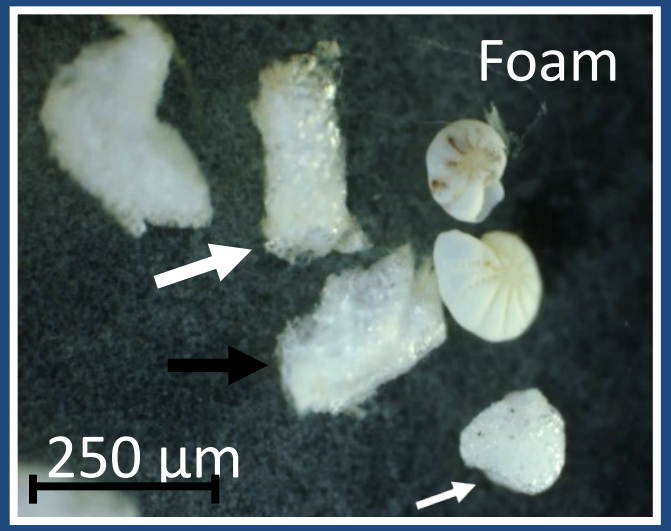
Source: Duke Energy (2007)

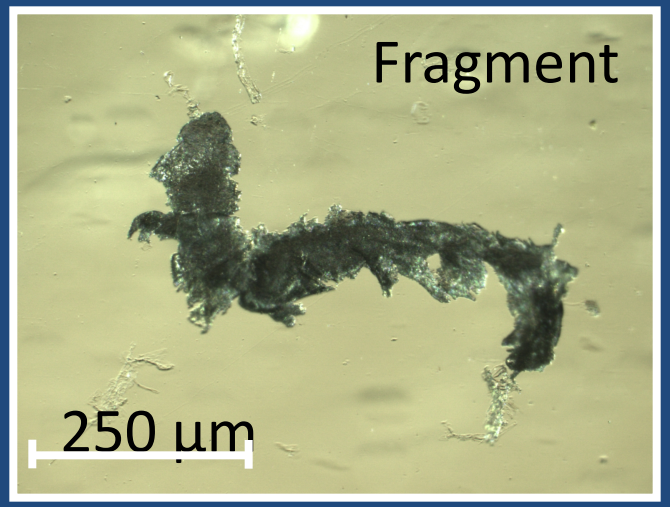
Catawba-Wateree River Basin

- 11 reservoirs, 14 dams and 5000 miles of waterways
- Supplies drinking water to approximately 2 million people.
- Most endangered river *(American Rivers, 2008)*
- 3rd most endangered river in SE U.S. *(Southern Environmental Law Center, 2012)*
- 4th most stressed river in the U.S. from power production *(Union of Concerned Scientists, 2011)*

(Clyburn, K. 2019. Masters Thesis, USC)

Microplastics from Charleston Harbor





Minimal Defense
Many communities have developed right along the ocean with only minimal natural defenses from a small strip of beach between them and the ocean.

Natural
Natural habitats that can provide storm protection include salt marsh, oyster and coral reefs, mangroves, seagrasses, dunes, and barrier islands. A combination of natural habitats can be used to provide more protection, as seen in this figure. Communities could restore or create a barrier island, followed by oyster reefs and salt marsh. Temporary infrastructure (such as a removable sea wall) can protect natural infrastructure as it gets established.

Managed Realignment
Natural infrastructure can be used to protect built infrastructure in order to help the built infrastructure have a longer lifetime and to provide more storm protection benefits. In managed realignment, communities are moving sea walls farther away from the ocean edge, closer to the community and allowing natural infrastructure to recruit between the ocean edge and the sea wall.

Hybrid
In the hybrid approach, specific built infrastructure, such as removable sea walls or openable flood gates (as shown here) are installed simultaneously with restored or created natural infrastructure, such as salt marsh and oyster reefs. Other options include moving houses away from the water and raising them on stilts. The natural infrastructure provides key storm protection benefits for small to medium storms and then when a large storm is expected, the built infrastructure is used for additional protection.

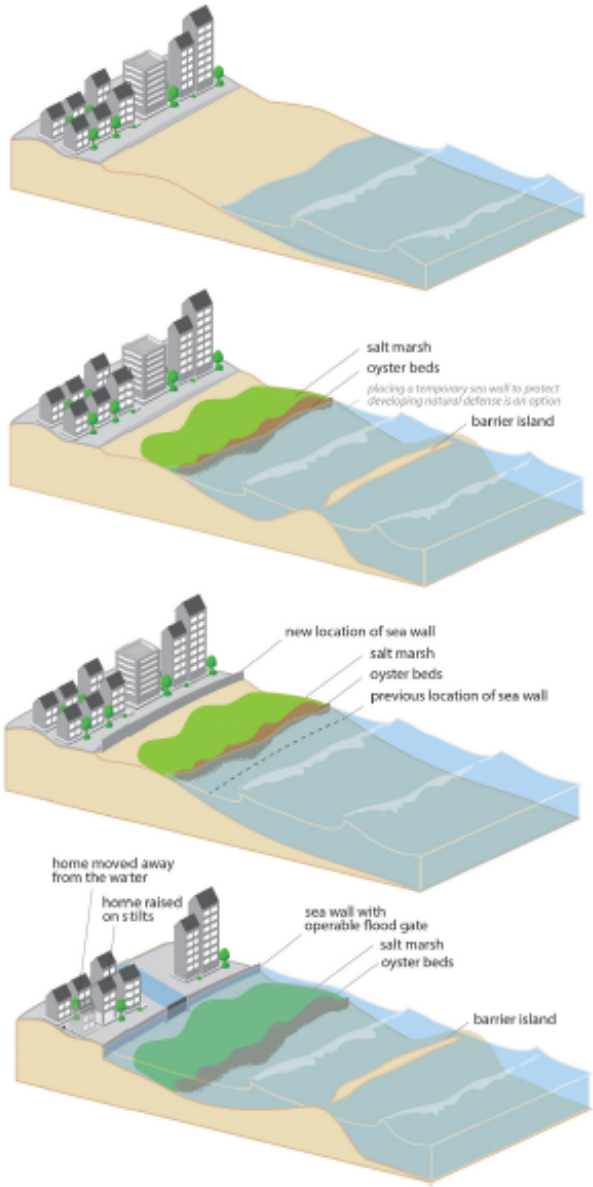


Fig. 2 – Examples of coastal defenses including natural infrastructure, managed realignment, and hybrid approaches.

From IOOS Website

Critter Cams/Critter Oceanographers (Wired Animals)

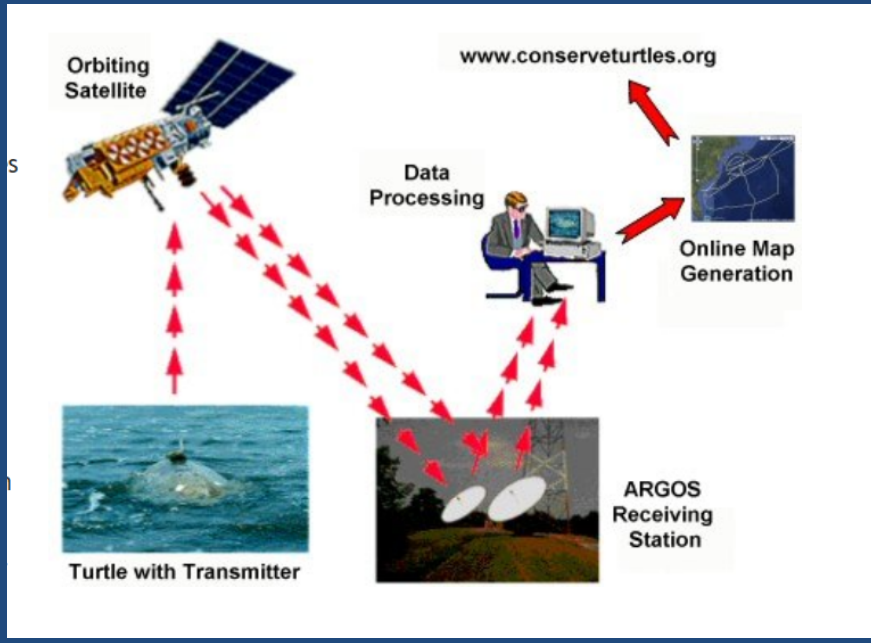
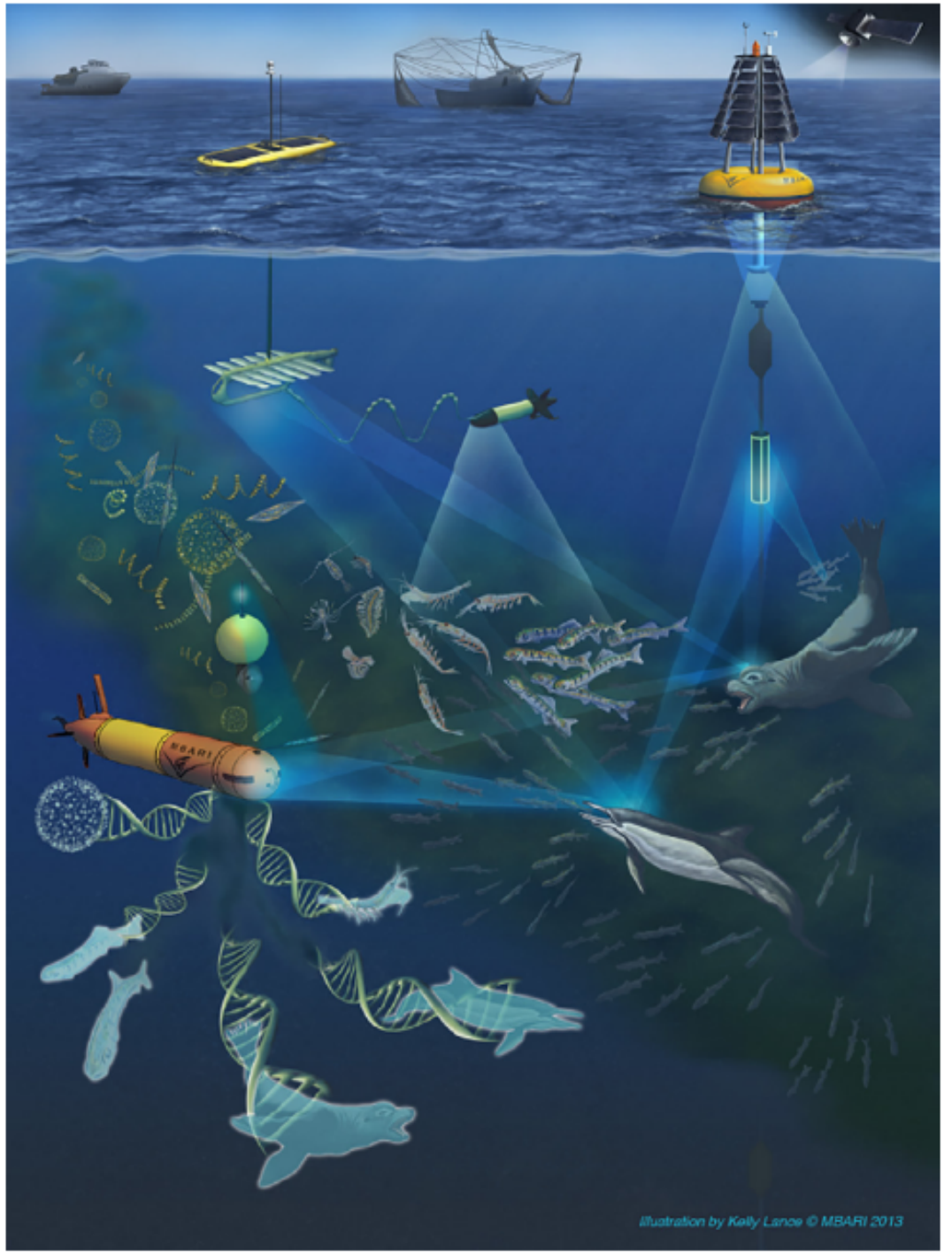
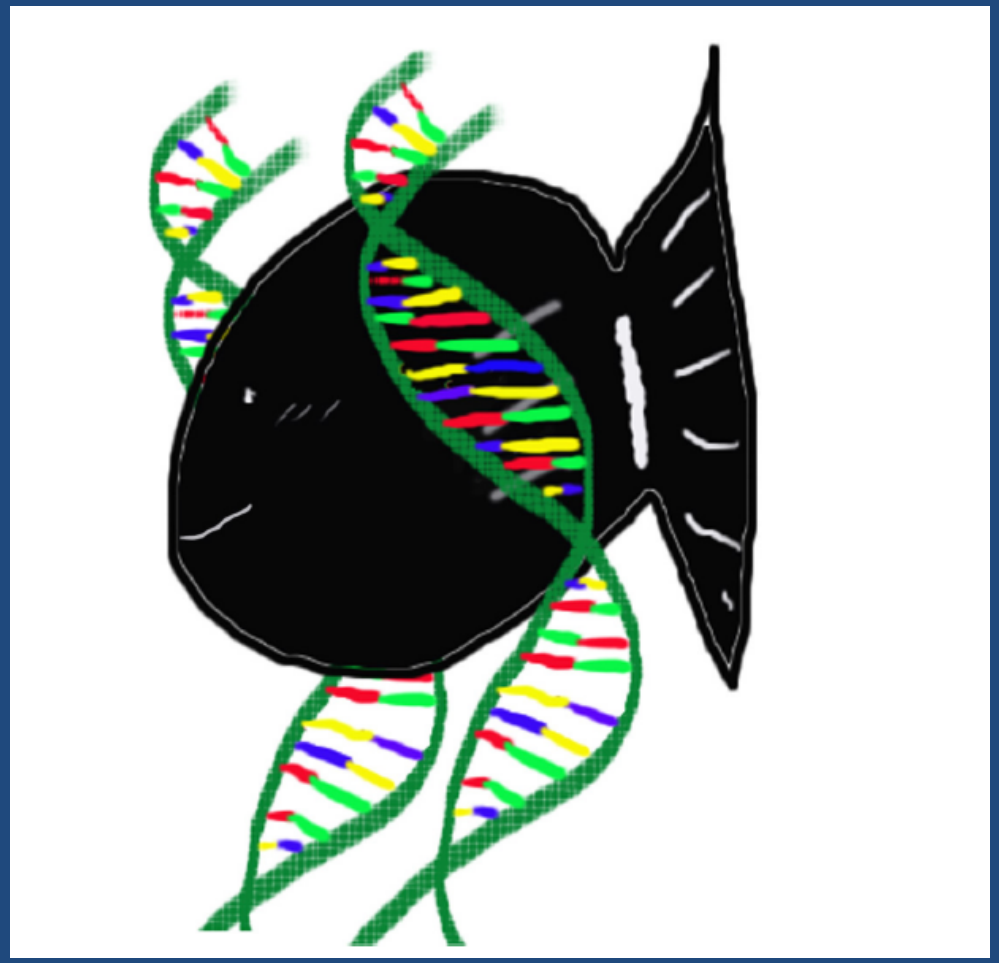


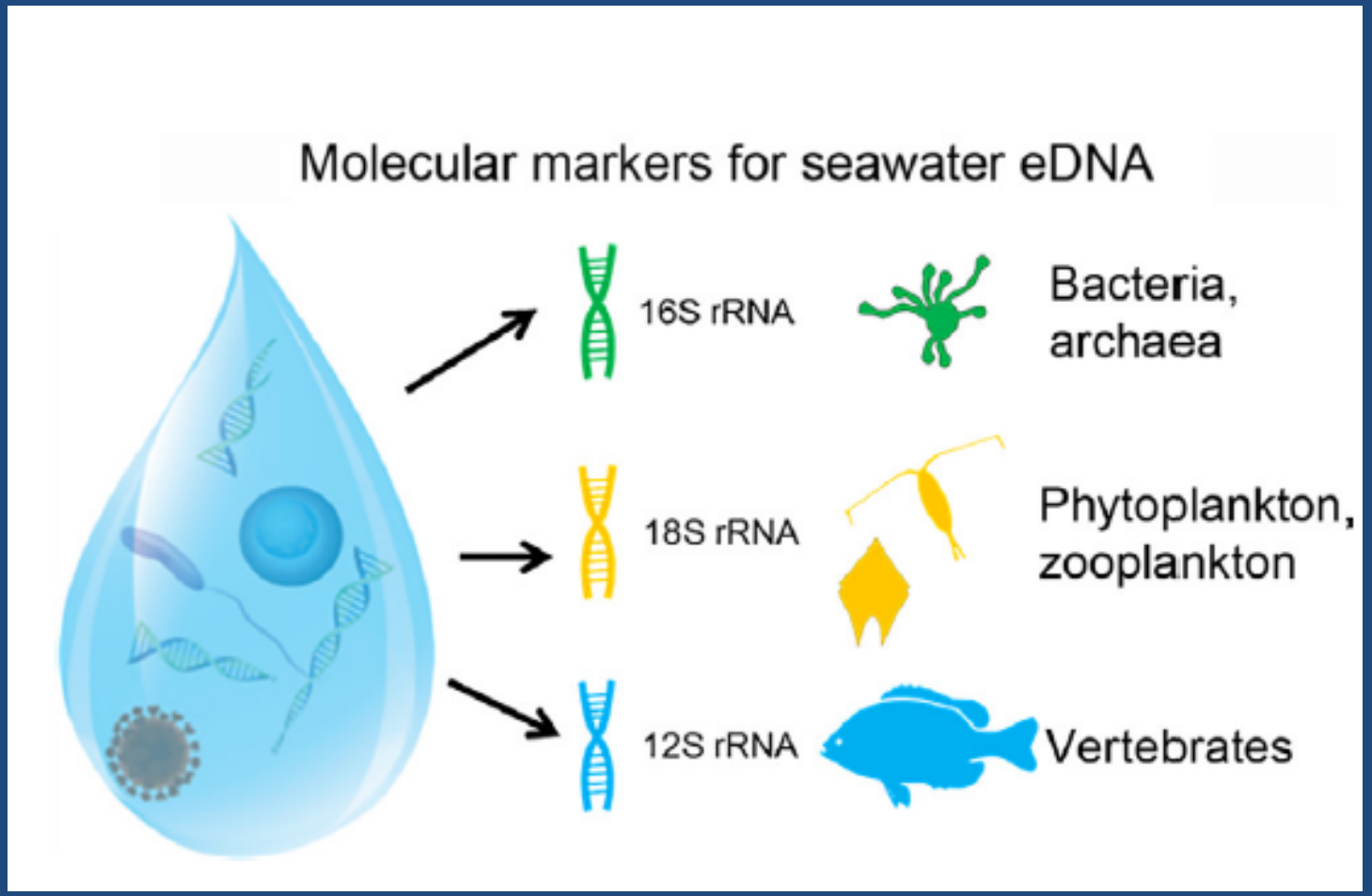
Fig. 32.1. The concept of the Marine Biodiversity Observation Network is to support sustained ecosystem resources by integrating data from a variety of long-term sources (Image credit: Kelly Lance, MBARI).

(From: Goodwin et al. 2019. Molecular approaches for an operational Marine Biodiversity Observation Network. Ch. 32. In; World Seas: an Environmental Evaluation)



From Goodwin et al. 2019






Oregon State
Oregon State
Oregon State


Morning Time
Distance


OK
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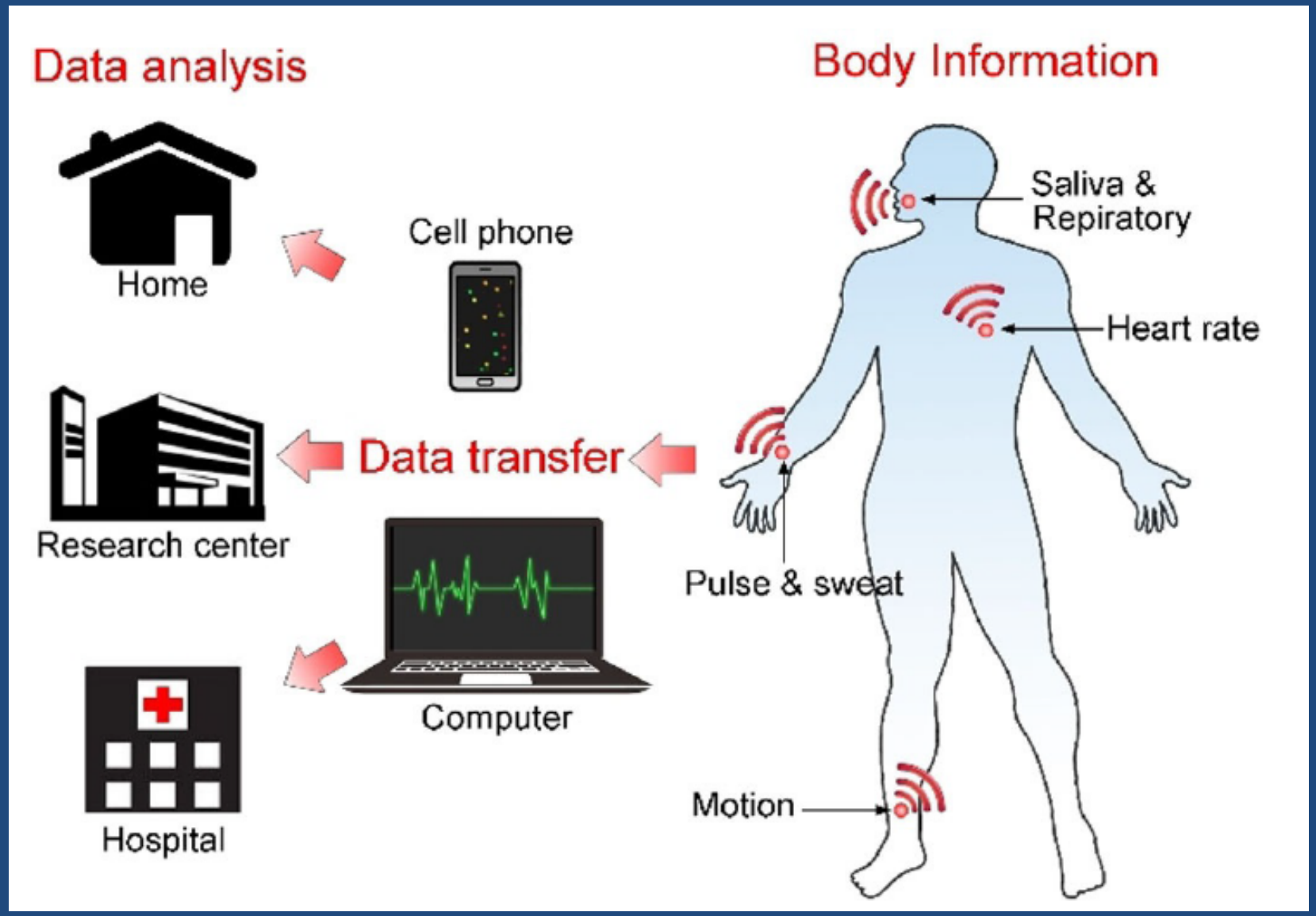
127
128
127
00:00
12:00
24:00

From Qian & Long. 2018. Wearable Chemosensors

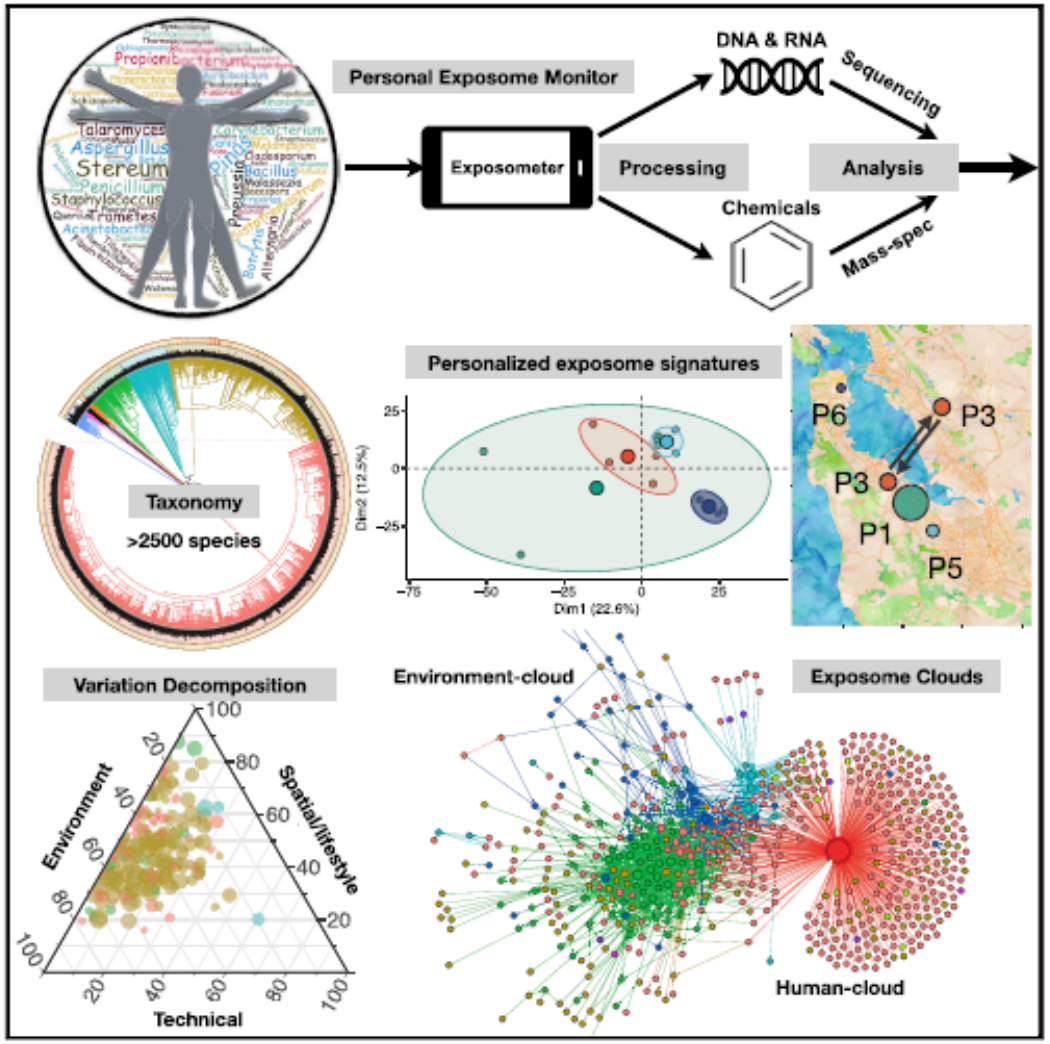


Cell. 2018. 175: 277-291.

Cell

Dynamic Human Environmental Exposome Revealed by Longitudinal Personal Monitoring

Graphical Abstract



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In Brief

Tracking personal exposure to airborne biological and chemical agents enables construction of an interaction network linking individuals, their geographic locations, and environmental factors, which could have broad implications for human health.

“Wired” Beaches

Great Lakes Commission
des Grands Lacs

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Questions?

Comments or questions about the Commission's announcements? Contact **Christine Manninen** at

Contacts:
Christine Manninen
E-mail: *manninen@glc.org*
Phone: 734-971-9135

For immediate release
May 31, 2012
Download **PDF**

Get mobile: Real-time beach data now available for all Great Lakes states

Ann Arbor, Mich. - Going to the beach? Now you can get real-time information on beach water quality advisories, weather and water conditions all on your mobile phone.

The Great Lakes Commission (GLC), in partnership with LimnoTech and the Great Lakes states, has developed a free smartphone application that provides convenient, public access to swim advisories

How’s the Beach?

Headed to the beach? Use this app to see if the water quality is healthy before diving in!

Did you know bacterial levels at some swimming beaches and recreational waters are a public health concern?

How's the Beach makes daily forecasts of bacteria conditions for Nags Head, NC, the Grand Strand and Charleston, SC, and Sarasota, FL. These forecasts do not represent swimming advisories; however, they do provide the public with information on beach water quality.

Did you know?

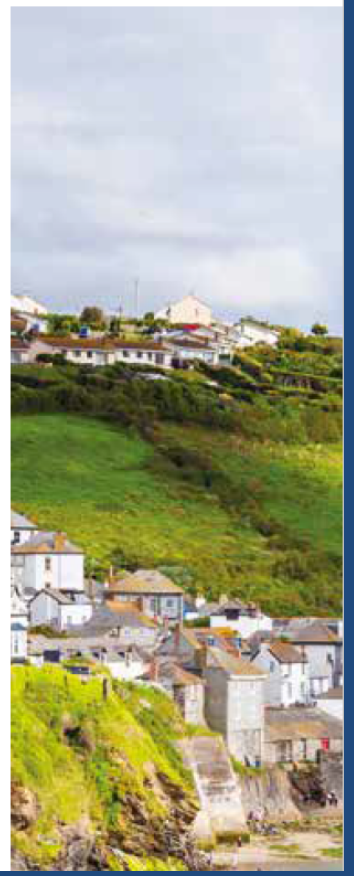
Despite the Health Threats, Living by the Sea is Good for You!

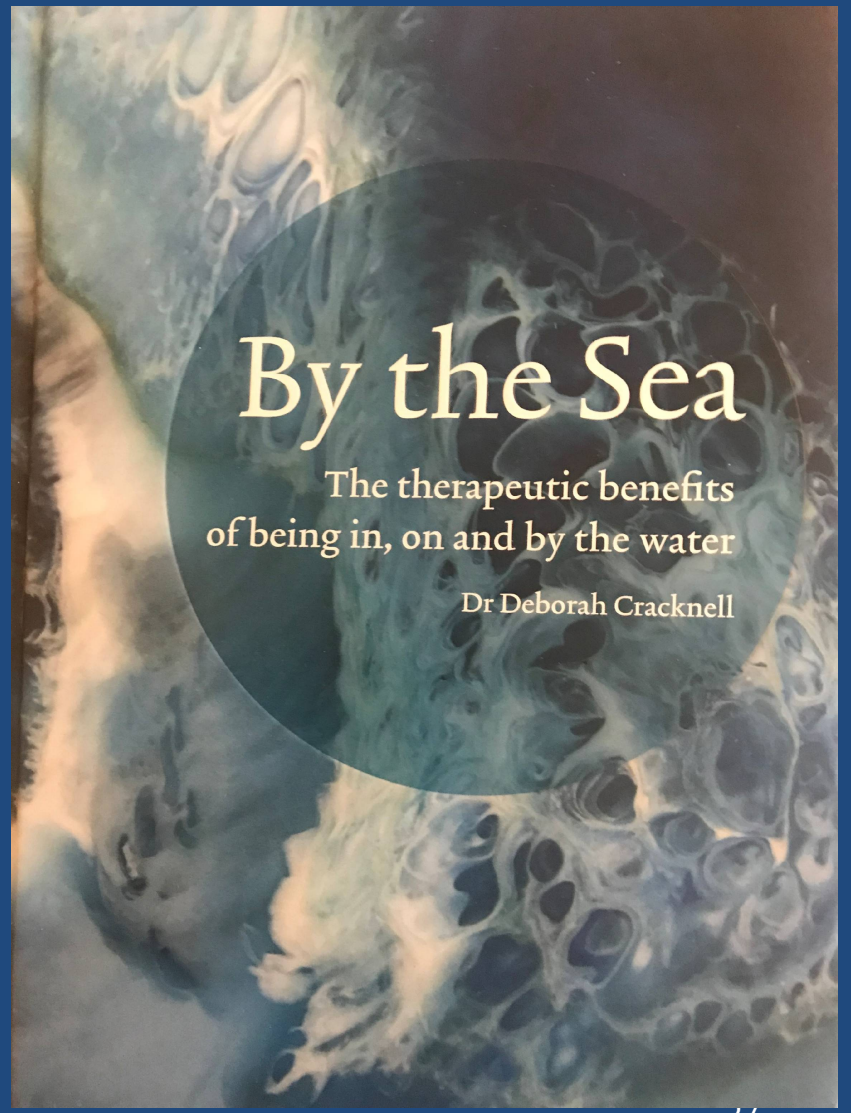
coast WELLBEING

THE OCEAN EFFECT

Living by the sea really is good for you – now there's evidence to back that up. Environmental psychologist Dr Lewis Elliott explores the therapeutic benefits of being in, on and by the water

WORDS: *Anna Turns*





Fleming et al. 2019. Fostering human health through ocean sustainability in the 21st century. People and Nature. DOI: 10.1092/pan3.10038.

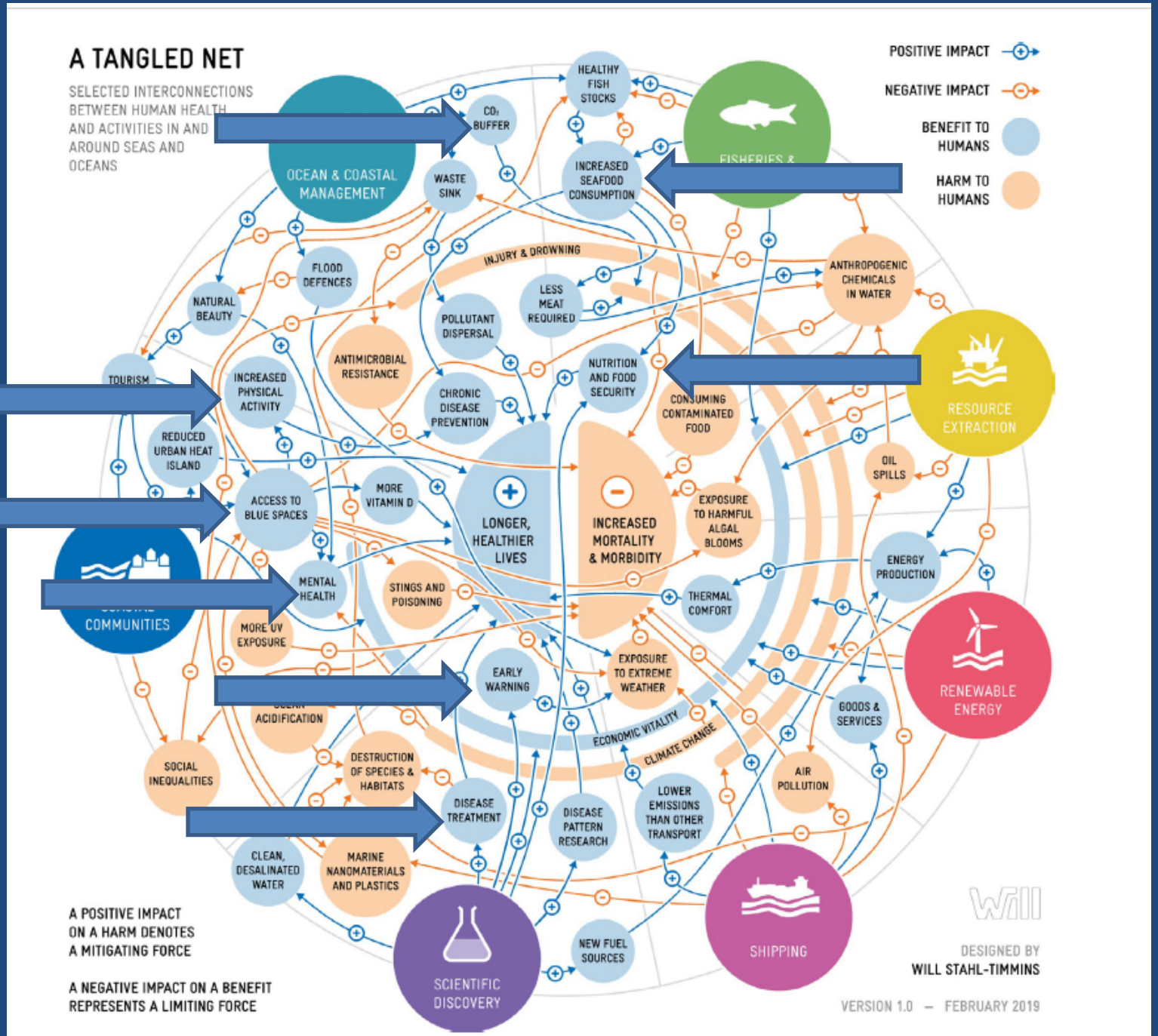


FIGURE 1 A tangled net – selected interconnections between human health and activities in and around the seas and oceans (designed

Summary of Suggestions

1. Get creative with ways SECOORA data can be used to improve disaster preparedness, response, and recovery.
2. Include periodic surveys of status and “health” of natural coastal infrastructure, including marshes, mangroves, dunes, fringing forests.
3. Collect much more data on harmful microbes, including Vibrios and HABs that originate in freshwater.
4. Add microplastics to routine data collection, including from air.
5. Institute collection of e-DNA data for biodiversity analyses.
6. Embrace innovative uses of humans & megafauna as sensor platforms.
7. Include measure(s) of coastal therapeutic values as available.