

# OHH Overview: Research and Community Engagement to Enhance Ocean Health and Human Health

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COLLEGE *of*  
CHARLESTON

CENTER FOR COASTAL  
ENVIRONMENTAL & HUMAN HEALTH



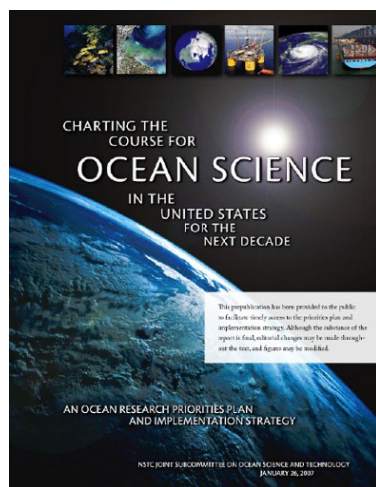
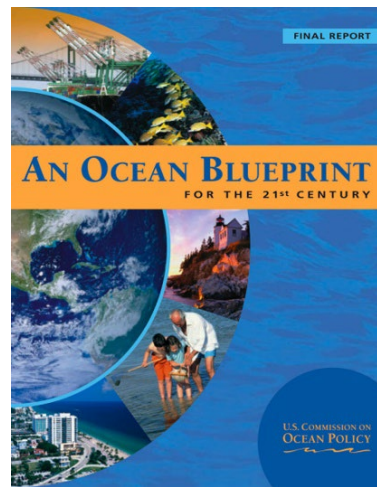
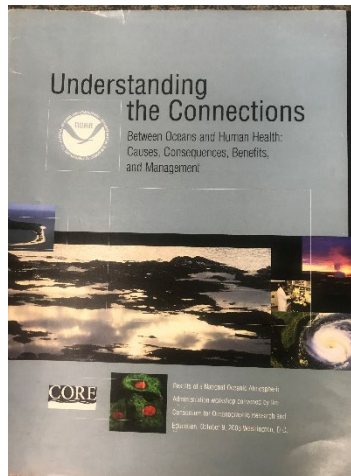
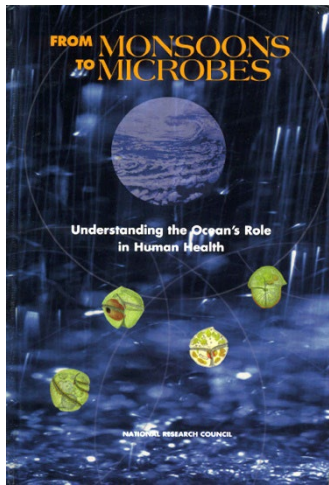
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# Oceans and Human Health (OHH)

## “Meta-discipline”

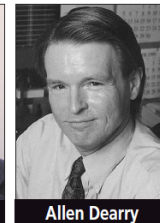
- Includes elements of oceanography, marine biology/ecology, biodiversity, biomedical science, medicine, environmental science, and public health
- Focuses principally on water- and food-borne causes of human and animal illnesses associated with ocean, coastal, and other aquatic systems and on health benefits and risks of seafood, other marine products, and coastal habitation
- Integrates information across multiple disciplines to better understand health risks and benefits for improved ocean health and public health protection and management

TITLE IX--OCEANS AND HUMAN HEALTH ACT



Guest Editorial

Connecting the Oceans and Human Health



Frederick L. Tyson

Donald L. Rice

Allen Dearry

Life on Earth is and has always been inextricably associated with the oceans that occupy greater than 70% of the planet's surface. The origins of life as we know it began in the depths of the oceans, and human life is still unreservedly dependent on the same oceans. As of 1994, more than 2 billion people lived within 60 miles of a coastline (Cohen et al. 1997); today, 14 of the world's 17 largest cities lay on or near coasts (United Nations Population Division 2002).

The proximity of human populations to ocean coasts is not surprising when our past, current, and future dependence on coastal waterways for food, commerce, travel, and recreation are taken into consideration. The largest source of protein in the world is fish, and more fish are harvested throughout the world than cattle, sheep, poultry, or eggs (Srinivas 1999). Billions of dollars are generated annually from fishing alone (National Marine Fisheries Service 2003), and other commercial ventures include travel and recreational use of coastal waterways. In addition to human dependence on the oceans for life, work, food, travel, and fun, human health is also associated with the oceans.

The oceans are teeming with life and serve as the world's greatest reservoir of biodiversity, including marine mammals, fish, crustaceans, mollusks, and countless species of zoo- and phytoplankton. It is this marvelous biodiversity that will allow us to take advantage of the oceans' bounty, and identify and develop marine-derived bio-pharmaceuticals to improve human health outcomes. Recent work

invertebrates produce compounds that have potential for development as pharmaceuticals, with applications in treatment of neurodegenerative disorders, cardiovascular and infectious diseases, and certain cancers.

Human health outcomes related to the oceans have been documented as far back as 800 B.C., when illness resulting from consumption of contaminated fish was recorded in Homer's *Odyssey* (Halstead 1988). In present times, ocean-related human illnesses are still primarily caused by consumption of contaminated seafood, but are also caused by inhalation of aerosolized toxins. Worldwide each year, more than 60,000 cases of poisoning by exposure to harmful algal blooms (HABs) are reported (Van Dolah 2000). HABs release marine toxins that are frequently associated with kills of fish, birds, and marine mammals. Adverse health outcomes in humans range from acute neurotoxic disorders such as paralytic shellfish poisoning, neurotoxic shellfish poisoning, and ciguatera fish poisoning to more chronic diseases such as chronic liver disease

Perspectives | Editorial

Guest Editorial

The Oceans and Human Health

For millennia, the oceans have been perceived by mankind as a producer of essential protein, a vital transportation artery, a source of great danger (from storms, hurricanes, typhoons, tsunamis, and venomous and predatory animals) and the greatest mystery on the planet, inspiring untold realms of poetry and prose. The oceans are the world's most important sources of biological activity, water, biodiversity, and biomass production. They supply food, oxygen, and other natural products critical for human existence, and interactions between the oceans and atmosphere shape our climate and weather. Today, we recognize the oceans for all these attributes and also for their marvelous, incredible, and almost infinite diversity of life forms and life processes, as well as the extraordinary potential for many of those life forms, biological and physical processes, and other resources to be harnessed for human welfare. We are just beginning to understand the numerous and complex ways in which humans can affect the oceans, and the oceans, in turn, can affect human health, including the discovery of new pharmaceuticals to fight human illnesses.

Although not truly an island, the United States is bordered on all sides by seas, and the lands immediately adjacent to the coast annually contribute over \$1 trillion to the U.S. economy. In addition, our coastal waters provide invaluable waste processing and other ecologic

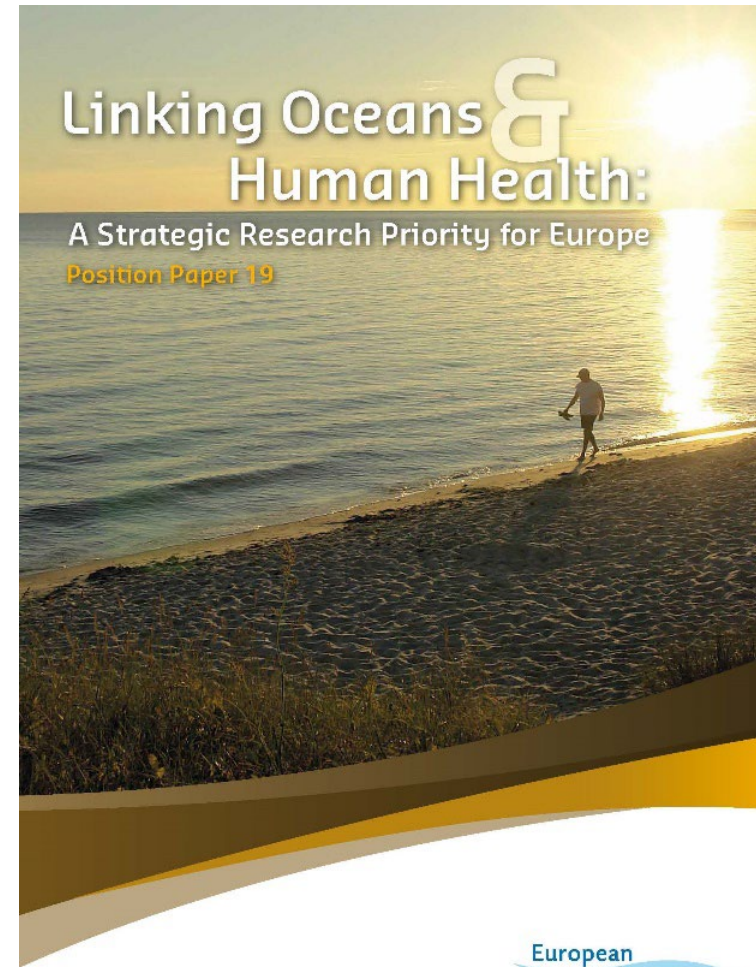
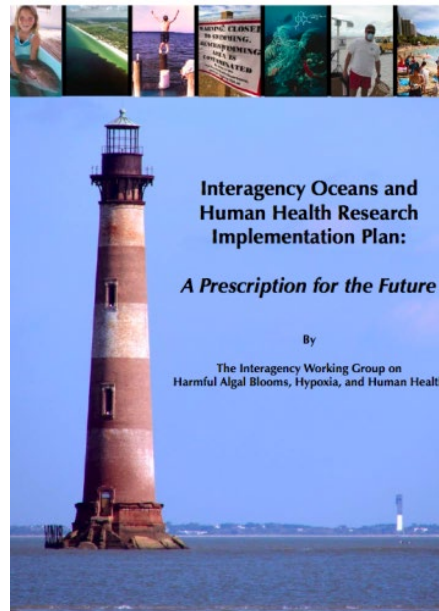
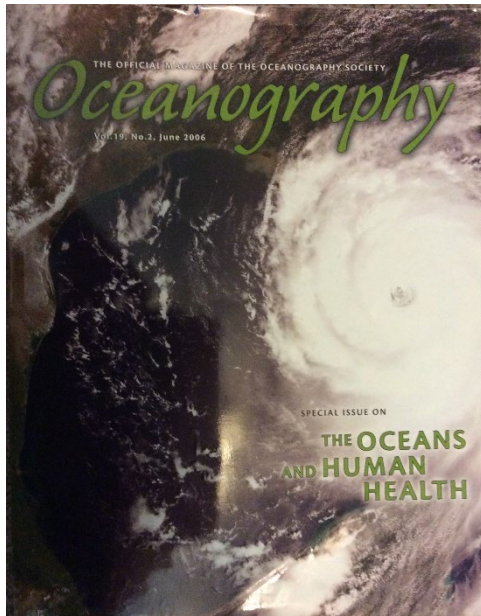


Left to right: Paul A. Sandifer, A. Frederick Holland, Teri K. Rowles, Geoffrey I. Scott

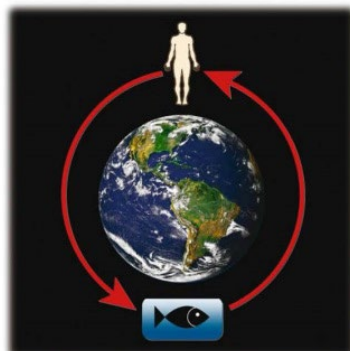
increased threats to human health from microbial agents transmitted via water, food, or other vectors, or which may be harbored in animal reservoirs.

The safety and economic risks of extreme weather events, climate change, and rising sea levels to those who live on or visit our coasts are reasonably well known. However, while cases of human illness linked directly or indirectly to stressed estuarine and coastal environments are being documented with increasing frequency, the risks to human health from continued and expanded impairment of coastal and ocean environments remain very poorly understood. Globally





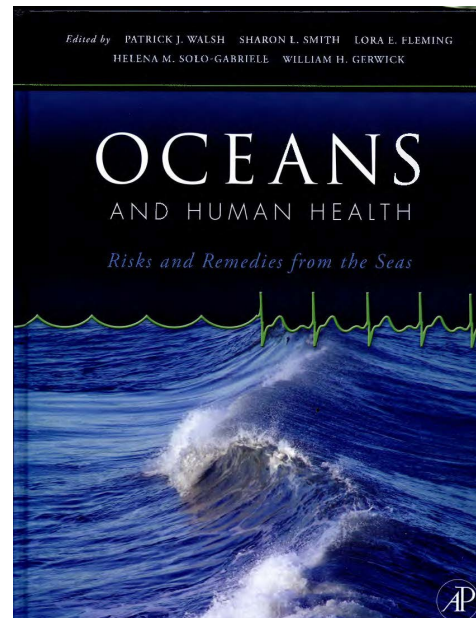
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# Top Questions

How might living near and recreating in the oceans, Great Lakes, and other water bodies affect my health and well-being?



Is the seafood safe to eat?



Is the water safe to recreate in or on, or drink?

What effects will climate change have?

# Today's session will focus on a few selected activities in 4 NIEHS-NSF funded OHH Centers & some related work in R01, Research to Action and Environmental Justice Projects







**GREAT LAKES CENTER**  
FOR FRESH WATERS AND HUMAN HEALTH  
AT BOWLING GREEN STATE UNIVERSITY

**BGSU.**

**Primary focus: Cyanobacterial  
blooms and their toxins in  
freshwater**



# Toledo Water Crisis: August 2014



Microcystins above 1 ppb in finished water

400,000 residents had no drinking water

\$65M loss to City of Toledo in 3 days

Some people still drink bottled water



Research Project 1: Mechanisms of cyanobacterial success, persistence and decline

Research Project 2: Discovery and characterization of novel toxins and other natural products

Research Project 3: Integration of sampling and sensor-based strategies for cHAB forecasting

Community Engagement Core: water quality monitoring by charter boat captains and citizen science with US Coast Guard

Photo: Colleen Yancey

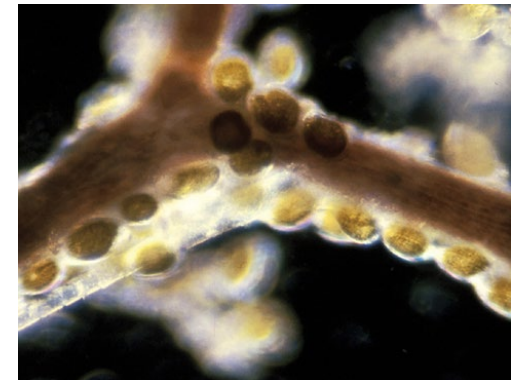
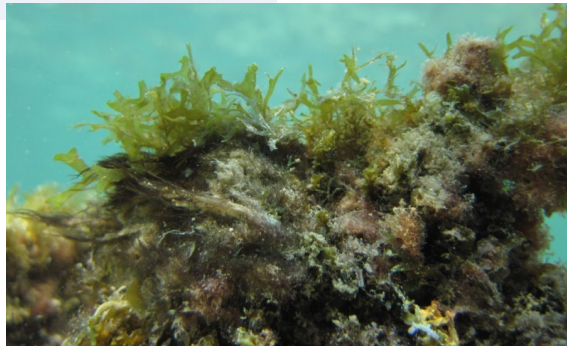
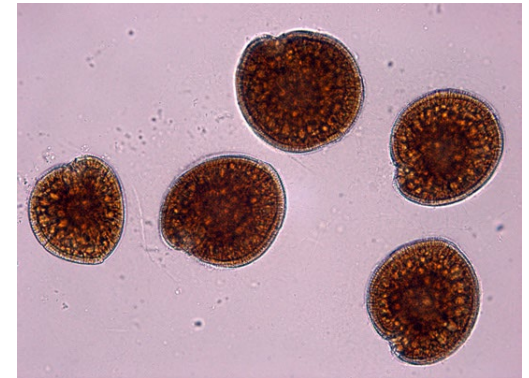


# GCCCR

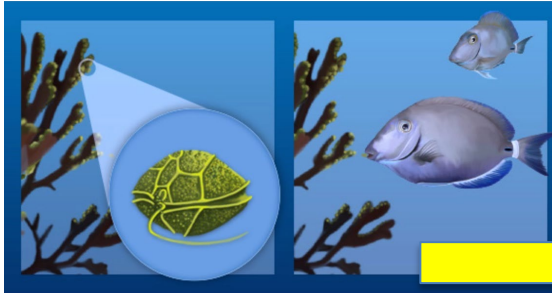
GREATER CARIBBEAN CENTER FOR CIGUATERA RESEARCH

## Ciguatera Poisoning

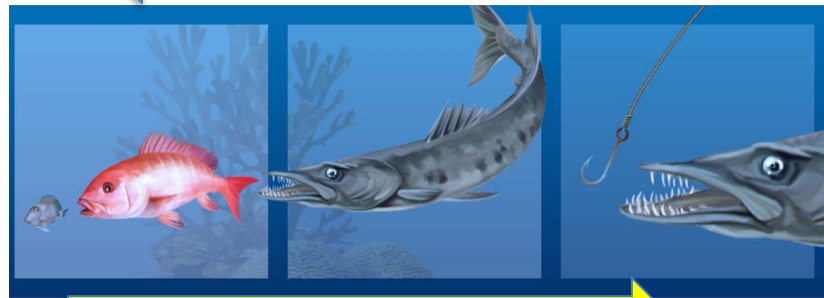
- Thought to be caused by toxins (or precursors) produced by some members of the dinoflagellate genus, *Gambierdiscus*
  - ciguatoxins (CTX)
  - 18 characterized species
  - Found worldwide in tropical and sub-tropical oceans
- They are epiphytic - known to attach to the surface of macroalgae
- May be expanding in geographic and temporal range in response to climate change



Herbivorous fish eat the epiphytic algae and ingest dinoflagellates and their toxins  
**Ciguatoxin**



Predatory fish eat the herbivores and make the toxins more potent →  
**Ciguatoxin**



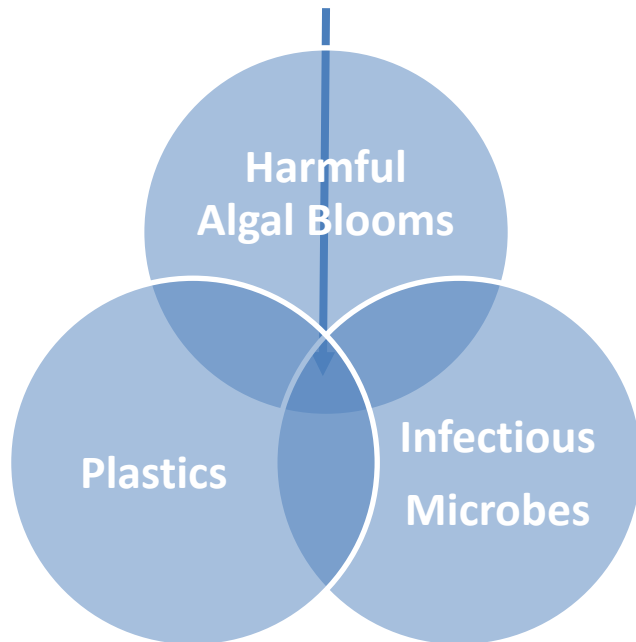
People consume toxic fish and get  
**Ciguatera Poisoning**



# GCCCR Components

- Research Project 1: Ecology of Gambierdiscus and epiphyte communities
- Research Project 2: Toxicology – identifying toxins and metabolites
- Research Project 3: Human Health: how toxins cause human illness
- Community Engagement Core: Knowledge and Information needed in the medical and public health sectors to diagnose, treat, and prevent ciguatera poisoning

Focus: environmental and climate change  
Interactions affecting *Vibrio* bacteria,  
cyanobacteria, microplastics and their  
impacts singly and in combination on  
human and ecosystem health.



## Interacting projects

- Microbiology (*Vibrios*)
- Freshwater HABs
- Chemistry
- Toxicology
- Microplastics
- Community Engagement

## Some Findings From OHHC2I Research



- **Climate-change associated increases in temperature and salinity are projected to result in 200% increase in optimum growing conditions for Vibrios in some areas**
- **Municipal waste-water effluents enhance growth and likely virulence of the highly dangerous *V. vulnificus***
- **Development of improved forecasting tools for *Vibrio* occurrence and virulence**
- **Vibrios and cyanos interact with each other and N increasing risks to humans**
- **Other FW algae that can cause HABS (e.g., *Microsiera*) and their toxins identified**
- **FW HABS can be danger to potable water supplies, not only by their occurrence but also via byproducts produced during standard water disinfection procedures**
- **FW HABS are likely contributing to increases in non-alcoholic fatty liver disease, an additional risk for obese people**
- **Exposure to FW HAB toxins early in life can lead to later life health problems, including possibly earlier onset of obesity and diabetes**
- **FW HAB toxins affect the gut microbiome, increasing inflammation which can affect the brain-blood barrier, posing as yet unknown health risks**
- **FW HAB toxins can be endocrine disrupters and potentially affect human reproduction at environmentally relevant concentrations**
- **Micro- and nano-plastic particles, particularly tire wear particles, are ubiquitous in coastal waters, can be picked up by filter-feeding organisms such as oysters and thereby be consumed by humans**



# Community Engagement With Environmental Justice Communities Via Workshops, Webinars, and Field Exercises





## WHCOHH Objectives

- Understand and predict blooms of HAB toxin producing organisms in a changing climate
- Determine the risks to health from exposure to low levels (below action limits) of toxins, especially from exposure of sensitive early life stages
- Communicate findings / forecasts to managers, public health professionals, and the public



## WHCOHH Projects and CEC

**Project 1.** D. Anderson, M. Brosnahan

Physiological and behavioral plasticity in HAB dynamics and chemical toxicants

**Project 2.** D. McGillicuddy, D. Ralston, K. Hubbard

Climate forcing of HABs and toxicity of blooms

**Project 3.** M. Hahn N. Aluru

Cellular and molecular mechanisms of effects of early life exposure to HAB toxins

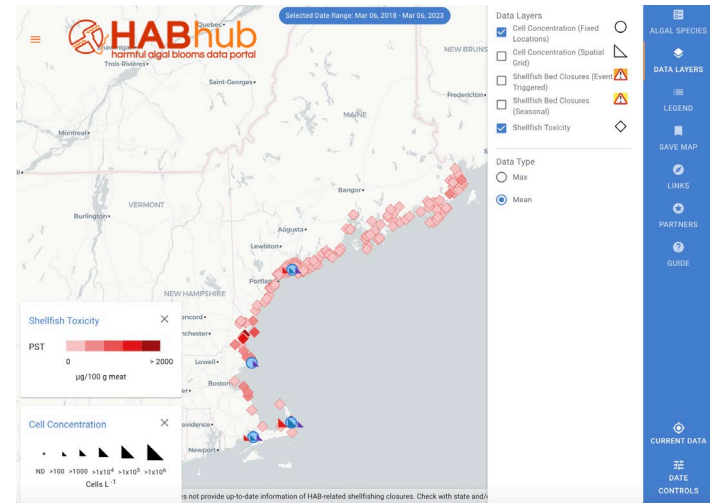
**CEC** - M. Richlen

Involve students, stakeholders



# WHOI CEC Stakeholder Engagement

- “Gulf of Maine HAB Science Symposium” convened annually from 2019-2023.
- WHOI HABhub (<https://habhub.whoiedu>)- Goal is to provide best possible situational awareness about HABs and HAB toxins
- Multiple K-12 educational activities developed and assessed for middle school and high school classrooms



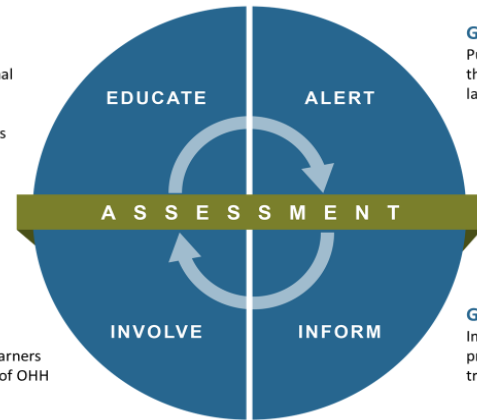
# Developing an Integrated Community Engagement Strategy for All Centers

## Goal: How to achieve combined effort and impact.

- Leveraging existing resources and networks
- Identifying areas of distinction, areas of commonality
- Support each other in areas of distinction – collaborate more aggressively in areas of commonality – **“EJ Strong”**
- Which of the communication and community engagement tools should be adopted by two or more or all four Centers, and how could they be connected and integrated across and among Centers?
- **Strategies are “K-Gray” and will broaden scope of initiatives and opportunities**

**GOALS**  
Develop effective informal and formal educational opportunities for multiple audiences

**GOALS**  
Actively engage participants as learners and practitioners of OHH research



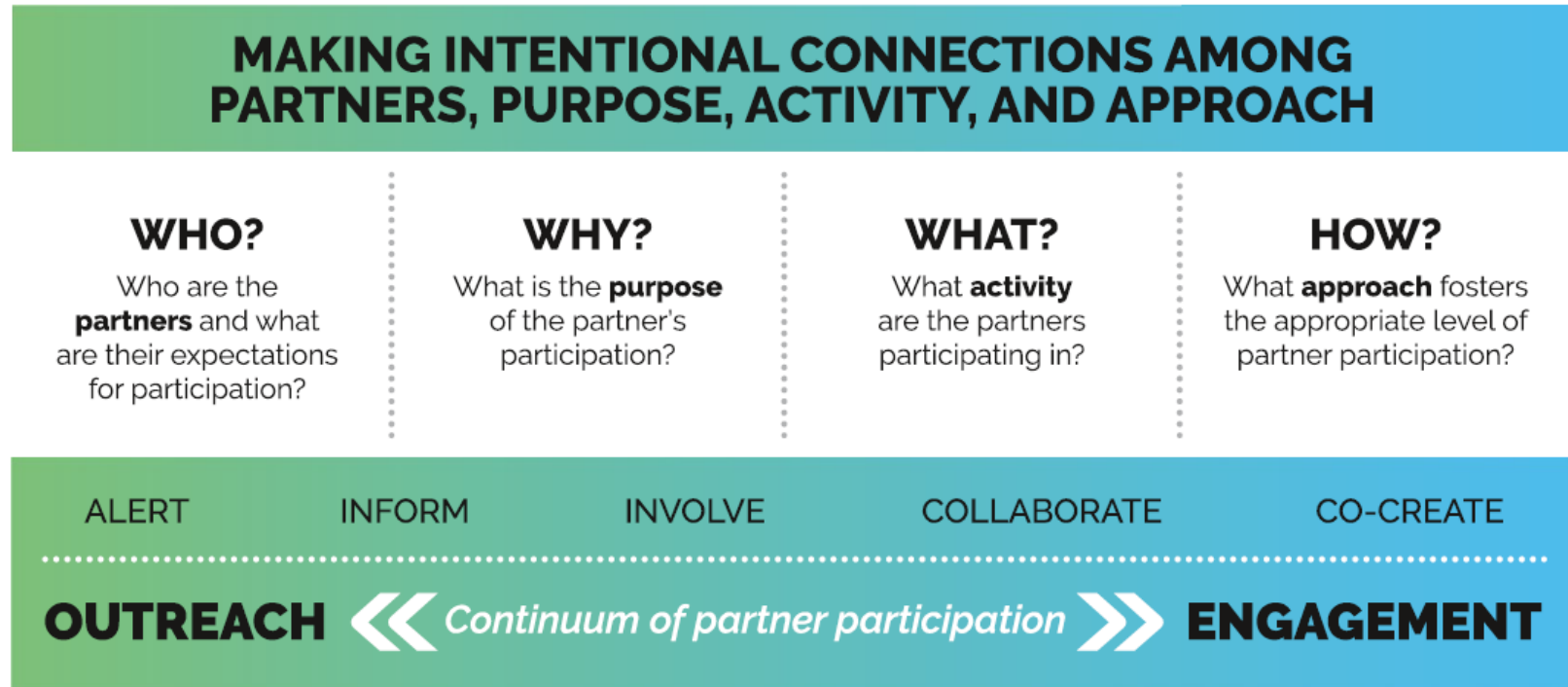
**GOALS**  
Public health protection through effective multi-layered risk messaging.

**GOALS**  
Improve public health protection targeted training on OHH research



Annual OHH Meeting of COHH Directors, NIEHS/NSF Program Managers, CEC PIs, Kimbel Living and Learning Center, Oct 2019

# Strategic Framework for OHH Community Engagement Developed by All Centers CEC's Working Together



**Figure 1.** Strategic Framework for Oceans and Human Health Community Outreach and Engagement modified from the International Association for Public Participation (IAP2) spectrum of public participation (International Association for Public Participation, 2018). See [www.iap2.org](http://www.iap2.org) and [https://cdn.ymaws.com/www.iap2.org/resource/resmgr/pillars/Spectrum\\_8.5x11\\_Print.pdf](https://cdn.ymaws.com/www.iap2.org/resource/resmgr/pillars/Spectrum_8.5x11_Print.pdf).

From: Carson et al. 2022. A strategic framework for community engagement in oceans and human health. *Community Science* 1:e2022CSJ000001.



SECOND EDITION

# OCEANS AND HUMAN HEALTH

OPPORTUNITIES AND IMPACTS

Edited by

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Chapter 4: Food from the ocean

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