NOAA’s Oceans and Human Health Initiative: From Problems to Policy and Practice

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Consortium for Ocean Leadership - Public Policy Forum 03.05.09
OHHI’s Mission: To improve understanding and management of the ocean, coasts and Great Lakes to enhance benefits to human health and reduce public health risks

Goal 1: Lead development of early warning systems to forecast threats and predict long-term ocean risks to human health

Goal 2: Investigate and optimize health benefits from the sea.

Goal 3: Develop a robust, interdisciplinary OHH community to improve public health
Ocean Health Risks and Benefits

The Health Risks
- Seafood-borne Illnesses
- Harmful Algal Blooms
- Ocean Pathogens
- Chemical Contaminants

The Health Benefits
- New Drugs and Products
- Seafood Health Benefits
- Drinking Water
- Ecosystem Services
- Healthy Economies
NOAA’s Role in OHH Research

Closes the Loop In Understanding Connections Between Ocean Health and Human Health

- Natural Products & Pharmaceuticals
- Seafood & Beach Quality
- Sentinels Species and Habitats

Ocean and Coastal Health

- Climate change
- Pollution
- Invasive species
- Land & resource use
- Extreme natural events

Human Health
What the NOAA OHHI Has Supported

3 Centers of Excellence: 75 scientists, 50 projects, 22 partnerships

26 External Grants

2 Distinguished Scholars: Drs. Rita Colwell, Phil Roberts

5 Traineeship Consortia: UGA, UW, UC Irvine, UCONN, MUSC

15 Member External Advisory Panel

Numerous Undergrads, Grads and Post Doc

Public Information, Outreach & Data
Federal Partners – Who Else Is Involved?

The other principal federal players dealing with ocean health threats, to one degree or another, are:

- CDC
- EPA
- FDA
- NASA
- NIEHS
- NSF
- USDA
- USGS

Coordination of these agencies and NOAA is achieved via the Interagency Working Group on Harmful Algal Blooms, Hypoxia, and Human Health (IWG-4H) which NOAA and CDC co-chair. A primary product is the 10-year joint OHH research plan.
Harmful Algal Blooms (HABs) Are Increasing Threats to the Environment and Humans
The US and Global HAB Pictures

Pre-1972
- Occasional anoxia

Present
- Occasional anoxia
- Diarrhetic shellfish poisoning (unconfirmed)
- Marine mammal mortalities (whales, manatees, sea lions, dolphins)
- Noxious blooms (aesthetics)
- Noedalgal blooms

1970
- PSP

2006
- PSP
OHH scientists determined that two environmental stressors interact in the marine mammal fetus to cause greater harm.

**DDT**

*a man-made insectide* discharged into our waters during our post-WWII industrial period

* & 

**Domoic Acid**

*an emerging neurotoxin*, produced by harmful algal blooms fueled by nutrient pollution and changing environmental conditions.

*This is a new perspective of how harmful algal blooms react with pollutants that persists in our oceans*
Fetal Domoic Acid Poisoning Leads to Adult Neurological Disease

Pregnant sea lions and dolphins accumulate domoic acid in the amniotic fluid which bathes the fetus in toxin during critical stages of brain development.

NOAA research indicates that fetal animals are susceptible to a silent poisoning that becomes manifest later in life as aberrant behavior and epileptic seizures. The lead scientist put the findings this way: “We are just beginning to understand how not just a single chemical, but a complex mix of chemicals we start life with leave us vulnerable to disease later in life.”
These two environmental trends meet in a very important place, the Channel Island National Marine Sanctuary, mixing in animals seeking refuge in their most important breeding ground.

Each year the number of California sea lions that strand on beaches increases & may be due to this newly described neurological disorder - which could further exacerbate marine mammal health.

Photo credit: Rick Loomis
Bacterial Pathogens Occur Commonly in Ocean and Coastal Waters

- 25,000-35,000 days of beach closures annually
- NRDC estimates 10% of beachgoers contract GI illness for >7,000,000 cases per year
- Several *Vibrio* species occur naturally and ubiquitously in US coastal waters and two of these (*V. parahaemolyticus*, and *V. vulnificus*) cause most shellfish-associated illnesses
- *Vibrio* infection rates increased 41% over last decade and the organisms appear to be spreading due to global warming
- US has thousands of miles of beaches that attract over 900 million trips annually, generate $40 billion in spending and support millions of jobs
Antibiotic Resistance in Ocean Waters

- Antibiotics and other pharmaceuticals are found in waterways throughout the US; they get there primarily by human actions.

- MRSA (Methicillin resistant *Staphylococcus aureus*) has been detected on some beaches.

- Antibiotic-resistant *Vibrio vulnificus* and *V. parahaemolyticus* occur in coastal waters.

- 60% of sick and stranded marine wildlife studied by WHOI researchers and nearly 40% of live-captured dolphins in Charleston, SC carried antibiotic resistant bacteria.
What Do We Need to Combat Antibiotic Resistance?

1) New Antibiotics
2) Ways to make “old” antibiotics effective again.
Antibiotic Discovery at NOAA
A Focus on Pseudopterogorgia americana

Caribbean has lost over 80% of its hard coral cover in the past years.

Image Credit: Dr. Ernesto Weil, University of Puerto Rico- Mayaguez, PR
Chemical Warfare: Antimicrobial Screening Assay

• Bacterial isolates tested against a series of pathogenic bacteria
• Antimicrobial screening often highlights potential antibiotic selectivity
• Selective antibiotic activity targets potential for “personalized medicine”

Inhibition

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<th>Coral Isolate A</th>
<th>Coral Isolate B</th>
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<td>vs K. rhizophila</td>
<td>vs P. aeruginosa</td>
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Human Pathogens:
- *Pseudomonas aeruginosa*
- *Escherichia coli*
- *Kocuria rhizophila*
- *Bacillus spp. (B. subtilis)*
- *Aspergillus spp. (A. sydowii)*

Coral Pathogens:
- *Vibrio coralliilyticus*
- *Aspergillus sydowii*

Other Marine Invertebrate Pathogen:
- *V. harveyi*
Biofilm Relevance To Human Health

Bacteria in biofilms are 1,000-fold more resistant to antibiotics

65-80% of all bacterial infections are biofilm-based

Examples include:
• Mortality of Cystic Fibrosis patients
• Infection of indwelling medical devices such as stents
• Nosocomial infections
• Destruction of citrus and other agricultural products
• Corrosion of petroleum pipelines
Anti-biofilm Chemicals Enable Effective Use of Current Generation Antibiotics

**MRSA**
Methicillin Resistant Staphylococcus aureus

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<tr>
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<th>Anti-biofilm agent</th>
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**Acinetobacter baumannii**
Isolated from military personnel wounded in Afghanistan

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A harmful algal bloom has been identified in patches from southern Lee to central Collier County. Patchy very low impacts are possible from southern Lee County to central Collier County today through Thursday. No other impacts are expected.

Conditions Report (public)

HAB Bulletin (managers)

http://www.csc.noaa.gov/crs/habf
Mapping Pathogens in the Chesapeake Bay

Guillaume Constantin de Magny et al. (in prep)
Remote Sensing to Forecast the Distribution and Abundance of *Vibrio parahaemolyticus*

SST – May 4, 2004
Mean log \( V. parahaemolyticus/\text{g} = 0.871 \times \exp\left[0.2648 \times \text{SST}\right] \)
NOAA Science Advisory Board’s Oceans and Health Working Group

Charged to explore opportunities to enhance NOAA’s ongoing ocean health efforts and their impacts on ecosystem and public health.

1) What are NOAA’s unique and important scientific roles in OHH?

2) What ocean health science questions, products and services should NOAA address?

3) Are there additional ocean health science issues that should be included in the NOAA research portfolio?

4) What steps should NOAA take to incorporate OHH as part of its core mission?

5) How could NOAA more systematically develop ocean health products and services to enhance ecosystem, organism, human, and community health?

6) How can NOAA better integrate among its internal and external programs to better define and assess ocean health issues?
For more information, see NOAA's OHHI Website: http://www.eol.ucar.edu/projects/ohhi/

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