GLOBAL OCEAN ACIDIFICATION OBSERVING NETWORK

Presented by…
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Ocean Acidification Program Deputy Director

Presented for…
WESTPAC Workshop on
Research and Monitoring of the Ecological Impacts of
Ocean Acidification on Coral Reef Ecosystems
Phuket, Thailand
19-21 January 2015

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(as of May 2014):

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GOA-ON Technical Architect
Cathy Cosca (US-NOAA)

http://www.oceanacidification.noaa.gov/
http://www.goa-on.org/
The Global Ocean Acidification Observing Network (GOA-ON) is a collaborative international approach to document and understand the status and trends of ocean acidification including ecological impacts.

University of Washington, USA, June 2012, 62 participants, 23 countries. St. Andrews, UK, July 2013, 87 participants, 26 countries.
An International Workshop on Ocean Acidification: State-of-the-Science Considerations for Small Island Developing States
August 28 – 29, 2014
Pacific Jewel, Apia, Samoa

• **OA threat to marine ecoservices** including food security, livelihoods and economic stability, resilience to extreme weather events, and cultural identity.

• **OA capacity networks** for the Caribbean, Pacific Islands, and AIMS SIDS regions which will continue to develop next steps in their regions including:
  – Fostering additional SIDS participation.
  – Near-term development of SIDS-driven, SIDS-connected and SIDS-focused “Joint SIDS Recommendations on Ocean Acidification”.

• **OA is a current and escalating threat with a need for need to establish standardized, affordable, long-term research and monitoring capacity.**
To build the GOA-ON, the community has defined:

- The *rationale, design, and locations of components for an international ocean acidification observing network*, taking into account existing activities
- A *minimum suite of measurement parameters*
- A *strategy for data quality assurance and for data distribution*
- The *requirements for international programme integration*
To build the GOA-ON, fit to purpose:

Globally distributed, high quality data, and data synthesis products that:

- Facilitate research (new knowledge) on OA
- Document status and trends of OA and biological response
- Enable forecasting/prediction
- Provide validation
The Global Ocean Acidification Observing Network (GOA-ON) is a collaborative international approach to document the status and progress of ocean acidification in open-ocean, coastal, and estuarine environments, to understand the drivers and impacts of ocean acidification on marine ecosystems, and to provide spatially and temporally resolved biogeochemical data necessary to optimize modeling for ocean acidification.

http://www.goa-on.org/

**Interactive Map of Ocean Acidification Platforms**

Building on the existing global oceanic carbon observatory network of repeat hydrographic surveys, time-series stations, floats and glider observations, and volunteer observing ships, the interactive map below offers the best information available on the current inventory of global OA observing platforms. This is a strong foundation of observations of the carbonate chemistry needed to understand chemical changes resulting from ocean acidification.

**An International Effort**

**Network Members** - Scientists from 30 countries are currently participating in the GOA-ON.

**Workshops/Activities**

- **GOA-ON 2012 Workshop, University of Washington, Seattle, WA** attended by 62 participants from 22 countries
- **GOA-ON 2013 Workshop, St. Andrews, UK** attended by 87 participants from 26 countries
- **GOA-ON Side Event at the GEO-X Plenary Session, 2014 Geneva, Ministerial Summit**

**GOA-ON Governance**

The GOA-ON is an integrated international research effort closely linked with other international carbon research programs.

**GOA-ON Executive Council**

*(as of May 2014):*

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  - Libby Jewett (US - NOAA)
- **Members:**
  - Richard Bellerby (Norway - NIVA)
Conceptual Nested System Design: 5 Ecosystem’s: Polar, Temperate, Tropical, Nearshore, and Coral Reef environments.

1. GOAL 1 (Geochem): understanding global OA conditions
2. GOAL 2 (Bio): understanding ecosystem response/feedback
3. GOAL 3: data to optimize modeling for OA

http://www.goa-on.org/
## Conceptual Nested System Design

5 Ecosystems:
- Polar
- Temperate
- Tropical
- Nearshore
- Coral Reef environments.

### GOAL 1 (GeoChem): understanding global OA conditions

### GOAL 2 (Bio): understanding ecosystem response/feedback

### GOAL 3: data to optimize modeling for OA

### Coral reefs

### Coasts & shelf seas

### Open ocean

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<thead>
<tr>
<th>Level 1</th>
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<tr>
<td>Goal 1</td>
<td>Goal 2</td>
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<td>OA conditions</td>
<td>Ecosystem response</td>
<td>OA modeling</td>
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<td>Level 2</td>
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Inputs to models

http://www.goa-on.org/
1. What is the status of U.S. coral reef ecosystem biota?
2. Is community structure changing over time within U.S. coral reef ecosystems?
3. What are the trends in temperature and acidification in waters surrounding U.S. coral reefs?

- Develop scientifically sound, consistent methods and strong partnerships
- Collect geographically comprehensive status and trends data
- Deliver products and tools to provide context for localized monitoring

- NCRMP data provide a robust picture of the status and trends of U.S. coral reef ecosystems and the communities connected to them.
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<td><strong>Biological</strong></td>
<td><strong>Benthos</strong></td>
<td>- 10m x 1m coral demographic surveys&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Stratified random sampling optimized for commercially and ecologically important fish and coral species in shallow (0-30 m) hard bottom areas. Strata include depth, habitat type, and management zone.</td>
<td>Surveys conducted every 2&lt;sup&gt;a&lt;/sup&gt; or 3&lt;sup&gt;a&lt;/sup&gt; years, all surveys generally conducted within the same 3-month season</td>
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<td>Fish</td>
<td>- paired 18m coral demographic transects&lt;sup&gt;p&lt;/sup&gt;</td>
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<td>- 20m line point intercept (LPI) transect&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>- paired 15m phototranssects&lt;sup&gt;p&lt;/sup&gt;</td>
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<td>- 25x2m key species transect&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>- 200x10m towed-diver survey&lt;sup&gt;p&lt;/sup&gt;</td>
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<td>- 25x4m benthic complexity estimates&lt;sup&gt;a&lt;/sup&gt;</td>
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<td><strong>Climate</strong></td>
<td><strong>Thermal stress</strong></td>
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<td>- Temperature/thermal stress: sea surface temperature (SST)</td>
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<td>- Vertical thermal structure</td>
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<td>- coral bleaching HotSpots and degree heating weeks (DHWs) derived from satellite SST</td>
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<td>- sub-surface temperature recorder (STRs) arrays include 4 Sea-Bird sensors at ~1, 5, 15, 25 m depth</td>
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<td><strong>Ocean acidification</strong></td>
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<td>- discrete water sampling</td>
<td><strong>Class 0 and I</strong> (n=15°&lt;sup&gt;0&lt;/sup&gt;, 45°&lt;sup&gt;0&lt;/sup&gt;)</td>
<td>Sampling conducted every 2&lt;sup&gt;a&lt;/sup&gt; or 3&lt;sup&gt;a&lt;/sup&gt; years</td>
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<td>- conductivity-temperature-depth (CTD) cast</td>
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<td>- diurnal cycle water sampling and CTD casts</td>
<td><strong>Class II and III</strong> (n=6°&lt;sup&gt;0&lt;/sup&gt;, 14°&lt;sup&gt;0&lt;/sup&gt;)</td>
<td>Diurnal sampling for 48 hours every 2&lt;sup&gt;a&lt;/sup&gt; or 3&lt;sup&gt;a&lt;/sup&gt; years</td>
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<td>- acoustic doppler current profilers (ADCP)&lt;sup&gt;p&lt;/sup&gt;</td>
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<td>- moored autonomous pCO&lt;sub&gt;2&lt;/sub&gt; (MAPCO2) telemetered surface buoy includes sui generis, Li-COR, Sea-Bird, Aanderaa, and Sunburst sensors</td>
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<td>- discrete water sampling&lt;sup&gt;a&lt;/sup&gt;</td>
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<td><strong>Ecological impacts</strong></td>
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<td><strong>Class III</strong> Fixed sites (n=3°&lt;sup&gt;a&lt;/sup&gt;, 3°&lt;sup&gt;a&lt;/sup&gt;):</td>
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<td>- La Parguera, PR</td>
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<td>- Cheeca Rocks, Islamorada, FL</td>
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<td>- Flower Garden Banks&lt;sup&gt;*&lt;/sup&gt;</td>
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<td>- Kåne’ohe Bay, HI</td>
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<td>- Saipan, CNMI&lt;sup&gt;*&lt;/sup&gt;</td>
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<td>- Aunu’u, American Samoa&lt;sup&gt;*&lt;/sup&gt;</td>
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<td>Data retrieved every 3 hours. Bi-weekly discrete water sampling conducted at Class III sites in the Atlantic.</td>
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<td><strong>Socio-economic</strong></td>
<td>Knowledge, attitudes, and perceptions</td>
<td>- resident in-person, telephone, or internet surveys</td>
<td><strong>Kanoa sampling or residents or inhabited islands/counties in direct proximity to coral reefs, data aggregated to jurisdiction level</strong></td>
<td>Surveys conducted every 3 to 4 years, secondary data compiled and analyzed for the same 3 to 4 year period</td>
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<td>Participation in coral reef activities</td>
<td>- synthesis and analysis of secondary data from public sources (e.g., U.S. Census Bureau, EPA, Bureau of Economic Analysis)</td>
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<td>Economic dependence on coral reefs</td>
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<td>Population changes and distribution</td>
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NOAA National Coral Reef Monitoring Program
Class III Station (n = 6)

GOAL 1

3 hourly, fixed

bi-weekly, fixed

GOAL 2

Tri-annual, fixed

(seasonal)
NOAA National Coral Reef Monitoring Program
Class II Station (n = 20)

GOAL 1

Triannual, fixed

GOAL 2

Tri-annual, fixed
GOAL 1

Triannual, random

NOAA National Coral Reef Monitoring Program
Class 0 Station (n = 600)
NOAA National Coral Reef Monitoring Program
Class 0 Station (n = 600)

Flower Garden Banks

St. John, USVI
NOAA National Coral Reef Monitoring Program
Class 0 Station (n = 600)

Andersson & Gledhill, 2013
Optimal Periods Created by diurnal $\Omega_{\text{arg}}$ Dynamics

La Parguera, Puerto Rico, Class III
Concluding Remarks

• Ocean acidification is but one aspect of global change. It is unfolding in tandem with climate change at rates perhaps unprecedented in earth history. We are in uncharted waters.

• Status & Trends monitoring should be multidisciplinary and serve as an enabling infrastructure to foster understanding. The Global Ocean Acidification Observing Networks (GOA-ON) provides the beginnings of a framework for obtaining globally comparable data on the effects of OA.

• The GOA-ON compliments and significantly leverages existing capacity. It represents a thematic area of inquiry against which to apply and adapt current monitoring capacity where ever possible.

• Continued ocean acidification may further compromise coral reef ecosystem resiliency to recover from episodic climate-induced and local events (thermal stress, disease, ect.). A multidisciplinary monitoring approach should ideally be capable of evaluating this hypothesis if emplaced prior to the next global-scale event.

• The NOAA National Coral Monitoring Program offers an example of GOA-ON implementation within one particular ecosystem of interest. International engagement through the GOA-ON community will work to disseminate and refine these protocols for adoption within international monitoring initiatives.