Local OA Response strategies

Three multi-benefit examples from Washington

Ocean Acidification: From Knowledge to Action

*Washington State’s Strategic Response*


By Brad Warren
globaloceanhealth.org
Introduction

- Who we are
- Example 1: Biogas digesters: tackling multiple problems
- Example 2: Coastal vegetation and OA
- Example 3: Pilot on SLR v OA
1. Dairy methane, nutrient runoff

Among U.S. dairies larger than 300 cows in 2000, 75% were spreading manure at rates exceeding crop needs for nitrogen; 96% exceeded crop needs for phosphorus. SOURCE: Ribaudo et al 2003, per WSU Fact Sheet 040E.

Anthropogenic increase in bio-available N exceeds increase in CO2, SOURCE: Howarth et al 2002
Game changer on nutrients: Trust

Terry Williams, Tulalip Tribes, reached out to farmers and hit “reset” button
Reducing nutrients and emissions

- Nationwide, dairy manure digesters reduce CO$_2$e emissions by > 860,000 t, generating 52.8 mw of power.
- Six dairy digesters in Washington reduced CO$_2$e emissions by 44,870 t.
- Tulalip’s project has enfranchised farmers in habitat, water quality efforts.
The diagram illustrates the process of converting various waste materials into useful products through an Anaerobic Digester. Here’s a breakdown:

- **Dairy Manure**: Used in the Anaerobic Digester to produce RNG (Renewable Natural Gas).
- **Food Processing Waste**: Also fed into the Anaerobic Digester to generate RNG.
- **Other Organics**: Contributing to the biomass feedstock for the digester.

**Outputs from the Anaerobic Digester**:
- **Carbon Credits**: Emissions reductions.
- **Pipeline Quality RNG**: Renewable natural gas for energy production.
- **Fiber**: Used for various applications.
- **Nutrient Recovery**:
  - **Bio-fertilizer**: 50% N, 90% P.
  - **Ammonium Sulfate Crystals**
  - **Peat Moss Substitute and Cow Bedding**

**Additional Products**:
- **Transportation**: Benefit from reduced emissions due to RNG use.

This system effectively manages waste while generating valuable outputs.
Greenhouses & Digesters: Powerful Synergies

AD System outputs:
- CO2
- Reclaimed water
- Nutrients (NPK, micro)
- Fiber, potting soil

Greenhouse inputs
2. Coastal vegetation and OA

— 3-4 studies under way on West Coast, 1 on East
— Coast Focus on seagrass & kelp

**Preliminary results**
— clear effects from photosynthesis
— strong diurnal signal
— conditions matter: depth, flow, density etc
First documented refuge?

Ocean Acidification Refugia of the Florida Reef Tract

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Abstract

Ocean acidification (OA) is expected to reduce the calcification rates of marine organisms, yet we have little understanding of how OA will manifest within dynamic, real-world systems. Natural CO₂, alkalinity, and salinity gradients can significantly alter local carbonate chemistry, and thereby create a range of susceptibility for different ecosystems to OA. As such, there is a need to characterize this natural variability of seawater carbonate chemistry, especially within coastal ecosystems. Since 2009, carbonate chemistry data have been collected on the Florida Reef Tract (FRT). During periods of heightened productivity, there is a net uptake of total CO₂ (TCO₂) which increases aragonite saturation state (Ω₉₉₉₉) values on inshore patch reefs of the upper FRT. These waters can exhibit greater Ω₉₉₉₉ than what has been modeled for the tropical surface ocean during preindustrial times, with mean (± std. error) Ω₉₉₉₉ values in spring = 4.69 (± 0.101). Conversely, Ω₉₉₉₉ values on offshore reefs generally represent oceanic carbonate chemistries consistent with present day tropical surface ocean conditions. This gradient is opposite from what has been reported for other reef environments. We hypothesize this pattern is caused by the photosynthetic uptake of TCO₂ mainly by seagrasses and, to a lesser extent, macroalgae in the inshore waters of the FRT. These inshore reef habitats are therefore potential acidification refugia that are defined not only in a spatial sense, but also in time; coinciding with seasonal productivity dynamics. Coral reefs located within or immediately downstream of seagrass beds may find refuge from OA.
3. SLR vs OA?

Storm in South Korea, 2012. Reuters
Is there a silver lining?

1 meter of sea level rise...

- In U.S., inundated area = size of New Jersey
- Can we learn to manage this new coastal inundation zone?
- Huge potential to deliver
  - flood protection
  - fisheries & aquaculture
  - acidification refuges
  - carbon sequestration
Delicate ribbon of coastal carbon burial

0.5% of ocean area roughly matches all world forests

Total vegetated marine habitat (seagrass, mangrove, saltmarsh) is 1.7 million sq km today.

Nicholls, RJ and multiple authors, 2007. Chapter 6 Coastal systems and low-lying areas. IPCC Working Group 2, Fourth Assessment Report: Climate Change 2007. (Table 6.12)
Coastal ecosystems have high carbon sequestration rates

Rate of carbon sequestration in sediment (gC m² y⁻¹)

- Tropical forests
- Temperate forests
- Boreal forests
- Grasslands
- Deserts
- Tundra
- Wetlands
- Tidal Salt Marshes
- Mangroves
- Seagrass meadows

Adapted from Laffoley & Grimsditch eds. 2009
Can we make SLR into a friend?

Projected change in habitat at Grays Harbor with 1m increase

<table>
<thead>
<tr>
<th>Amount of change</th>
<th>Sea Level Rise</th>
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<tbody>
<tr>
<td>NWI habitat categories</td>
<td>Our Habitat Category</td>
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<tr>
<td>Dry Land</td>
<td>Dry Land</td>
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<tr>
<td>Nontidal Swamp</td>
<td>Forest</td>
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<tr>
<td>Inland Fresh Marsh</td>
<td>Scrub/Shrub Cover</td>
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<tr>
<td>Tidal Fresh Marsh</td>
<td>High Emergent Marsh</td>
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<tr>
<td>Transitional Marsh / Scrub Shrub</td>
<td>Scrub/Shrub Cover</td>
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<tr>
<td>Regularly Flooded Marsh (Saltmarsh)</td>
<td>High Emergent Marsh</td>
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<tr>
<td>Estuarine Beach</td>
<td>Cobble/gravel/Sand beach</td>
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<tr>
<td>Tidal Flat</td>
<td>Mud Flat/Sand Flat</td>
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<tr>
<td>Inland Open Water</td>
<td>Open Water</td>
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<tr>
<td>Riverine Tidal Open Water</td>
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<td>Aquatic Vegetation Beds?</td>
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<td>Inland Shore</td>
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<tr>
<td>Tidal Swamp</td>
<td>Forest</td>
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</tbody>
</table>
Can high-res data give communities power to manage change?

1m vertical

15cm vertical