Temperature and Water Quality in Wequetequock Cove: What does climate change mean for the cove?

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Introduction

In recent years, Wequetequock Cove in Stonington, Connecticut has been experiencing poor water quality. In particular, measurements of water quality parameters by the organization Clean Up the Sound and Harbors (CUSH) have consistently revealed low dissolved oxygen concentrations in summer mornings, including the complete absence of oxygen on some occasions. During the night and into the early morning, in the absence of oxygen-producing photosynthesis, biota respire all available.

In light of warming water temperatures due to global climate change we examined the relationship of temperature to oxygen and chlorophyll concentrations to uncover the influence of temperature on water quality. Chlorophyll is a measure of phytoplankton abundances in the water. Our results suggest that the progressive increase in the duration of warm summer conditions is likely to exacerbate low oxygen conditions in Wequetequock Cove.

Objectives

Based on water quality measurements made by CUSH in summer months of 2009-2015

- Compare oxygen concentrations in Wequetequock Cove to those offshore of Sandy Point
- Determine whether oxygen concentrations are related to water temperatures in Wequetequock Cove and Sandy Point
- Determine whether chlorophyll-a concentrations generally increase as a function of water temperature

Map of Study Site

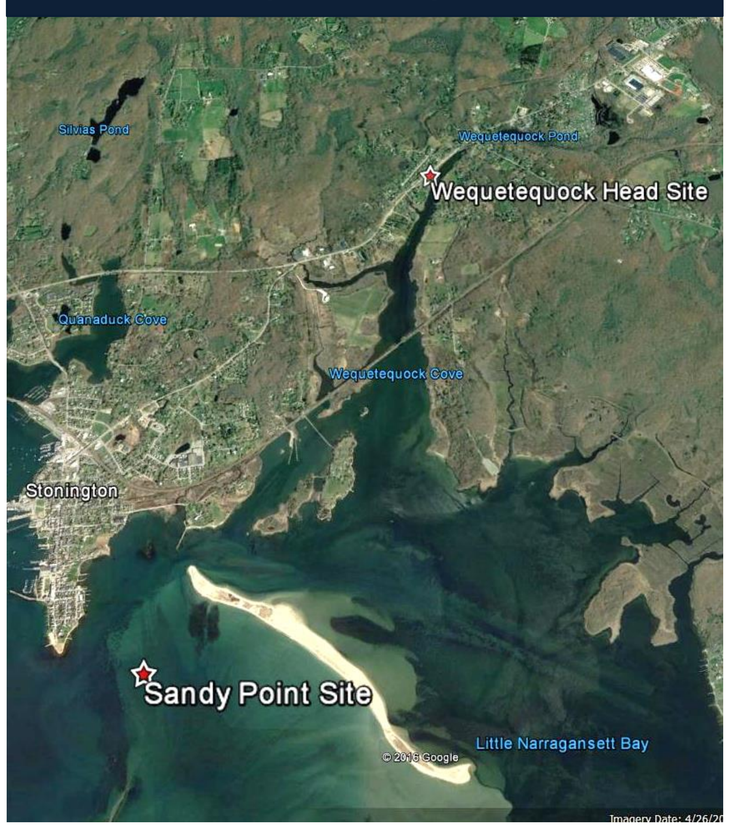

Figure 1: Map of study site in Stonington, Connecticut.

Results

- **Oxygen concentrations** in early morning tended to be lower at higher water temperatures, more so in Wequetequock Cove compared to Sandy Point (Fig. 2).
- **Oxygen saturation** in early morning was generally lower at higher water temperatures in Wequetequock Cove (Fig. 3)
- At Sandy Point, oxygen in early morning was generally slightly under-saturated with respect to atmospheric oxygen, but not in apparent relation to water temperature (Fig. 3)
- **Chlorophyll-a concentrations** increased exponentially as a function of water temperature in Wequetequock Cove (Fig. 4).
- A temperature effect on chlorophyll-a was not apparent at Sandy Point (Fig. 4).

Dissolved Oxygen vs. Temperature

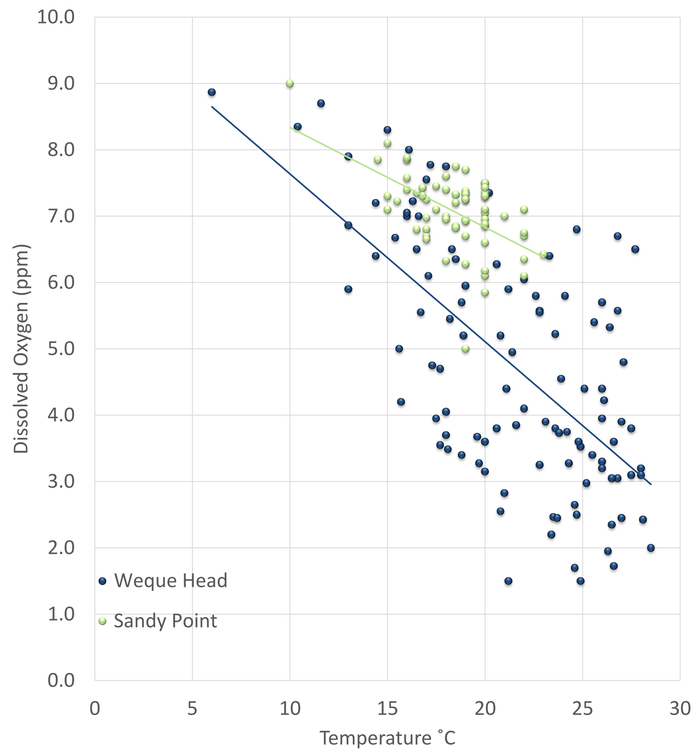

Figure 2: Early–morning concentrations of dissolved oxygen vs. water temperature at Wequetequock Head and Sandy Point.

Oxygen Saturation vs. Temperature

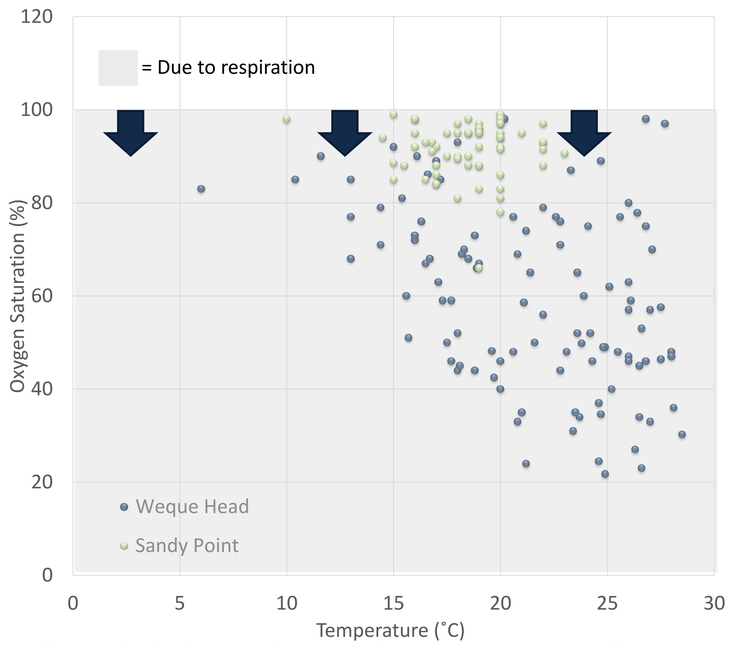

Figure 3: Early-morning morning measurements of oxygen saturation vs. temperature at Wequetequock Head and Sandy Point in Stonington, CT.

Chlorophyll-a vs. Temperature

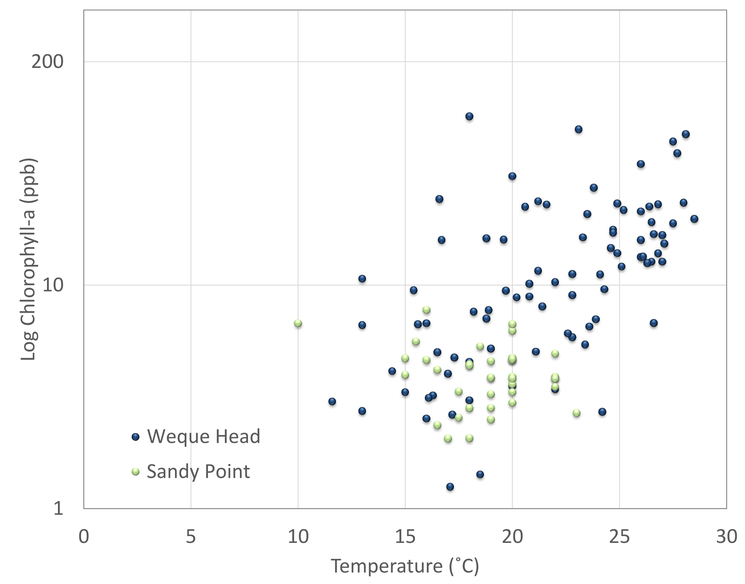

Figure 4: Chlorophyll-a concentrations in early-morning (log scale) vs. water temperature in Wequetequock Cove and Sandy Point.

Discussion

Oxygen concentrations decreased as a function of temperature at Wequetequock Cove and Sandy Point. This is expected on the basis that oxygen is less soluble at higher temperatures. In addition, **oxygen saturation** decreased with increasing temperature in Wequetequock Cove; oxygen saturation should be at 100% regardless of temperature unless it has been consumed. Thus, the **biological consumption** of oxygen at night time through to early morning, namely, **respiration**, increases with temperature in the cove. The rate of respiration of organisms is known to increase with temperature. Moreover, throughout the summer season, temperatures are increasing allowing for buildup of plant life which results in a higher oxygen demand in the cove. Indeed, **chlorophyll-a concentrations**, proportional to phytoplankton abundances, correlated exponentially with water temperature in the cove. Thus, higher summer-time biomass in the cove enabled by warm temperatures result in the near full consumption of O2 at night when there is no photosynthesis.

At Sandy Point, slight oxygen under-saturation indicates consumption by respiration. Temperature does not correlate with either the degree of under-saturation nor with chlorophyll-a concentrations. This likely results from the higher water flushing at Sandy Point with oxygen-replete and chlorophyll-a deplete water from offshore.

Coastal water temperatures and the duration of the summer season are expected to increase due to global climate change. This may lead to further increases in chlorophyll-a concentrations and/or macro-algae biomass in Wequetequock Cove, and concurrent decreases in dissolved oxygen over longer time periods. Unless the loading of nutrients that over-fertilize the cove is curtailed, water quality in Wequetequock Cove may deteriorate further.

References

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