Anthropogenic Influence on *K. brevis* Blooms near Venice, Florida

Phase 1 Report

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Introduction

Following discussions with the Sarasota Bay Estuary Program (SBEP), the University of Florida Center for Coastal Solutions (CCS) proposed a project to investigate the influence of nutrient-enriched freshwater inputs on *Karenia brevis* bloom dynamics in the Gulf of Mexico near Venice Inlet, considering that construction of canals during the 20th century expanded the associated drainage basin fivefold from its historical extent (from approximately 15 mi^2 to 75 mi^2). This Phase 1 report provides an assessment of the intensity and duration of *K. brevis* blooms near Venice Inlet relative to three nearby inlets: Longboat Pass, Big Sarasota Pass, and Stump Pass. If SBEP elects to pursue Phase 2 of the project, the goal would be to quantify causal relationships between *K. brevis* dynamics near Venice Inlet and upstream watershed covariates (water quality and discharge), using nonlinear time series analysis.

Methods

K. brevis concentration data (cells/L) were obtained from the NOAA HABSOS database, version 5.5 (NOAA National Centers for Environmental Information, 2014). The analysis includes data from the vicinity of each of the four inlets between June 2012 through March 2020, with 'vicinity' defined as the area within 0.3° latitude north and south of the inlet, and within 1.6 km west of the coastline. The 2012–2020 study period was determined by the availability of data near Venice Inlet (there was a substantial monitoring gap near Venice Inlet after March 2020). The locations of *K. brevis* sampling near each inlet are shown in **Figure 1**.

Using R version 4.1.0 (R Core Team, 2021), the log-transformed *K. brevis* data from each of the four study areas were visualized against time to investigate bloom events. In addition, the empirical cumulative distribution function (ECDF) was plotted for each area to visualize non-zero *K. brevis* concentration distributions. The non-parametric Kolmogorov-Smirnov procedure was used to test whether the distribution at Venice Inlet was significantly greater than the distributions at the three comparison areas (α=0.05).

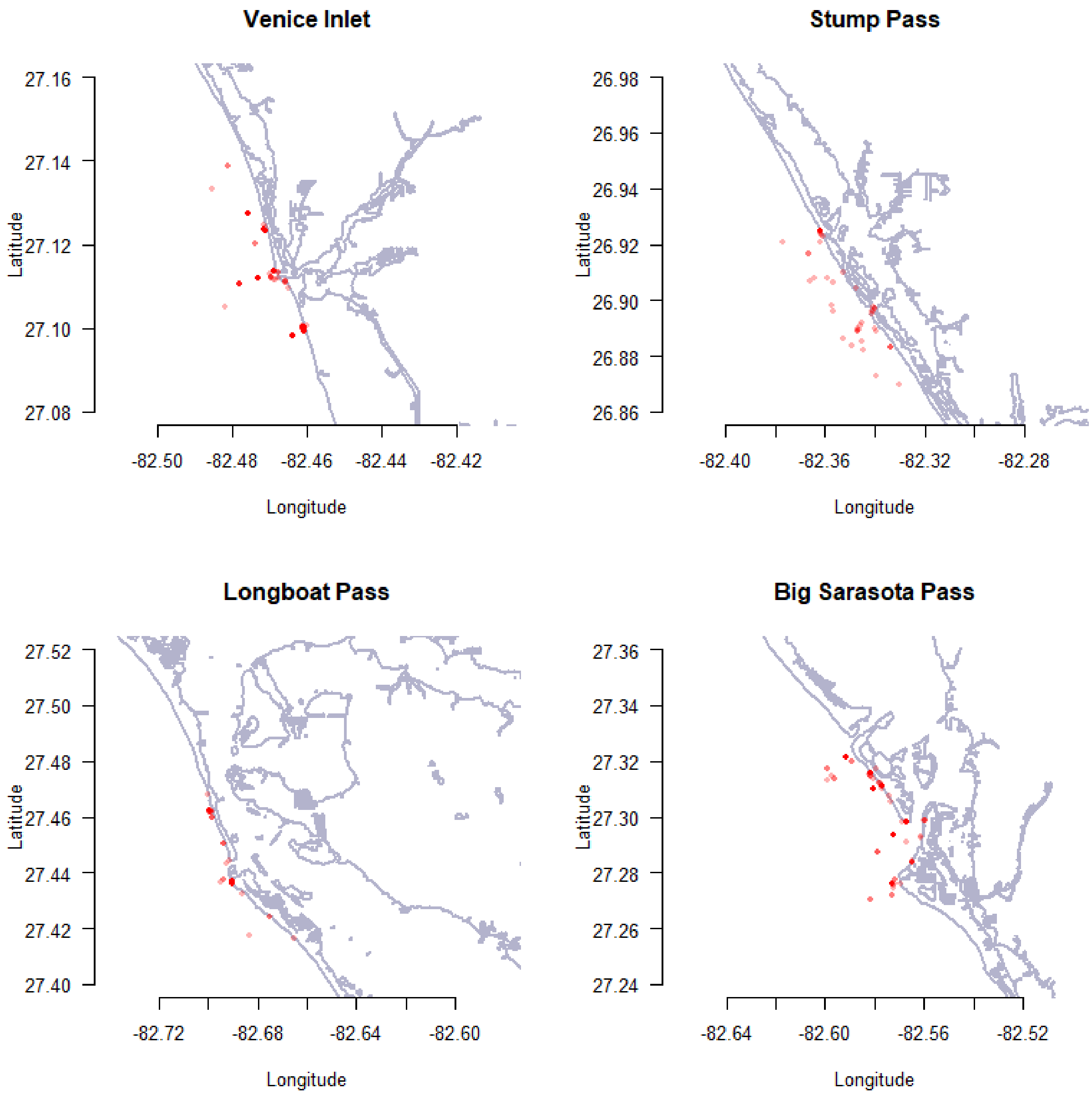

Figure 1. Sample locations (red points) at Venice Inlet and at the three comparison areas. A point with greater color saturation indicates repeated sampling at the same location.

Results

The analysis provided no indication that *K. brevis* bloom intensity and duration were greater at Venice Inlet than at the three comparison areas between June 2012 through March 2020. A visual examination of time plots (**Figure 2**) suggests that bloom intensities and durations were similar across all four areas. Within each of these plots, the periods highlighted in red indicate bloom events near Venice Inlet, as determined by visual assessment of the data. The time plots indicate that the durations of blooms near

Venice Inlet were similar to those near Big Sarasota Pass and Stump Pass. The data from Longboat Pass were too sparse to support comparison of bloom durations.

Regarding bloom intensities, the time plots (**Figure 2**) indicate that during each bloom event, the maximum order of magnitude of observed *K. brevis* concentrations near Venice Inlet was equaled or exceeded by observations at one or more comparison areas. For instance, during the 2016–2017 bloom, concentrations near Venice Inlet exceeded 10^6 cells/L, and Big Sarasota Pass and Stump Pass showed a similar intensity with one observation at Stump Pass exceeding 10^7 cells/L. Further, ECDF plots (**Figure 3**), which visualize the overall distributions of non-zero *K. brevis* concentrations across the study areas, indicate that the Venice Inlet distribution was similar to the distributions at the three comparison areas. Because most bloom events near Longboat Pass were under-sampled (**Figure 2**), the ECDF is poorly resolved and likely biased downward (**Figure 3**). Despite this limitation, Kolmogorov-Smirnov tests (**Table 1**) confirmed that the Venice Inlet distribution was not significantly greater than the distributions from the comparison areas ($P>0.05$). Exclusion of samples containing zero cells provided a more conservative test, and the Kolmogorov-Smirnov results were robust to the inclusion of zeros.

References

NOAA National Centers for Environmental Information. (2014). *Physical and biological data collected along the Texas, Mississippi, Alabama, and Florida Gulf coasts in the Gulf of Mexico as part of the Harmful Algal BloomS Observing System from 1953-08-19 to 2021-03-09 (NCEI Accession 0120767.5.5)*. Retrieved from: https://www.ncei.noaa.gov/archive/accession/0120767

R Core Team. (2021). R: A language and environment for statistical computing (Version 4.1.0). Vienna, Austria: R Foundation for Statistical Computing. Retrieved from https://www.R-project.org/

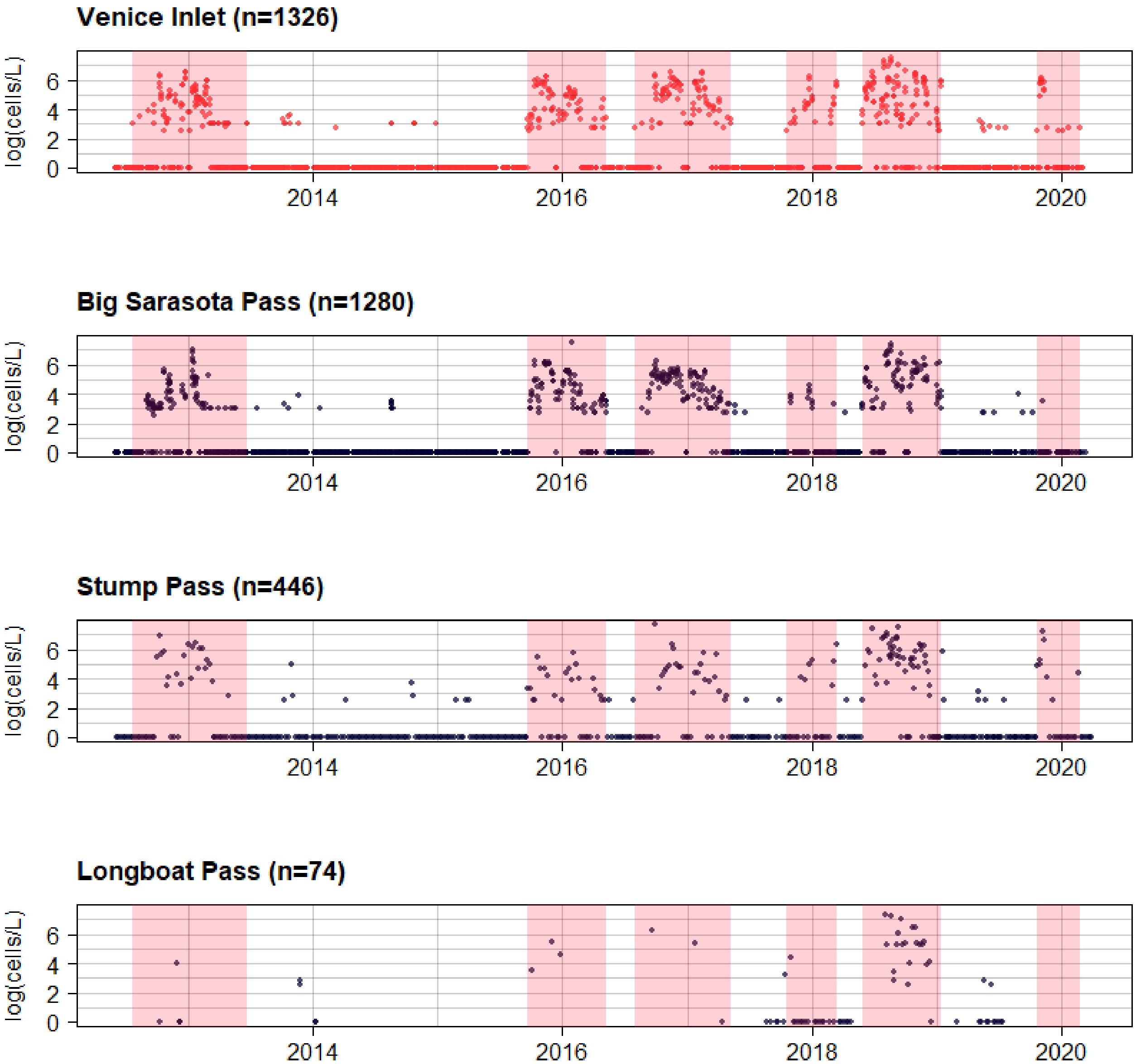

Figure 2. Time plots display log-transformed *K. brevis* concentrations over time at the four study areas. Sample sizes (n) varied across areas. Periods highlighted in red indicate bloom events near Venice Inlet.

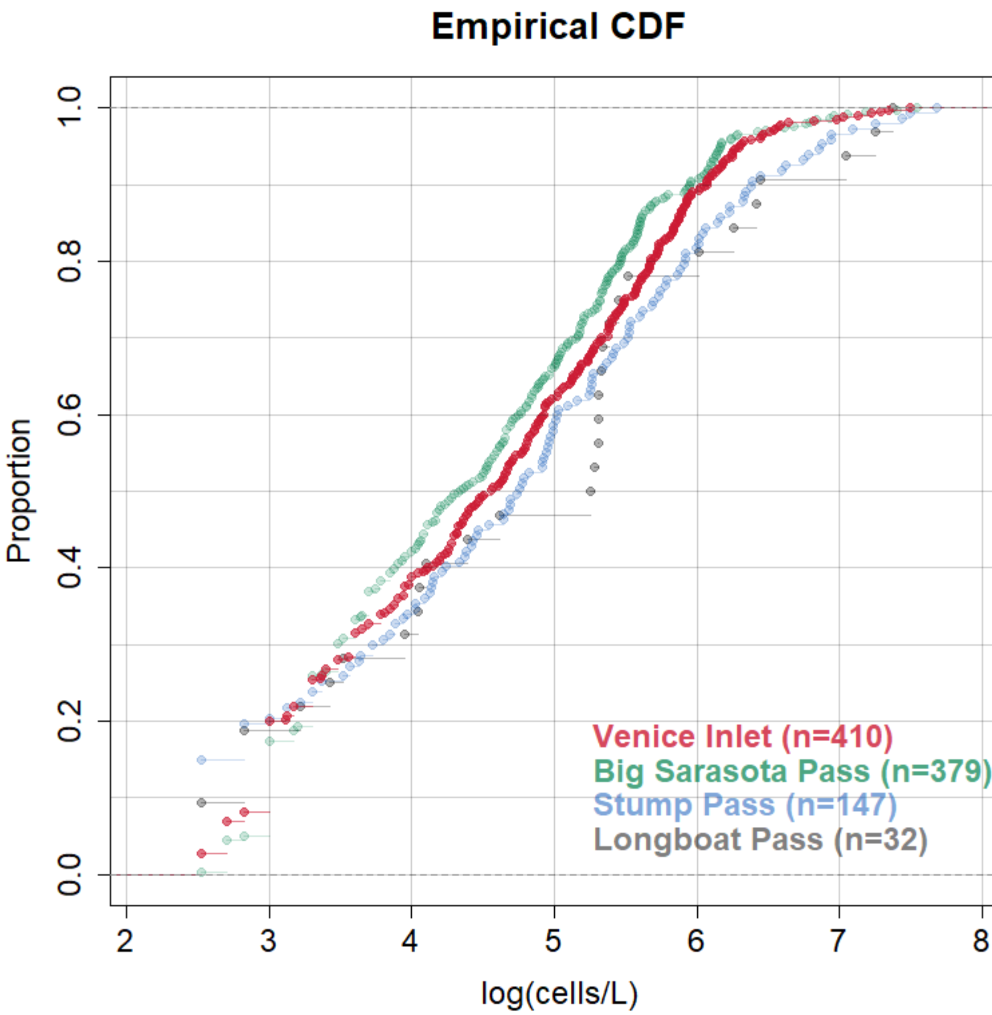

Figure 3. Empirical cumulative distribution functions for non-zero *K. brevis* concentrations at the four study areas. The vertical axis indicates the proportion of observed values less than or equal to a given log-transformed *K. brevis* concentration (horizontal axis).

Table 1. Kolmogorov-Smirnov results.

Comparison area	*D statistic*	*P*
Longboat Pass	0.207	0.079
Big Sarasota Pass	0.033	0.648
Stump Pass	0.083	0.226