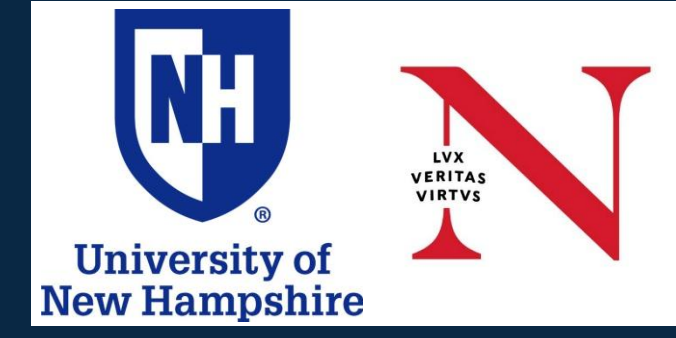


Exploring *Vibrio* Population Ecology in New Hampshire's Great Bay Estuary

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Introduction

Vibrio spp. are bacteria that naturally occur in New England coastal waters.

- Some species can be pathogenic, causing an infection called vibriosis.
- In the U.S., there are 80,000 annual cases of vibriosis, with 65% of infections from consuming contaminated raw shellfish such as oysters¹.
- Over the past few decades, the number of vibriosis cases has increased, corresponding with warmer ocean temperatures^{2,3}.

Since 2007, *V. parahaemolyticus*, *V. vulnificus*, and *V. cholerae* have been consistently monitored in New Hampshire's Great Bay Estuary^{3,4}.

- *V. parahaemolyticus* is the leading cause of vibriosis and the most prevalent species in the region^{1,3}.
- *V. vulnificus* can cause serious infections with high mortality rates¹.
- *V. cholerae* can cause cholera, but infections are rare in the northeast¹.

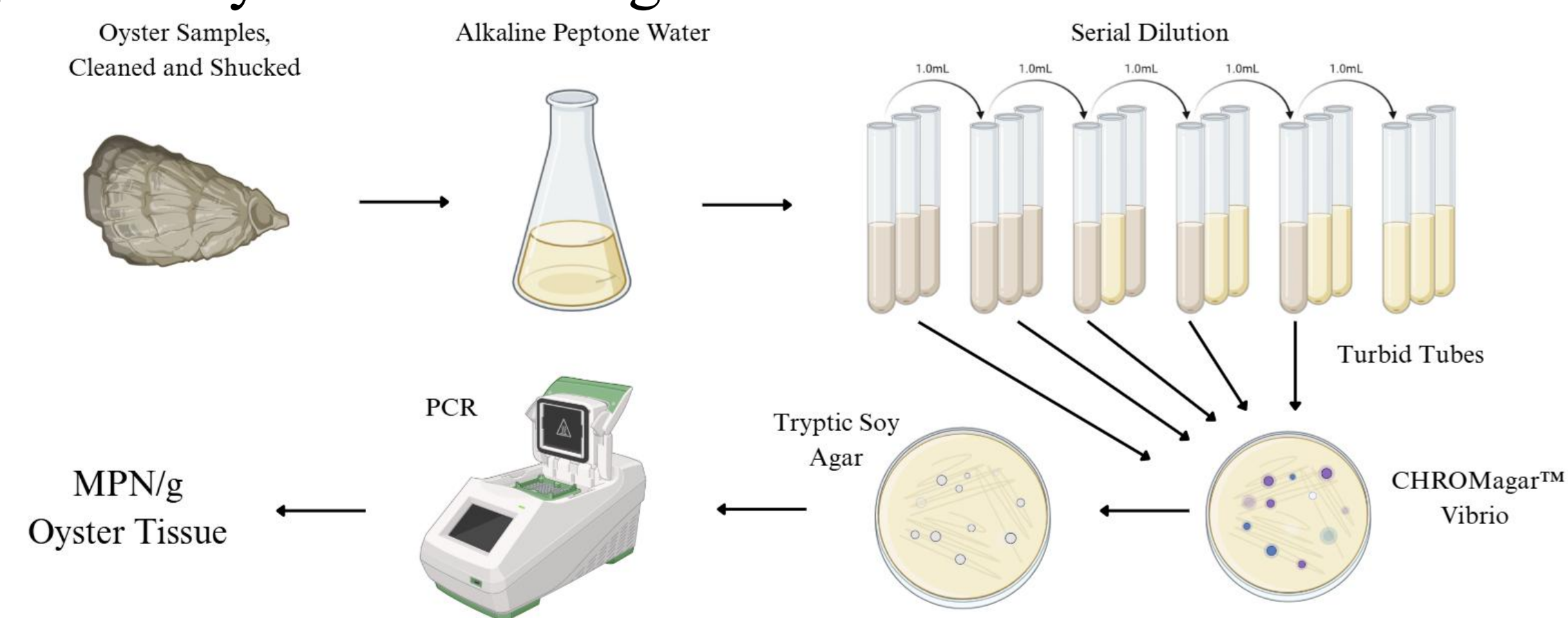
The ecology of *V. parahaemolyticus* has been well studied in Great Bay^{3,4}, but that of *V. vulnificus* and *V. cholerae* remains largely unknown. Understanding the population trends of all three species in relation to ecological conditions can provide important knowledge for shellfish producers and public health agencies to manage public health risks.

Objectives

- Compare the long-term population trends of *Vibrio* spp. in oysters, water, and sediment in Great Bay.
- Identify the ecological factors correlated with *Vibrio* concentrations.

Methods

Figure 1: Oyster Processing Protocol

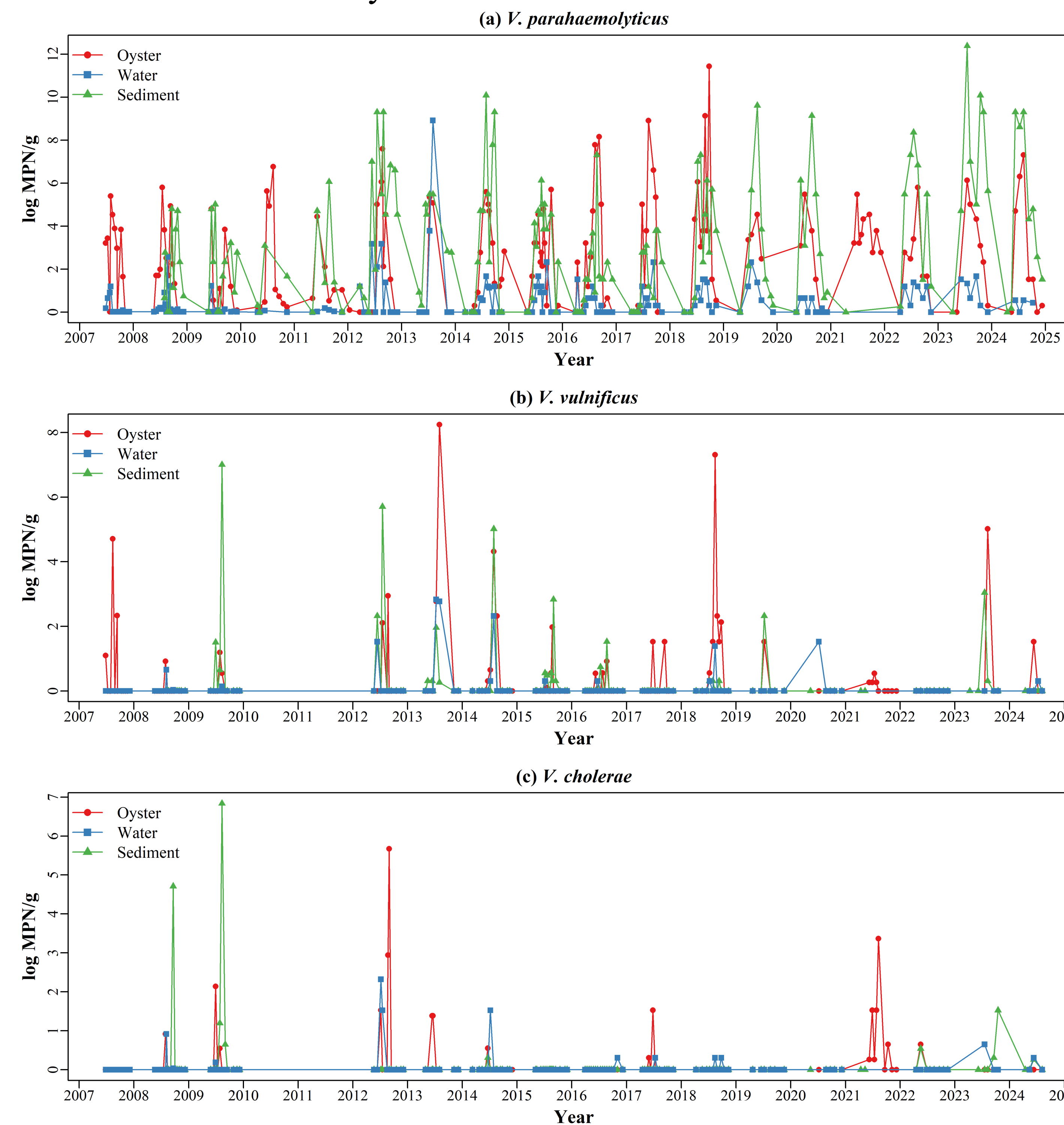


Oysters were collected from two natural beds in Great Bay monthly from April to December. Oysters were cleaned, shucked, weighed, and homogenized with alkaline peptone water (APW). The oyster-APW mixture was serially diluted in triplicate and enriched overnight at 37°C. APW tubes with growth were streaked onto CHROMagar™ Vibrio, where *V. parahaemolyticus* appears as purple, and *V. vulnificus* and *V. cholerae* appear as blue colonies. Isolates of each color were re-streaked onto tryptic soy agar (TSA) for further isolation. TSA colonies were boiled to make lysates containing DNA for PCR to confirm species ID and determine the concentration (MPN/g oyster tissue) of each species in each sample^{3,4}. This protocol was also completed for the water and sediment samples.

Data analyses were performed using R statistical software. *Vibrio* spp. concentrations were log transformed before analysis to ensure data normality. Trends in average annual concentrations were assessed using one-way ANCOVAs. Generalized linear models with a negative binomial distribution were fit to determine environmental predictors of *Vibrio* concentrations in oysters³. Temperature, salinity, and pH data for 2007 to 2024 were downloaded from the Great Bay National Estuarine Research Reserve's buoys⁵.

Results

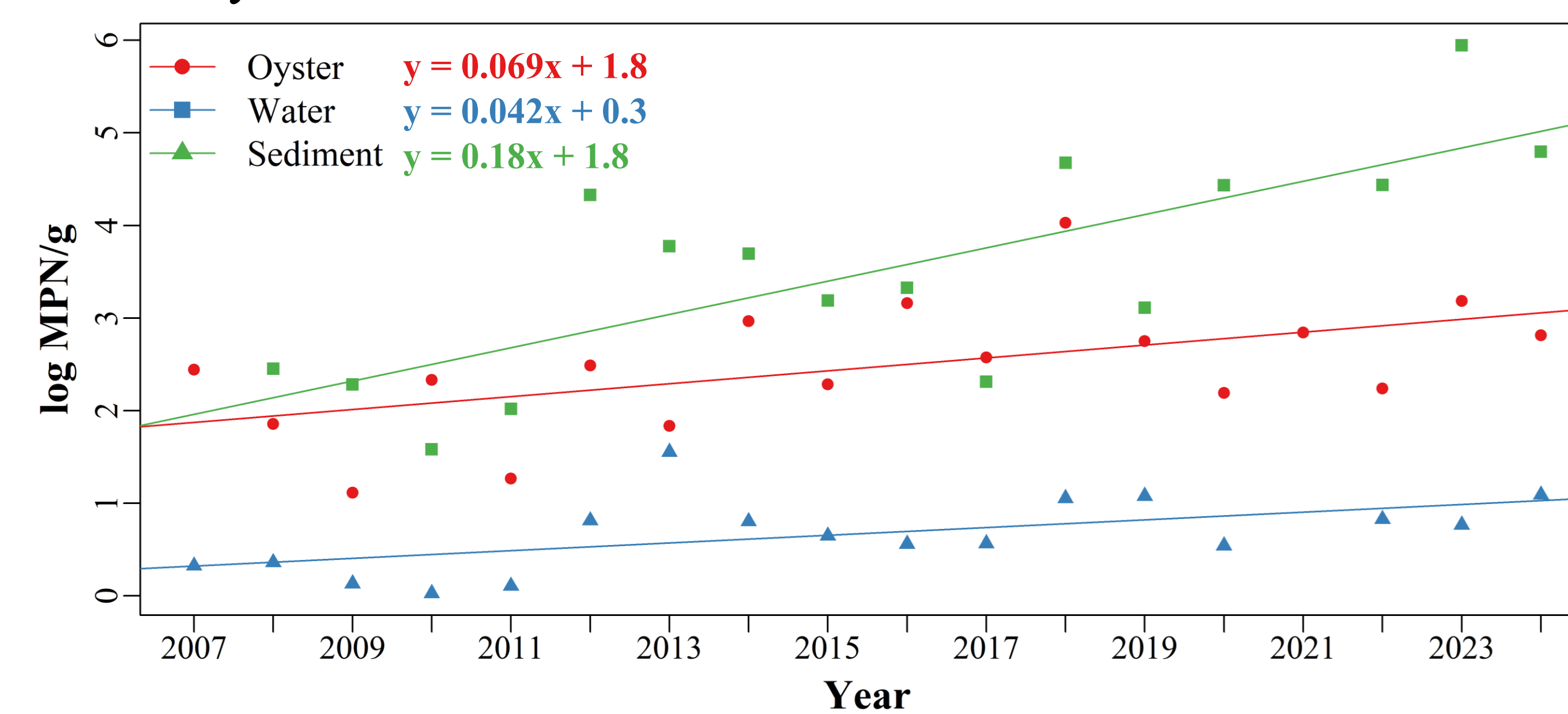
Figure 2: *Vibrio* spp. concentrations in oysters, water, and sediment from 2007 to 2024 in Great Bay.



Total Percent Detection (Oyster, Water, Sediment):

- *V. parahaemolyticus*: 74%, 56%, 72%
- *V. vulnificus*: 18%, 7%, 13%
- *V. cholerae*: 9%, 6%, 5%

Figure 3: Average annual *V. parahaemolyticus* concentrations increased significantly ($p < 0.05$) in oysters, water, and sediment from 2007 to 2024 in Great Bay. $R^2 = 0.81$.

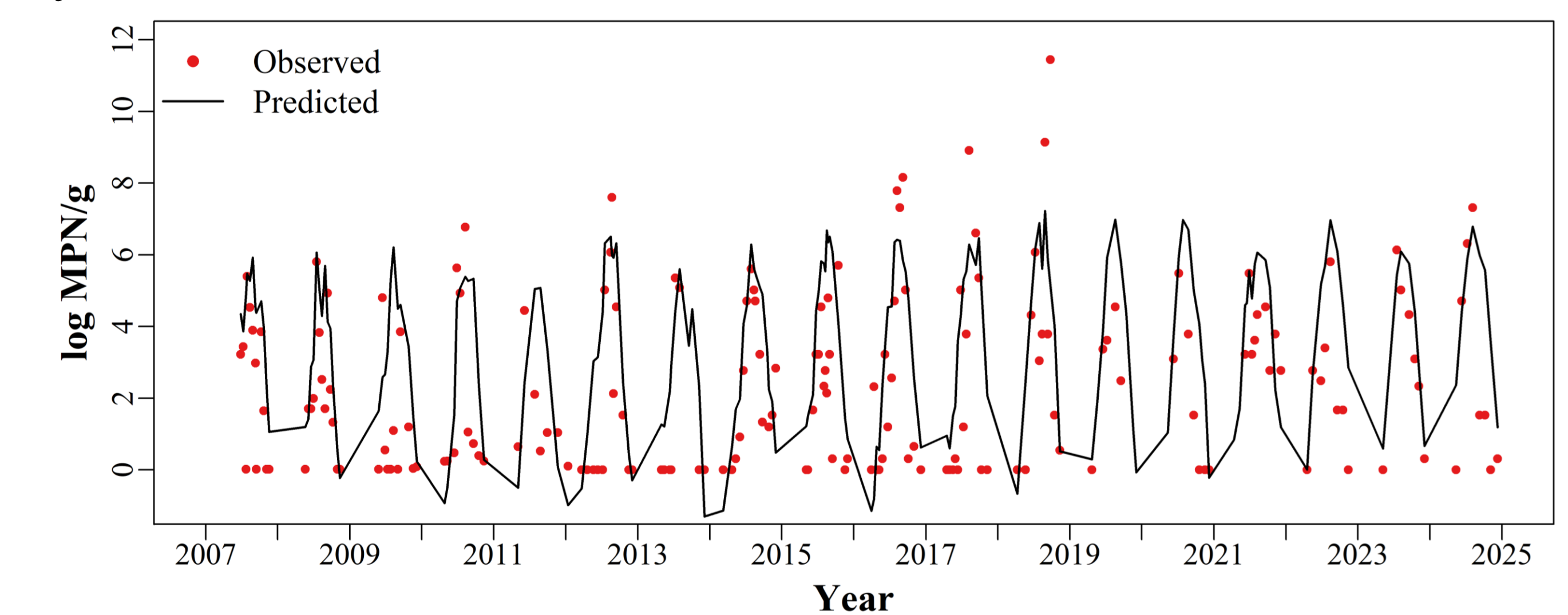


Results

Table 1: Negative binomial regression results for *V. parahaemolyticus* concentrations in Great Bay oysters from 2007 to 2024. Significance codes: *0.001, **0.01, *0.05.**

Variable	Coefficient	Standard Error	Chi-Square (DF = 1)	P
Site	2.57	1.51	22.21	0.000024 ***
Time	0.00016	0.000065	3.98	0.046 *
Site:Time	-0.000099	0.000090	0.70	0.40
Temperature	0.23	0.054	16.70	0.000044 ***
Salinity	0.052	0.020	5.07	0.024 *
pH	2.23	0.42	20.18	0.0000071 ***
sin	-1.73	0.31	25.62	0.00000034 ***
cos	-0.94	0.57	2.57	0.11

Figure 4: Observed and predicted values (negative binomial regression) for *V. parahaemolyticus* concentrations in Great Bay oysters from 2007 to 2024. $R^2 = 0.49$.



Discussion & Future Implications

Population Trends

- *V. parahaemolyticus* concentrations have increased significantly in Great Bay since 2007, with the highest concentrations found in sediment.
- *V. vulnificus* and *V. cholerae* have remained at relatively low concentrations.

Modeling & Ecological Factors

- Negative binomial regression provides a moderate fit for capturing *V. parahaemolyticus* population trends³, while additional data are needed to develop effective models for *V. vulnificus* and *V. cholerae*.
- Temperature is a significant predictor of *Vibrio* spp. concentrations – as Great Bay's water temperature continues to rise, *Vibrio* concentrations will likely increase, furthering the need for monitoring to protect public health⁶.

Acknowledgements & References

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