

The Neurological Effects of Florida Red Tide (FRT) Blooms

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BACKGROUND:

Previous research has demonstrated that *Karenia brevis* blooms, the main dinoflagellate responsible for Florida Red Tide, predict emergency department visits and in-patient admissions for both respiratory and digestive illnesses.

In this study, we analyzed if Florida Red Tide blooms predict neurological illnesses.

CLINICAL SYMPTOMS:

Karenia brevis is responsible for neurotoxic shellfish poisoning (NSP). Some of the clinical symptoms of NSP are:

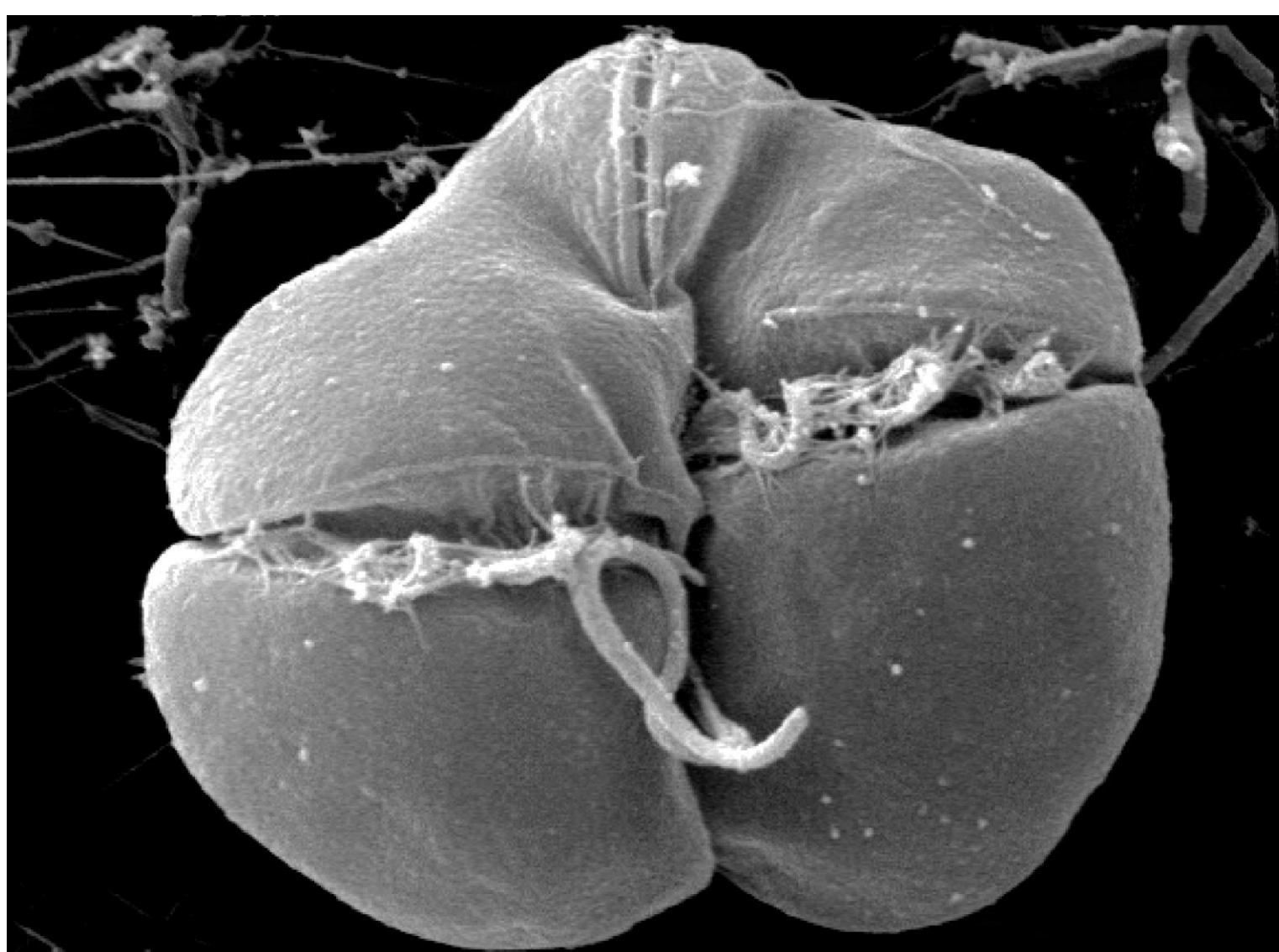
- Vomiting and nausea
- Paresthesias of the mouth, lips, and tongue
- Slurred speech
- Dizziness
- Partial paralysis

Figure 1 – *Karenia brevis* cell (right).

K. brevis cells contains brevetoxins, a type of neurotoxin responsible for neurotoxic shellfish poisoning.

Figure 2 – Red Tide Algal Bloom by Little Gasparilla Island, FL in 2006 (below).

K. brevis cells rupture with breaking waves and release their neurotoxin, which also causes discoloration of water.



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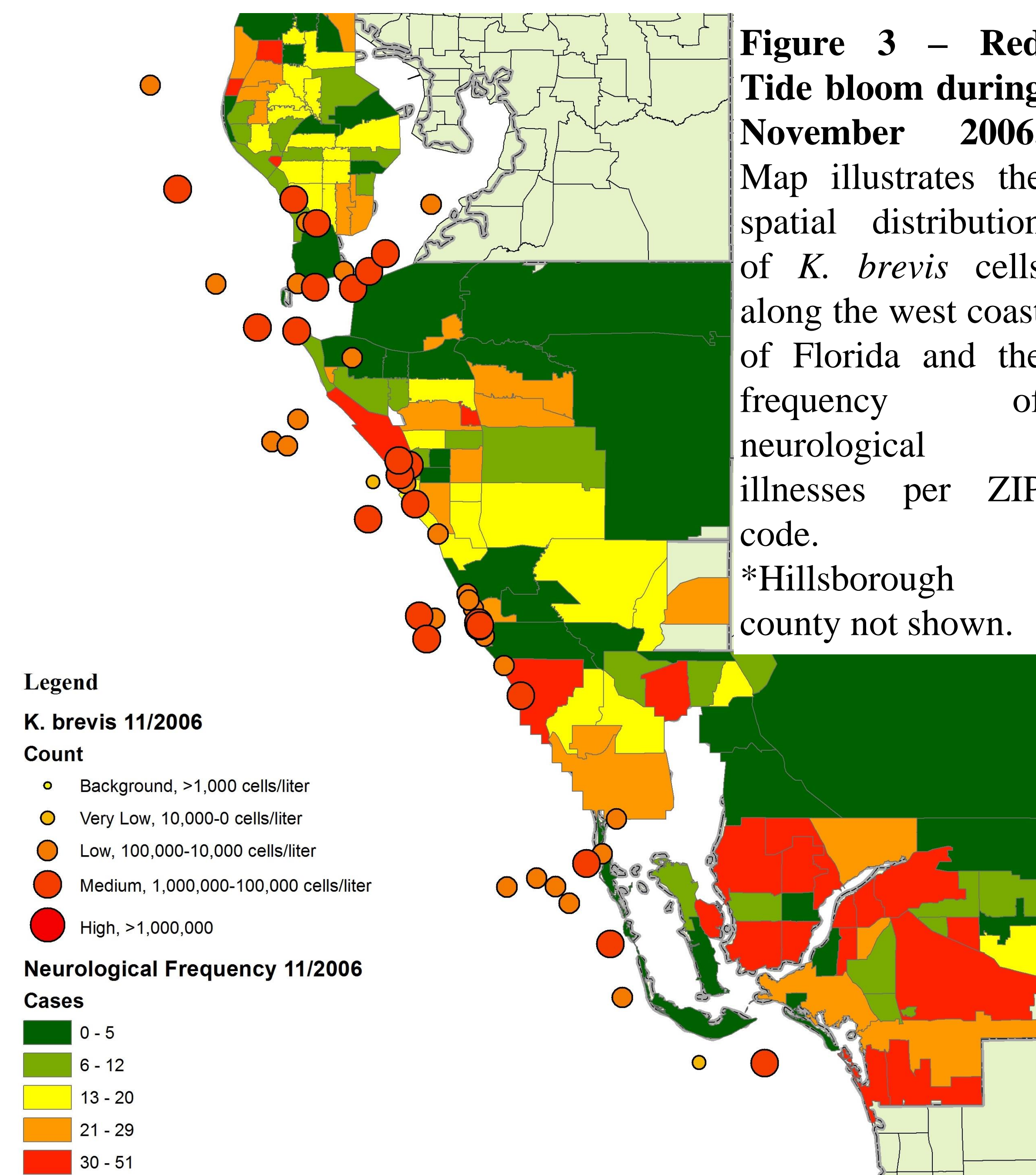


Figure 3 – Red Tide bloom during November 2006. Map illustrates the spatial distribution of *K. brevis* cells along the west coast of Florida and the frequency of neurological illnesses per ZIP code. *Hillsborough county not shown.

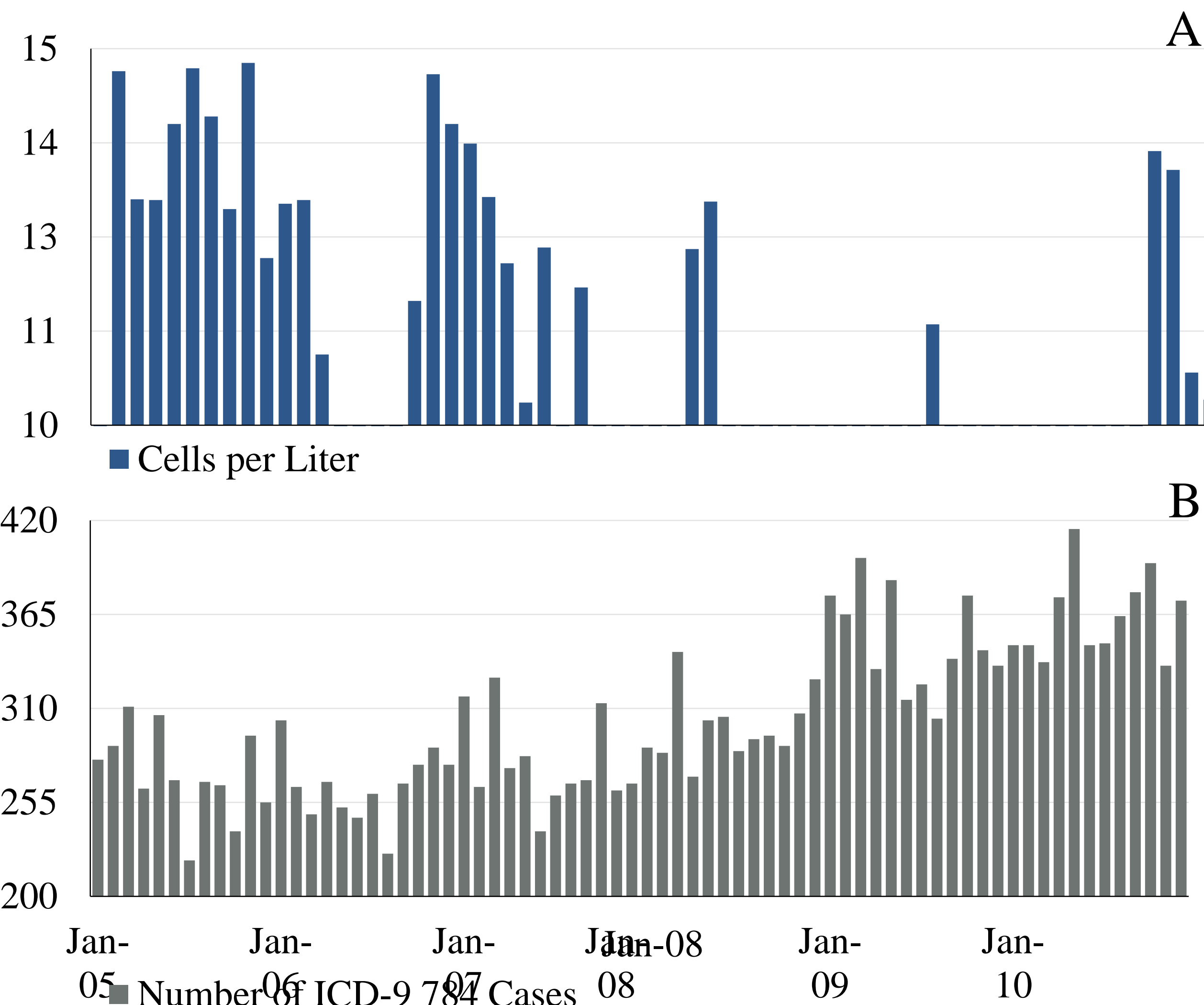


Figure 4A – Density of *Karenia brevis* cell counts. Graph illustrating the density of *K. brevis* cells during Red Tide blooms from 2005 through early 2010.

Figure 4B – Frequency of ICD-9 784. Graph illustrating the frequency of ICD-9 784, Symptoms involving head and neck, from 2005 through early 2010.

Reference:

1. Hoagland P, Jin D, Beet A, Kirkpatrick B, Reich A, Ullmann S, Fleming L, Kirkpatrick G (2014), The human health effects of Florida Red Tide (FRT) blooms: An expanded analysis. Environment International 68: 144-153.

METHODS:

- Florida Red Tide blooms were plotted spatially in ArcGIS
- Blooms were assigned colors and sizes based on *K. brevis* cells per liter (Figure 3)
- Emergency and in-patient data were sorted by ICD-9 code, then assigned to their respective locations by ZIP code
- ICD-9 is a standard diagnostic tool for clinical purposes
- Time-Series Cross-Section (TSCS) Regressions¹ were run using general categories of neurological illness counts
- Time-series of monthly data from 2005-09
- Cross-section coastal zip codes in 6 FL counties: Pinellas, Hillsborough, Manatee, Sarasota, Charlotte, and Lee
- Response measured as all illnesses in the following categories of neurological illnesses: Diseases of the nervous system (ICD-9 320-359), Diseases of the sense organs (360-389), Diseases of the musculoskeletal system and connective tissue (710-739), Symptoms, signs, and ill-defined conditions (780-799), Injury and poisoning (800-999)
- Predictor was Kb counts squared
- Controlled for county populations, tourist visits using hotel occupancy, months, and years

RESULTS:

We developed separate models to investigate the effects of red tide on emergency department (ED) visits for different categories of neurological illnesses by different age groups.

We found statistically significant positive relationships between Kb cell counts and the number of ED visits in the following cases:

- **For Ages <18**
 - All of the above-mentioned neurological illnesses
 - Symptoms, signs, and ill-defined conditions (ICD-9 780-799)
- **For Ages 18-55**
 - All of the illnesses
- **For Ages >55**
 - All of the illnesses
 - Diseases of the nervous system (ICD-9 320-359)
 - Symptoms, signs, and ill-defined conditions (ICD-9 780-799)

We identified that symptoms involving head and neck (ICD-9 784) were driving the significance between Kb counts and ED visits.

CONCLUSION:

A positive relationship exists between *K. brevis* cell counts and certain neurological illnesses indicating that Florida Red Tides may influence the frequency of related neurological illnesses. However, many of the illness categories in ICD-9 784 such as sore throat and headache are possibly symptoms of respiratory illness.

FUTURE DIRECTIONS:

Identify more specific ICD-9 codes that exclusively represent neurological illness as well as control for other predictors, such as air temperature or flu outbreaks.