Chapter 6.1

Abundance and Frequency of Occurrence of Brown Tide, *Aureococcus anophagefferens*, in Maryland's Coastal Bays

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Abstract
Aureococcus anophagefferens, the micro-organism that causes brown tide, was first identified in the United States in 1987 and was discovered in Maryland in 1998, though recent research indicates that it was present before then. Brown tide blooms have been categorized based on their potential impacts to living resources [categories 1 (lowest), 2, and 3 (highest)]. Brown tide is a problem in the Coastal Bays; annually since 1999, at least one of the bay segments has experienced a category 3 bloom.

Introduction

Brown tide**,** *Aureococcus anophagefferens***,** blooms can have serious impacts on shellfish populations (scallops, hard clams and mussels) and seagrasses. Brown tides are known from their occurrence in the northeastern United States and western Africa. *A. anophagefferens* was first identified in the United States in Narragansett Bay, Rhode Island in 1987 and discovered in Maryland in 1998 (Gastrich and Wazniak, 2000). Data collected by the National Park Service (NPS) showed *A. anophagefferens* was present in the Coastal Bays since at least 1993 based on the presence of a pigment unique to this algal species detected in archived NPS samples (Trice et al., 2004). No samples were available for the period prior to 1993. Maryland is currently the southern extent for *A. anophagefferens* in the United States.

Monitoring

Since 1999, the Maryland Department of Natural Resources' (DNR) Brown Tide (BT) monitoring program has been conducted with a fixed station network of 15 stations throughout the Coastal Bays. Results have revealed that blooms tend to occur in late spring and early summer (May-July). Brown tide has been found in all Coastal Bays segments; however, an area in the Southern Bays from Newport Bay to Public Landing across to Tingles Island consistently has the highest levels. Scientists classify Brown Tide blooms similar to hurricanes Category 1, 2 and 3 (Gastrich and Wazniak, 2000) with 3 having the most serious environmental impacts (Table 6.1.1).

Table 6.1.1 Brown tide categories and potential environmental impacts.

Category	*Aureococcus* concentration	Potential Ecosystem Impacts
1	<35,000 cells*ml^{-1}	No observed impacts
2	35,000 to < 200,000 cells*ml^{-1}	• Reduction in growth of juvenile hard clams, (*Mercenaria mercenaria*). • Reduced feeding rates in adult hard clams; • Growth reduction in mussels (*Mytilus edulis*) and bay scallops (*Argopecten irradians*).
3	≥ 200,000 cells*ml^{-1}	• Water becomes discolored yellow-brown; • Feeding rates of mussels severely reduced; • Recruitment failures of bay scallops; • No significant growth of juvenile hard clams; • Negative impacts to eelgrass due to algal shading; • Copepod production reduced and negative impacts to protozoa.

Status of brown tide bloom activity in the Coastal Bays

Bloom intensity and distribution varied annually across the Coastal Bays. The 3-year status of max blooms is presented as a summary (Figure 6.1.1). To learn more about the annual and interannual variability, please visit: http://dnr..maryland.gov/coastalbays/bt_results.html.

Table 6.1.2 Flow at USGS Gage on Birch Branch- Annual Mean Discharge (cubic feet per second) by water year.

USGS	148471320	2001	5.87
USGS	148471320	2002	1.84*
USGS	148471320	2003	15.4
USGS	148471320	2004	12.2
USGS	148471320	2005	9.93
USGS	148471320	2006	4.4
USGS	148471320	2007	8.41
USGS	148471320	2008	4.08
USGS	148471320	2009	8.65
USGS	148471320	2010	19.2
USGS	148471320	2011	4.71
USGS	148471320	2012	6.34
USGS	148471320	2013	16.3

Table Data Source:
http://waterdata.usgs.gov/md/nwis/annual/?referred_module=sw&site_no=0148471320&por_0148471320_2=15

56908,00060,2,2000,2016&year_type=W&format=html_table&date_format=YYYY-MM-DD&rdb_compression=file&submitted_form=parameter_selection_list

2007 The highest concentrations over the 12 year period were observed at Public Landing, Trappe, and Newport Bay. The bloom continued at many southern sites during May and June. The conditions were generally dry based on the RAWS weather stations. However, no bloom was recorded in the northern bays. Average flow at Birch Branch on the St Martin River. (Figure 6.1.6)

2008 Public Landing and Tingles Island sites were the only two to see a count above the category 3 threshold in late May. Category 2 blooms were seen in the Northern bay sites as well as Trappe, Newport and Public Landing. (Figure 6.1.7)

2009 No blooms occurred in the northern bays. There was a Category 3 bloom that lasted a month at Public Landing and Tingles Island sites. (Figure 6.1.8)

2010 No blooms occurred in the northern bays. Wettest year observed at Birch Branch (Table 6.1.1). There was a Category 3 bloom that covered Green Point, Public Landing, and Tingles Island (lesser bloom at Taylors Landing) in late May/early June. (Figure 6.1.9)

2011 The northern bays had a category 2 bloom in Isle of Wight Bay near Rt. 90 bridge (site XDN3445) in May reaching cell counts of over 120,000; while the southern bays had widespread blooms in June with lower concentrations than the Isle of Wight bloom. (Figure 6.1.10)

2012 Early June three sites in the southern bays (Newport, Public Landing and Tingles Island) had category 3 blooms but did not last long due to weather and one site in the northern bays exceeded 200,000 cells/ml (Manklin Creek in late May). (Figure 6.1.11)

2013 No significant blooms were found. (Figure 6.1.12)

References

Gastrich, M.D. and C.E. Wazniak. 2002. A brown tide bloom index based on the potential harmful effects of the brown tide alga, *Aureococcus anophagefferens*. Aquatic Ecosystem Health and Management 5: 435-441.

Trice, T.M., P.M. Glibert, C. Lea, and L. Van Heukelem. In press. HPLC pigment records provide evidence of past blooms of *Aureococcus anophagefferens* in the coastal bays of Maryland and Virginia, USA. Harmful Algae.

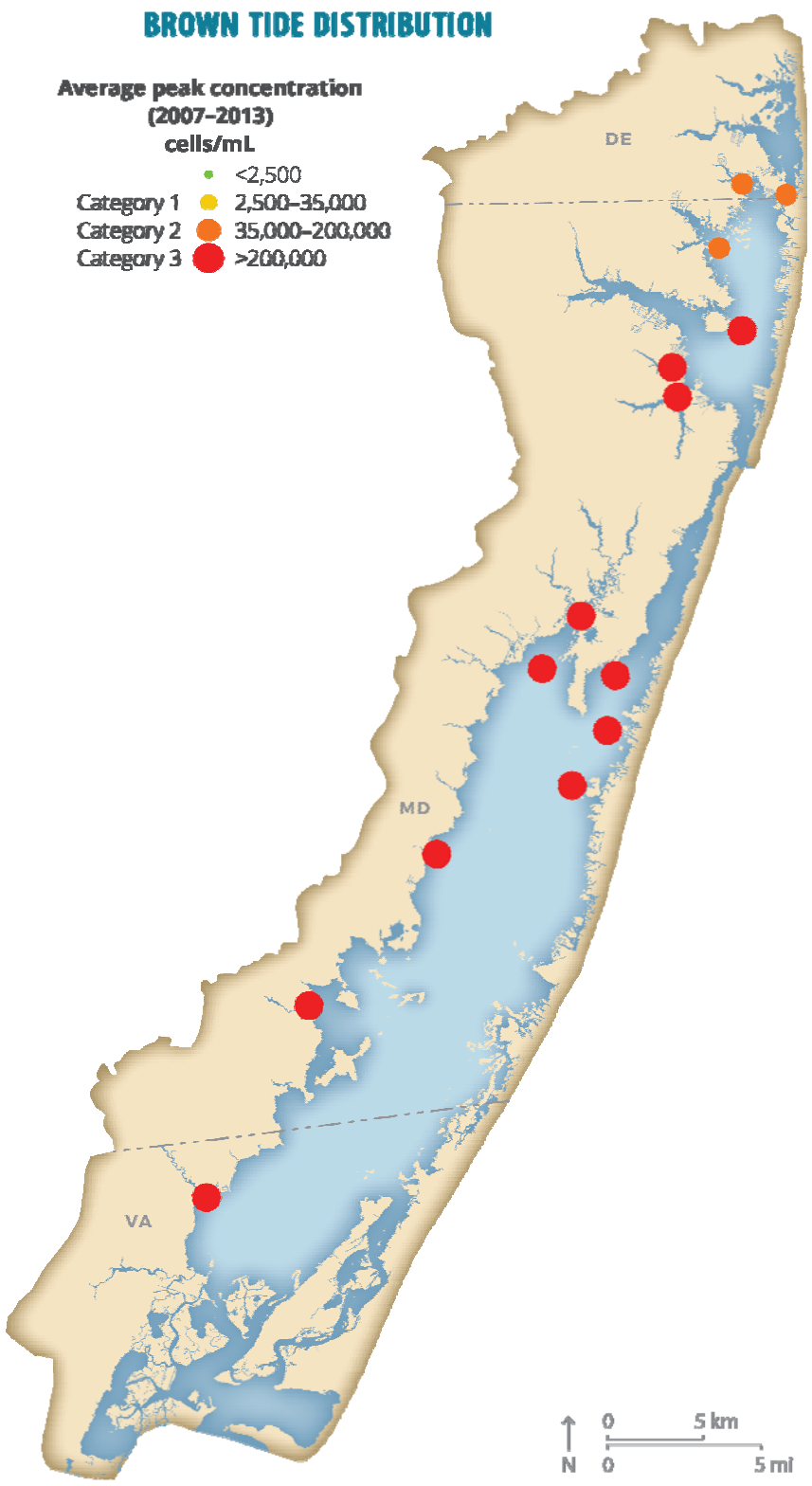

Figure 6.1.1 Average peak concentration of brown tide cells at fourteen Maryland Coastal Bays station between 2007and 2013.

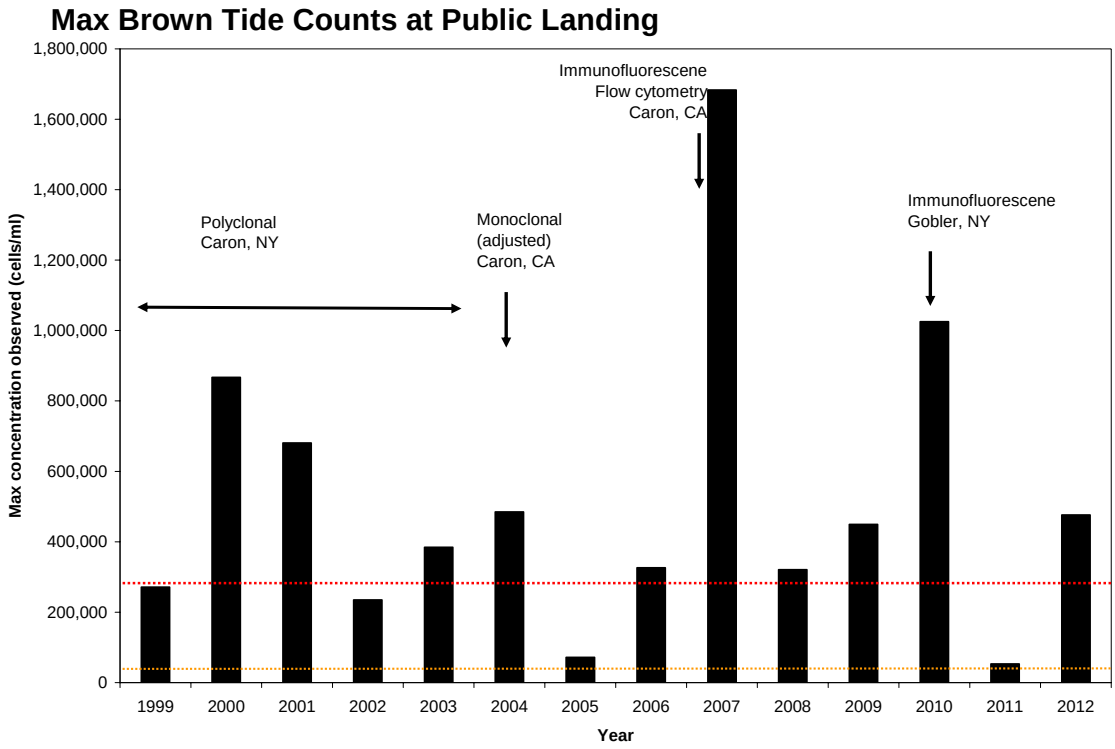

Figure 6.1.2 Maximum annual *Aureococcus* concentrations at Public Landing (1999-2012). Enumeration methods used for counts are also noted.

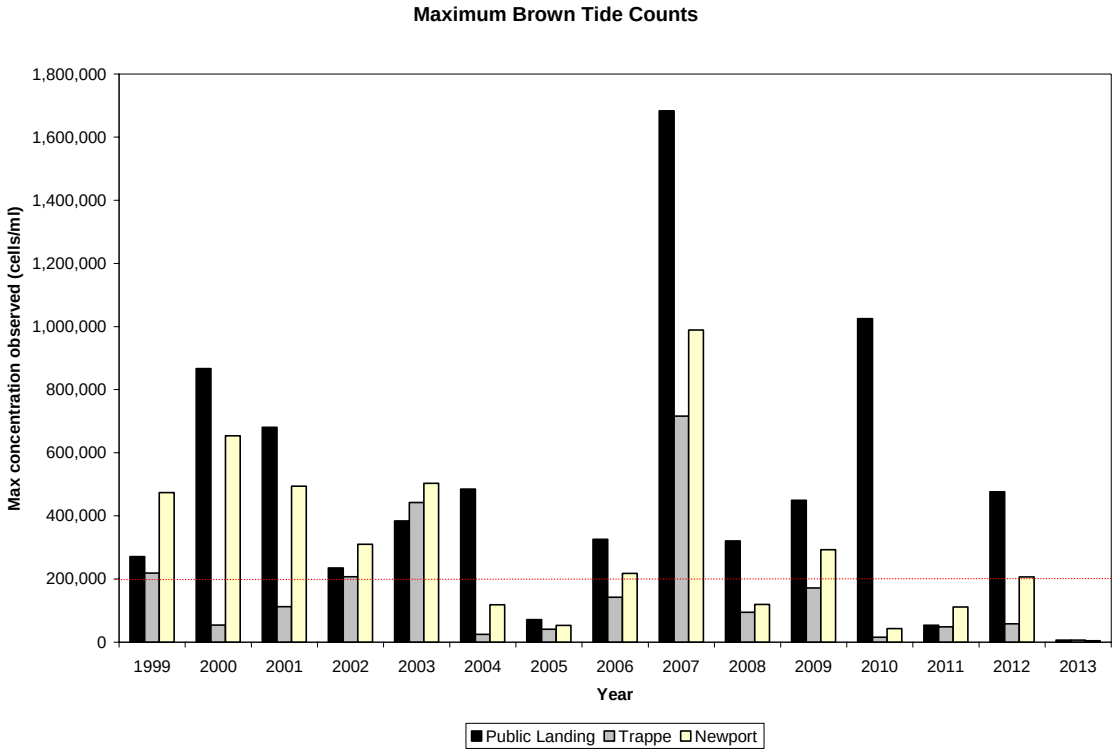

Figure 6.1.3 Maximum *Aureococcus* cell counts at three stations (Public landing, Trappe Creek and Newport Bay (1999-2013)

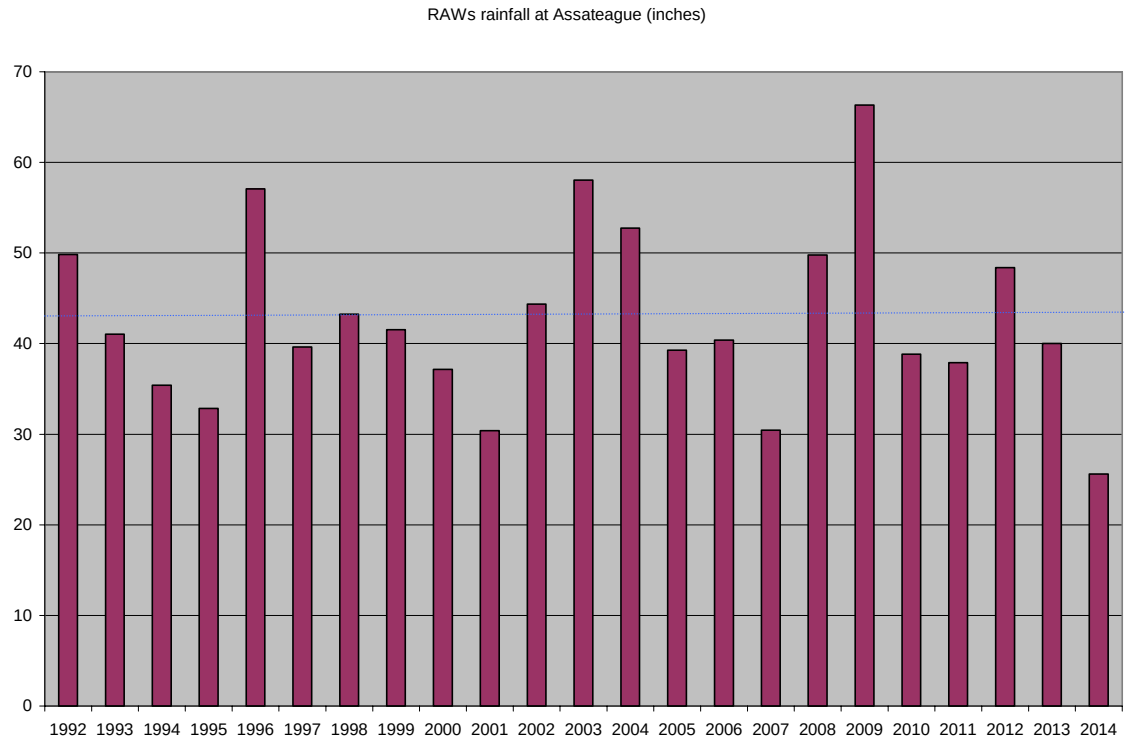

Figure 6.1.4 Annual rainfall at Assateague Island Rainfall at Remote Automated Weather Station (RAWS) rain gage in inches per year (1992-2014).

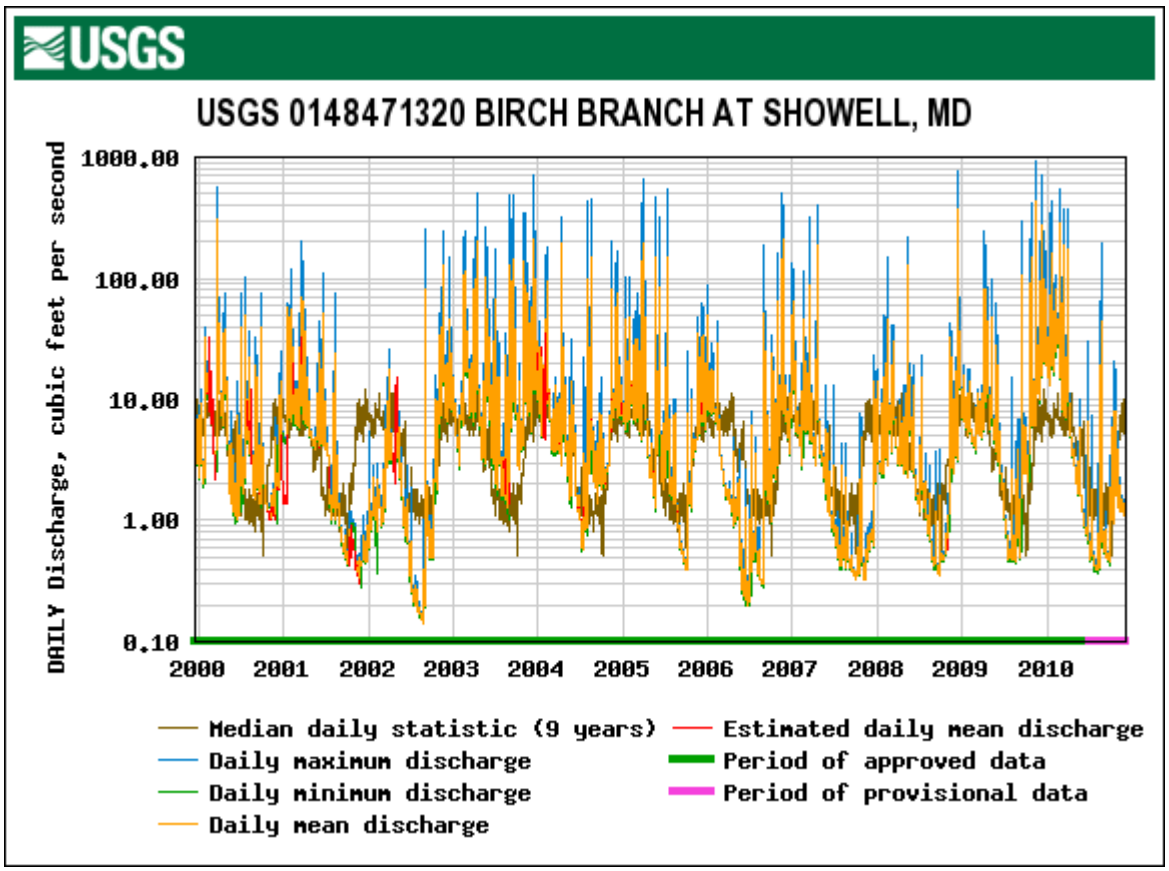

Figure 6.1.5 Daily river discharge at the USGS gage on Birch Branch (cubic feet per second) 2000-2010.

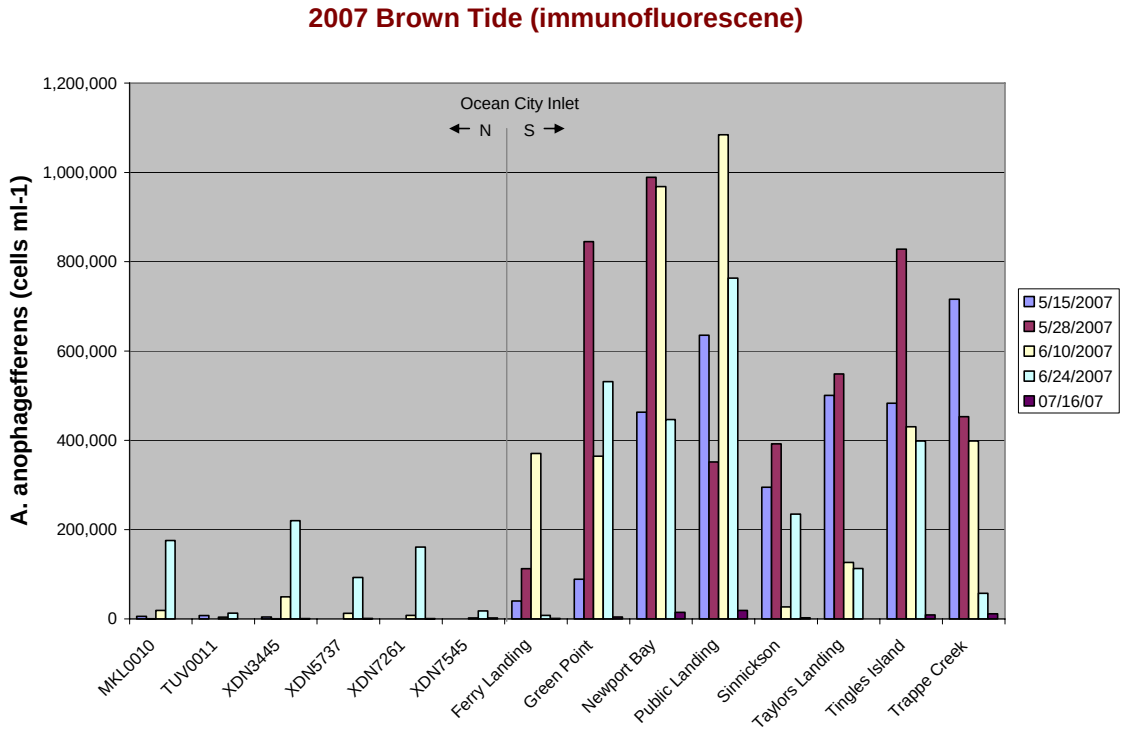

Figure 6.1.6 2007 Brown Tide, *Aureococcus anafagefferens*, cell counts at 14 stations.

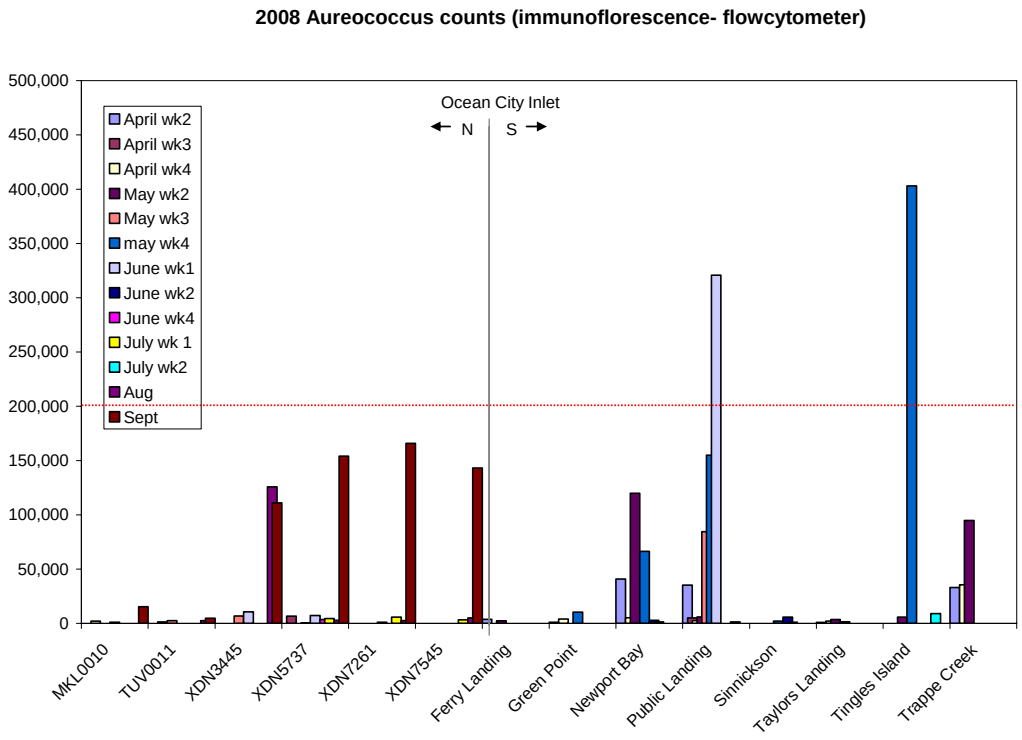

Figure 6.1.7 2008 Brown Tide, *Aureococcus anafagefferens*, cell counts at 14 stations.

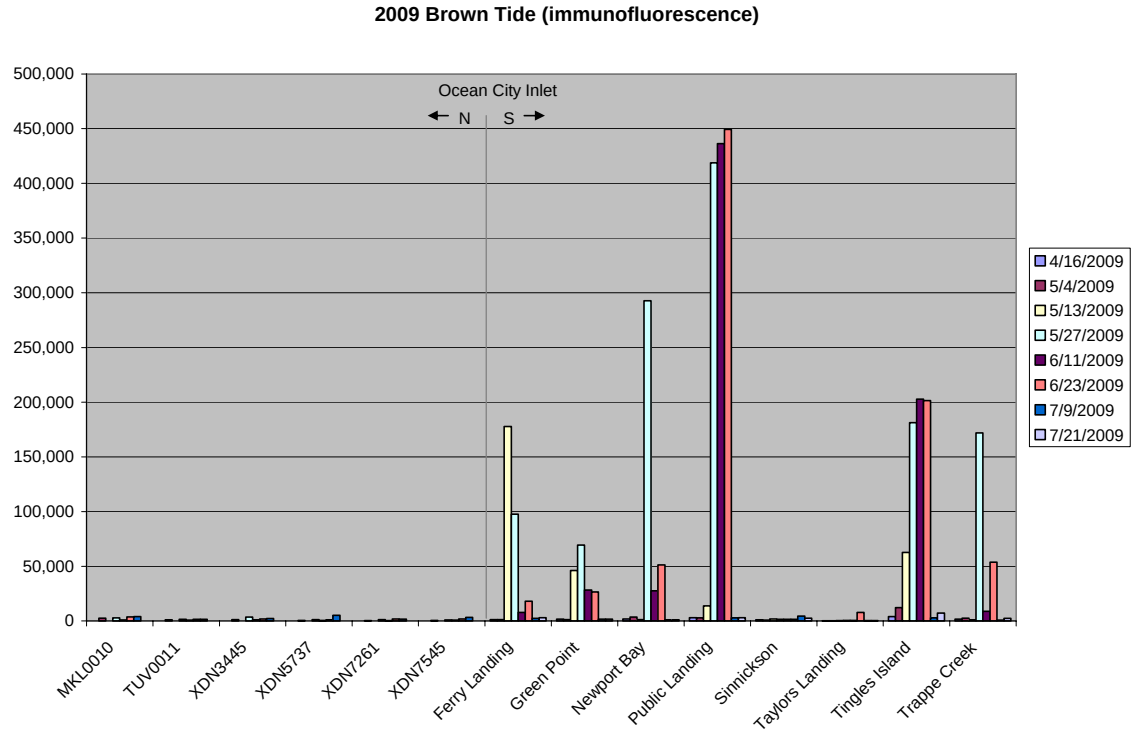

Figure 6.1.8 2009 Brown Tide, *Aureococcus anafagefferens*, cell counts at 14 stations.

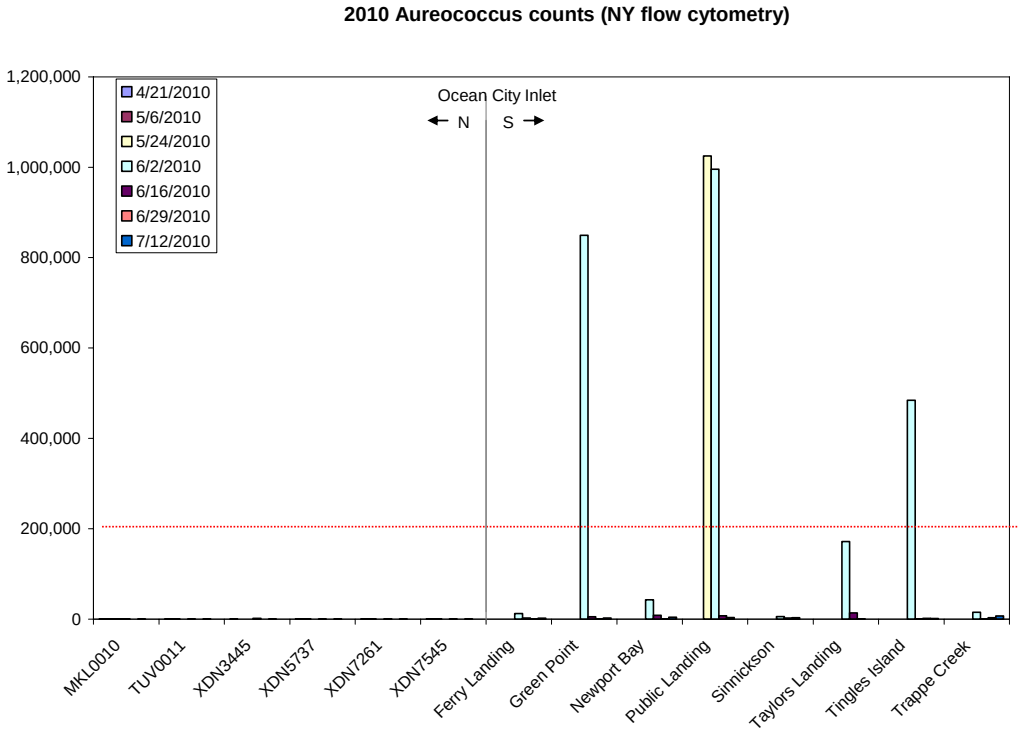

Figure 6.1.9 2010 Brown Tide, *Aureococcus anafagefferens*, cell counts at 14 stations.

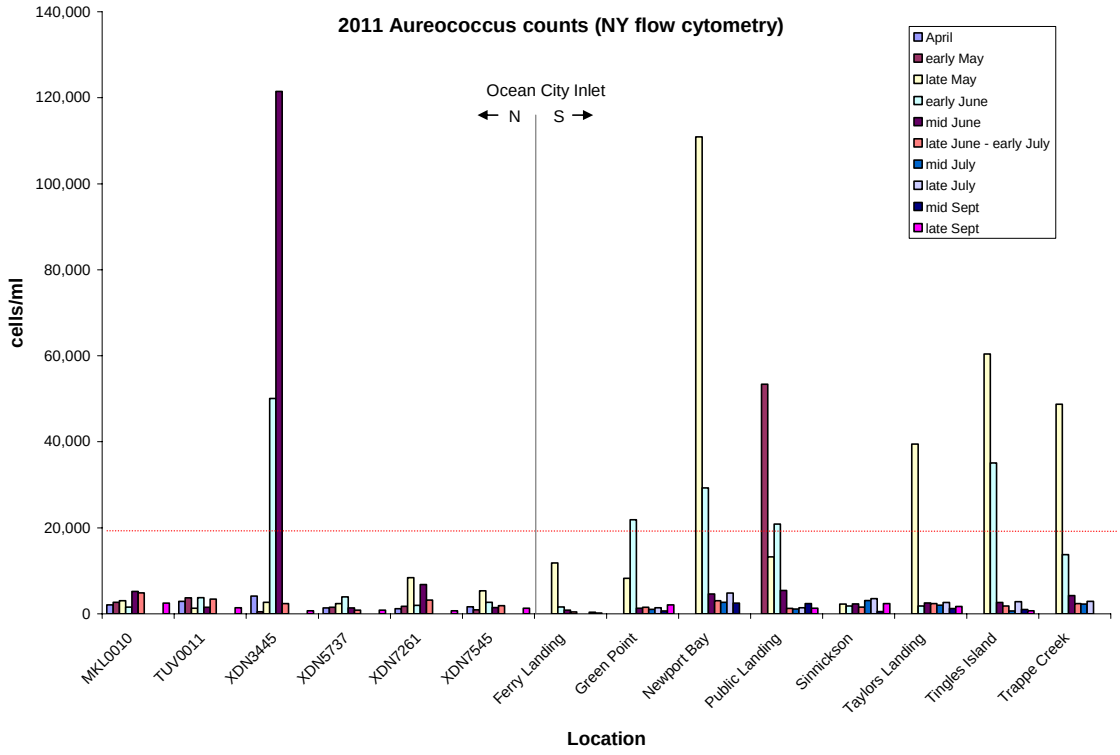

Figure 6.1.10 2011 Brown Tide, *Aureococcus anafagefferens*, cell counts at 14 stations.

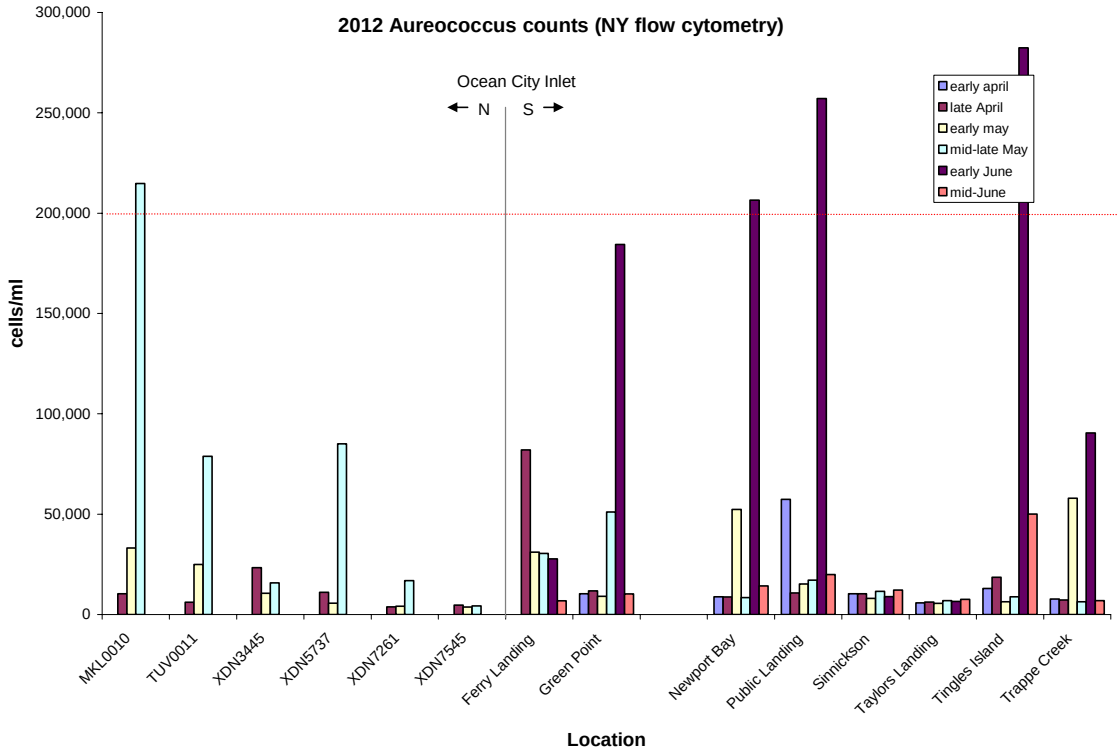

Figure 6.1.11 2012 Brown Tide, *Aureococcus anafagefferens*, cell counts at 14 stations.

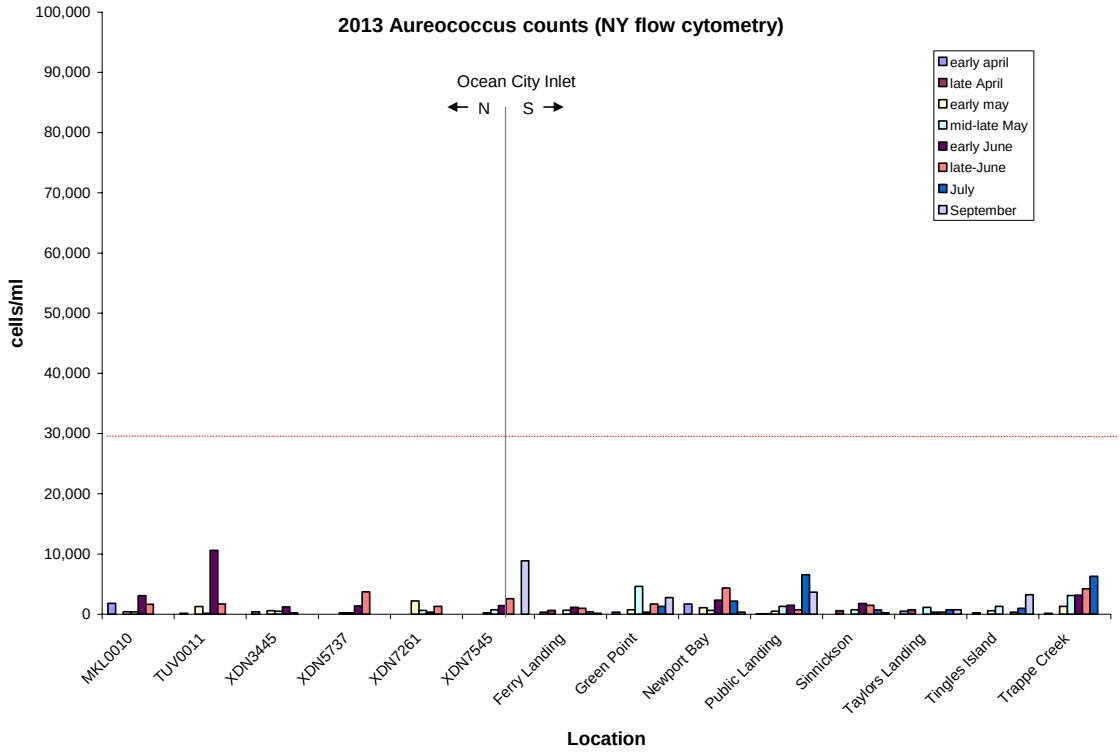

Figure 6.1.12 2013 Brown Tide, *Aureococcus anafagefferens*, cell counts at 14 stations.