Chapter 3.1

Nitrate + Nitrite concentrations in non-tidal streams flowing into the Maryland Coastal Bays (2006-2013)

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Abstract
Several monitoring programs have monitored stream enrichment over the past two decades. Natural background concentrations of nitrate in streams nationwide is 0.6 mg/L with concentrations greater than 1.0 mg/L indicating anthropogenic inputs. Newport and Isle of Wight had the highest mean concentrations of nitrate/nitrite while Sinepuxent and upper Chincoteague Bay streams had the lowest. Continued monitoring will be needed to determine if concentrations/inputs begin to change.

Introduction
Nearly every stream in the Coastal Bays watershed has been altered at some point over the past century, having been straightened and/or deepened to promote faster drainage of adjacent land. The natural conditions of local streams are generally flat, sandy and slow moving. Many are tidally influenced as they discharge into the estuary; some originate in upland low-lying areas and are dark stained from tannic acids at the headwaters. The shorter stream reaches in this narrow watershed often have small catchment basins and reduced refugia for biota.

Nitrate + nitrite (NOx) are essential plant nutrients that are readily assimilated by aquatic plants. At excessive levels, however, eutrophication of the stream can occur. Anthropogenic sources of NOx to streams and groundwater include septic systems, wastewater/agricultural/stormwater ponds, leaky sewer lines, and manure fertilizer application.

Data Sets
The Maryland Coastal Bays Program initiated a spring stream water chemistry sampling program in 2006. The purpose of this survey is to document springtime existing conditions over time, pinpoint nutrient hotspots and act as a proxy measure of management efforts within the watershed. Sampling takes place annually in April when flows are typically low and generally reflects higher groundwater discharge to ditches and streams before plant uptake of nutrients takes place. The April timeframe was also chosen to compare with historical Maryland Department of Natural Resources synoptic surveys results and to coincide with Maryland Biological Stream Survey (MBSS) macroinvertebrate sampling through the state Stream Waders program. Samples are collected after a minimum of 48 hours without rainfall. Site conditions are noted, dissolved oxygen, temperature, pH, conductivity and salinity are measured in the field. Water samples are collected and analyzed for total and inorganic nitrogen, phosphorus, and chlorophyll a concentrations. The University of Maryland, Horn Point Laboratory conducts the chemical analyses using standardized and approved protocols.

Management Objective: Improve stream health.. To achieve bay water concentrations of nutrients that meet seagrass thresholds.

Indicator: NOx <1.5 mg/L >1.0 mg/L indicates probable anthropogenic sources

Data Analyses

Summary statistics were done on bay-wide and subwatershed nitrate/nitrite data collected in streams. A time series linear regression was performed to fit a trend line to the data and to determine the strength of the relationship between nitrate and time.

Results

During the period of 2006 – 2013, 41 to 58 separate streams sites were monitored each year, with a sum total of 413 samples collected. The range of nitrate/nitrite (NOx) was 0.00 – 8.82 mg/L (Figure 3.1.1). The bay wide median value is 0.83 mg/L and the mean concentration is 1.51 mg/L. Median concentrations of streams aggregated by subwatershed are presented below in Table 3.1.1 and Figure 3.1.2 displays the box and whisker plot for each sub-embayment.

Newport Bay streams had the highest average NOx concentrations followed by Isle of Wight Bay, Assawoman, St Martin River and Lower Chincoteague. Sinepuxent and upper Chincoteague had the lowest average stream NOx levels. Except for streams in Sinepuxent, which exhibited low concentrations, all other areas typically exhibited wide variation. For all samples, 47.9% were greater or equal to 1.0 mg/L which indicates potential anthropogenic inputs. A closer analysis by individual stream sites over a longer timeframe may reveal minor changes in concentration, but those changes may be imperceptible given the long residence time of groundwater NOx loads. Figure 3.1.3 indicates that as an aggregate, there is no correlation with time.

For comparative purposes the five fresh water streams below in Table 3.1.2 show decreasing concentrations between the DNR Synoptic Surveys (1999-2003) and the mean spring survey conducted by Maryland Coastal Bays Program (2006-2013). However, these concentrations do not appear when comparing the spring survey with year-round means, though seasonality may explain the difference.

Figure 3.1.1 Mean stream Nitrate/Nitrite, NOx, concentrations (2006-2013).

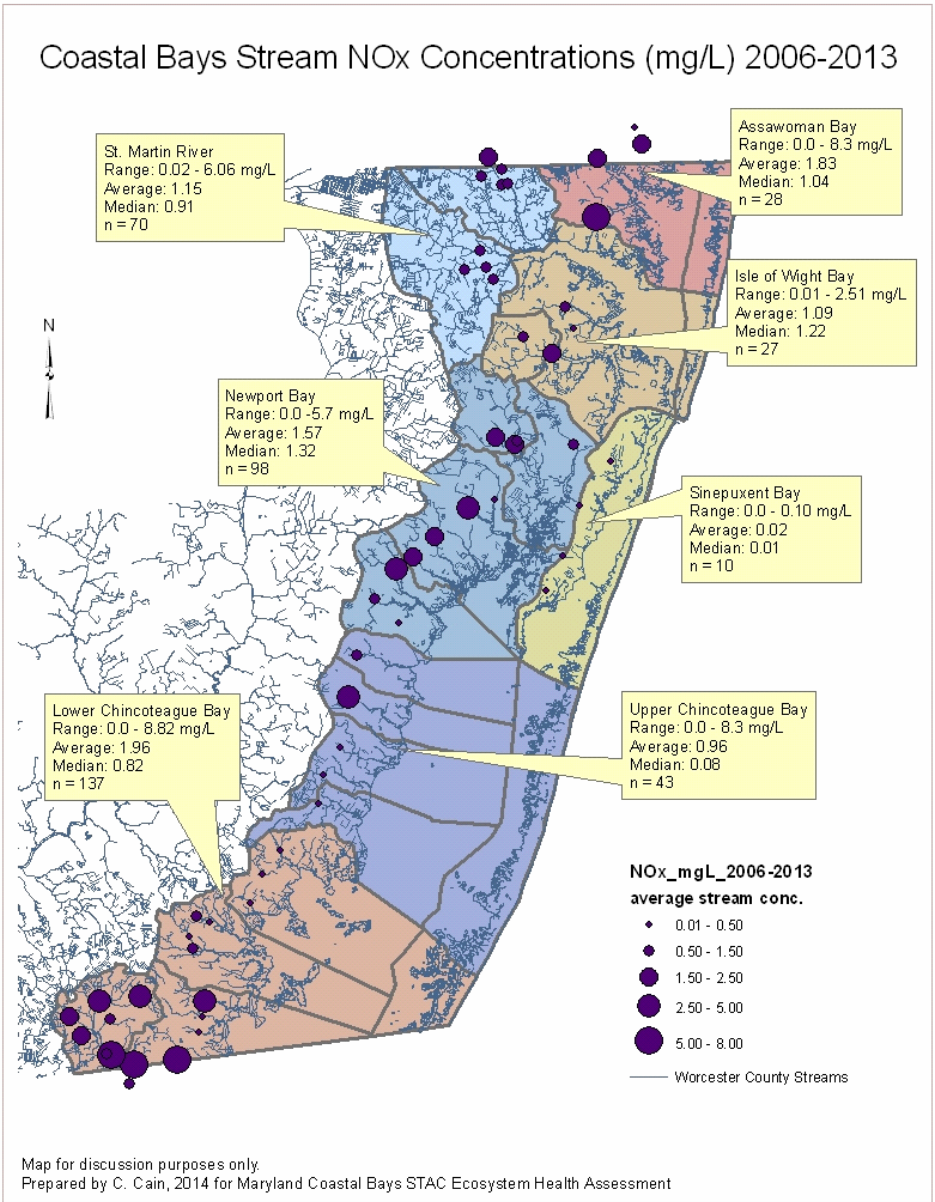

Table 3.1.1 Median concentrations in stream nitrate/nitrite, NOx, by embayment.

Embayment	Median NOx (mg/L)	# samples	# sampling sites
Assawoman Bay	1.04	28	5
St. Martin River	0.91	70	9
Isle of Wight Bay	1.22	27	4
Sinepuxent Bay	0.01	10	3
Newport Bay	1.32	98	12
Upper Chincoteague Bay	0.08	43	5
Lower Chincoteague Bay	0.82	137	20

Figure 3.1.2 Box and whisker plots of Nitrate/Nitrite, NOx, concentration by subwatershed.

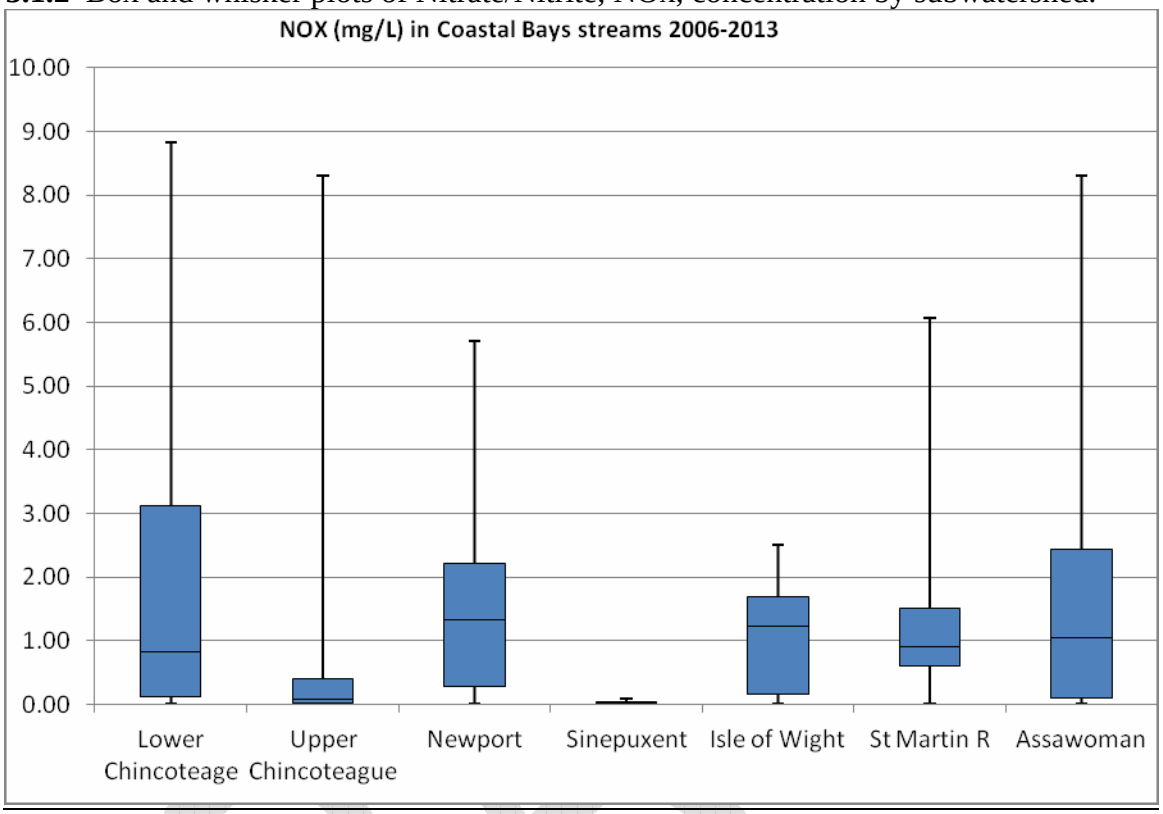

Figure 3.1.3 Timeseries of NOx concentrations in Coastal Bays streams over time.

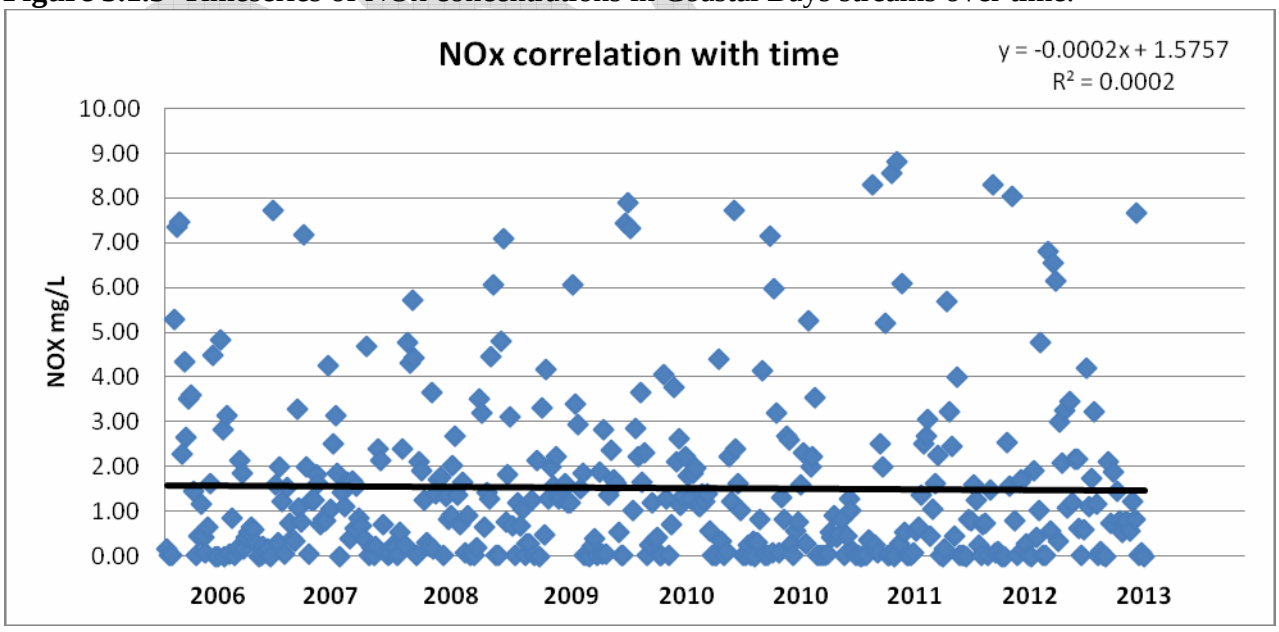

Table 3.1.2 Median concentrations of nitrate + nitrite (mg/L) over time via multiple monitoring surveys

		Monthly sampling, year round (years sampled)		Spring only surveys (years sampled)		
Drains to	Stream name	MCBP [1]	DNR[2]	MCBP streams[3]	USGS[4]	DNR Synoptic[5]
Newport Bay	**Hudson Branch**	2.35 (2010-2013)		1.62 (2006-2013)		1.9 (2003)
Newport Bay	**Bottle Creek**	2.21 (2006-2013)	2.23 (2007-2013)	2.16 (2006-2013)		4.05 (2003)
Newport Bay	**Trappe Creek**	1.2 (1998-2013)	0.95 (2007-2013)			0.67 (2003)
Newport Bay	**Bassett Creek**	2.33 (2004-2013)		1.28 (2006-2013)	1.35/1.74 (2003- 2004)	2.08 (2003)
St. Martin River	**Birch Branch**	1.14 (2006-2013)	1.18 (2007-2013)	1.15 (2007-2013)		2.59 (1999)

1. Maryland Coastal Bays Program, volunteer monitoring program (1998-2013)
2. Maryland Department of Natural Resources Core Trend data
3. Maryland Coastal Bays Program, spring stream survey
4. U. S. Geological Survey, Estimates of the Loads of NO2+NO3 in the flow of Bassett Creek to the MD Coastal Bays
5. Maryland Department of Natural Resources

Summary
Elevated stream nitrate/nitrite concentrations are attributable to groundwater input as well as stormwater run off. Natural background concentrations of nitrate in streams is 0.6 mg/L with concentrations greater than 1.0 mg/L indicative of anthropogenic inputs (USGS 1999). Concentrations are above these thresholds for healthy streams may impact stream biota as well as contribute to total nitrogen loads in the bays. Continued monitoring will be needed to determine if concentrations/ inputs begin to change. Stream specific enrichment can be used to focus management actions to reduce eutrophication impacts to the bays.

References
U.S. Geological Survey, 1999, The Quality of Our Nation's Water – Nutrient and Pesticides, Circular 1225, 82 p.