An Ecological Study of Gunston Cove

2010

FINAL REPORT

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by

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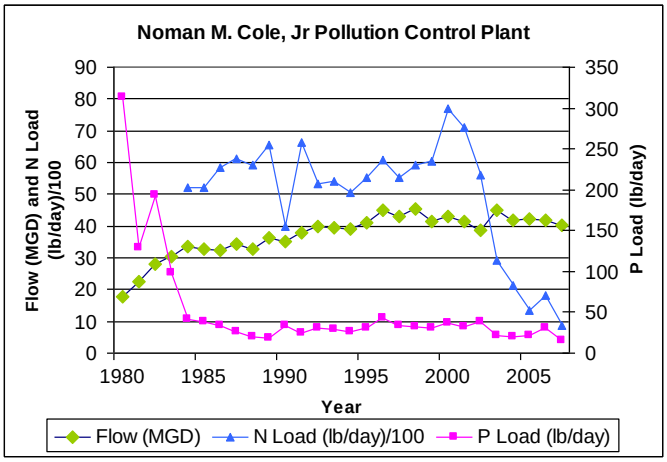
Executive Summary

Gunston Cove is an embayment of the tidal freshwater Potomac River located in Fairfax County about 12 mi (20 km) downstream of the I-95/I-495 Woodrow Wilson bridge. The Cove receives treated wastewater from the Noman M. Cole, Jr. Pollution Control Plant and inflow from Pohick and Accotink Creeks which drain much of central and southern Fairfax County. The Cove is bordered on the north by Fort Belvoir and on the south by Mason Neck. Due to its tidal nature and shallowness, the cove does not seasonally stratify vertically, and its water mixes gradually with the adjacent tidal Potomac River mainstem. Since 1984 George Mason University personnel have been monitoring water quality and biological communities in the Gunston Cove area including stations in the cove itself and the adjacent river mainstem. This document presents study findings from 2010 in the context of the entire data record.

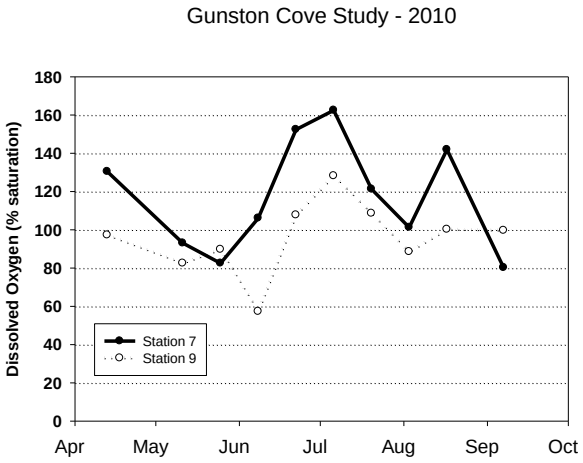
The Chesapeake Bay, of which the tidal Potomac River is a major subestuary, is the largest and most productive coastal system in the United States. The use of the Bay as a fisheries and recreational resource has been threatened by overenrichment with nutrients which can cause nuisance algal blooms, hypoxia in stratified areas, and declining fisheries. As a major discharger of treated wastewater into the tidal Potomac River, particularly Gunston Cove, Fairfax County has been proactive in decreasing nutrient loading since the late 1970's. As shown in the figure to the right, phosphorus loadings were dramatically reduced in the early 1980's. In the last several years, nitrogen loadings have also been greatly reduced. The reduction in loadings has been achieved even as flow through the plant has been increasing.



The ongoing ecological study reported here provides documentation of major improvements in water quality and biological resources which can be attributed to those efforts. Water quality improvements have been substantial in spite of the increasing population and volume of wastewater produced. The nearly 30 year record of data from Gunston Cove and the nearby Potomac River has revealed many important long-term trends that validate the effectiveness of County initiatives to improve treatment and will aid in the continued management of the watershed and point source inputs. Gunston Cove is now internationally recognized as an exemplary example of how reductions in point source loading can yield enormous benefits to water quality and the living resources of tidal waters.

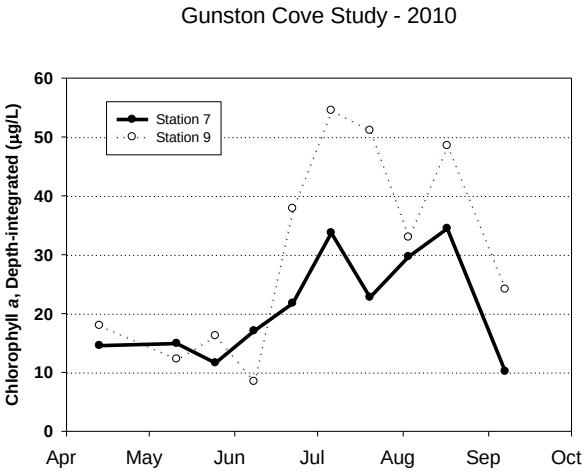
The year 2010 was characterized by above normal temperatures for most of the year. July was the warmest month and June had the greatest departure from normal. There were 62 days with high temperatures above 90°F (32.2°C) which was twice the number in any

other recent year. Potomac River flows were about average in spring, but dropped steadily to below normal values in June where they remained for most of the summer. Local tributary flows were somewhat below normal for most of the year, but dropped to almost nothing in September. A late September rain event lifted flows back into the normal range. Specific conductance, chloride, and alkalinity increased gradually through the year reflecting increasingly dry conditions.



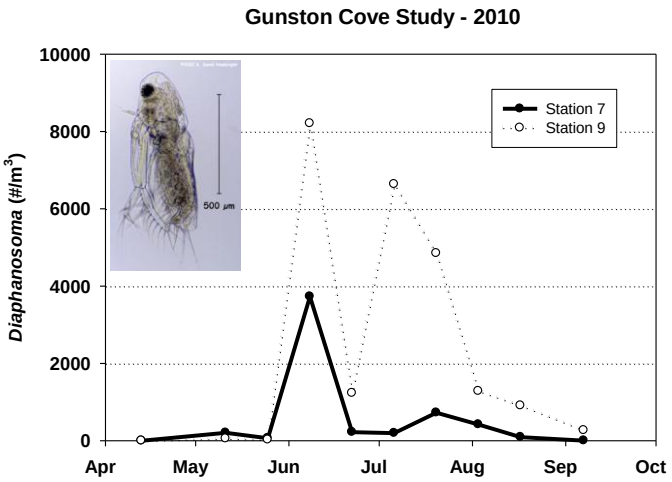
Dissolved oxygen was generally higher in the cove than in the river. Values above 120 % saturation indicate robust photosynthesis whereas values below 80% indicate a dominance of respiration. Levels below about 50% would be of concern for aquatic life. Supersaturated dissolved oxygen does not have a direct effect on aquatic life, but may indicate algal blooms. Dissolved oxygen was relatively high in April, dropped off a bit in May and then was above saturation again in the summer due to active photosynthesis. While DO was somewhat higher in the cove, supersaturation was also observed in the river consistent with high phytoplankton chlorophyll levels. pH showed similar patterns. Water clarity was actually higher in the cove than in the river on many dates as indicated by Secchi depth, light attenuation coefficient and turbidity as the cove continues to become clearer.

Ammonia nitrogen was very low at both sites during most of the year, but increased rather dramatically in the river in May and June. Nitrate was steady at about 1 mg/L in spring, but declined strongly in June to very low values (<0.1 mg/L) for the remainder of the year. Organic nitrogen was generally higher in the cove and reached a peak in late June. Total phosphorus exhibited a seasonal increase at both sites with maximum values in July. Soluble reactive phosphorus was consistently higher in the river and did not show any clear seasonal patterns. N to P ratio was similar at the two sites and declined seasonally, approaching values indicating a shift from P to N limitation. BOD and VSS, reflecting organic matter in water column, were similar at the two sites as was TSS.



Chlorophyll concentrations were low (10-20 µg/L) and very similar in both cove and river sites in the spring. In June chlorophyll increased markedly in the river reaching over 50 µg/L in July and remaining high through August. Surprisingly, cove values increased only gradually reaching a peak of about 35 µg/L in July and August. This is the first year that summer chlorophyll was higher in the river than the cove. And all values in 2010 were much reduced from

the pre-2000 levels of 100 µg/L or more. Phytoplankton density peaked first in the cove, but was higher later in the summer in the river. Phytoplankton biovolume was higher all summer in the river. Cyanobacteria were dominant in terms of cell density in the cove and river. Cove and river had similar abundance of cells which is unusual; cove is generally higher. Of the cyanobacteria, *Oscillatoria* and *Aphanocapsa* were more abundant in the cove and *Microcystis* was more abundant in the river. The diatom *Melosira* was the most abundant eukaryotic alga in both areas. In terms of biovolume, diatoms were dominant on most dates at both stations. *Oscillatoria* and *Anabaena* were the most important cyanobacteria, but *Melosira* was the most dominant taxon overall.



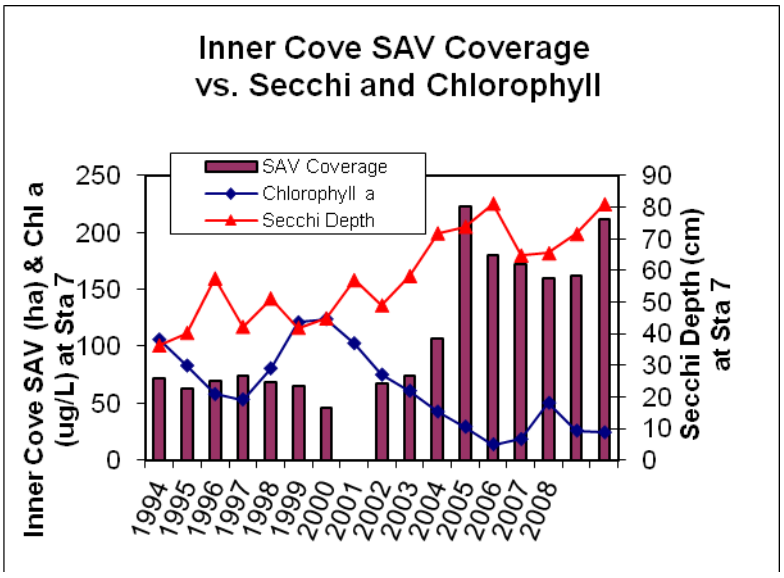
Rotifers are a normal component of freshwater zooplankton communities and were numerous in the cove from May through July. *Filinia* and *Keratella* were dominant in May followed by *Brachionus* in June and a mix of all three in July. In the river a large surge of *Keratella* in early May led to the highest rotifer densities of the year. On other dates river rotifer densities were much lower than those in the cove. The small cladoceran *Bosmina* was found in moderate numbers in May and early June at both sites with higher abundance in the cove. The larger cladoceran *Diaphanosoma* was quite high in early June at both sites with a second peak in the river in early July. Following its high abundance in early May, *Daphnia* was uncommon in the cove, but maintained moderate values in the river. *Moina*, normally a relatively rare cladoceran, reached high densities in late May and early June in the river, but was much less common in the cove. *Leptodora* was quite abundant in May and early June in the cove and river. Copepod nauplii were present at moderate values in the cove and river over the entire year with a peak in May in the cove and July in the river. *Eurytemora* was very abundant in some samples in April, May and June and was rarer in the late summer and fall. *Diaptomus* was relatively rare in 2010, peaking in the spring with a secondary peak in late July in the river. Cyclopoid copepods were relatively rare in the cove, but showed a strong late summer peak in the river.

In 2010 ichthyoplankton was dominated by *Dorosoma* sp (gizzard shad) and, to a lesser extent, alosids (herring and shad). Members of the genus *Morone* (white perch or striped bass) were significant, but comprised a lesser percentage of the catch than normal. Yellow perch and inland silversides were found at numbers somewhat greater than normal.

In trawls, the overwhelming majority of the fish collected were represented by 2 taxa: white perch and *Alosa* sp. (shad/herring). Other numerically abundant species included: blue catfish, spottail shiner, bay anchovy, and gizzard shad. As usual, white perch was found throughout the year and at all stations. *Alosa* sp. were sporadic through time and found mainly in the mid cove area. Blue catfish was found throughout the year, but

mainly in the river. Spottail shiner were found throughout the year, but mainly at cove sites. Adults tended to be captured in spring and juveniles in the late summer. The most abundant species collected in seines was banded killifish followed by *Alosa* sp. and white perch. Banded killifish and white perch were collected at all stations and throughout the year.

Submersed aquatic vegetation (SAV) continued to be present at high densities in both Pohick and Accotink Bays and to penetrate the inner portions of Gunston Cove in 2010. A fringe of SAV was observed all along the Gunston Cove shoreline and a band of lower density SAV was found across the cove mouth. Coverage reported by aerial surveys in 2010 was similar to the last few years and much elevated over pre-2005 levels, approaching the peak year of 2005. The increased presence of SAV provides habitat for a wider range of species and indicates improved water quality in the cove.

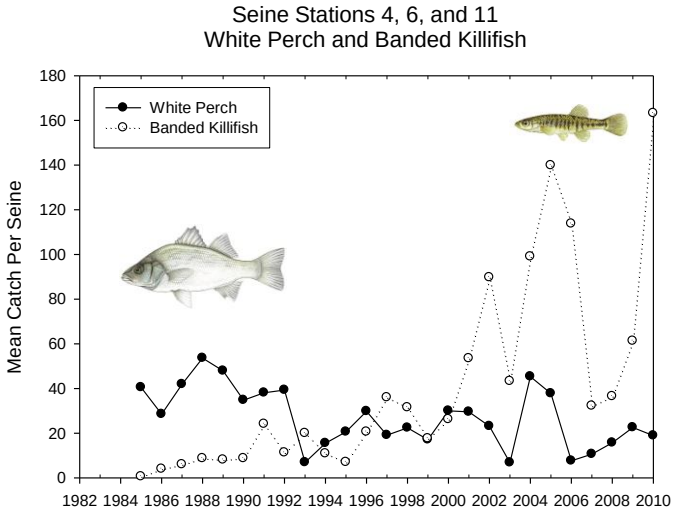


In benthic samples, oligochaetes were the most common invertebrates collected and were found at about twice the density at Station 9 than at Station 7. In the cove diptera (chironomid/midge) larvae made up the bulk of the remaining organisms with a handful of amphipods turning up in some of the samples. In the river, several groups were found in moderate numbers: amphipods (crustaceans commonly known as scuds), and *Corbicula* (Asiatic clam). Diptera were rare in the river and *Corbicula* were absent in the cove. These results were similar to those observed in previous years.

Data from 2010 generally reinforced the major trends which were reported in previous years. First, phytoplankton algae populations in Gunston Cove have shown a clear pattern of decline since 1989; in fact in 2010 summer chlorophyll in the cove was lower than in the river. Accompanying this decline has been more normal levels of pH and dissolved oxygen, increased water clarity, and a virtual cessation of cyanobacteria blooms such as *Microcystis*. The increased water clarity has brought the rebound of SAV which provides increased habitat value for fish and fish food organisms. The SAV also filters nutrients and sediments and itself will inhibit the overgrowth of phytoplankton algae. This trend is undoubtedly the result of phosphorus removal practices at Noman Cole wastewater treatment plant which were initiated in the late 1970's. This lag period of 10-15 years between phosphorus control and phytoplankton decline has been observed in many freshwater systems resulting at least partially from continued loading of P from enriched sediments to the water column which can continue for a number of years. Gunston Cove is now an internationally recognized case study for ecosystem recovery due to the actions

that were taken and the subsequent monitoring to validate the response. In 2010 transparency increased, phytoplankton were near record lows, and SAV acreage increased.

Another significant change in water quality documented by the study has been the removal of chlorine and ammonia from the Noman M. Cole, Jr. PCP effluent. A decline of over an order of magnitude in ammonia nitrogen has been observed in the cove as compared to earlier years. The declines in ammonia and chlorine have allowed fish to recolonize tidal Pohick Creek. Monitoring of creek fish allowed us to observe recovery of this habitat which is very important for spawning species such as shad. The decreased ammonia has also lowered nitrogen loading from the plant contributing to overall Bay cleanup.



Another trend of significance to managers is changes in the relative abundance of fish species. While it is still the dominant species in trawls, white perch has gradually been displaced in seines by banded killifish. Blue catfish have entered the area recently and brown bullhead has decreased greatly in the cove. The introduction of snakeheads of recent years (not sampled very well by trawl and seine but found in the cove using drop ring sampling) may have some pronounced effects on the other fish species. The causes and significance of these changes are still being studied as are similar patterns throughout the Chesapeake Bay.. Clearly, recent increases in SAV provide refuge and additional spawning substrate for the adhesive eggs of banded killifish. Data from drop ring studies reported above show that SAV harbors high densities of banded killifish. While the seine does not sample these SAV areas directly, the enhanced growth of SAV provides a large bank of banded killifish that spread out into the adjacent unvegetated shoreline areas and are sampled in the seines. Combined with the short generation time and high intrinsic rate of population growth of banded killifish, SAV appears to be direct cause of the recent high catch rates. In addition, the invasive blue catfish may also have both direct (predation) and indirect (competition) effects on brown bullhead, but details on these interactions require additional study. Declines in white perch probably have little direct connection to increases in banded killifish, and instead may be due to a combination of reduction in gear efficiency due to SAV and population-wide changes that result from environmental factors and/or fishing mortality. Overall, the fish assemblage in Gunston Cove is dynamic and supports a diversity of commercial and recreational fishing activities.

In short, due to the strong management efforts of the County and the robust monitoring program, Gunston Cove has proven an extremely valuable case study in eutrophication

recovery for the Bay region and even internationally. The onset of larger areas of SAV coverage in Gunston Cove will have further effects on the biological resources and water quality of this part of the tidal Potomac River. It is important to continue the data record that has been established to allow assessment how the continuing increases in wastewater volume and improved efforts at wastewater treatment interact with the ecosystem as SAV increases and plankton and fish communities change in response. Furthermore, changes in the fish communities from the standpoint of habitat alteration by SAV, introductions of exotics like snakeheads, and possible contaminant effects such as those from hormone pollution need to be followed.

Global climate change is becoming a major concern worldwide. In the past five years a slight, but consistent increase in summer water temperature has been observed in the cove which may reflect the higher summer air temperatures documented globally. Other potential effects of directional climate change remain very subtle and not clearly differentiated given seasonal and cyclic variability.

We recommend that:

1. Long term monitoring should continue. The revised schedule initiated in 2004 which focuses sampling in April through September should capture the major trends affecting water quality and the biota. The Gunston Cove study is a model for long term monitoring which is necessary to document the effectiveness of management actions. This process is sometimes called adaptive management and is recognized as the most successful approach to ecosystem management.
2. New methods of fish assessment such as drop ring sampling have proven effective. The drop ring sampling has been deployed as part of the on-going monitoring to effectively sample fish populations in areas which have been heavily colonized by SAV. We were unable to conduct drop ring sampling in 2010 or 2011 due to the departure of Dr. Kraus in spring 2010, but we will reevaluate our program for fish assessment in SAV beds when the new fish ecologist arrives.
3. Anadromous fish sampling should be continued with the slightly revised methods adopted in 2007-08. As anadromous river herring were recently listed (2006) as species of concern due to declines throughout the range, continued efforts to monitor these populations should aim to quantify spawning biomass.
4. The Virginia Department of Environmental Quality conducted continuous monitoring of water quality at Pohick Bay park dock for the last three years. Some of this data was included in annual reports and helps to clarify some trends observed in the monitoring data. Last year we recommended that a continuous monitor be re-established to aid in the Gunston Cove study. The Potomac Environmental Research and Education Center obtained funding from George Mason University in conjunction with the NOAA BWET program and reinstituted the Pohick Bay site in May 2011. We anticipate keeping this station going for the foreseeable future.

List of Abbreviations

BOD	Biochemical oxygen demand
cfs	cubic feet per second
DO	Dissolved oxygen
ha	hectare
l	liter
LOWESS	locally weighted sum of squares trend line
m	meter
mg	milligram
MGD	Million gallons per day
NS	not statistically significant
NTU	Nephelometric turbidity units
SAV	Submersed aquatic vegetation
SRP	Soluble reactive phosphorus
TP	Total phosphorus
TSS	Total suspended solids
um	micrometer
VSS	Volatile suspended solids
#	number

Dedication

This report is dedicated to Ann Powel, wife of Project Director R. Christian Jones. Without her encouragement and unfailing support, this project could not have achieved its consistency and longevity.