

# An Ecological Study of Gunston Cove

2009

FINAL REPORT

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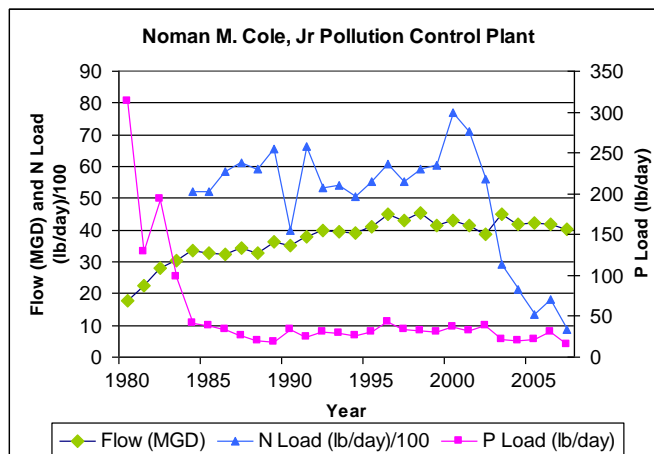
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## An Ecological Study of Gunston Cove – 2009 Executive Summary

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 2009 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 1970s. As shown in the figure to the right, phosphorus loadings were dramatically reduced in the early 1980s. 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.



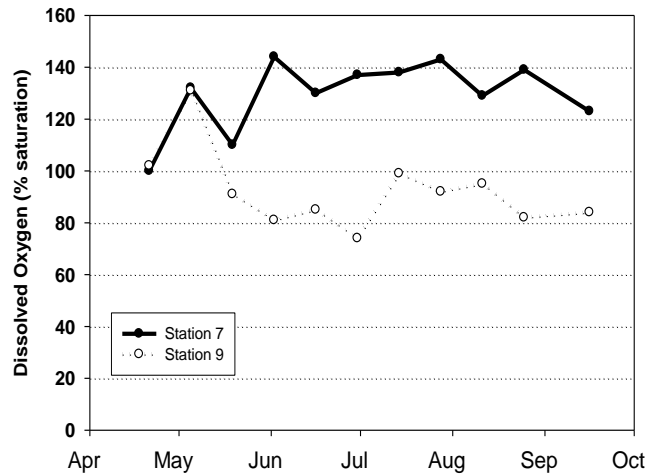
The ongoing ecological study reported here provides documentation of major improvements in water quality and biological resources which can be attributed to those efforts. Water quality improvements have been substantial in spite of the increasing population and volume of wastewater produced. The 25+-year 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.

The year 2009 was characterized by near normal temperatures with August being the warmest month. Potomac River flows were above average in May and June with one large surge exceeding 100,000 cfs. July, August, and early September had near normal flows, but late September and October were below normal reflecting the dry conditions from July through September. Specific conductance, chloride, and alkalinity declined

markedly in May reflecting the flow surge, but increased gradually through the rest of the year reflecting increasingly dry conditions.

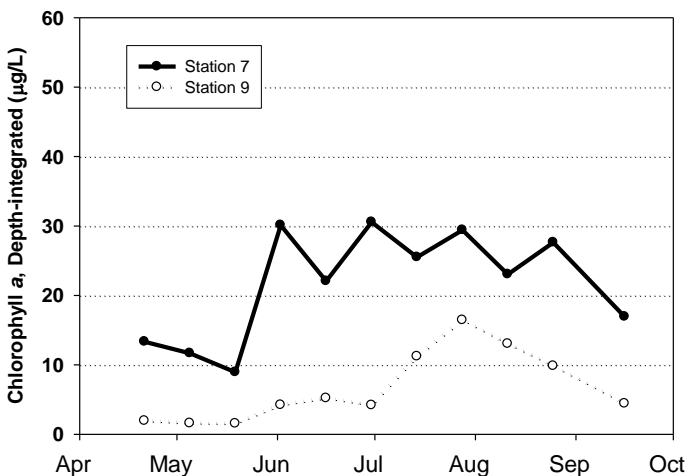
Dissolved oxygen was high at both stations in the spring reflecting increased solubility of oxygen at lower temperatures. DO concentrations remained high during the summer in the cove as photosynthetic production offset decreased solubility leading to supersaturation conditions in the cove. pH was also elevated during the summer in the cove further indicating high photosynthetic rate. Water clarity was generally slightly higher in the river than in the cove as indicated by Secchi depth, light attenuation coefficient and turbidity. However, differences were less marked than in previous years as the cove becomes clearer.

Gunston Cove Study - 2009



Ammonia nitrogen was higher in the river than in the cove in spring and early summer. River values declined in late summer reaching the lower cove values. Nitrate showed a gradual seasonal decline at both stations with values remaining somewhat higher in the river. Nitrite nitrogen was also consistently higher in the river. Organic nitrogen was generally higher in the cove and reached a peak in August. Total phosphorus was fairly constant and similar at both sites. 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 somewhat seasonally, but remained in the range indicating phosphorus limitation. BOD and VSS were higher in the cove than in the river reflecting the higher phytoplankton densities.

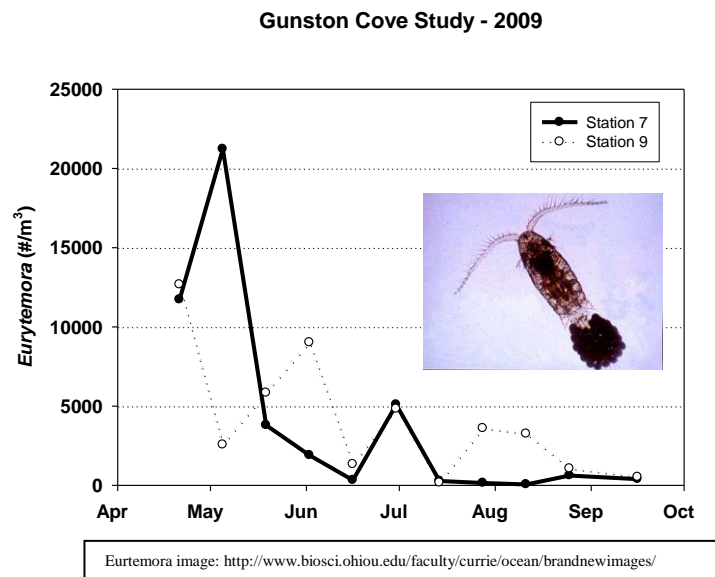
Gunston Cove Study - 2009



In the cove chlorophyll concentrations were low in April and early May, but increased in late May to about 30 µg/L and remained in the 20-30 µg/L range through the summer. In the river chlorophyll remained below 5 µg/L through June and peaked at about 17 µg/L in late July. In the cove phytoplankton density and biovolume increased strongly in June and remained high for most of the remainder of the summer. One exception was late June when both phytoplankton measures were quite low in the cove. In the river

phytoplankton were low through June, but increased somewhat in July and August. Cyanobacteria dominated phytoplankton density in the cove principally due to *Oscillatoria*. In the river densities were somewhat lower and *Oscillatoria* shared dominance with other cyanobacteria. Cryptophytes were also important in density values in the river especially in spring and early summer. Biovolume in the cove increased strongly in mid June led by diatoms and then by cyanobacteria in July. In the river cryptophytes and diatoms were most important all year.

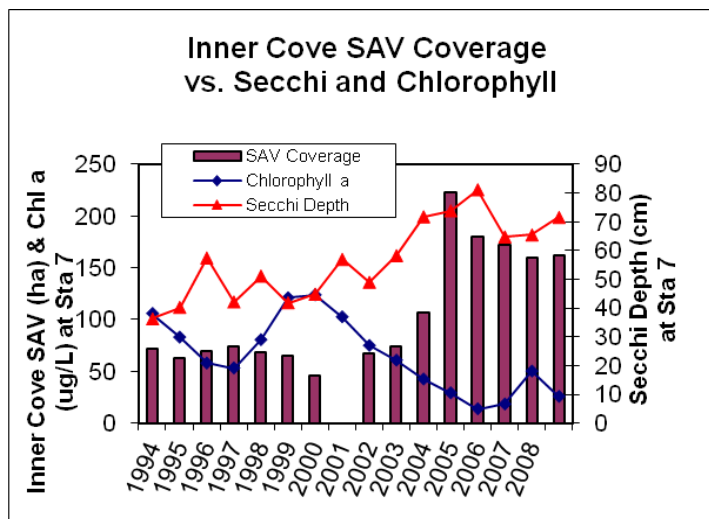
Rotifers were numerous in the cove for most of the year with *Brachionus* being dominant or codominant and *Keratella* and *Polyarthra* being very abundant in mid July. In the river rotifers were much less abundant with peaks in late June and September. The small cladoceran *Bosmina* was found in moderate numbers in summer samples from both sites with a peak in the river in late August. The larger cladoceran *Diaphanosoma* was quite high in early June and mid August at both sites. Following its high abundance in April, *Daphnia* was fairly uncommon. *Leptodora* was quite abundant in May and June in the cove and was found at somewhat lower levels in the river at the same time. Copepod nauplii were present at moderate values in the cove and river over the entire year showing a tendency to increase through the year. *Eurytemora* was very abundant in some samples in April, May and June and was rarer in the late summer and fall. *Diaptomus* peaked in April in both cove and river at moderately high densities. Cyclopoid copepods were abundant in the cove and river in June.



In 2009 ichthyoplankton was dominated by *Dorosoma* sp (gizzard shad) and, to a lesser extent, *Morone* sp. (white perch or striped bass) which comprised over 90% of the catch. Alosids, yellow perch, and inland silversides were found reduced numbers.

In trawls, the majority of the catch was composed of 4 species: alewife, bay anchovy, bluegill sunfish, blue catfish, and white perch. As usual, white perch was found throughout the year at all stations. The sunfish were found throughout the year, but mainly at cove sites. In both groups, 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 gizzard shad, Atlantic menhaden 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 2009. 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 was



much elevated over pre-2005 levels, but less extensive than in 2005.

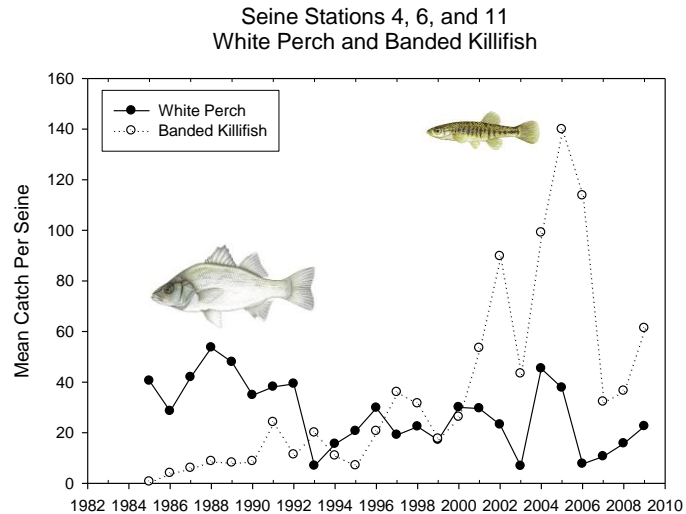
Data from 2009 generally reinforced the major trends which were reported in previous years. First, phytoplankton algae populations in Gunston Cove have shown a clear pattern of decline since 1989 (although chlorophyll values increased somewhat in 2008).

Accompanying this decline

have 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 sediment loading 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. The increase in chlorophyll observed in 2008 may have resulted from unique conditions in 2008 such as the high loading of sediments and associated P from May storms. Chlorophyll declined in 2009 and Secchi depth 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 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.
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. This should continue when new fish ecologist arrives at Mason.
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. They are currently in their final year of monitoring. We should consider continuing this data collection via a joint Mason-Fairfax County effort.



## 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 Dr. Theresa Connor who has been the zooplankton analyst on the Gunston Cove Study for the last 20 years.