February 7, 2008

<u>Hand Delivered</u>

Dear Governor O'Malley:

Please find enclosed our **2008 SevernStat Report.**

Unfortunately, we are sad to report that the Severn River is dying. Based on our findings, it is imperative that you act now to help us stop the stormwater and leaching septic systems that are killing our river.

Our 15 monitoring stations throughout the Severn are telling us that the dead zones are increasing and resources are disappearing. The Maryland Department of Natural Resources recently reported the loss of a major Severn River fishery, the yellow perch fishery.

The Severn is fast becoming a wasteland, and only you can stop it. We have the technology to stop stormwater pollution and leaching septic systems. As Howard Ernst stated in **Chesapeake Bay Blues**, it only remains for us to provide the political will.

Now that you have established **BayStat** to provide the political oversight and the **Chesapeake Bay 2010 Trust Fund** to provide funding, it is important that the $50 million go to stop stormwater runoff and not be wasted on additional studies. Funds from the **flush tax** could also be used to help upgrade failing septic systems.

We are including a list of stormwater protection projects that you can pass on to those who are supervising the **Trust Fund**. We have partners who are willing to contribute to the cost of these projects, so that Trust Fund monies can be spent most effectively.

Thank you for your dedication to protecting and restoring the Chesapeake Bay and particularly your concern for restoring the Captial River of the State of Maryland, the Severn.

Respectfully submitted,

Frederick L. Kelly
The Severn Riverkeeper

SEVERNSTAT REPORT
2008

Introduction

The Severn River is the Capital River of the State of Maryland and as such deserves our best efforts to protect and restore it. Because of its outstanding beauty, the Severn was designated as a Maryland Scenic River in 1971. Unfortunately, special protection did not come with this special designation.

In February of 2007, Governor O'Malley announced the creation of **BayStat**, a program to monitor the health of the Bay and its tributaries and the effectiveness of state agencies in protecting these important resources.

In March of 2007, the Severn Riverkeeper Program delivered our first **SevernStat Report** to the Governor. This report gave the status of the Severn River based on 15 monitoring sites and recommended action to better protect and restore the Severn.

Our **SevernStat 2008 Report** is comprised of two parts, our **2007 Severn River Monitoring Report** on the status of the river and our recommendations for immediate action in 2008.

Part One – Summary of the 2007 Severn River Monitoring Report

The attached **2007 Monitoring Report** reveals a dying body of water. Dissolved oxygen levels from 15 monitoring stations are below healthy levels and show increasing dead zones.

Crabs, oysters, fish and other marine life depend on dissolved oxygen in the water. The Maryland Department of Natural Resources recently confirmed the loss of an entire fishery, the yellow perch fishery. The oysters that have been planted in the Severn as a part of the **Oyster Restoration Program** will not survive in dead zones.

The Severn is fast becoming a wasteland due to uncontrolled stormwater runoff and leaching septic systems. We have the technology to stop stormwater runoff, as demonstrated by our successful prototype project at Howard's Branch, and we can stop leaching septic systems.

Part Two – Recommendations for Action in 2008

The Severn River will continue to deteriorate without immediate action. We know the primary causes of the problem, and we know the solutions. We can act immediately to address uncontrolled stormwater runoff and leaching septic systems. The Governor's **BayStat Program** gives us the vehicle to act on the following recommendations, and the **Chesapeake Bay 2010 Trust Fund** gives us funding to get started.

Recommendation One – That funds from the Chesapeake Bay 2010 Trust Fund be added to funds from our other partners to pay for the following three stormwater control projects on the Severn River:

1. <u>Clements Creek Stormwater Control Project</u> for a cost of $95,000 (Community and Severn Riverkeeper Partnership).
2. <u>Bear Branch Restoration Project</u> for a cost of $1,000,000 (Anne Arundel County Partnership).
3. <u>College Creek Restoration Project</u> for $1,200,000 (City of Annapolis and HUD Partnership).

Supporting the above projects will have an immediate beneficial impact on the Severn River and will also ensure the best use of Trust Fund dollars, due to financial contributions from other partners. We will monitor the projects, so that monies will not be wasted on unnecessary studies.

Recommendation Two – That the state agencies responsible for BayStat initiate an aggressive campaign with Anne Arundel County to help waterfront property owners test their septic systems and upgrading where necessary.

Ron Bowen, the Director of the Anne Arundel County Department of Public Works, recently testified that leaching septic systems are contributing a significant nutrient load to the waterways. Mr. Bowen would certainly welcome state assistance in addressing this problem.

The Severn Riverkeeper Program will ask our waterfront members to join such an effort and recruit their neighbors and community associations to participate. Past efforts have had limited success, but now is the time to initiate a more aggressive campaign that includes everyone.

2007 Severn Riverkeeper Monitoring Project

Pierre Henkart

Severn Riverkeeper Program

The Severn Riverkeeper Program
Is dedicated to Protecting and
Restoring the Severn River

The 2007 Severn Riverkeeper Monitoring Project
Is sponsored by
The Severn 1000 Club:

Joe Allwein
Jeff Armiger
BB&T
Harry Ballman
Gary & Jude Biedenkapp
Allison Burbage
James & Jana Carey
Jim & Janet Clauson
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Keith & Mary Underwood
David & Sara Wallace
Bob & Ann Whitcomb

To join the **Severn 1000 Club** call (410) 849-8540
Or write to: The Severn Riverkeeper Program
329 Riverview Trail
Annapolis, MD 21401

Foreword

By Fred Kelly, Severn Riverkeeper

The Severn River is the "Capital River" of the State of Maryland. Because of its outstanding beauty, the Severn was designated as a Maryland Scenic River in 1971. Unfortunately, special protection did not come with this designation and the Severn has received little or no protection since then.

The 2006 and 2007 SevernStat Reports tell us the story of a dying river. Dead zones are spreading and resources are disappearing. The Maryland Department of Natural Resources recently announced, in its Severn River Yellow Perch study, the loss of this fishery. The once productive Severn spawning grounds have collapsed, and the Severn is fast becoming a wasteland.

The only hope for the Severn is for all of us to review our impact on the waterway and change our destructive practices. We know the causes of the problem, and we know the solutions, it only remains for us to commit the funding to apply the available technology.

The Severn Riverkeeper Program is a vehicle for all who care to become directly involved in protecting and restoring the River. Please join us in this effort, so that future generations can enjoy the Severn that we have enjoyed.

My special thanks to all those who made this report possible especially the Severn 1000 Club and Dr. Pierre Henkart.

2007 Severn Riverkeeper Monitoring Project

By Pierre Henkart, PhD, Severn Riverkeeper Program

Summary

The 2007 Severn monitoring project regularly measured salinity, temperature, dissolved oxygen, and surface water clarity from 15 stations throughout the tidal Severn River during the months of May through October. Bottom dissolved oxygen levels throughout the River were consistently below the Chesapeake Bay Program's "healthy" level of 5 mg/liter. In the mid-Severn/Round Bay section the mean summer bottom dissolved oxygen levels averaged less than 1 mg/liter, and hydrogen sulfide was often detected in water samples. These data confirm our 2006 finding of a summer "dead zone" in this region of Severn. This problem is similar to that occurring in the Chesapeake as a whole, and results from excessive growth of phytoplankton, driven by nitrogen- and phosphorous-based nutrients in the water. Salinity measurements showed an increasing salinity at all stations throughout the summer, and also showed the Severn is generally well mixed. Water clarity measurements showed that the mid Severn/Round Bay region had the best surface water clarity, correlating with the growth of substantial submerged aquatic vegetation along the shore in this region. Restricting the influx of phytoplankton nutrients into the Severn would improve both its low dissolved oxygen and restricted water clarity problems, and could lead to improved fishing and crabbing.

Background

The Severn Riverkeeper Monitoring Project was initiated in the spring of 2006, and resulted in regular water quality measurements carried out throughout the tidal

Severn from June through September 2006. Measurements of dissolved oxygen, salinity, temperature, and surface clarity were made every 1-2 weeks. These measurements revealed that the great majority of bottom dissolved oxygen levels throughout the Severn were lower than the Chesapeake Bay Program's "healthy" minimum of 5 mg/liter. The Round Bay portion of the Severn and nearby Severn Narrows showed the most severe hypoxia (low oxygen), with mean DO levels below 1 mg/liter. These low levels are suggestive of a "dead zone" that is incompatible with normal bottom-dwelling organisms such as clams, worms, and amphipods. Water samples from near the bottom of this area consistently contained readily detectable hydrogen sulfide, a product of anaerobic bacterial metabolism characteristic of dead zones. This severe hypoxia throughout a large area of the Severn had not been reported by regular government monitoring programs. While most of the tidal creeks had modest bottom hypoxia, Asquith Creek suffered severe hypoxia indicative of a small local "dead zone" persisting for much of the summer.

Salinity measurements by the 2006 Severn Riverkeeper Monitoring Project surrounding a major rain event in late June revealed a movement of fresh water into the tidal Severn from the adjoining Chesapeake rather than from the local watershed. This "reverse flow" was previously observed by Maryland Department of Natural Resources monitoring in the early spring.

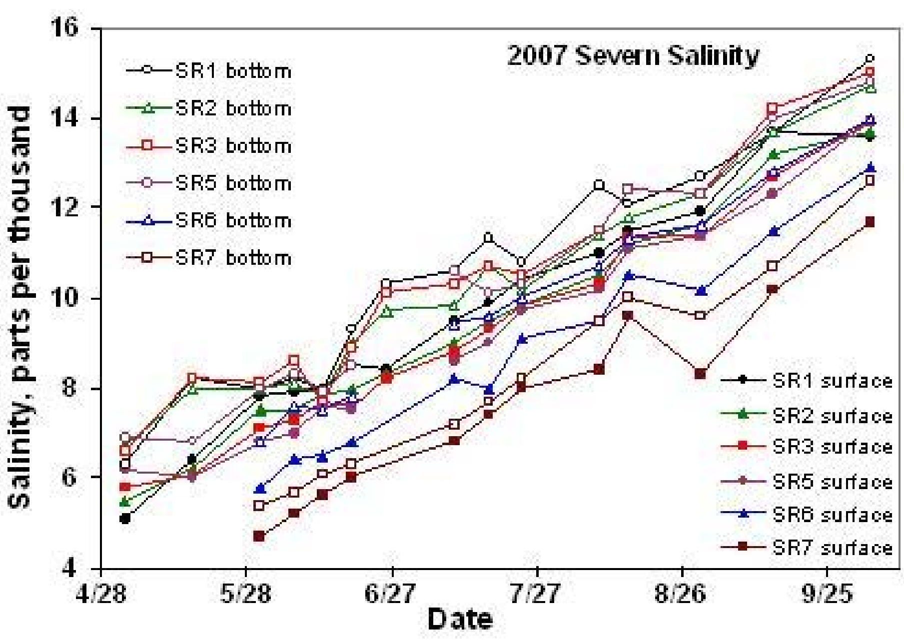
The Severn Riverkeeper Program initiated the 2007 Monitoring Project as a follow-up to the 2006 Project to observe the degree of bottom hypoxia throughout the Severn, particularly in Round Bay and Asquith Creek. In addition, the 2007 Project sought to compare the Severn's summer salinity and water clarity profiles with those obtained in 2006.

Methods

In general, the selection of monitoring stations in 2006 appeared to give a complete picture of the Severn, assessing both the tidal creeks as well as the mainstem (deep channel, mid-Severn) from Annapolis to its tidal head some10 miles to the northwest. The 2006 Severn Monitoring Project was a highly successful collaboration between the Arlington Echo Outdoor Education Center, which monitored 5 stations above Round Bay, and the Severn Riverkeeper, which measured all stations from Annapolis through Round Bay. In 2007, Arlington Echo was unable to continue supporting this effort with a regular monitoring schedule, requiring substantially longer monitoring trips by the Riverkeeper boat berthed in Saltworks Creek. Because three additional stations had been established in Round Bay in August 2006 to document the severe hypoxia there, it was decided to drop the monitoring stations in Plum and Yantz Creeks in the upper Severn; this allowed the entire upper portion of the Severn to be monitored in one trip from Saltworks Creek. A map of the 2007 monitoring stations is shown below.

Two probe-based YSI 85 meters capable of measuring dissolved oxygen, temperature and salinity were successfully used in 2006 and were used initially in 2007. Meter SRK1 has a 25 foot cable useful for all stations except the deep SR6 station in the middle of the Severn off Joyce. Meter SRK2 with its 50-foot cable was used at all stations, and a third such meter (SRK3) was purchased later in the summer. To allow regular assessment of the presence of hydrogen sulfide in regions of severe hypoxia, a water-sampling device was obtained from Aquatic Ecosystems (#W78305). Surface water clarity was measured with a standard Secchi disk.

Each monitoring station was located by maneuvering the boat using visual line-ups of shore-based landmarks from a photo-based guide established in 2006. The boat was anchored at the designated position, and the monitoring probes (normally two different meters at each station) were lowered to ~.5 meter off the bottom using a lead weight suspended under the probe. Readings of dissolved oxygen percent saturation, mg/liter dissolved oxygen, salinity and temperature were made at 1-2 meter depth intervals to the surface, with care taken to keep the probe moving via a jigging motion as required for accurate readings by the oxygen electrode. Data was recorded by a second person using a clipboard, and subsequently transferred to an Excel spreadsheet, normally within one day. This spreadsheet was regularly updated to provide a complete record of 2007 water quality monitoring data, and remains available on the Riverkeeper website (www.severnriverkeeper.org/07MonitoringCumulative.xls).



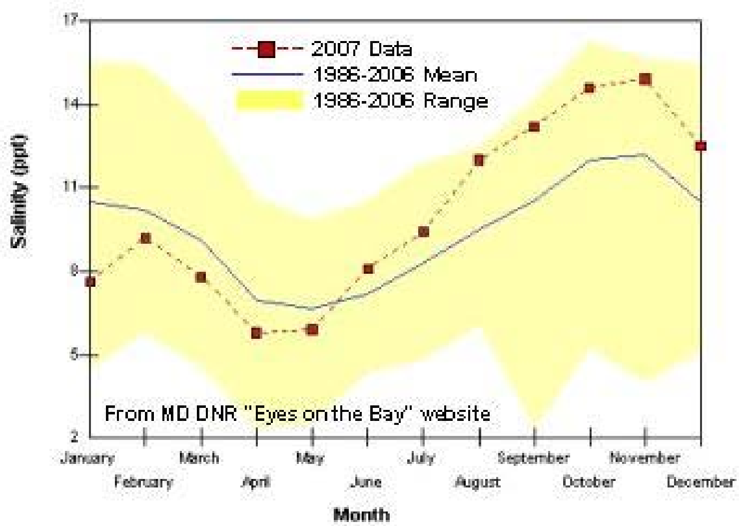
Salinity--Results

As can be seen in the first figure below, salinity increased dramatically at all stations during the course of the 2007 monitoring period. By comparing the surface and bottom salinity of a single station at one particular time, it can be seen that the Severn is generally well mixed vertically, i.e., there is only a small difference (~1 ppt) in salinity between the top and bottom layers. The data in the second figure also show that the salinity of most of the Severn was very similar at any one time, with lower salinities due to local fresh water inflow apparent mainly at the shallow uppermost tidal regions near station SR7, with a lesser effect seen at station SR6. Although not shown in the figures, the Severn tidal creek stations SC1-4 and SC6 had salinities very similar to the nearby mainstem stations.

Salinity--Discussion

Variations in salinity are a natural and essential feature of estuaries such as the Chesapeake, and the 2006 Monitoring Project showed clearly that the Severn is very much a part of the Chesapeake estuary. The salinity in estuaries is determined by a balance between fresh water inflow from the watershed and seawater intrusion from the ocean. The summer and fall of 2007 were unusual in that rainfall in the Severn and most of the Chesapeake watershed was approximately half the normal level, so that more saltwater intrusion would be expected up the Chesapeake and into the Severn.

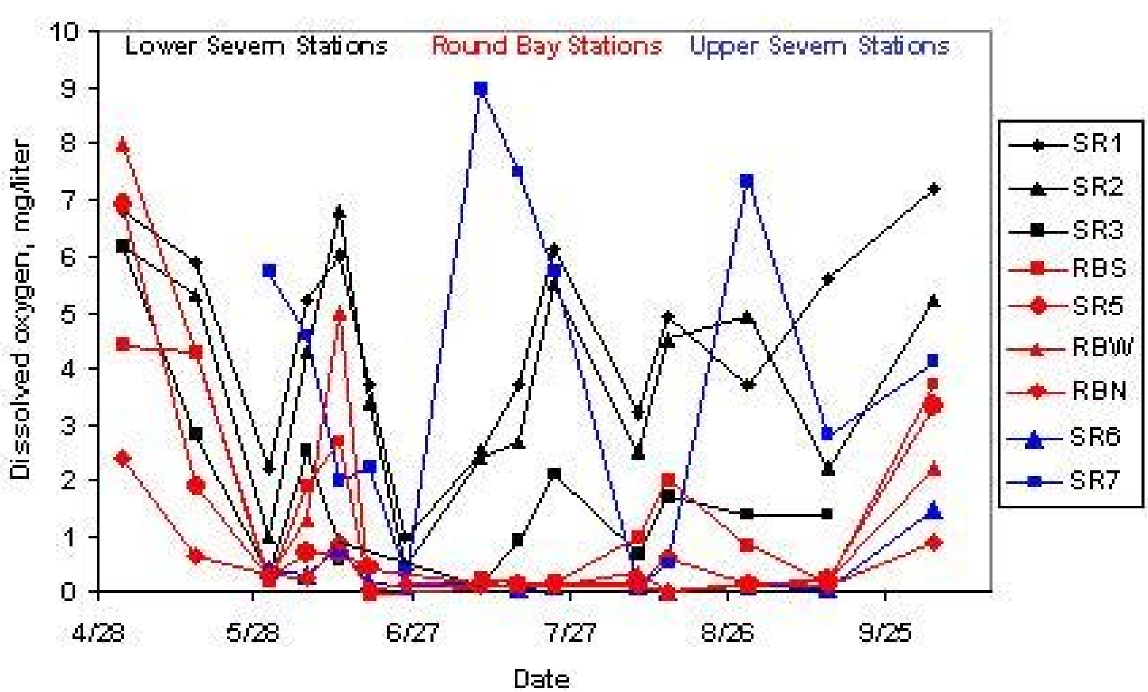
The salinity data in 2007 show a generally linear increase in salinity at all stations throughout the monitoring period. Unlike 2006, 2007 saw no major rainstorm bringing large amounts of fresh water into the Severn, and the drought gave rise to a steeper-than-normal salinity increase throughout the summer. This can be best appreciated using the Maryland DNR data from their Rte 50 Bridge monitoring station (SR2), comparing 2007 with the 20- year average data. Although the springtime salinity was lower than average, it increased much more sharply than normal throughout the summer and by the fall the salinity was near the 20 year maximum. This reflects the very low rainfall in the region in 2007. The only significant source of salt in estuaries is the ocean, and in the Severn it is the adjoining Chesapeake. Our 2007 data show that the Severn's low salinity in May was replaced by saltier water from the Chesapeake throughout the summer. This situation contrasts with what we observed after a huge rainstorm at the end of June 2006, when moderately salty water in the Severn was replaced by much fresher water coming down the Chesapeake from the Susquehanna River. However, at most times the Severn shows a generally uniform pattern of salinity throughout the tidal river. This pattern, when combined with the changes induced by the 2007 drought and the 2006 heavy rainfall, shows that the great majority of water in most of the tidal Severn River comes from the adjoining Chesapeake.



Dissolved Oxygen--Results

As shown in the appendix, a series of vertical profiles of dissolved oxygen (DO) concentration with depth were created for each station throughout the Severn. These show that dissolved oxygen concentrations near the Severn's surface were generally close to saturated levels, indicative of the exchange between atmospheric oxygen and the top water layer. In some cases dissolved oxygen levels greater than saturation was observed, reflecting oxygen produced by photosynthesizing phytoplankton. Dissolved oxygen readings greater than 150% of saturation, indicative of phytoplankton blooms, were uncommon in the Severn during the summer of 2007.

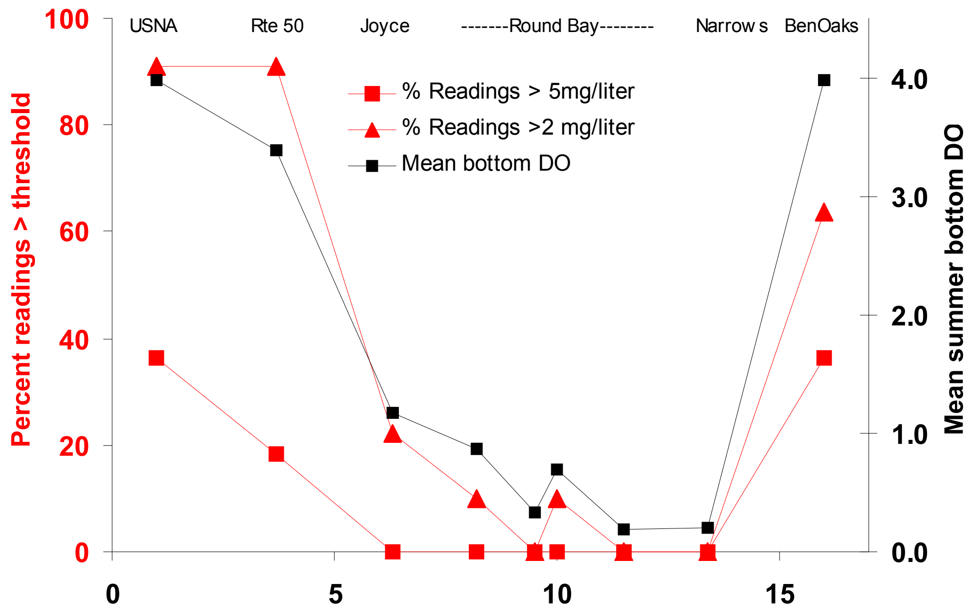
Dissolved oxygen concentrations decreased with depth, with minimum values for each station invariably at the deepest measurement, about .5 meters from the bottom. This bottom reading reflects the environment of benthic organisms such as clams, worms and amphipods that are an integral part of the normal local food chain. It was important to see if the low bottom dissolved oxygen levels observed in 2006, particularly in Round Bay, would be found again in 2007. The figure below shows the 2007 bottom dissolved oxygen data for the Severn mainstem stations. DO levels throughout the Severn declined during May and rose in the fall, and were lowest from June-September. In the lower Severn (black symbols) bottom DO levels fluctuated considerably, with mid summer levels mostly above 3 mg/l but sometimes less than 2 mg/l, particularly at the deep station SR3. The very shallow (~3-4 ft deep) uppermost station SR7 was also highly variable, while the Severn Narrows station SR6 showed consistently low DO levels of less than 1 mg/l throughout the summer. The red symbols show stations in Round Bay, which all showed generally low DO levels from June through September. The southernmost Round Bay station RBS had higher DO levels than the other Round Bay stations. Round Bay readings in early June were quite variable, but settled into a highly hypoxic condition by late June.



The Chesapeake Bay Program has set a threshold of 5 mg/l dissolved oxygen as a lower limit for acceptable water quality, based on well documented studies with fish. The above figure shows that most of the Severn summer bottom DO readings failed to meet this criterion, and acceptable values were often followed by failing values soon thereafter. Another threshold of 2 mg/l DO can be set for bottom-dwelling organisms such as oysters, worms, etc., that are better adapted to low oxygen conditions; this threshold is thus more relevant to our bottom DO readings. Although most of the lower Severn readings were above this value, most of the summer readings in Round Bay and Severn Narrows (SR6) were not.

Mean summer DO values and threshold clearance values are shown in the chart below, plotted as the distance of each mainstem station up the Severn up from Annapolis.

(Data from Severn mainstem, June-September)



This data shows that summer bottom DO levels above the 5 mg/l threshold occur only rarely, and then only at the shallow Ben Oaks station and the lower Severn stations. Using the more relaxed 2 mg/l criterion for healthy bottom water, the mid-Severn/Round Bay area rarely has acceptable bottom water. The above graph includes data from June and September, when DO levels were higher than those observed from July-August.

Dissolved oxygen values less than 0.2 mg/l are characterized by the Chesapeake Bay program as “anoxic”, and are associated with “dead zones” formed in the deeper parts of the mid-Chesapeake every summer. In our experience, the YSI 85 meters do not give reliable readings at these low levels, although many of our Round Bay values were below this value. To confirm the anoxic character of water giving such readings, a water sampler was used to retrieve a sample, which was immediately tested for hydrogen sulfide by its characteristic “rotten egg” smell. The great majority of samples recovered after meter readings with DO <0.2 mg/l were positive for hydrogen sulfide. These were found at most of the Round Bay stations throughout the summer.

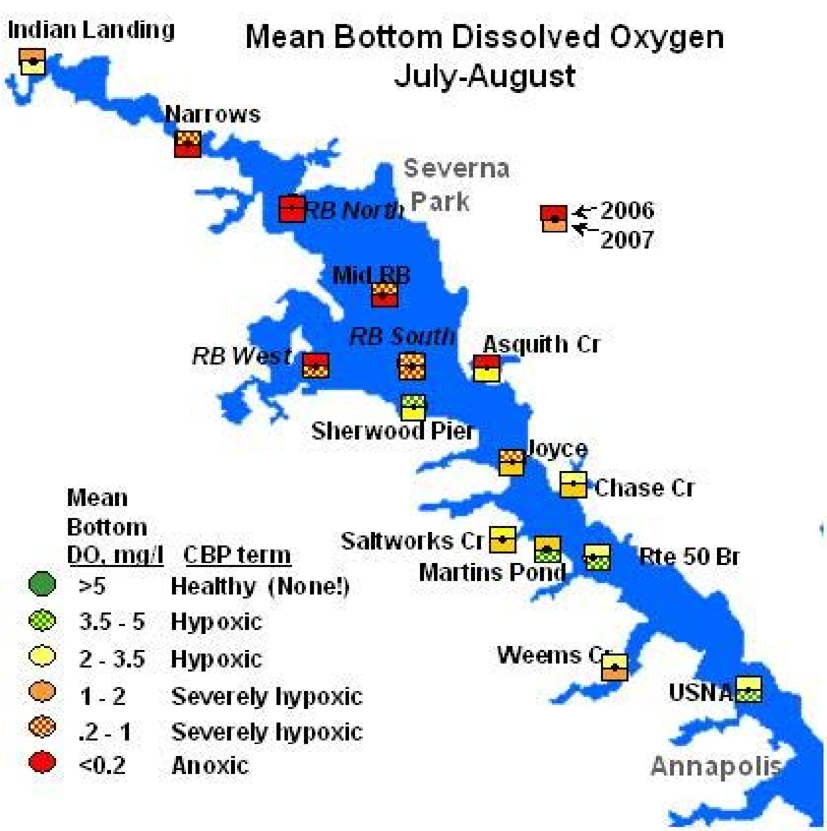
In addition to the Severn mainstem stations discussed above, we monitored 5 creek stations in 2007. Four of these creeks are south of Round Bay, and these had average bottom DO (June-September) levels ranging from 1.7 mg/l (Saltworks Creek) to 3.4 mg/l (Martin's Pond). Weems Creek was the site of a fish kill in late June involving ~20,000 fish deaths (see the Riverkeeper report on this incident on our website: http://www.severnriverkeeper.org/Weems%20Fish%20Kill.htm). The Maryland Department of Natural Resources ascribed this fish kill to low DO. Our Weems Creek monitoring station (between its two bridges) had a mean summer DO of 2.0 mg/l. Readings at this station two days before the fish kill showed anoxia (DO <0.2 mg/l) at the bottom but not higher in the water column. However, the fish kill occurred ~1/4 mile further up Weems Creek than our monitoring station.

The bottom depth at the Severn creek stations is typically about 10 feet. Occasional bottom DO readings <1 mg/l were observed (in addition to the Weems Creek example cited above), but there was considerable variability from one sampling date to the next. As in 2006, the most hypoxic creek in 2007 was Asquith Creek (station SC6, off Round Bay), with its entrance blocked by shallow water and a prolific SAV bed. Its mean summer DO was 1.7 mg/l, higher than 2006, but a closer examination shows that from May through mid July the bottom DO averaged a very hypoxic 0.3 mg/l, and from mid July through September it averaged 3.0. Hydrogen sulfide was detected in Asquith bottom water samples when the bottom DO was >0.3 mg/l.

Complete dissolved oxygen profiles, with all our data at each Severn station are shown in the Appendix.

Dissolved oxygen--Discussion

One of the primary goals of our 2007 monitoring project was to compare this year's dissolved oxygen readings with those of 2006, especially with regard to the degree of bottom hypoxia in the Round Bay region. The figure below presents a summary comparison of these findings, comparing data from July and August. It is clear that the central Severn region from Joyce to Severn Narrows was the region of lowest bottom DO in both 2006 and 2007. The station near the end of the Sherwood Forest pier showed only mild hypoxia both years, presumably because shoreline influences promoted greater vertical mixing. However, both years all the



mid-Severn stations from Joyce to Severn Narrows had severely hypoxic average summer DO values of <2 mg/l. The average DO values were higher in 2007 for the southernmost of these stations and lower in the Severn Narrows station, but the basic pattern was similar.

As discussed above, local rainfall and salinity patterns were quite different in 2006 and 2007, with substantially less rainfall (and accompanying runoff) than normal starting in April 2007. Given the reported correlation of the size of the Chesapeake's "dead zone" and rainfall levels, it was perhaps surprising to find such similar DO patterns in the Severn in 2006 and 2007. One possible explanation might be that the major nutrient loading driving phytoplankton growth in the Severn throughout the summer came from runoff associated with the normal levels of rain in the late winter/early spring of 2007.

The most likely explanation for the better DO levels in the lower Severn is that these areas have a more efficient exchange with the top layer of the nearby Chesapeake. Water entry into the Severn occurs due to density-driven exchange with the top ~30 feet of the adjacent Chesapeake, and this Chesapeake water is reasonably well oxygenated due to stronger mixing forces in the open Bay. The weak tidal flows in the Severn do not promote efficient mixing, and this may explain why DO is lowest in Round Bay and Severn Narrows. At the head of the tidal Severn at Ben Oaks, the shallow water (3-4 feet) is easily mixed and less hypoxia is generally seen.

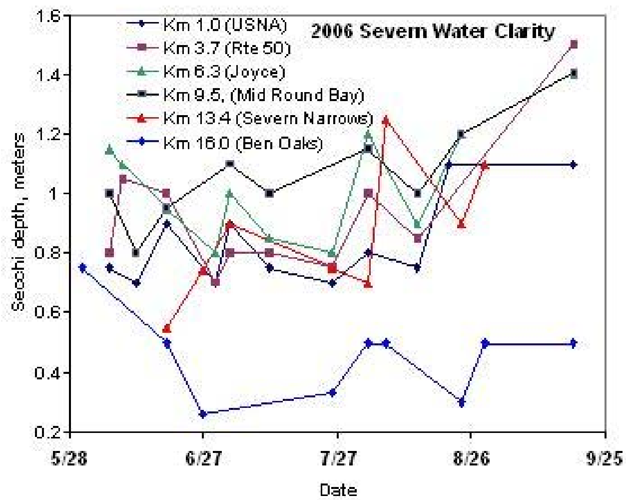
The Severn creek stations are generally about 10 feet deep, so the variable degree of hypoxia we observed probably reflects better vertical mixing than occurs in the deeper Severn mainstem. In addition, horizontal exchange with the adjacent Severn would be expected to bring in moderately oxygenated water even along the bottom of these creeks. The one problem creek we have identified is Asquith, which was very hypoxic from May until mid-July. This severe hypoxia/anoxia was similar to our findings during the whole summer of 2006, and was confirmed by the presence of hydrogen sulfide in bottom water. However, in 2007 Asquith's bottom DO improved considerably after mid-July. This increased bottom oxygen may have resulted from: 1) the aeration apparatus installed ~1/4 mile away in Asquith Creek in early June; 2) a reduction in bottom bacterial metabolism from lessened phytoplankton caused by reduced nutrients resulting from the accumulated lack of rainfall during previous months; 3) weakening of the stabilizing vertical density gradient due to warming of bottom water; or 4) other influences promoting vertical mixing.

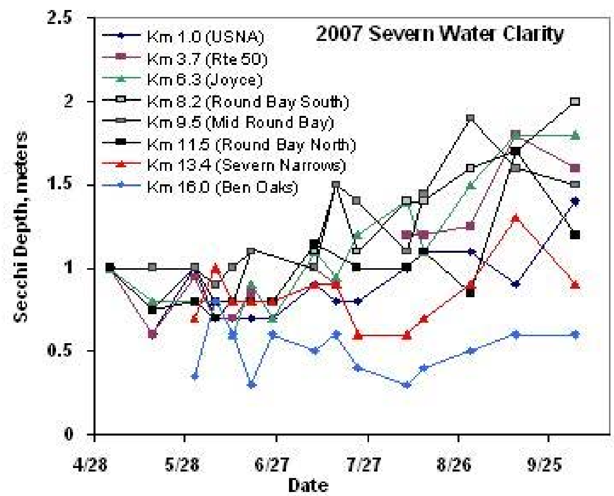
The sequence of processes that lead to hypoxia in estuaries is well known. It begins with the loading of nitrogen- and phosphorous-based plant nutrients into waterways, largely derived from stormwater runoff. When temperature and sunlight increase in the spring, these nutrients stimulate the growth of various types of naturally occurring phytoplankton in estuaries. After growing to the point of nutrient limitation, phytoplankton die and drop to the bottom where they are decomposed by bacteria. This bacterial metabolism uses up dissolved oxygen at the bottom, and the restricted vertical mixing results in a zone of hypoxia along the bottom and extending upwards until it is overcome by mixing with oxygenated water. Vertical mixing in estuaries is inhibited by natural density gradients resulting from lower density fresher and warmer surface water layered on top of denser saltier and cooler water.

Although the Chesapeake's summer "dead zone" has been well documented in recent years, we believe our findings in the Severn provide the first clear evidence that the Chesapeake's shallower tributary rivers can also suffer from severe hypoxia. We suspect that other Chesapeake tributaries may be similarly affected, but monitoring programs have either not existed or not looked in the right places to document this problem. Hypoxia-induced degradation of the Severn's benthic habitat could explain the widely acknowledged decline in local recreational fishing and especially crabbing.

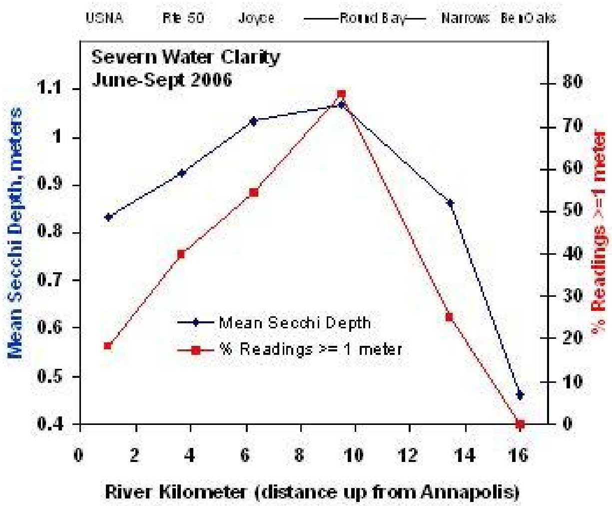
Water Clarity—Results

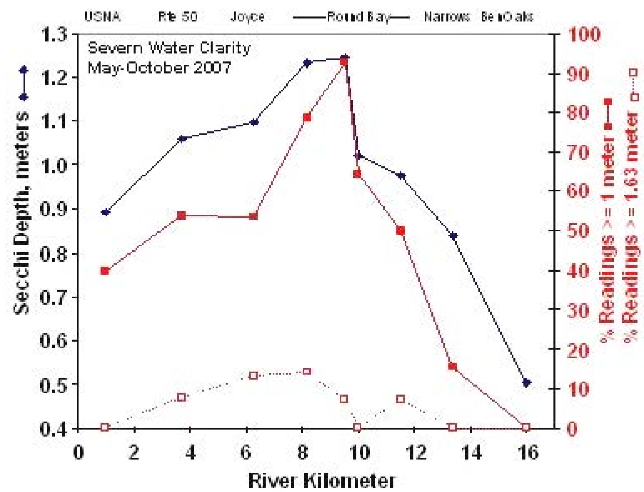
Water clarity was measured near the surface by using a Secchi disk at each station throughout the monitoring period. This measurement shows the maximum depth at which a standard white disk is visible from the surface when lowered from the boat. Since we did not include water clarity data in our 2006 monitoring report, we will include it here to allow comparison. However, we had more monitoring stations and a longer monitoring season in 2007 compared to 2006. The graphs below show our data for the Severn mainstem stations.





Several trends are apparent in both years. Overall, water clarity was considerably better in 2007 than in 2006, presumably because of the drought. Water clarity was consistently worse at Ben Oaks, our northernmost monitoring station, which is heavily influence by fresh water inflow from Severn Run. At times the water there is clearly muddy, due to rainstorms, but other times the cause of low clarity is not obvious. The next station down, Severn Narrows, also showed somewhat less clear water than other Severn stations, particularly in 2007. There was a tendency for the water clarity to improve in the later part of the summer (starting in August 2006 and in July 2007). Close inspection of the above graphs also show that USNA station generally had lower water clarity than other stations. Plotting water clarity against station position in the river shows the mid-Severn tends to have the clearest water, as shown below.



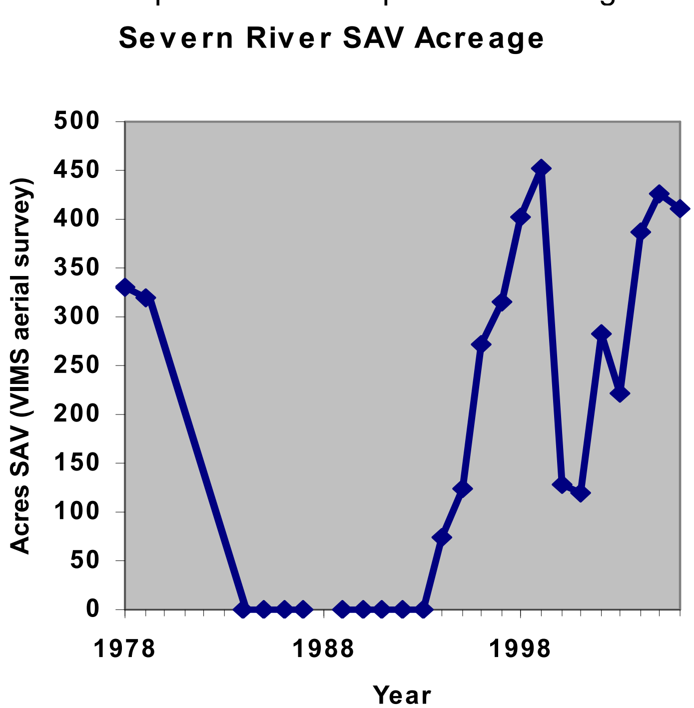


As discussed below, these plots also show the percentage of measurements with a Secchi reading of 1.0 meter or more, which is the criterion set by the Chesapeake Bay Program for acceptable water quality to allow the growth of submerged aquatic vegetation. In addition, the percent exceeding the CBP1.63 meter criterion for phytoplankton growth is shown, although this is unusually clear water for the Severn.

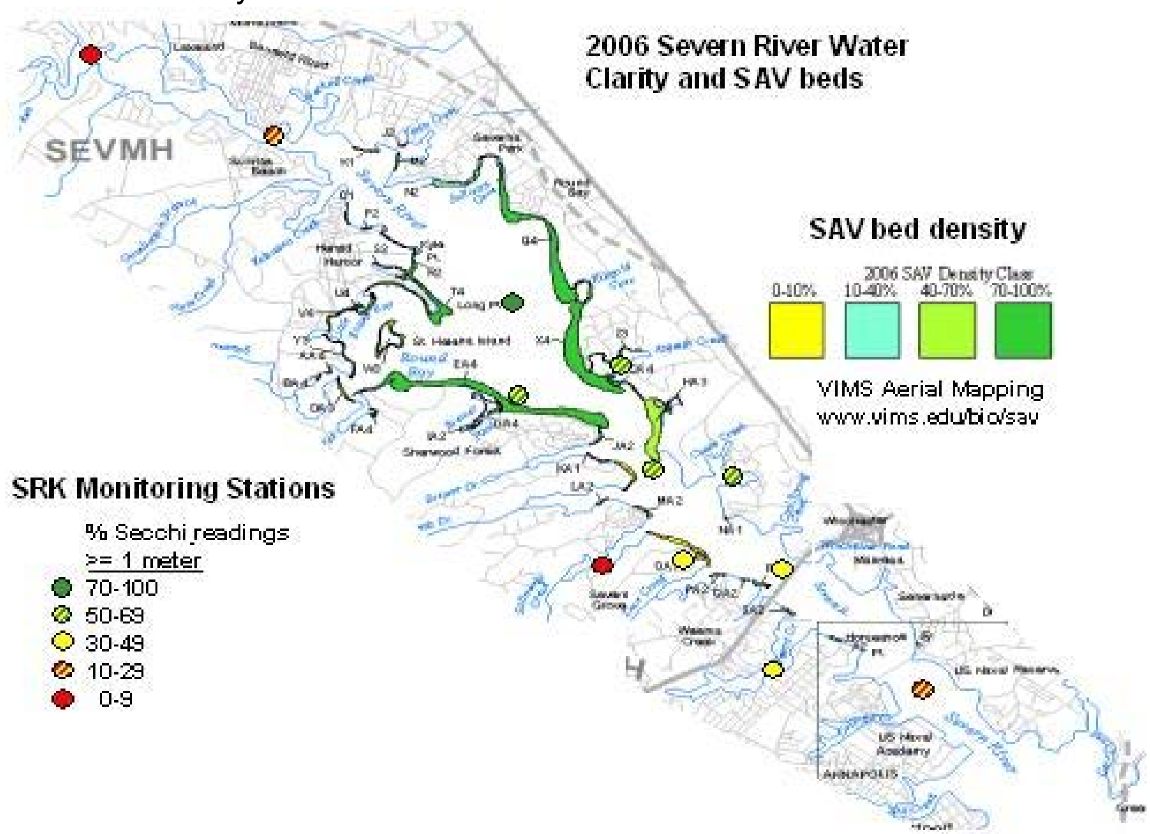
Water clarity in the tidal Severn Creeks appeared to be determined by how much freshwater entered the creek, as clarity was degraded by proximity to these sources of nutrients and sediment. Not surprisingly, near the entrance to the creeks the clarity was similar to the adjoining Severn.

Water clarity--discussion

A principal reason for measuring water clarity is to assess the potential of nearby areas to support the growth of submerged aquatic vegetation (SAV), which provides excellent habitat for fish and crabs. Water clarity is only one of the factors with the potential to limit SAV growth, and one question we sought to address was whether this factor is responsible for the pattern of SAV growth in the Severn. Historically, the shallow waters of the Severn had substantial SAV beds, and boaters considered these beds a nuisance. SAV disappeared from the Severn in the 1980s, but re-grew in the mid-Severn in the 1990s. Several species of these rooted grasses grow in the Severn, with the most dominant being redhead grass and widgeon grass (named after ducks that like to eat their seeds). SAV is monitored throughout the Chesapeake by an excellent comprehensive program run by the Virginia Institute of Marine Science, using aerial surveillance mapping (http://www.vims.edu/bio/sav/).



Data provided by this program shows the striking recent resurgence of SAV growth in the Severn. The steep decline in SAV in 1990 was caused by a springtime phytoplankton bloom, which occurred throughout the neighboring Chesapeake region. Since then SAV acreage has recovered well, but all this growth is limited to the midsection of the river, from the top of Round Bay down to the Rte 50 Bridge. It is striking that shallow areas in the Severn near Annapolis and above Round Bay are devoid of SAV while apparently similar shallow areas around Round Bay support dense SAV beds. The water clarity data graph on the previous page shows that our Secchi readings indicated clearer water in the mid-Severn, with lower readings above Round Bay and near Annapolis. A map of the 2006 SAV beds (provided by the VIMS aerial survey) overlaid with average Secchi readings from our 2006 monitoring shows this correlation clearly.



This figure shows that those regions where more than half of our Secchi readings were one meter or more showed good SAV growth along the shoreline, while those regions where less than half of our readings were this clear showed marginal or no SAV. SAV growth in the Severn's creeks is generally minimal (principally other species, especially horned pondweed early in the season) which seems to correlate with generally reduced water clarity. It may not be apparent from this map, but the Severn creek with the most SAV growth was Asquith Creek, and this creek had the clearest water of any of the five creek stations we monitored.

The 2007 Severn SAV map was not available at the time this report was written, but the preliminary report from VIMS, confirmed by our monitoring observations, is that the Severn's 2007 SAV beds were similar to those in 2006. Given the generally similar pattern in our mean water clarity patterns in these two years, the correlation between SAV growth and water clarity appears to be holding in 2007.

Yellow Perch—Results and Discussion

In March and April 2007, the Severn Riverkeeper Monitoring Project collaborated with the Fisheries Division of the Maryland Department of Natural Resources and the Arlington Echo Outdoor Education Center in measuring larval yellow perch in the upper Severn. Yellow perch are a fresh water fish that can adapt to estuarine habitats, and this species has traditionally been a favorite target of anglers in the Severn. However, yellow perch have declined dramatically in the Severn and neighboring Chesapeake tributaries in recent years, leading the DNR to ban fishing for this species in the Severn in 1989. The reasons for the decline of the Severn's yellow perch were addressed in a 2005 DNR study by Jim Uphoff and other DNR biologists, in which they concluded that a combination of increasing salinity and low dissolved oxygen were likely responsible.

As part of DNR's continuing yellow perch monitoring efforts, Allison Albert Buckalew and Pierre Henkart of the Riverkeeper Program, along with Arlington Echo staff, were trained by DNR personnel in their standard procedure of counting post-hatching larval yellow perch by plankton tows in the upper Severn. The picture shows Allison and Arlington Echo intern Sue Schoepe in the Riverkeeper boat, deploying the plankton net prior to towing it through the water.

Larval yellow perch were counted on ten monitoring trips from the end of March through the beginning of May, with each trip completing ten two minute plankton tows at standard stations throughout the upper Severn. Live larvae were found in five of these monitoring trips, but only two trips recorded significant numbers, and those were found only in the uppermost stations. Based on comparisons with historical data and with rivers with healthy yellow perch populations, DNR biologists concluded that this data indicated continuing marginal reproduction of the Severn's yellow perch population in 2007.

Improving the Severn's water quality—Discussion

Our monitoring has focused on two problems with the Severn's water quality, summer hypoxia and reduced water clarity. Both of these problems result from the excess growth of phytoplankton, a problem affecting the Chesapeake as a whole, and coastal waters world-wide. Because measurements of phytoplankton levels (based on chlorophyll content) are not simple technically, we have not tried to measure this, although chlorophyll measurements are made by the Maryland DNR at the Rte 50 monitoring station. The Severn is not included in the CBP phytoplankton monitoring program which identifies species present and their abundance. However, phytoplankton densities vary rapidly and it is often hard to interpret such data. It is well known that the excessive phytoplankton growth results from an overabundance of nitrogen- and phosphorous-based nutrients in the water, and considerable study has been devoted on the sources of these nutrients for the Chesapeake as a whole. Focusing on the Severn, an open question is how much of the relevant phytoplankton nutrients are derived from the local watershed and how much come into the tidal Severn from the adjacent Chesapeake. It seems likely that where there is a clear fresh water influence (areas like Ben Oaks), nutrients will be largely derived from the local watershed. However, for areas like Round Bay it is not simple to analyze this problem.

Phytoplankton growth in estuaries is controlled by the amount of available sunlight and the levels of nitrogen and phosphorous nutrients necessary for metabolism. In the Severn, phytoplankton growth increases in the springtime with its longer days and more overhead sunlight, along with increasing fresh water input containing nitrogen and phosphorous nutrients. It is not known which of these nutrients is most critical to the Severn's phytoplankton growth (known as the limiting nutrient) responsible for creating bottom hypoxia. In general, phytoplankton growth in fresh water tends to be limited by phosphorous, while marine phytoplankton are limited by nitrogen-based nutrients. Some modeling studies have suggested that in the Severn, phytoplankton growth is limited by phosphorous in the spring when the water is fresher, and later in the summer there is a switch to nitrogen limitation. Whether this is actually the case, and which nutrient limits the growth of the phytoplankton responsible for the Severn's serious hypoxia is not known.

Considerable recent debate in Anne Arundel County has addressed the need for improving local stormwater runoff, especially for older areas built up before current regulations were put in place. It seems clear that nutrients and sediment from local stormwater runoff are major contributors to the water quality problems we have identified in the upper Severn and in the tidal creeks. Modern methods of stormwater control can reduce both nutrients and sediment, and their implementation would have a beneficial effect. While regulations for new construction in the County include such controls, the problem in the Severn watershed is attributable to older development, and improvements in water quality are unlikely until runoff from these areas is addressed.

One major source of phytoplankton nutrients for the Chesapeake is runoff from fertilizers in agricultural areas. While the Severn watershed has almost no agriculture, it has considerable acreage in suburban lawns, many of which are heavily fertilized. These lawns are striking to those of us who monitor the Severn from the water, but lawns throughout the watershed potentially contribute to nutrient enrichment. We are unaware of studies addressing whether restricting lawn fertilizer usage would significantly reduce overall nutrient influx and phytoplankton growth in the tidal Severn.

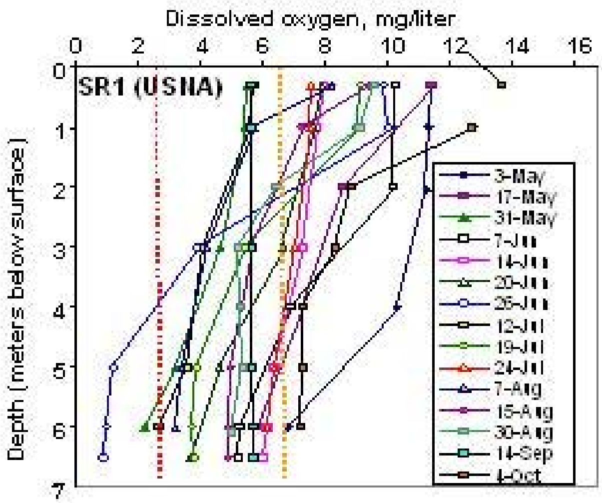
Acknowledgments

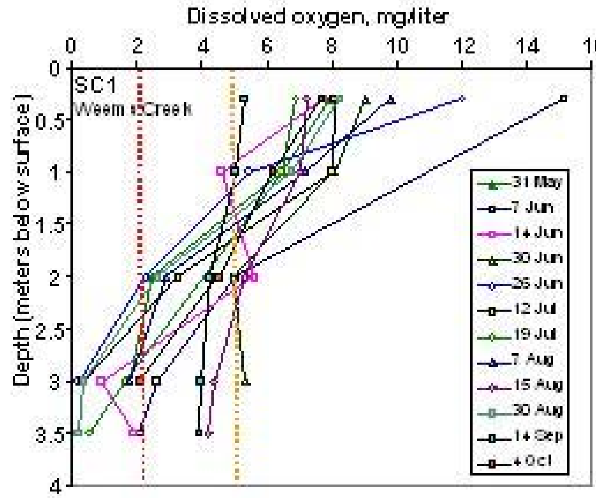
This project was initiated and funded by the Severn Riverkeeper Program, and first in line to be thanked is Riverkeeper Fred Kelly. Fred was a major resource for this project, from directly participating in monitoring, maintaining the boat, helping supervise monitoring personnel, and inspiring donors to help fund our efforts. Funds for this project were provided by the Chesapeake Bay Trust, the Spring Creek Foundation and the Abell Foundation, and the Severn 1000 Club.

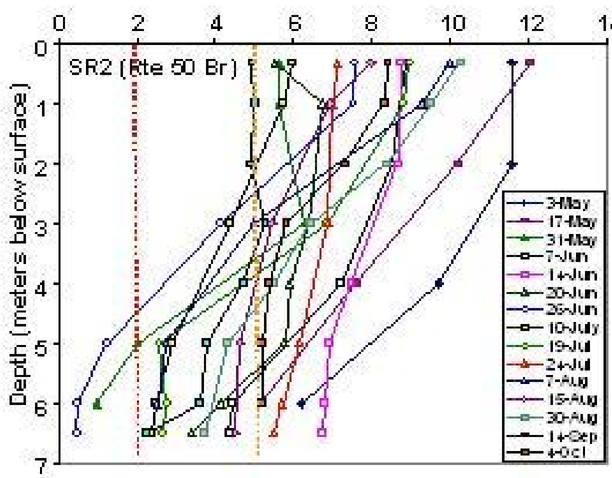
Allison Albert Buckalew, Riverkeeper Program Director deserves much of the credit for the success of this monitoring project. She was instrumental in writing the grants that funded the project, she directed many of the actual monitoring trips, and organized the various components needed to provide reliable data for the project. Riverkeeper Program interns manned the boat, read the meters, and recorded data. Their efforts have made this the most comprehensive water quality monitoring effort in the Severn. This summer's interns were: Annelies de Groot (St. John's College), John Clauson, (Colby College), and Lindsay Hall (Virginia Tech). We thank the St. Johns College Hodson Internship for supporting Ms. De Groot. Student volunteers Nate Frankoff and Aaron Canale played equally vital roles in monitoring and boat handling throughout the summer. Other volunteers who joined at least one monitoring trip were: Arlington Echo's Suzanne Kilby and Kate Skowron, along with Arlington Echo interns Sue Schoepe, Heather Hatfield, Becky Lang, Alicia Henry and Sarah Weller.

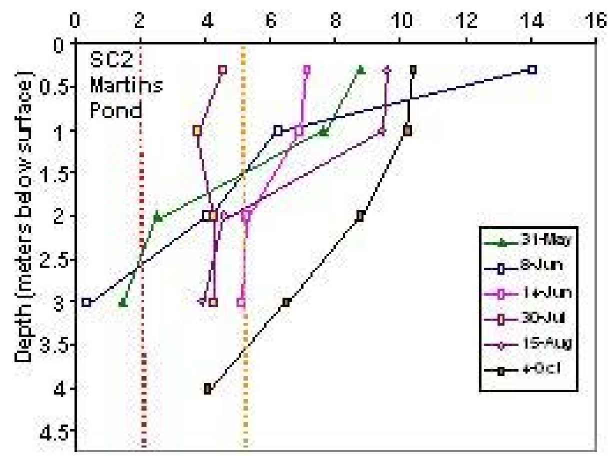
In both 2006 and 2007, this monitoring project has greatly benefitted from expert guidance from NOAA's Dr. Peter Bergstrom. Most recently he has made an effort to standardize the reporting of water quality monitoring results from groups like ours so that local rivers can be compared in a meaningful way. We support this effort and have adopted these standards in this report, although we sometimes additionally report other parameters. Dr. Bergstrom's expertise in submerged aquatic vegetation has greatly aided our efforts on the Severn.

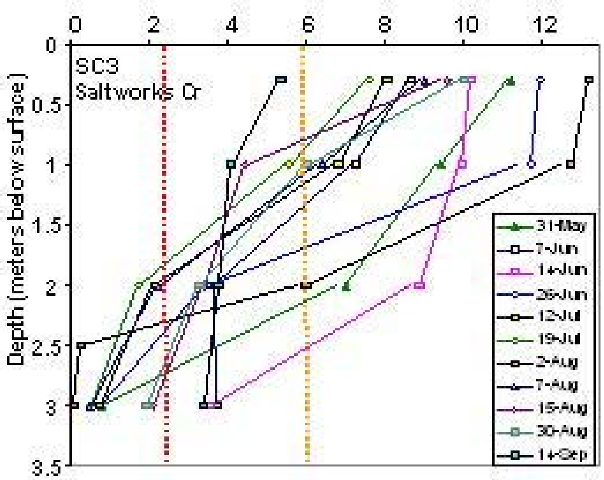
Appendix: 2007 Dissolved Oxygen Profiles, Lower Severn

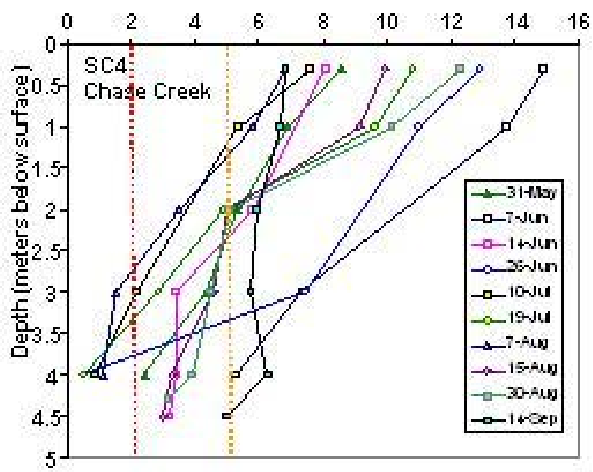




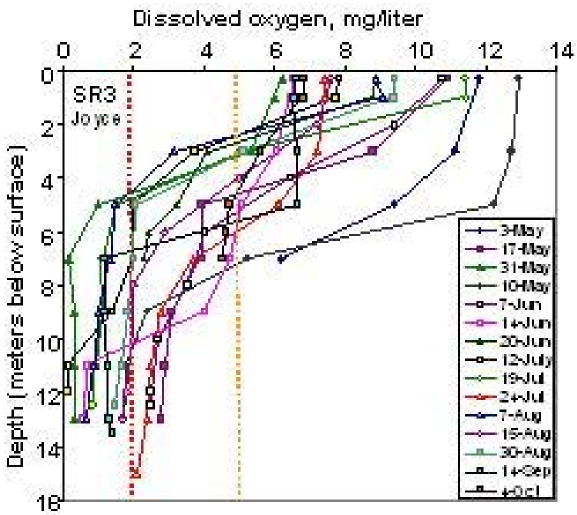


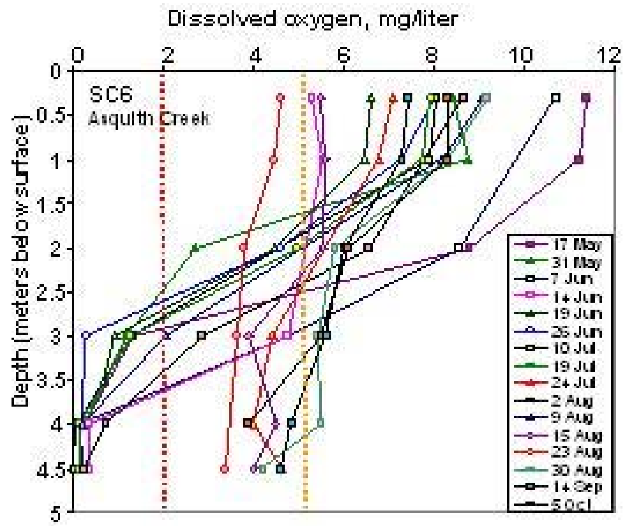


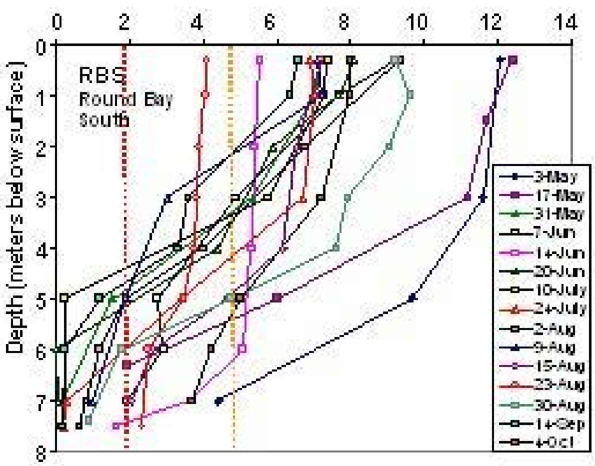


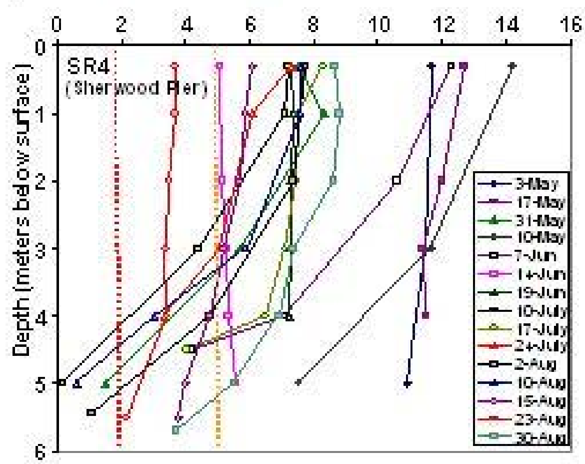


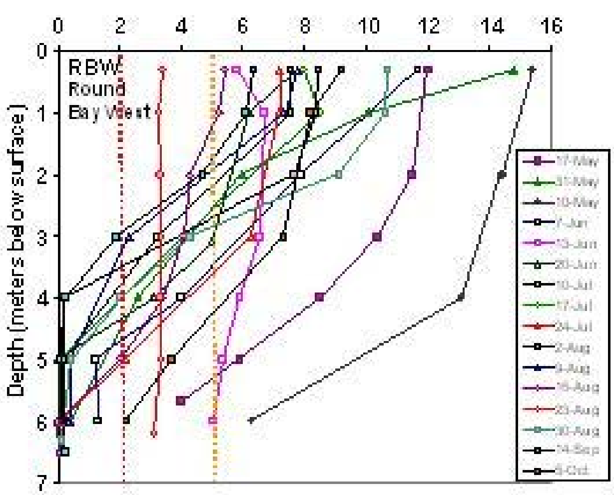
Appendix: 2007 Dissolved Oxygen Profiles, Mid Severn-Round Bay

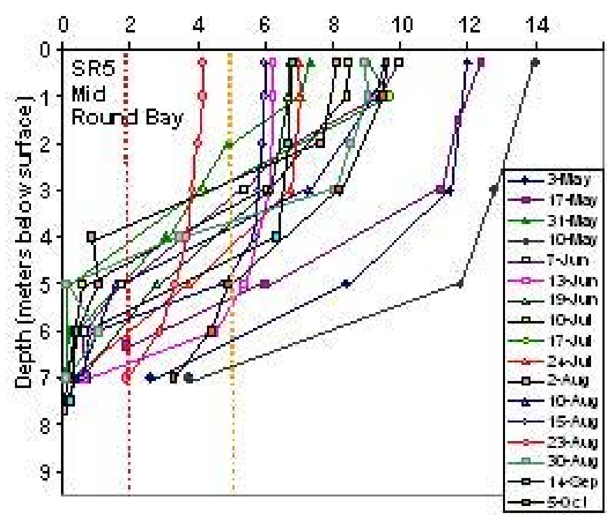












Appendix: 2007 Dissolved Oxygen Profiles, Upper Severn