

Yellow Perch and the Bush River
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Introduction

The Chesapeake Bay is the largest estuarine system in America, draining 175,000 square kilometers of land (Murdy et al. 1997). The actual waters of the Chesapeake Bay cover 11,000 square kilometers and nearly half of that total area is comprised of the many tributaries to the Bay (Murdy et al. 1997). The ecology of the Chesapeake Bay is complex and diverse due to the interface between the salty ocean habitat and the freshwater tributary habitat, and thus hosts a wide array of resident species (Murdy et al. 1997). Therefore, it is of no surprise that the Chesapeake Bay holds much ecological and economic importance. However, this work is limited to a single fish species (the yellow perch), and a single Chesapeake Bay watershed (the Bush River).

The Bush River sits at the northern reaches of the Chesapeake Bay in Harford County, Maryland and yellow perch is one of the many species that call the river home. While populations of yellow perch are in decline around the Chesapeake Bay, the populations in the Bush River are proving to be resilient. It is well known that a major factor in any estuarine system is the interplay between water and land (Murdy et al. 1997). Therefore, one can look to the land that the Bush River drains and how it is used by humans for answers to the questions concerning the success of its yellow perch population. Understanding what it is about the Bush River watershed that allows the yellow perch to survive may allow researchers to understand why these fish are no longer present in other rivers in the Chesapeake Bay tributary system. However, one must be reminded that correlation is not causation, and in complex biological systems many factors influence the success of a species.

Yellow Perch and the Bush River

Yellow Perch

Yellow perch (*Perca flavescens*) is a freshwater fish that belongs to the perch family (Percidae) and are a native species that ranges from South Carolina in the United States to Nova Scotia in Canada along the Atlantic coast (Murdy et al. 1997, DNR-FF 2007). Yellow perch also live in a wide array of freshwater lakes throughout the eastern and central United States and have been imported to many locations where they are not native (DNR-FF 2007, Murdy et al. 1997). These schooling fish can live for up to 13 years and attain an average maximum size of 1 ½ feet (DNR-FF 2007). While yellow perch are a primarily freshwater species of fish and are found in all of Maryland's reservoirs, the population inhabiting the Chesapeake Bay's tributaries have adapted to survive in mildly brackish water conditions (DNR-FF 2007). Indeed, yellow perch have been historically found in all of the tributaries of the Chesapeake Bay where they inhabited slow moving near-shore waters (DNR-FF 2007). The preferred habitat of yellow perch is moderately dense SAV (submerged aquatic vegetation) beds which provide food and shelter for the fish (Murdy et al. 1997). Adult yellow perch feed on small fish and crustaceans as well as on aquatic insect larvae while the larval perch feed on zooplankton (Murdy et al. 1997, DNR-FF 2007). The yellow perch spawning season runs from late February through March in Maryland (DNR-FF 2007). Male and female yellow perch migrate upstream from lower tributary areas towards shallow fresh water to spawn (DNR-FF 2007). Once at their spawning location, female yellow perch attach a gelatinous strand of eggs to shallow (to the point of being exposed at low tide) sticks and branches or other snag material where it is then fertilized externally by multiple male perch (DNR-FF 2007). Eggs incubate for a week to a month depending on the temperature of the water (DNR-FF 2007). After hatching, yellow perch larvae travel downstream (or offshore if they are in a lake or pond) towards deeper water, gaining protection from shallow

water predators (DNR-FF 2007). Once the larvae have grown enough to be able to evade predation, they return to the shallows of their tributaries as juveniles to feed and mature (DNR-FF 2007).

The yellow perch is a highly sought recreational sport fish and is taken by commercial fishing concerns as well (DNR-FF 2007). The majority of the yellow perch caught in the Chesapeake Bay are taken in late winter at the beginning of their spawning run towards shallow tributary headwaters (DNR-FF 2007). Due to their schooling nature and the shallow habitat in which they spawn, the perch are easily taken during these spawning runs (DNR-FF 2007). Unfortunately, there are many tributaries that now have no yellow perch spawning runs (Murdy et al. 1997). It is suspected that environmental degradation within their watersheds is the cause of this decline. (Murdy et al. 1997).

For 2008 the Bush River yellow perch fishery (harvest and sale) is closed from February 1st through March 14th to protect the fish during its spawning season (DNR-CF 2007). Regulations for 2008 also prohibit the placement of fyke nets in any part of a river narrower than 200 feet for the Bush and several other large rivers in the Chesapeake Bay watershed (DNR-CF 2007). In areas where the river channel is wider than 200 feet fyke nets are allowed, but any yellow perch caught within the February 1st to March 14th window must be released back into the open water in accordance with the restriction on yellow perch harvest (DNR-CF 2007). This yellow perch release rule applies not only to fyke nets, but any type of net fishing gear used within the February-March window (DNR-CF 2007). These regulations were enacted on January 28, 2008 in accordance with State Senate Bill 702 for the purpose of ensuring that the yellow perch can safely reach their spawning habitat (Campbell 2008). These regulations are a result of both citizen input and government research into the yellow perch, with the aim of fairly

distributing restrictions between recreational fishers and commercial operations while protecting yellow perch stocks (Campbell 2008).

The Bush River Watershed

The Bush River watershed (see Map 1) covers around 117 square miles of land in Harford County, Maryland (DNR-WQN 2007). The lower half of the watershed lies in the coastal plains region, with the upper half in the Piedmont plateau area of Maryland (DNR-WQN 2007). Land use in the watershed nearly evenly divided between forest, developed land, and agricultural land (DNR-WQN 2007). All five of the sub-watersheds in the overall Bush River watershed (see Map 2) are listed as impaired water bodies, and the Bush River itself is considered to be a priority site for restoration (DNR-WQN 2007). While not pristine by any stretch of the imagination, the Bush River and its watershed are in better shape than many other tributaries of the Chesapeake Bay.

Aside from restrictions on fishing, the protection of the land surrounding (both the immediate surroundings and the wider watershed) the Bush River is also important for the yellow perch population. The Chesapeake Bay Critical Areas Law is designed to prevent land development along tributaries that feed the Chesapeake Bay (Pelton 2006). The law was enacted in 1984 to help prevent runoff from going straight from developed land into the waters that feed the Chesapeake Bay and the task of enforcing the law falls to the local governments (Pelton 2006). Any new development that does occur within the 1,000 foot Critical Area buffer zone must be designed so that there is 10% less runoff from the developed land than the land in its undeveloped state (Cameron 1990). Unfortunately there is little enforcement of the law and too few inspectors to do the job (Pelton 2006). Also, the main causes of the runoff (developers,

residents of developments, farmers, etc.) are usually politically influential groups and therefore politicians are reluctant to come down harshly on them (Cameron 1990). This leads to a problematic paper tiger scenario: a law written to protect the Chesapeake Bay and its tributaries is of little use if it is not properly adhered to and enforced. While current legislative efforts are useful in preventing further environmental degradation, it is also important to examine the history of the Bush River to understand the damage that has already occurred.

By researching historic plant community composition via pollen trapped in sediment strata, researchers have determined that the ecosystem around the freshwater tidal wetlands of Otter Point Creek (a major tributary at the headwaters of the Bush River) had remained relatively stable before the arrival of European settlers in the seventeenth century (Hilgartner and Brush 2006). At that time, the native population was less than 6,000 people along the entire Chesapeake Bay, and less than one percent of the forests had been cleared (Hilgartner and Brush 2006). The population and rate of land use change in Harford County increased after European settlement, with the peak in land use change occurring between 1840 and 1880 (Hilgartner and Brush 2006). The peak in deforestation actually occurred earlier; between 1730 to 1800 thirty percent of the forest in Harford County was cleared (Hilgartner and Brush 2006). In the late 1800's and early 1900's many farms were abandoned and forests regrew. By 1975 about half of the forest cover in Harford County was a result of second growth (Hilgartner and Brush 2006). Today there is some new loss of forests, but the majority of new development is occurring on previously cleared land (such as farms) (Hilgartner and Brush 2006). Forested land within a watershed is known to be important for waterways, affecting water quality, temperature regulation, and bank stabilization to name a few (DNR-BRWC 2002). Currently in the Bush River basin 37 % of the land is forested, 35% is developed land, and fully one third of all the

land in the watershed is owned by the government (Aberdeen Proving Ground [APG] and Edgewood Arsenal) and is off limits to private development interests (DNR-BRWC 2002, DNR-WQN 2007). Indeed, the protection afforded by the federal ownership of the APG and Edgewood sites can be seen in the land's erosion potential. The erosion potential is expressed in a "value/acre" unit, which refers to how erodible the land is (the closer the value is to zero, the more stable the land is). In the other watersheds of the Bush River basin the soil erodibility is greater than 0.3 value/acre while the Bush River is 0.18 value/acre and the area within APG boundaries is 0.01 value/acre (a erodibility score of less than 0.275 value/acre is considered good) (DNR-BRWC 2002). The difference between the APG lands and the rest of the watershed can also be seen in the loss of wetlands; only 258 acres of historic wetlands have been lost within APG, while over 9,700 acres of historic watershed have been lost in the rest of the Bush River watershed (DNR-BRWC 2002). Maps 3 and 4 illustrate the change in land use in the Bush River watershed between 1973 (Map 3) and 2002 (Map 4). Note how the increase in developed land (gray shades) between 1973 and 2002 has come at the expense of agricultural land (yellow shades) and not forested land (green shades). Also note that the APG and Edgewood Arsenal areas (southwestern section of the watershed) look almost the same in Maps 3 and 4, indicating that there has not been much in the way of forest clearing there in the past 3 decades. This is important as yellow perch spend the majority of their adult life living in these middle reaches of the river that are bordered by undeveloped land.

The population of Harford County slowly increased after European arrival, with the rate of growth accelerating in 1925 and still accelerating today (Hilgartner and Brush 2006). Human population growth is considered a problem for waterways, as human activities are primarily responsible for the degradation in habitat in and around watersheds (DNR-BRWC 2002).

Census data from 2000 indicate that population densities within the Bush River watershed varied from less than one person per acre in the APG area to over three people per acre in the Bynum Run watershed (which includes Bel Air) (DNR-BRWC 2002).

The Future of the Bush River Watershed

There is no doubt that the population within Harford County and the Bush River watershed will continue to increase, and with an increase in population there will inevitably be an increase in the amount of pollution running off into the river. The population of Harford County was 241,402 people in 2006 according to the U.S. Census Bureau, increasing by about 100,000 people from the 1980's (DNR-WQN 2007). Furthermore, the population of Harford County is expected to rise by another 70,000 people (approximately half of these new residents will be moving to Harford County due to the Base Realignment and Closure [BRAC] program) by the year 2020, bringing the population of Harford County to over 300,000 residents (DNR-WQN 2007). Associated with this increase in population there is a projected increase of impervious surfaces (roads, buildings, parking lots, etc.) from the current 10.8% (see Map 6) to 12.4% (DNR-WQN 2007).

It is feared that this increase in impervious surface area, and the subsequent increases in runoff caused by it, will overwhelm storm water management systems in the near future (DNR-WQN 2007). The increase in runoff will likely increase the inputs of pollutants such as sediments, nutrients, and other toxic chemicals to the Bush River and the Chesapeake Bay, severely degrading water quality (DNR-WQN 2007). It is already known that the amount of nutrient pollution entering the Bush River has recently risen back to 1980's levels from its low point earlier this decade, with gains through pollution control being overridden by the increase in population (DNR-WQN 2007). Since the land use is tightly tied to the quality of the water, and

the quality of the water determines the biota living in it, it is not a stretch of the imagination to see how the yellow perch, and other species, within the Bush River could face increasing challenges in the near future. In fact, it is this cause and effect chain of land, water, and fish that makes the Bush River such an interesting subject of study. The Bush watershed has many of the same environmental problems as other watersheds in the Chesapeake Bay, yet yellow perch persist here while they have disappeared from other watersheds. The presence of the largely undeveloped Aberdeen Proving Ground/Edgewood Arsenal installations is the likely reason why the yellow perch have continued to inhabit the Bush River.

Monitoring of Yellow Perch in the Bush River

Historic Data

By analyzing almost 30 years of archived National Oceanic and Atmospheric Administration (NOAA) commercial fishery data from the Bush River one can see certain patterns from the historic fishing in the river (Fig. 1). As one can clearly see, over the last 30 years the yellow perch has been the third most abundant fishery in the Bush River, behind catfish and white perch. It is also should be noted (Fig. 2) that most of the yellow perch caught has been within the last two decades (1985-2004) and that the majority of this catch is attributed to fyke nets, and more recently pound nets (a variation on the fyke net) (Fig. 3). A fyke net is a long cylindrical net with a square holding area at one end and an open mouth at the other, with a series of funnel shaped sections inside the cylinder to prevent fish from swimming out of the cylinder (much like a stack of plastic cups with the bottoms cut out), and is completely scalable to the size of fish being sought (UMN 2005). At the mouth a straight net extends straight outwards from the middle and two funneling nets extend from either side of the mouth out at a

45 degree angle, channeling the fish into the mouth of the net and then through the cylindrical chamber to the holding area (UMN 2005). These nets are installed so that the nets run from the bottom of the water column to above the water and can be left out in the field for months at a time, with fishers removing the live fish from the trap every few days (UMN 2005). The main difference between fyke and pound nets is that pound nets are comprised of open topped heart shaped chambers of decreasing size instead of the straight cylinder/funnel design found in fyke nets (UMN 2005). The mesh size of the nets used is determined by the size of fish sought: fine nets catch small fish while larger fish swim around them, and coarse nets capture large fish while small fish swim through the nets (UMN 2005).

Larval Perch Sampling

In order to track the migration of yellow perch larva from their hatching location to their deep, open water nursery area (as well as confirming that there is a perch migration each year) a multi-year presence/absence study was initiated in the Bush River by the Maryland Department of Natural Resources. The goal of this survey is to confirm the presence of larval yellow perch in the Bush River as they migrate downstream to mature. The same sampling is also conducted in other watersheds around the Chesapeake Bay, with the ultimate goal of comparing watersheds that have no perch spawning runs to those that do. Identifying certain conditions common to watersheds with perch runs will hopefully allow researchers to determine the cause of the absent spawning runs in other watersheds. Ten sample sites (see Map 5) were designated along the upper reach of the Bush River and were sampled 1-2 times per week (weather permitting) from the last week in March until two consecutive sampling runs found no yellow perch larvae (Keller 2008). The sampling consisted of towing a 6 foot long conical plankton net behind a motorized

research vessel for two minutes per site (Keller 2008). The speed of the vessel was adjusted so that the top of the net was still visible at the surface while keeping the aperture of the net below the water (Keller 2008). Great care was taken so as to not have the net touch the bottom, as it fills with heavy silt and mud when this occurs and can damage the net. While the net was being towed, the salinity and temperature of the water was taken at the surface using a calibrated Yellow Springs Incorporated (YSI) Model 85 electronic water quality meter (Keller 2008). At the end of the two minute towing period the net was hauled aboard and the collection jar at the end of the net emptied into a clear mason jar (Keller 2008). The sample was poured into a dark bottomed pan and observed for presence or absence of yellow perch larvae (Keller 2008). Any ambiguous samples were brought back to Anita C. Leight Estuary Center and fixed with 10% formalin for later identification in the laboratory (Keller 2008).

This larval perch study has been conducted for the past three consecutive years (2006, 2007, and 2008) in the Bush River. The data shows that the yellow perch larvae appear at the upper sites (1-3) first, then becoming present in samples from all sites within a week or two (see Map 5 for site locations) (Keller 2008). The end of the migration shows a similar trend, with yellow perch being found only at the lower sites (7-10) for the last week or two (see Map 5) (Keller 2008). Due to the length of this study the yellow perch larva are actually observed at various growth stages; appearing as small almost see-through fry at the beginning and as small minnow-like fish by the end of the sampling window. Each year's run of larvae lasts about one month: March 29th to April 17th in 2006, April 2nd to May 9th in 2007, and March 27th to April 24th in 2008 (Keller 2008).

While more complicated, if the DNR is interested in how populous each year's migration is and how fast the fry are growing, it may be of more use to attempt to count the population

density of the larval perch and to attempt to measure their rate of growth rather than merely performing a presence/absence survey. This data could give more resolution, so to speak, for identifying differences between larval yellow perch populations from different watersheds (differences in growth rates, abundance, etc.). Also, the surface trolling method used is only effective at finding yellow perch larvae within the upper 1-2 feet of the water column. Since it is already known that yellow perch larvae migrate to deeper open waters to avoid predation, it would be interesting to sample the bottom or middle of the water column in deeper areas of the Bush River. This sampling would no doubt require different sampling techniques and equipment, as the bottom of the Bush River is mostly soft, pudding consistency silt and washed out snags (not to mention the hazards posed by unexploded ordinance from Aberdeen Proving Ground).

Conclusion

The Bush River, unlike many other Bay tributaries, harbors a reproductively successful population of yellow perch. Were it not for the protection that is afforded by the largely undeveloped Aberdeen Proving Ground land bordering the main stem of the Bush River the yellow perch fishery there might look more like other tributaries where yellow perch no longer spawn. While this is good news for now, the coming tide of new residents (and the subsequent impacts they bring with them) from general population growth and the influx of new personnel associated with the Base Realignment and Closure program will no doubt erase the environmental gains made since the widespread enactment of environmental laws like The Clean Water Act or the Chesapeake Bay Critical Areas Law in the 1970's and 1980's, respectively. It is more important now than ever for environmental laws like the Chesapeake Bay Critical Areas Law to be enforced and adhered to, helping to offset the damage caused by Harford County's

burgeoning population. The importance of this goes beyond just the Bush River however; as it's tributaries decline, so does the Chesapeake Bay as a whole.

All in all, the current yellow perch trolling method being used in the Bush River does provide useful data in that it allows researchers to know when the yellow perch fry migration occurs, as well as confirming that there actually is a perch migration in a given year. Changes in methodology mentioned previously could add new dimensions to the data collected, such as growth rate (measuring the length of the fry before they are thrown back into the water) and possibly population density (number of perch found per unit water sampled, for example). The data from this study provides an anchor, so to speak, for investigating differences between watersheds when it comes to the success of the perch. If you know perch are present in one set of rivers but absent in another where they were historically found, you can then look for similarities and differences among these groups to determine if there is a factor or set of factors that allows perch to survive in certain rivers. This data can then inform policy, allowing for regulations to be created and/or modified in the hopes of making conditions habitable for yellow perch in rivers where they are currently no longer found.

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<<http://glei.nrri.umn.edu/default/fykenet.htm>>

Data Sources for Maps

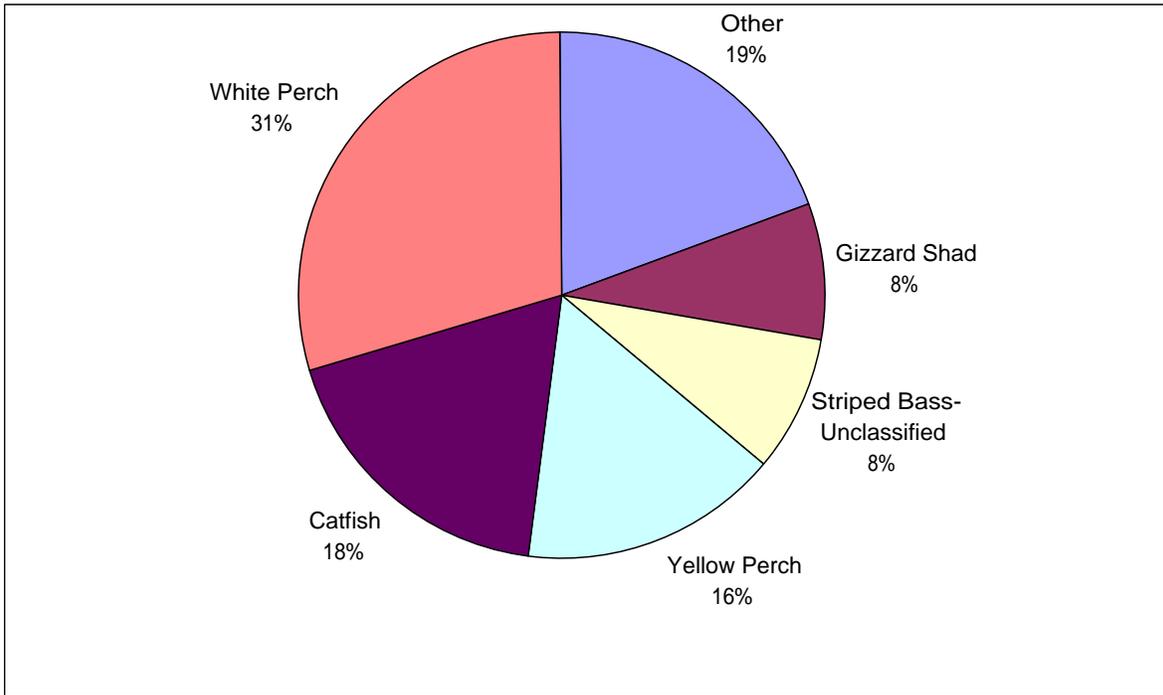
Maryland Department of Planning. GIS Data Download Site. (Land Use/Land Cover 1983 and 2002)

Maryland Department of Natural Resources. Geospatial Data Download. (SLEUTH Urban Growth Projections under multiple Scenarios {Impervious Surfaces}, Watershed Boundaries)

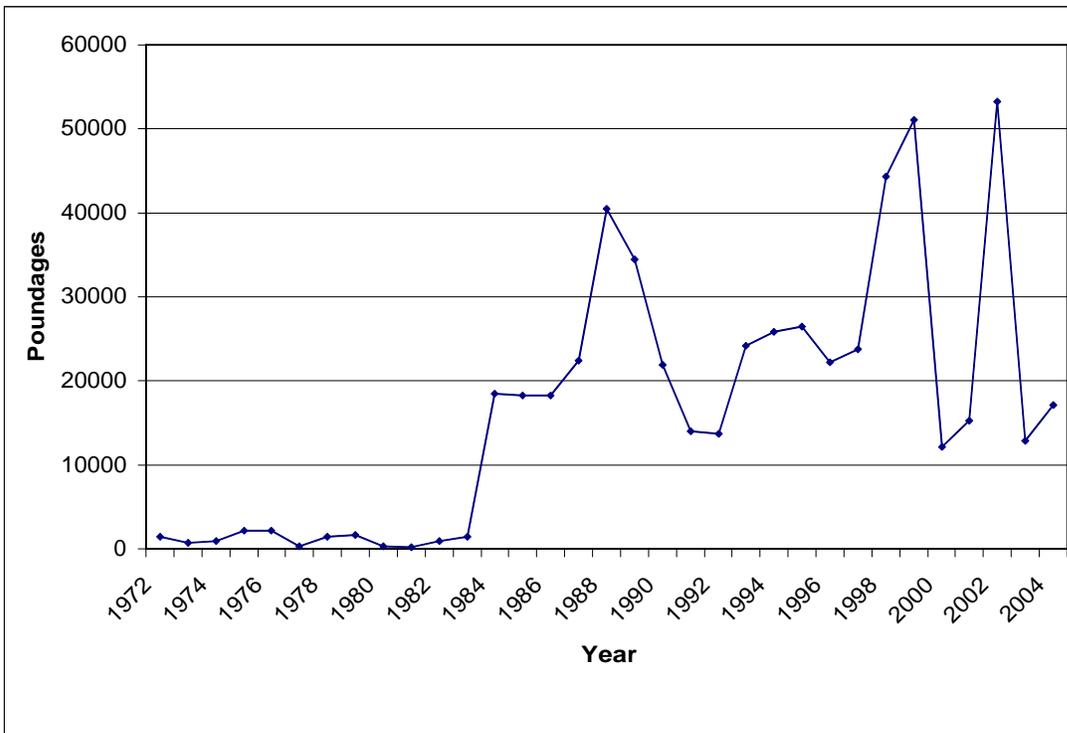
Maryland State Highway Administration. SHA Download Center. (County Boundaries, Water Bodies)

All maps produced by Patrick S. Breitenbach using ArcGIS 9.2 software.

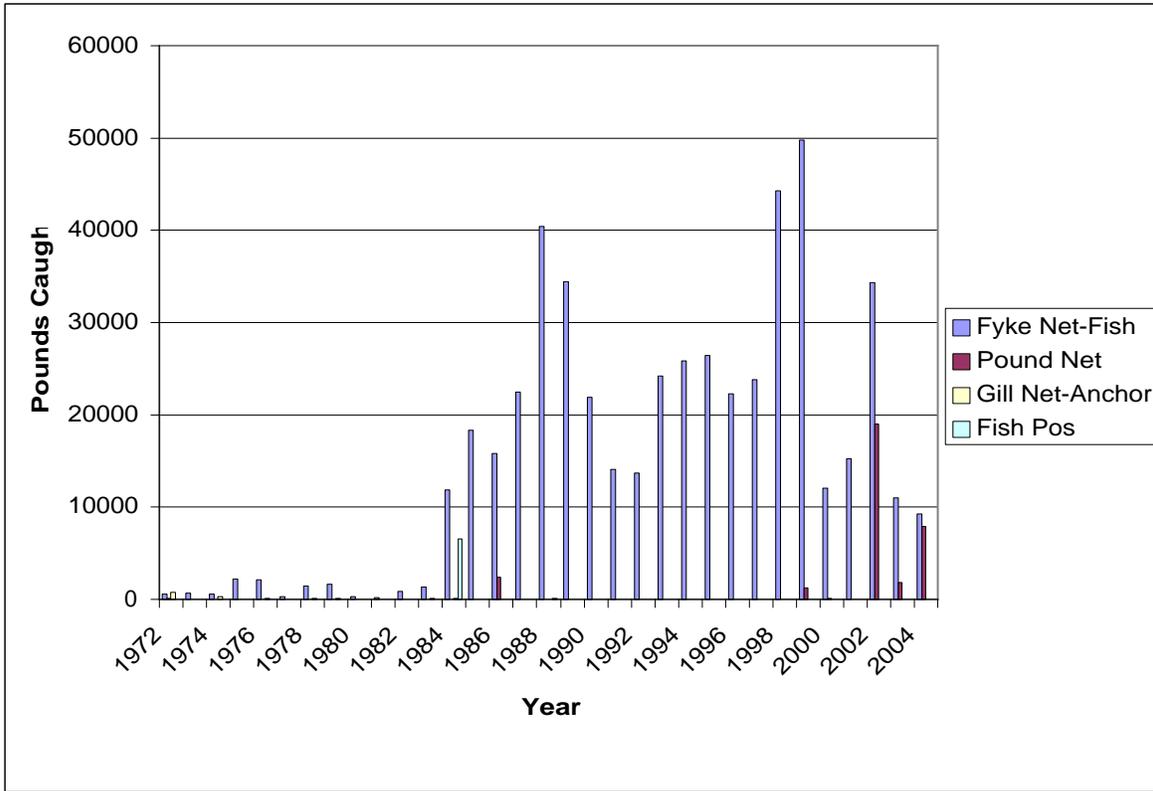
Appendix A: Figures and Maps



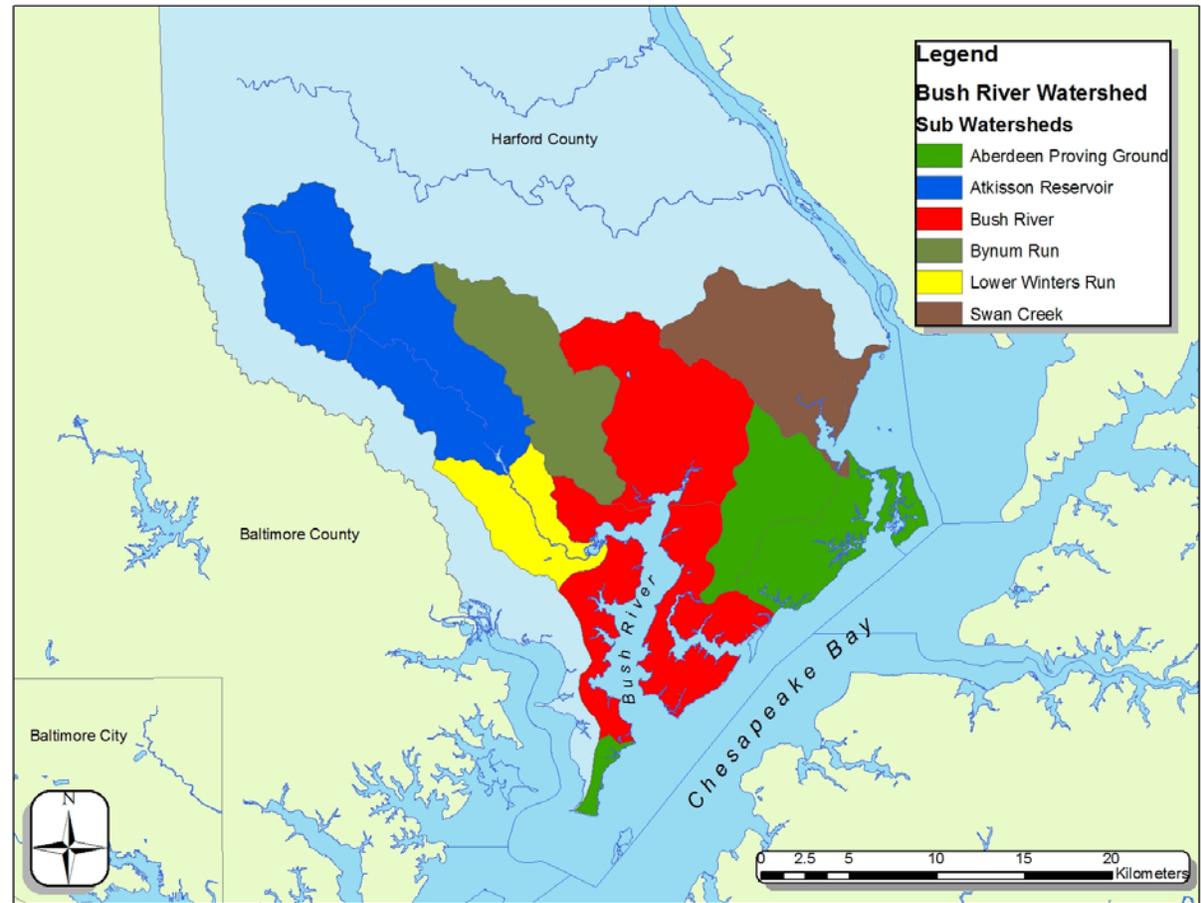
1: Percentage of total catch in the Bush River (1972-2004)



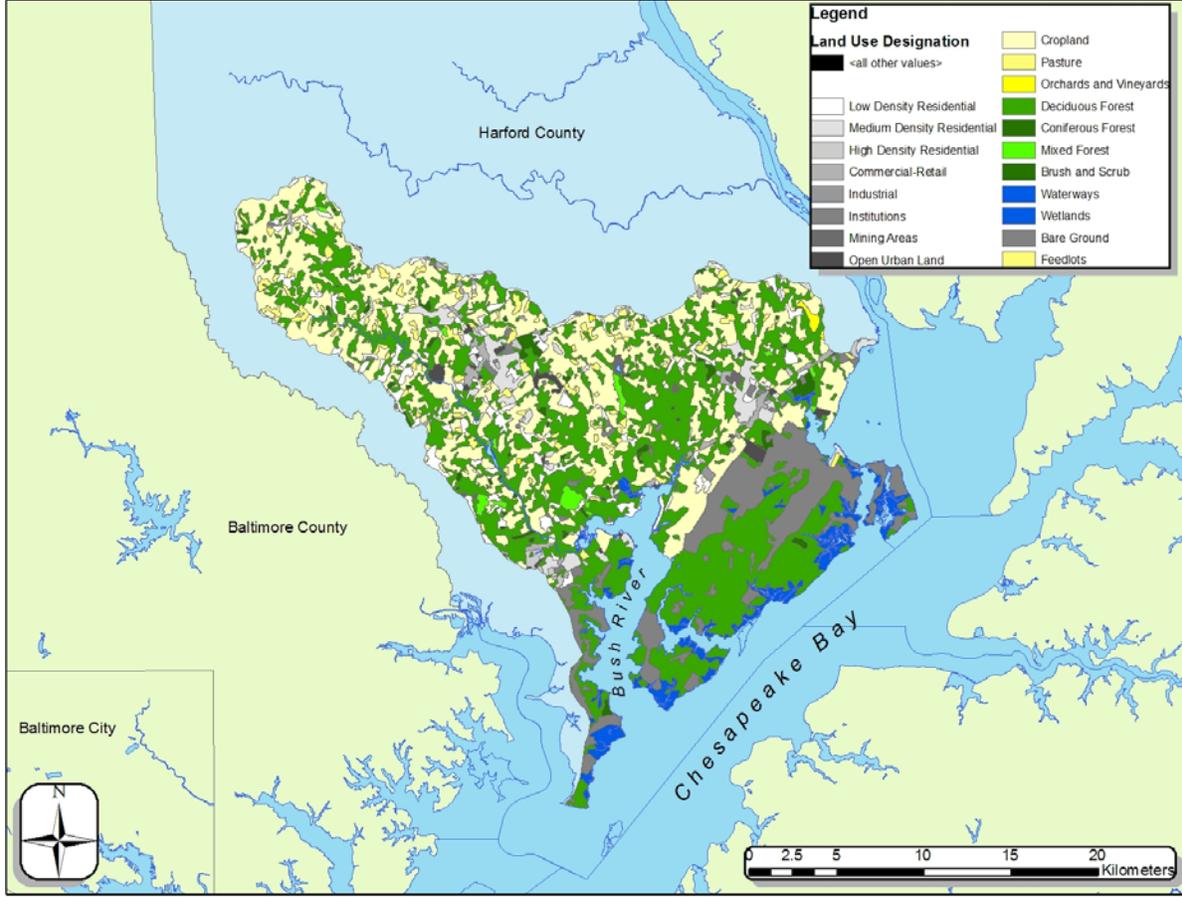
2: Yellow perch landings in the Bush River (1972-2004)



3: Ye Ilo w pe rc h la nd in gs in th e Bu sh Ri ve r by ge ar us ed (1 97 2- 20 04)

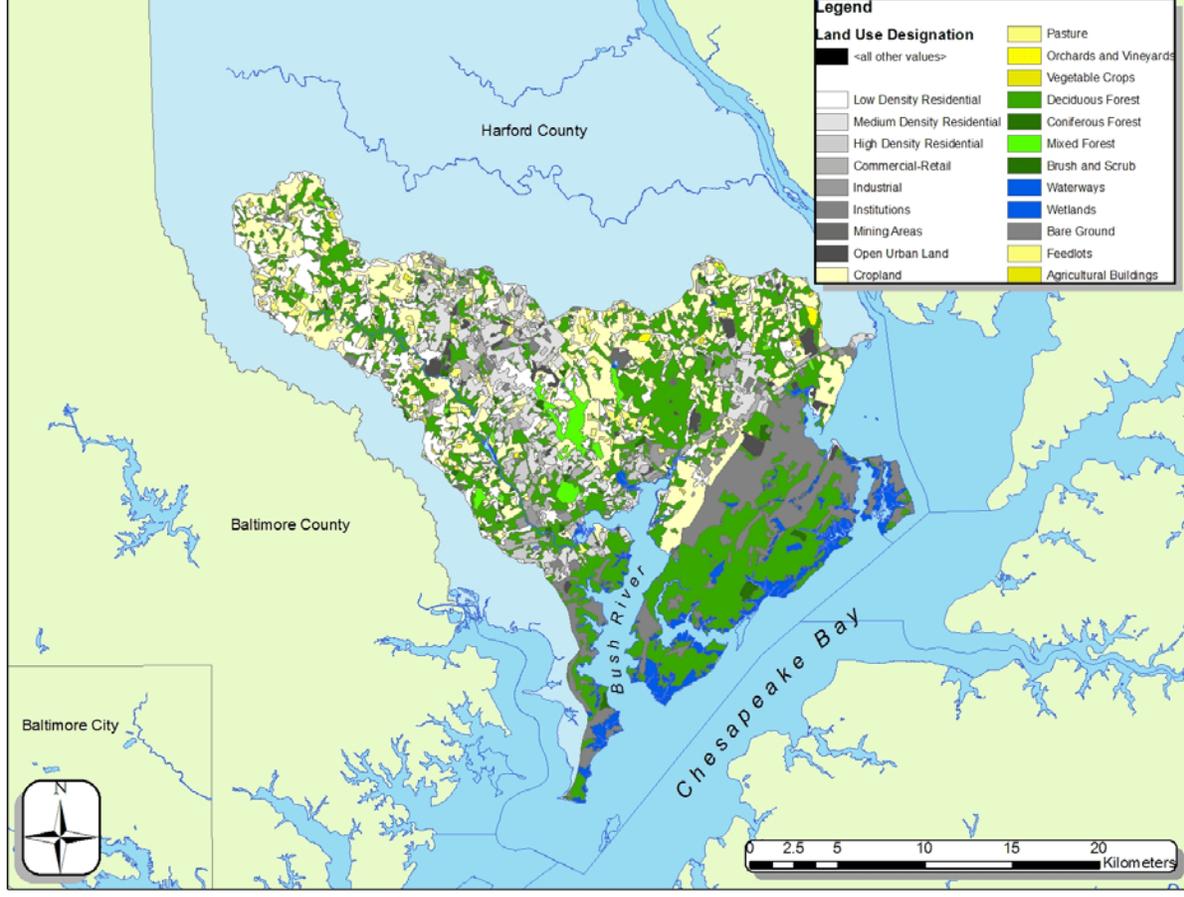


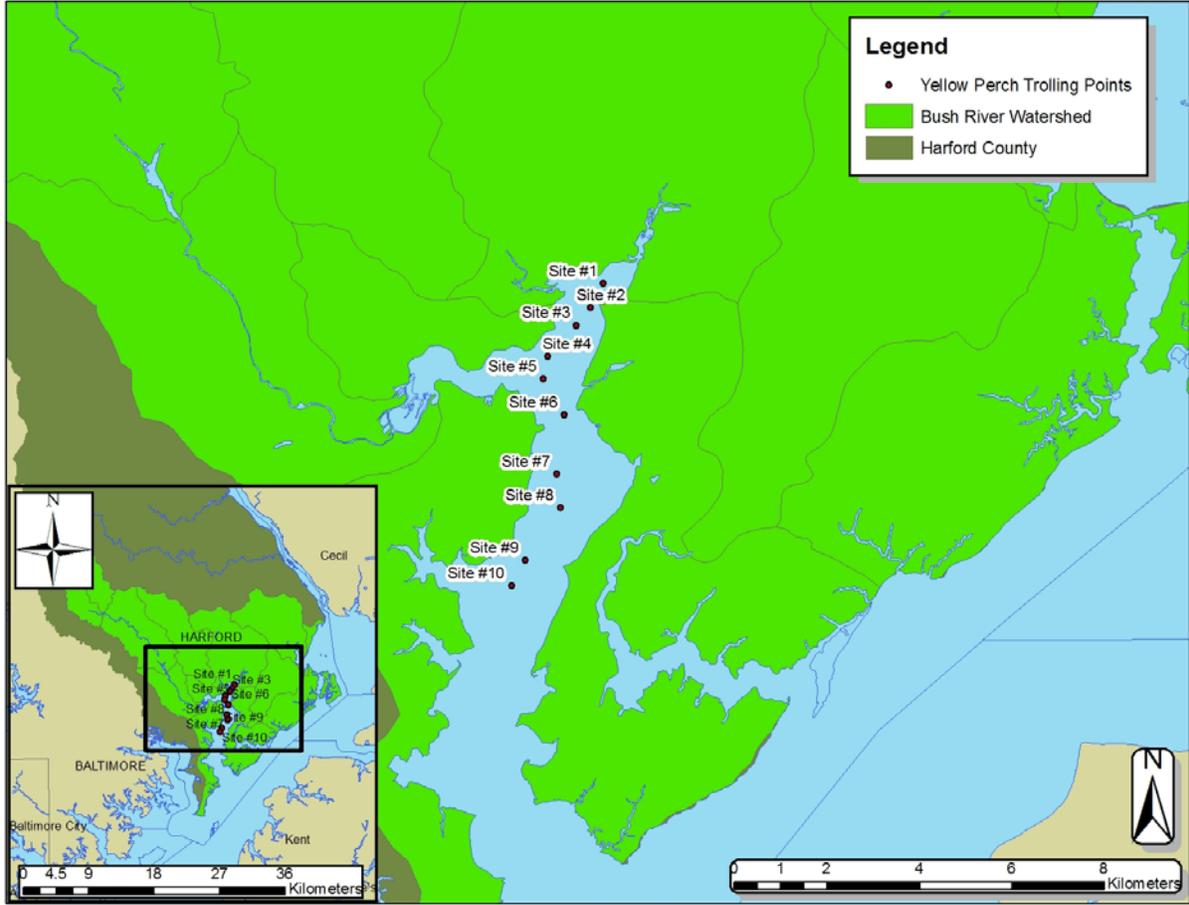
Map 2/Map 1: Watersheds Within the Greater Bush River Watershed Please Harford that the County Aberdeen Proving Ground is purely political distinctions the land is into the adjacent Bush River and Swan Creek, Maryland Sources: Maryland State of Natural Resources SHA Downspout Data Maryland Department of Natural Resources Geospatial



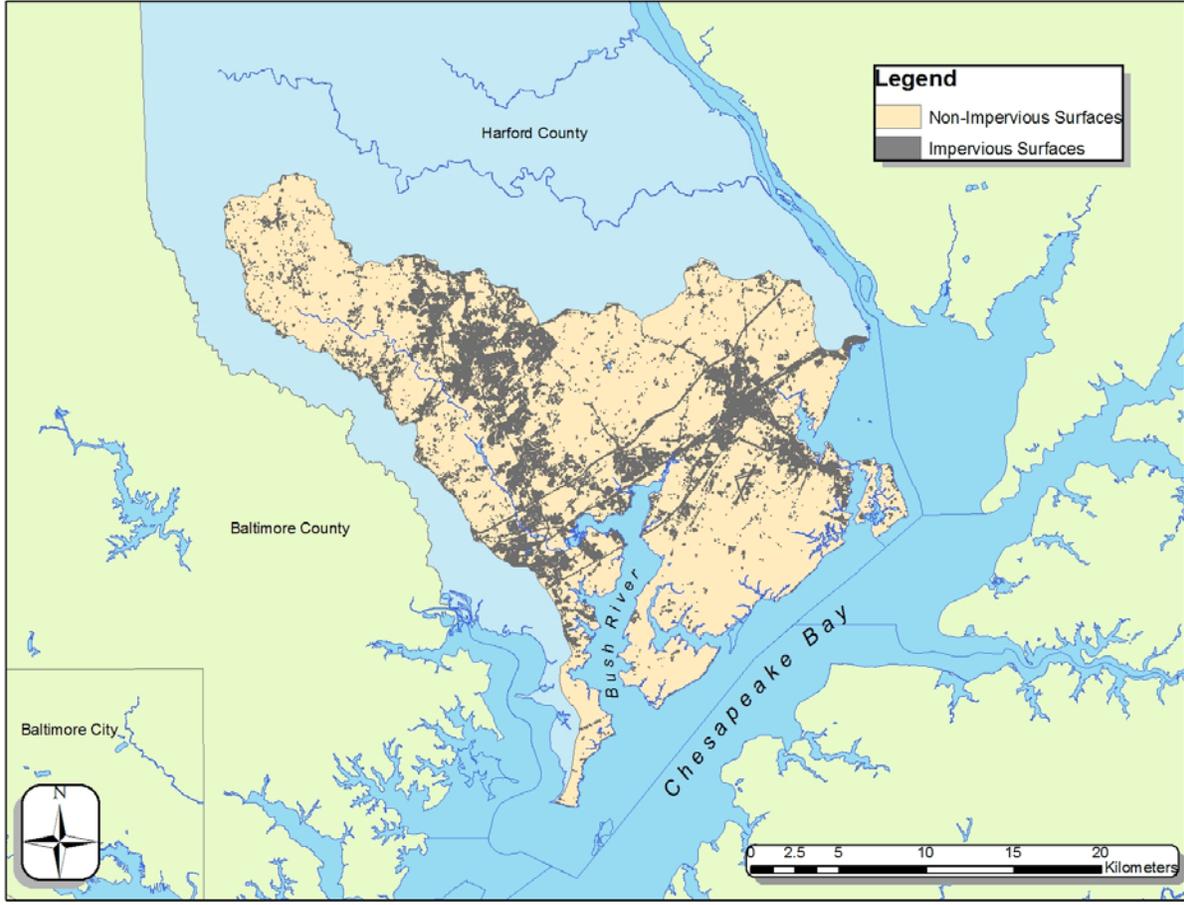
Map 3: 1973
 Land Use Within
 the Bush River
 Watershed
 Note the large
 area of forest and
 “institutional”
 land in the
 southern part of
 the watershed;
 this is Aberdeen
 Proving Ground.
 Sources:
 Maryland
 Department of
 Planning GIS
 Data Download
 Site, Maryland
 State Highway
 Administration
 SHA Download
 Center, Maryland
 Department of
 Natural
 Resources
 Geospatial Data
 Download

Map 4: 2002
 Land Use Within
 the Bush River
 Watershed
 Again, note the
 large (practically
 unchanged) area
 of forest and
 “institutional”
 land that
 represents
 Aberdeen
 Proving Ground.
 Sources:
 Maryland
 Department of
 Planning GIS
 Data Download
 Site, Maryland
 State Highway
 Administration
 SHA Download
 Center, Maryland
 Department of
 Natural
 Resources
 Geospatial Data
 Download





Map 5: Yellow Perch Sample Sites. Sources: Maryland State Highway Administration SHA Download Center, Maryland Department of Natural Resources Geospatial Data Download



Map 6: 2000 Impervious Surfaces Within the Bush River Watershed. Note the general absence of impervious surfaces within the lower reaches of the Bush watershed due to the Aberdeen Proving Ground Area. Sources: Maryland State Highway Administration SHA Download Center, Maryland Department of Natural Resources Geospatial Data