

St. Mary's College Of
Maryland

Analysis of the Port Tobacco Christmas Bird Count



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An Analysis of the Christmas Bird Count of Port Tobacco

Analysis Conducted for the Southern Maryland Audubon Society by Genevieve McPherson-Shambarger, Peter Webster and Joseph Carr

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Special Thanks to:

- Amanda VerMeulen - Research & Instruction Librarian, St. Mary's College of Maryland
- Lynne Wheeler - Secretary, Southern Maryland Audubon Society
- Ricci Reber - Visiting Professor of Economics, St. Mary's College of Maryland

About this Project

Experiential Statistics is a statistically-based capstone experience as well as a service-learning based course. Members of the class were assigned to one of three consulting groups each consisting of three students. Each consulting group was paired with a local non-profit organization (client), for whom they conducted a data-based research project, including an inferential statistical analysis.

This report compiles the results and recommendations of the consulting group for the Southern Maryland Audubon Society. Specifically, this paper examines the results of the Christmas Bird Count and how bird populations in the Port Tobacco area have changed over the last 27 years. Additionally, changes in populations of specific groups of birds (such as those that share a similar habitat) as well as changes in populations of individual bird species were studied along with environmental factors such as human population changes, new housing permits, and fish populations.

Although all research and analysis were conducted by students, extensive help and guidance was given from our professor, Dr. Amy Henderson. If you would like more information on this project or the other projects completed by this capstone experience, you can contact Dr. Henderson at abhenderson@smcm.edu or call at (240) 895-2256. Her office is on the St. Mary's College of Maryland campus in Calvert Hall, room B19.

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Introduction

The Southern Maryland Audubon Society

The Southern Maryland Audubon Society (SMAS), a local chapter of the National Audubon Society (NAS), is one of the largest citizen groups involved in natural resource conservation, environmental education and nature study in Calvert, Charles, St. Mary's, and southern Prince George's counties. SMAS was founded in 1971 and was chartered by the National Audubon Society in 1972. They are a non-profit organization, incorporated in Maryland, with their organization financed by a membership dues-sharing arrangement with NAS and SMAS fundraising activities. The society operates under the provisions of an approved constitution with business conducted by directors and officers elected by it approximately 750 members. Given the focus this organization puts on environmental conservation and sustainable development in Southern Maryland, it naturally follows that the analysis we have been commissioned to conduct for them falls in line with this mission. Specifically, we have conducted a study of bird biodiversity and population trends on the Port Tobacco River; this study was intended to explore the questions of not only the general health of the Port Tobacco bird populations, but also the possible impacts of neighboring human populations and economic developments within Charles County.

*“The Christmas Bird
Count has been a
tradition of bird
watchers across the
country going back
to 1901.”*

The Christmas Bird Count

This study is grounded in the bird population data provided to us by SMAS during its Christmas Bird Count (CBC), an annual census conducted in late December over several days by a team of dedicated birders, volunteers, SMAS staff members, and citizen scientists who come together to help provide a detailed picture of the birds present on the Port Tobacco River; surveyors are individually responsible for an assigned small quadrant of land (or marsh), in which they are to report every sighting of a bird in their area via a detailed checklist, including not only a catalog of potential birds that may be sighted but also details on the weather and time spent by each individual surveyor. Data for Port Tobacco are recorded within a 15-mile-diameter circle with the center at Longitude -77.033314 degrees, Latitude 38.483301 degrees N. The area of the count is approximately 170 square miles. Volunteers can spend the better part of a day surveying, making the CBC one of the best and most consistent year-to-year measurement of avian biodiversity.



May, 2016

*“Analysis conducted on
population trends of
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overall environmental
health”*

The data provided to us by SMAS goes back to the winter of 1989, but the CBC has been a tradition at some local Audubon chapters going back to the turn of the 20th century. We have reformatted a complex, fragmented, set of databases into a structure which can be utilized to respond to questions posed by the SMAS. Statistical analyses, using SAS statistical software, were performed to compare analyze fluctuations in bird population, both in general and among individual species, and determine how these fluctuations relate to environmental changes in the county. To this end we have collected time-series data on land usage, county population growth, residential development, and fish commonly preyed upon by many wetland species, relating these various indicators of environmental health to changes in overall bird population. Additionally, documents such as state and local budgets, official economic assessments done by the county, publicly available ecological information, past academic studies on the topic, and legislation related to environmental protection all serve to provide the broader context in which to place our findings. The project as a whole is ultimately designed to provide a genuine assessment of the bird population of Port Tobacco, adding a small piece to the body of research on the ecological health and human footprint of Charles County; the conclusion of our analysis is meant to provide the necessary context and information to anyone who may need it in the future, be it volunteers from SMAS, local ecologists, students, public officials, or even those just curious about the topic.

Why It's Important

The Port Tobacco watershed/basin is a mix of eastern deciduous forest and wetland, and provides a haven for many fish and wildlife species endemic to the Chesapeake Bay area. Examining the health and biodiversity of the local bird population through this study will allow conservationists, advocacy groups such as the Audubon Society, as well as legislators, to get a clearer picture of the Port Tobacco ecosystem. Analyses conducted on population trends of particular 'core' species (migratory, cavity-dwelling, and waterfowl species that regularly make up bulk of those studied) can serve as a stand-in for overall environmental health, depending on their presence as or interaction with certain 'bio-indicator' species that are cornerstones of the local ecosystem's food chain. This study is not solely concerned with birds, but is also an exploration of the human impact on the environment of Charles County. Our findings may prove relevant to future economic or sustainability initiatives undertaken by the county government or local non-profits, hopefully better informing those empowered to start such projects.

"...it is also an exploration of the human impact on the environment of Charles County"



Methodology and Metrics

When looking at the bird populations trends, many different variables must be accounted for to get accurate and conclusive results. Direct variables, such as number of birds and type of bird, have substantial impact on the end result. Indirect variables, such as weather and effort, must also be accounted for as they too can have potential effects on the results. Overall, a combination of direct and indirect variables was used to obtain reliable results.

Multivariate regression allows us to determine which variables have a meaningful impact on the variable(s) of interest — the observed number of birds. We term these “impact” variables “explanatory” variables, as they explain the behavior of the “dependent” variable — the variable determined by the explanatory variables. In the case of this project the dependent variable was number of birds while all other were explanatory, as it is assumed that all other variables affect the number of birds counted. The estimated relationship not only allows us to determine which variables have a significant impact on bird populations, but also the direction of the impact; in other words, whether the factor increases the number of birds observed or decreases the number of birds observed.

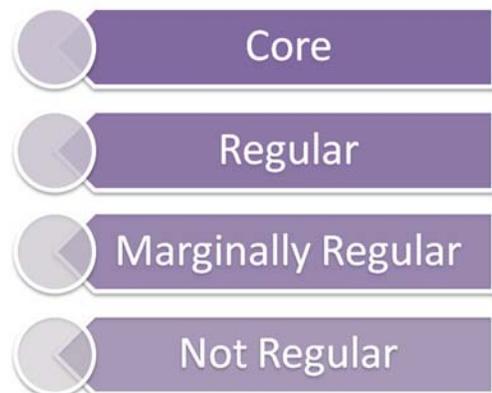
“Data was
constructed in a
way to provide a
descriptive yet
simple format.”



In total thirteen final databases were constructed.

These databases included:

- Total bird population
- Subpopulations:
 - cavity dwellers
 - water dependent species
- Frequently observed species
- Species of specific interest to SMAS



Sources and Context

Charles County Government provided many resources concerning development of land both in county-wide cross sectional and time series data formats. The county has a large internet archive of internal reports and other documents; the most far-reaching in scope of these sources is the county's comprehensive plan, a sort of legislative blueprint that integrates economic data and political developments from the previous year with plans and projections for the coming year. The most recent of this series is the 2016 plan. Similarly, the Charles County online archive of publicly available information also includes the yearly budget books; a financial counterpart to the comprehensive plan that details expenditures on any and all public projects. The Charles County government only has budgetary information going back to the 2007 fiscal year freely available, making it valuable for accounts of public works involving infrastructure, conservation, and water quality in the last decade, but incompatible with the wider time-frame of our study, therefore this information can not be incorporated into the statistical analysis, but is useful in putting our analysis in a modern policy context.

Maryland state government also provided both qualitative and quantitative data; the Maryland statistical handbook (2014) provided detailed statistics at both the state and county levels on a range of issues; the data in the handbook is comprehensive going back to around 2002 on average. The data collected from state sources allowed us to fully populate a dataset derived from incomplete Charles County data related to the issuance of housing permits. It also allowed us to include qualitative information not originally available at the county level, such as cross-country comparisons and percentage changes in land use over time.



Charles County: A Changing Community

Charles County was founded in 1658 and encompasses 643 square miles. According to the 2010 U.S. Census, it is a thriving community that has been growing its population, development, and economy since the 1970s. When the Southern Maryland Audubon Society first conducted their Christmas Bird Count in the winter of 1988, the population of the county was a mere 95,375. Today, the population has increased to 152,864, an increase of about 60%.

In order to house this growing population, the residents of Charles county needed more homes, and therefore residential development has increased as well. According to the Charles County Department of Planning, from 1990 to 2005 Charles County saw an overall increase of 14,936 residential dwellings, from 34,487 homes in 1990 to 49,423 homes in 2005, an increase of 43%. The majority (82%) of these dwellings were single family homes, which take up considerably more land than townhouses or apartment complexes.

This increased development, both residential and commercial, has changed the landscape of Charles County. Between 1990 and 2002 developed land increased by approximately 9,200 acres, mostly in the low density category. Most of the land converted to residential development has previously been in agricultural, open, and forest lands, although most of the forest land loss occurred prior to 1997 and the amount of forest land in the County actually increased between 1997 and 2002 (most likely due to conversion of cropland to forest land). For those birds who rely on tree cavities for their nesting, this change in their habitat has consequences, some of which can be tracked by using the Christmas Bird Count.

“This increased development, both residential and commercial, has changed the landscape of Charles County”

Coexisting of Farming and Conservation

While these two aspect of human interaction with the environment may seem at odds, they can actually be done in concert. Overly intensive human agricultural practices have led to extremely destructive externalities that can threaten even robust ecological systems. However, Charles county sits at the precipice of major economic development; median incomes have risen steadily risen over the last decade (over \$90,000 in 2016, up from \$78,347 in 2006, roughly a 15% increase), agricultural land usage is on the decline, and there is wider public attention towards sustainable development goals.

For an area with a rich agricultural history, Charles county is uniquely positioned to create a system of farms that provide jobs in the agricultural sector as well as have an explicit commitment to tend the natural and undeveloped lands in rural Charles County. Because the size of the local agricultural industry has shrunk in the last two decades, the remaining firms and small farm owners no longer tend towards intensive practices; intensive agriculture refers to practices typically seen on larger farms in post-industrial economies, where owners attempt to maximize their yields through higher capital inputs per unit of land or unit of livestock.

Credit: visitstmarysmd.com

Often times this practice is derisively called 'factory farming' due to the exhaustive and mechanized approach taken by farmers. These farms may be characterized by maximizing returns (and minimizing cost) through tightly confined animal pens, aggressive usage of pesticides and fertilizers, and the farming of truly massive tracts of land. Because local farms no longer have the ability or incentive to create such an 'economy of scale' (where costs shrink relative to the size of the operation), they are increasingly appearing as allies in land conservation. Sustainable agricultural practices have the potential to not only ameliorate some of the harmful externalities that farming may bring, but also actively contribute to stewarding natural wilderness. Cavity-dwelling and ground-nesting bird species stand to gain from some of these practices, such as partial reseeded with local flora or gentler livestock grazing. We believe advocating for a more holistic approach may pay dividends in terms of biodiversity and overall conservation.

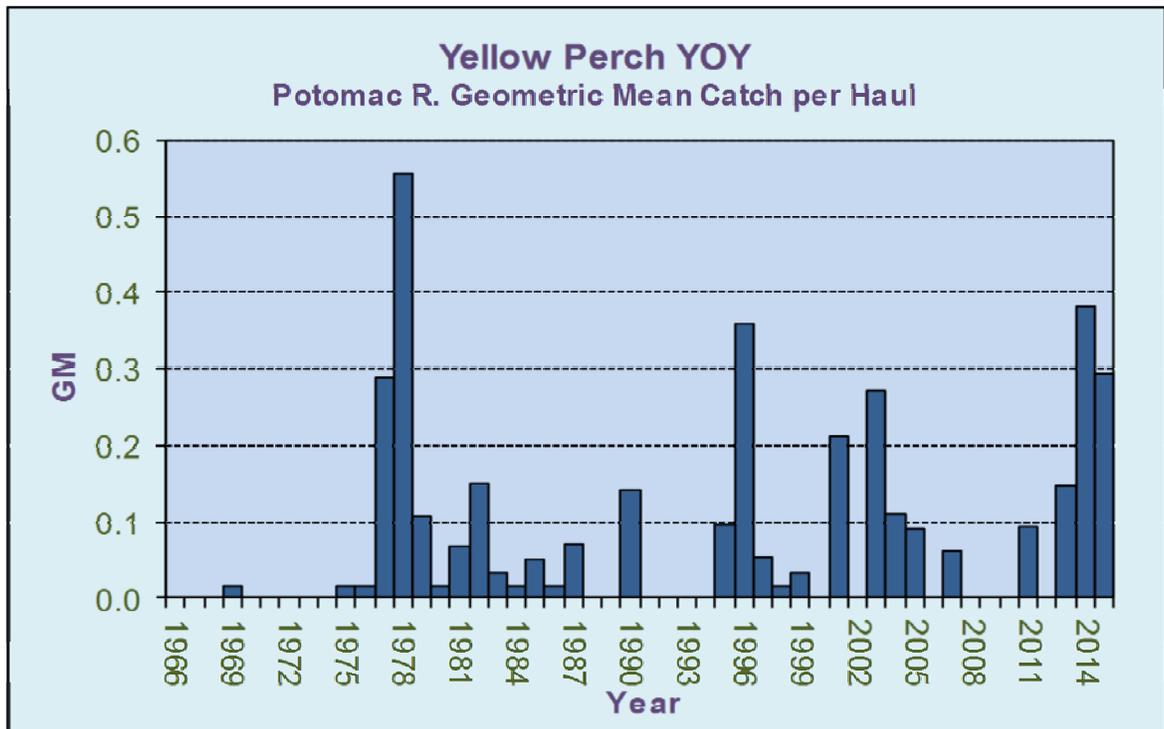
Yellow Perch and the Year Of the Young (YOY) Survey

Port Tobacco is home to more than just birds; in keeping with the tradition of the Audubon society, we think it is valuable to elaborate on the wider ecosystem housed by the watershed. Overall biodiversity among birds, terrestrial mammals, fish, and arthropods is valuable, both to the watershed, and the county. Promoting and protecting biodiversity among the species of Port Tobacco, not just birds, is a valuable mission for SMAS. One such species is the Yellow Perch, a small semi-brackish fish, that provides a valuable lower link in the food chain; it is preyed upon by nearly all piscivorous birds in the area, mostly waterfowl.

For the most part, these fish reside in the bay, lower Potomac, and adjacent estuaries, swimming into the relative safety of freshwater tributaries such as Port Tobacco to spawn. They are the primary food source of many birds endemic to the area, including the Double-crested Cormorant, the black duck, and the Belted Kingfisher. We included the yearly fluctuation in observed juvenile yellow perch populations into our analysis because we thought this predation relationship speaks to the interdependence of the different species within Port Tobacco.

Credit: porttobaccoriver.com

The graph below shows the geometric mean (the standard for relative abundance) of the Yellow Perch from survey point 052, near the mouth of the Port Tobacco River, from 1966 through 2014.



Yellow Perch As an Indicator of Watershed Health

Using Data collected by the Maryland Department of Natural Resources, we incorporated Yellow Perch population statistics as a proxy for water quality conditions and for the general marine health of Port Tobacco. Thanks to spawning populations of these fish, as well as the relative abundance of even smaller insect larvae and fish (which are in turn preyed upon by the Perch), Port Tobacco serves as an important refuge for migratory bird species.

The shared habitat and surrounding organisms of the birds observed in the CBC is valuable in and of itself, providing an incubator for biodiversity. Continuing to protect not only endemic bird species but also surrounding non-avian taxa is an important endeavor; generally, the more genetic diversity that exists in a given ecosystem, the more robust that system will be in the face of negative events. What can be taken away here is that diversity, or the lack thereof, is not only an indicator of current environmental health in a given area, but a predictor of future resilience as well. Concerns about the potentially long-reach of urban sprawl and runoff are well placed, as even small alteration in the quality of water, forested land, or balance in inter-species competition could have potentially outsized effects thanks to the highly interdependent nature of wetlands ecosystems.

“The more genetic diversity that exists in a given ecosystem, the more robust that system will be towards change”

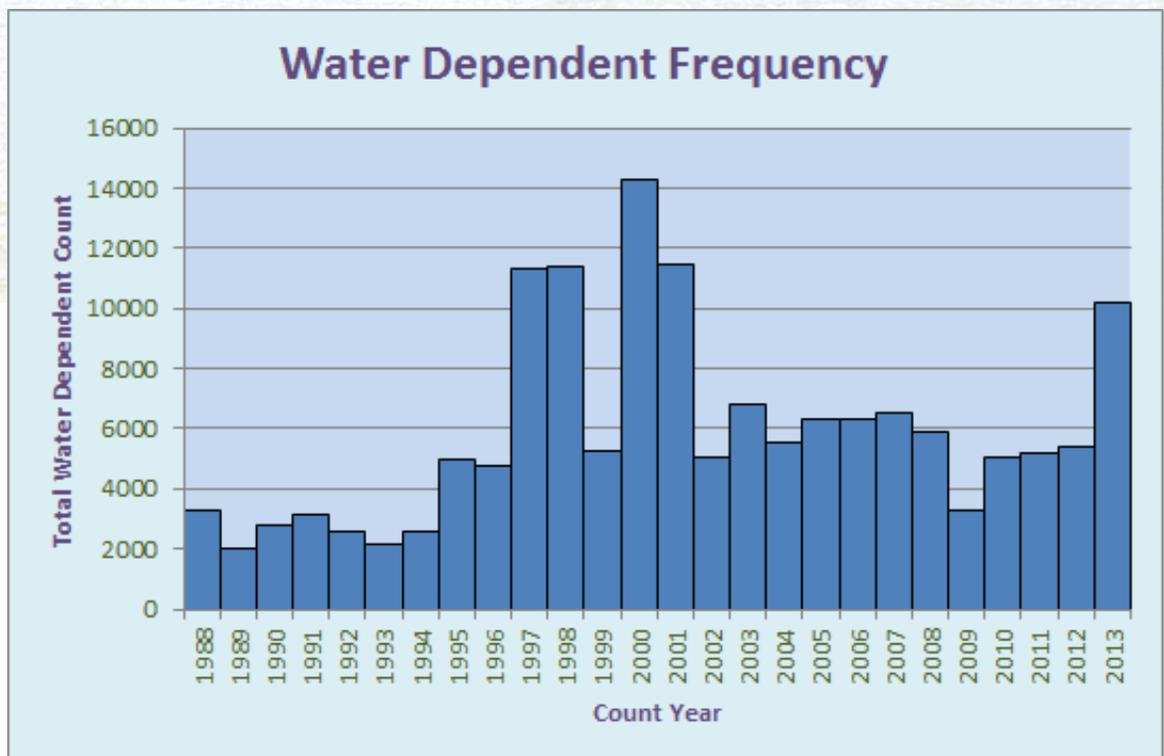


Credit: maryland.gov

Waterfowl and Water Dependent Populations

Waterfowl and water dependent bird species include both birds who live directly in and along the Port Tobacco River as well as those species who rely on a healthy watershed for food and shelter. While acquiring direct water quality data for the Port Tobacco River proved to be beyond the reach of this analysis (see “Further Research Suggestions”), we have used fish populations, in this case yellow perch, as a water quality indicator as noted above.

The graph below shows the total number of waterfowl and water dependent birds counted in the Port Tobacco CBC for each year from 1988 through 2014.



Credit: Debra Zimmerman

From this graph, we can see that waterfowl and water dependent bird species sightings have fluctuated throughout the years of the CBC. Although sightings rose steadily from the beginning of the CBC through 2001, there was a definite decline in sightings around the year 2002. After 2002, sightings have remained relatively stable, but with a definite increase during the last count. We will have to wait and see whether this is a trend that will continue

The Impact of Water Quality

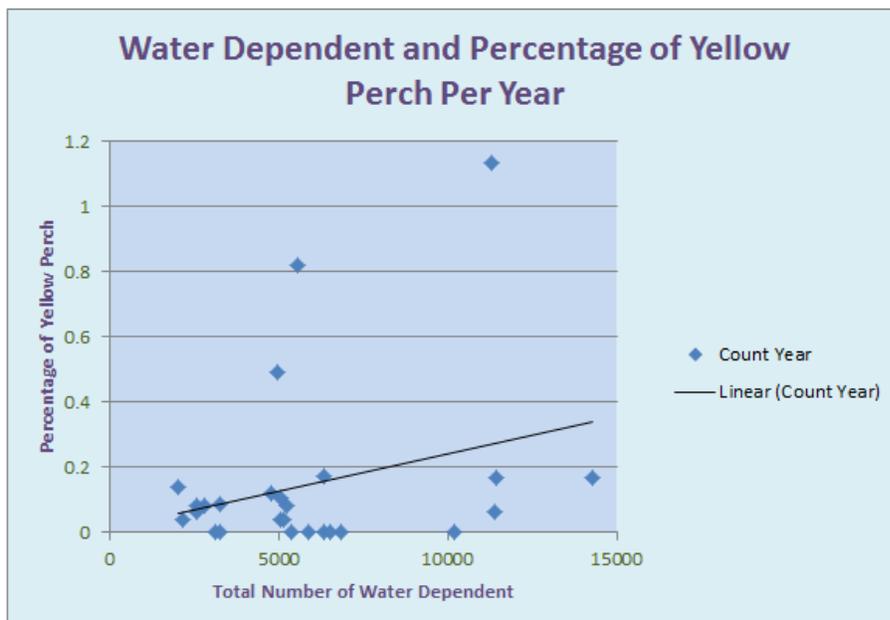
As noted in the last section, the Port Tobacco River is a place Yellow Perch come to spawn. This, coupled with the fact the Yellow Perch survey is conducted in the summer, while the CBC is conducted in the winter, led us to use a lag function when running our analysis. This means that the CBC sightings for a given year were compared against the Yellow Perch data from the previous year. Using this approach, we can see a positive correlation between CBC sightings of waterfowl and water dependent species and Yellow Perch populations. This statistically significant relationship is represented by the following equation, in which WFWD represents the total number waterfowl and water dependent birds sighted in a given CBC and GM represents the geometric mean of relative abundance for the Yellow Perch from the previous year.

$$WFWD = -1711.25 + 4776.45GM$$

“Using this metric, we can see a positive correlation between CBC sightings of waterfowl and water dependent species and Yellow Perch populations.”

Credit: Southern Maryland Living

A graph of this relationship can be seen below. The graph includes a trend line which illustrates the positive correlation specified in the equation above.



The American Kestrel: A Cautionary Tale

Background

North America's smallest falcon, the American Kestrel, can be found year round in the Port Tobacco area. It is one of the most colorful of all raptors: the male's slate-blue head and wings contrast elegantly with his rusty-red back and tail; the female has the same warm reddish color on her wings, back, and tail. Kestrels hunt for insects and other small prey, and can often be found perched on telephone poles and wires.

American Kestrels nest in tree cavities, although they lack the ability to excavate their own. They rely on old woodpecker holes, natural tree hollows, rock crevices, and nooks in buildings and other human-built structures. As available space for their nests have declined, so too has their population. However, kestrels take readily to nest boxes, such as those supported by the "Adopt a Raptor" program offered by the Southern Maryland Audubon Society.

Credit: audubon.org



Credit: George Jett

On the left is an example of a Kestrel Nesting Box such as those supported by the "Adopt a Raptor" program offered by the Southern Maryland Audubon Society.



© Bert Bowler

Credit: Bert Bowler

Credit: Bob Young

As Humans Move In, Kestrels Move Out

Our analysis has shown that CBC sightings of the Kestrel in Port Tobacco are negatively correlated with the increasing population of Charles County, as expressed in the estimated equation below.

$$\text{Kestrels Sighted} = 33.52 - 0.00018 (\text{Population})$$

Population was found to be highly statistically significant in explaining the number of Kestrels sighted (p-value = 0.0015). As the population of the county has increased, the sightings of Kestrels have decreased with a coefficient of -0.00018240. It should be noted that both of these variables have a unit of one, meaning that both the population of humans and the sightings of each bird species are expressed in their absolute totals, which explains why the coefficient is such a low number. We can interpret this coefficient in a more relatable way: every increase of the county's population by 5,555 people is predicted to reduce the number of Kestrels sighted by one. Similarly, an additional 10,000 residents can be expected to reduce sighted Kestrels by 1.8.

Extrapolating from this estimated relationship, if this trend continues we would expect to see no Kestrels by the time the population of Charles County reaches 186,245. If the population of the county continues to increase at the rate it has since 1988, we would expect the county to reach this mark sometime between 2026-2027, a mere decade away from the publication of this analysis. Something, therefore, must be done to ensure that this incredible species is not lost from the Port Tobacco area, never to be seen in by future generations continuing the tradition of the Christmas Bird Count.

“If this trend continues, we would expect to see no Kestrels by the time the population of Charles County reaches 186,245...sometime between 2026-2027.”



Credit: allaboutbirds.com

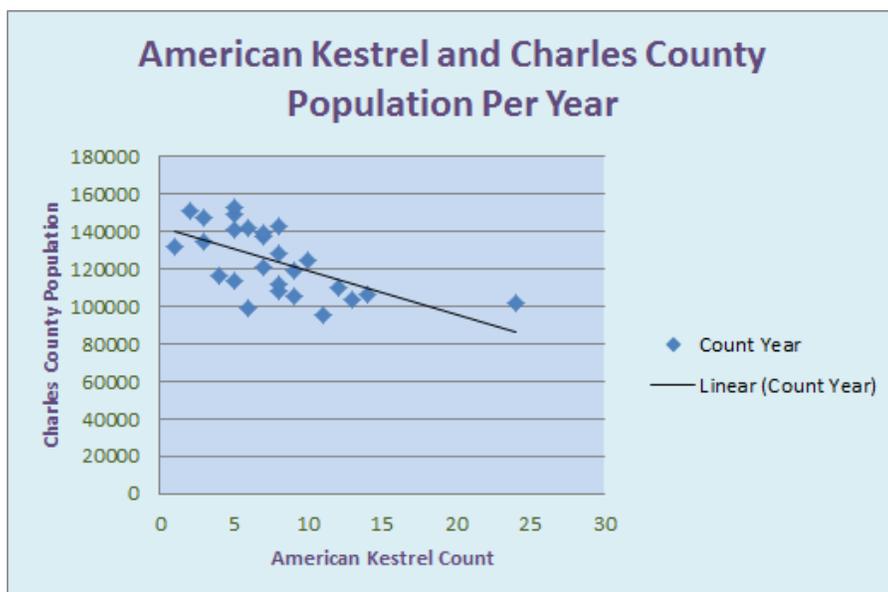
The Downhill Decline

Since the beginning of the Christmas Bird Count, sighting of the Kestrel in Port Tobacco have dramatically decreased. Although the Kestrel is currently the most populous raptors in North America and is classified by the International Union for Conservation of Nature and Natural Resources as “least concern”, the Kestrel has nevertheless declined approximately 66% between 1966 and 2014, according to the North American Breeding Bird Survey. Declining populations can be due to many factors, including deforestation which reduces the number of available tree cavities available for their nesting, as well as so-called “clean” farming practices, which remove hedgerows, trees, and brush. “Clean” farming, as well as increased use of pesticides, reduces the number of spiders, insects, and other prey that the Kestrels rely on. An additional threat of pesticides and other pollutants is the risk of reduced clutch sizes and hatching success for the Kestrels. In the Port Tobacco CBC, sightings of the Kestrels have decreased faster than the national average, 81% since their height in 1990. Sightings of the Kestrel have remained in the singles digits since 2002, with only two Kestrels seen during the 2014 count.

“Sightings of the Kestrel have decreased... 81% since their height in 1990”

Credit: Southern Maryland Living

Below is a graph showing the decline in Kestrel sightings during the Port Tobacco CBC since 1988.





Bald Eagles: A Story of Success

With such foreboding numbers surrounding the fate of the American Kestrel, is there any hope that the problem can be solved? We believe that the answer is yes, as evidence by the incredible success story of the American Bald Eagle.

The Chesapeake Bay region is an important stop for bald eagles migrating from other parts of North America during spring and autumn. Found year-round throughout the Chesapeake Bay watershed, particularly in sparsely developed areas near water, the Bald Eagle is certainly one of the most majestic inhabitants of Charles County. Today, there are nesting Bald Eagles in every county in Maryland, with over 400 pairs recorded throughout the state in 2004. Charles County had the second highest number of nesting sites, with 54 nesting sites noted in the Maryland Department of Natural Resources' aerial survey in 2004. This was, however, not always the case.

In 1978, there were a mere 41 nesting pairs of bald eagles in all of Maryland. 1978 also marked the year that the Bald Eagle was added to the list of federally endangered and threatened species, bringing with it federal protection and strict repercussions for endangering a Bald Eagle or its nest. The elimination of the pesticide DDT in the 1980s was also crucial to the comeback of the Bald Eagle, as was the improvement of water quality in the Chesapeake Bay watershed, which is home to much of the Bald Eagle's prey.

“Today, there are nesting Bald Eagles in every county in Maryland, with over 400 pairs recorded throughout the state in 2004.”

The Charm of Charles County

According to the National Audubon Society website, the average percentage increase in the CBC sightings of Bald Eagles nation wide was approximately 6% per year from 1967 to 2006. Charles County however, far exceeds the national average in terms of growth. Since the first CBC by the Southern Maryland Audubon society in 1988, Bald Eagle sightings have steadily increased, with an average increase of 20.23% per year from 1988 through 2013 (it should be noted that for this calculation, the outlier year of 2012 where 175 Bald Eagles were sighted has been eliminated), due no doubt in large part to the concerted national effort to protect the living symbol of our nation. However, the Charles County government itself should also be recognized for its efforts that helped to solidify the counties Bald Eagle population. In 1996, a number of new conservation efforts were passed in the county's Comprehensive Plan (later updated in 2006) that afforded protection to areas beyond what was required by the State's "Chesapeake Bay Critical Area Law" which was passed in 1984.

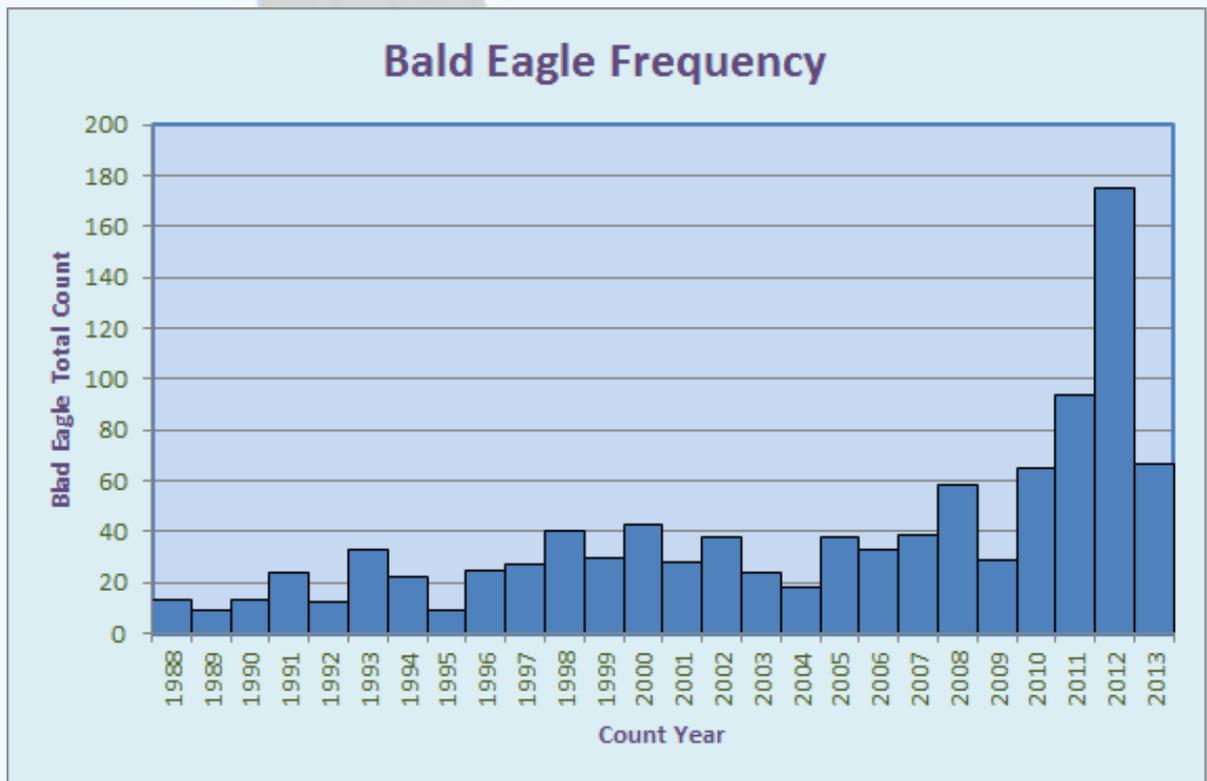
Credit: defenders.org

The creation of these additional critical areas afforded additional protection to areas including, but not limited to, waterfowl nesting sites, fish spawning areas, and the habitats of rare and endangered species (which at the time, included the Bald Eagle). Charles County also included the Port Tobacco River as one of twelve wetlands of special state concern. Identifying these key critical areas meant that any activities which involve clearing of vegetation, filling, excavating, flooding or draining are regulated by the State as well as requiring a 100-foot protective buffer around the Port Tobacco River. Since 1995, the year before these regulations were first put into effect, the number of Bald Eagle sightings in the Port Tobacco CBC has increased by an incredible average of 55.52% per year.



Incredible Increases

The graph below shows the total number of Bald Eagles counted in the Port Tobacco CBC for each year from 1988 through 2014.



©2008 GEORGE JETT

All of this growth is in spite of the fact that the Bald Eagle is living in the same county as the American Kestrel. The Bald Eagles of Charles County were subjected to the same increases in population growth and land development as the Kestrel, and yet the Bald Eagle has not only maintained its presence, but thrived. All of this goes to show that the protection of our birds, and our natural resources in general, does not have to come at the cost of human development and economic growth. Instead, we need to identify those species that are most in need of our protection and create conservation efforts that target the protection of those species, in order to ensure that ecosystems in Charles County continue to host the most diverse and healthy array of bird species as possible.

Credit: George Jett

Possible Outcomes and Policy Suggestions

It is not too late to balance economic expansion and sustainable development in Charles county; the press releases, official documents, and budget initiatives proposed by the county all point to a more pressing emphasis on economic growth and expansion of investment opportunities in the county. While efforts towards environmental conservation have definitely become more focused (and better funded) in the last decade, thanks in part to the activism of SMAS and organizations like it, there are still many more specific policies that could be adopted or widened to help lessen the

Agriculture and Wetland Easement Programs

Agricultural and wetland easement programs could be expanded, directly targeting lands adjacent to the Port Tobacco watershed. Easements consist of payments to landowners and the operators of small rural farms, meant to incentivize preservation of natural or undeveloped land. Easement programs sometimes involve the partial 're-wilding' of agricultural land in order to cultivate naturally occurring grass- and shrub-lands, providing a larger refuge for native wildlife.

Reducing Run-Off

Planting and preservation of riparian forest buffers in the vicinity of the watershed. These buffers consist of narrow strips of forested land that snake alongside of creeks and small streams, protecting them from runoff and erosion; active cultivation of these riparian forests could help protect the many of the smaller waterways that flow into Port Tobacco. Zone 1 is the unmanaged woody zone nearest the stream. Trees in this zone are selected for rapid root development and tolerance of wet conditions. Zone 2 is the wider managed woody zone. Trees and shrubs in this zone should be fast-growers that can tolerate periodic flooding. Zone 3 consists of at least a 20 to 24 foot width of warm-season grasses and forbs and is essential in an agricultural setting. Switchgrass is often the preferred species.



Credit: University Of Maryland

Another possible way to reduce runoff is to create laws that place more prohibitively expensive fines on sources of heavy nutrient runoff, as well as development plans that prioritize the modernization or maintenance of area septic systems.

Growing With Grace

While we understand that as an ever growing and expanding community, Charles county will continue to develop, however it is important that we reduce the impact of humans to the environment. This can include pressure on local economic interests and subdivisions of the county government in charge of licensing and land usage to limit suburban sprawl. If Charles county could avoid the unnecessary construction of residential and commercial areas (and thus accompanying infrastructure such as septic systems and new roads) in as-yet undeveloped areas and focus instead on the modernization and growth of existing urban hubs, it would help lessen the environmental impact of new economic development.

Similarly, Charles county could focus on incentivizing less intensive methods of farming among agricultural businesses; education and wider awareness of the economic value that wilderness like Port Tobacco brings to Charles county (through carbon sequestration, tourism, and state grant money targeted at meeting specific conservation goals) may also help make the case for more gentle and holistic development plans.

Targeted policy in this area could include:

State and federal legislation specifically protecting bald eagles has seen tremendous success in protecting their population, as have more restrictive licensing on the hunting of other migratory bird species. Therefore we would like to see additional legislation specifically aimed at the conservation of certain keystone species in Port Tobacco watershed.

More stringent enforcement of existing logging and hunting/fishing statutes across the county, but specifically when the area in question is peripheral to important nesting and breeding grounds for vulnerable species, such as the Port Tobacco watershed.

Suggestions for Future research

With such foreboding numbers surrounding the fate of the American Kestrel, is there any hope that the problem can be solved? We believe that the answer is yes, as evidenced by the incredible success story of the American Bald Eagle.

Our study is by no means a fully exhaustive one; for a broader and more robust analysis, we would suggest the inclusion of more time series data sets and a wider scope in terms of the number of count years observed. Due to time and resource constraints, we did not collect as many parcels of potentially relevant data as we would have liked to. Consistent measurements of water quality indicators in the Port Tobacco watershed, information regarding average agricultural runoff in Charles county, quantitative data on septic and sewage systems around the watershed, and accurate, annual data on the changing trends in local land usage would have improved the accuracy of our results; even if our findings were not significantly expanded for having used them, the inclusion of these other variables would at least have given us a sense of how these factors play into the overall health of bird species in Port Tobacco.

Should SMAS or other Audubon chapters attempt similar studies in the future, we would suggest that they expand the scope of the analysis beyond just Port Tobacco and collaborate with other organizations to collect comprehensive data that may prove relevant across various conservation missions. Similarly, we felt that the same analysis, conducted at an older Audubon chapter (who presumably have data stretching further back into the 20th century than SMAS) may be a more accurate reflection of long term trends in observed bird populations. We would like to see our model used or expanded upon by others, and believe that it provides the basic framework with which to analyze trends in bird species observed during the CBC; anthropogenic impacts on bird species and the complex ecosystem they inhabit should be as fully explored as possible, the true extent of which is best analyzed with large sample statistical analyses.

Credit: birdnote.org