CSN TECHNICAL BULLETIN No. 8

The Clipping Point: Turf Cover Estimates for the Chesapeake Bay Watershed and Management Implications

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April 1, 2010

Important Note: This Technical Bulletin was developed with technical assistance from Peter Claggett, Research Geographer, U.S. Geological Survey. Portions of this paper will be submitted to a peer-reviewed journal, but the initial methods and finding are being released now due to its possible implications for future nutrient management in the Chesapeake Bay watershed. Please e-mail any comments to Tom Schueler at watershedguy@hotmail.com by July 1, 2010.

ABSTRACT

Three independent methods are used to estimate the extent of turf cover in the Chesapeake Bay watershed and data from previous studies is cited to estimate the potential environmental management implications of turf grass. The three methods include: 1) a GIS based approach using moderate-resolution satellite derived land cover data, 2) pro-rated state turf industry statistics, and 3) coarse-resolution satellite derived regression equations. The methods, which represent different base years from 2000 to 2005, suggest that turf cover ranges from 2.1 to 3.8 million acres, or 5.3% to 9.5% of total Bay watershed area. Approximately 75% of current turf cover is potentially devoted to home lawns. In Virginia, data indicate that turf acreage grew faster than population or impervious cover in the last three decades with an annual growth rate of 8%. Turf cover arguably constitutes the single largest fraction of pervious area in the watershed, exceeding the total individual acreage devoted to row crops, pasture, hay/alfalfa or freshwater wetlands, respectively.

The potential impacts to the Bay due to turf cover are expressed in terms of annual biomass production, nitrogen fertilization, pesticide application, water use, runoff from compacted soils, energy use, carbon sequestration, VOC emissions and the cost to maintain such a large fraction of watershed area as a grass crop. Although much more needs to be learned about turf management practices in the Bay watershed, initial estimates suggests that turf has a strong influence on water quantity and quality in the Bay watershed.

Despite the large size of the turf sector in the Bay watershed, it only receives a small fraction of the resources, funding and technical assistance devoted to managing other nutrient sources, such as agriculture, wastewater, and forestry. An estimated 6.1 million “turf grass farmers” exist in the watershed who currently spend nearly 5 billion dollars a year (including more than $600 million expended alone for fertilizers and chemicals). By changing their attitudes and behaviors about what constitutes a green lawn, it may be possible to achieve major runoff and nutrient reductions to the Chesapeake Bay.

INTRODUCTION

Watershed managers are increasingly interested in isolating the land cover components of urban land use (turf cover, impervious cover and forest cover) in order to obtain better predictions about current and future runoff, pollutant export and stream quality. The importance of defining actual *land cover* rather than *land use* to understand linkages with the aquatic integrity of streams and the Bay has been emphasized by both researchers and watershed managers (Goetz et al, 2003, CWP, 2003 and Schueler et al, 2009).

While techniques have been developed to accurately estimate impervious and forest cover at the watershed scale (Cappiella and Brown 2001, Cappiella et al, 2005, Goetz et al, 2004), turf cover is much more difficult to isolate, measure or forecast (Law et al, 2009). The extent of turf cover associated with urban, suburban and exurban land development is poorly understood and land use/turf cover coefficients do not exist to predict current and future turf acreage (Law et al, 2009).

Our poor understanding of the extent of turf is due to the fact that it is interspersed within the broader mosaic of land uses. In most cases, turf cover is the residual of urban and suburban land use, and its extent is a function of lot size, development intensity, zoning setbacks and age of development in the zoning categories in which it occurs. But turf cover is also present within non-urban land cover/use categories (e.g., within highway rights of way in areas classified as "transportation", within local parks in areas classified as "forest", or on sod farms in areas considered to be "cropland").

In other cases, turf cover is associated with unique land uses such as golf courses, airports, cemeteries, schools, churches, hobby farms and institutions. Consequently, turf cover is hard to detect from satellite imagery, aerial photography or GIS databases because it is hidden by tree canopy, confused with pasture in exurban areas, or is a small micro-feature that is not easy to pickup (e.g., a narrow strip next to sidewalk, highway median or commercial buffer, or interspersed with landscaping).

It is also difficult to establish the actual management status of turf cover. While the main distinguishing feature of turf is that it is mowed frequently, much less is known about the rate of fertilization, irrigation, pesticide application. This paper provides initial estimates of turf cover in the Bay watershed and offers some generalized projections as to its aggregate environmental impact. While these initial estimates are cause for concern, more research and survey data are needed to refine them, and undertake more effective turf management efforts.

METHODS

Three independent methods were used to derive estimate of turf cover in the Chesapeake Bay watershed for the years 2000 and 2005, as described below.

1. GIS Analysis of Moderate-resolution Imagery

The first approach was to assess the extent of turf cover within the Bay watershed using a GIS and a combination of spatial datasets to characterize the urban and turf environments. For describing general land cover characteristics (e.g., urban, forest, agriculture, recreational grass, etc.), a 30-meter resolution land cover dataset derived from Landsat satellite imagery was used representing the year 2001 (Goetz et al., 2004). Impervious surface data for the year 2001 (Ibid) derived from Landsat imagery were also used.

Because low density and forested residential neighborhoods are not fully represented in Landsat derived land cover datasets, the urban extent was modified using a dasymetric mapping technique for delineating residential areas based on the population density on residential roads (Claggett 2004). The use of this technique resulted in expanding the urban footprint in the Bay watershed by 59% from 4,184 to 6,649 square miles compared to the strictly satellite derived land cover map. In Maryland, the 2001 satellite derived land cover map underestimated the extent of urban and structural land uses by 38.8% as compared with the 2000 Maryland Land Use dataset developed by the Maryland Department of Planning. The expanded urban footprint based on population and road density exhibited a 10.6% overestimate of urban land use for the State.

The modified urban footprint and the impervious surface dataset were used to identify pervious urban lands throughout the Bay watershed. The land cover dataset was used to subtract likely forested areas from the extent of pervious urban lands. Likely forested areas are those in which the interior forest canopy, greater than 30m from the forest edge, is at least one acre. The remaining pervious, non-forested, urban lands were identified as turf grass. This estimate was then combined with the extent of "recreational grass" land cover outside the urban footprint. Examples of such areas include golf-courses, ball fields, and pervious lands surrounding commercial areas and airports.

2. Statewide Turf Grass Industry Statistics

The second approach was to analyze published statewide turf grass industry reports compiled by agricultural statistics offices (VAASS, 1998, VADACS, 2006, PAASS, 1990, NYASS, 2004, MDASS, 1996 and 2006). Published surveys are available for the four largest Bay states (VA, PA, MD and NY) for one to four periods of record. The reports document phone and written surveys for 10 to 12 different turf sectors in each state that describe the economic importance of the turf grass industry. Examples of the sectors include: home lawns, highway right of way, parks, schools, sod farms, golf courses, municipal land, airports, churches, apartments, cemeteries and commercial land.

An initial estimate of Bay watershed turf cover of 3,000,000 acres was developed by Schueler (2001) using PA, VA, and MD surveys for base years 1989, 1994 and 1995. For this study, we utilized turf grass surveys in MD, VA and NY for the years 2004 and 2005, and updated the 1989 PA survey assuming a 25% increase in turf over the 15 year period. Statewide estimates were converted to watershed estimates by multiplying them by the fraction of the land area in each state within the Bay watershed. These fractions were developed using the 2001 National Land Cover Dataset and excluded inland and tidal waters. No turf grass data were available for four jurisdictions that collectively comprised 17% of the Bay watershed (NY, DE, DC and WV). It was conservatively assumed that 5% of their total acreage in the Bay watershed was turf.

Statewide statistics were also adjusted for Maryland, New York and Virginia surveys to reflect the relative suburbanization of the fraction of each state in the Bay watershed compared to the state as a whole. For example, in Virginia and Maryland turf grass estimates were increased by a factor of 1.15 and 1.03 respectively, since their urban areas are more concentrated within the Bay watershed than the State as a whole. By contrast, New York turf grass data were adjusted by a factor of 0.60 since New York's urban areas are mostly located outside the Bay watershed. Recent turf grass surveys were also analyzed to determine the rate and distribution of growth in turf cover and associated economic implications.

3. Impervious Surface/Turf Cover Regression

The third method to estimate the extent of turf cover in the Bay watershed follows the approach described by Milesi et al (2005) who conducted a national assessment of turf grass. Milesi et al (2005) estimated the extent of turf cover by relating it to the fractional extent of impervious surface area derived from nighttime lights radiance, road density, and Landsat-derived urban land cover values (Elvidge et al., 2004). A linear regression (Equation 1) was used to relate the fractional impervious surface area within a 1 km^2 cell to the fractional turf grass area as measured from 80 high-resolution aerial photographs. Milesi et al (2005) used this predictive equation to calculate aggregate estimates of statewide turf cover in the continental US with a confidence interval of +/- 20%.

Equation 1 (Milesi et al, 2005):

$$\text{Fractional Turf Grass Area (\%)} = 79.53 - 0.83 * \text{Fractional ISA (\%)}$$

We processed this equation and the fractional ISA raster data produced by Elvidge et al. (2004) within a GIS to estimate the extent of turf grass in the Bay watershed.

RESULTS AND DISCUSSION

Based on the GIS analysis of satellite derived land cover datasets combined with spatial data on roads and population density, approximately 9.5% of the Bay watershed land area is covered by turf grass (Table 1). The distribution of areas with high turf cover is shown in Figure 1.

Maryland had the largest amount of turf grass despite having half the land area within the Bay watershed compared to Pennsylvania or Virginia. The extent of exurban turf was also particularly high in Maryland.

Table 1. Year 2001 Turf Cover Estimate Using a GIS and Satellite Data

State	Land Acres in Bay Watershed	Urban[1] Turf Acres	Exurban[2] Turf Acres	Total Turf Acres	Percent Land Area with Turf
MD	5,639,428	1,007,269	298,476	1,305,745	23.15%
VA	13,706,037	988,291	135,792	1,124,083	8.20%
PA	14,345,262	900,803	158,212	1,059,015	7.38%
DC	38,956	16,071	2,320	18,391	47.21%
DE	450,384	31,337	3,648	34,985	7.77%
NY	3,983,079	160,788	32,982	193,770	4.86%
WV	2,288,363	75,515	12,425	87,940	3.84%
Total	40,451,509	3,180,074	643,855	3,823,929	9.45%

[1] Urban area includes impervious and non-forested pervious surfaces in industrial, commercial, and residential areas with lot sizes generally less than 2-acres.
[2] Exurban areas represent all non-urban lands. The "urban recreational grass" land cover class was solely used to identify turf grass in exurban areas.

The headwater states of New York and West Virginia had the lowest percentages of land area covered by turf. This may be partly due to issues associated with the terrain (more dissected) and climate (cooler with shorter growing seasons) but also may be due to relatively lower densities of residential development which are difficult to detect with Landsat derived land cover data.

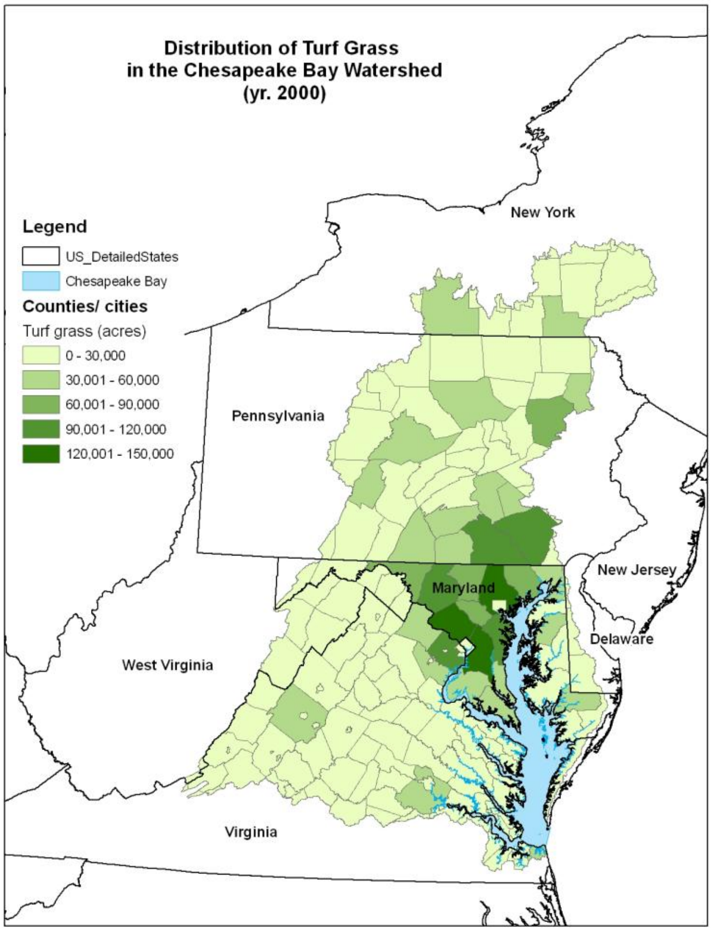

Figure 1:
Distribution of Counties with High Turf Cover in the Chesapeake Bay Watershed

The counties with the greatest amount of turf grass are all suburban jurisdictions surrounding major metropolitan centers such as the District of Columbia, Baltimore, Maryland, Harrisburg, Pennsylvania, Richmond and Norfolk, Virginia. Three counties (Fairfax, VA, Montgomery and Howard, MD) were found to have more than 40% of their land area covered by turf grass. Together, the 15 counties with the highest amount of turf grass represent 37% of the total area covered by turf in the Bay watershed, even though they compromised less than 13% of its total land area (see Appendix A).

The large extent of turf grass in these counties is a function of the prior agricultural land use, dense residential population, and abundance of land uses associated with residential developments such as golf courses, schools, and churches.

The turf grass industry statistics reveal interesting trends in the distribution of turf cover in each state (Table 2). As might be expected, the home lawn comprises the largest share of turf cover in each state (62% to 83%) and its share appears to be increasing over time. Roadsides, municipal open space, parks and schools collectively represent about 15% of the remaining turf cover.

The rapid growth in turf cover is evident in Table 3 which tracks turf cover in the Commonwealth of Virginia between 1972 and 2004. During this 32 year period, the acreage of turf grass tripled, growing by an average of 8.6% per year. Home lawns were the fastest growing turf sector, primarily due to low density development. An indication of the increasing suburban footprint of the state is that per-capita turf acreage nearly doubled during this period, climbing from 0.13 to 0.24 acres/resident.

For the entire Bay watershed, the turf estimate based on industry statistics for the mid to late 1990s was just over 3 million acres (Schueler, 2001), but climbed to nearly 3.8 million acres by the 2004/2005 baseline year (Table 4).

Table 2. Distribution of Turf Grass by Sector in Maryland, Virginia and New York (percent)[3]

Turf Sector	1989-1998 [1]	MD 2005	VA 2004	NY 2005
Home lawns	70	82.6	61.6	82.1
Apartments	nd [2]	0.6	nd	0.8
Roadside right of way	10	4.3	17.5	nd
Municipal Open Space	7.0	3.5	6.0	nd
Parks	3.5	1.9	2.5	1.9
Commercial	Nd	Nd	5.0	0.3
Schools	3.0	3.4	2.9	1.6
Golf Course	2.5	1.4	2.2	3.0
Churches/ Cemeteries	2.0	1.2	1.4	1.1
Airports/Sod farms)	1.0	1.1	0.9	0.6

[1] Average of three states: MDASS (1996), VAASS (1998) and PAASS (1989)
[2] nd = no data as the indicated turf sector was not sampled or estimated
[3] As reported in MDASS (2006), VADACS (2006) and NYASS (2004)

Table 3 Virginia Turf Grass Growth (1972-2004) [1]

Year	VA Turf Grass Acres
1972	617,923
1982	826,121
1998	1,368,000
2004	1,702,000
Rate of Change	33,875 acres per year (8.6%/year)

[1] historical surveys as reported in VADACS (2005)

Table 4 Updated Turf Cover Estimates Using More Recent Industry Statistics					
State	**Survey Year**	**Turf Acres**	**Development Adjustment**	**Fraction In Bay**	**Total Turf Acres**
MD	**2005**	**1,100,000**	**1.03** [1]	**0.938**	**1,062,754**
VA	**2004**	**1,702,000**	**1.15** [1]	**0.546**	**1,068,686**
PA	**1989**	**1,999,408**	**1.25** [2]	**0.500**	**1,249,630**
DC	**Nd** [3]	**1,950**		**1.0**	**1950**
DE	**Nd** [3]	**21,330**		**0.360**	**21,330**
NY	**2005**	**3,430,000**	**0.60** [1]	**0.132**	**271,656**
WV	**Nd** [3]	**113,789**		**0.148**	**113,789**
Watershed Total					**3,789,795**
				Percent of Bay Watershed (40,451,509 acres)	**9.37%**

Notes:
[1] Adjustment factors based on ratio of percent urban land in the fraction of the state in the Bay watershed to the percent urban land statewide from NLC 2000 dataset.
[2] Adjusted upward to reflect 2.5% annual growth in turf cover to the year 2000 in PA
[3] For states with no turfgrass data (nd), turf cover was conservatively assumed to be 5% of total state acres present in the watershed.

Following the methods outlined in Milesi et al (2005), the extent of turf grass in the Bay watershed is estimated to be only 5.31%. This estimate contrasts greatly with the estimates derived from the GIS analysis of moderate resolution imagery (9.45%) and State industry statistics (9.37%). The Milesi et al (2005) method is conservative in estimating overall turf acreage due to its coarse resolution, and the fact that it did not compute turf cover for 1 km^2 cells with less than 10% ISA (i.e., the authors indicated it was not possible to discriminate turf from pasture, hay, crops and other pervious cover within these cells).

As Cappiella and Brown (2001) note, however, the greatest fraction of turf cover is associated with low density development (i.e., one and two acre lots) and over the past 15 years, the average lot size of new development in Maryland, for example, ranged from 0.7 to 0.83 acres (MSP, 2006).

Table 5: Bay Wide Turf Estimates Using Landsat Data, ISA/Turf Regression Method [1]	
State	**Total Turf Acres**
MD	**621,070**
VA	**799,953**
PA	**574,976**
DC	**15,159**
DE	**13,355**
NY	**94,011**
WV	**30,754**
Watershed Total	**2,149,279**
Percent of Bay Watershed	**5.31%**

[1]Milesi et al (2005)

While both the GIS analysis of moderate-resolution imagery and the approach used by Milesi et al (2005) rely on remotely sensed imagery as the main source of information, the estimated extent of turf grass based on GIS analysis of Landsat-derived land cover data and population and road density was 78% higher than the estimate based on the approach used by Milesi et al. (2005). As discussed above, we attribute this difference to 10% threshold applied to the 1-km2 resolution fractional impervious surface dataset derived from nighttime lights data. The impact of this threshold is apparent in eastern Loudoun County, Virginia, (Figure 2) where estimates of the percentage of turf grass are lacking in many of the 1-km² cells that clearly contain both

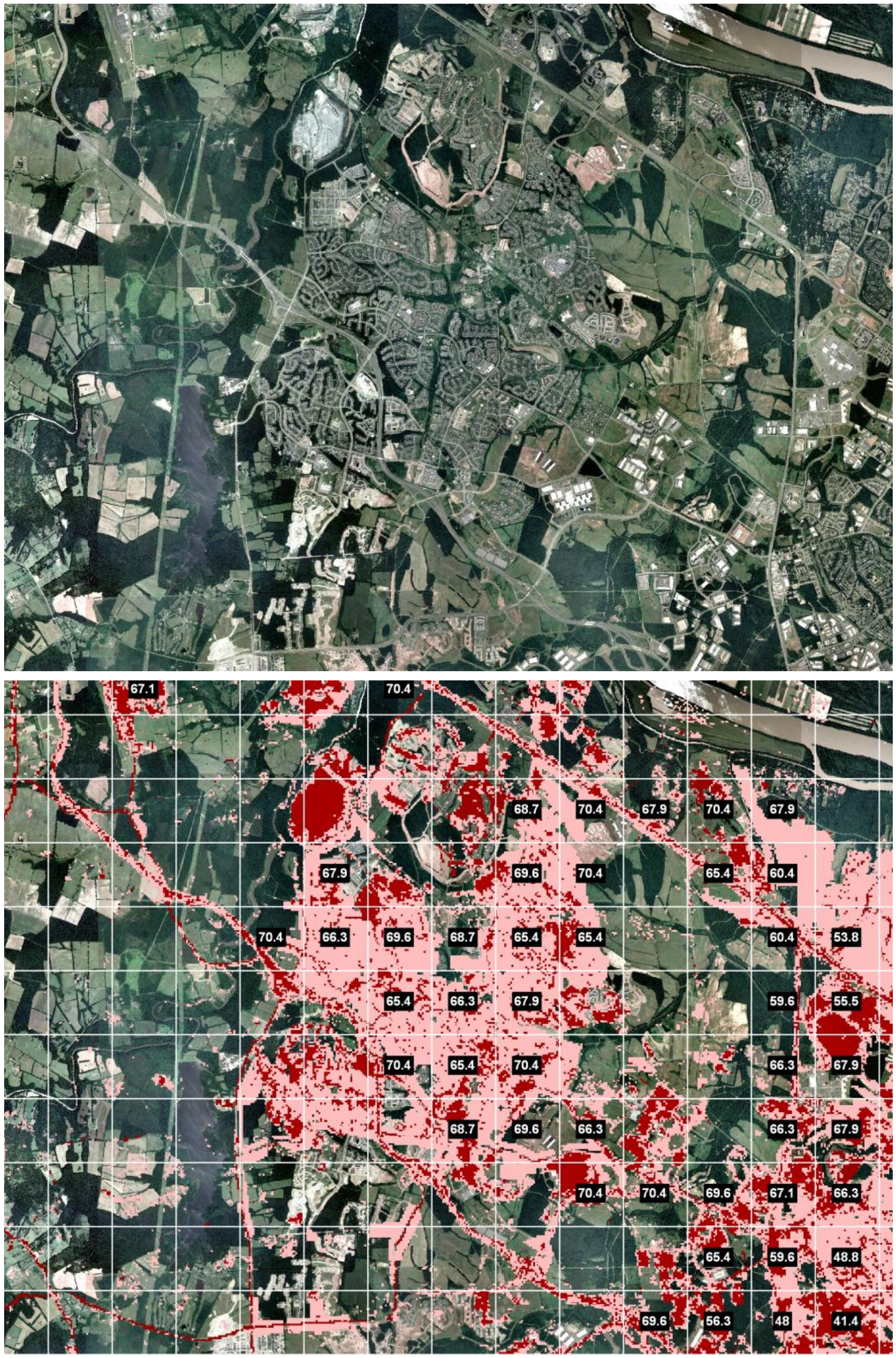

Figure 2. Representation of urban lands based on Landsat-derived land cover, population and road density data (red and pink areas) compared to turf grass estimates from Milesi et al., 2005 (white outlines for each 1-km^2 cell noted with the percentage of turf grass in each cell). Cells not labeled were ignored because they fell below the 10% of threshold of fractional impervious cover. The area is shown is in eastern Loudoun County, Virginia (2003 NAIP imagery).

impervious surfaces and associated turf grass as judged by the aerial imagery and Landsat land cover data. For those 1-km^2 cells lacking turf grass percentages, impervious surfaces were either under-represented (below the 10% threshold) or not represented at all. For these reasons, we believe the estimate of turf grass based on the approach of Milesi et al., 2005 is not representative of the full extent of turf grass in the Bay watershed.

The estimates of the extent of turf grass in the Bay watershed based on the GIS analysis of moderate resolution imagery and the state industry statistics are almost identical. The GIS analysis has the advantage of providing turf grass estimates for any geographically referenced overlay area (e.g., watersheds, townships, counties) and enables separation of estimates into urban and exurban categories. The major disadvantages are that it only represents a single date (2001) corresponding with the availability of land cover, road, and population census data. Also, even with the enhanced detection of residential areas using the census and road datasets, highway rights-of-way and low density developments (e.g., 2+ acre lot sizes) and are easily missed and confused with pasture.

The state industry surveys are useful in that they evaluate many non-residential turf categories that are hard to pick out from remotely sensed imagery. Because several states have conducted multiple surveys, it is also possible to calculate rates of change in turf cover over time, in the aggregate and within individual turf sectors. The turf grass statistics do have some limitations. First, while each state utilizes a common survey methodology, they may not always provide a comprehensive inventory of all types of turf cover (i.e., not all states reported data for commercial, institutional and highway categories).

Second, the survey may be biased since the statistics are often used to demonstrate the economic value of the turf grass industry in each state, and some minor over-counting was observed in a few surveys. Third, the surveys are conducted asynchronously among and within individual states, so it is not possible to aggregate them for a common base year, without adjustment. Lastly, the state-wide turf grass statistics need to be adjusted to subtract turf grass outside the Bay watershed.

Given the noted under-representation of turf grass based on the Milesi et al., 2005 methods, general agreement between the estimates of turf grass derived from the GIS analysis and state industry statistics, and the estimated population increase of over 1.1 million people in the Bay watershed since 2000, it is reasonable to expect that turf grass covers at least 3.8 million acres of the Bay watershed or about 9.4% of total watershed land area.

Table 6 provides a comparison of turf grass versus other major land uses in the Bay. The extent of turf cover is more than double the total tidal and non-tidal wetland area and is slightly greater than the total pasture cover, hay/alfalfa, or row crops (corn, soybean, wheat) grown in the Chesapeake Bay watershed. Therefore, this study finds that turf grass is the largest “crop” grown in the Chesapeake Bay watershed, complementing the findings by Milesi et al. (2005) that turf grasses "represent the single largest irrigated crop in the United States". Moreover, the extent of turf grass in the Bay watershed will likely continue to grow with the expected population increase of more than 2 million people over the next twenty years and demand for additional services (roads, schools, golf courses etc.).

Table 6. Comparison of Turf Cover Estimates to Other Bay Land Cover Types			
Land Cover Type	**Estimated Acres in Bay Watershed**	**Year**	**% of Bay Watershed**
Turf Method [1]	**3,823,929**	**2000**	**9.5%**
Turf Method [2]	**3,789,795**	**2005**	**9.4%**
Turf Method [3]	**2,149,280**	**2000**	**5.3%**
Wetlands [4]	**1,720,000**	**1990**	**4.2%**
Row Crops [5]	**3,751,115**	**2000**	**9.2%**
Hay/Alfalfa [5]	**3,017,201**	**2000**	**7.4%**
Pasture [5]	**3,139,520**	**2000**	**7.7%**
Forest [5]	**26,135,487**	**2000**	**64.1%**
[1]See Table 1. [2] Schueler, 2001. [3]See Table 5. [4]Tidal and non-tidal wetlands reported by Tiner et al 1994. [5]Goetz et al (2004).			

Turf Management Status and Bay-wide Multipliers.

While turf is ubiquitous in urban, suburban and rural portions of the Bay, we lack accurate data on its management status. For example, what proportion of turf receives high inputs of fertilizer, pesticides, and is irrigated; and what proportion is managed with few or no chemical or water inputs and simply just mowed. A few surveys have been undertaken to assess the lawn management behaviors of Chesapeake Bay homeowners (most notably Swann, 1999 and Law et al, 2004), and other national and regional surveys have been summarized in Schueler (2001), Robbins et al (2003) and Milesi et al (2005). In general, patterns of fertilizer and pesticide applications and irrigation vary according to income, lot size, water service and other demographic factors. Additional data on the economics of the turf grass industry can be derived from data reported in MDASS (2006), VADACS (2004) and NYASS (2005).

These data and other sources have been used to develop an order of magnitude estimate of the impact of turf cover in the Chesapeake Bay watershed, assuming a current cover of 3.8 million acres. Table 7 summarizes these estimates for the lawn clippings generated, N fertilizer applied, summer irrigation, gas consumed, Vox emissions, additional runoff from compacted soils and carbon sequestered. In addition, estimates are provided about the probable population of "grass farmers", lawn care employment, and turf maintenance costs for the Bay watershed as a whole. To put these statistics in context, we compared them to other Bay statistics.

Table 7. Initial Estimates of Turf Multipliers in Chesapeake Bay Watershed [1]

Activity	Activity Rate	Unit Generation	Bay Watershed Estimate	Equivalent to:
Clippings	100% [2]	2 tons/ac/yr (dry weight) [3]	7,600,000 tons	272 million bushels corn [4]
Nitrogen Fertilization	65% [5,6]	87 lbs/acre/yr [6]	214,950,000 lbs/yr	High N input, but unclear how much reaches Bay waters
Irrigation	40% [6]	1.25 acre-feet/acre/summer irrigated [8]	1,900,000 ac-feet/summer	Equivalent to 7875 cfs of summer river flow to Bay [9]
Gasoline Usage	95% [10]	15 gallons/ac/yr [11]	57,015,000 gallons/yr	Equivalent to one fully laden supertanker/yr
Emissions	95% [10]	Too complex to calculate, given changes in emission regulations and technology equipment. Lawn/garden equipment is 2nd leading emitter of VOx in MD [12]		
Pesticide Applied	83%	6 lbs ai/acre/yr [13]	18,929,000 lbs/yr	
Incremental Runoff	100%	0.23 acre-feet/yr [14]	Average of 1244 cfs/day/yr of storm runoff into Chesapeake Bay	
Carbon Sequestration	80% [15]	Too complex to calculate, but ranges from 200 to 800 lbs C/ac/yr, depending on fertilization, irrigation and clipping management [15]		
No. of grass Farmers	90% [16]	Lawns at 90% of households [17]	2005 population 16.6 million	6.8 million grass farmers
Lawn Care Employees	N/A	Full and part-time employees in all turf sectors (non-homeowners) [18]		50,500
Homeowner Time Spent	75% [19]	48 hours/acre/yr [19]	137 million hours/year	65,788 full time jobs
Maintenance Cost	100%	$1306/acre/yr [20]	$4,964,000,000	20 to 30% of Bay restoration cost

[1] assumed turf cover of 3,800,000 acres
[2] clippings removed or recycled
[3] Qian et al 2003 and Milesi et al 2005
[4] 35.7 bushels corn per ton
[5] Swann (1999)
[6] Law et al (2005)
[7]
[8] assumes 16 weeks @ one-inch per week
[9] USGS average total daily summer river flow to Bay ranges from 20-40,000 cfs
[10] assumes 5% use of electric/reel mowers
[11] Website source (VT Extension Service)
[12] MDE website MD Top Ten VOx Sources
[13] Schueler, 2001
[14] Rv of 0.075 for compacted B/C/D/ soils
[15] Milesi et al (2005) and Qian et al (2003); older lawns have low sequestration
[16] 10% of owners used lawn care companies- Swann 1999
[17] 90% respondents had a lawn, assume 2.2 persons per household
[18] Prorated industry employment statistics
[19] For home lawns, excluding lawn care:2 hours mow per acre, 24 times/yr, 2080 hours for full time job
[20] Average of per acre turf maintenance costs is VADACS (2004) and MDASS (2005)

CONCLUSIONS

Many Bay managers may be surprised at the current extent of turf cover in the Chesapeake Bay watershed presented in this paper. Given the steady growth of turf cover over the last four decades, we have reached a clipping point whereby turf is the most significant non-forested pervious area in the watershed. What are some of the key management implications? First, more basic and applied research is needed to understand how turf is currently being managed in all sectors, including monitoring to define more accurate turf cover coefficients, homeowner and lawn care input rates, lawn mower emissions, carbon sequestration and other basic turf multipliers. It is certainly true that while the acreage of turf has greatly increased, our understanding of its consequences has not.

The second management implication is that the 9.4% of land area devoted to turf grass in the watershed presents an unrivalled opportunity to apply stewardship practices over this extensive land cover at little or no additional costs. Stewardship may consist of tree planting, soil compost amendments, rain gardens, meadow management, and of course, reducing or eliminating fertilizer, pesticide and water use.

An estimated 6.8 million “grass farmers” and 50,000 lawn care workers exist in the watershed who collectively expend more than 4 billion dollars a year (including $600 million for fertilizers and chemicals alone). By changing attitudes and behaviors about what constitutes a green lawn, it may be possible to achieve major runoff and nutrient reductions. One key benefit is that these reductions might be attained by spending less on our lawns, or shifting the dollars we currently spend to more watershed friendly practices.

The last implication is that Bay managers have largely neglected turf cover in comparison to other nutrient sources. For example, the USEPA’s Chesapeake Bay Program Office reported total annual spending of $120 million on agricultural nutrient prevention practices in 2007. Annual spending on residential nutrient prevention practices is not known, but is presumed to be very low.

Turf is unique in that it can be treated by a wide range of practices to improve runoff quality and quantity. Given its share of the watershed land area, lack of management data, and potential implications to water quality, Chesapeake Bay managers may want to allocate greater education, stewardship and cost-share resources to this neglected sector in the future.

APPENDIX A

Counties in Bay Watershed with the Highest Turf Grass Cover Based on GIS				
Jurisdiction/County	**State**	**Turf Acres**	**Total Land Acres**	**Percent Turf**
Montgomery	Maryland	140,272	317,420	44.2%
Baltimore	Maryland	136,456	379,708	35.9%
Prince George's	Maryland	121,008	306,846	39.4%
Lancaster	Pennsylvania	119,615	605,215	19.8%
Fairfax	Virginia	116,932	251,360	46.5%
York	Pennsylvania	110,564	577,749	19.1%
Frederick	Maryland	96,309	424,381	22.7%
Anne Arundel	Maryland	93,081	260,832	35.7%
Carroll	Maryland	85,114	286,896	29.7%
Harford	Maryland	77,084	272,524	28.3%
Howard	Maryland	66,239	160,906	41.2%
Luzerne	Pennsylvania	63,887	486,405	13.1%
Washington	Maryland	61,527	295,043	20.9%
Dauphin	Pennsylvania	56,347	337,650	16.7%
Henrico	Virginia	55,643	150,305	37.0%

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