LITTER POTENTIAL OF SUB-WATERSHEDS WITHIN DOG RIVER WATERSHED

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Any drainage basin located in an area inhabited by humans can be plagued by litter, and watersheds that drain urban areas are most affected. The purpose of the research is to locate the sub-watersheds within Mobile, Alabama's Dog River Watershed which are most susceptible to the littering behavior of humans. This information is useful to direct a concentrated effort towards finding a solution for improving the worst areas. The research includes mapping and spatial analysis of the variables which contribute to litter in the Dog River Watershed using ESRI's ArcGIS software. The project results help identify the target areas for anti-litter campaigns, and the most likely places in which law enforcement officers could fine someone for the act of littering. Research identifies Eslava Sub-watershed and Moore Sub-watershed as the most problematic. Exacerbated by impermeable surfaces, water runoff transports litter into storm drains which leads to streams, and eventually to Dog River, where it remains unsightly and environmentally unhealthy, unless it is picked up and properly discarded by volunteers.

Keyword: litter, trash, watershed-Dog River

Introduction

The Dog River Watershed is the main drainage basin for the city of Mobile. Anything that washes from this watershed flows into Dog River, which has a mouth that opens into Mobile Bay, and then to the Gulf of Mexico. The four largest sub-watersheds within the Dog River Watershed can be identified where they connect to Dog River. For reference purposes, these four are the Eslava sub-watershed, which encompasses Eslava Creek as well as Bolton Branch east of I-65; the Moore sub-watershed, in which Moore Creek catches the outflow of the Montlimar Canal; the Halls Mill sub-watershed, which includes Halls Mill Creek, Milkhouse Creek, Campground Branch, Second Creek, and Spring Creek; and finally, the Rabbit sub-watershed, which contains Rabbit Creek and Rattlesnake Bayou (Fig. 1). Gregor Gilpin Beck, an author on the topic of healthy watersheds, wrote, "The effects of what goes on upstream become magnified and increasingly complicated downstream," (1999).

Litter is a nationwide problem so much that Keep America Beautiful, a national organization focused on improving community environments, did a nationwide study in 2009 entitled "Litter in America" about littering behavior and litter quantification – the largest research on litter ever conducted in the United States. Research yielded that the most heavily littered

Figure 1 *The study area is the four largest sub-watersheds. All maps were created using ESRI's ArcGIS software, and with GIS downloads from* *http://cityofmobile.org/*

sites are roadways from motorists and pedestrians. Older people are less likely to litter than people less than 30 years of age. Residential areas are 40% less littered, whereas roads near convenie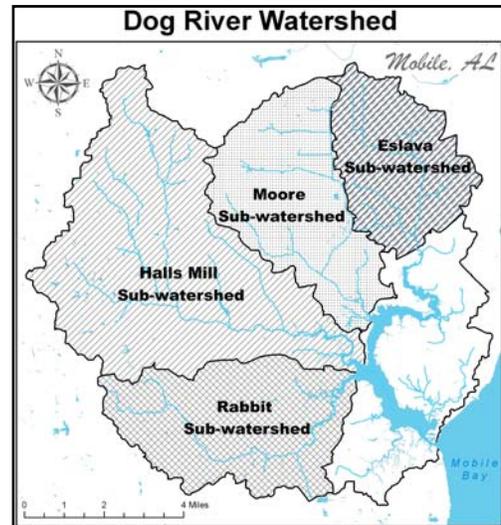nce stores and commercial sites are 11% more littered. Based on a probability sample of 1,039 people given a telephone survey, 15% admitted to littering within the last month. Plastic, including expanded polystyrene (Styrofoam) comprised almost 38% of the composition of larger litter items (Kab.org). These plastic items are the litter that can be seen floating in Dog River after a rainfall event (Fig. 2).

Figure 2 *After a rain in Mobile, litter is washed from roads and parking lots into storm drains where it is piped into Dog River. Photo courtest of Rob Nykvist via* *http://mobilepaddler.logspot.com/2012/02/ 02252012-upper-dog-river-one-week-later.html*

Litter in the river has negative effects on people and the environment. When trash is floating in Dog River, then the river becomes unsuitable for recreation purposes, swimming, or fishing. Also garbage is fatal to wildlife. Plastic washed from rivers is a choking hazard for turtles, can tangle with jellyfish, and causes seabirds to starve by filling their stomachs (Royte, 2005).

The problem the Mobile community needs to better understand about roadway litter and litter at commercial sites is the runoff factor. Solid surfaces, such as asphalt, concrete, and buildings, prevent water penetration and are widespread in urban areas. The impermeable surfaces of roads and parking lots are designed with storm drain systems to direct the excess water – which hauls litter that is washed from these surfaces – into the creeks that channel into Dog River. Stream Ecologist, Colbert E. Cushing, stated, "Storm drains collect contaminants of diffuse origin and pipe them into rivers and streams," (2001). When the littered water goes down a storm drain, it does not go to a treatment plans to get filtered, as many people may believe (Coleman, 1999). It is flushed directly to the river.

The results from "Litter in America" can be applied to the city of Mobile. The sub-watersheds within the Dog River Watershed which are the most susceptible to litter can be identified using GIS applications. The research, in conjunction with eye-witness accounts from Dog River residents and kayakers, will prove the origins of floating plastic litter from the city.

Research Question

Knowing the factors that contribute to litter quantity can help locate the most problematic areas. What is the distribution of litter potential among the four largest sub-watersheds within the Dog River Watershed? Identifying the problem is the first step towards finding a solution for community awareness, prevention, and clean up efforts.

Methods

The study area is of the Dog River Watershed, but delineated into the aforementioned sub-watersheds. Data layers associated with the area were accessed through the University of South Alabama's GIS server. I added the layers watersheds, waterbody, stream, parking, and roads. From the City of Mobile website, I downloaded and added the layers land use, and block groups 2010.

The watersheds layer showed the entire southwestern corner of Alabama, so it had to be narrowed. I selected by attributes that the name field equals Dog River, and exported this data as a new layer named DR_watershed (watershed). Then the watershed layer needed to be divided into sub-watersheds. I added a new field and named it sub_wtrshd. Then I selected by attributes from the mod-basin field, and used the field calculator to populate the new field with the appropriate sub-watershed names for the four main sub-watersheds, which are Eslava, Moore, Halls Mill, and Rabbit. The portion of the watershed surrounding the river was field calculated as Dog River in the sub-wtrshd field. I used the dissolve tool and input watershed with sub_wtrshd field to aggregate the features based on the specified attribute. After that, I was able to create four new layers – one for each sub-watershed.

I determined the amount of area covered by roads and parking lots. The parking and roads layers were clipped to match the extent of the watershed layer. Then a 22 feet buffer was added to the roads, because one lane on a street road averages 11 feet. The merge tool was used to create a single shapfile for roads and parking lots combined. The new shapefile was clipped to each of the four sub-watershed layers. Then, I was able to run the statistics on the shape_area field to determine the sum of all the square footage of area covered by parking lots and roads for the four sub-watersheds.

I turned the sums into percentages to make an equal comparison, since the sub-watersheds vary in size. This was done by creating a new field in the dissolved watershed layer for area. I calculated the geometry for each sub-watershed in the area field. The area of roads and parking lots was divided by the area of the sub-watershed and multiplied by 100 for each sub-watershed (See Figure).

I found out the age distribution of the Dog River Watershed with 2010 Census data and the block groups layer. I obtained a table of age and sex Census data from my GIS instructor, Mr. Sam Stutsman. After the block groups layer was clipped to the watershed, I joined the attributes of the Census table. Three new fields were added; age 30 and over, age under 30, and percent under 30. The fields were calculated using information from the table. Finally, I rasterized the block groups polygon based on the value field percent under 30 (See Figure).

I mapped restaurants and convenience stores using the land use layer. The land use layer was clipped to the watershed. I selected by the attribute for the land use (LU) codes for convenience stores. The LU code values are 401, 413, 4011, and 4012. The selection was exported as a new layer for convenience stores. Then, I selected attributes of restaurants with LU

code values 421 through 425. The selection was exported as a new layer for restaurants. I did a select by location in each sub-watershed layer and checked convenience stores and restaurants to get a total. For a true comparison among the sub-watersheds, I converted the sum into a number per square mile (See Table).

I also established the area within 50 square feet of commercial site clusters of more than 100 businesses with the land use layer. I selected by the LU code attribute for commercial buildings. The LU code values are all of the 400's, 500's, 600's, and 4000's. Then, I created a commercial point density with a 50' by 50' cellsize. I used the single output map algebra tool to select all values of point densities greater than 100. To finish, I converted the output raster to points to calculate the area so I could find the percentages.

Results

Eslava and Moore sub-watersheds had the largest percentages of area covered by roads and parking lots, whereas Halls Mill and Rabbit had the smallest. The Eslava sub-watershed has 62,615,219 square feet of roads and parking lots covering an area of 320,387,960.83 square feet, which means 19.5% of the area is covered by either a road or a parking lot. Moore sub-watershed has 58,898,472 square feet of roads and parking lots covering an area of 440,807,531.67 square feet for a total of 13.4%. Halls Mill sub-watershed has 65,149,428 square feet of roads and parking lots covering an area of 902,932,757.13 square feet for a total of 7.2%. Rabbit sub-watershed has 32,787,537 square feet of roads and parking lots covering an area of 463,788,359.70 for a total of 7.1% (Fig.3).

The age distribution shows the largest percentages of people under age 30 in the Eslava and Moore sub-watersheds, with a few outliers near the extent of each sub-watershed. There is a large fetch of low values in the middle to lower portion of the Halls Mill sub-watershed, and the average age tends to decrease heading north. Rabbit Sub-watershed appears to have a random age distribution with the youngest average furthest west (Fig.4).
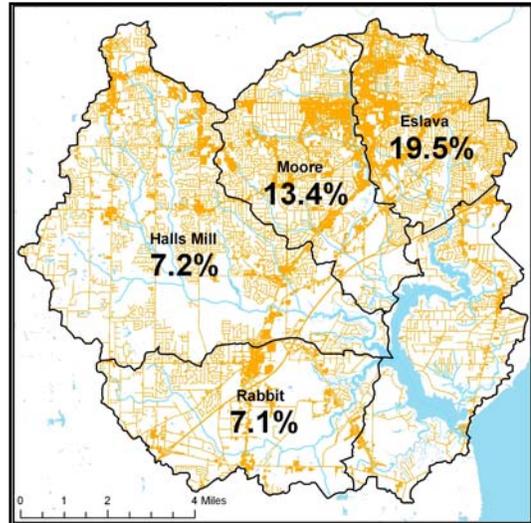

Figure 3 Area covered by roads and parking lots.

The number of restaurants and convenience stores per square mile, again, shows that the Eslava sub-watershed has the highest percentage, leading around to the smallest percentage in the Rabbit sub-watershed. The number of restaurants and convenience stores is important, because these locations are two of the easiest places to purchase plastic or Styrofoam to-go containers, which, when
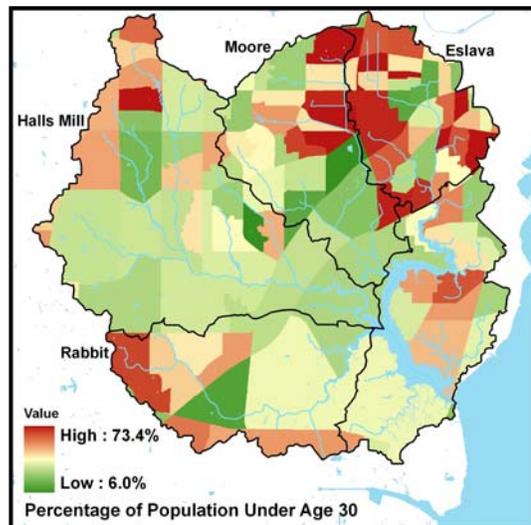

Figure 4 Age distribution by 2012 Census block groups.

littered, are likely to end up floating in Dog River. The count and allocation of the business types for each sub-watershed is described as follows: Eslava has 92 restaurants and 37 convenience stores, which averages 11.2 per square mile; Moore has 97 restaurants and 23 convenience stores, which averages 7.6 per square mile; Halls Mill has 103 restaurants and 16 convenience

stores, which averages 3.7 per square mile; and

Rabbit has 42 restaurants and 27 convenience stores,

which averages 4.2 per square mile (Fig. 5).

Figure 5 Number of restaurants and convenience stores per square mile.

The area within 50 square feet of commercial

densities follows a similar trend. Eslava has

168,667,500 out of 320,387,960.83 square feet, or

52.6% of the area, which is within 50 square feet of a

commercial site cluster of more than 100 sites. I

chose the value of 100 or more commercial sites as the determining factor of a significant cluster

of commercial sites, because the more heavily trafficked sites will have a greater potential for

accumulating litter. Moore has 126,750,000 out of 440,807,531.67 square feet, or 28.8% of the

area near significant commercial clusters. Halls Mill has 96,810,000 out of 902,932,757.13

square feet, or 10.7% of the area near commercial

clusters. Lastly, Rabbit has 19,872,500 out of

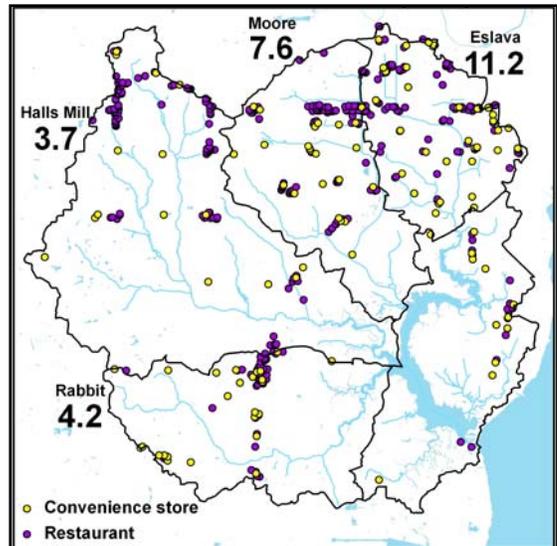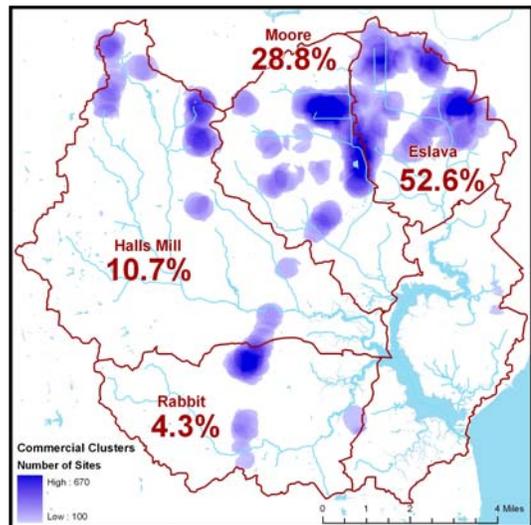463,788,359.7, or 4.3% or the area near commercial

clusters (Fig.6).

Figure 6 Area within 50 square feet of significant commercial site clusters.

Conclusion

Based upon the variables that were researched, the Eslava sub-watershed has the greatest litter potential of the four main sub-watersheds within the Dog River Watershed. More than half of Eslava is in close proximity to significant clusters of commercial sites, nearly one-fifth of Eslava is covered by a road or parking lot, and there are a minimum of 11.2 places per square mile to obtain plastic trash. These results means that more trash is littered around Eslava's heavily trafficked areas – by motorist or pediestrian – than any other sub-watershed. Plus Eslava's litter has the greatest potential from being washed from the roads and lots into storm drains, which lead to Dog River. A significant concentration of people under age 30 means that younger people tend less to care about their environment; therefore they will litter more than more mature and older people, who seem to uphold a sense of ownership.

The Moore sub-watershed comes in a not-so-distant second place for prospective litter issues. I expected Moore to pose a litter problem, because this region is home to many shopping centers and restaurants. This area has rapidly developed in recent years as Mobile grew westward. With more development, the numbers for Moore would likely trend towards those of Eslava.

With numbers akin to one another, the Halls Mill and the Rabbit sub-watersheds show the least litter potential. These areas are less developed, therefore less populated. Less people mean that the Halls Mill and the Rabbit sub-watersheds will be less bothered by littering behavior and its nasty and lasting effects.

Littering is a despicable and lazy behavior, and although some people will not stop littering, a plan can be created to minimize the amount of litter from flowing into Dog River. The

project results identify Eslava and Moore as the sub-watersheds to target for anti-litter campaigns, and as the most likely places in which law enforcement officers could fine someone for the act of littering. Placing a litter trap – which is a strategically-placed floating device designed to accumulate floating litter – on Eslava Creek is an attainable solution to reduce the laborious attempts needed to clean up the problem (Bandalong.com).The results are useful in cleaning efforts and raising awareness over our cause to prevent our river from contamination. The League of Women Voters Education Fund are quoted, "It is our belief that increased public awareness about the growing problems caused by plastic debris, and cooperation among all groups that contribute to this problem, will result in practical solutions and cleaner waters," (League, 1993). All citizens alike – from volunteers to city leaders – can work together for the sake of the community to protect Mobile's Dog River Watershed from the unhealthy and negative effects of litter.

Discussion

Future research could focus more on the age variable. This aspect of my research was limited by the time that would be necessary to make the Census data accurately match the borders of each sub-watershed. This is why my project does not have solid numbers to show for the age distribution, and I was only able to express generalizations about the age variable.

Works Cited

Bandalong International. (2009). Retrieved March 4, 2012, from
>http://www.bandalong.com.au/products-and-services/bandalong-litter-trap/

Beck, G. G. (1999). *Watersheds: A practical handbook for healthy water*. Ontario, Canada:
>Firefly Books.

Coleman, J. W., & Cressey, D. R. (1999). *Social problems* (7th ed.). New York: Addison-Wesley.

Cushing, C.E., & Allan, J. D. (2001). *Streams: Their ecology and life*. San Diego, CA: Academic
>Press.

Dog River Clearwater Revival. Retrieved March 4, 2012, from
>http://www.dogriver.org/purpose.hrml

Keep America Beautiful. Retrieved March 4, 2012, from
>http://www.kap.org/site/PageServer?pagename=Focus_litter_prevention

Porro, J. D. (1993). *Plastic waster primer: A handbook for citizens*. New York: Lyons &
>Burford.

Royte E. (2005). *Garbage land: On the secret trail of trash*. New York: Little, Brown &
>Company