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Team Marine Trio from Santa Monica High School Wins First Place at LA County Science Fair

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This past Saturday, SaMoHi Team Marine members Martin Liu, Kimberly Fuentes, and Zoe Parcells were awarded first place out of 16 teams in the Environmental Management category at the Los Angeles County Science Fair and will now advance to the state fair. Their project titled, *Cigarette Pollution and Mitigation in Santa Monica, CA*, examined short-term ($\leq$ 7 days) and longer term ($\leq$ 2 months) cigarette accumulation rates for seven urban streets over a one year period. Their study also included two beach collections of cigarettes from in front of the Pico-Kenter Storm Drain following the first rain storms of the season. Cigarette counts from street and beach collections totaled 20,119 and 20,580 cigarettes, respectively, suggesting significant storm drain transport of cigarettes to the beach and warranting expansion of Santa Monica's cigarette pollution prevention measures.

Following a scientific protocol called a 2 m belt transect, students mapped, counted, and collected all cigarette butts along the street-sidewalk interface - one meter either side of the curb - for 4-6 blocks per street depending on the street. Each street (Wilshire*, Arizona, Santa Monica, Broadway, Colorado, 3rd Street Promenade, and Montana) was surveyed at one week intervals for four weeks during all four seasons (spring, summer, fall, and winter) with approximately two months separation time between seasons. In total, students conducted 112 surveys/collections for the street study. For the beach study, a combined 70 students worked for a total of three hours collecting cigarettes from the storm drain mouth and beach intertidal zone on November 21 and December 5, 2014 following the first and second major storms of the rainy season.

The street study revealed that Broadway, followed by Santa Monica Blvd., had the greatest short-term accumulations of cigarettes, possibly owed to higher foot traffic as corridors to the 3rd St. Promenade, SM Place, and SM Pier (Fig. 1). A longer term accumulation effect was not readily noticeable, suggesting the city's current anti-pollution measures prevent cigarette buildup over time. Spring, followed by summer, had the highest short-term cigarette accumulations, likely due to optimal weather for city goers and visitors (Fig. 2). Within streets, 25 "cigarette hotspots" (defined as $\geq$ 25 cig. per 10 m^2) were identified, most of them on Montana Ave., followed by Broadway, with the record on Montana containing 117 cig. per 10 m^2 (Table 1). Surprisingly, hotspots showed little consistency in location over one week and two month time scales (Fig. 3), suggesting that the strategic deployment of cigarette receptacles (a.k.a., "ashcans") will not sufficiently fix the issue. More cigarette pollution was found on streets (69%) compared to the adjacent areas of sidewalk (31%), likely a result of wind, runoff, gravity, broom sweeping by businesses (personal observation), and littering behavior of pedestrians and drivers. Prevalence at street level likely facilitates easier entry into catch basins and passage to the beach. The vast majority of cigarettes recovered during the beach study were found sequestered in clumps of seaweed and organic debris lying along the damp sandy banks of the storm drain mouth and along the adjacent upper intertidal zone. That relatively few cigarettes were found on the dry sandy beach was expected given previous student research showing low cigarette abundance there[1] and SM's law prohibiting beach smoking[2]. Moreover, given the Pico-Kenter Storm

Drain's outflow history during the first flush (e.g., [3]), storm drain transport of cigarettes is the only reasonable explanation for the vast quantity of cigarettes recovered from the search area.

Options for mitigating the human health, environmental, and economic impacts of cigarette pollution include warning labels on cigarette packaging, restricting smoking in public areas (e.g., restaurants, shopping malls, beaches, all city streets), public education, beach/tractor clean ups, littering fines, collection screens inside curbside catch basins, installation of cigarette disposal receptacles ("ashcans") in high foot traffic areas, and the employment of street sweeping vehicles and ground maintenance "broom crews." While broom crews were spotted on occasion during surveys and while the city performs nightly street sweeping and has no-smoking signs on the 3rd St Promenade, public education, litter enforcement laws, and ashcans appear to be lacking or completely absent. There is also question as to the presence and/or effectiveness of current capture screens inside catch basins. Furthermore, smaller plastics, including cigarette butts are often missed by beach tractors that comb for larger items (personal observation), and the tractors are not used in the upper intertidal zone where students found the most cigarettes. Given students collected more cigarettes from one beach location (20,580) than thousands of volunteers did on Coastal Clean Up Day 2013 across multiple sites in Los Angeles County (18,308[4]) suggests that the multiple measures being used by the City of Santa Monica are very limited in preventing a toxic and persistent pollutant from accumulating in storm drains and being delivered into the ocean. Based on these data, we strongly recommend the SM City Council expand its smoking restrictions to include all public places as has recently been done by the City of Manhattan Beach[5]. Stricter law enforcement and steeper littering penalties may also prove fruitful.

1. http://www.teammarine.org/wp-content/uploads/2013/08/Splash-Into-Science-Cigarette-Study_press-release-2013.pdf
2. http://www.smgov.net/Content.aspx?id=3869
3. http://www.teammarine.org/wp-content/uploads/2012/03/Pico-Kenter-Storm-Drain-Plastic-Pollution_09-101.pdf
4. http://www.latimes.com/local/la-me-g-snapshot-beach-trash-20141117-htmlstory.html
5. http://www.ci.manhattan-beach.ca.us/city-services/public-works/going-green/breathe-free-mb-smoke-free-public-areas
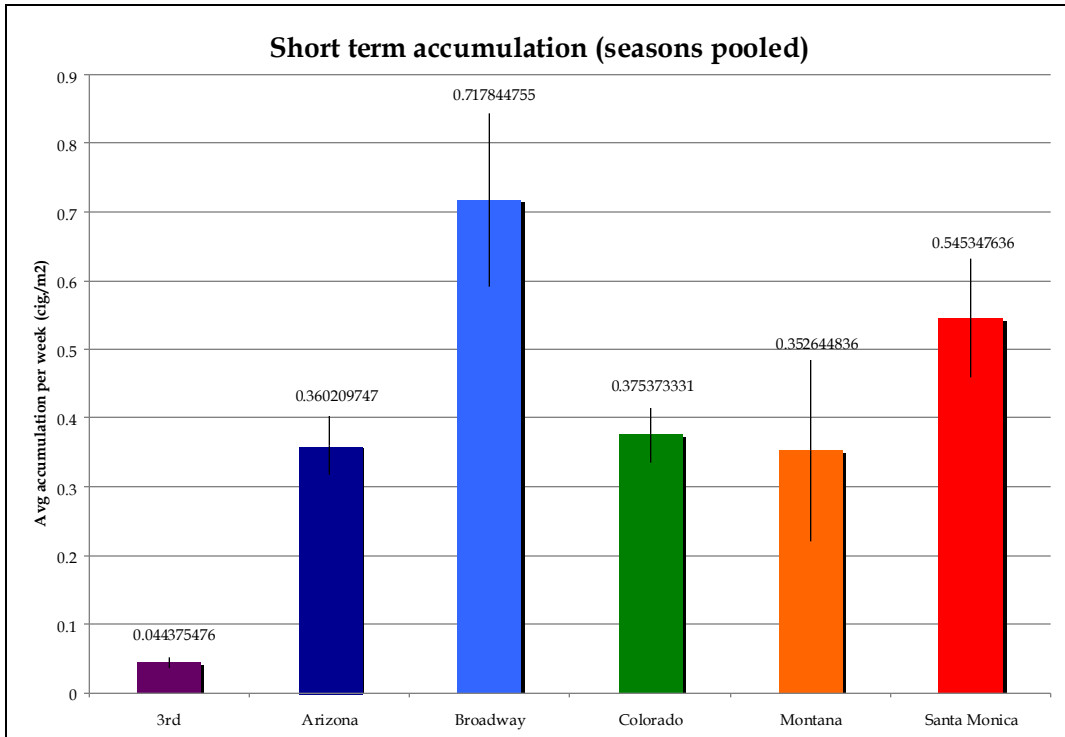
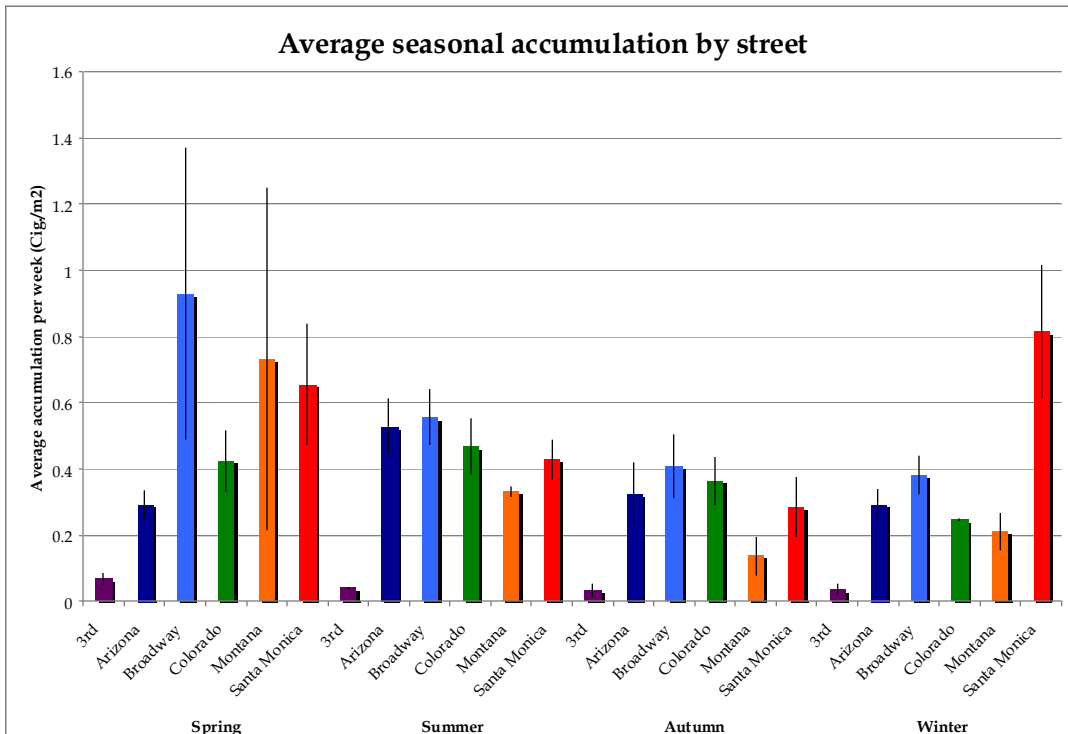Figure 1. Average short-term cigarette accumulation by street. Average taken from weeks 2, 3, and 4 only.

Figure 2. Average short-term accumulation by season and street. Average taken from weeks 2, 3, and 4 only.

Table 1. Ranking of high cigarette concentration areas or "hotspots" by season, week, street, block and side of street.

Hotspot Ranking	Season	Week	Street	Block	Side	Latitude	Longitude	Abundance
1	Spring	4	Montana	1	N	34° 1'50.18"N	118°29'50.31"W	117
2	Spring	4	Montana	2	N	34° 1'53.03"N	118°29'46.91"W	75
3	Spring	4	Montana	6	S	34° 2'1.83"N	118°29'35.02"W	70
4	Spring	4	Montana	3	N	34° 1'55.88"N	118°29'43.31"W	68
5	Spring	4	Montana	5	S	34° 1'58.99"N	118°29'38.54"W	67
6	Spring	4	Montana	4	N	34° 1'57.64"N	118°29'41.18"W	63
7	Spring	4	Montana	4	S	34° 1'55.98"N	118°29'42.04"W	62
8	Spring	4	Montana	5	N	34° 2'0.47"N	118°29'37.68"W	53
9	Spring	4	Montana	6	N	34° 2'2.94"N	118°29'34.60"W	50
10	Spring	3	Santa Monica	4	N	34° 0'59.76"N	118°29'42.26"W	47
11	Spring	2	Broadway	2	N	34° 0'50.66"N	118°29'41.86"W	42
12	Spring	2	Broadway	4	S	34° 0'55.21"N	118°29'35.48"W	40
13	Summer	4	Arizona	2	S	34° 1'0.64"N	118°29'51.90"W	38
14	Spring	4	Montana	3	N	34° 1'54.63"N	118°29'44.90"W	36
15	Spring	4	Montana	4	N	34° 1'57.45"N	118°29'41.41"W	33
16	Spring	2	Santa Monica	4	N	34° 0'59.76"N	118°29'42.26"W	33
17	Spring	2	Broadway	1	N	34° 0'47.67"N	118°29'45.62"W	32
18	Spring	4	Montana	5	N	34° 2'0.47"N	118°29'37.68"W	31
19	Spring	2	Broadway	2	N	34° 0'49.84"N	118°29'42.87"W	30
19	Spring	4	Montana	6	N	34° 2'3.92"N	118°29'33.36"W	30
21	Summer	3	Broadway	2	N	34° 0'50.62"N	118°29'41.86"W	29
22	Spring	3	Broadway	2	N	34° 0'50.35"N	118°29'42.22"W	28
23	Spring	2	Broadway	1	N	34° 0'46.76"N	118°29'46.68"W	27
23	Summer	4	Broadway	3	N	34° 0'53.08"N	118°29'38.94"W	27
24	Autumn	4	Montana	2	N	34° 1'50.96"N	118°29'49.36"W	26
25	Summer	1	Arizona	2	S	34° 1'0.46"N	118°29'52.11"W	25

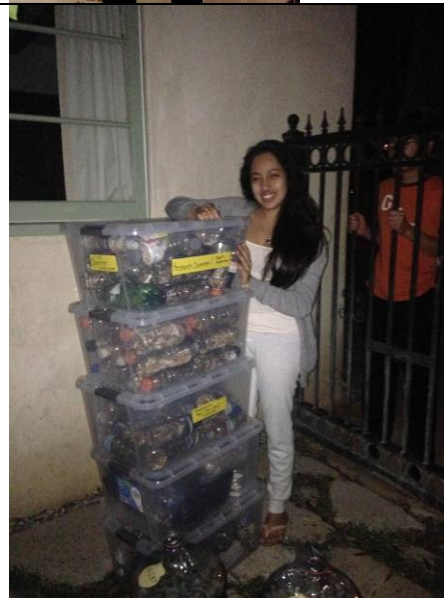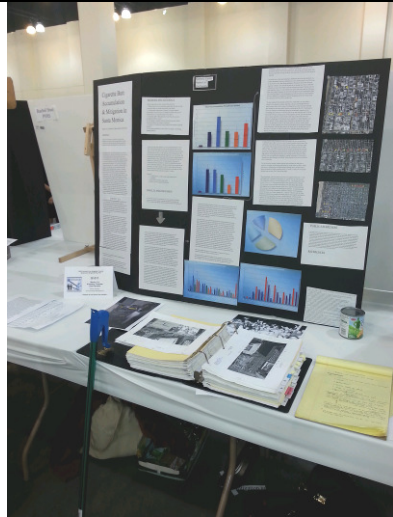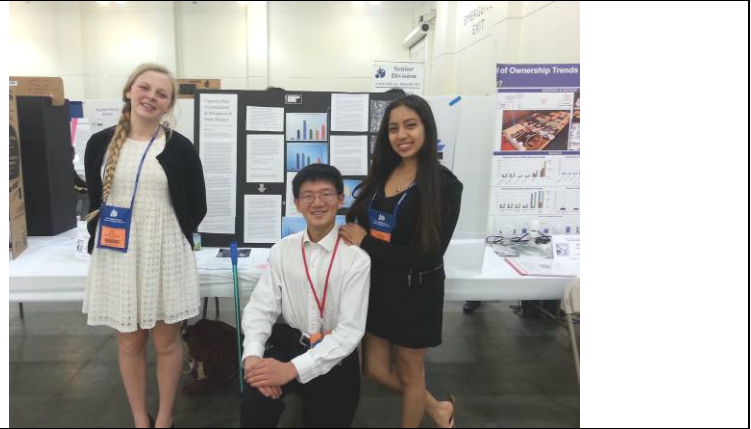Figure 3. Google Earth map showing cigarette hotspots.

Photos