Floating an international problem to local officials: the story of the booms, the blocks, and the bags

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1. Project Goals: To quantify the amount and types of plastic that are washed out of Hilo, Hawai'i, and to simulate the fate of that plastic in the ocean. To assess potential sources of plastic that reach nearby debris accumulation areas, such at Kamilo Point, where the Hawai'i Wildlife Fund removes ~16 metric tons of plastic debris a year.

2. Approach:

• Install and monitor floating debris-retention booms below two storm water outlets in Hilo, Hawai'i Island's urban center (population 43,263).

• Collect, weigh, and classify retained debris, and relate the timing of debris flow to precipitation events.

• Release wooden drift blocks stamped with contact information in Hilo Bay and at other locations to simulate debris fate once in the ocean.

Debris-retention Boom #1

Debris-retention Boom #2 and typical debris

3. Methods:

• Boom #1 spanned a 25 m storm water channel that drained a mostly residential area. Boom #2 spanned an 8 m channel that drained portions of downtown Hilo. Booms extended approximately 0.3 m above and below the waterline.

• Booms were inspected for debris weekly to semiweekly from mid-September 2011 through early January 2012.

• All debris was rinsed, dried, classified, counted and weighed.

• Rainfall data were collected from the National Weather Service.

• 1547 red wooden blocks (7 x 7 x 3 cm) were branded with contact information and a number denoting the release location and tide.

• 1142 blocks were released approx. 1 km offshore in four locations, half at low tide and half at high tide, the week of Oct. 24th, 2011. A second set of 405 were released from Hilo Bay on March 23rd, 2012.

Sample drift blocks

A recovery on uninhabited Kaho'olawe Island

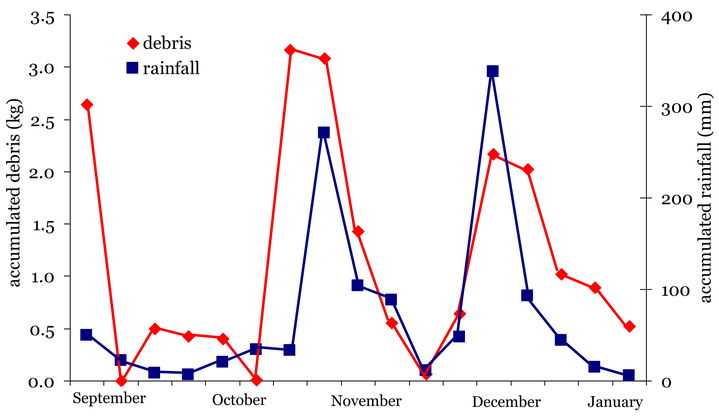

Figure 1: The accumulation of debris behind two retention booms compared to rainfall in Hilo, HI.

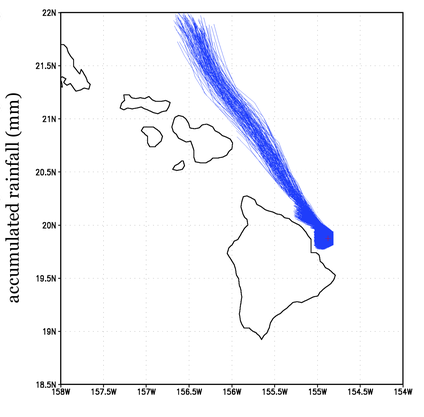

Figure 2: Predicted trajectory of drifters in the two weeks after October release from Hilo Bay, according to the University of Hawai'i Surface Currents from Diagnostic Model (SCUD)

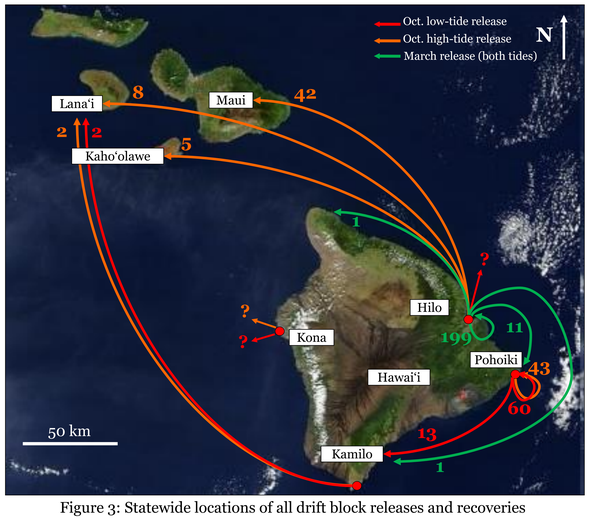

Figure 3: Statewide locations of all drift block releases and recoveries

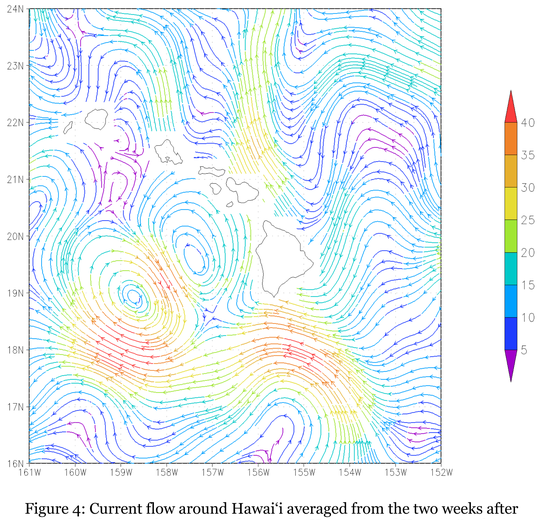

Figure 4: Current flow around Hawai'i averaged from the two weeks after October drifter release, according to the University of Hawai'i Surface Currents from Diagnostic Model (SCUD). Color scale is in cm/ s.

release		total recovered	Hawai'i Island		Maui	Lana'i	Kaho'olawe
location	tide		local	distant			
Hilo Bay 1	low	0.0%					
	high	24.3%			18.6%	3.5%	2.2%
Hilo Bay 2	low	51.5%	51.5%				
	high	53.2%	46.8%	6.3%			
Pohoiki (East Point)	low	60.3%	49.6%	10.7%			
	high	37.4%	37.4%				
Kaulana (South Point)	low	1.7%				1.7%	
	high	1.7%				1.7%	
Kailua-Kona	low	0.0%					
	high	0.0%					

Table 1: Recovery rates of 1,142 wooden drift blocks released around Hawai'i Island

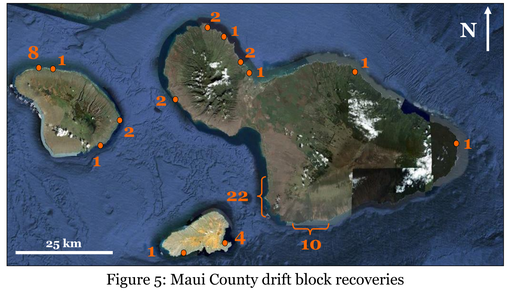

Figure 5: Maui County drift block recoveries

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4. Results - Debris-retention Booms:

• The booms captured ~20 kg of synthetic debris in 120 days, 76% of which was plastic. Items included 917 cigarettes / butts, 125 bottles, 116 plastic bags, 22 cups, and various footwear.

• The amount of debris recovered was positively correlated to the total accumulated rainfall between samplings (r^2=0.33, p=.015).

• During high flow, we observed low-buoyancy items (e.g., plastic bags) were not retained, while high-buoyancy items (e.g., plastic bottles) were retained by the booms.

• The two storm water channels drain approximately 7% of Hilo's land area, and 25% of the heavily urbanized portion.

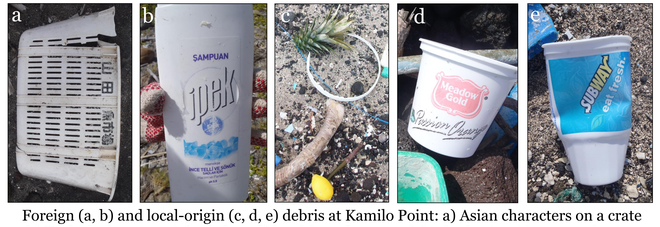
• Boom #1 captured 56% less debris than Boom #2 despite its larger channel width and watershed, perhaps because the #2 Boom drainage contains more commercial land area downtown.

5. Results - Drift Blocks:

• Hilo Bay blocks landed locally, at three other distant parts of the island (including Kamilo, the island's debris accumulation beach), and on three other islands.

• Drift speeds to 1st recoveries on Maui and Lana'i were between 20 - 30 cm/s, which agreed with SCUD model estimates.

• South Point blocks were first recovered on Lana'i after 51 days, which at 20 - 30 cm/s roughly corresponds to one lap around the eddy behind Hawai'i Island before beaching.



Foreign (a, b) and local-origin (c, d, e) debris at Kamilo Point: a) Asian characters on a crate b) Turkish shampoo c) fresh fruit d) local-brand yogurt e) fresh plastic without weathering

6. Implications:

• Extrapolated to all of urban Hilo, these results suggest that 230 kg of synthetic debris reach the ocean each year. Not all debris is captured during heavy flow, and intense rains are common in Hilo, so this is likely a large underestimate.

• This debris has the potential to pollute a variety of coastlines and harm wildlife on at least three other islands. Hawai'i Island's position "upstream" of the rest of the state gives its waste management practices increased importance.

• Students presented these results to city council members considering a ban on single-use plastic bags. At the time Maui County had a ban, but our results showed that bags and other debris from Hawai'i could affect wildlife and humans there. The ban was eventually passed. The whole story is really much better as a presentation, but thanks for reading this poster!