City of Monterey

VIA FIRST CLASS MAIL

September 18, 2007

Secretary A.G. Kawamura
CDFA Executive Office
1220 N Street, Room A-400
Sacramento, CA 95814

Dear Secretary Kawamura:

I am writing to you as the Vice-Mayor of Monterey, and also as a Ph.D. scientist with over a decade of experience studying and modeling "hydrometeors" (eg. clouds, rain, fog, any kind of particle in the atmosphere). I want to clarify that I am not writing to you on behalf of the rest of our City Council.

I have some serious reservations about the CDFA "drift analysis" used in conjunction with the recent aerial spraying of "Checkmate" over the Monterey Peninsula. I have enclosed a short critique that I hope you will respond to well in advance of any future spraying. I have published many peer-reviewed articles in meteorological journals, and I believe my drift analysis would hold up under the scrutiny of the atmospheric science community.

In addition, I request copies of all "Spray Drift Management Records" related to the aerial spraying of "Checkmate" on September 9, 10, 11, 12, 13, 2007 over the Monterey Peninsula by the CDFA.

Sincerely,

Jeff Haferman
Vice-Mayor

Cc: Mayor and City Council
MBNMS Main Office

Comment on CDFA Buffer Zone Calculation for Aerial Spraying of OLR-F and LBAM-F on the Monterey Peninsula[1]

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Background

The buffer zone calculation used by the CDFA for the aerial spraying of the synthetic pheromones OLR-F and LBAM-F on the Monterey Peninsula assumes a nominal dropsize diameter of 500 microns. The settling velocity used by the CDFA for this dropsize is 1475 feet per minute. The CDFA has computed various buffer zones based on this settling velocity.

We have two concerns with the CDFA analysis: (i) the settling velocity for the stated particle size is clearly much too large, and therefore, the necessary buffer zone has been severely underestimated; (ii) the CDFA buffer zone computation assumes a monodispersion of particles, and therefore does not accurately account for the complete distribution of particle sizes.

Analysis

After communicating with CDFA officials, we learned that the CDFA drift analysis was based on Chapter 3 of Sumner (2005). In Table 4 of Sumner (2005), "Droplet Settling Velocities" are presented for droplet diameters ranging from 10 to 200 microns. In addition, the Table is prefaced with the statement: "The fall rate of a spray droplet is roughly proportional to the square of the droplet's diameter." Thus, we believe the CDFA extrapolated the fall velocity for a 500 micron drop using the settling velocity given by Sumner for a 200 micron drop, stated as 231 ft per minute. We think the CDFA thus assumed the droplet would fall $(500/200)^2 = 6.25$ times faster than a 200 micron drop, or 1443.75 feet per minute (according to the CDFA, the actual number they used was 1475 feet per minute).

However, the fall velocity used by the CDFA is much too large for a 500 micron droplet. As noted by several researchers, notably Beard (1976) and Hermans (2006), for particles from about 20 to 100 microns in diameter, the fall rate is indeed roughly proportional to the square of the droplet's diameter. But, for larger droplet diameters, it is necessary to use empirical formulas to determine the droplet terminal velocity (beyond a diameter of approximately 5000 microns, droplets will break apart due to surface tension).

There are a number of published sources for dropsize terminal velocity, for example Ahrens (1994), Gunn and Kinzer (1949), Beard (1976), and Waldteufel (1973). Based on some of these sources, we provide, in Table 1, terminal velocities and the corresponding settling times for a range of dropsizes for application heights of 500 and 800 feet. For example, the terminal velocity for a 500 micron drop is 397.5 feet per minute, which is less than one-third the value cited by the CDFA. This translates to settling times that are more than three times larger than the settling times used by the CDFA. In other words, the particles will remain suspended in the atmosphere and are therefore subject to more drift than accounted for by the CDFA.

[1] Disclaimer: We base this commentary upon information that we obtained in discussions with CDFA and USDA officials, and from people answering the phone at Suterra. Assuming that the information we received is accurate, we believe our analysis to be correct.

Table 1: Droplet terminal velocities (ft/min) and corresponding settling times (min). Values for 20 and 100 micron terminal velocities from Ahrens (1994); larger particles from Waldteufel (1973).

diameter (microns)	velocity(ft/min)	500 ft settling time (min)	800 ft settling time (min)
20	1.8	277.78	444.44
100	54.0	9.26	14.81
200	101.3	4.94	7.90
250	154.4	3.24	5.18
500	397.5	1.26	2.01
1000	786.7	0.64	1.02
1500	1075.0	0.47	0.74
2000	1288.6	0.39	0.62
2500	1446.8	0.35	0.55
5000	1798.2	0.28	0.44

In Table 2, we present our buffer zone computations based on the settling times given in Table 1. The buffer zone is given in meters for application heights of 500 and 800 feet, and must be multiplied by the wind speed in miles-per-hour to get the necessary buffer zone. For example, assuming 500 micron particles and a 4 mph cross wind, the buffer zone for a 500 foot application height would be 136 meters. A buffer zone of 40 meters was computed by the CDFA for this scenario, though we were told by CDFA that they would provide "…a buffer zone that is two and a half times what is necessary…"[2] during the aerial application. Nevertheless, based on our computations, it appears that the buffer zone used by the CDFA is inadequate.

As an example, on September 11, 2007, the near-ground-level wind speed reported at the Monterey airport at approximately 11:00 p.m. was 8.1 mph from the southwest. Aerial spraying operations were being conducted at that time by CDFA over the Monterey Peninsula. Using the numbers in Table 2, the spray would have drifted over 400 meters (about a quarter-of-a-mile) to the northeast assuming an application height of 800 feet.

Table 2: Buffer zone (meters) per mile-per-hour of wind for various size particles at application heights of 500 feet and 800 feet.

diameter (micron)	buffer (meters) per mph wind 500 foot altitude	buffer (meters) per mph wind 800 foot altitude
200	132	212
250	87	139
500	34	54
1000	17	27
1500	12	20
2000	10	17
2500	9	15
5000	7	12

[2] Letter from CDFA to MBNMS dated 9/7/2007.

The previous example assumes that the particles from the aerial spray are monodisperse (i.e. they all have the same size). In reality, the spray will be polydisperse (i.e. will contain droplets with a range of sizes). Some of the drops will be very small and will remain suspended much longer (and therefore drift further) than their larger counterparts. As noted by Sumner (2005), the spray droplet size is dependent on many factors, such as: nozzle type, orifice diameter, spray angle, nozzle angle, travel speed, spray pressure, and other "operational parameters". There is anecdotal evidence[3] that the average-sized particle may have even been smaller than the nominal 500 micron size cited by the CDFA, so a complete description of the dropsize distribution is very important for putting together an accurate drift model.

Conclusions

The CDFA represented that there would be no discharge of OLR-F / LBAM-F into the Monterey Bay National Marine Sanctuary. However, based on information that we obtained from CDFA, USDA, and Suterra, it appears that the CDFA analysis may be spurious. Because the USDA (2007) "Environmental Assessment" on p. 8 suggests that these synthetic pheromones may be toxic to marine invertebrates in the upper ppb range, we recommend that the CDFA re-visit their drift analysis prior to conducting any further aerial spraying operations. We also encourage the CDFA to empirically validate their drift analysis.

References

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[3] [CDFA Secretary] "Kawamura stated that he felt no mist or dampness after the plane passed over several times." (Monterey County Herald, September 10, 2007, p. A1, "Planes apply first round of moth spray in Seaside.")