Calibrating a helicopter long-line sprayer treating incipient gorse patches in Humuula, Big Island

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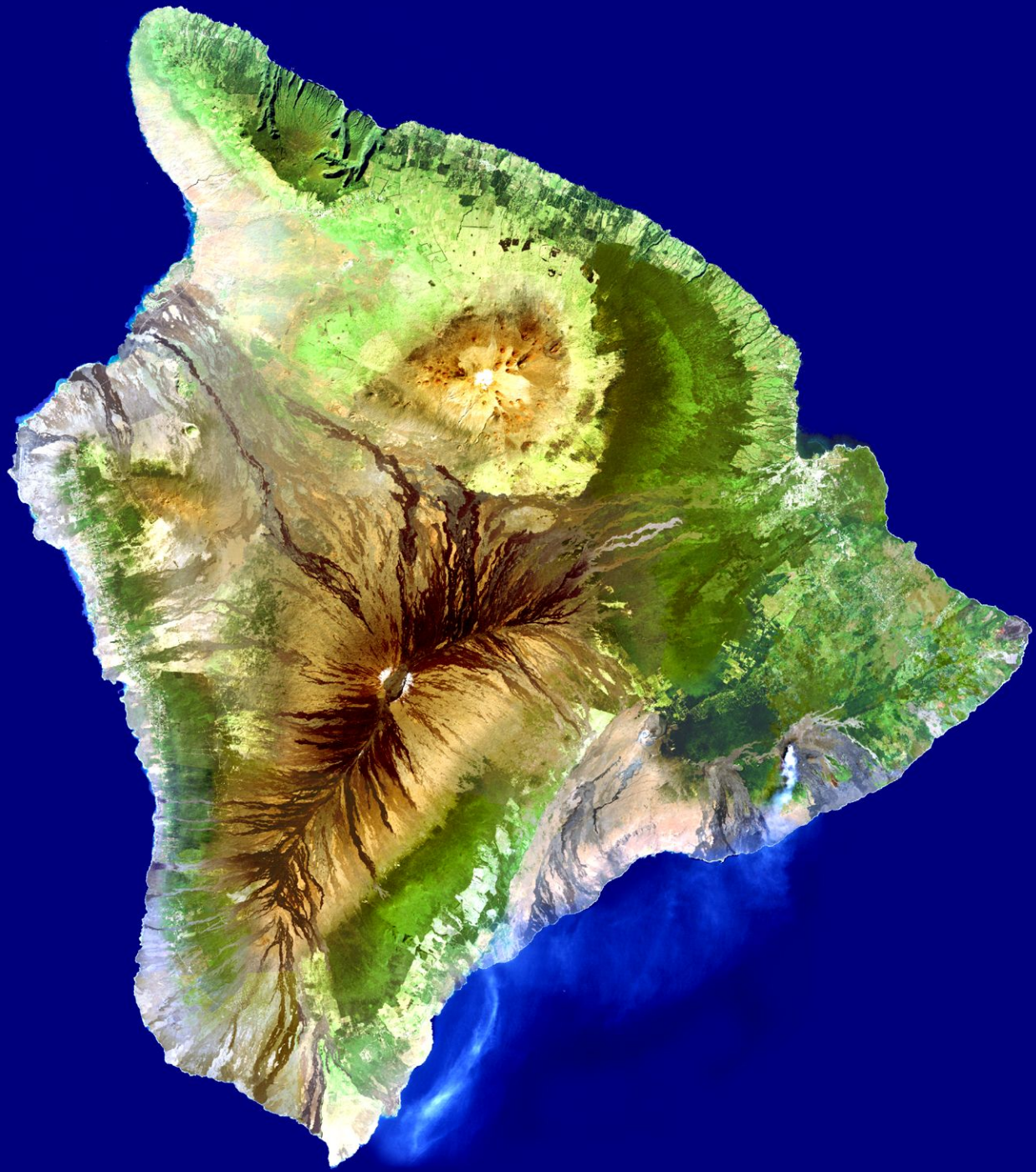
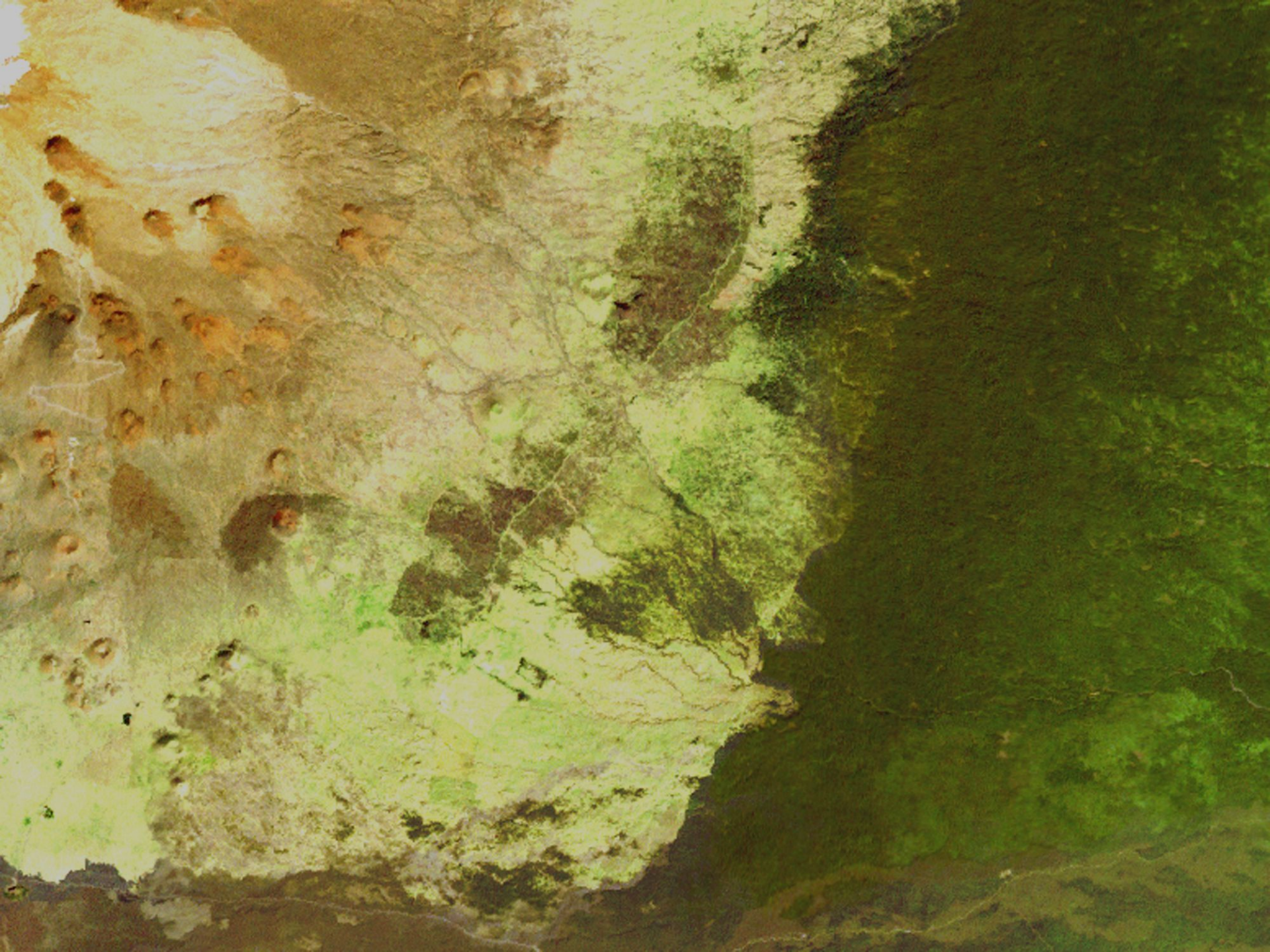
Ulex europaeus


Root nodules

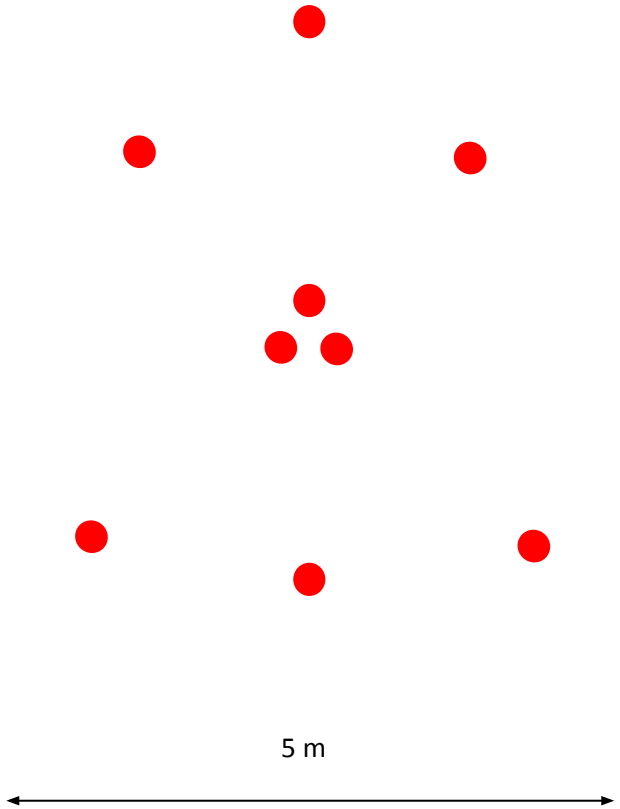

East facing slope of Mauna Kea >2000 m asl


Wailuku River headstream



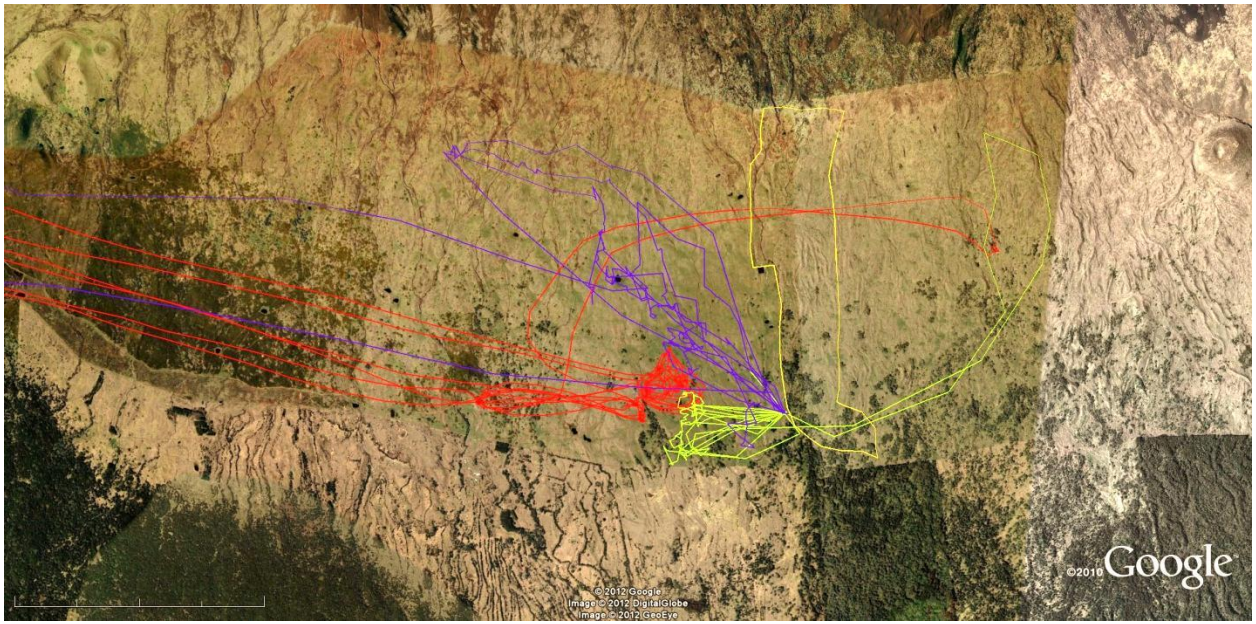


Aerial Long-line sprayer targeting incipient patches expanding beyond the perimeter infestation



The long-line spray assembly: 25 gal tank with 100 ft x 3/8 in. hose tethered to the under carriage of the helicopter. Distal nozzle assembly with three SJ3-06 vp solid stream nozzles (TeeJet Inc., Wheaton, IL) spaced 12 in. apart in a triangle and rotated 120^{o} from each other. Each nozzle had three orifices to create a (C) directed spray pattern with a total of nine treatment points evenly distributed across a 5 m diameter with the spray.

Flight surveillance tracks and (B) treated gorse patches for operations conducted in December 2011 (purple), January 2012 (green) and February 2012 (red).



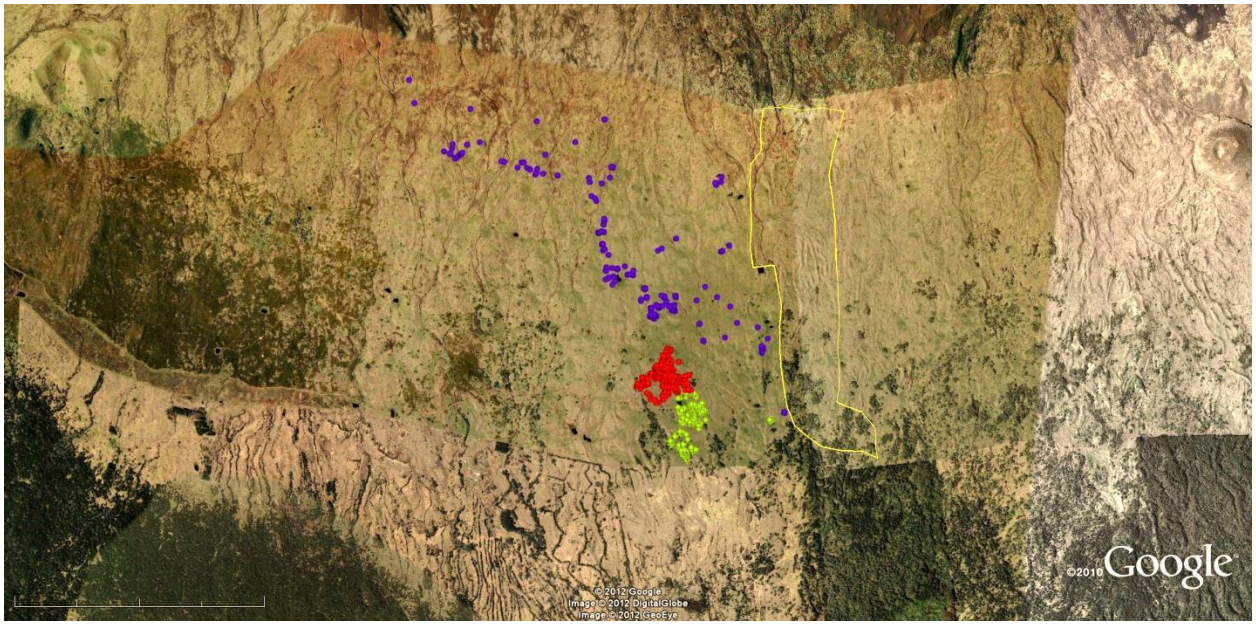
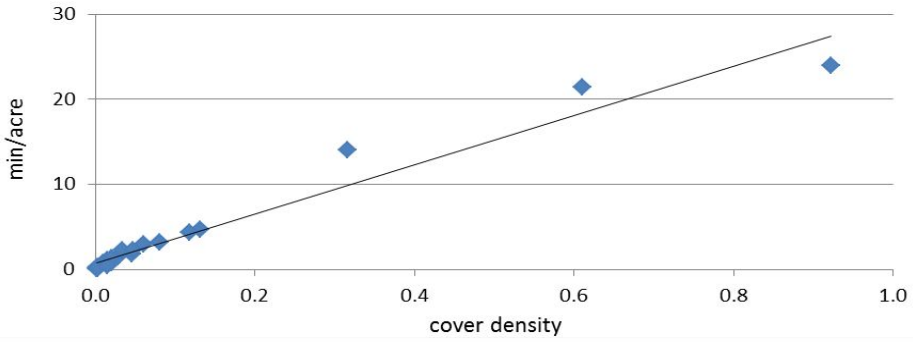


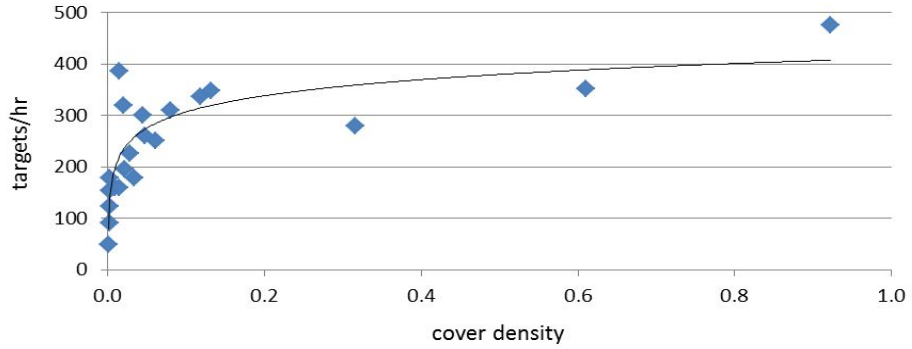
Table 1. Empirical parameters of sprayball operations treating satellite Gorse (Ulex europaeus) populations with 24 gallon herbicide batches (see methods for formulations)

	operation	targets	time (min)	distance (ft)
Dec 2011	1	29	35	20,807
	2	18	12	6,482
	3	60	12	2,673
	4	74	25	18,541
	5	69	27	19,995
	6	93	35	9,284
	7	112	21	6,495
	8	34	9	3,582
	9	66	25	7,733
	10	41	20	14,356
Jan 2012	11	65	14	1,339
	12	88	15	1,193
	13	81	14	2,946
	14	88	21	3,775
	15	95	12	1,098
Feb 2012	16	59	20	4,795
	17	56	17	4,304
	18	79	12	4,394
	19	63	15	3,436
	20	63	12	2,713
	21	97	17	3,781

Operational measures of efficiency



Search effort (min/acre) versus cover density for directed long-line treatment operations (n=21) conducted from December 2011 - October 2012.



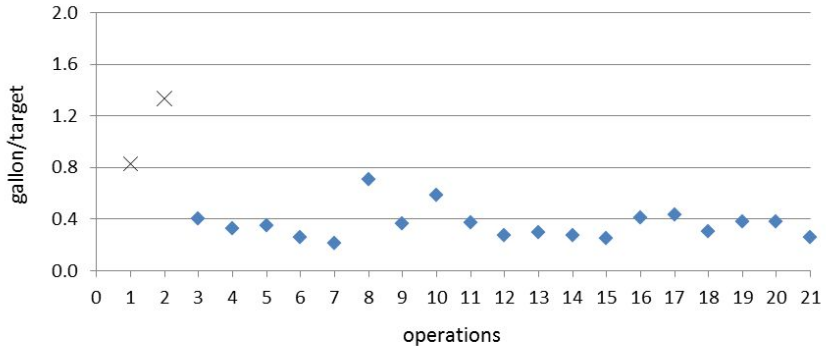
Patch treatment rate (targets/acre) versus cover density for directed long-line treatment operations (n=21) conducted from December 2011 - October 2012.

Simple regression coefficients as performance analytics for surveillance efficiency, target acquisition rate and operational cost estimates all relative to cover density

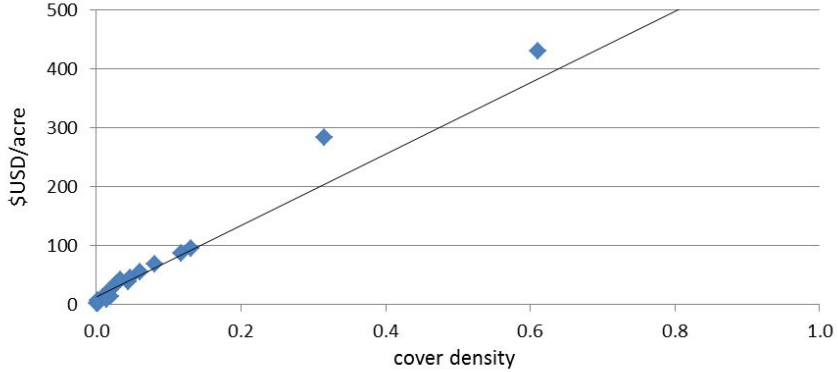
	Coefficients			
Dependant variable	m	b	R^2	$P_{0.05}$
Surveillance efficiency (SE; min/acre)	**28.937**	**0.769**	0.956	0.00
Patch treatment rate (PTR; T/hr)	**45.122*ln**	**410.64**	0.691	0.00
Cost estimation ($USD)	604.2	14.14	0.968	0.00

[a] Refer to figures 2, 3 and 4 for SE, TAR and HP, respectively. [b] Refer to figure 5 for simulations.

Operational measures of efficiency continued…



Mean herbicide target application rates (gallon/target) for all directed long-line treatment operations (n=21).
(X- outliers removed from further calculations)



Operational costs ($USD/acre) versus cover density estimated for each of the directed long-line treatment operations (n=21) conducted from December 2011 - October 2012.

Simple regression coefficients as performance analytics for surveillance efficiency, target acquisition rate and operational cost estimates all relative to cover density

	Coefficients			
Dependant variable	m	b	R^2	$P_{0.05}$
Surveillance efficiency (SE; min/acre)	28.937	0.769	0.956	0.00
Patch treatment rate (PTR; T/hr)	45.122*ln	410.64	0.691	0.00
Cost estimation ($USD)	**604.2**	**14.14**	0.968	0.00

[a] Refer to figures 2, 3 and 4 for SE, TAR and HP, respectively. [b] Refer to figure 5 for simulations.

Table 3. Operational estimates relative to gorse cover density

cover density	targets/ acre	acres/ tank	min/ acre	targets/ min	flight time/tank	ops/ fuel cycle	herbicide $/acre	flight $/acre	total cost /acre
0.01	2	31.6	1.1	2	33.5	3.0	1.75	15.88	17.62
0.02	4	15.8	1.3	3	21.3	4.7	3.50	20.22	23.71
0.03	6	10.5	1.6	4	17.3	5.8	5.25	24.56	29.80
0.04	8	7.9	1.9	4	15.2	6.6	6.99	28.90	35.89
0.05	11	6.3	2.2	5	14.0	7.1	8.74	33.24	41.98
0.06	13	5.3	2.5	5	13.2	7.6	10.49	37.58	48.07
0.07	15	4.5	2.8	5	12.6	7.9	12.24	41.92	54.16
0.08	17	4.0	3.1	5	12.2	8.2	13.99	46.26	60.25
0.09	19	3.5	3.4	6	11.9	8.4	15.74	50.60	66.34
0.1	21	3.2	3.7	6	11.6	8.6	17.48	54.94	72.43
0.11	23	2.9	4.0	6	11.4	8.8	19.23	59.28	78.51
0.12	25	2.6	4.2	6	11.2	8.9	20.98	63.62	84.60
0.13	27	2.4	4.5	6	11.0	9.1	22.73	67.96	90.69
0.14	**30**	**2.3**	**4.8**	**6**	**10.9**	**9.2**	**24.48**	**72.30**	**96.78**
0.15	32	2.1	5.1	6	10.8	9.3	26.23	76.64	102.87
0.16	34	2.0	5.4	6	10.7	9.4	27.97	80.98	108.96
0.17	36	1.9	5.7	6	10.6	9.4	29.72	85.33	115.05
0.18	38	1.8	6.0	6	10.5	9.5	31.47	89.67	121.14
0.19	40	1.7	6.3	6	10.4	9.6	33.22	94.01	127.23
0.2	42	1.6	6.6	6	10.4	9.6	34.97	98.35	133.32
0.21	44	1.5	6.8	6	10.3	9.7	36.72	102.69	139.40
0.22	46	1.4	7.1	7	10.3	9.7	38.46	107.03	145.49
0.23	49	1.4	7.4	7	10.2	9.8	40.21	111.37	151.58
0.24	51	1.3	7.7	7	10.2	9.8	41.96	115.71	157.67
0.25	53	1.3	8.0	7	10.1	9.9	43.71	120.05	163.76

Collaborators:
DHHL

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