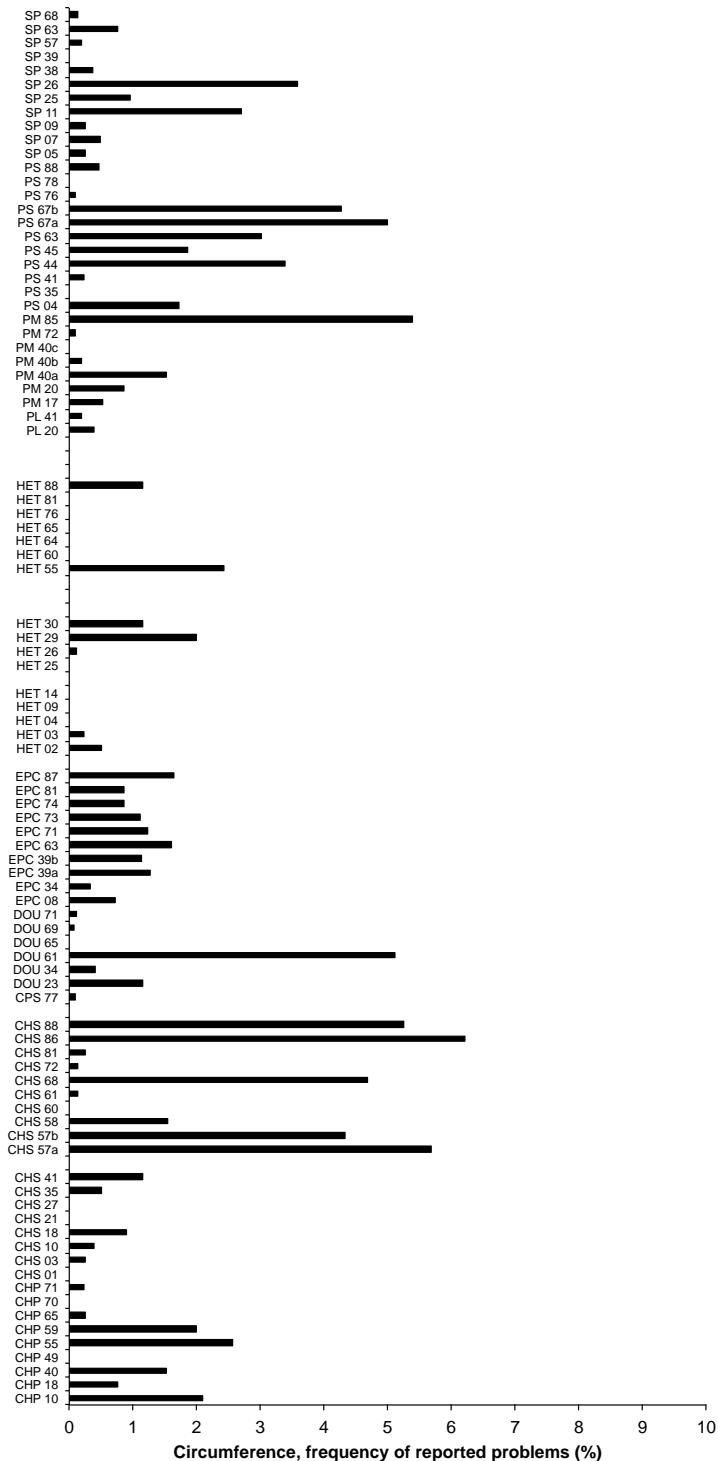
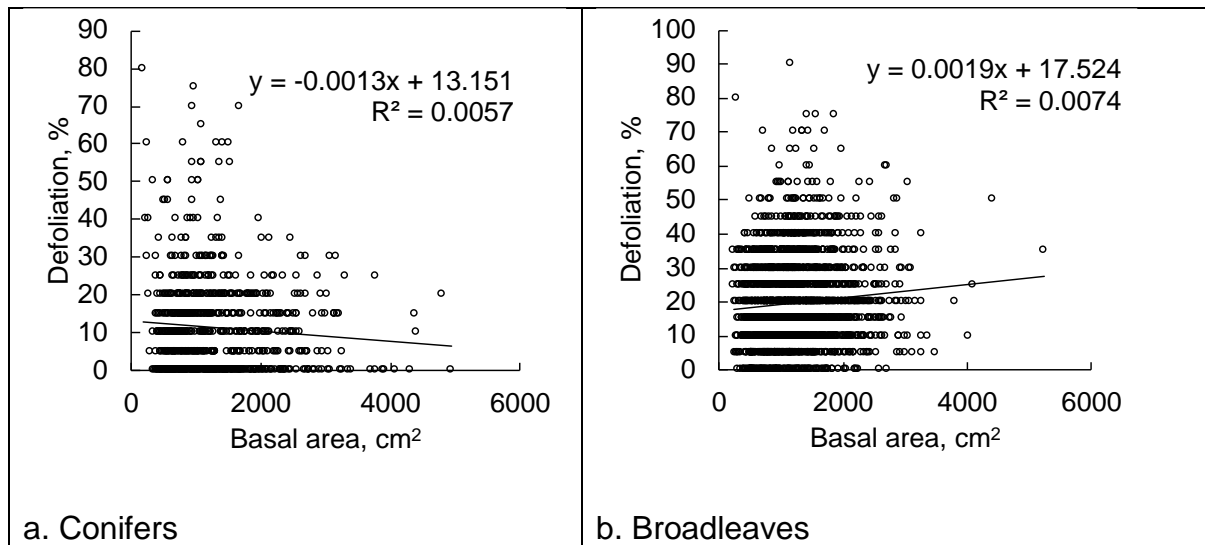


Appendix A - Supplementary information

**Figure A1. Quality of circumference measurements.** Overall frequency (all measurements, all years) of reported observation problems for individual plots. Codes identify individual plots. The overall frequency of reported anomalies is rather low (1.1%, on average) and maximum values were always below 10% and occurred on a limited number of plots.

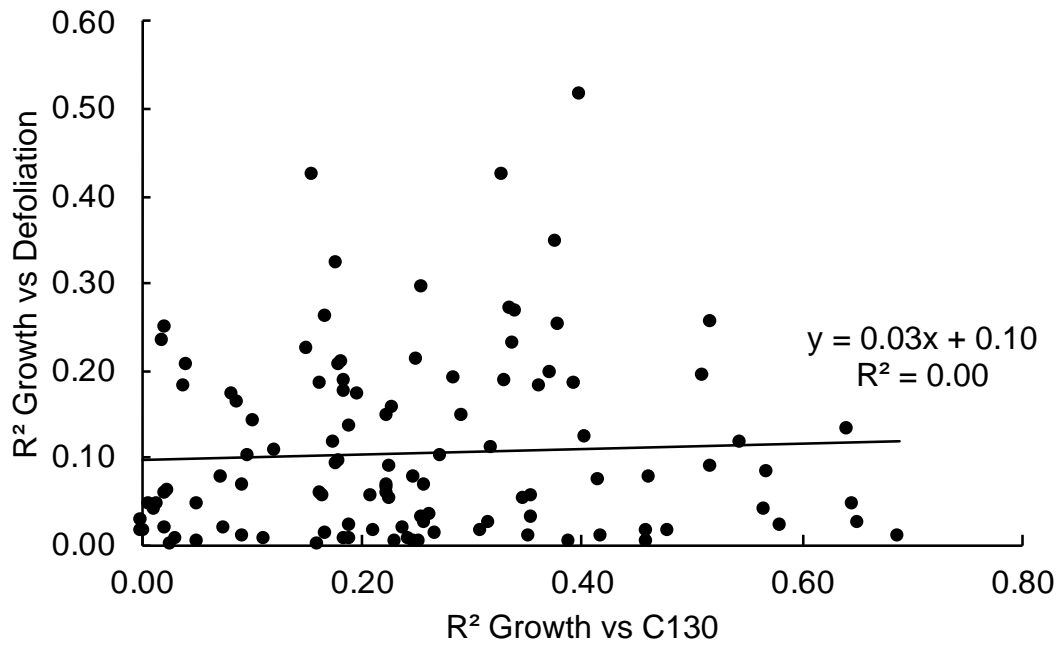


**Figure A2. Defoliation and tree size, individual trees, entire population.**  
Relationship between basal area and defoliation for individual trees.



**Figure A3. Defoliation, growth and tree size, individual plots.**

Pattern of relationships between tree growth and tree size (in term of circumference at 130 cm above ground) (x-axis) and the patten of relationship between tree growth and defoliation (y-axis) for individual plots, depicted by individual data points.



### Table A1 and A2. Defoliation – BAI relationship: model performance

Model's performance was evaluated on the basis of model RMSE for all trees (Tables S1, S2). It is obvious that most models performed quite comparably, with the exception of the quantile models 25 and 75. First order linear model, 2nd order linear model, 50th quantile model and exponential model display similar range of RMSE. This pattern remains similar among the species. Given its immediate meaning and information potential, first order linear model has been selected for further discussion.

*Table A1. 1995-2004: model results expressed as slope (slo), p-value (pval), and root mean square error (rmse) for the various models.*

Model	Model results	Abies alba	Picea abies	Pinus nigra subsp. laricio	Pinus pinaster	Pinus sylvestris	Pseudotsuga menziesii	All
Linear 1st order	n	520	466	90	290	419	223	2008
	slo.lm1	-5.39	-1.72	-5.44	-5.62	-1.36	-5.87	-4.09
	pval.lm1	0.00000	0.02243	0.00554	0.00000	0.07758	0.00000	0.00000
	rmse.lm1	153.8	123.3	89.6	117.7	91.3	200.8	166.6
Linear 2nd order	slo1.lm2	-1347.25	-283.02	-257.76	-687.36	-161.99	-1149.05	-1734.26
	pval1.lm2	0.00000	0.02128	0.00575	0.00000	0.07579	0.00000	0.00000
	slo2.lm2	461.81	-370.99	45.53	186.94	-225.06	-283.80	686.24
	pval2.lm2	0.00264	0.00259	0.61824	0.11353	0.01379	0.15985	0.00004
	rmse.lm2	152.4	122.1	89.5	117.2	90.7	199.9	165.9
Quantile 25	slo.q25	-4.38	-1.94	-4.92	-7.08	-1.36	-5.51	-2.48
	pval.q25	0.00000	0.00000	0.04196	0.00115	0.12588	0.00000	0.00000
	rmse.q25	191.1	147.4	105.9	148.6	110.6	254.2	205.6
Quantile 50	slo.q50	-4.59	-2.80	-4.91	-5.47	-1.99	-6.62	-3.10
	pval.q50	0.00000	0.00000	0.03160	0.00097	0.11690	0.00000	0.00000
	rmse.q50	154.2	125.9	90.4	117.7	92.6	202.4	171.1
Quantile 75	slo.q75	-5.23	-3.00	-3.96	-6.11	-1.47	-6.11	-4.15
	pval.q75	0.00000	0.00000	0.04343	0.00110	0.12067	0.00000	0.00000
	rmse.q75	177.1	133.7	99.7	142.5	102.0	228.0	185.1
Exponential	a.nl	410.4	262.0	372.6	432.3	218.4	602.6	356.8
	pval.a	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	b.nl	0.021	0.006	0.021	0.026	0.006	0.011	0.016
	pval.b	0.00000	0.04481	0.00644	0.00000	0.10557	0.00000	0.00000
	rmse.nl	152.5	123.4	89.6	117.1	91.4	201.6	166.1
Spearman Rho	r.Spm	-0.40	-0.11	-0.32	-0.31	-0.09	-0.33	-0.24
	pval.Spm	0.00000	0.01595	0.00192	0.00000	0.05686	0.00000	0.00000

Table A2 2000-2009. Model results expressed as slope (slo), p-value (pval), and root mean square error (rmse) for the various models.

Model	Model results	Abies alba	Fagus sylvatica	Picea abies	Pinus nigra subsp. laricio	Pinus pinaster	Pinus sylvestris	Pseudots uga menziesii	Quercus petraea	Quercus robur	Q. robur + Q. petraea	Broadleaves	Conifers	All
Linear 1st order	n	298	817	195	52	192	132	52	896	435	47	2195	921	3116
	slo.lm1	-4.18	-0.06	-3.72	-4.60	-9.87	-9.73	-11.47	-2.48	-4.45	-5.82	-1.98	-5.80	-3.83
	pval.lm1	0.00000	0.91938	0.00174	0.01193	0.00000	0.00000	0.18067	0.00000	0.00000	0.00001	0.00000	0.00000	0.00000
	rmse.lm1	166.7	144.9	120.5	82.9	135.9	159.7	168.2	116.2	121.2	119.2	129.9	167.4	143.9
Linear 2nd order	slo1.lm2	-1009.81	-14.69	-384.63	-220.49	-1084.22	-772.88	-232.94	-724.42	-762.85	-600.58	-910.81	-2106.87	-2379.68
	pval1.lm2	0.00000	0.91941	0.00179	0.01282	0.00000	0.00000	0.18308	0.00000	0.00000	0.00001	0.00000	0.00000	0.00000
	slo2.lm2	474.77	87.51	-35.34	5.52	236.96	310.42	118.31	-118.14	95.03	151.64	-267.08	669.81	767.87
	pval2.lm2	0.00437	0.54677	0.77130	0.94874	0.08274	0.05346	0.49601	0.31024	0.43454	0.21704	0.03992	0.00006	0.00000
	rmse.lm2	164.4	144.9	120.5	82.8	134.8	157.4	167.4	116.2	121.1	117.2	129.8	165.9	143.2
Quantile 25	slo.q25	-2.96	-1.36	-3.31	-5.55	-11.82	-4.67	-10.19	-2.42	-3.48	-4.64	-2.08	-4.87	-2.59
	pval.q25	0.00000	0.06070	0.01330	0.01344	0.00000	0.00962	0.42652	0.00000	0.00000	0.01120	0.00000	0.00000	0.00000
	rmse.q25	209.2	181.3	147.9	102.6	170.7	201.4	197.6	143.0	148.4	147.3	159.1	211.2	177.8
Quantile 50	slo.q50	-4.65	-0.30	-4.74	-5.88	-10.89	-8.99	-12.46	-2.86	-4.45	-5.29	-2.57	-5.35	-3.53
	pval.q50	0.00001	0.05715	0.01015	0.00946	0.00000	0.01039	0.40151	0.00000	0.00000	0.01543	0.00000	0.00000	0.00000
	rmse.q50	167.8	146.9	123.3	84.9	136.3	162.4	168.3	118.4	123.4	119.7	132.3	169.4	146.1
Quantile 75	slo.q75	-4.66	0.89	-3.44	-4.94	-7.70	-15.55	-9.49	-3.47	-5.55	-5.79	-2.54	-6.26	-4.72
	pval.q75	0.00001	0.05886	0.01560	0.00966	0.00000	0.00992	0.39900	0.00000	0.00000	0.01415	0.00000	0.00000	0.00000
	rmse.q75	193.2	170.5	137.1	89.4	168.5	182.9	188.3	130.8	134.5	132.5	146.7	198.6	163.0
Exponential	a.nl	460.5	275.8	309.9	355.7	647.0	595.7	646.1	336.4	409.1	638.5	318.6	433.1	384.4
	pval.a	0.00000	0.00000	0.00000	0.00035	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	b.nl	0.014	0.000	0.014	0.025	0.037	0.047	0.020	0.009	0.018	0.023	0.007	0.021	0.015
	pval.b	0.00000	0.91821	0.00578	0.02139	0.00000	0.00000	0.17283	0.00000	0.00000	0.00004	0.00000	0.00000	0.00000
	rmse.nl	165.3	144.9	120.6	83.0	135.3	158.0	168.1	116.3	121.0	117.1	130.0	166.1	143.4
Spearman Rho	r.Spm	-0.38	-0.01	-0.17	-0.44	-0.52	-0.40	-0.19	-0.23	-0.27	-0.60	-0.15	-0.39	-0.26
	pval.Spm	0.00000	0.71528	0.01912	0.00123	0.00000	0.00000	0.18689	0.00000	0.00000	0.00001	0.00000	0.00000	0.00000

**Table A3, A4, A5. Defoliation and BAI per individual species and defoliation class**

Table A3. Conifers, 1995-2004. Number of trees, median BAI, difference between BAId and BAIr, with significance after the U test.

Defol. %	Abies alba				Picea abies				Pinus sylvestris			
	Trees n	BAI median cm2	BAId-BAIr cm2	U test, P-value	Trees n	BAI median cm2	BAId-BAIr cm2	U test, P-value	Trees n	BAI median cm2	BAId-BAIr cm2	U test, P-value
0	48	454.2	-	-	72	232.1	-	-	3	166.1	-	-
5	161	395.7	-	-	151	237.9	-	-	44	188.0	-	-
10	76	313.3	-	-	83	232.4	-	-	117	197.8	-	-
15	73	295.0	-111.6	0.000	90	232.7	-4.6	0.935	146	191.4	-3.7	0.348
20	71	266.9	-127.3	0.000	42	202.2	-35.2	0.264	76	190.9	-4.1	0.202
25	40	273.1	-71.0	0.000	15	142.3	-95.1	0.001	22	155.9	-39.2	0.120
30	22	278.9	-92.9	0.004	4	110.5	-126.9	NA	9	160.0	-35.1	0.333
35	12	272.0	-77.7	0.025	7	149.5	-87.9	0.004	2	38.2	-156.8	NA
40	6	221.9	-111.2	0.007	1	132.8	-104.6	NA	0	NA	NA	NA
45	4	154.2	-248.7	NA	1	130.2	-107.2	NA	0	NA	NA	NA
50	3	277.0	-71.4	NA	0	NA	NA	NA	0	NA	NA	NA
55	2	189.0	-181.1	NA	0	NA	NA	NA	0	NA	NA	NA
60	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
65	1	181.0	-189.2	NA	0	NA	NA	NA	0	NA	NA	NA
70	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
75	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
80	1	15.0	-355.1	NA	0	NA	NA	NA	0	NA	NA	NA
85	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
90	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
95	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
100	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
Defol. %	Pinus pinaster				Pinus nigra var. laricio				Pseudotsuga menziesii			
	Trees n	BAI median cm2	BAId-BAIr cm2	U test, P-value	Trees n	BAI median cm2	BAId-BAIr cm2	U test, P-value	Trees n	BAI median cm2	BAId-BAIr cm2	U test, P-value
0	0	NA	-	-	0	NA	-	-	40	642.5	-	-
5	0	NA	-	-	0	NA	-	-	68	520.2	-	-
10	11.0	355.6	-	-	14	307.1	-	-	26	516.1	-	-
15	108.0	305.5	-50.1	0.119	41	282.3	-24.8	0.428	27	638.9	91.9	0.211
20	88.0	233.5	-122.1	0.004	20	221.1	-86.0	0.024	10	535.3	-11.8	0.997
25	48.0	293.0	-62.6	0.082	11	235.6	-71.5	0.106	15	390.1	-156.9	0.001
30	19.0	188.2	-167.4	0.008	4	211.7	-95.4	NA	9	449.8	-97.3	0.121
35	7.0	142.7	-212.9	0.007	0	NA	NA	NA	12	386.7	-160.3	0.139
40	5.0	170.3	-185.3	NA	0	NA	NA	NA	8	185.7	-361.3	0.000
45	0.0	NA	NA	NA	0	NA	NA	NA	6	345.2	-201.8	0.005
50	3.0	165.1	-190.5	NA	0	NA	NA	NA	0	NA	NA	NA
55	0.0	NA	NA	NA	0	NA	NA	NA	1	225.0	-322.0	NA
60	0.0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
65	0.0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
70	1.0	41.381	-314.2	NA	0	NA	NA	NA	0	NA	NA	NA
75	0.0	NA	NA	NA	0	NA	NA	NA	1	85.6	-461.4	NA
80	0.0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
85	0.0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
90	0.0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
95	0.0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
100	0.0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA

Table A4. Conifers, 2000-2009. Number of trees, median BAI, difference between BAId and BAIr, with significance after the U test.

Defol. %	Abies alba				Picea abies				Pinus sylvestris			
	Trees n	BAI median cm2	BAId-BAIr cm2	U test, P-value	Trees n	BAI median cm2	BAId-BAIr cm2	U test, P-value	Trees n	BAI median cm2	BAId-BAIr cm2	U test, P-value
0	45	551.2	-	-	23	278.3	-	-	0	NA	-	-
5	53	403.3	-	-	92	283.3	-	-	0	NA	-	-
10	41	344.7	-	-	44	256.2	-	-	7	502.5	-	-
15	45	280.0	-158.8	0.000	17	258.7	-19.6	0.616	34	299.5	-203.1	0.307
20	26	337.9	-100.9	0.000	6	188.0	-90.3	0.062	41	179.0	-323.6	0.031
25	21	281.2	-157.6	0.000	3	204.5	-73.8	NA	25	165.3	-337.3	0.018
30	29	338.9	-99.9	0.002	5	122.7	-155.6	NA	12	170.2	-332.4	0.016
35	14	296.9	-141.9	0.005	4	165.0	-113.3	NA	10	108.6	-394.0	0.022
40	10	367.7	-71.1	0.313	1	244.0	-34.3	NA	3	49.0	-453.6	NA
45	7	373.7	-65.0	0.073	0	NA	NA	NA	0	NA	NA	NA
50	3	383.9	-54.9	NA	0	NA	NA	NA	0	NA	NA	NA
55	1	219.7	-219.0	NA	0	NA	NA	NA	0	NA	NA	NA
60	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
65	1	53.1	-385.7	NA	0	NA	NA	NA	0	NA	NA	NA
70	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
75	1	428.4	-10.3	NA	0	NA	NA	NA	0	NA	NA	NA
80	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
85	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
90	1	30.6	-408.2	NA	0	NA	NA	NA	0	NA	NA	NA
95	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
100	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
Defol. %	Pinus pinaster				Pinus nigra var. laricio				Pseudotsuga menziesii			
	Trees n	BAI median cm2	BAId-BAIr cm2	U test, P-value	Trees n	BAI median cm2	BAId-BAIr cm2	U test, P-value	Trees n	BAI median cm2	BAId-BAIr cm2	U test, P-value
0	0	NA	-	-	0	NA	-	-	6	623.5	-	-
5	0	NA	-	-	0	NA	-	-	33	607.7	-	-
10	7	414.5	-	-	0	NA	-	-	12	576.7	-	-
15	26	369.1	-45.4	0.218	3	194.3	NA	NA	1	421.3	-166.4	NA
20	38	362.0	-52.5	0.324	4	232.8	NA	NA	0	NA	NA	NA
25	59	309.6	-105.0	0.046	13	200.5	NA	NA	0	NA	NA	NA
30	37	259.9	-154.7	0.003	21	158.7	NA	NA	0	NA	NA	NA
35	15	131.0	-283.5	0.002	8	126.9	NA	NA	0	NA	NA	NA
40	6	49.1	-365.4	0.003	1	72.4	NA	NA	0	NA	NA	NA
45	2	170.9	-243.7	NA	1	200.2	NA	NA	0	NA	NA	NA
50	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
55	1	195.1	-219.4	NA	1	92.4	NA	NA	0	NA	NA	NA
60	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
65	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
70	1	53.0	-361.5	NA	0	NA	NA	NA	0	NA	NA	NA
75	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
80	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
85	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
90	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
95	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
100	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA

