

Assessing spatial deposition of aquatic subsidies by insects emerging from agricultural streams

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S1: Hydrological and physical parameters of streams and land at the scale of catchment area scale

When available, coefficient of variation are between brackets.

	Yaigne	Serein	Ise	Vaunoise	Garun	Flume	Illet	Veuvre
Area (km²)	62	64	110	115	126	136	168	180
Semi-natural (%)	1	16	3	1	6	1	27	11
Artificial (%)	9	2	9	7	6	11	4	4
Agricultural (%)	89	82	88	92	88	88	69	85
Discharge (m³.s⁻¹)	0.4	0.4	0.7	0.7	0.9	0.9	1.4	1.5
Water temp. (°C)	10.2 (0.4)	11.2 (0.5)	12.1 (0.4)	11.1 (0.4)	11.0 (0.5)	11.6 (0.4)	10.5 (0.5)	12.9 (0.5)
Turbidity (FNU)	5.7 (0.5)	9.8 (0.7)	9.8 (0.5)	12.9 (0.4)	8.3 (0.7)	9.7 (0.7)	13.4 (0.5)	9.2 (0.4)
Conductivity (µS.cm⁻¹)	518 (0.2)	276 (0.2)	378 (0.1)	807 (0.6)	1,126 (0.9)	430 (0.3)	358 (0.3)	533 (0.6)
Suspended matter (mg DM.L⁻¹)	9 (0.8)	10 (0.6)	10 (0.5)	16 (0.4)	7 (0.5)	19 (1.1)	15 (0.6)	10.2 (0.5)
Nitrates (mg NO₃.L⁻¹)	30.1 (0.5)	17.6 (0.6)	28.1 (0.2)	17.1 (0.4)	25.0 (0.2)	25.7 (0.2)	11.1 (0.6)	11.5 (0.4)
Ammonium (mg NH₄⁺.L⁻¹)	0.10 (0.9)	0.23 (0.6)	0.09 (0.2)	0.23 (0.6)	0.13 (0.6)	0.25 (0.7)	0.17 (1.1)	0.17 (0.4)
Phosphorus (mg total P.L⁻¹)	0.14 (0.4)	0.21 (0.7)	0.11 (0.3)	0.22 (0.5)	0.20 (0.3)	0.28 (1.2)	0.19 (0.6)	0.12 (0.3)
Related sites	Sauvagère	Ormal	Tertre Ourmais Bray	Moulin	Roncelinois	Champagne	Jardièr Rocher	Fèvre Vallée

S1 (continued): Morphological and physical parameters at each tent (*2) of each site

Sites	Sauvagère	Ormal	Ourmais	Bray	Tertre	Moulin	Roncinelais	Champagne	Jardière	Rocher	Vallée	Fèvre												
Substrate score	1.88	1.11	1.48	1.52	1.10	1.27	2.40	2.88	0.35	0.07	0.85	1.07	1.99	1.52	2.72	2.94	0.69	2.74	1.28	0.19	2.89	2.42	2.24	1.64
Substrate index	1.48	1.23	1.37	1.23	1.18	1.20	1.18	1.14	0.56	0.19	0.97	1.05	1.61	1.42	1.16	1.14	0.84	1.62	1.20	0.38	1.06	1.48	1.47	1.33
Channel openness (%)	17	2	24	11	6	6	32	51	12	13	30	80	92	51	54	64	41.2	12	34	34	51	12	52	16
Bank height (cm)	152	130	166	150	100	120	154	150	100	92	140	136	50	62	162	138	138	90	132	136	126	82	96	130
Stream width (cm)	470	440	420	370	700	700	450	640	360	410	600	600	430	450	560	490	750	710	540	570	720	710	760	910
Embankment score	3.2	3.4	2.6	2.5	7.0	5.8	3.0	4.3	3.6	4.5	4.3	4.4	8.6	7.5	3.5	3.6	5.5	8.2	5.8	4.2	5.9	9.2	9.5	7.0
Water depth (cm)	19	28	33	24	54	39	50	19	15	38	31	26	23	32	39	38	34	27	30	35	26	29	43	34
Silt depth (cm)	0	8	3	2	5	2	1	0	11	28	7	2	0	1	0	0	10	1	41	14	0	0	0	2
Current velocity (m/s)	0.17	0.12	0.02	0.02	0.05	0.06	0.11	0.27	0.10	0.04	0.13	0.13	0.17	0.17	0.12	0.10	0.14	0.22	0.11	0.11	0.19	0.19	0.12	0.11

S2: Emerging dry mass (mg) of aquatic insects, summed at each site over all campaigns

	Bray	Rocher	Champagne	Sauvagere	Roncelinois	Tertre	Fèvre	Moulin	Ormal	Jardière	Vallée	Ourmais
Chironomidae	151.0	175.1	198.4	220.3	250.7	307.6	358.8	440.6	497.3	52.6	632.3	93.1
Trichoptera	577.4	222.3	769.4	302.5	1,326.1	518.8	872.6	364.1	734.5	184.5	1107.4	336.1
Ephemeroptera	147.4	185.7	66.8	21.8	170.2	133.6	306.0	111.5	39.5	198.0	352.0	682.9
Total	875.8	583.1	1,034.6	544.6	1,747.0	960.0	1,537.4	916.2	1,271.3	435.1	2,091.7	1,112.1

S2: Esitmated dry mass of caught aquatic insects emerging per day (mg DM m-2 d-1). Values are means of the two emergence traps.

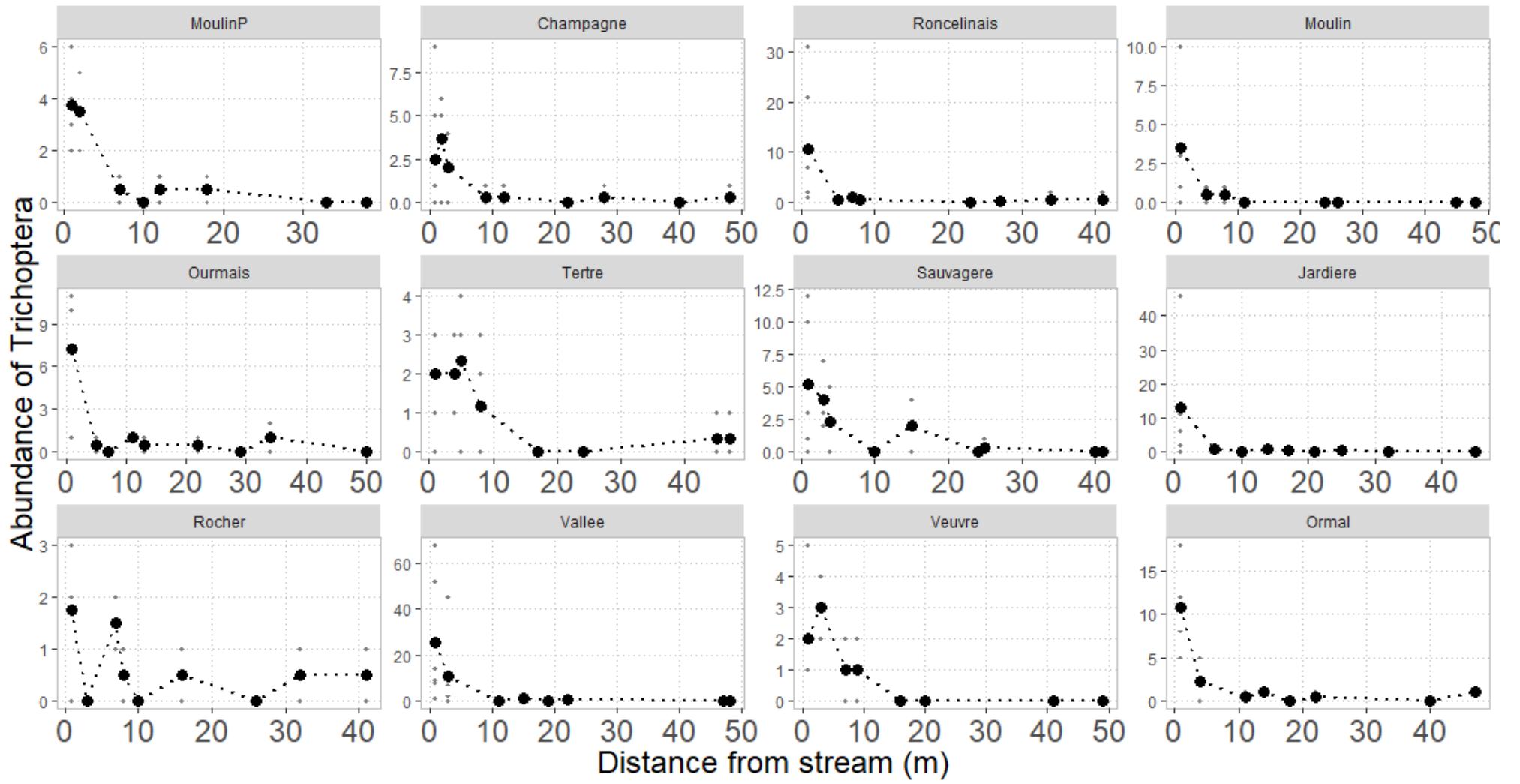
Campaing 6 was performed only at one site (due to risk of damage under harsh meteorologic conditions) to confirm that emerging dry mass during winter was negligible.

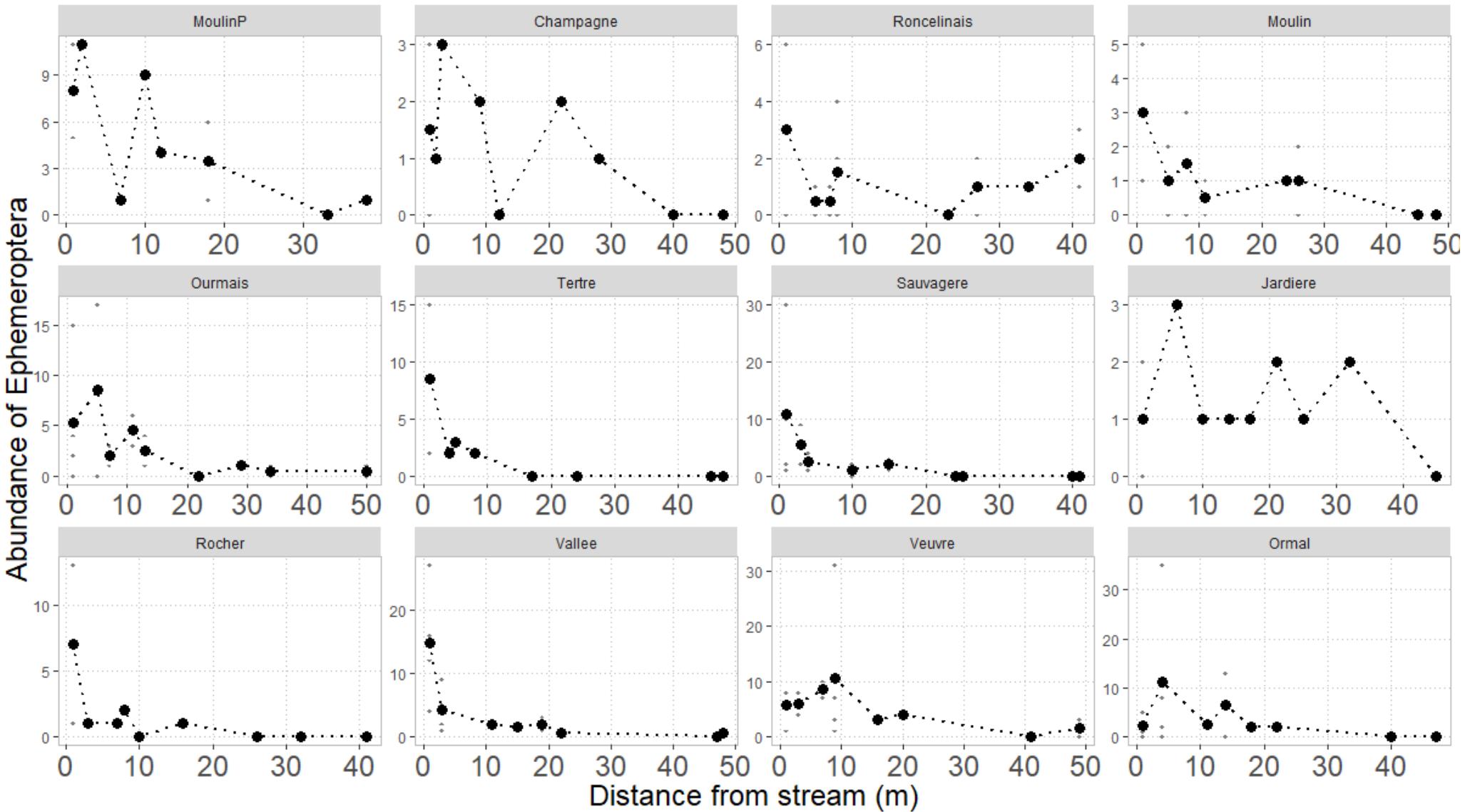
		Champagne	Roncelinois	Jardiere	Rocher	Bray	Ourmais	Tertre	Ormal	Moulin	Vallee	Fevre	Sauvagere
Campaign 2	Chironomidae	5.60	11.31	1.49	3.77	1.31	2.69	7.83	17.03	3.60	8.00	10.51	4.11
	Ephemeroptera	3.49	10.86	12.79	3.99	5.19	9.09	8.35	2.13	5.91	16.29	18.62	1.48
	Trichoptera	18.80	19.86	2.16	3.65	11.42	6.29	25.14	35.71	11.75	11.56	5.67	5.33
Campaign 3	Chironomidae	2.70	1.86	0.49	1.99	1.14	0.27	0.77	7.09	2.09	9.71	3.70	2.83
	Ephemeroptera	0.94	2.99	0.70	8.69	2.22	35.55	0.43	0.61	1.39	5.98	0.49	0.03
	Trichoptera	27.53	62.22	6.26	5.48	15.88	9.89	1.91	11.11	10.36	13.84	16.41	6.80
Campaign 4	Chironomidae	0.66	2.11	0.18	3.04	2.52	0.43	12.54	2.87	6.00	24.89	8.11	5.26
	Ephemeroptera	0.24	5.40	0.42	0.44	1.15	4.09	0.98	0.08	0.64	2.71	5.43	0.02
	Trichoptera	15.29	34.11	2.62	5.18	11.81	7.11	10.46	5.64	2.73	50.66	79.53	7.04
Campaign 5	Chironomidae	3.81	8.90	1.24	3.37	3.23	0.56	0.63	-	10.33	1.45	6.83	1.77
	Ephemeroptera	0.04	1.04	0.23	0.14	0.00	0.04	0.00	-	0.04	0.16	0.04	0.03
	Trichoptera	0.99	5.51	2.13	1.57	4.26	0.71	0.51	-	1.16	3.03	0.48	2.44
Campaign 6	Chironomidae	0.17											
	Ephemeroptera	0.00											
	Trichoptera	0.00											
Campaign 7	Chironomidae	1.56	0.87	0.36	0.69	4.19	2.70	0.59	8.53	9.46	1.11	1.06	1.76
	Ephemeroptera	0.19	0.00	0.00	0.00	1.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00

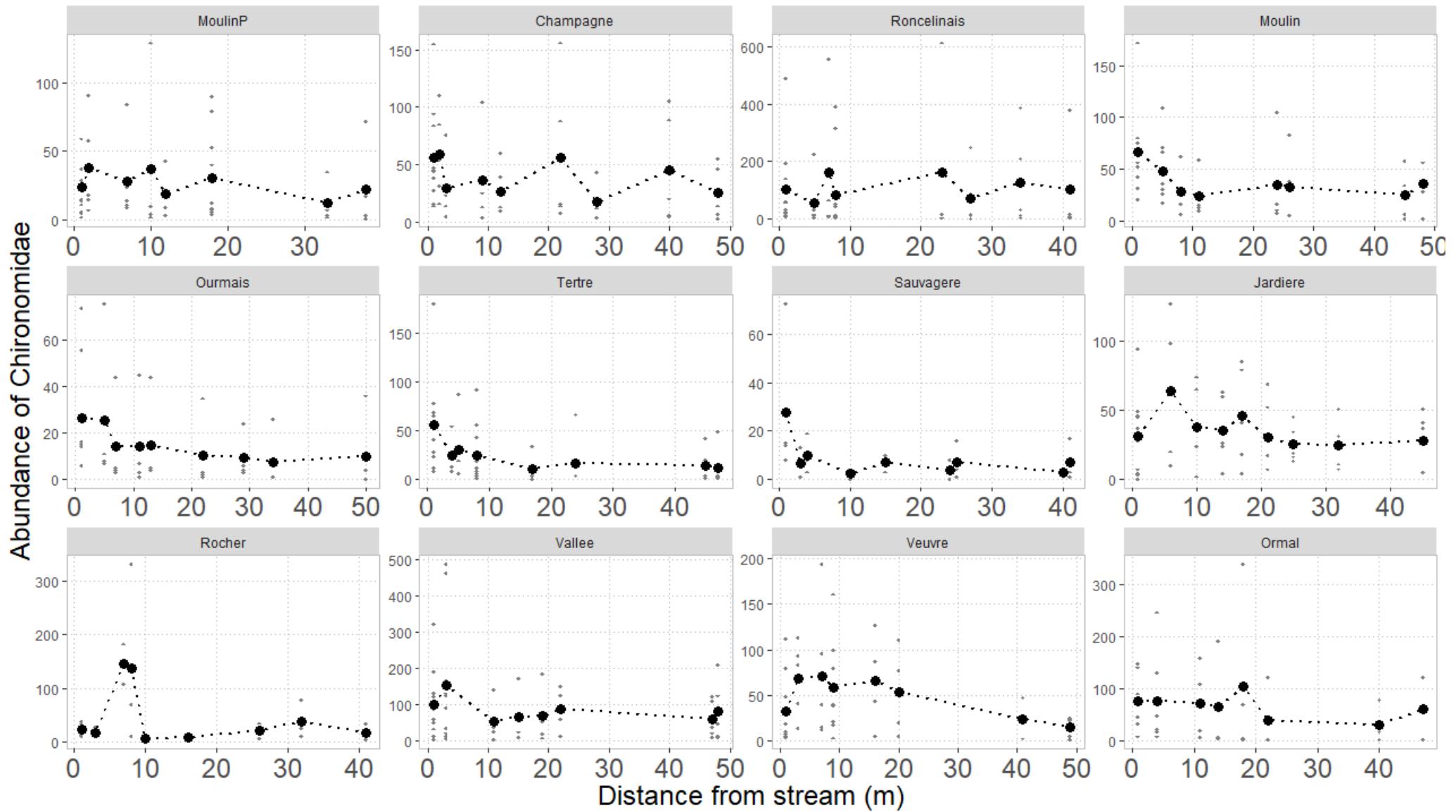
Trichoptera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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S3: Abundance of winged aquatic insects (Trichoptera, Ephemeroptera and Chironomiade) caught on sticky traps.

Gray dots are actual counts, and black circles are the mean of each distance at each site for all sampling sessions. Plotted data were collected in sampling campaign 2-4 for Trichoptera, 1-2 for Ephemeroptera and 1-5 for Chironomidae. The scale of y-axis varies among plots.







S4: Posterior checking and posterior distributions of several HBM structures

Table S4.1 . Results of model checking. Ephemeroptera and Trichoptera models were exponential decay models with increasing distance from the stream. The Chironomidae model was an alternate exponential model.

Taxon	Hierarchy level	Gelman-Rubin index	Mean P value (std. deviation)
Ephemeroptera	None	1.00	0.39 (± 0.26)
	Site	1.00	0.38 (± 0.25)
	Date	1.00	0.38 (± 0.25)
	Site & Date	1.00	0.37 (± 0.24)
Trichoptera	None	1.00	0.32 (± 0.29)
	Site	1.00	0.29 (± 0.25)
	Date	1.00	0.31 (± 0.28)
	Site & Date	1.00	0.29 (± 0.25)
Chironomidae	None	1.02	0.49 (± 0.26)
	Site	1.00	0.46 (± 0.24)
	Date	1.01	0.50 (± 0.25)
	Site & Date	1.01	0.50 (± 0.20)

S4.2 : Detailed posterior checking results and posterior distributions of several HBM structures

Ephemeroptera	2
1.1 Exponential	2
1.1.1 None HBM	2
1.1.2 HBM site	3
1.1.3 HBM date	3
1.1.4 HBM site date	4
Trichoptera.....	6
1.2 Exponential	6
1.2.1 None HBM	6
1.2.2 HBM site	6
1.2.3 HBM date	7
1.2.4 HBM date + site.....	9
Chironomidae.....	10
1.3 Local-maximum	10
1.3.1 None HBM	10
1.3.2 HBM site	10
1.3.3 HBM date	13
1.3.4 HBM date + site.....	15

Ephemeroptera

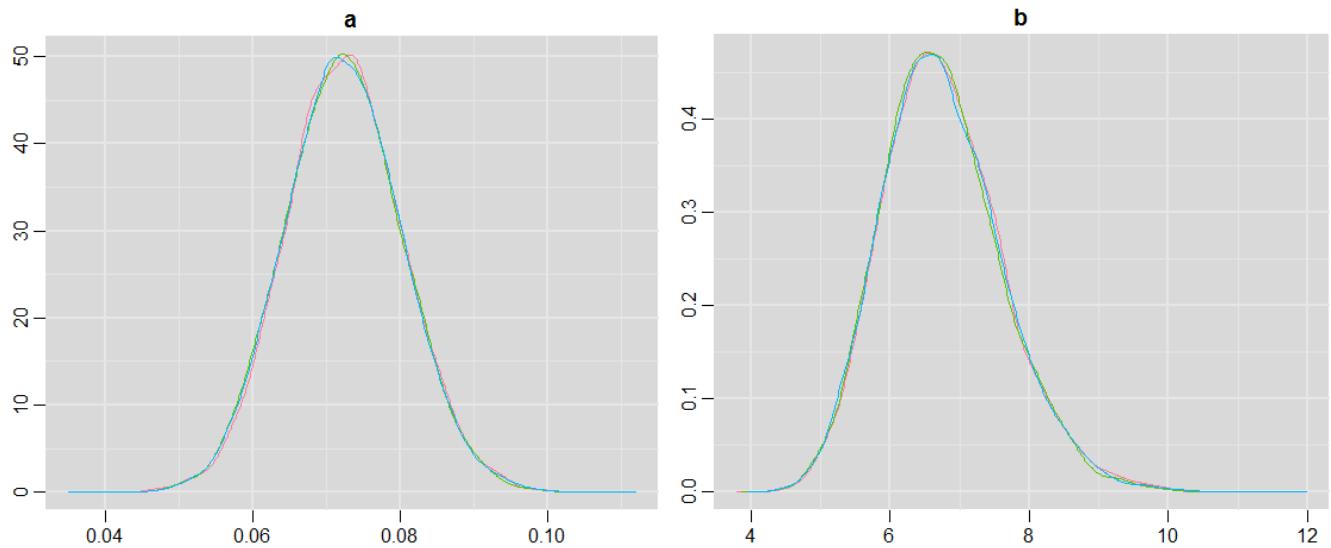
1.1 Exponential

$$\text{Abundance}_{s,t} = a_{s,t} \cdot \exp^{-b_{s,t} \cdot X} \quad (\text{Eq. } I)$$

1.1.1 None HBM

WAIC = 761.1, penalty parameter = 10.9

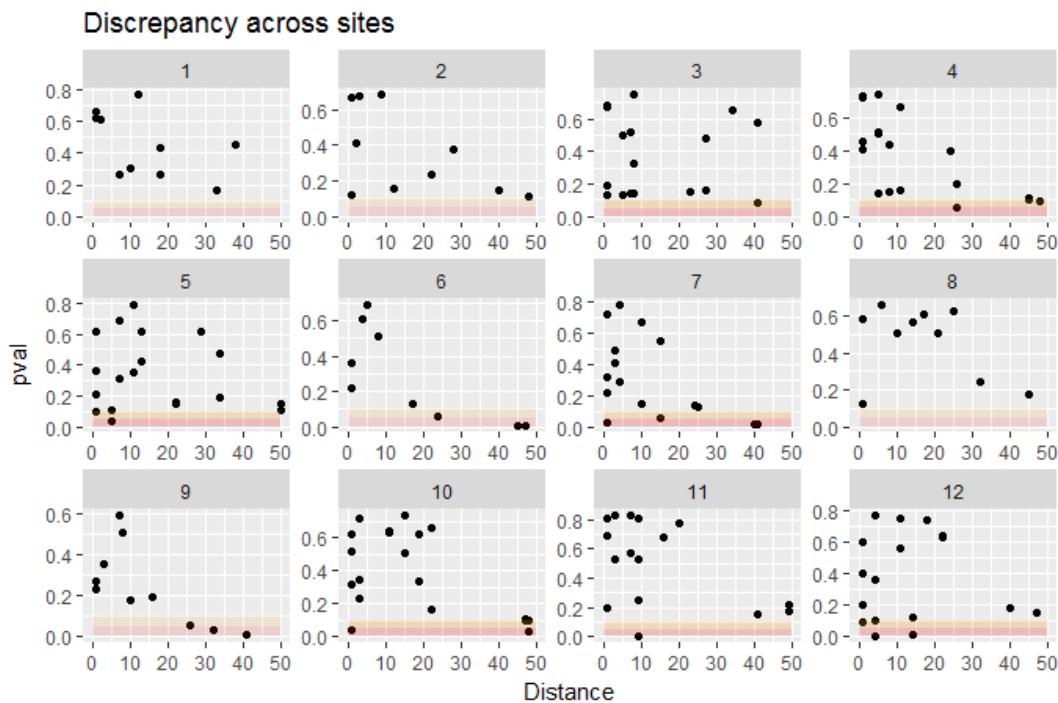
Chi² (p value) = 0.39 +/- 26.1



1.1.2 HBM site

WAIC = 728, penalty parameter = 23.8

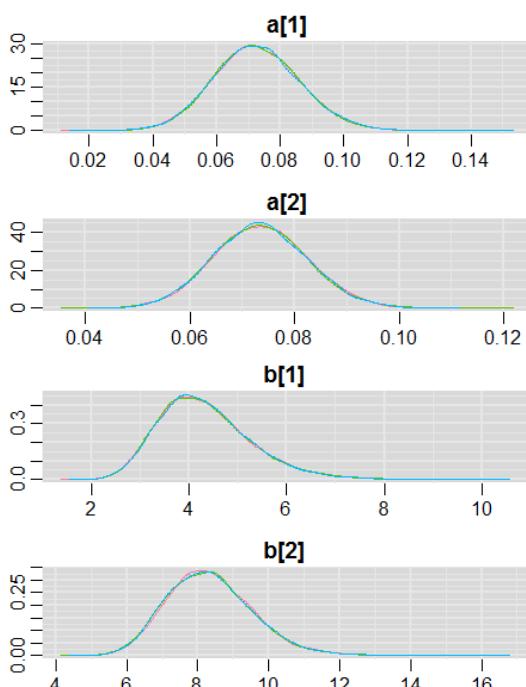
Chi² (p value) = 0.38 +/- 0.25



1.1.3 HBM date

WAIC = 752.2, penalty parameter = 12.9

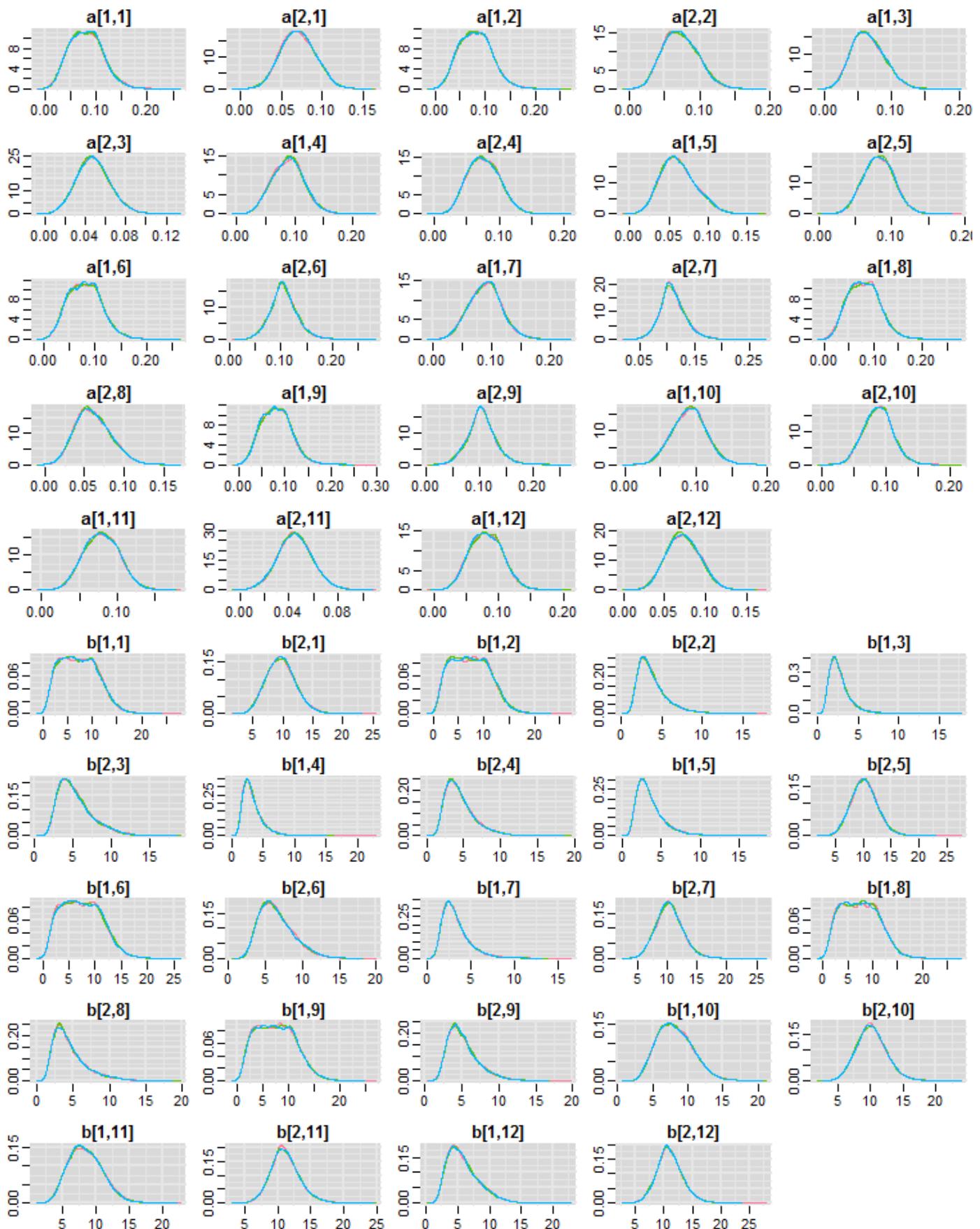
Chi² (p value) = 0.38 +/- 0.25



1.1.4 HBM site date

WAIC = 740, penalty parameter = 28.7

Chi² (p value) = 0.37 +/- 0.24



Trichoptera

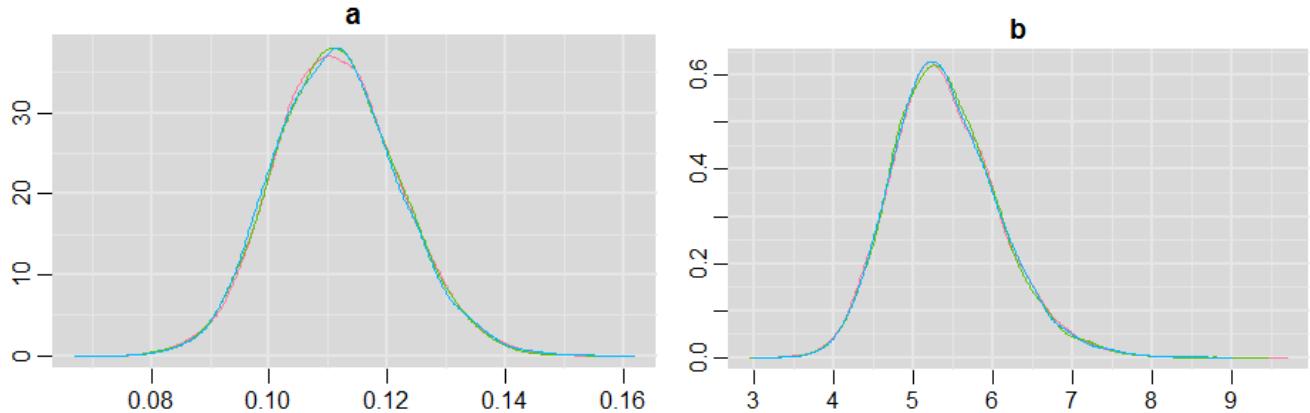
1.2 Exponential

$$\text{Abundance}_{s,t} = a_{s,t} \cdot \exp^{-b_{s,t} \cdot X} \quad (\text{eq. 1})$$

1.2.1 None HBM

WAIC = 913, penalty parameter = 10.8

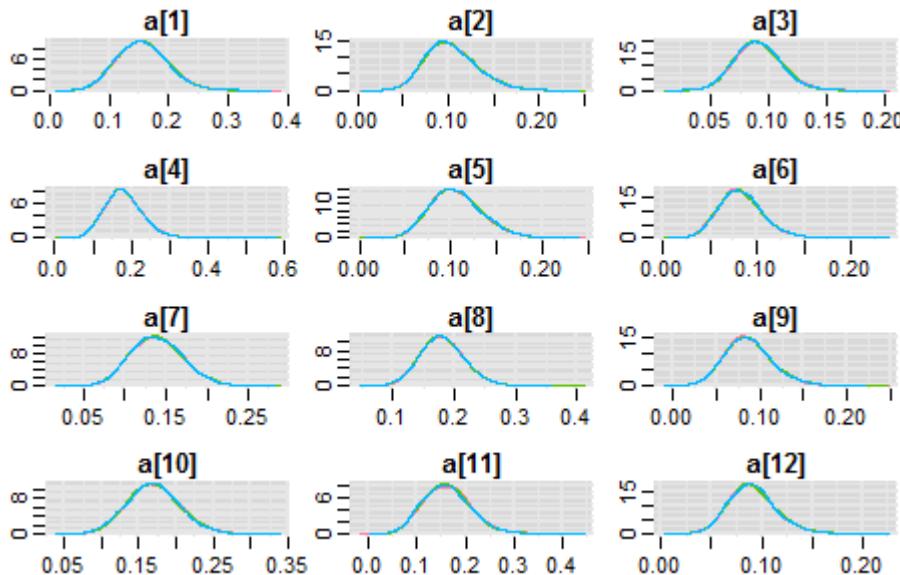
Chi² (p value) = 0.32 +/- 0.29

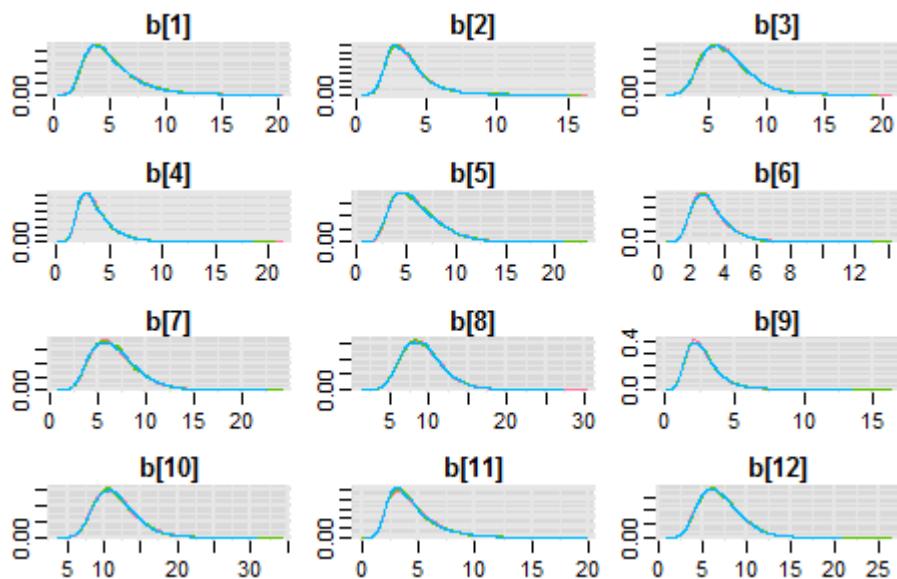


1.2.2 HBM site

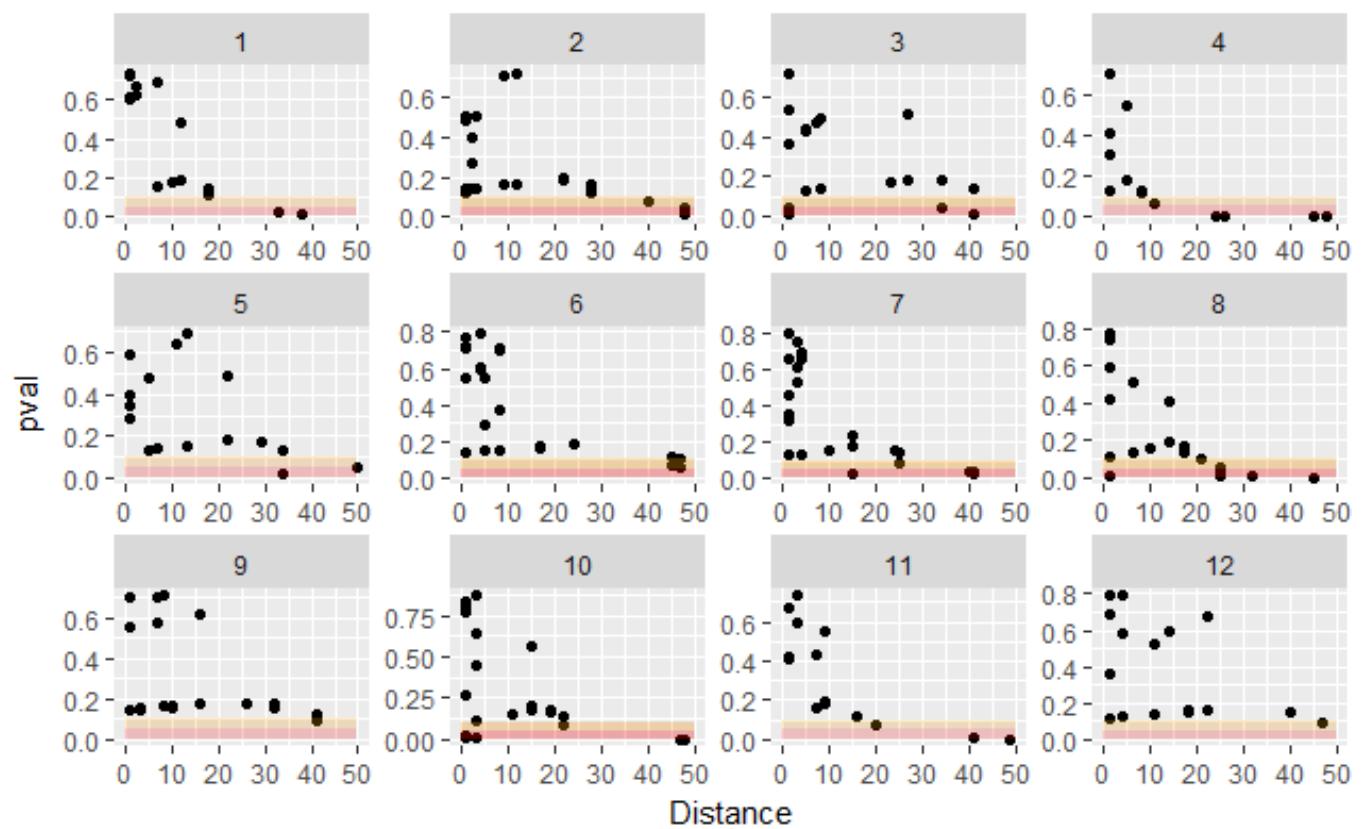
WAIC = 886.4, penalty parameter = 29.3

Chi² (p value) = 0.29 +/- 0.25





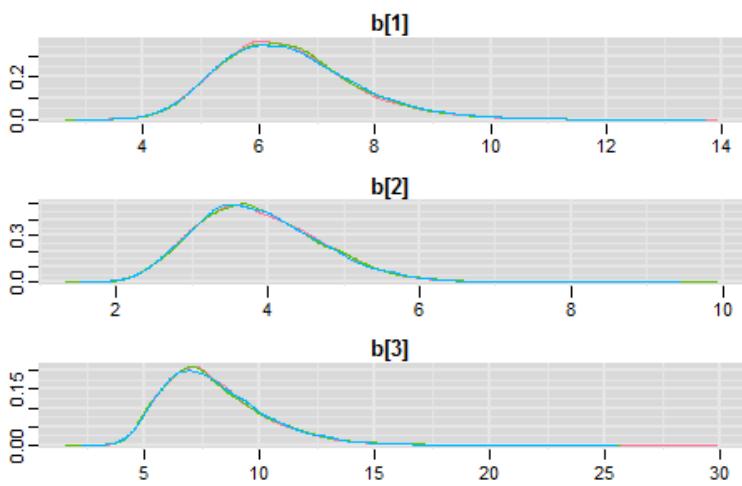
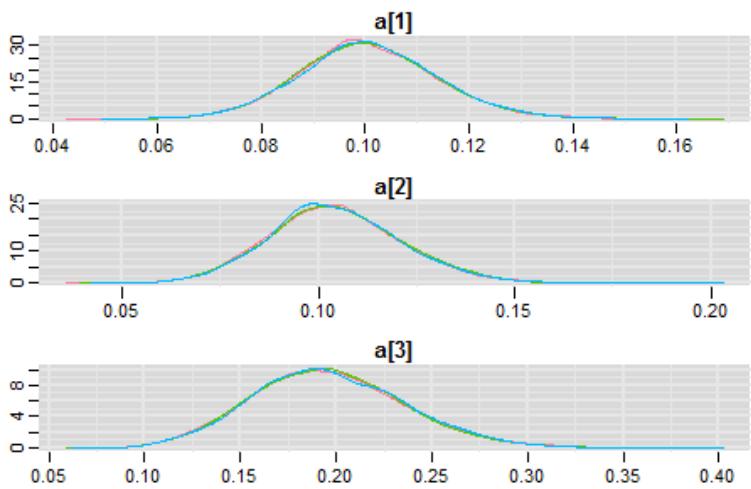
Discrepancy across sites



1.2.3 HBM date

WAIC = 904.7, penalty parameter = 16.8

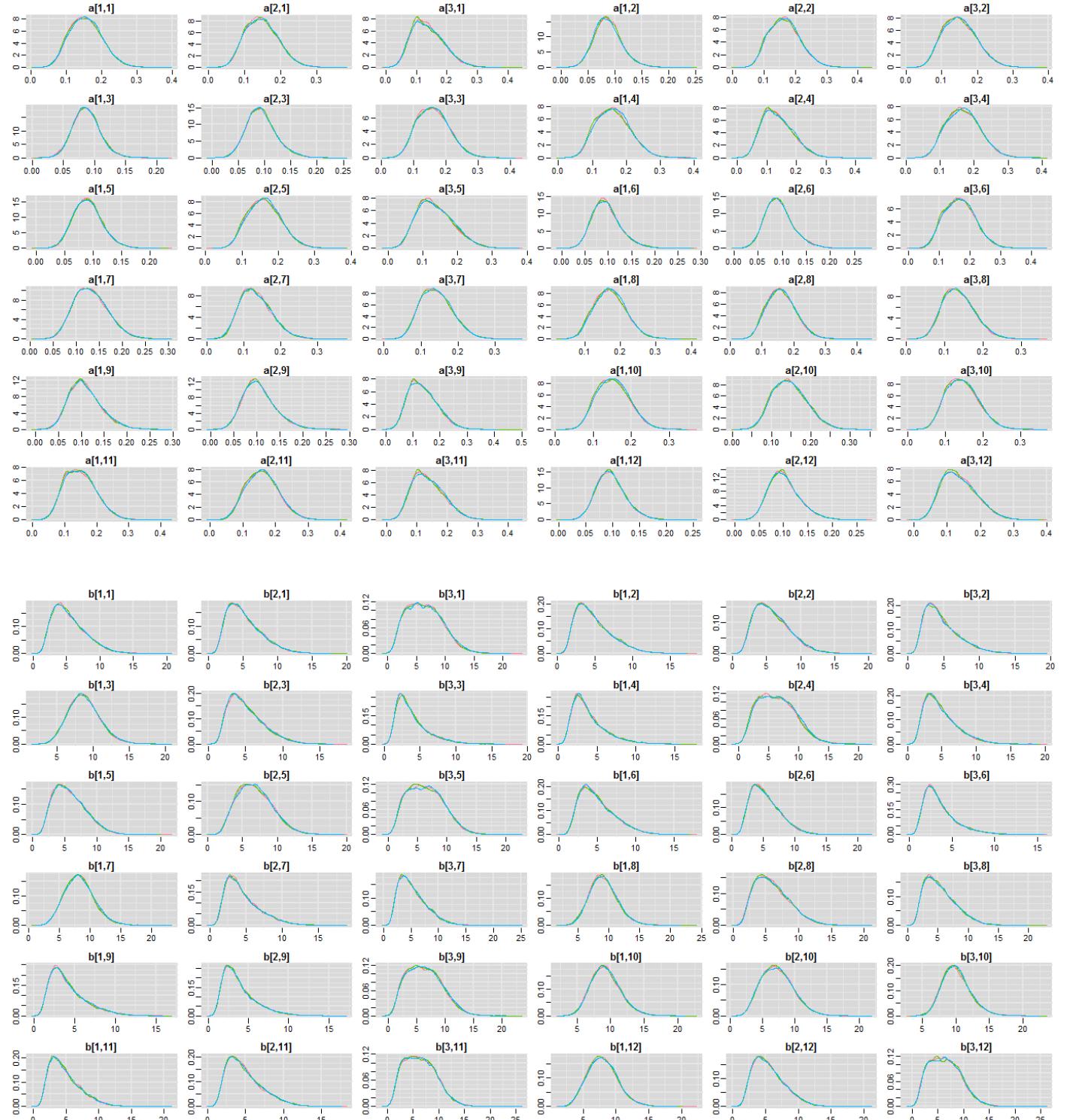
Chi^2 (p value) = 0.31 ± 0.28



1.2.4 HBM date + site

WAIC = 892.3, penalty parameter = 31.7

Chi^2 (p value) = 0.29 ± 0.25



Chironomidae

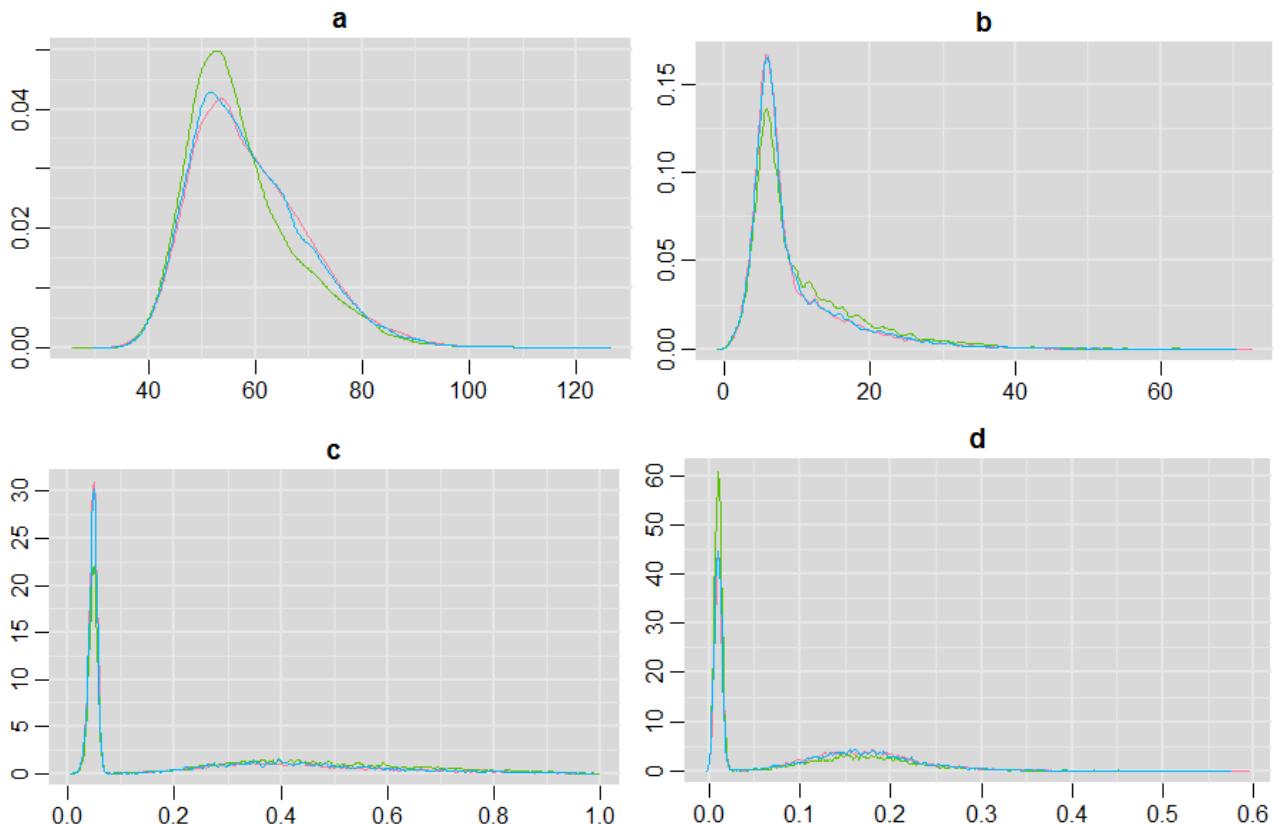
1.3 Local-maximum

$$\text{Abundance}_{s,t} = a_{s,t} \cdot \exp^{-d_{s,t} \cdot X} + b_{s,t} \cdot X \cdot \exp^{-c_{s,t} \cdot X} \quad (\text{eq. 2})$$

1.3.1 None HBM

WAIC = 5071.9, penalty parameter = 6.8

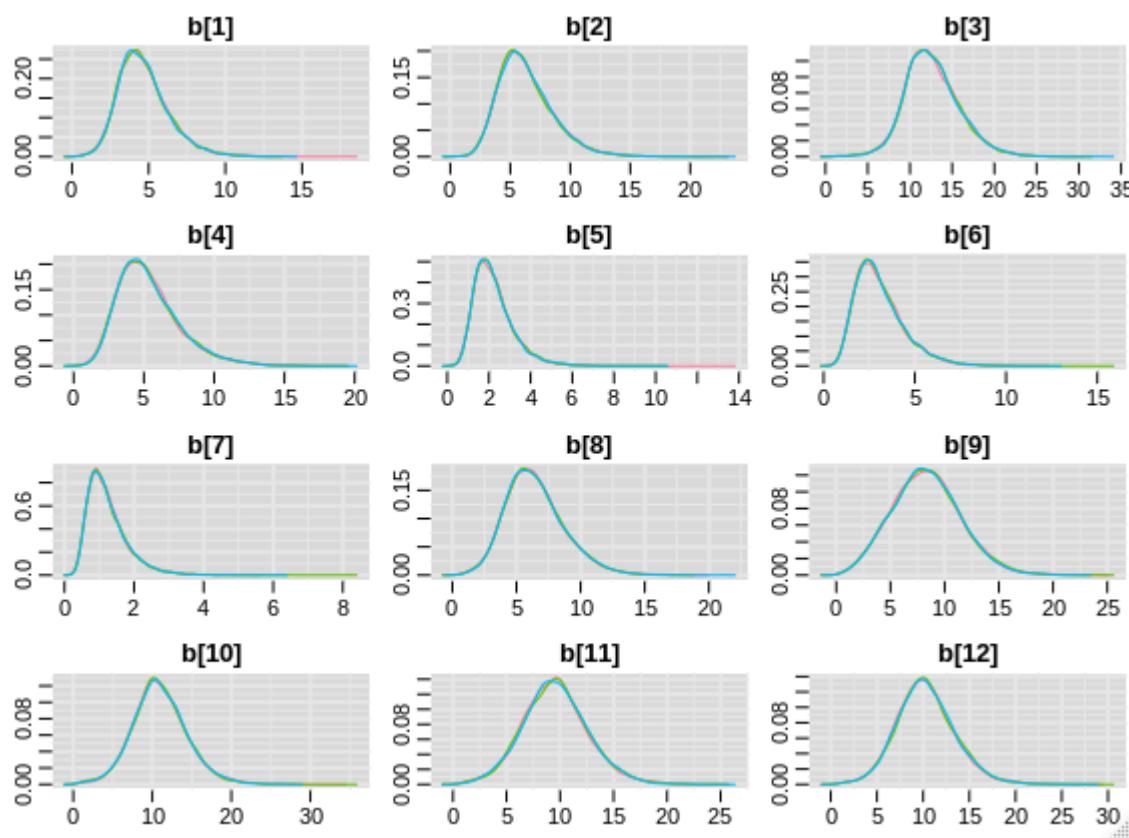
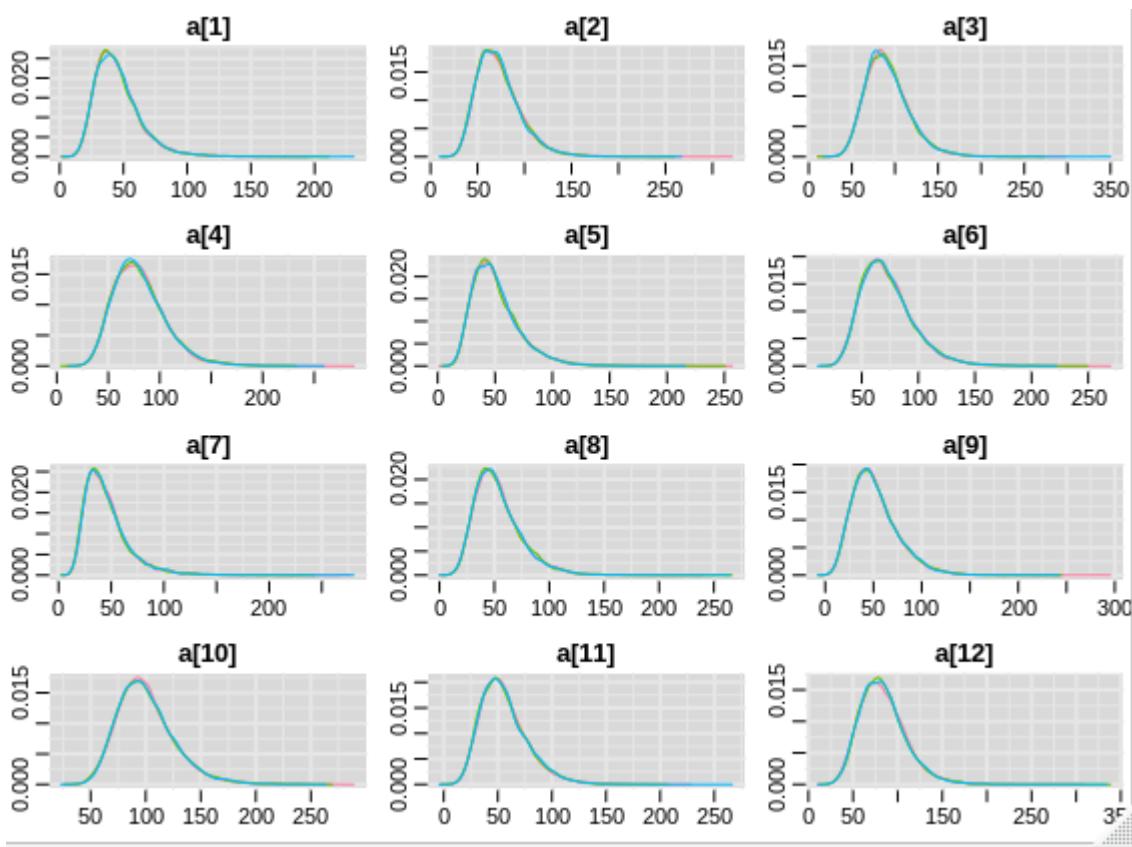
Chi² (p value) = 0.49 +/- 0.26

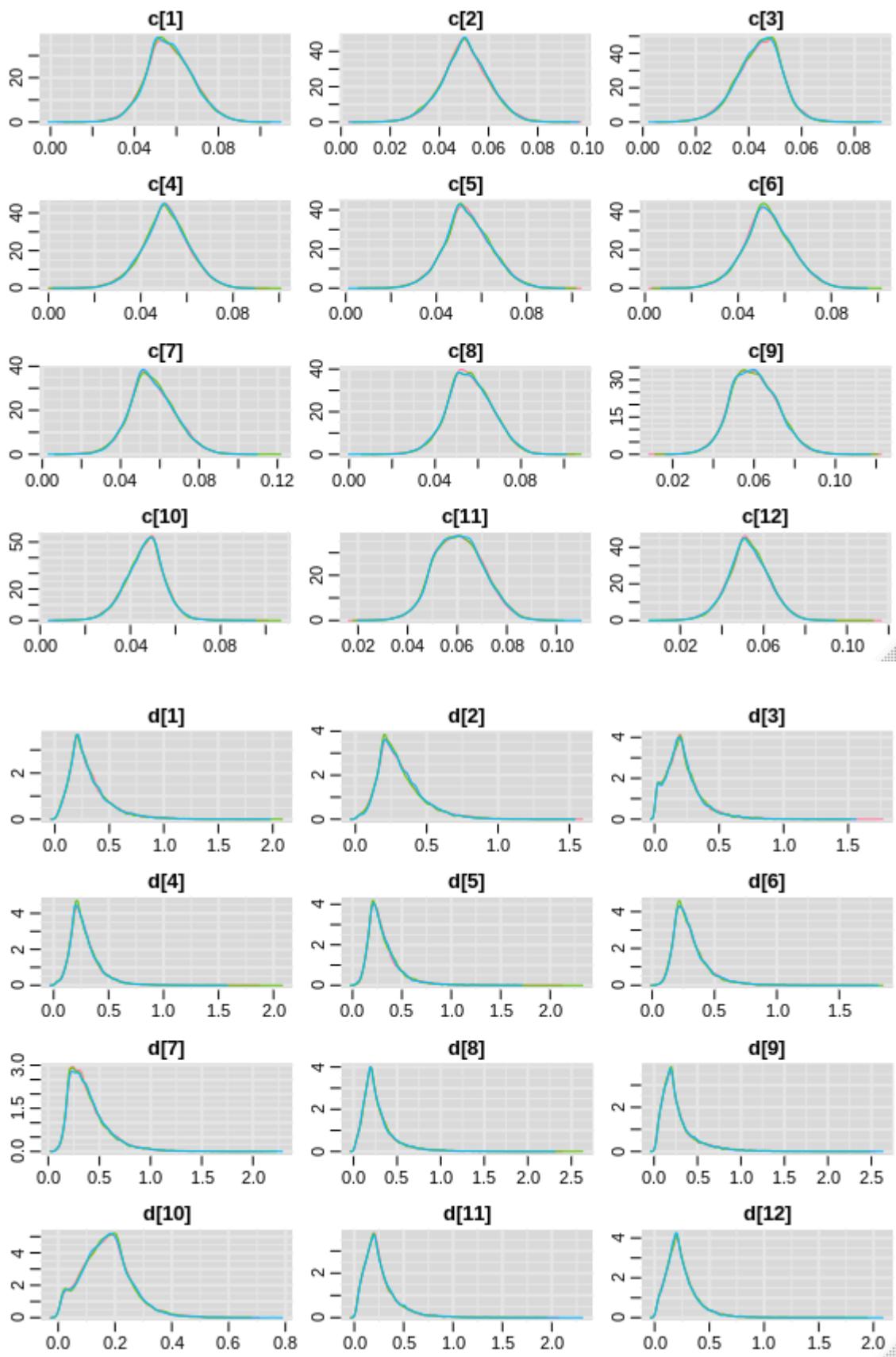


1.3.2 HBM site

WAIC = 4948.5, penalty parameter = 26.7

Chi² (p value) = 0.46 +/- 0.24

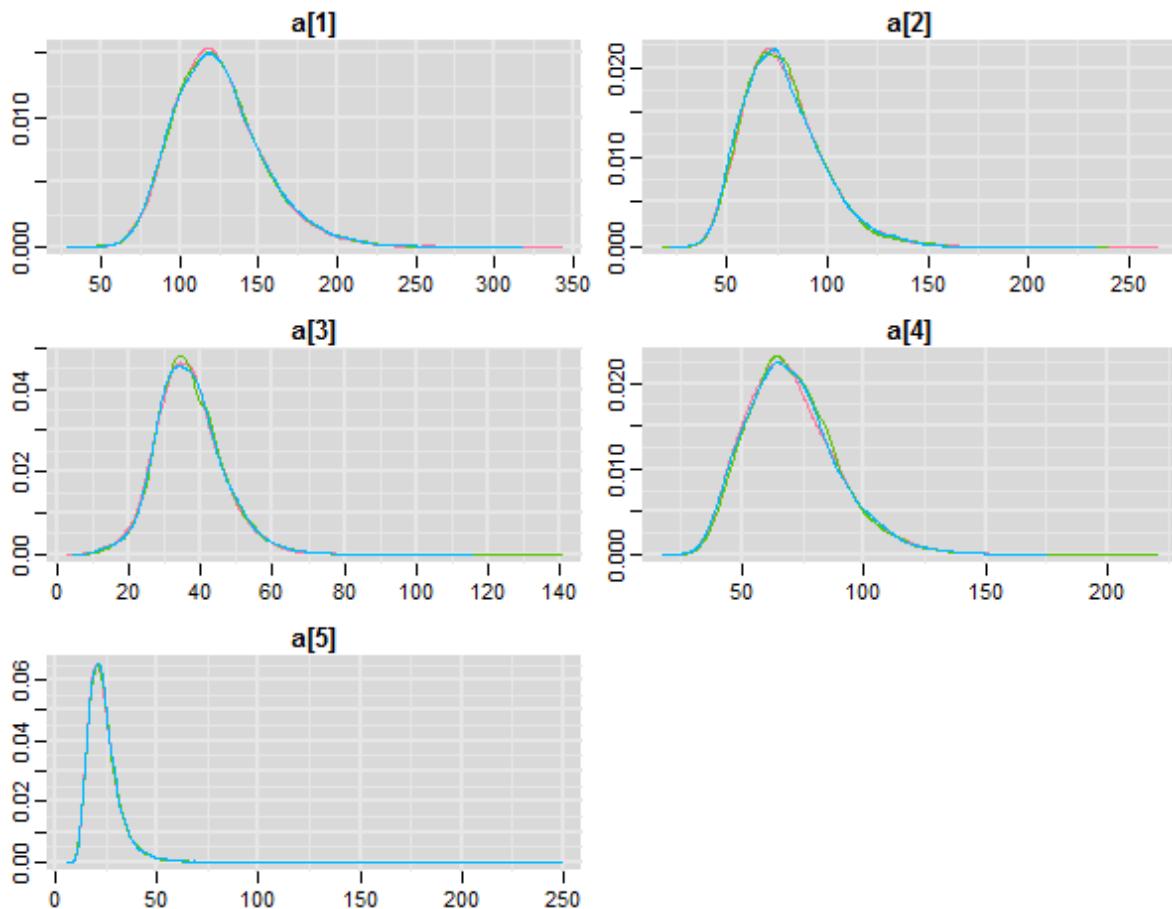


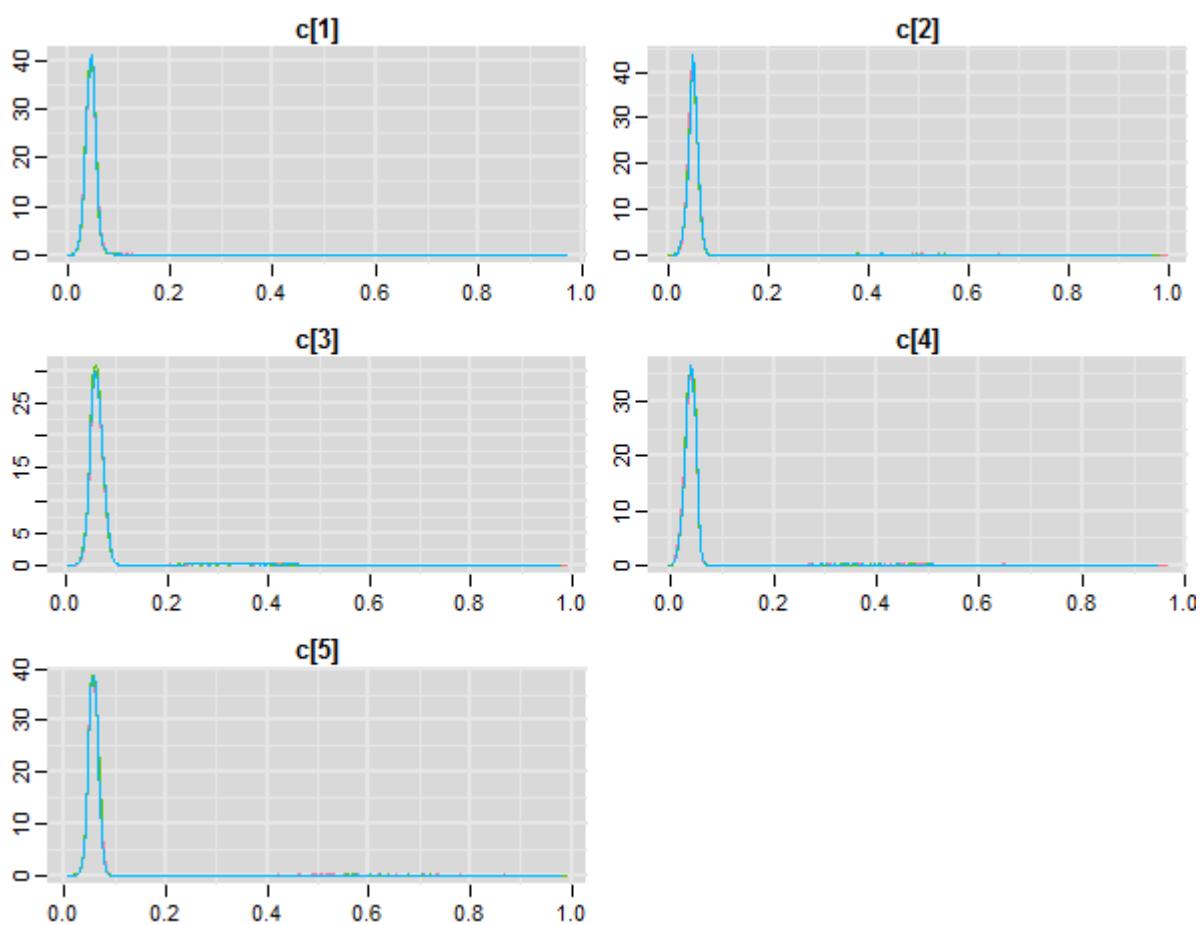
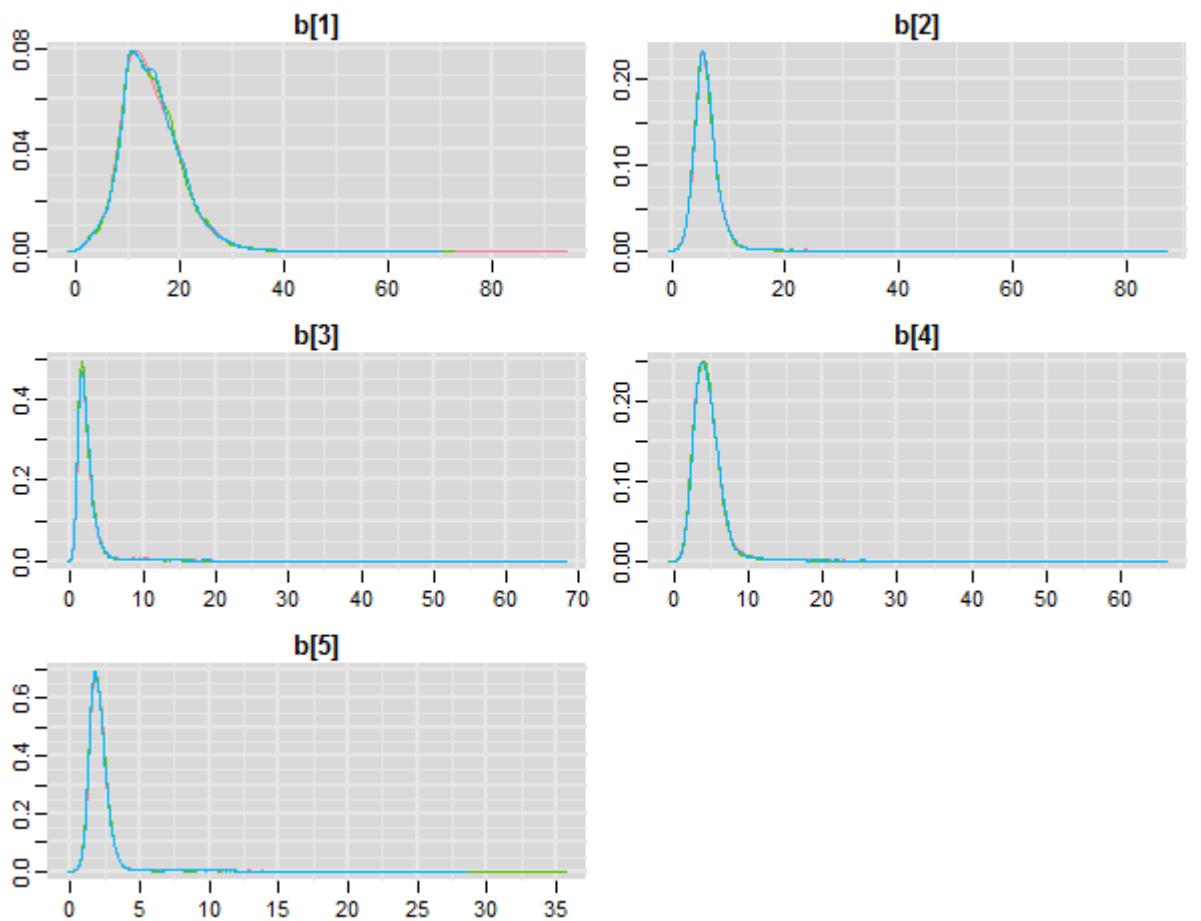


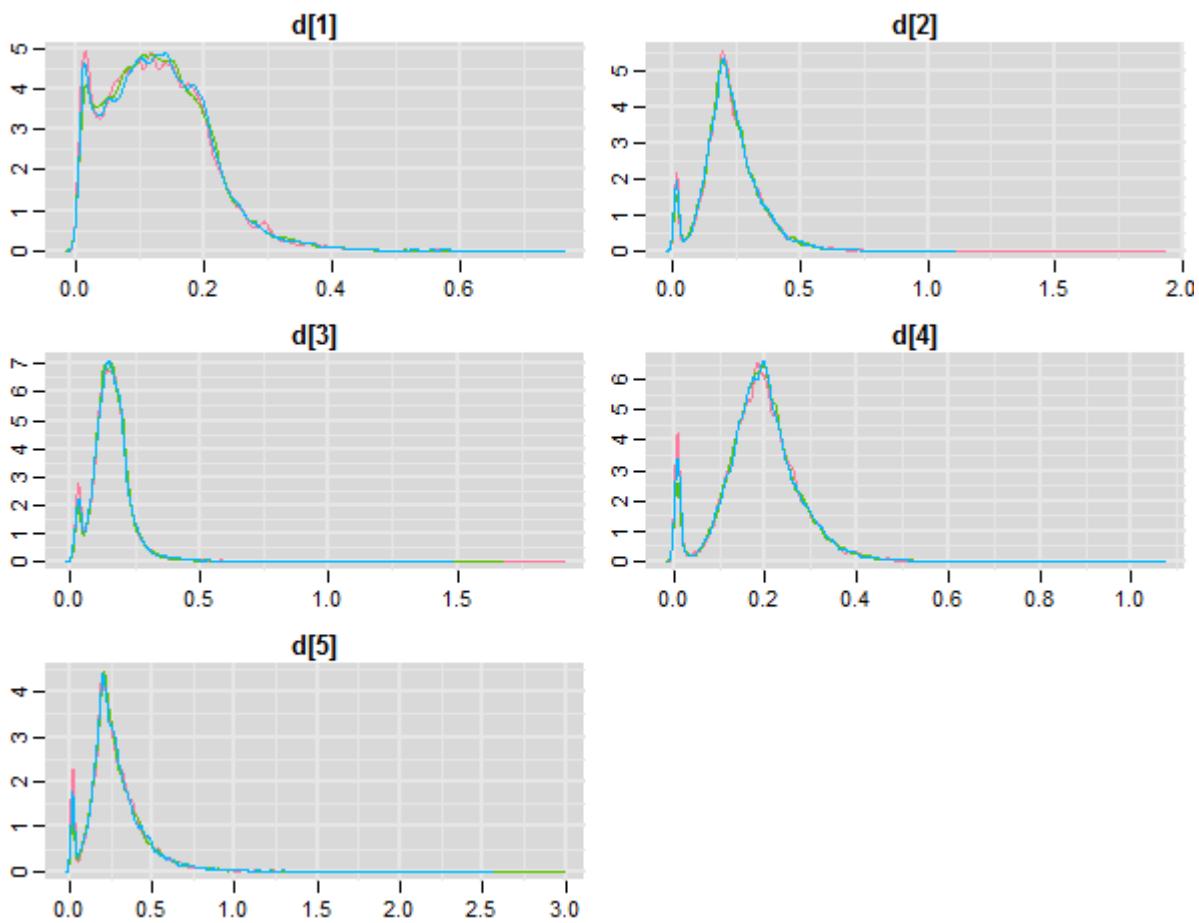
1.3.3 HBM date

WAIC = 4784.8, penalty parameter = 26.6

Chi² (p value) = 0.5 +/- 0.25



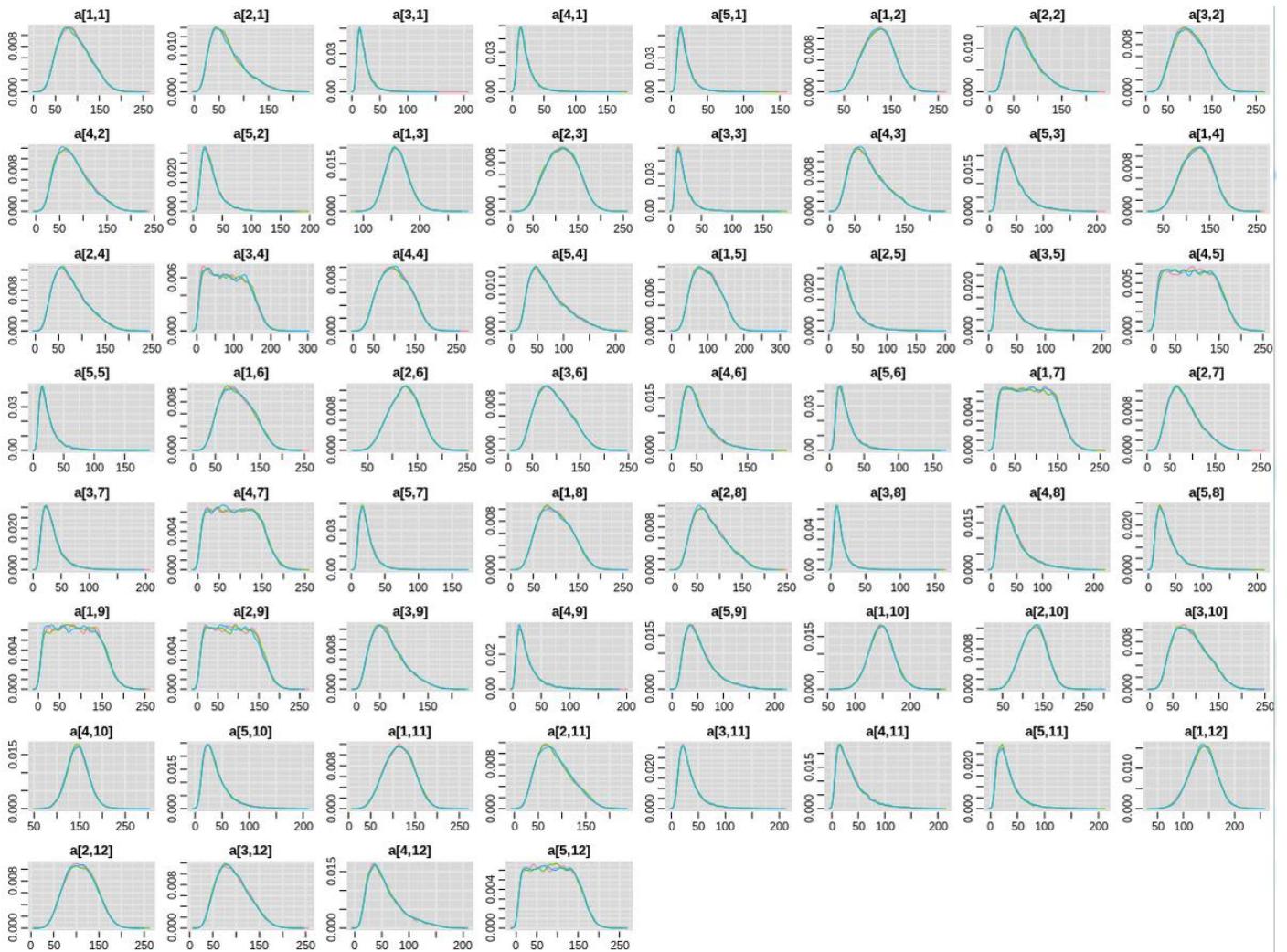


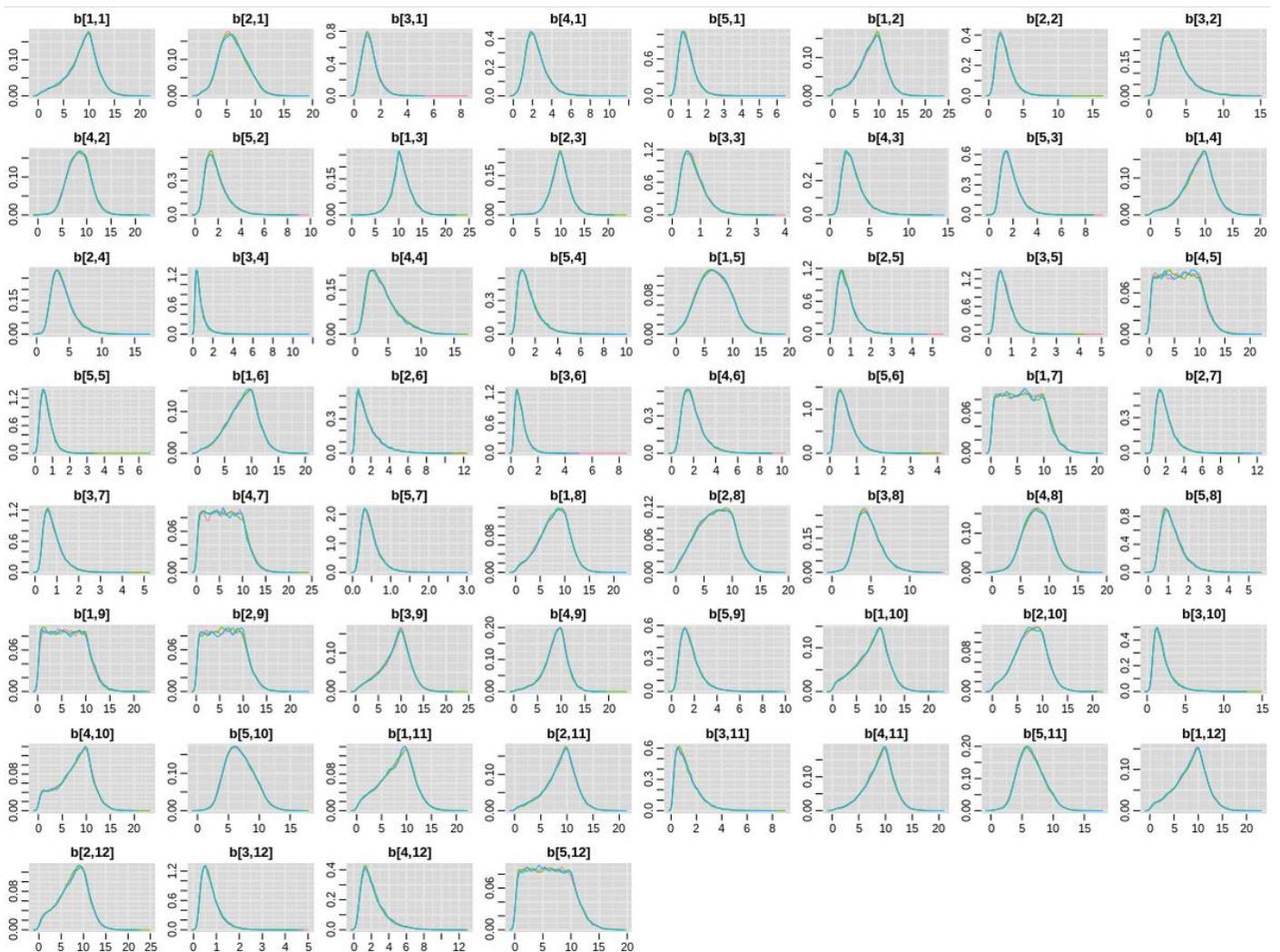


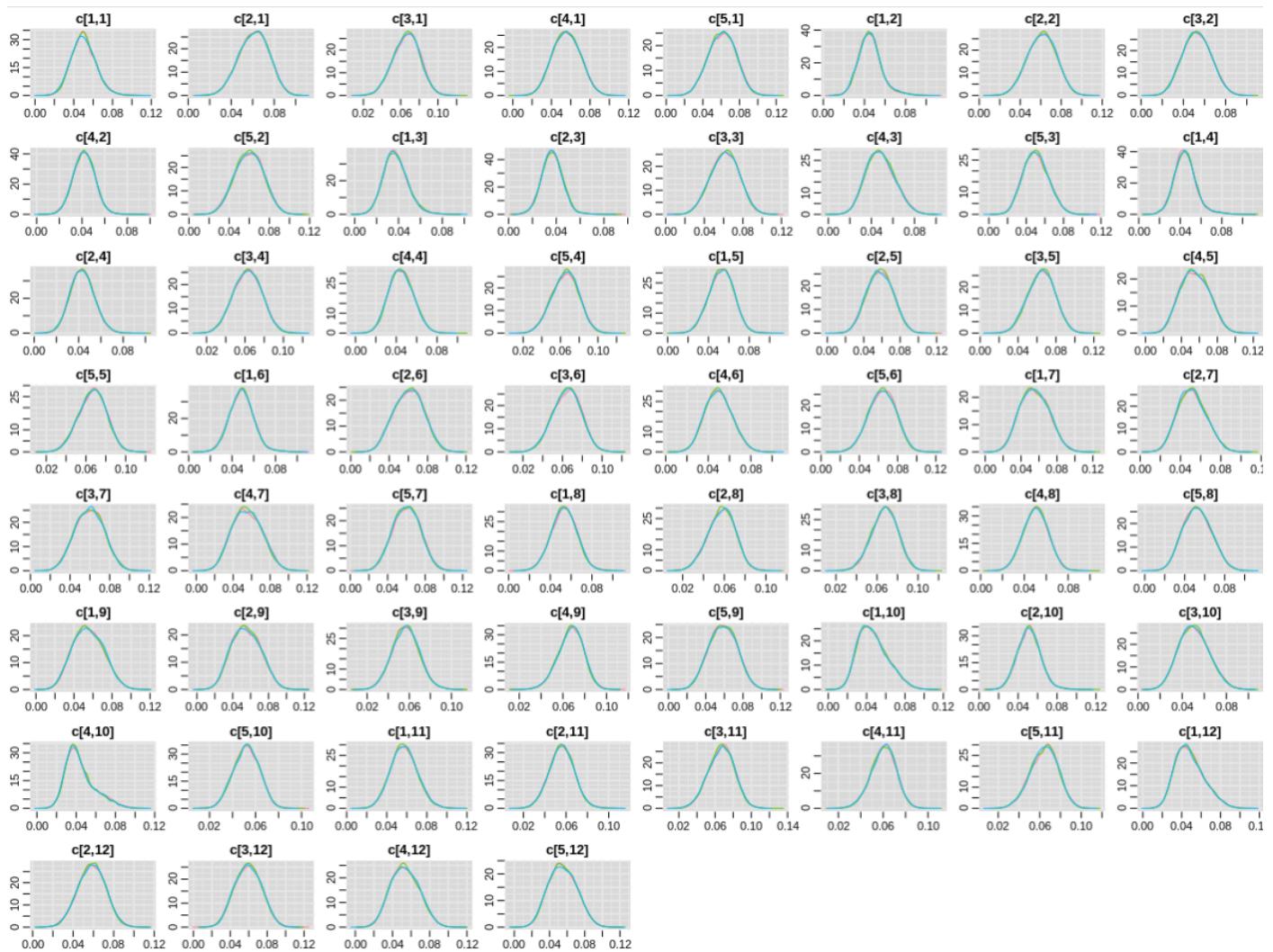
1.3.4 HBM date + site

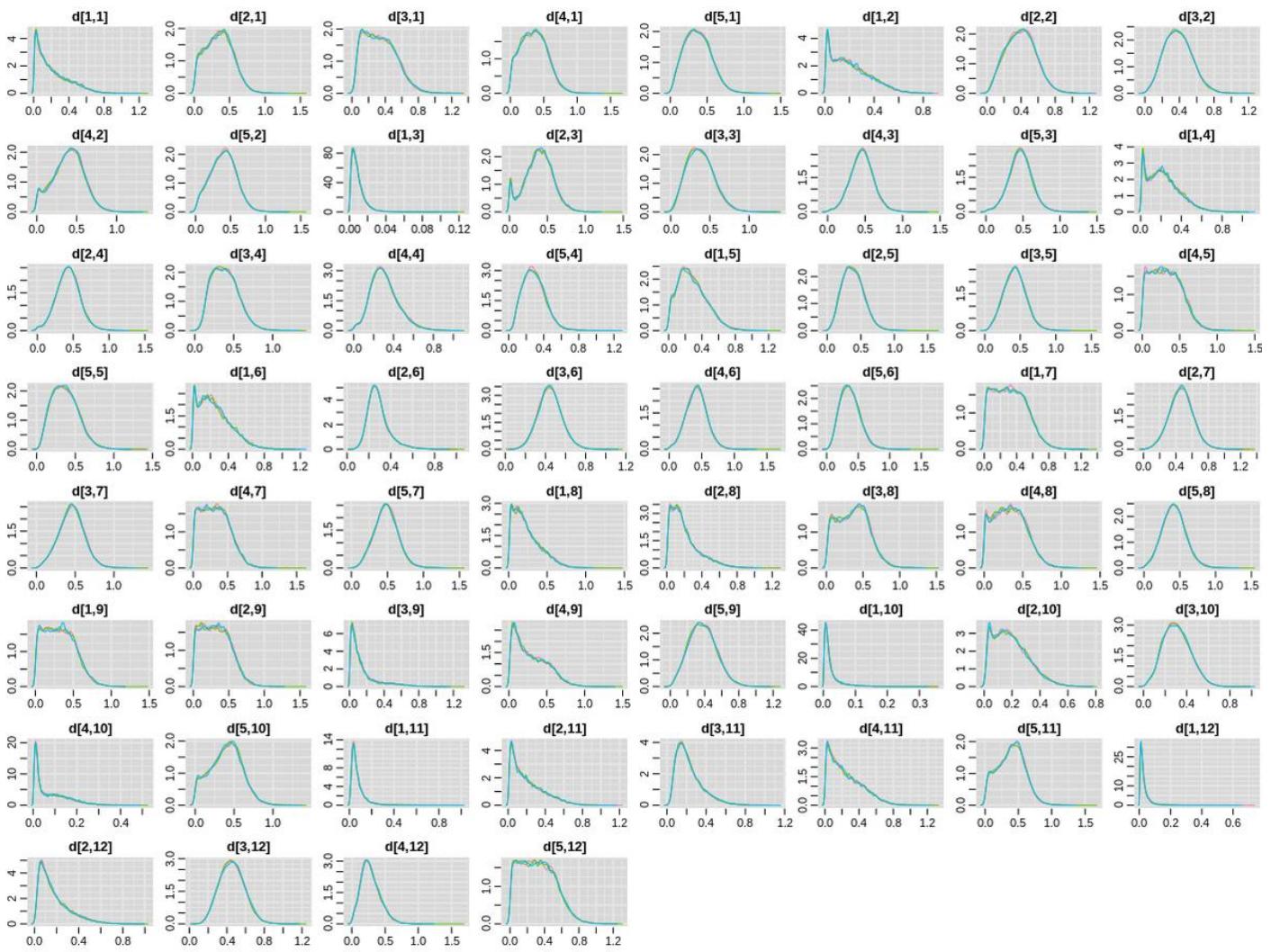
WAIC = 4373.3, penalty parameter = 95.2

Chi^2 (p value) = 0.5 +/- 0.2

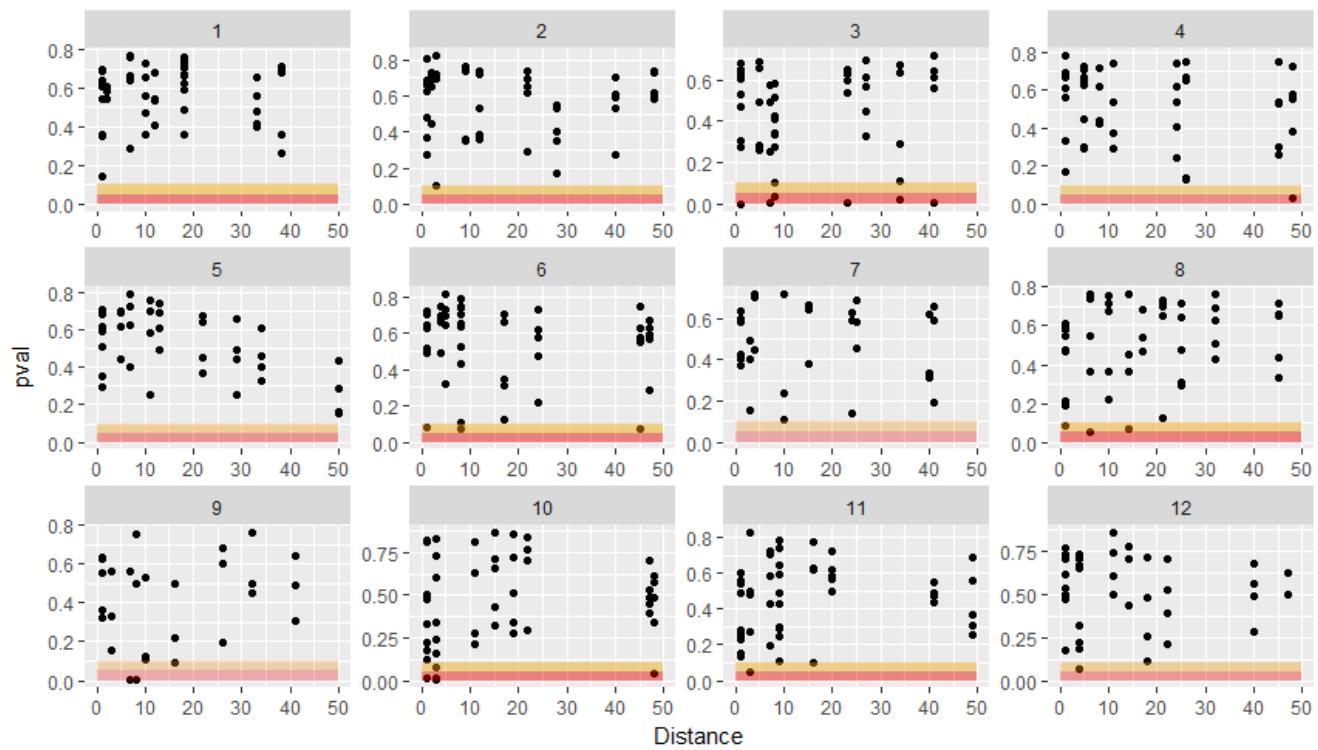








Discrepancy across sites



S5 . Sensitivity analysis : prior influence on prediction of deposition of dry mass

Because no information was available to generate informative priors for parameters, we assessed the sensitivity of our models to three sets of priors and hyperpriors distributions and values (table S5.1). We first explored data of dispersal for each taxonomic group and done a preliminary analysis of different values for each parameters to fit data to our models. For Ephemeroptera and Trichoptera, the exponential model was built on two parameters: “a” the slope of the decrease with growing distances, “b” the abundance when distance was 0m from stream. For Chironomidae, the model was built with two sets of parameters: a and b (same as exponential model), c and d defining the shape and slope of the potential plateau near the stream.

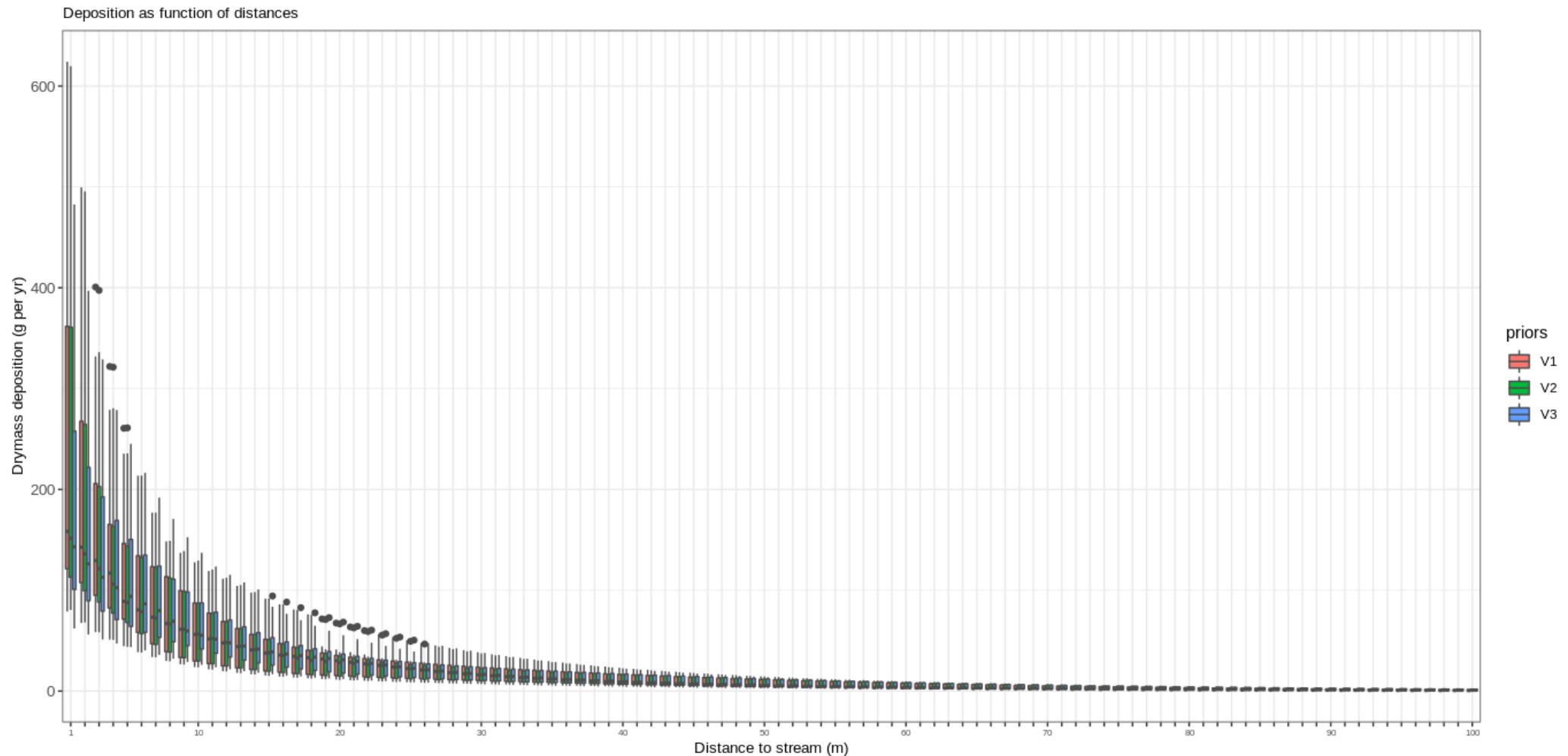
In V1, we first decided to run all the models with sets of uniform priors for each parameters. We chose the bound of distributions to best fit the data of dispersal we collected. In V2, we extended the bounds of the Uniform distribution to more large and vague values than defined in V1 to test the sensitivity of the posteriors estimates to those uniform priors. In V3, we used for each parameter and hyperparameter weakly informative prior distributions as suggested in Gelman (2014) or Lemoine (2019), and commonly used in hierarchical models (Lahoz-Monfort et al. 2011; Olmos et al. 2020).We thus defined Lognormal priors for both parameters for Ephemeroptera and Trichoptera models. We detected difficulties to converge when using large and uninformative Lognormal priors for parameters (a) and (c) of the alternative models with Chironomidae data. We assimilated this concern as characteristic of a dataset of Chironomidae dispersal with a great variability among and between sites or dates, associated with a complex model. We thus decided to kept previous uniforms and large priors (V2) for this model. For the alternative model, performing a preliminary analysis we found that, in the context of our data of Chironomidae dispersal, the plateau could only be modeled when values of the slope parameter “c” was restricted within an approximate range of [0,1].

Estimates of total aquatic insect dry mass (sum of biomass of Chironomidae, Ephemeroptera and Trichoptera) deposited on land from 1 to100 meters away from the stream edge are shown of figure S5.1 for all three sets of priors. We detected no differences of mean deposition of total aquatic drymass at each distance from the stream.

Table S5.1 : Priors definitions and values. U stands for uniform distribution, N stands for Normal distribution.

	Priors V1 & V2	Hyperprios V1	Hyperprios V2	Priors V3	Hyperprios V3
Ephemeroptera	a ~ U(a_min, a_max)	a_min ~ U(0, 0.1) a_max ~ U(0.1, 5)	a_min ~ U(0, 1) a_max ~ U(1, 100)	log_a ~ N(log_mu_a, sigma_a)	log_mu_a ~ N(0,0.1) sigma_a ~ U(0,2)
	b ~ U(b_min, b_max)	b_min ~ U(0, 5) b_max ~ U(5, 200)	b_min ~ U(0, 1) b_max ~ U(1, 1000)	log_b ~ N(log_mu_b, sigma_b)	log_mu_b ~ N(0,0.1) sigma_b ~ U(0,3)
Trichoptera	a ~ U(a_min, a_max)	a_min ~ U(0, 0.1) a_max ~ U(0.1, 5)	a_min ~ U(0, 1) a_max ~ U(1, 100)	log_a ~ N(log_mu_a, sigma_a)	log_mu_a ~ N(0,0.1) sigma_a ~ U(0,2)
	b ~ U(b_min, b_max)	b_min ~ U(0, 5) b_max ~ U(5, 200)	b_min ~ U(0, 1) b_max ~ U(1, 1000)	log_b ~ N(log_mu_b, sigma_b)	log_mu_b ~ N(0,0.1) sigma_b ~ U(0,3)
Chironomidae	a ~ U(a_min, a_max)	a_min ~ U(0, 50) a_max ~ U(50, 5000)	a_min ~ U(0, 1) a_max ~ U(1, 100)	a ~ U(a_min, a_max)	a_min ~ U(0, 1) a_max ~ U(1, 100)
	b ~ U(b_min, b_max)	b_min ~ U(0, 10) b_max ~ U(10, 200)	b_min ~ U(0, 1) b_max ~ U(1, 1000)	b ~ U(b_min, b_max)	b_min ~ U(0, 1) b_max ~ U(1, 1000)
	c ~ U(c_min, c_max)	c_min ~ U(0, 0.05) c_max ~ U(0.05, 1)	c_min ~ U(0, 0.1) c_max ~ U(0.1, 1)	c ~ U(c_min, c_max)	c_min ~ U(0, 0.1) c_max ~ U(0.1, 1)
	d ~ U(d_min, d_max)	d_min ~ U(0, 0.2) d_max ~ U(0.2, 10)	c_min ~ U(0, 1) c_max ~ U(1, 1000)	d ~ U(d_min, d_max)	d_min ~ U(0, 1) d_max ~ U(1, 1000)

Figure S5.1 Estimates of total aquatic insect dry mass (sum of biomass of Chironomidae, Ephemeroptera and Trichoptera) deposited on land 1-100 m from the stream edge, in kg DM ha⁻¹ yr⁻¹. The boxplot at each distance shows inter-site variation in median deposition estimated using Bayesian posterior distribution of parameters. Red boxplots were built with the model running V1 priors, green boxplots with V2 priors and blue boxplots with V3 priors.



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