Supporting Material

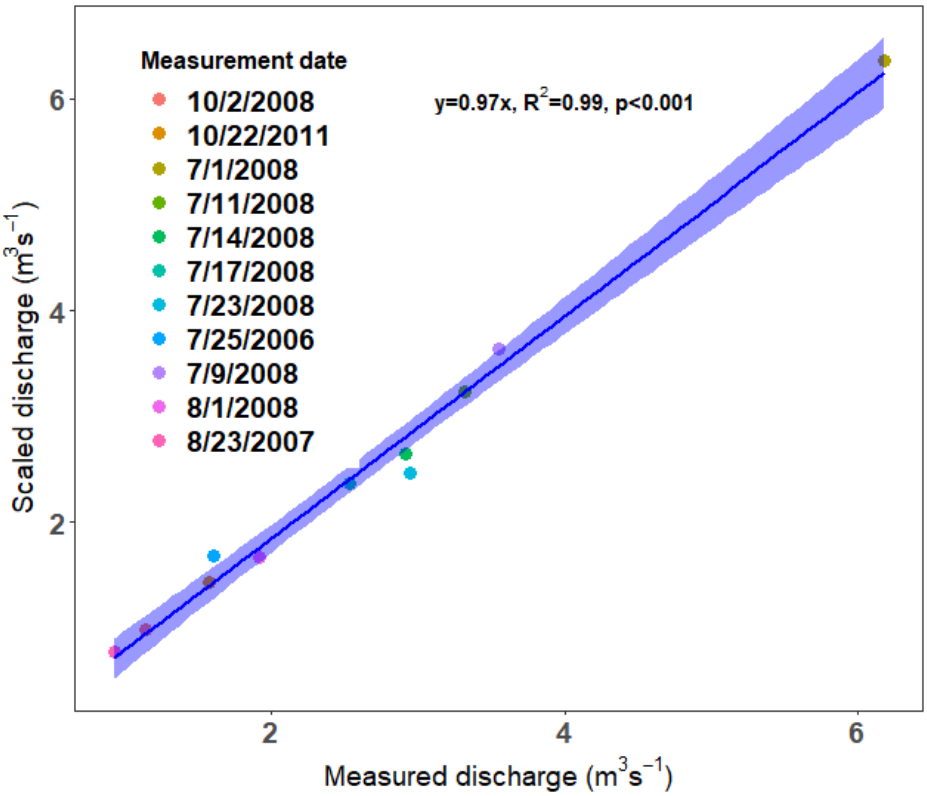

Figure S1: Comparison between discharge measured at the study site and area−scaled and predicted by VIC model.

Sediment mobility analysis

We calculated the local grain mobility by comparing the discharge-dependent cell shear stress, τ, predicted by the hydraulic numerical model, with the critical shear stress ($\tau_{c,i}$) for the i-*th* sediment grain, such that d_i is mobile when $R_{m,i}= \tau/\tau_{c,i}>1$. The streambed extent with d_i mobile is then quantified by summing the cells with $R_{m,i}>1$. Grain size heterogeneity gives rise to hiding/shielding effect, which reduces the mobility of small particles that are sheltered by large grains from the flow, while the large particles result more mobile because they are more exposed to the flow. To account for this mixed grain size effect, we estimated the dimensionless critical

shear stress ($\tau^*_{c,i}$) for each grain diameter (d_i) using the method of *Andrews and Parker* (1987) for surface material:

$$\tau^*_{c,i} = \theta_c \left(\frac{d_i}{d_{50}} \right)^m \quad \text{(S1)}$$

with d_{50} the surface grain median diameter for a sediment patch of a cell, and θ_c is the critical dimensionless Shields stress of the median grain size on the bed surface with value $\theta_c = 0.0455$ and the exponent $m = -0.9067$. The critical shear stress for each grain diameter is then:

$$\tau_{c,i} = \tau^*_{c,i}\, g\, (\rho_s - \rho_w)\, d_i \quad \text{(S2)}$$

where g = 9.8 m·s^{-2}, and ρ_s and ρ_w are density of the sediment (2650 kg·m^{-3}) and of water (1000 kg·m^{-3}), respectively. We defined 8 grain sizes, one for sand and 7 for gravel with d= 0.001, 0.003, 0.006, 0.011, 0.023, 0.045, 0.064, and 0.091 m and we analyzed their mobility in each cell. Figure S1a shows the fraction of streambed where each grain is potentially mobile with d_{50}=0.04m, while Figure S2 shows the fraction of streambed where sand class (d=0.001 m) is potentially mobile if the streambed was characterized by d_{50} with values 0.005, 0.01, 0.02, 0.03, 0.04, 0.05, 0.06 and 0.07m. The former graph shows that coarser grains are most likely not mobile thus the streambed should likely maintain this morphology, while the latter that sand is barely mobile at low flows.

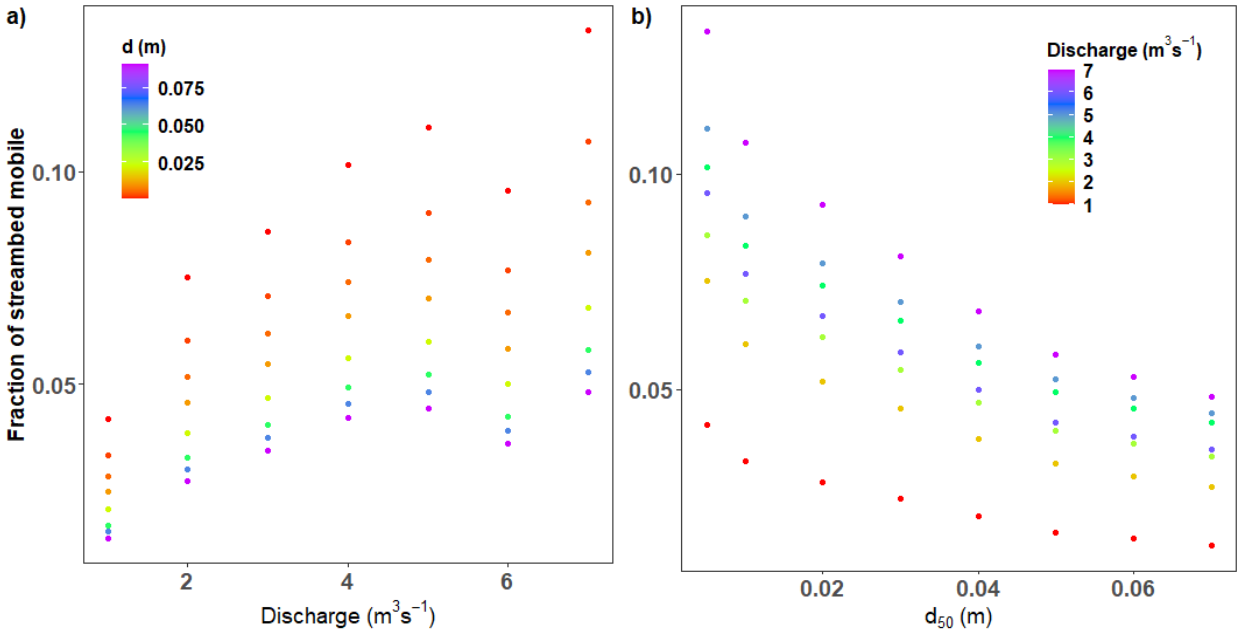

Figure S2: Fraction of streambed mobile (a) for different grain sizes at a spatially constant d_{50}=0.04 m over different discharges and (b) for the sand class (d=0.001 m) at different discharges for increasing size of the median grain size of the streambed d_{50}.

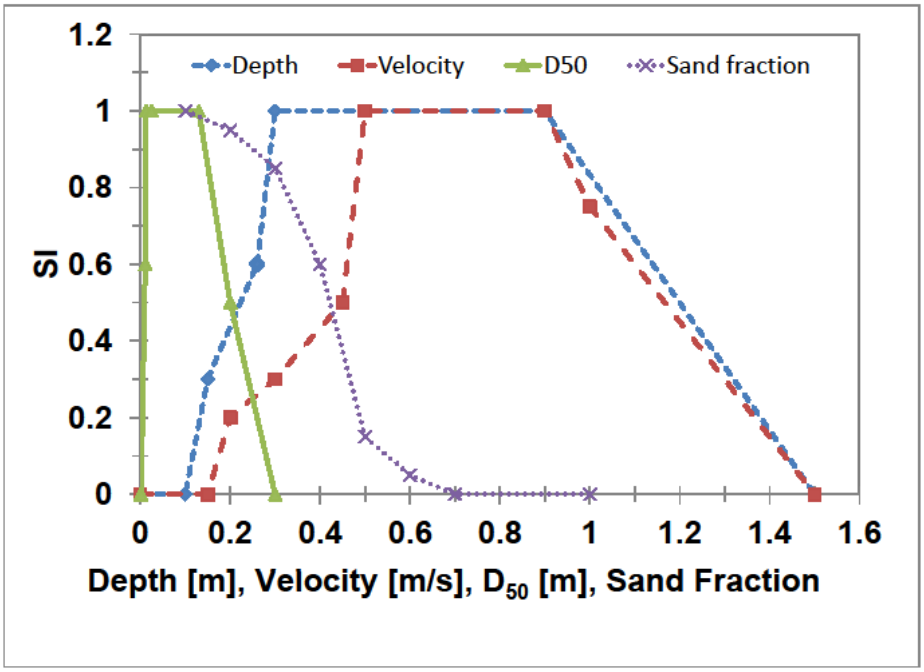

Figure S3: Habitat suitability indices (SI) for Chinook salmon spawning and rearing: A) velocity, B) depth, C) substrate grain size (spawning only) and sand percentage (spawning only).

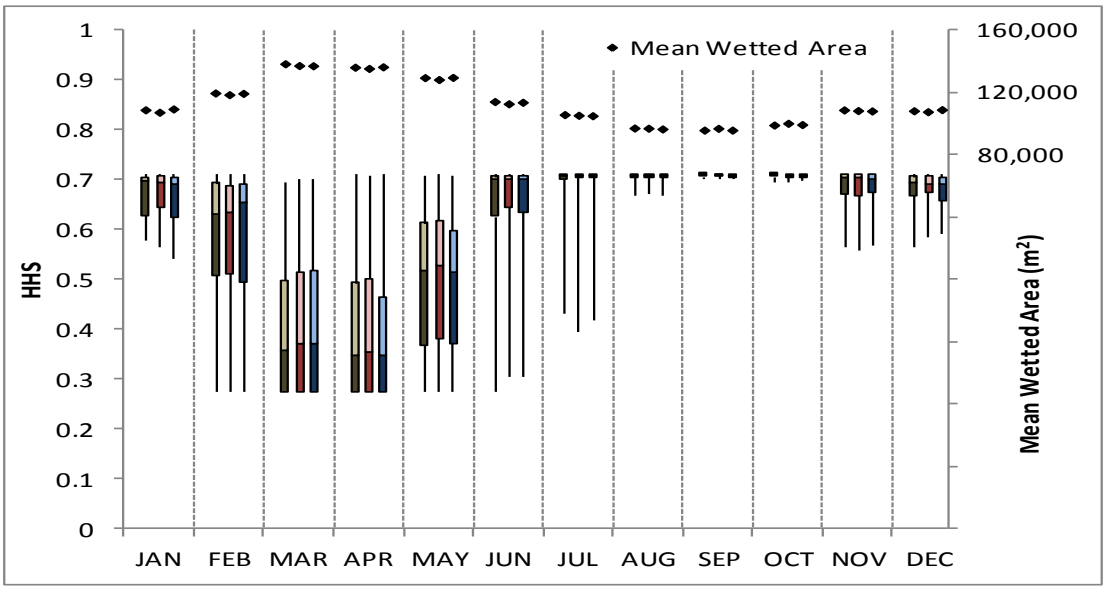

Figure S4: Box-and-whiskers plot of rearing HHS and mean wetted area for far future (FF; 2051-2090) A1B (left, brown hue whiskers), B1 (center, red hue whiskers) and Ensemble GCM (right, blue hue whiskers) models. Box gradations represent the 25, 50 and 75th percentiles. Whisker extents represent the maximum and minimum observed values.

Table S1: Near Future (NF; 2011-2050) and Far Future (FF; 2051-2090) A1B discharge statistics for each month at the Bear Valley Creek study site.

	Climate Scenario A1B 2011-2050 (NF)											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
N	40	40	40	40	40	40	40	40	40	40	40	40
Mean	1.19	1.55	4.17	7.75	7.57	3.53	1.41	0.71	0.67	0.82	1.69	1.23
Std Error	0.12	0.15	0.52	0.51	0.67	0.40	0.13	0.03	0.04	0.05	0.12	0.10
Median	1.03	1.16	2.99	8.51	7.41	2.75	1.13	0.71	0.64	0.77	1.68	1.05
Std Dev	0.75	0.93	3.35	3.30	4.30	2.56	0.83	0.18	0.28	0.32	0.80	0.65
Variance	0.56	0.86	11.26	10.86	18.47	6.57	0.70	0.03	0.08	0.11	0.63	0.43
Kurtosis	1.59	1.09	6.71	-1.28	0.82	1.05	9.52	1.32	-0.68	-0.51	-0.43	0.03
Skewness	1.26	1.32	2.27	-0.33	0.85	1.30	2.57	0.54	0.56	0.42	0.55	0.96
Range	3.05	3.60	16.71	10.84	19.14	9.96	4.72	0.91	0.99	1.22	3.08	2.29
Min	0.39	0.55	1.31	1.62	1.14	0.92	0.45	0.36	0.26	0.26	0.49	0.44
25 Perc	0.58	0.80	1.75	4.84	4.56	1.66	0.89	0.61	0.44	0.60	1.07	0.69
75 Perc	1.62	1.84	5.61	10.67	8.72	5.08	1.70	0.80	0.83	1.00	2.42	1.62
Max	3.43	4.15	18.02	12.46	20.28	10.88	5.17	1.27	1.26	1.48	3.57	2.73
	Climate Scenario A1B 2051-2090 (FF)											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
N	40	40	40	40	40	40	40	40	40	40	40	40
Mean	1.46	2.79	7.60	6.80	4.81	2.02	1.20	0.67	0.61	0.76	1.45	1.40
Std Error	0.13	0.30	0.75	0.53	0.53	0.26	0.11	0.04	0.04	0.05	0.12	0.11
Median	1.43	2.30	6.92	7.14	3.53	1.38	1.02	0.63	0.54	0.76	1.12	1.30
Std Dev	0.80	1.91	4.72	3.36	3.34	1.62	0.70	0.28	0.28	0.29	0.73	0.68
Variance	0.64	3.65	22.25	11.31	11.17	2.62	0.49	0.08	0.08	0.09	0.53	0.46
Kurtosis	-1.27	2.98	-0.38	-0.90	1.68	7.68	15.80	8.02	-0.83	-0.28	-0.46	-0.44
Skewness	0.31	1.55	0.66	0.23	1.33	2.71	3.43	2.27	0.57	0.28	0.74	0.38
Range	2.47	8.83	17.13	11.94	14.92	7.73	4.35	1.59	1.00	1.25	2.54	2.65
Min	0.39	0.54	1.46	0.78	0.61	0.79	0.33	0.27	0.23	0.19	0.44	0.33
25 Perc	0.66	1.51	3.73	3.81	2.50	1.21	0.82	0.52	0.39	0.52	0.92	0.91
75 Perc	2.27	3.63	10.68	8.91	6.60	2.36	1.33	0.72	0.82	0.95	1.81	1.83
Max	2.86	9.37	18.59	12.72	15.53	8.53	4.69	1.86	1.24	1.44	2.98	2.98

Table S2: Near Future (NF; 2011-2050) and Far Future (FF; 2051-2090) B1 discharge statistics for each month at the Bear Valley Creek study site.

	Climate Scenario B1 2011-2050 (NF)											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
n	40	40	40	40	40	40	40	40	40	40	40	40
Mean	1.11	1.50	4.06	7.46	7.20	3.28	1.34	0.70	0.72	0.89	1.63	1.18
Std Error	0.12	0.15	0.52	0.50	0.65	0.38	0.13	0.03	0.05	0.05	0.12	0.10
Median	1.03	1.12	2.89	8.42	6.90	2.43	1.04	0.68	0.67	0.84	1.59	0.99
Std Dev	0.76	0.95	3.36	3.19	4.16	2.46	0.82	0.18	0.30	0.35	0.76	0.64
Variance	0.58	0.90	11.29	10.20	17.33	6.04	0.67	0.03	0.09	0.12	0.58	0.41
Kurtosis	2.18	1.79	7.34	-1.28	0.61	1.38	9.47	1.17	-0.77	-0.69	-0.57	0.08
Skewness	1.49	1.47	2.36	-0.32	0.87	1.40	2.61	0.68	0.52	0.37	0.52	0.99
Range	2.96	3.88	16.93	10.43	17.66	9.58	4.59	0.90	1.02	1.26	2.92	2.26
Min	0.32	0.49	1.27	1.54	1.06	0.93	0.45	0.36	0.29	0.29	0.48	0.42
25 Perc	0.50	0.78	1.73	4.49	4.16	1.49	0.88	0.59	0.48	0.63	1.00	0.67
75 Perc	1.45	1.72	5.42	10.17	8.39	4.83	1.59	0.81	0.93	1.10	2.27	1.54
Max	3.28	4.37	18.20	11.97	18.72	10.51	5.04	1.26	1.31	1.55	3.40	2.68

	Climate Scenario B1 2051-2090 (FF)											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
n	40	40	40	40	40	40	40	40	40	40	40	40
Mean	1.32	2.62	7.18	6.54	4.51	1.85	1.16	0.66	0.66	0.82	1.41	1.35
Std Error	0.12	0.29	0.69	0.51	0.48	0.23	0.13	0.04	0.05	0.05	0.11	0.10
Median	1.32	2.18	6.54	7.01	3.38	1.29	0.99	0.61	0.59	0.81	1.12	1.25
Std Dev	0.75	1.85	4.38	3.21	3.06	1.48	0.82	0.28	0.30	0.31	0.72	0.65
Variance	0.56	3.41	19.21	10.31	9.36	2.20	0.68	0.08	0.09	0.10	0.52	0.42
Kurtosis	-0.90	3.00	-0.71	-0.92	1.40	7.78	24.35	7.30	-0.77	-0.47	-0.25	-0.42
Skewness	0.42	1.61	0.55	0.19	1.26	2.74	4.49	2.20	0.54	0.22	0.82	0.37
Range	2.63	8.41	15.49	11.73	13.52	7.01	5.36	1.56	1.08	1.24	2.62	2.47
Min	0.35	0.50	1.33	0.73	0.56	0.73	0.33	0.26	0.23	0.21	0.42	0.32
25 Quart	0.67	1.55	3.52	3.70	2.44	1.09	0.77	0.51	0.42	0.58	0.90	0.91
75 Quart	1.92	3.54	9.69	8.70	6.14	2.13	1.24	0.71	0.90	1.02	1.81	1.73
Max	2.99	8.91	16.82	12.46	14.09	7.74	5.69	1.82	1.31	1.45	3.05	2.79

Table S3: Near Future (NF; 2011-2050) and Far Future (FF; 2051-2090) Ensemble Mean discharge statistics for each month at the Bear Valley Creek study site.

	Climate Scenario Ensemble Mean 2011-2050 (NF)											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
n	40	40	40	40	40	40	40	40	40	40	40	40
Mean	1.23	1.53	3.94	7.94	7.68	3.41	1.28	0.68	0.67	0.84	1.59	1.25
Std Error	0.12	0.15	0.48	0.53	0.68	0.39	0.12	0.03	0.04	0.05	0.11	0.10
Median	1.10	1.18	2.82	9.35	7.79	2.56	1.07	0.67	0.61	0.81	1.62	1.07
Std Dev	0.79	0.95	3.10	3.39	4.32	2.51	0.75	0.17	0.27	0.33	0.72	0.66
Variance	0.62	0.89	9.58	11.52	18.68	6.28	0.56	0.03	0.07	0.11	0.52	0.43
Kurtosis	1.92	1.38	5.18	-1.33	0.28	1.76	8.81	1.33	-0.72	-0.63	-0.65	0.45
Skewness	1.33	1.39	2.04	-0.30	0.75	1.44	2.48	0.69	0.57	0.37	0.43	1.04
Range	3.21	3.71	14.71	10.86	17.75	10.40	4.21	0.85	0.97	1.19	2.85	2.57
Min	0.41	0.55	1.24	1.65	1.19	0.96	0.40	0.35	0.28	0.27	0.47	0.44
25 Perc	0.57	0.85	1.69	4.94	4.44	1.54	0.84	0.58	0.44	0.59	0.96	0.72
75 Perc	1.70	1.73	5.56	10.82	8.97	4.60	1.49	0.77	0.87	1.05	2.22	1.59
Max	3.61	4.26	15.96	12.50	18.94	11.36	4.61	1.20	1.24	1.46	3.32	3.01
	Climate Scenario Ensemble Mean 2051-2090 (FF)											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
n	40	40	40	40	40	40	40	40	40	40	40	40
Mean	1.51	2.75	7.13	6.89	4.85	1.96	1.14	0.64	0.61	0.78	1.39	1.47
Std Error	0.13	0.30	0.69	0.53	0.53	0.24	0.12	0.04	0.04	0.05	0.11	0.11
Median	1.45	2.02	6.50	7.15	3.55	1.35	0.96	0.61	0.55	0.74	1.08	1.42
Std Dev	0.84	1.89	4.38	3.34	3.34	1.51	0.73	0.27	0.28	0.31	0.70	0.68
Variance	0.71	3.57	19.17	11.16	11.17	2.27	0.53	0.07	0.08	0.09	0.49	0.47
Kurtosis	-1.21	2.54	-0.68	-0.94	1.57	6.63	21.07	11.03	-0.60	-0.44	-0.25	-0.83
Skewness	0.30	1.45	0.55	0.16	1.32	2.56	4.08	2.70	0.63	0.35	0.80	0.17
Range	2.80	8.71	15.34	11.86	14.82	6.90	4.71	1.60	1.03	1.22	2.52	2.37
Min	0.42	0.57	1.35	0.82	0.62	0.84	0.32	0.27	0.23	0.20	0.44	0.35
25 Quart	0.73	1.54	3.49	4.15	2.66	1.18	0.79	0.50	0.38	0.54	0.88	1.02
75 Quart	2.25	3.78	9.25	9.15	6.50	2.27	1.27	0.69	0.81	0.97	1.74	1.87
Max	3.22	9.28	16.68	12.68	15.44	7.74	5.03	1.87	1.26	1.42	2.97	2.72

Table S4: Historical discharge statistics for each month at the Bear Valley Creek study site.

Historical Hydrograph 1929-2010

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
n	61	61	61	61	62	62	62	62	62	61	61	60
Mea	0.93	0.84	0.93	2.41	10.06	9.67	2.73	1.24	1.04	1.11	1.08	1.01
Std	0.03	0.02	0.02	0.14	0.42	0.51	0.18	0.05	0.03	0.04	0.04	0.04
Med	0.88	0.82	0.90	2.21	9.61	9.67	2.43	1.20	1.01	1.05	1.02	0.93
Std	0.27	0.17	0.19	1.13	3.31	4.04	1.44	0.43	0.23	0.29	0.30	0.34
Vari	0.07	0.03	0.04	1.28	10.96	16.31	2.08	0.18	0.05	0.08	0.09	0.11
Kurt	16.79	7.61	8.03	9.46	-0.67	-0.76	1.28	1.26	1.11	2.81	2.64	10.74
Ske	3.35	2.00	2.35	2.35	0.42	0.08	1.14	0.83	0.49	1.29	1.35	2.81
Ran	1.83	1.11	1.10	7.13	13.78	15.27	6.94	2.20	1.28	1.51	1.56	2.09
Min	0.61	0.55	0.69	0.92	4.66	2.16	0.63	0.48	0.46	0.64	0.62	0.61
25	0.78	0.75	0.82	1.71	7.43	6.86	1.75	0.97	0.91	0.94	0.89	0.83
75	0.98	0.89	1.00	2.95	12.28	12.56	3.37	1.42	1.15	1.27	1.20	1.06
Max	2.44	1.66	1.79	8.05	18.44	17.43	7.58	2.69	1.74	2.14	2.18	2.70