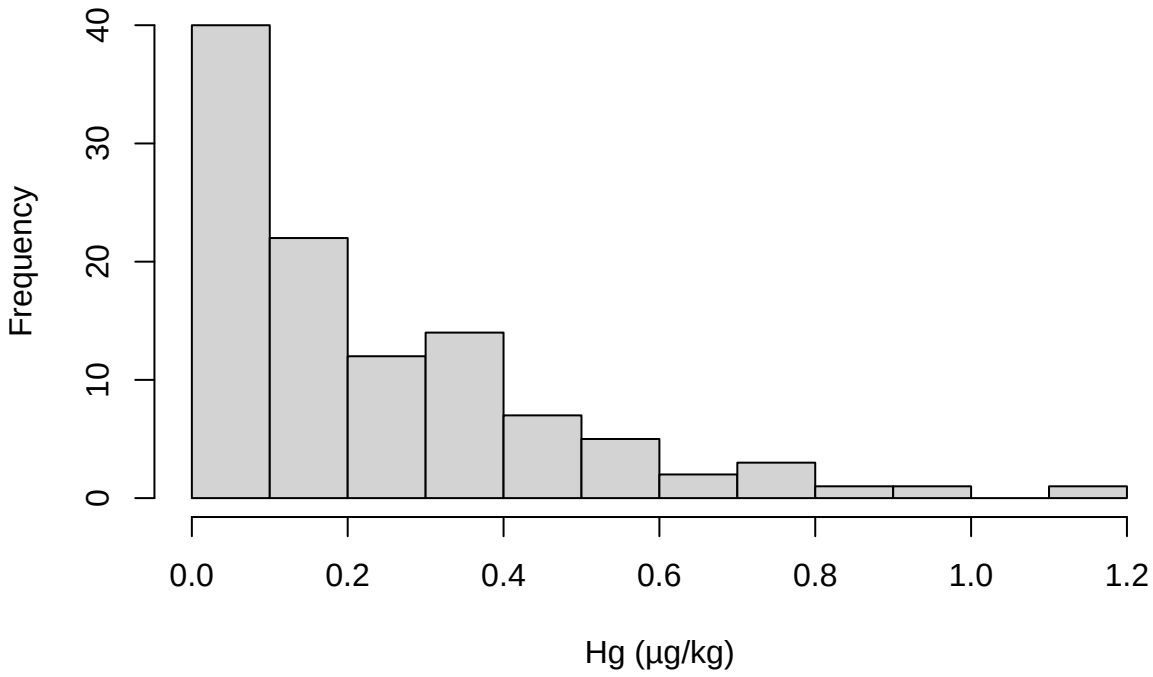
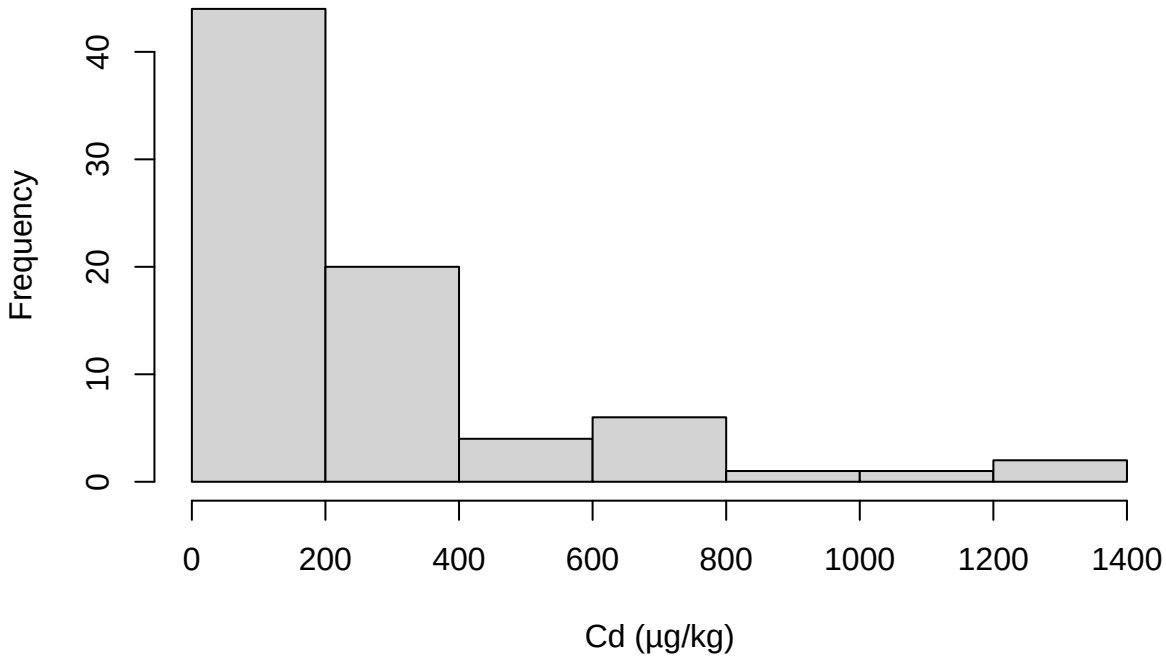
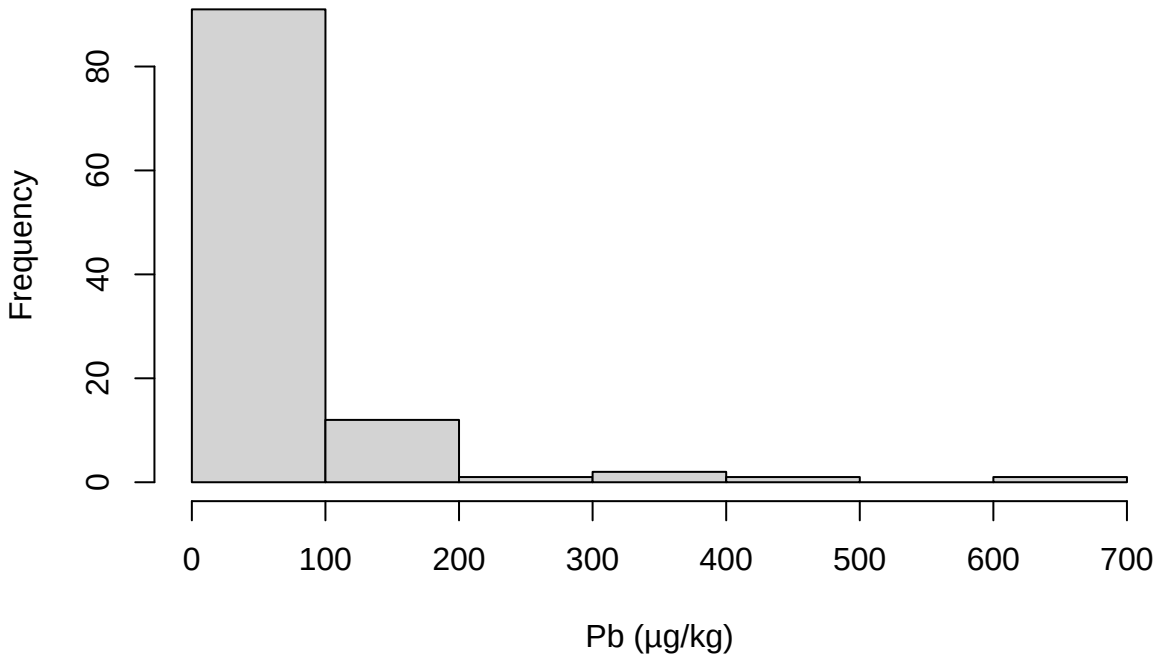
conger

Initial data inspection






Frequency
0
20
40
60
80
0
100
200
300
400
500
600
700
Pb (µg/kg)

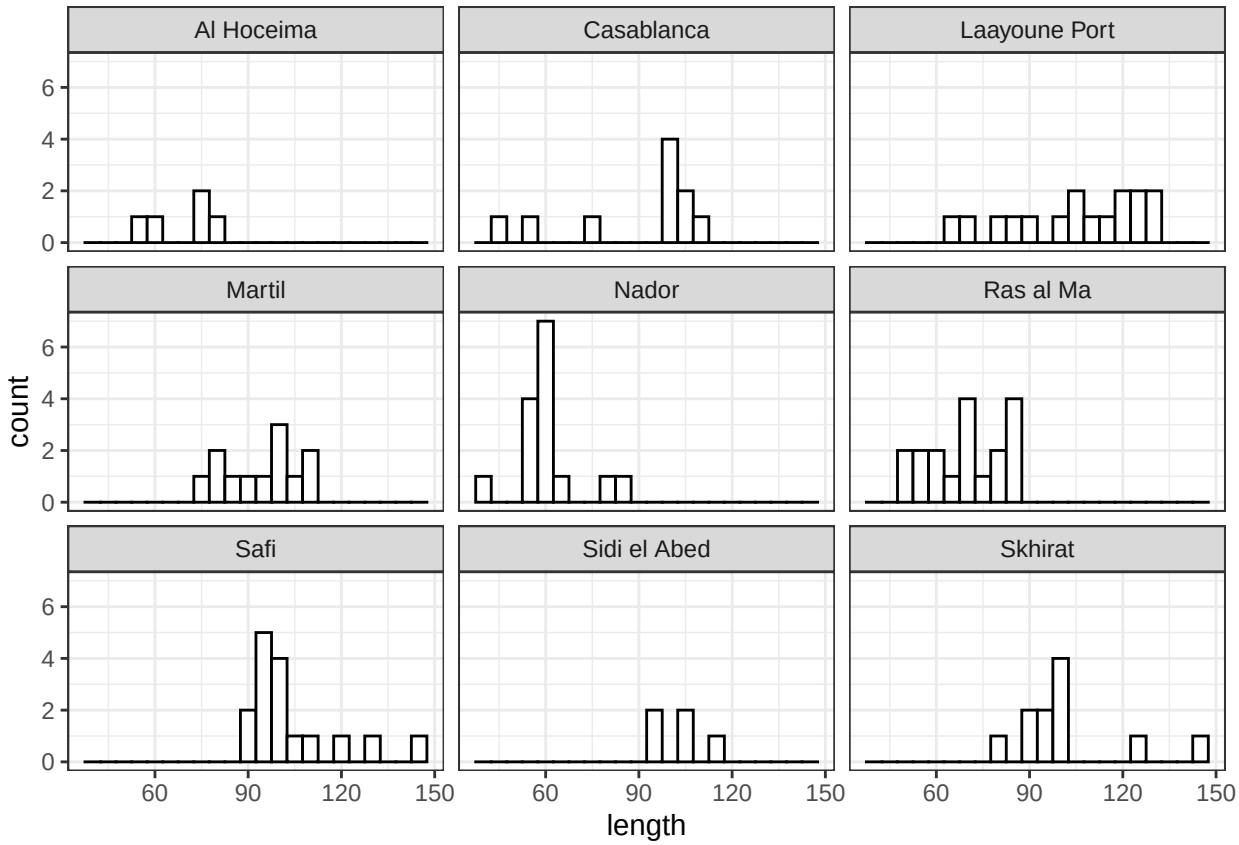
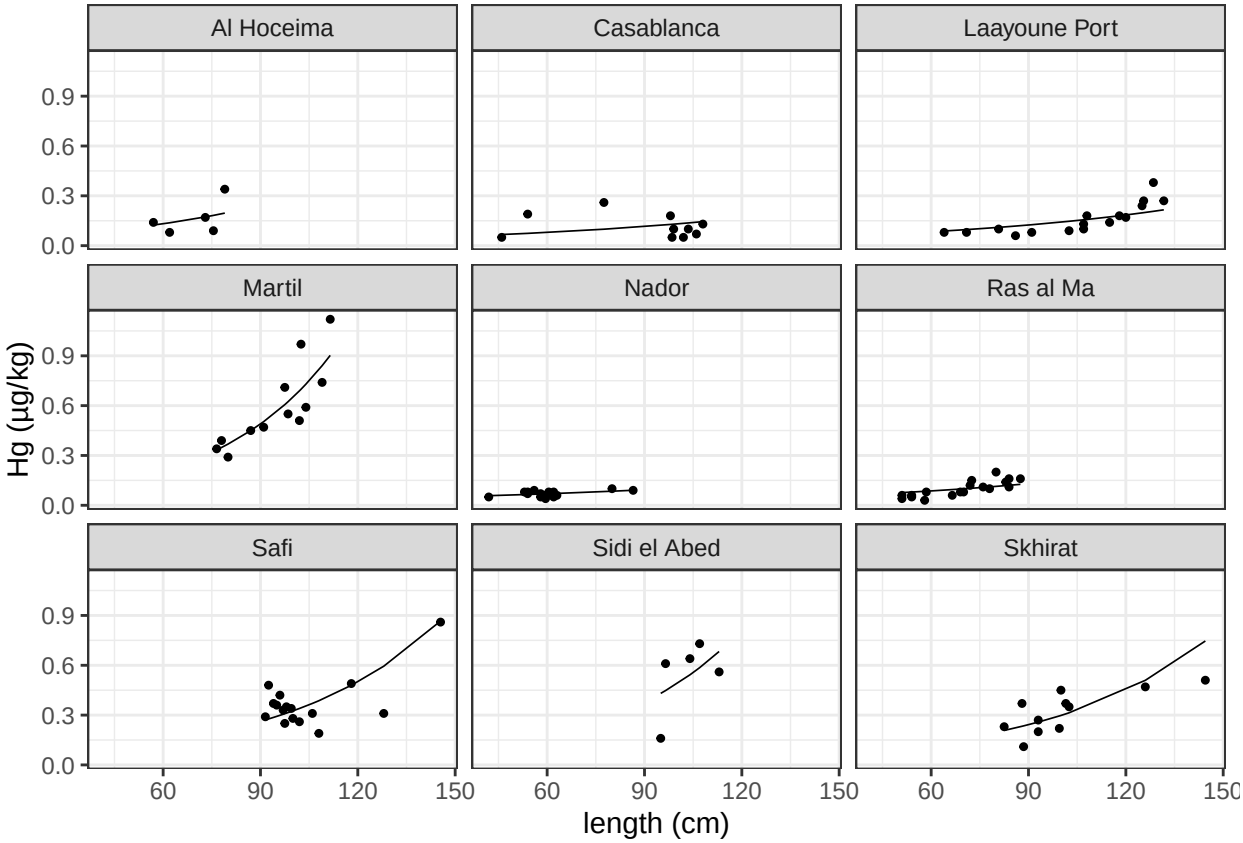
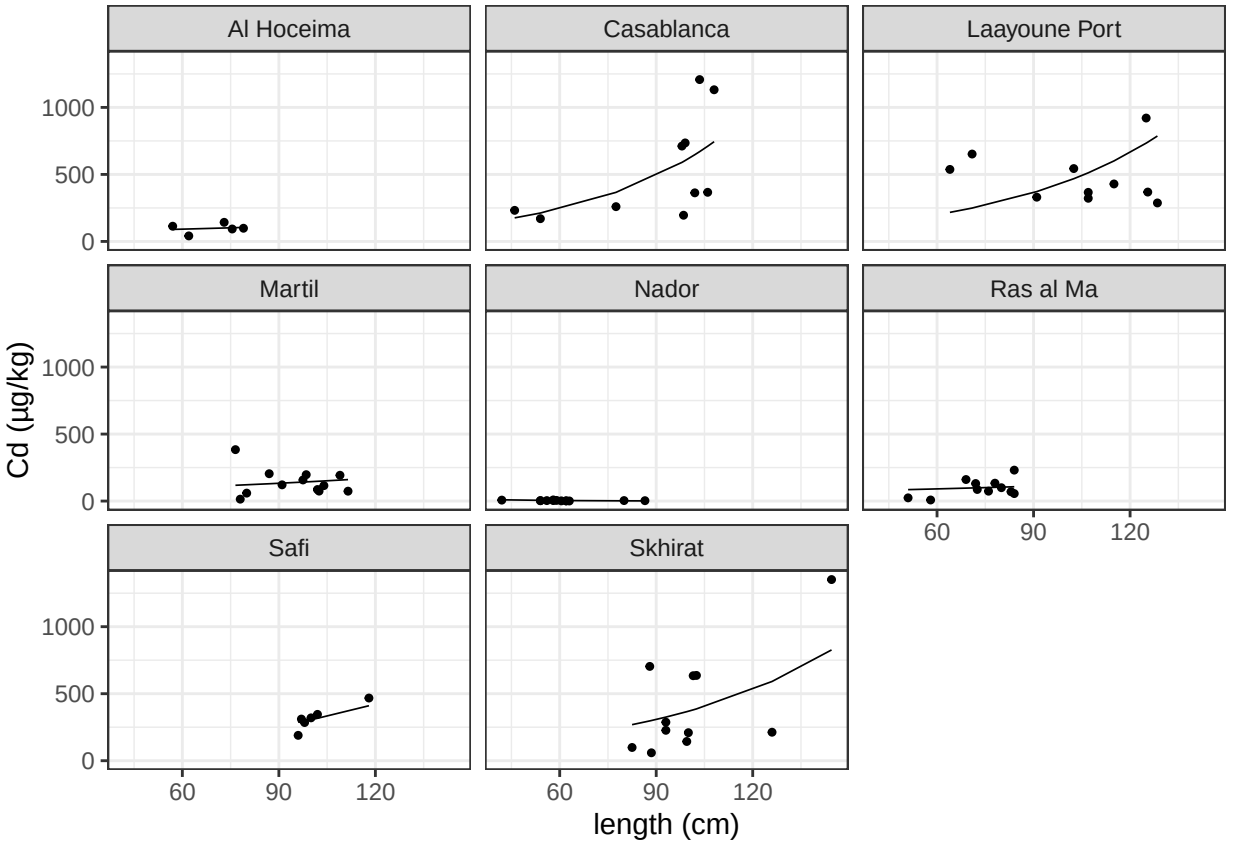


Fig 1 Overview of data distribution

Plotting the model results





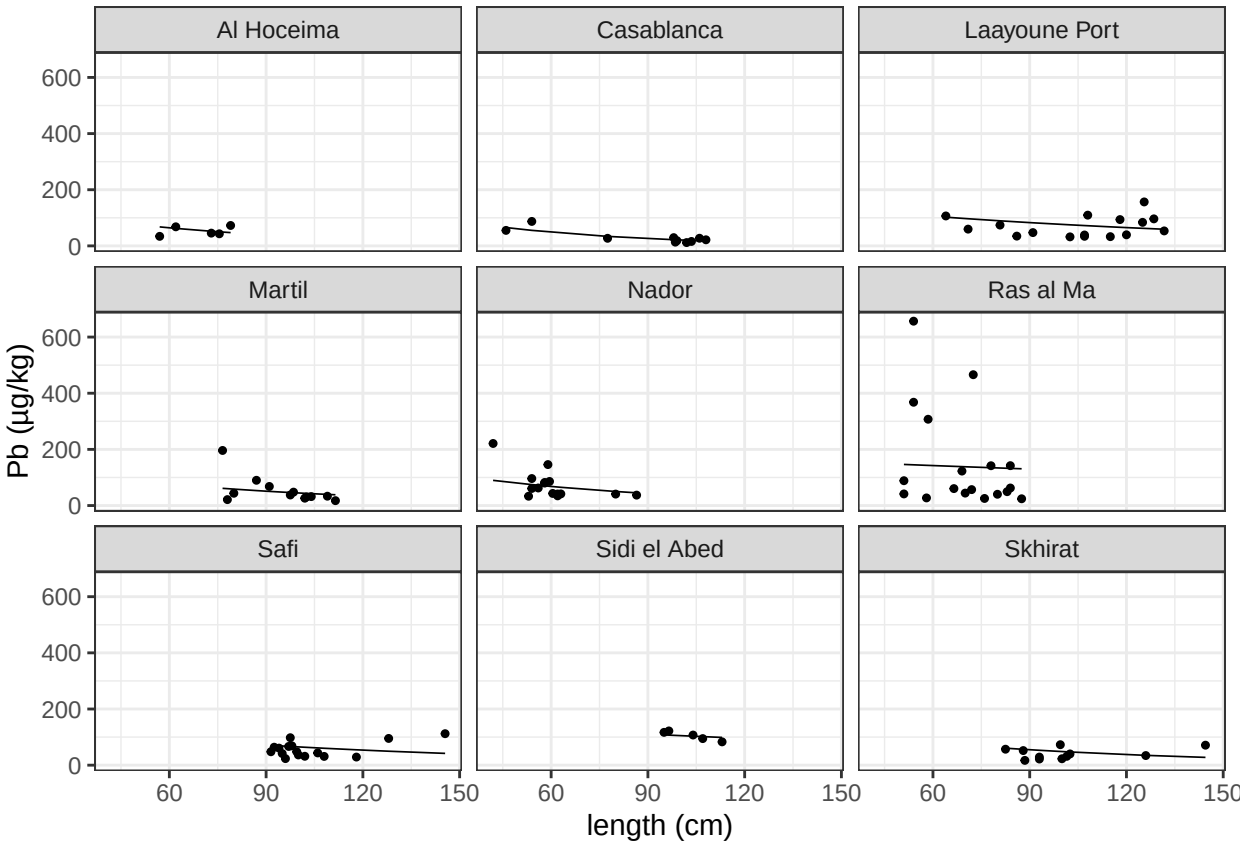
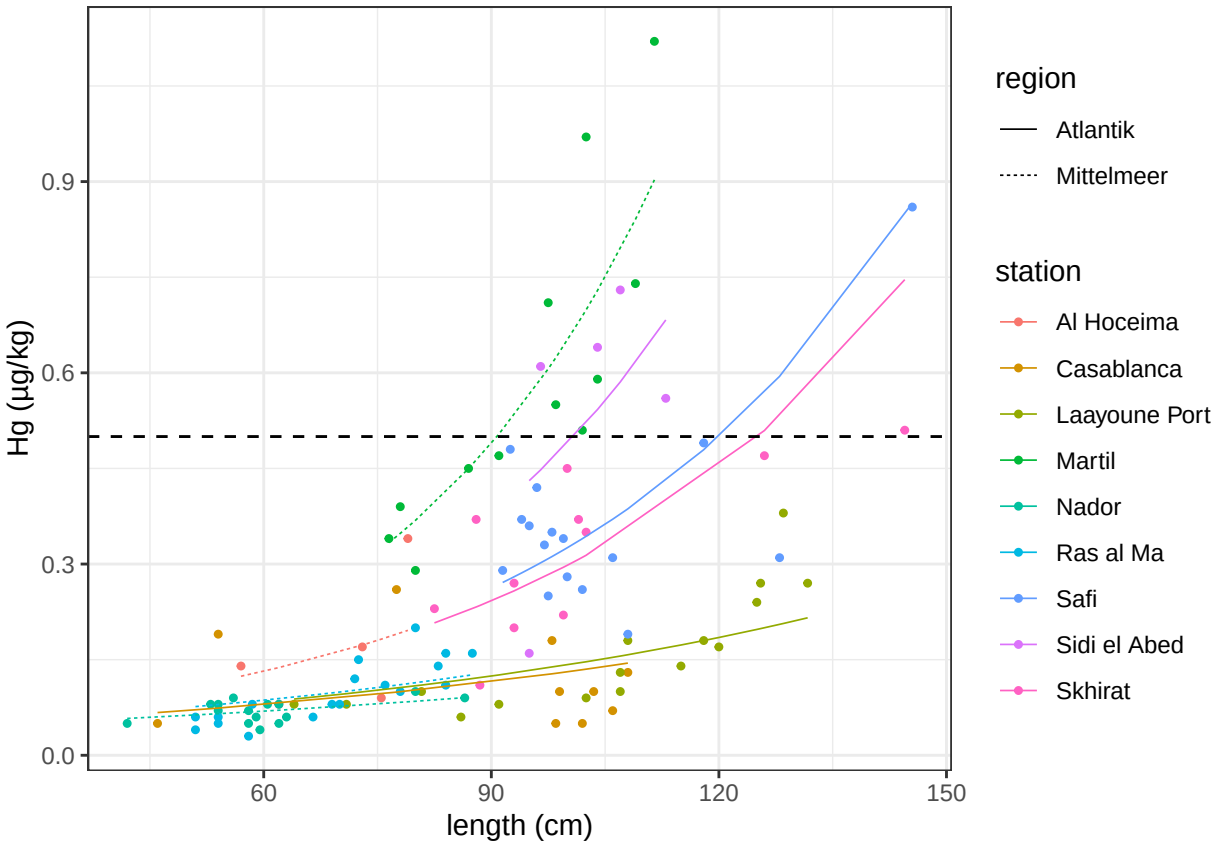
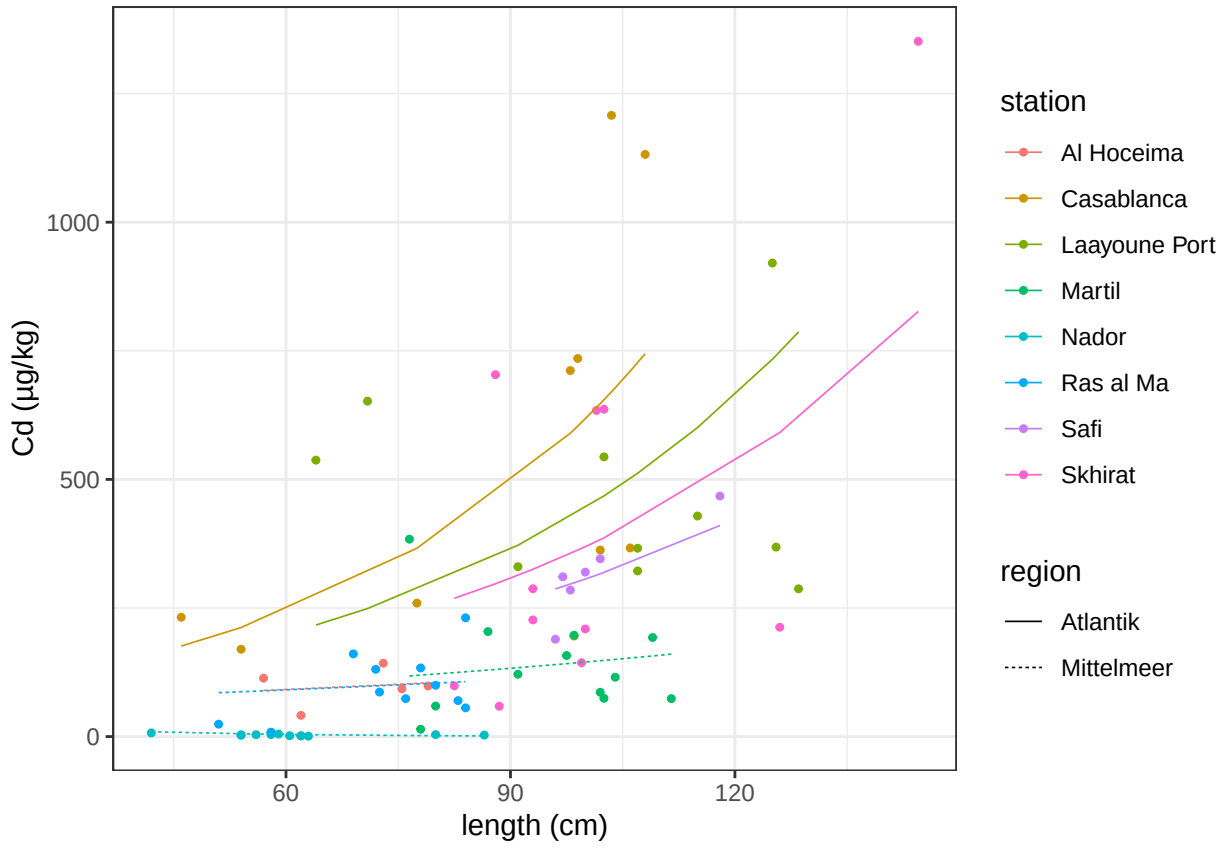


Fig 2a Raw data and GLM predictions of contaminat levels in Conger per Station as panel


Hg (µg/kg)
0.0
0.3
0.6
0.9
60
90
120
150
length (cm)
region
Atlantik
Mittelmeer
station
Al Hoceima
Casablanca
Laayoune Port
Martil
Nador
Ras al Ma
Safi
Sidi el Abed
Skhirat


Cd (µg/kg)
1000
500
0
60
90
120
length (cm)
station
Al Hoceima
Casablanca
Laayoune Port
Martil
Nador
Ras al Ma
Safi
Skhirat
region
Atlantik
Mittelmeer

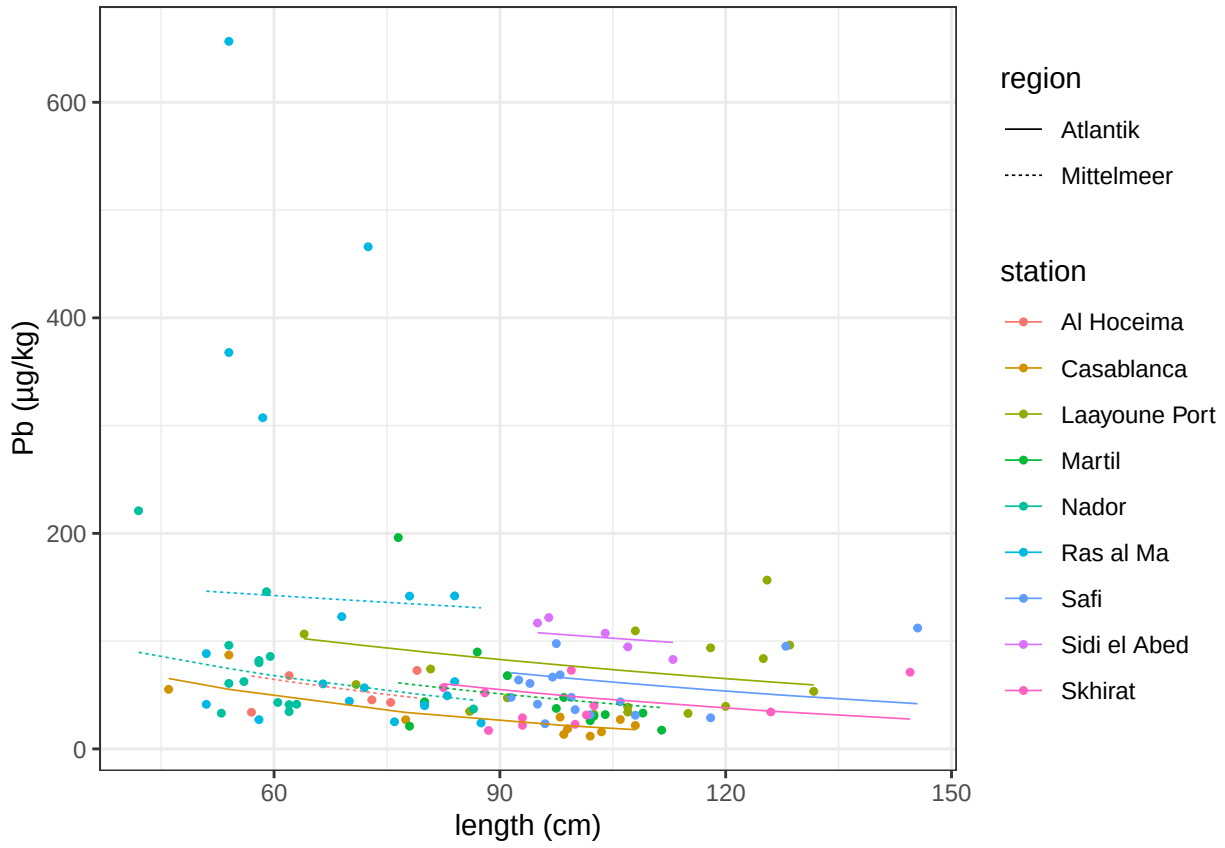


Fig 2b Raw data and GLM predictions of contaminat levels in COnger in single graph

Tab 1 Model statistics, all values are provided on the log scale. Estimate for "station" provides the y-Intercept (i.e. contaminant load for a given station when length is 0) per station; significance indicates different from 0. Estimates of "station:length" provide the effect of length for this station (i.e. the change in contaminant load for an increase of one unit in length); significance indicates whether the effect is different from 0 at this station (i.e. the slope of contamination load over length at this station is significantly different from 0).

Hg_Coefficient	Estimate	std_error	t_value	p_value
(Intercept)	-3.273	0.235	-13.942	0.000
stationAl Hoceima:length	0.021	0.004	4.936	0.000
stationCasablanca:length	0.012	0.003	4.355	0.000
stationLaayoune Port:length	0.013	0.002	5.621	0.000
stationMartil:length	0.028	0.003	10.434	0.000
stationNador:length	0.010	0.004	2.435	0.017
stationRas al Ma:length	0.014	0.004	3.875	0.000
stationSafi:length	0.022	0.002	8.934	0.000
stationSidi el Abed:length	0.026	0.003	8.957	0.000
stationSkhirat:length	0.021	0.003	8.149	0.000

Cd_Coefficient	Estimate	std_error	t_value	p_value
(Intercept)	4.101	0.459	8.943	0.000
length:stationAl Hoceima	0.007	0.008	0.890	0.376
length:stationCasablanca	0.023	0.005	4.320	0.000
length:stationLaayoune Port	0.020	0.005	4.255	0.000
length:stationMartil	0.009	0.005	1.690	0.096
length:stationNador	-0.044	0.008	-5.610	0.000
length:stationRas al Ma	0.007	0.007	1.014	0.314
length:stationSafi	0.016	0.005	3.112	0.003
length:stationSkhirat	0.018	0.005	3.774	0.000

Pb_Coefficient	Estimate	std_error	t_value	p_value
(Intercept)	5.141	0.437	11.756	0.000
length:stationAl Hoceima	-0.016	0.008	-2.071	0.041
length:stationCasablanca	-0.021	0.005	-3.939	0.000
length:stationLaayoune Port	-0.008	0.004	-1.834	0.070
length:stationMartil	-0.013	0.005	-2.641	0.010
length:stationNador	-0.015	0.008	-1.995	0.049
length:stationRas al Ma	-0.003	0.007	-0.461	0.646
length:stationSafi	-0.010	0.004	-2.153	0.034
length:stationSidi el Abed	-0.005	0.005	-0.911	0.365
length:stationSkhirat	-0.013	0.005	-2.671	0.009

Tab 2 Pairwise comparisons between stations; significance indicates whether the effect of length differs between the two stations. Theoretically, when effect of length is stronger in one station compared to another then also the contaminant level should will be higher given that the "base" contamination load is equal between stations (i.e. all conger have the same contamination at length 0, the y-intercept). However, models perform better when "base" contamination is calculated separately per station (e.g. for Hg the calculated intercept ranges from 0.014 - 0.22 and differences are significant). Considering this value is far outside the observed range of data (starting around 60cm) they have little biological meaning; yet, especially when expressed per kg, differences in the "base" contamination are theoretically possible (particularly when expressed per kg) and thus we did not force the model thorgh the same y-Intercept to achieve the best fit to the empiric data. This does, however, require a more differentiated interpretation, since contamination is not solely explained by accumulation (i.e. as a function of length) at a given station, but also by differences in the "base" contamination.

```
## Lade nötiges Paket: emmeans

## The 'lsmeans' package is now basically a front end for 'emmeans'.
## Users are encouraged to switch the rest of the way.
## See help('transition') for more information, including how to
## convert old 'lsmeans' objects and scripts to work with 'emmeans'.
```

contrast.Hg	estimate	SE	df	t.ratio	p.value
Al Hoceima - Casablanca	0.008	0.003	98	2.760	0.141
Al Hoceima - Laayoune Port	0.008	0.003	98	2.546	0.223
Al Hoceima - Martil	-0.008	0.003	98	-2.559	0.218
Al Hoceima - Nador	0.011	0.003	98	3.456	0.022
Al Hoceima - Ras al Ma	0.007	0.003	98	2.428	0.281
Al Hoceima - Safi	-0.001	0.003	98	-0.237	1.000
Al Hoceima - Sidi el Abed	-0.005	0.003	98	-1.458	0.872
Al Hoceima - Skhirat	0.000	0.003	98	0.059	1.000
Casablanca - Laayoune Port	-0.001	0.002	98	-0.470	1.000
Casablanca - Martil	-0.016	0.002	98	-8.705	0.000
Casablanca - Nador	0.002	0.003	98	0.925	0.991
Casablanca - Ras al Ma	-0.001	0.002	98	-0.646	0.999
Casablanca - Safi	-0.009	0.002	98	-5.341	0.000
Casablanca - Sidi el Abed	-0.013	0.002	98	-5.905	0.000
Casablanca - Skhirat	-0.008	0.002	98	-4.488	0.001
Laayoune Port - Martil	-0.015	0.002	98	-9.759	0.000
Laayoune Port - Nador	0.003	0.003	98	1.248	0.943
Laayoune Port - Ras al Ma	-0.001	0.002	98	-0.275	1.000
Laayoune Port - Safi	-0.008	0.001	98	-6.199	0.000
Laayoune Port - Sidi el Abed	-0.012	0.002	98	-6.260	0.000
Laayoune Port - Skhirat	-0.007	0.002	98	-4.930	0.000
Martil - Nador	0.018	0.002	98	7.439	0.000
Martil - Ras al Ma	0.015	0.002	98	7.347	0.000
Martil - Safi	0.007	0.002	98	4.439	0.001
Martil - Sidi el Abed	0.003	0.002	98	1.338	0.917
Martil - Skhirat	0.008	0.002	98	4.596	0.000
Nador - Ras al Ma	-0.004	0.002	98	-1.668	0.764
Nador - Safi	-0.011	0.002	98	-4.596	0.000
Nador - Sidi el Abed	-0.016	0.003	98	-5.443	0.000
Nador - Skhirat	-0.011	0.003	98	-4.121	0.002
Ras al Ma - Safi	-0.008	0.002	98	-3.941	0.005
Ras al Ma - Sidi el Abed	-0.012	0.002	98	-4.888	0.000
Ras al Ma - Skhirat	-0.007	0.002	98	-3.325	0.033
Safi - Sidi el Abed	-0.004	0.002	98	-2.059	0.507
Safi - Skhirat	0.001	0.002	98	0.584	1.000

contrast.Hg	estimate	SE	df	t.ratio	p.value
Sidi el Abed - Skhirat	0.005	0.002	98	2.368	0.313

contrast.Cd	estimate	SE	df	t.ratio	p.value
Al Hoceima - Casablanca	-0.016	0.005	69	-3.167	0.045
Al Hoceima - Laayoune Port	-0.013	0.005	69	-2.479	0.222
Al Hoceima - Martil	-0.002	0.005	69	-0.356	1.000
Al Hoceima - Nador	0.051	0.005	69	9.660	0.000
Al Hoceima - Ras al Ma	0.000	0.005	69	0.030	1.000
Al Hoceima - Safi	-0.009	0.005	69	-1.703	0.686
Al Hoceima - Skhirat	-0.011	0.005	69	-2.154	0.392
Casablanca - Laayoune Port	0.003	0.003	69	1.051	0.964
Casablanca - Martil	0.015	0.003	69	4.720	0.000
Casablanca - Nador	0.067	0.004	69	15.032	0.000
Casablanca - Ras al Ma	0.016	0.004	69	4.344	0.001
Casablanca - Safi	0.007	0.004	69	1.972	0.508
Casablanca - Skhirat	0.005	0.003	69	1.680	0.700
Laayoune Port - Martil	0.011	0.003	69	3.877	0.006
Laayoune Port - Nador	0.064	0.005	69	13.629	0.000
Laayoune Port - Ras al Ma	0.013	0.004	69	3.406	0.023
Laayoune Port - Safi	0.004	0.003	69	1.115	0.951
Laayoune Port - Skhirat	0.002	0.003	69	0.667	0.998
Martil - Nador	0.053	0.004	69	12.025	0.000
Martil - Ras al Ma	0.002	0.004	69	0.535	0.999
Martil - Safi	-0.007	0.003	69	-2.222	0.352
Martil - Skhirat	-0.009	0.003	69	-3.291	0.032
Nador - Ras al Ma	-0.051	0.004	69	-12.105	0.000
Nador - Safi	-0.060	0.005	69	-12.339	0.000
Nador - Skhirat	-0.062	0.005	69	-13.532	0.000
Ras al Ma - Safi	-0.009	0.004	69	-2.269	0.325
Ras al Ma - Skhirat	-0.011	0.004	69	-2.990	0.071
Safi - Skhirat	-0.002	0.003	69	-0.563	0.999

contrast.Pb	estimate	SE	df	t.ratio	p.value
Al Hoceima - Casablanca	0.005	0.006	98	0.818	0.996
Al Hoceima - Laayoune Port	-0.008	0.006	98	-1.481	0.862
Al Hoceima - Martil	-0.003	0.006	98	-0.513	1.000
Al Hoceima - Nador	-0.001	0.006	98	-0.156	1.000
Al Hoceima - Ras al Ma	-0.013	0.005	98	-2.443	0.273
Al Hoceima - Safi	-0.007	0.006	98	-1.195	0.956
Al Hoceima - Sidi el Abed	-0.011	0.006	98	-1.865	0.639
Al Hoceima - Skhirat	-0.004	0.006	98	-0.650	0.999
Casablanca - Laayoune Port	-0.013	0.003	98	-4.051	0.003
Casablanca - Martil	-0.007	0.003	98	-2.183	0.425
Casablanca - Nador	-0.006	0.005	98	-1.175	0.960
Casablanca - Ras al Ma	-0.018	0.004	98	-4.592	0.000
Casablanca - Safi	-0.011	0.003	98	-3.542	0.017
Casablanca - Sidi el Abed	-0.016	0.004	98	-3.858	0.006
Casablanca - Skhirat	-0.008	0.003	98	-2.436	0.277
Laayoune Port - Martil	0.005	0.003	98	1.851	0.648
Laayoune Port - Nador	0.007	0.005	98	1.561	0.823
Laayoune Port - Ras al Ma	-0.005	0.004	98	-1.343	0.915
Laayoune Port - Safi	0.002	0.002	98	0.652	0.999
Laayoune Port - Sidi el Abed	-0.003	0.004	98	-0.863	0.994
Laayoune Port - Skhirat	0.005	0.003	98	1.627	0.788
Martil - Nador	0.002	0.005	98	0.423	1.000
Martil - Ras al Ma	-0.010	0.004	98	-2.784	0.134
Martil - Safi	-0.004	0.003	98	-1.292	0.932
Martil - Sidi el Abed	-0.009	0.004	98	-2.161	0.439
Martil - Skhirat	-0.001	0.003	98	-0.259	1.000
Nador - Ras al Ma	-0.012	0.004	98	-2.986	0.082
Nador - Safi	-0.006	0.005	98	-1.229	0.948
Nador - Sidi el Abed	-0.011	0.005	98	-1.977	0.563
Nador - Skhirat	-0.003	0.005	98	-0.579	1.000
Ras al Ma - Safi	0.007	0.004	98	1.803	0.680
Ras al Ma - Sidi el Abed	0.002	0.005	98	0.399	1.000
Ras al Ma - Skhirat	0.010	0.004	98	2.479	0.255
Safi - Sidi el Abed	-0.005	0.004	98	-1.301	0.929
Safi - Skhirat	0.003	0.003	98	1.042	0.981

contrast.Pb	estimate	SE	df	t.ratio	p.value
Sidi el Abed - Skhirat	0.008	0.004	98	1.982	0.560

Comparing station averages

Tab 3 Predictions of contamination at mean length of all congers (and mean for Pb)

station	length	Hg_at_length	Cd_at_length	Pb_at_length	Pb_mean	Pb_g
Al Hoceima	88.1	0.2	111.4	40.8	52.7	
Casablanca	88.1	0.1	468.7	27.1	30.8	
Laayoune Port	88.1	0.1	351.1	84.2	68.4	
Martil	88.1	0.5	130.6	52.4	53.6	
Nador	88.1	0.1	1.2	44.2	73.7	
Ras al Ma	88.1	0.1	109.9	130.7	151.3	
Safi	88.1	0.3	252.6	73.0	56.1	
Sidi el Abed	88.1	0.4		111.5	104.7	
Skhirat	88.1	0.2	297.7	56.4	40.8	