

## **Hydraulic data and channel bed characteristics for River 2D and CASiMiR-vegetation model parameterization**

**Table S1.** Flow curve considered in the downstream section of OCBA study site as the outflow condition in River2D model.

Discharge (m <sup>3</sup> s <sup>-1</sup> )	Water surface elevation (m)
0.05	139.65
0.1	139.67
0.3	139.80
0.5	139.92
0.7	140.00
1	140.08
2	140.25
3	140.39
4	140.50
5	140.60

**Table S2.** Flow curve considered in the downstream section of OCPR study site as the outflow condition in River2D model.

Discharge (m <sup>3</sup> s <sup>-1</sup> )	Water surface elevation (m)	Discharge (m <sup>3</sup> s <sup>-1</sup> )	Water surface elevation (m)
0.1	113.68	18	114.7
0.5	113.77	20	114.76
0.7	113.82	25	114.9
1	113.89	30	115.03
1.5	113.95	40	115.25
2	114	50	115.42
2.5	114.04	60	115.55
3	114.08	80	115.78
4	114.14	100	116
5	114.2	150	116.47
6	114.25	200	116.82
7	114.29	300	117.41
8	114.34	400	117.96
9	114.38	600	118.71
10	114.42	800	119.28
12	114.49	1000	119.77
14	114.58	1200	120.22
16	114.64		

**Table S3.** Channel roughness classification of the different substrates in the aquatic zone of the river without vegetation used in the River2D model for both case studies.

Substrate	Effective roughness height, $k_s$ (m)
Sand and gravel	0.1
Boulders and stones	0.5

**Table S4.** Channel roughness classification of the different considered riparian vegetation succession phases used in the River2D model for both case studies (IP – Initial phase, PP – Pioneer phase, ES – Early succession woodland phase, EF – Established forest phase and MF – Mature forest phase).

Succession phase	Effective roughness height, $k_s$ (m)
IP	0.4
PP	0.5
ES	1.6
EF	1.1
MF	1.4

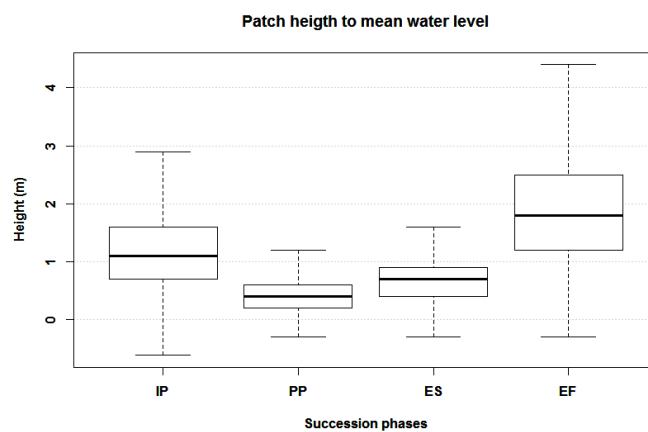
**Table S5.** CASiMiR-vegetation model parameterization (IP – Initial phase, PP – Pioneer phase, ES – Early succession woodland phase, EF – Established forest phase and MF – Mature forest phase).

Parameter	Succession phase	Value
Height to water table (m)	IP	< 0.2
	PP	0.2 – 0.6
	ES	0.6 – 1.05
	EF	1.05 – 3.4
	MF	> 3.4
Age (years)	IP	< 2
	PP	2 – 6
	ES	6 – 19
	EF	19 – 26
	MF	> 26
Resistance to shear stress ( $N \cdot m^{-2}$ )	IP	30
	PP	30
	ES	50
	EF	300
	MF	300

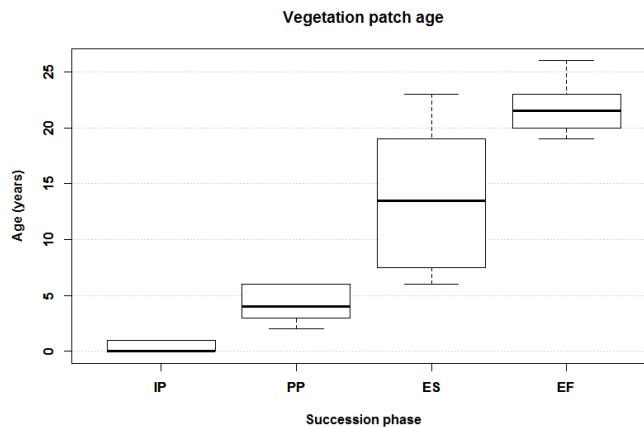
# Summary of collected data supporting the ecological background for riparian vegetation and fish modeling.

**Table S6.** Patch characterization of succession phases (IP – Initial phase, PP – Pioneer phase, ES – Early succession woodland phase, EF – Established forest phase and MF – Mature forest phase).

Succession phase	Patches surveyed	Mean height to mean water level (m)	Mean area ( $m^2$ )	Mean cover of herb layer (%)	Mean cover of shrub layer (%)	Mean cover of tree layer (%)	Mean number of woody species
IP	11	1.12	357.51	0.48	0.05	0.00	0
PP	17	0.40	350.73	0.81	0.26	0.00	1
ES	20	0.68	256.82	0.29	0.71	0.04	2
EF	8	1.89	1132.20	0.61	0.46	0.19	5



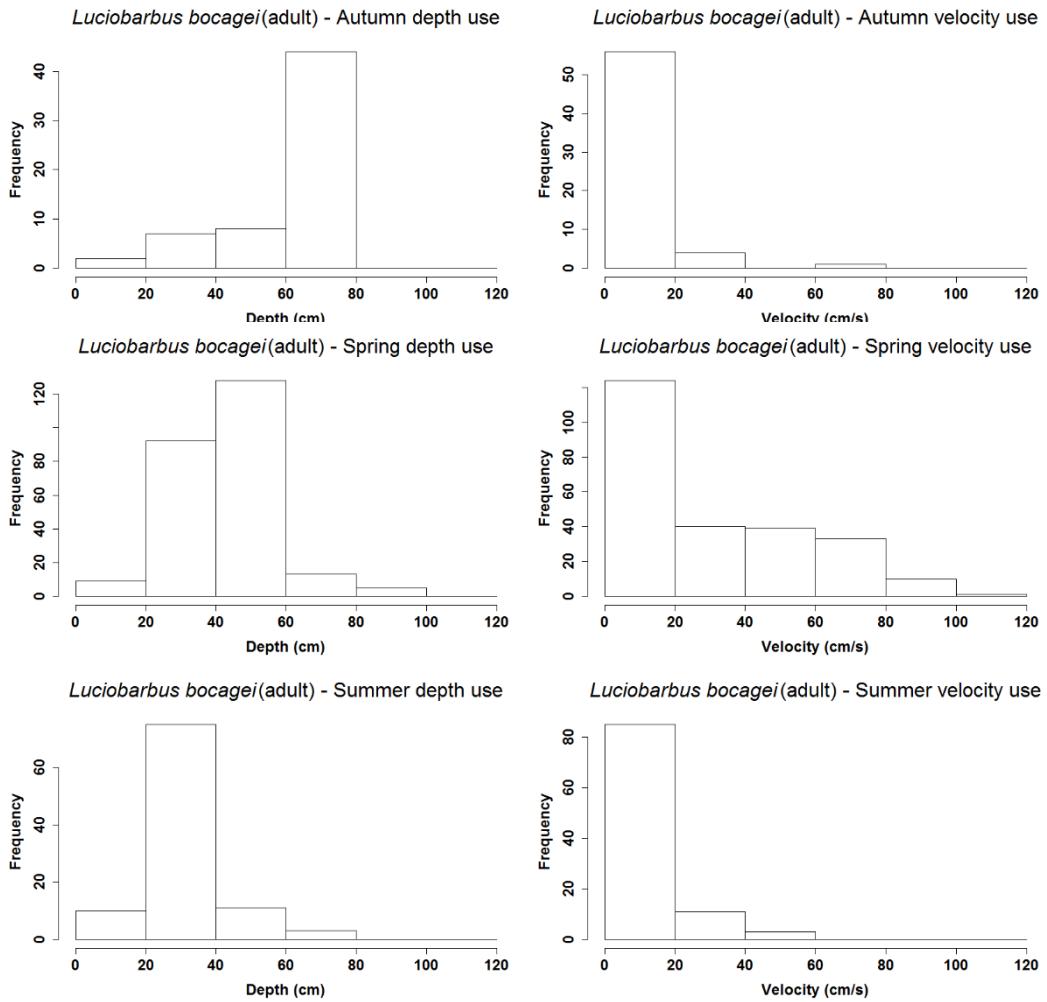
**Figure S1.** Patch height to mean water level grouped by succession phase (IP – Initial phase, PP – Pioneer phase, ES – Early succession woodland phase and EF – Established forest phase).



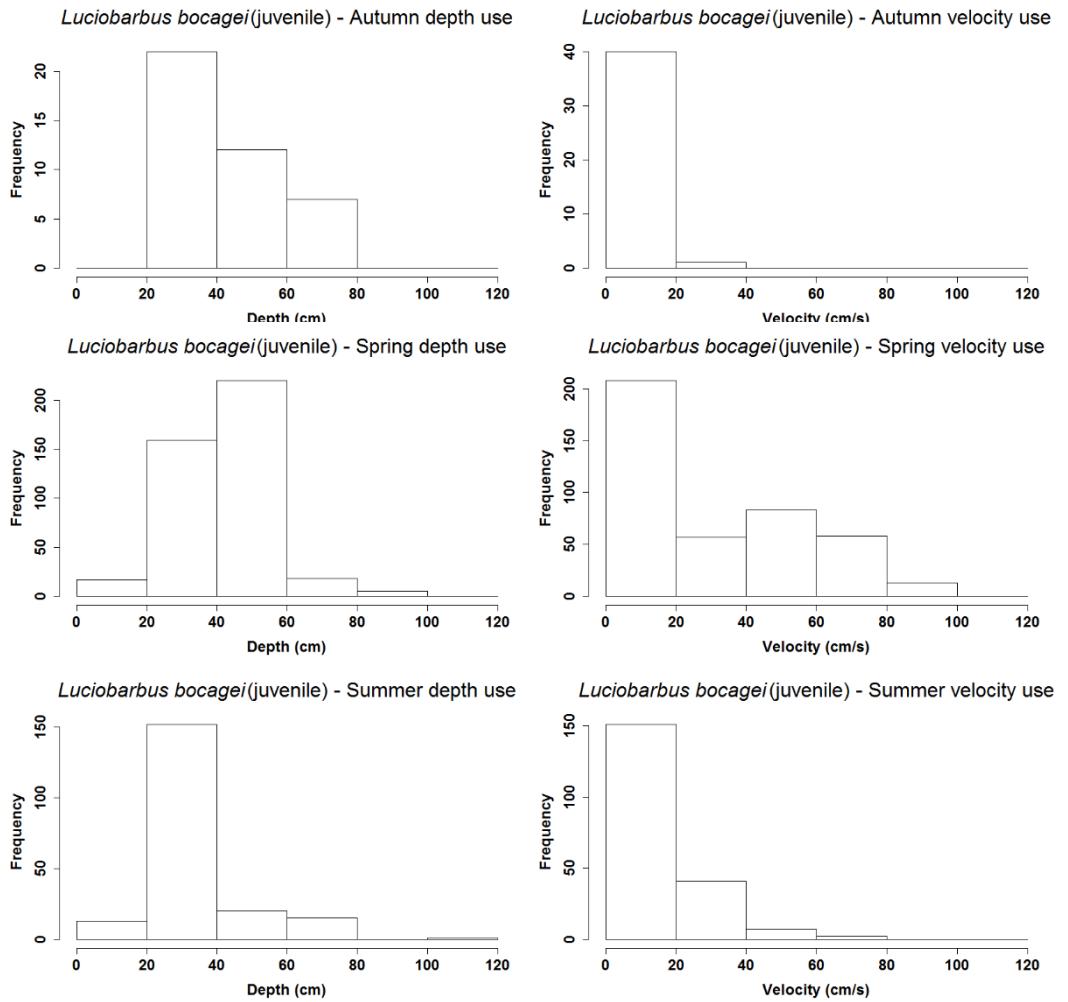
**Figure S2.** Patch age grouped by succession phase (IP – Initial phase, PP – Pioneer phase, ES – Early succession woodland phase and EF – Established forest phase).

**Table S7.** Number of captured cyprinid individuals throughout different sampling seasons in Ocreza river basin.

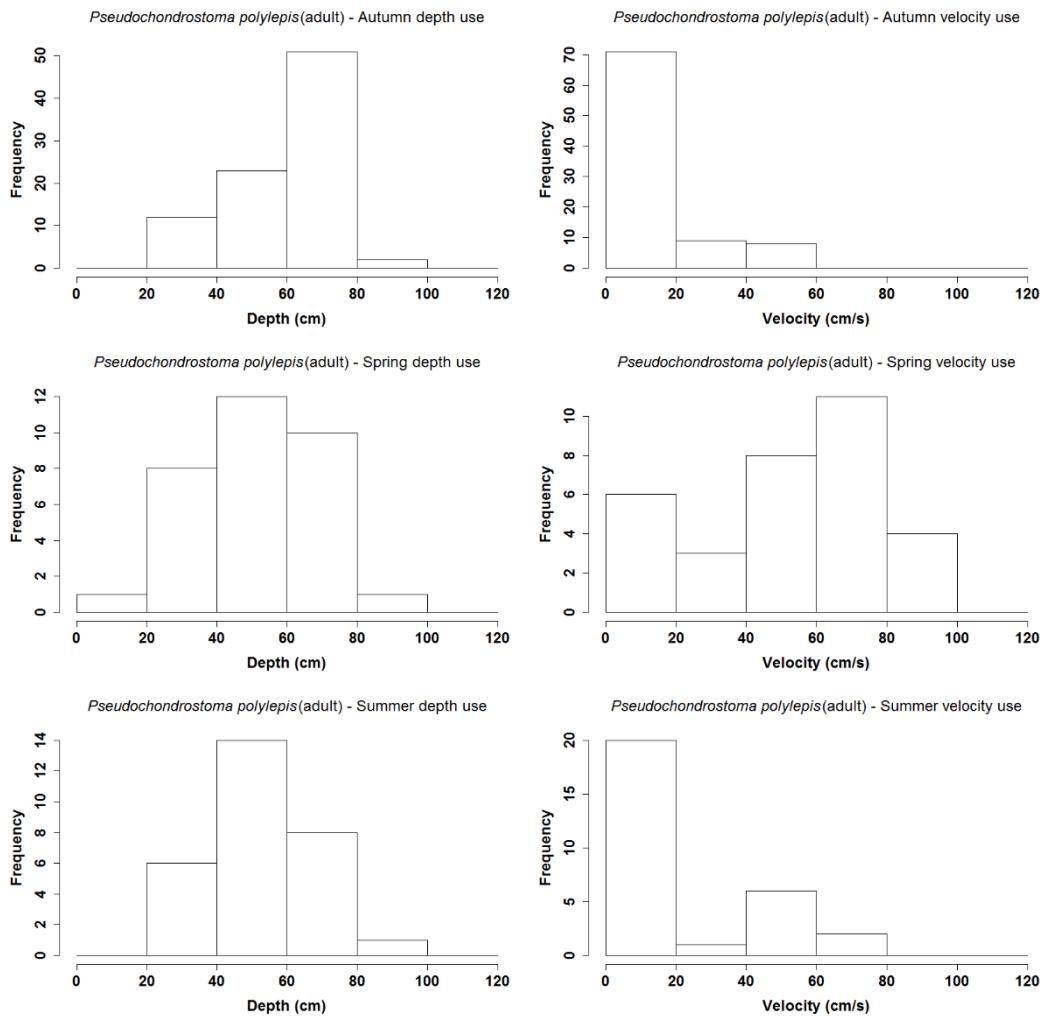
Common name	Cyprinid Species	Spring	Summer	Autumn	Total
Iberian barbel	<i>Luciobarbus bocagei</i>	666	300	102	1068
Iberian straight mouth-nase	<i>Pseudochondrostoma polylepis</i>	46	62	102	210
Calandino	<i>Squalius alburnoides</i>	277	364	134	775
Southern Iberian chub	<i>Squalius pyrenaicus</i>	9	0	29	38
	Total	998	726	367	2091



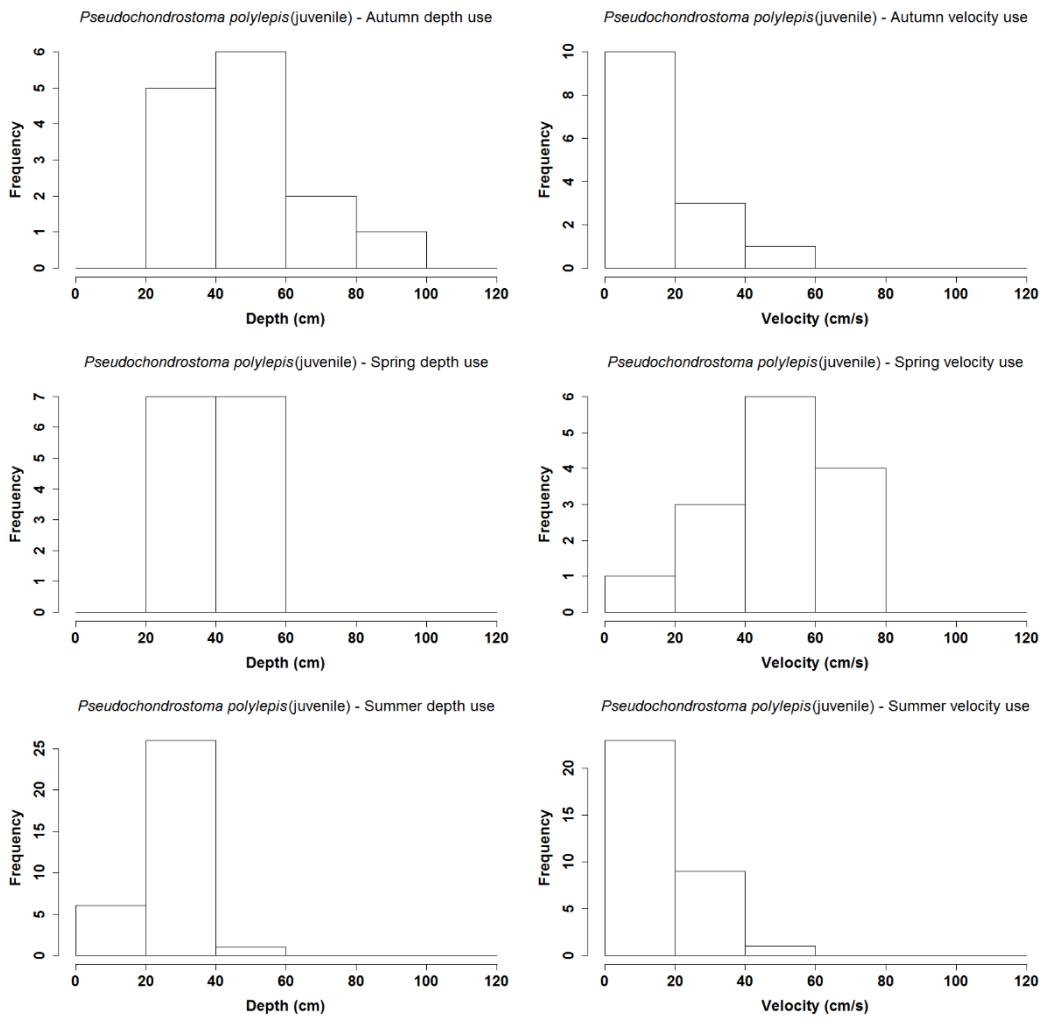
**Figure S3. Use frequency of *Luciobarbus bocagei* adults for water depth (cm) and flow velocity ( $\text{cm s}^{-1}$ ) during Autumn, Spring and Summer.**



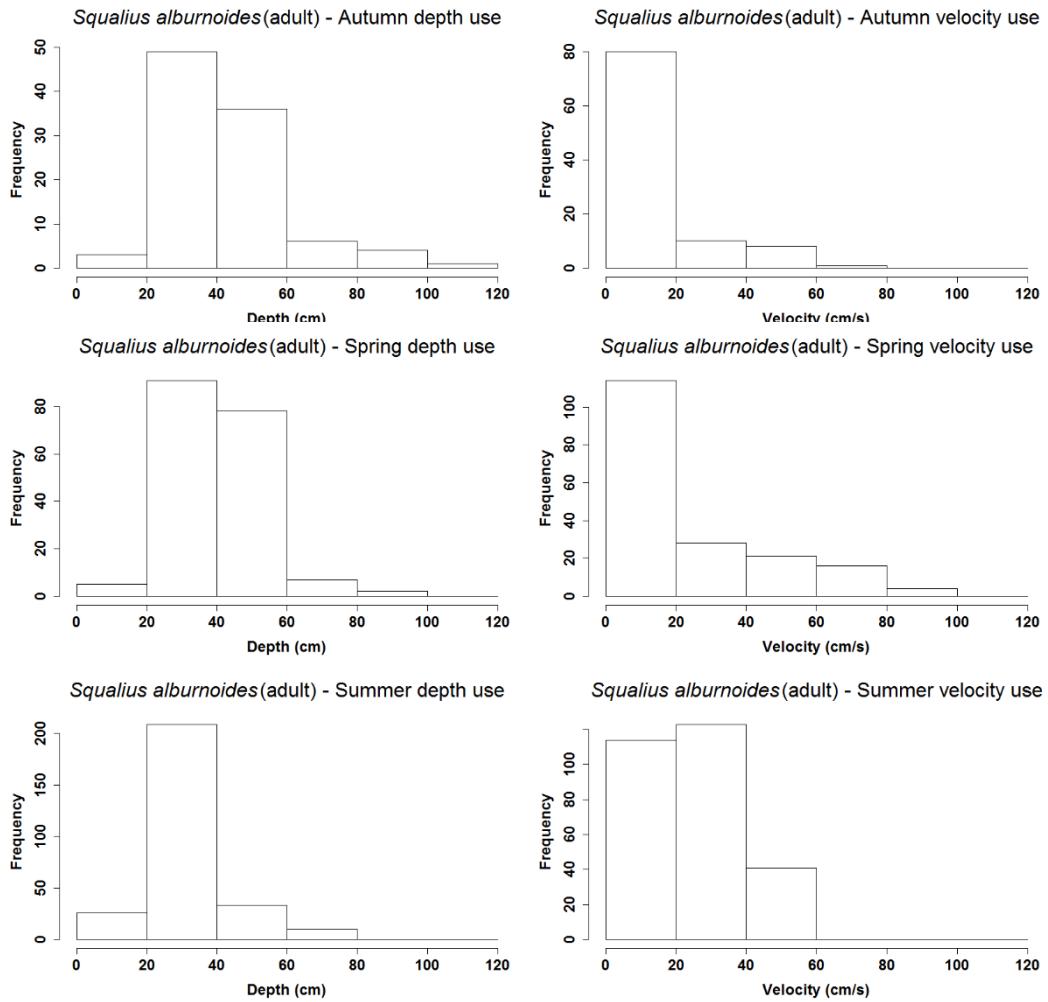
**Figure S4.** Use frequency of *Luciobarbus bocagei* juveniles for water depth (cm) and flow velocity ( $\text{cm s}^{-1}$ ) during Autumn, Spring and Summer.



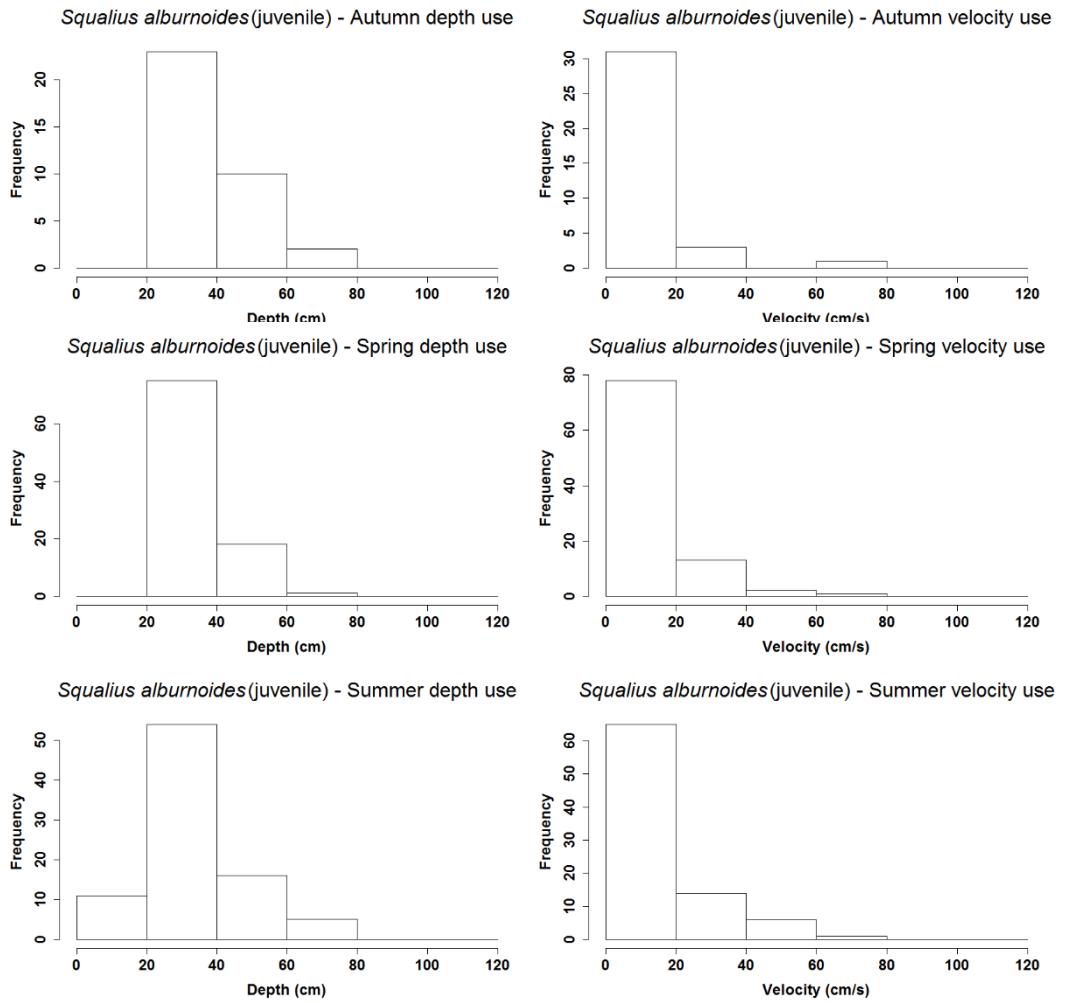
**Figure S5. Use frequency of *Pseudochondrostoma polylepis* adults for water depth (cm) and flow velocity (cm s<sup>-1</sup>) during Autumn, Spring and Summer.**



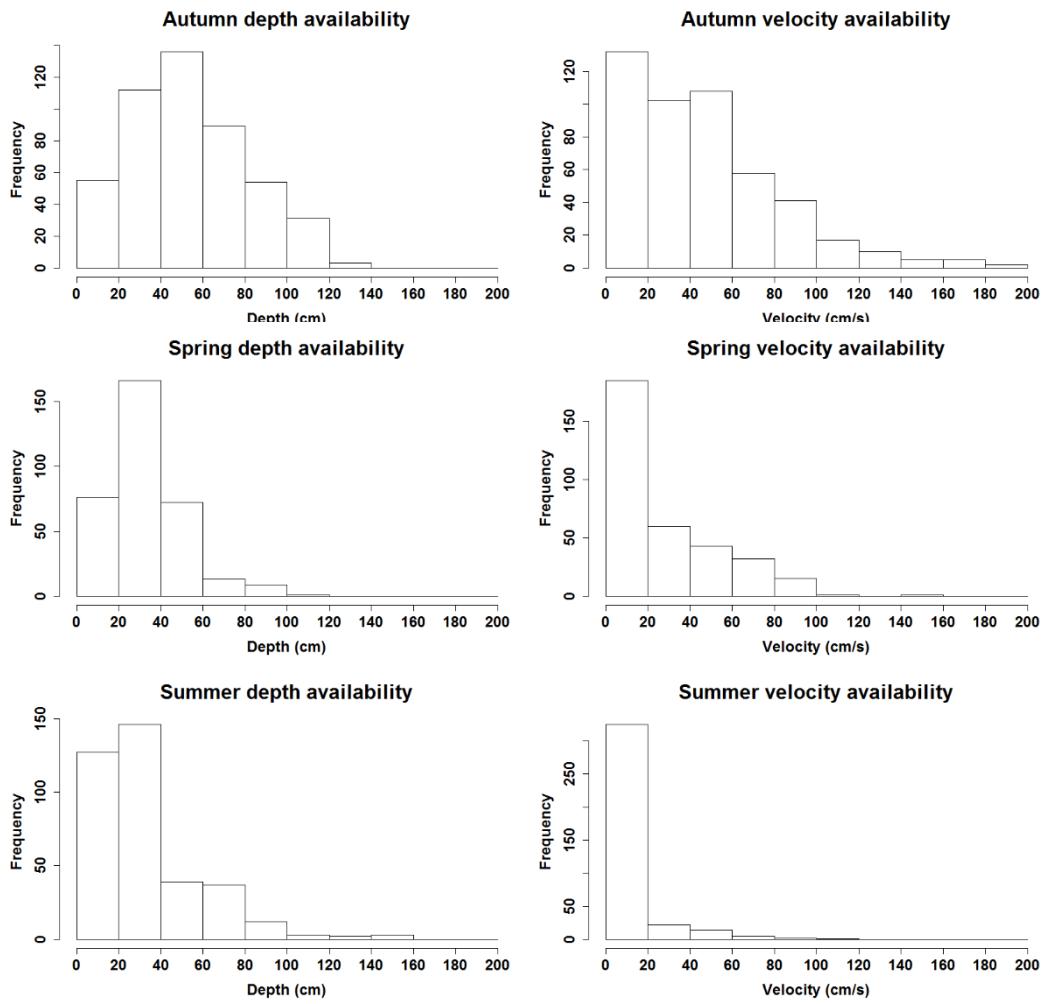
**Figure S6.** Use frequency of *Pseudochondrostoma polylepis* juveniles for water depth (cm) and flow velocity ( $\text{cm s}^{-1}$ ) during Autumn, Spring and Summer.



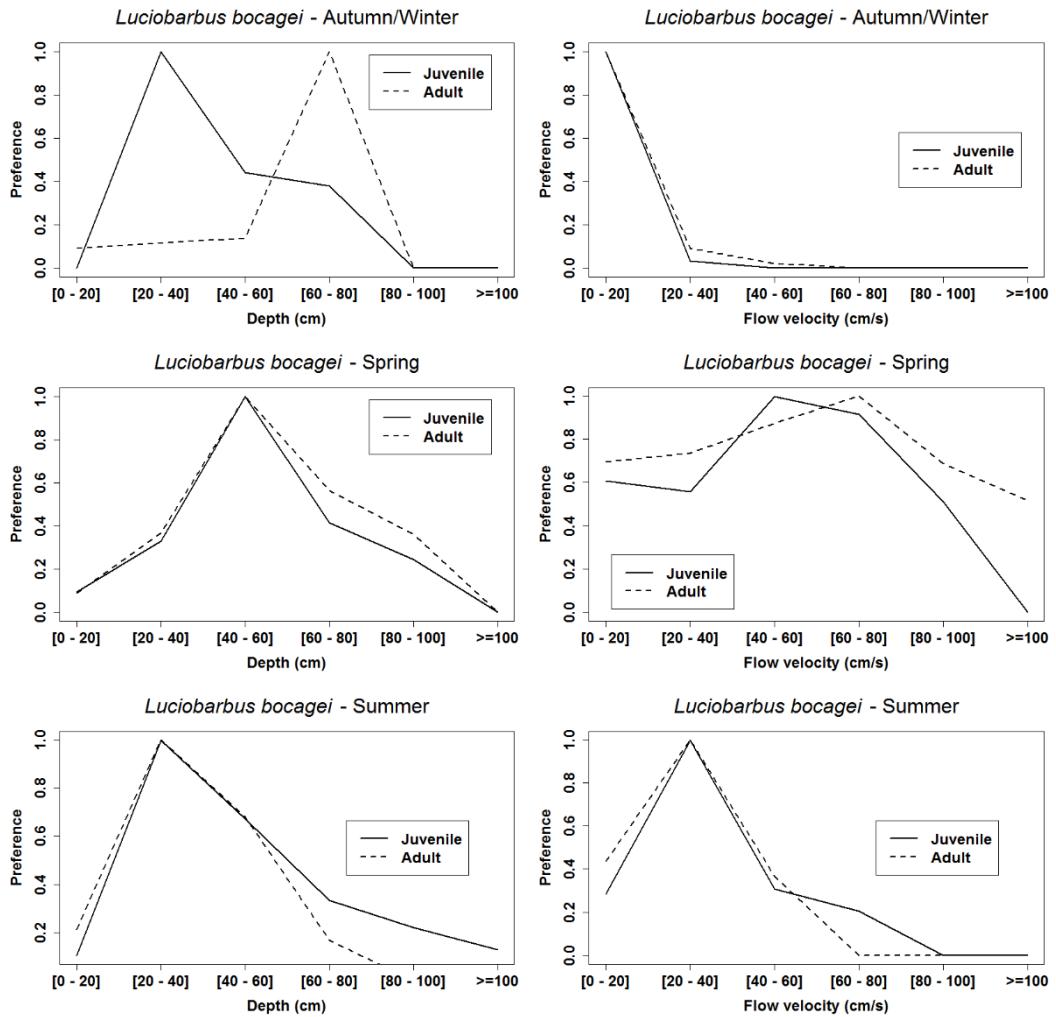
**Figure S7. Use frequency of *Squalius alburnoides* adults for water depth (cm) and flow velocity ( $\text{cm s}^{-1}$ ) during Autumn, Spring and Summer.**



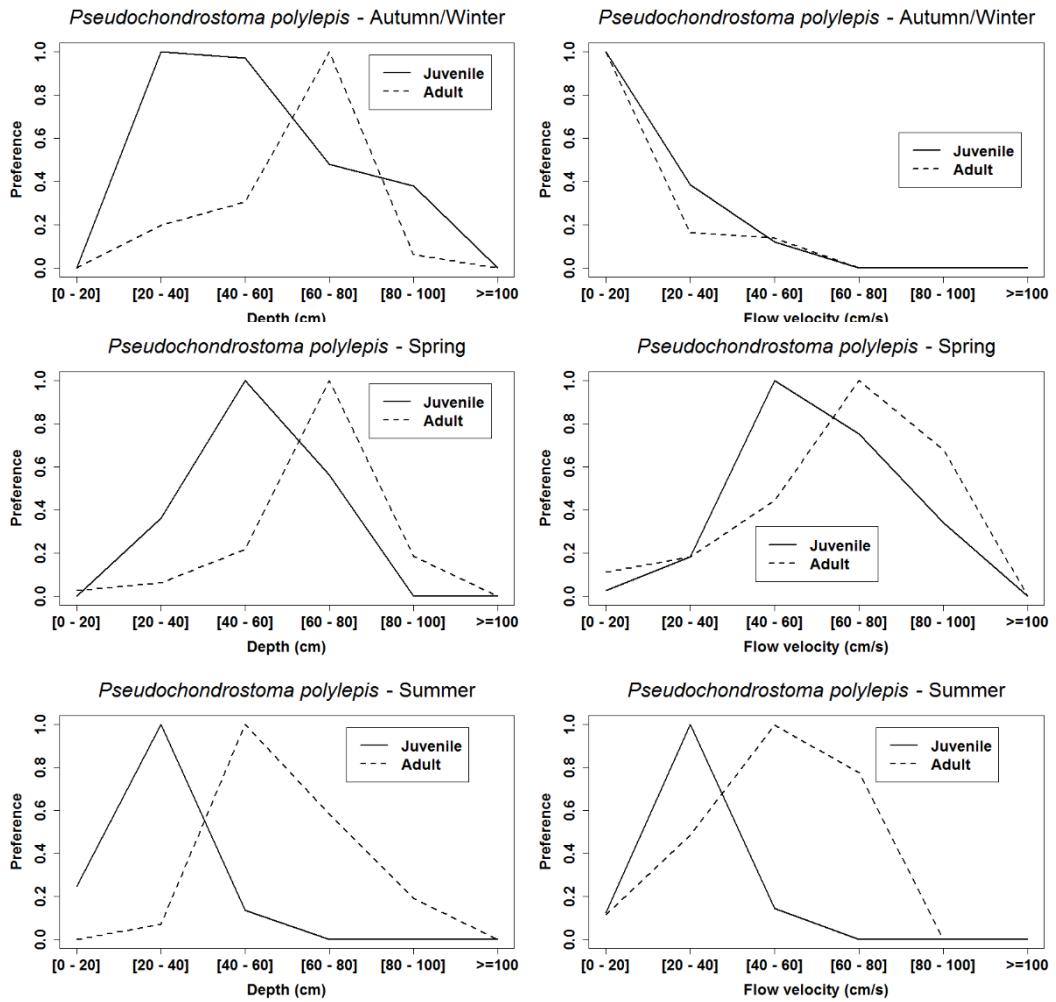
**Figure S8.** Use frequency of *Squalius alburnoides* juveniles for water depth (cm) and flow velocity ( $\text{cm s}^{-1}$ ) during Autumn, Spring and Summer.



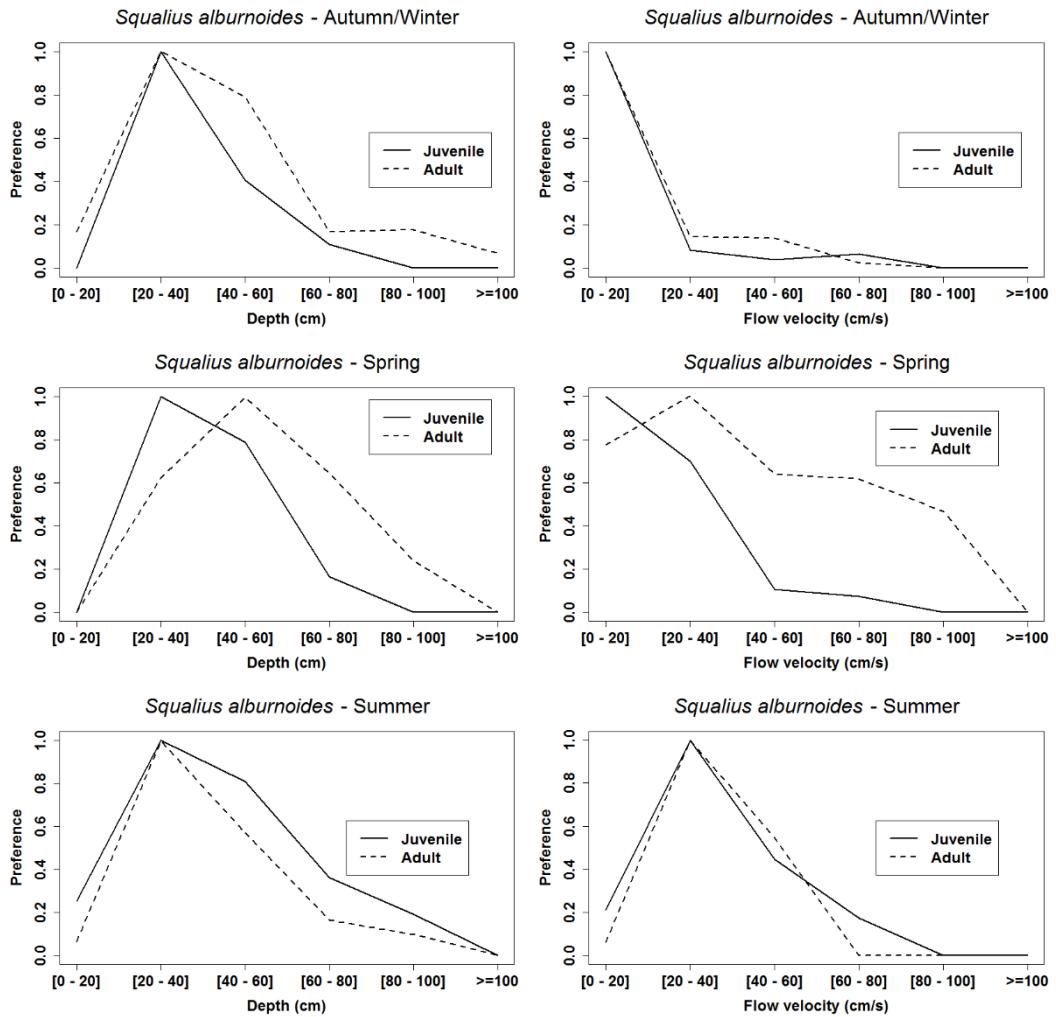
**Figure S9.** Habitat availability for water depth (cm) and flow velocity ( $\text{cm s}^{-1}$ ) during Autumn, Spring and Summer.



**Figure S10. Habitat preference of *Luciobarbus bocagei* for water depth (cm) and flow velocity ( $\text{cm s}^{-1}$ ) during Autumn, Spring and Summer.**



**Figure S11. Habitat preference of *Pseudochondrostoma polylepis* for water depth (cm) and flow velocity ( $\text{cm s}^{-1}$ ) during Autumn, Spring and Summer.**



**Figure S12. Habitat preference of *Squalius alburnoides* for water depth (cm) and flow velocity ( $\text{cm s}^{-1}$ ) during Autumn, Spring and Summer.**

## Results of statistical tests

### Comparison of hydraulics features of the river channel between Natural, Eflow and Eflow&Flush habitats

**Table S8.** Results of the t-tests ( $H_0$ : true difference in means is equal to 0) for the differences between Natural, Eflow and Eflow&Flush habitats in channel roughness for OCBA and OCPR study sites.

	OCBA			OCPR		
	t	df	p-value	t	df	p-value
Natural-Eflow&Flush	-94.978	124890	< 2.2E-16	-5.511	28189	3.6E-08
Natural-Eflow	-194.420	118850	< 2.2E-16	-66.604	27816	< 2.2E-16
Eflow&Flush-Eflow	-92.292	137650	< 2.2E-16	-61.231	27855	< 2.2E-16

**Table S9.** Results of the t-tests ( $H_0$ : true difference in means is equal to 0) for the differences between Natural, Eflow and Eflow&Flush habitats in water depth for OCBA and OCPR study sites.

	OCBA			OCPR		
	t	df	p-value	t	df	p-value
Natural-Eflow&Flush	-2.047	445600	0.0407	0.107	121100	0.9145
Natural-Eflow	-5.841	448080	5.2E-09	-1.545	121360	0.1222
Eflow&Flush-Eflow	-3.789	450190	1.5E-04	-1.653	121500	0.0983

**Table S10.** Results of the t-tests ( $H_0$ : true difference in means is equal to 0) for the differences between Natural, Eflow and Eflow&Flush habitats in flow velocity for OCBA and OCPR study sites.

	OCBA			OCPR		
	t	df	p-value	t	df	p-value
Natural-Eflow&Flush	2.652	445460	0.0080	0.354	121090	0.7230
Natural-Eflow	16.122	443090	< 2.2E-16	3.629	121060	2.8E-04
Eflow&Flush-Eflow	13.457	446670	< 2.2E-16	3.279	121290	1.0E-03

## $\chi^2$ test p-values for the equality of proportions between the Natural habitat and the Eflow and Eflow&flush habitats

**Table S11.** Equality of proportions between Natural habitat and Eflow habitat in OCBA study site (H0: WUA's have the same true proportion). Species codes stand for Lb – *Luciobarbus bocagei*; Pp – *Pseudochondrostoma polylepis*; Sa – *Squalius alburnoides*.

Month	Lb_juv	Lb_adult	Pp_juv	Pp_adult	Sa_juv	Sa_adult
Oct	0.000216	0.582952	6.21E-05	0.940216	0.323139	0.297538
Nov	0.000148	0.530769	1.74E-05	0.896214	0.370834	0.329465
Dec	0.000608	0.244612	1.17E-07	0.483554	0.668862	0.868717
Jan	0.000519	0.257775	1.41E-07	0.510652	0.789124	0.991580
Feb	0.000229	0.388867	1.60E-06	0.723955	0.587666	0.438736
Mar	0.005353	0.053108	0.462443	0.688765	0.035578	7.11E-05
Apr	0.005855	0.037780	0.398626	0.717639	0.041171	7.97E-05
May	0.001723	0.709184	0.524064	0.379709	0.005987	1.65E-05
Jun	0.795967	0.142917	0.610609	0.548629	0.248239	0.823737
Jul	0.878494	0.902296	0.931916	0.887568	0.978652	0.745271
Aug	0.878494	0.902296	0.931916	0.887568	0.978652	0.745271
Sep	0.308822	0.576689	0.272860	0.683524	0.562069	0.474081

**Table S12.** Equality of proportions between Natural habitat and Eflow&flush habitat in OCBA study site (H0: WUA's have the same true proportion). Species codes stand for Lb – *Luciobarbus bocagei*; Pp – *Pseudochondrostoma polylepis*; Sa – *Squalius alburnoides*.

Month	Lb_juv	Lb_adult	Pp_juv	Pp_adult	Sa_juv	Sa_adult
Oct	0.850180	0.975380	0.937319	0.982124	0.889660	0.929312
Nov	0.837909	0.975984	0.918213	0.986510	0.879203	0.920722
Dec	0.088235	0.361823	0.101082	0.422564	0.247659	0.189515
Jan	0.146970	0.462011	0.162449	0.516233	0.312924	0.256096
Feb	0.721348	0.970973	0.770267	0.981017	0.757865	0.774812
Mar	0.934309	0.853870	0.863878	0.997663	0.934126	0.976693
Apr	0.929003	0.844001	0.858171	0.998189	0.928228	0.970043
May	0.984099	0.955728	0.944510	0.987440	0.993220	0.956985
Jun	0.951283	0.919954	0.985273	0.981322	0.998841	0.911286
Jul	0.891434	0.870963	0.924438	0.982402	0.891084	0.850580
Aug	0.891434	0.870963	0.924438	0.982402	0.891084	0.850580
Sep	0.747660	0.865492	0.690731	0.875758	0.796120	0.742462

**Table S13. Equality of proportions between Natural habitat and Eflow habitat in OCPR study site (H0: WUA's have the same true proportion). Species codes stand for Lb – *Luciobarbus bocagei*; Pp – *Pseudochondrostoma polylepis*; Sa – *Squalius alburnoides*.**

Month	Lb_juv	Lb_adult	Pp_juv	Pp_adult	Sa_juv	Sa_adult
Oct	0.467174	0.787298	0.047326	0.505018	0.115923	0.066840
Nov	0.018055	0.443040	5.32E-07	0.294739	0.002503	0.001363
Dec	0.002366	0.274062	1.61E-12	0.154162	0.001140	0.000319
Jan	0.002625	0.290223	3.80E-12	0.156759	0.001164	0.000346
Feb	0.008752	0.386039	7.98E-09	0.233811	0.001850	0.000819
Mar	0.061766	0.554872	1.42E-05	0.295786	0.004822	0.002455
Apr	0.001355	0.114244	0.226976	0.716657	0.141175	3.90E-12
May	0.019642	0.262956	0.380338	0.839495	0.170810	1.42E-08
Jun	0.442916	0.665689	0.509405	0.856592	0.751174	0.715195
Jul	0.976778	0.991759	0.958640	0.981950	0.917565	0.869678
Aug	0.918253	0.850503	0.903803	0.915809	0.852783	0.913014
Sep	0.967843	0.907693	0.935341	0.945988	0.884826	0.902486

**Table S14. Equality of proportions between Natural habitat and Eflow&flush habitat in OCPR study site (H0: WUA's have the same true proportion). Species codes stand for Lb – *Luciobarbus bocagei*; Pp – *Pseudochondrostoma polylepis*; Sa – *Squalius alburnoides*.**

Month	Lb_juv	Lb_adult	Pp_juv	Pp_adult	Sa_juv	Sa_adult
Oct	0.948755	0.972671	0.966995	0.994709	0.997594	0.995991
Nov	0.918275	0.834241	0.982070	0.975136	0.978806	0.989342
Dec	0.948791	0.944823	0.979856	0.998893	0.981760	0.987061
Jan	0.951852	0.953759	0.980720	0.987732	0.994761	0.998211
Feb	0.935172	0.985107	0.982133	0.971475	0.981222	0.986931
Mar	0.953429	0.997549	0.984473	0.987587	0.999956	0.995221
Apr	0.986832	0.997796	0.999768	0.998475	0.988456	0.960142
May	0.992298	0.970561	0.999811	0.998420	0.993079	0.974589
Jun	0.994943	0.990000	0.996416	0.994406	0.994190	0.991033
Jul	0.835681	0.860729	0.846797	0.931103	0.841102	0.835942
Aug	0.808999	0.774405	0.806757	0.882440	0.777273	0.846911
Sep	0.978260	0.817781	0.841934	0.910452	0.819581	0.863367