Hydrology and
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Discussions

*Supplement of*

# The inbuilt long-term unfeasibility of environmental flows when disregarding riparian vegetation requirements

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**Supplement S1**: Hydraulic data and channel bed characteristics for River 2D and CASiMiR-vegetation model parameterization

Table S1. Flow curve considered in the downstream section as the outflow condition in River2D model.

| Discharge ($m^3 s^{-1}$) | 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. Channel roughness classification of the different substrates in the aquatic zone of the river without vegetation used in the River2D model.

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

Table S3. Channel roughness classification of the different considered riparian vegetation succession phases used in the River2D model (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 S4. 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 elevation (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 ($N\ m^{-2}$) | IP | 30 |
| | PP | 30 |
| | ES | 50 |
| | EF | 300 |
| | MF | 300 |

**Supplement S2: Summary of collected data supporting the ecological background for riparian vegetation and fish modeling.**

Table S5. 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).

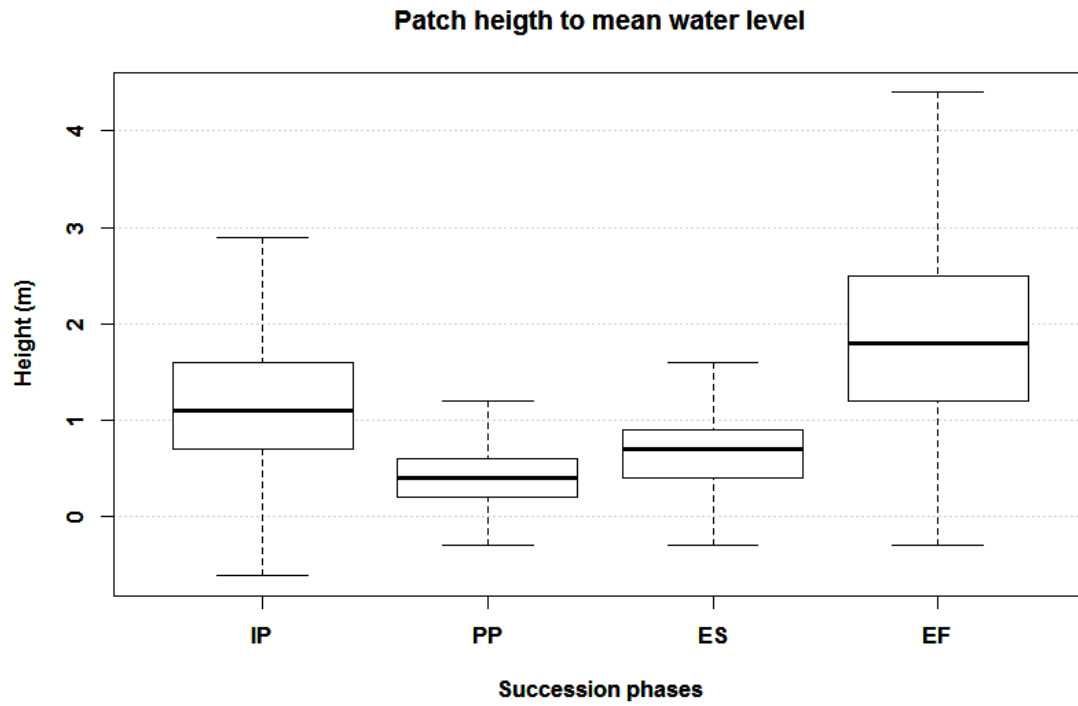| Succession phase | Patches surveyed | Mean height to mean water level(m) | Mean area ($m^2$) | Mean cover of herb layer (%) | Mean cover of shrub layer (%) | Mean cover of tree layer (%) | Mean number of woody species |
|---|---|---|---|---|---|---|---|
| IP | 11 | 1.12 | 357.51 | 0.48 | 0.05 | 0.00 | 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).
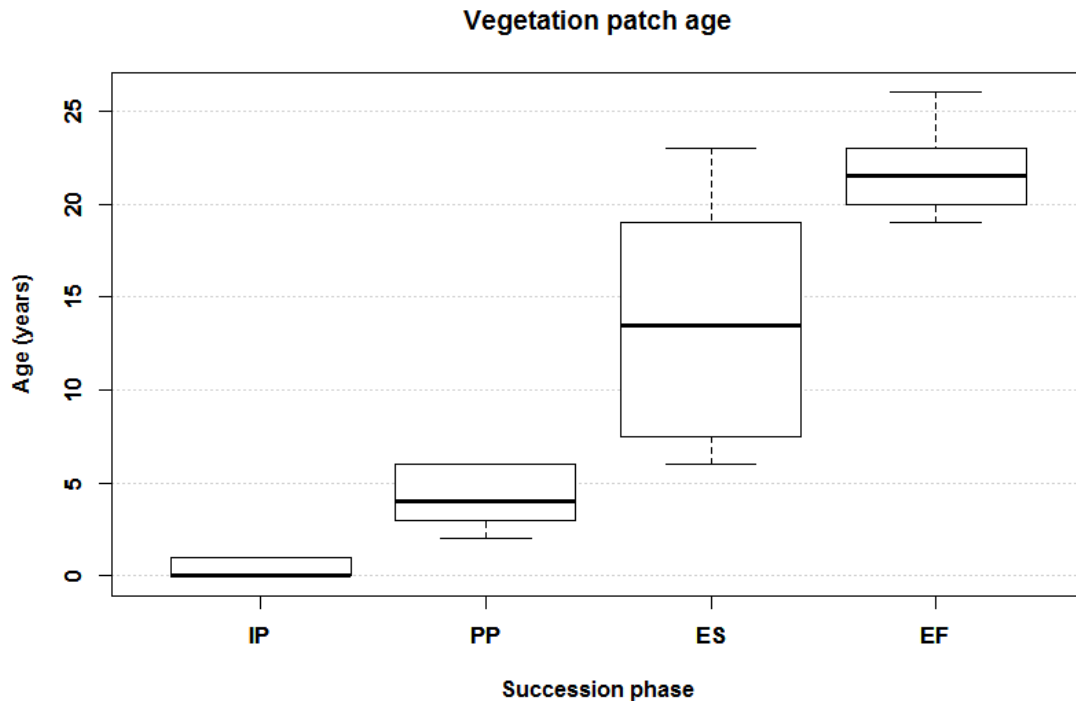
**Vegetation patch age**



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 S6. Number of captured cyprinid individuals throughout different sampling seasons in Ocreza river basin.

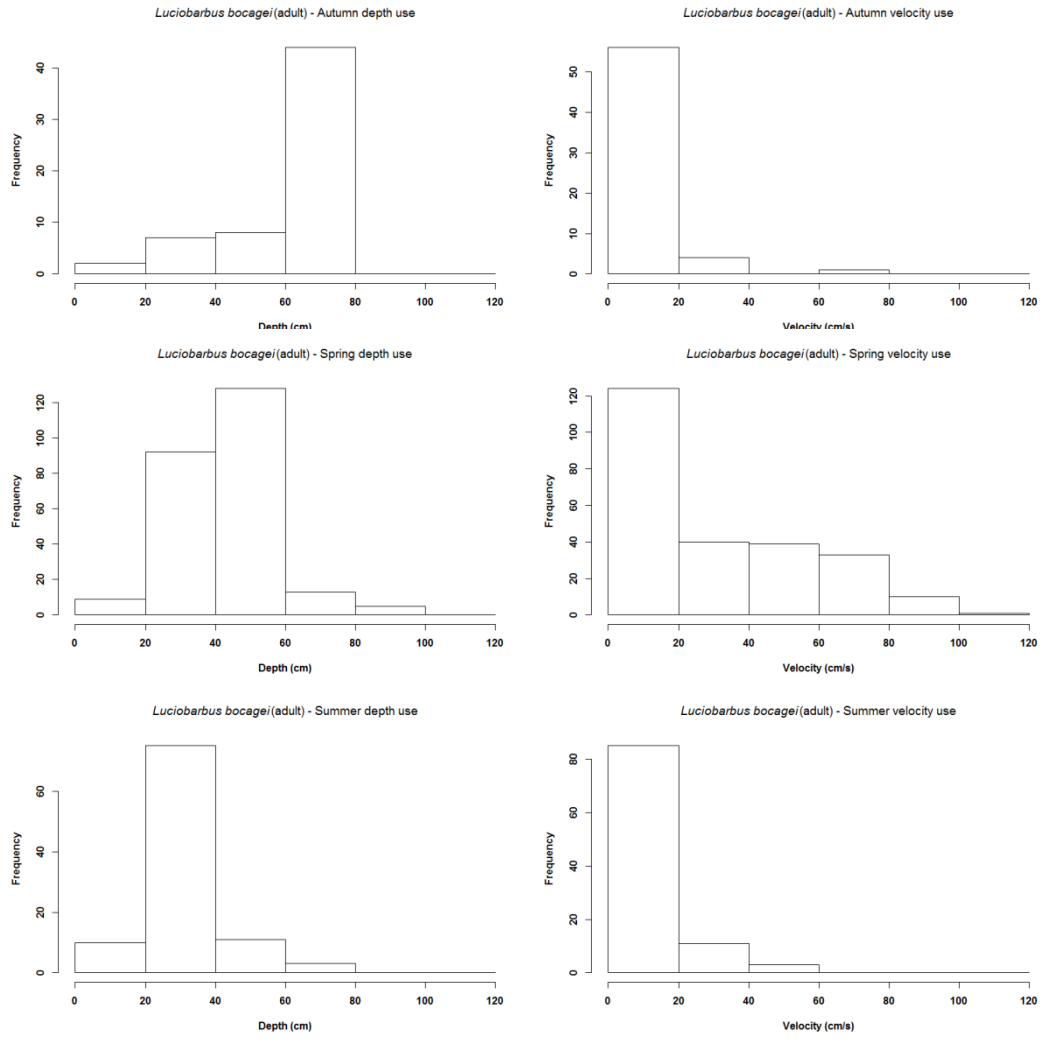| Common name | Cyprinid Species | Spring | Summer | Autumn | Total |
|---|---|---|---|---|---|
| Iberian barbel | *Luciobarbus bocagei* | 666 | 300 | 102 | 1068 |
| Iberian straight mouth-nase | *Pseudochondrostoma polylepis* | 46 | 62 | 102 | 210 |
| Calandino | *Squalius alburnoides* | 277 | 364 |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

Figure S3. Use frequency of *Luciobarbus bocagei* adults for water depth (cm) and flow velocity (cm/s) during Autumn, Spring and Summer.
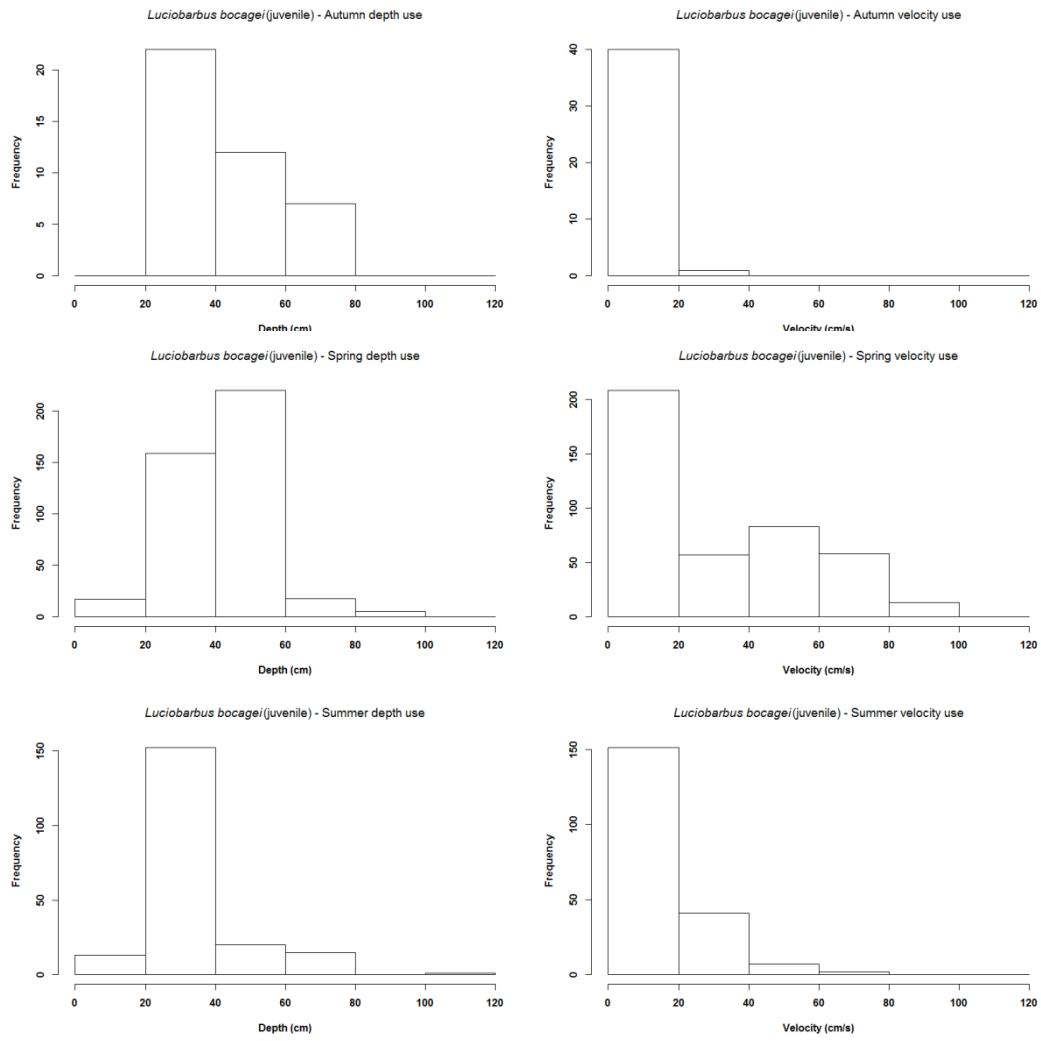
Figure S4. Use frequency of *Luciobarbus bocagei* juveniles for water depth (cm) and flow velocity (cm/s) during Autumn, Spring and Summer.
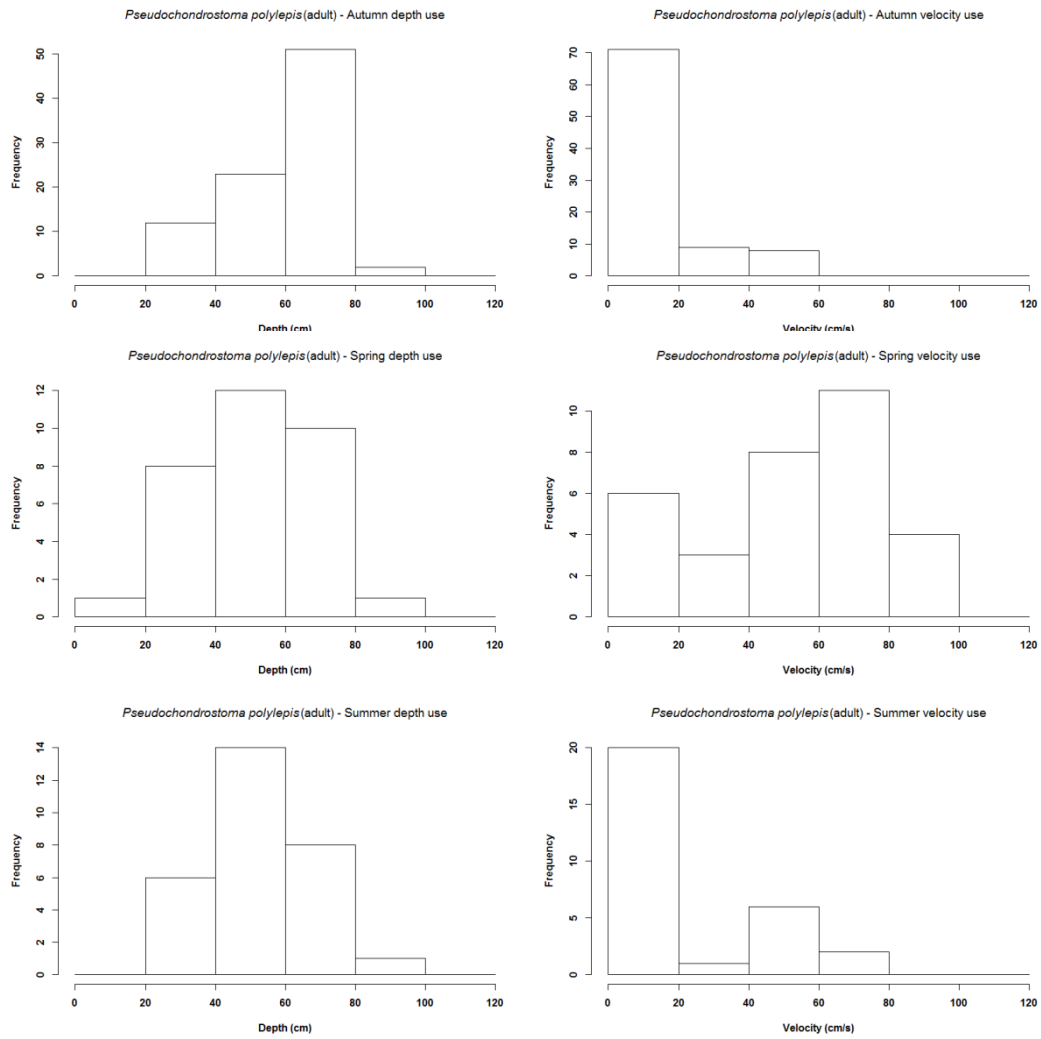
Figure S5. Use frequency of *Pseudochondrostoma polylepis* adults for water depth (cm) and flow velocity (cm/s) during Autumn, Spring and Summer.
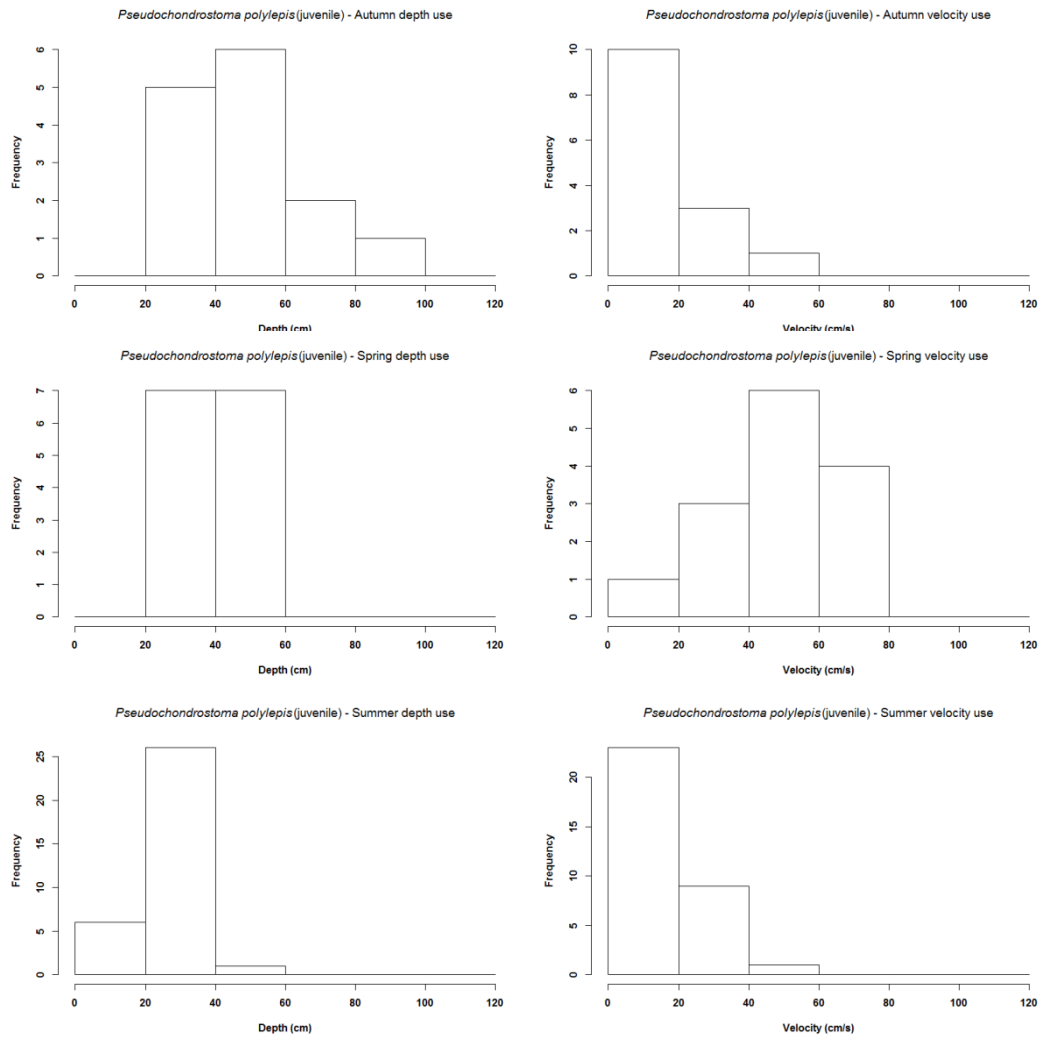
Figure S6. Use frequency of *Pseudochondrostoma polylepis* juveniles for water depth (cm) and flow velocity (cm/s) during Autumn, Spring and Summer.
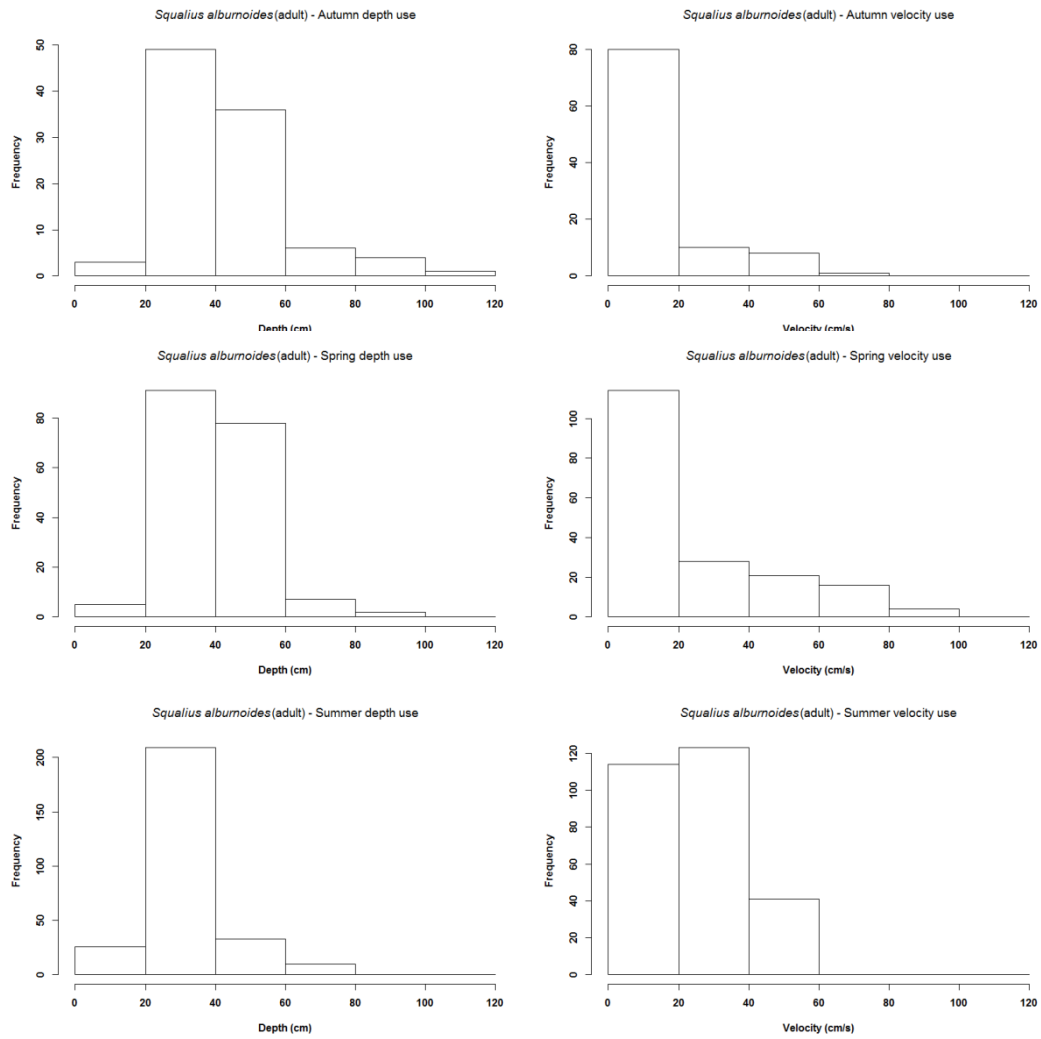
Figure S7. Use frequency of *Squalius alburnoides* adults for water depth (cm) and flow velocity (cm/s) during Autumn, Spring and Summer.
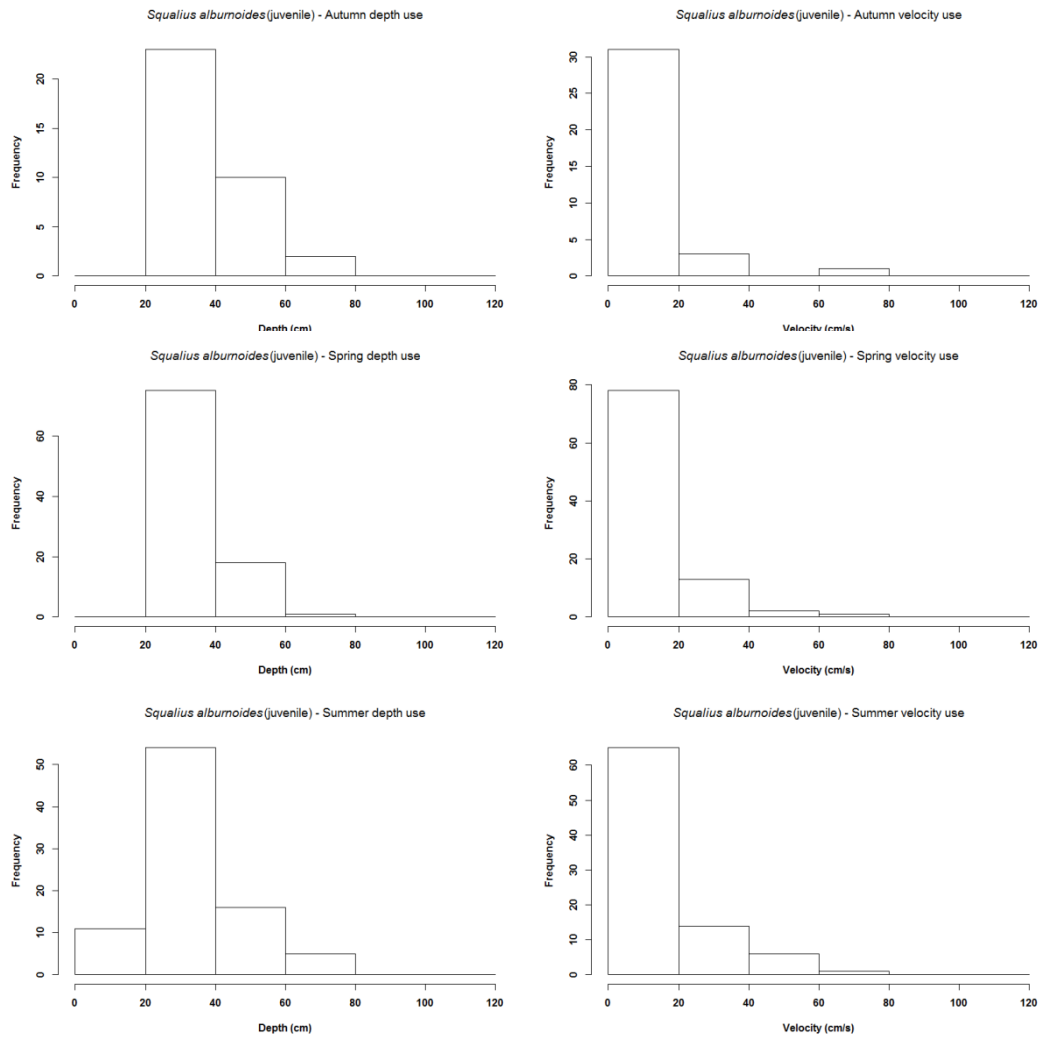
Figure S8. Use frequency of *Squalius alburnoides* juveniles for water depth (cm) and flow velocity (cm/s) during Autumn, Spring and Summer.
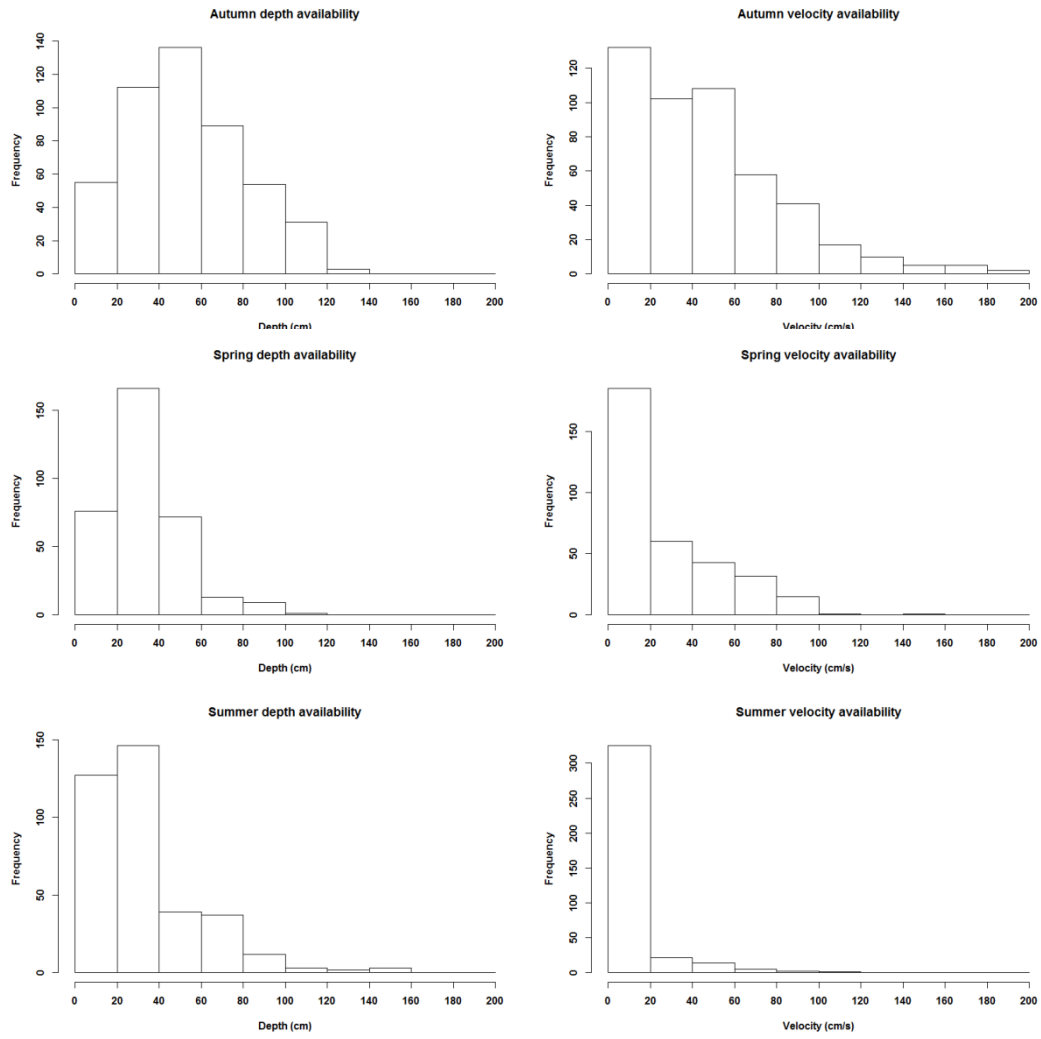
Figure S9. Habitat availability for water depth (cm) and flow velocity (cm/s) during Autumn, Spring and Summer.
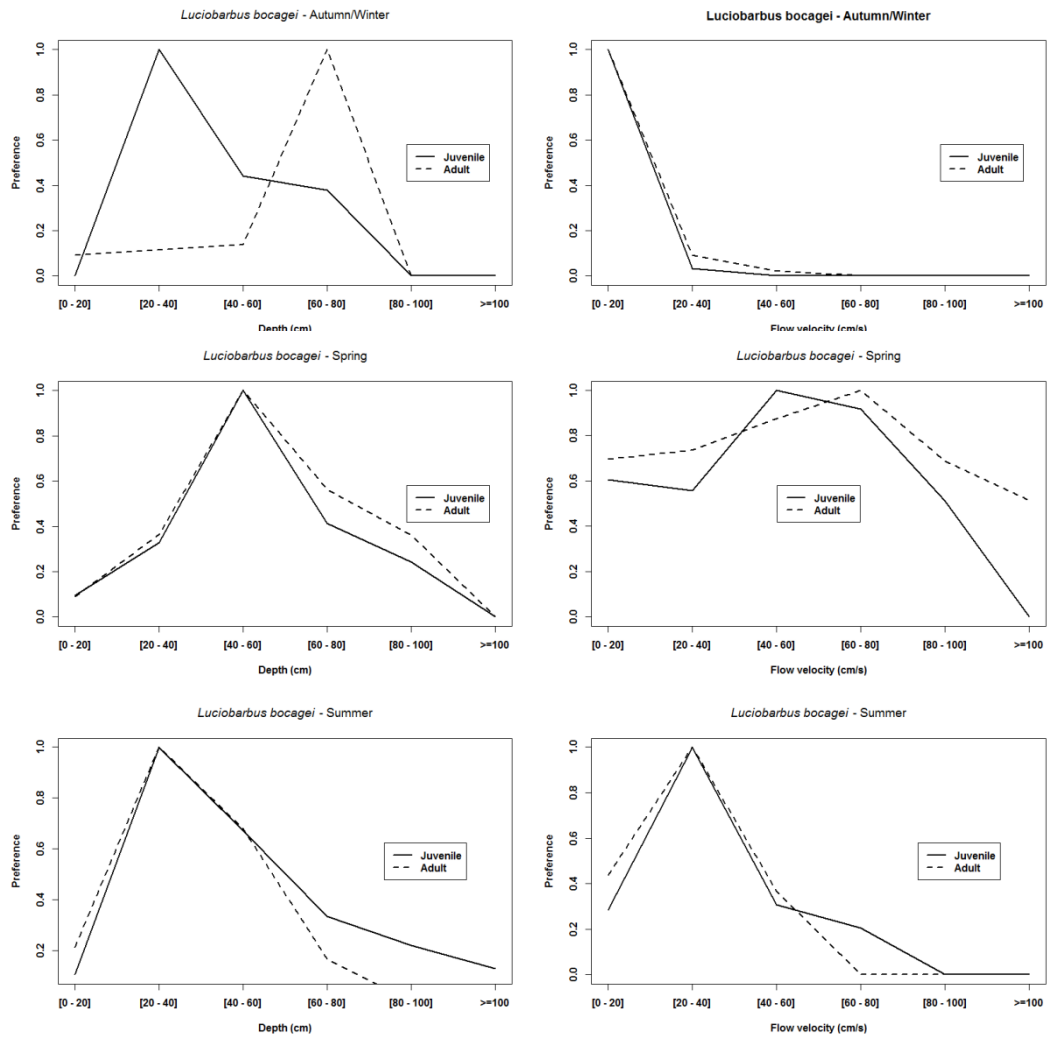
Figure S10. Habitat preference of *Luciobarbus bocagei* for water depth (cm) and flow velocity (cm/s) during Autumn, Spring and Summer.
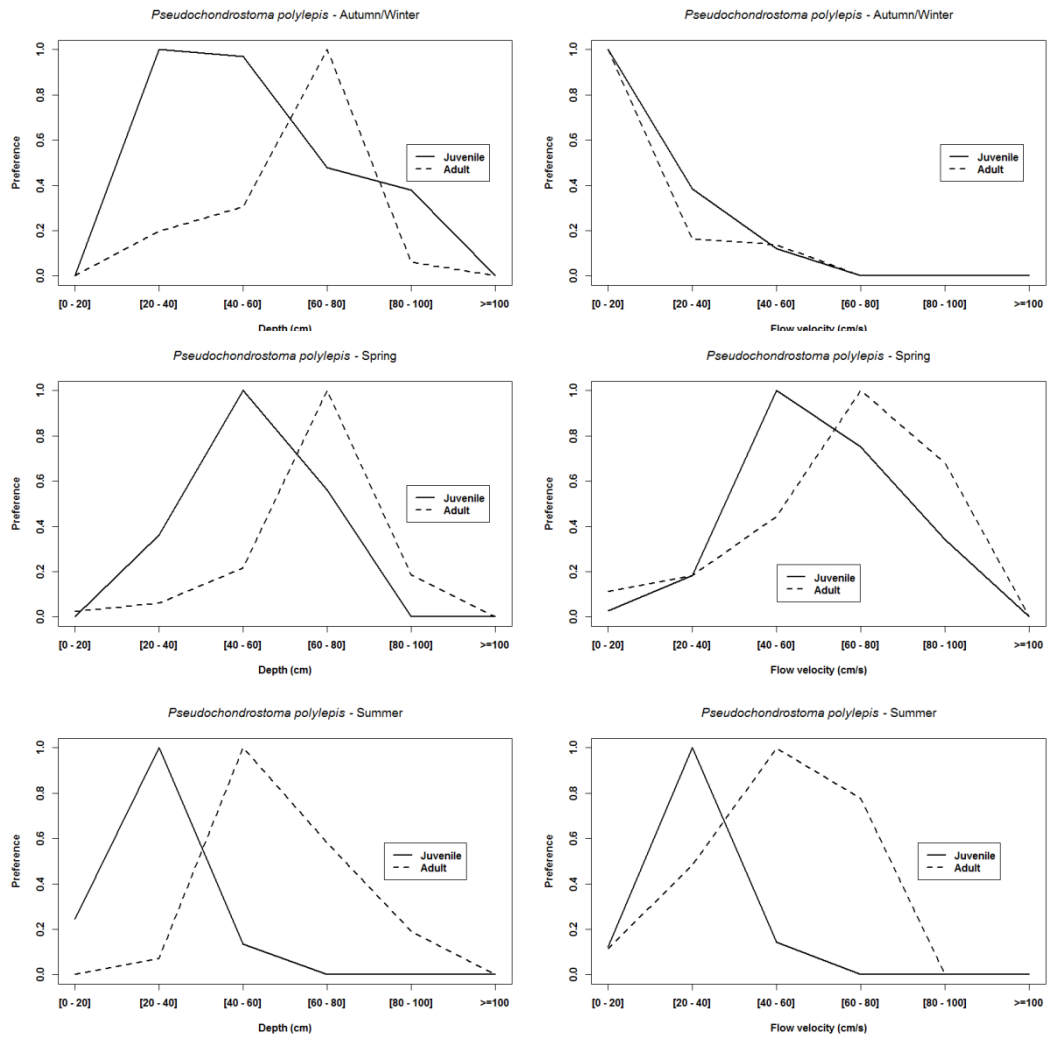
Figure S11. Habitat preference of *Pseudochondrostoma polylepis* for water depth (cm) and flow velocity (cm/s) during Autumn, Spring and Summer.
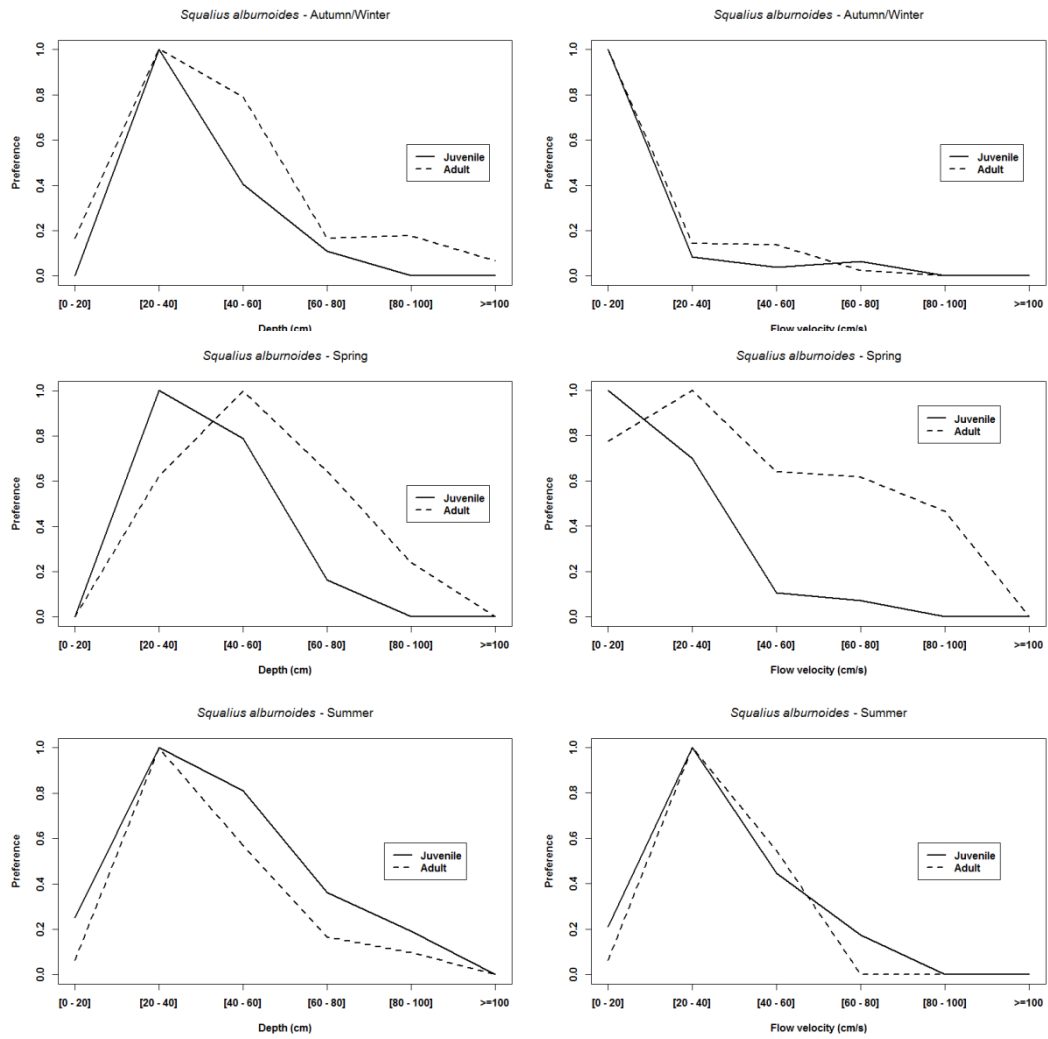
Figure S12. Habitat preference of *Squalius alburnoides* for water depth (cm) and flow velocity (cm/s) during Autumn, Spring and Summer.

**Supplement S3**: χ² test p-values for the equality of proportions between the Natural habitat and the Eflow and Eflow&flush habitats

Table S7. Equality of proportions between Natural habitat and Eflow habitat (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 S8. Equality of proportions between Natural habitat and Eflow&flush habitat (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 |