Supplementary Information 1 – EQR/EQC methods

Supplementary Table 1: Methods used to produce the Ecological Quality Ratios and Ecological Quality Classes for each country.

Country	Method	Method reference	Example reference
Austria	Multimetric index using three metrics[a,b]	www.wiser.eu/results/method-database/detail.php?id=49	1
Belgium	Multimetric Macroinvertebrate Index Flanders[a,b,c]	www.wiser.eu/results/method-database/detail.php?id=123	2
Bulgaria	Biotic Index[a]	www.wiser.eu/results/method-database/detail.php?id=344	3
Cyprus	STAR Intercalibration Common Metric Index[a,b,c,d]	www.wiser.eu/results/method-database/detail.php?id=48	4
Czech Republic	Multimetric index using river type-specific metrics	www.wiser.eu/results/method-database/detail.php?id=214	5
Denmark	Danish Streamfauna Index	www.wiser.eu/results/method-database/detail.php?id=217; 6	7
Estonia	Multimetric index using five metrics[a,b,c,d]	www.wiser.eu/results/method-database/detail.php?id=46	8
Finland	Finnish Multimetric Index[c]	www.wiser.eu/results/method-database/detail.php?id=146; 6	6
France	Global Biological Normalized Index[a]	www.wiser.eu/results/method-database/detail.php?id=147	9
Germany	Multimetric index using river type-specific metrics[c]	www.wiser.eu/results/method-database/detail.php?id=275	10
Hungary	Hungarian Multimetric Index[b,c,d]	11	11
Ireland	Quality Rating System[a,c]	www.wiser.eu/results/method-database/detail.php?id=311	12

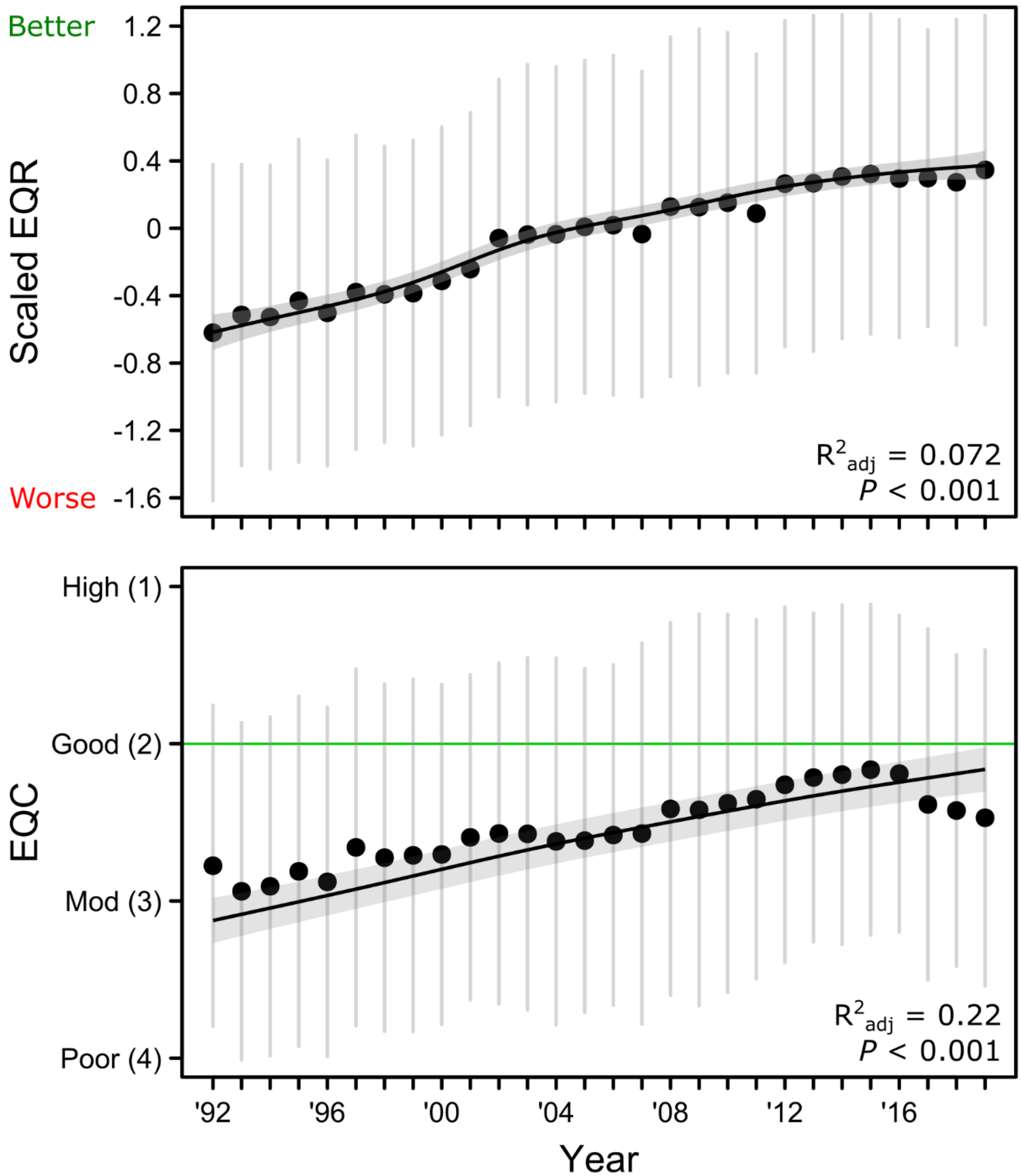
Italy	STAR Intercalibration Common Metric Index[a,b,c,d]	www.wiser.eu/results/method-database/detail.php?id=215	4
Latvia	Latvian Macroinvertebrate Index[a,c,d]	https://circabc.europa.eu/sd/a/0c2fdd3c-3720-45e4-8684-12dc4fc561c2/LV_river_macroinvertebrates_IC.pdf	13
Luxembourg	I_2M_2[a,b,d]	9	9
Netherlands	KRW-maatlatten	www.wiser.eu/results/method-database/detail.php?id=159	
Norway	Poorest out of the Average Score Per Taxon index and the River Acidification Macroinvertebrate Index[d]	www.wiser.eu/results/method-database/detail.php?id=316; www.vannportalen.no/veiledere/klassifiseringsveileder/; 6	6
Portugal	South Portugal macroinvertebrate biotic index[a,c,d]	www.wiser.eu/results/method-database/detail.php?id=216	14
Spain	Iberian Biological Monitoring Working Party	www.boe.es/buscar/doc.php?id=BOE-A-2015-9806	15
Sweden	Average Score Per Taxon and the DJ index[d]	www.wiser.eu/results/method-database/detail.php?id=96; 6,16	17
Switzerland	Multimetric index following the German system for a type 3.2 river[c]	www.wiser.eu/results/method-database/detail.php?id=275	10
UK	Whalley Hawkes Paisley Trigg (WHPT) Average Score Per Taxon and number of scored taxa[d]	http://wfduk.org/sites/default/files/River%20Invertebrates%20WHPT%20UKTAG%20Method%20Statement%20-%20updated%20May%202021.pdf	18

[a]Uses taxon richness
[b]Uses Shannon diversity
[c]Uses EPT richness
[d]Uses an ASPT index

Supplementary Information 2 – Time series data and sensitivity

Supplementary Table 2: Number of sites, sampling years, and time series length for each country (the latter two values are averaged if there are multiple sites).

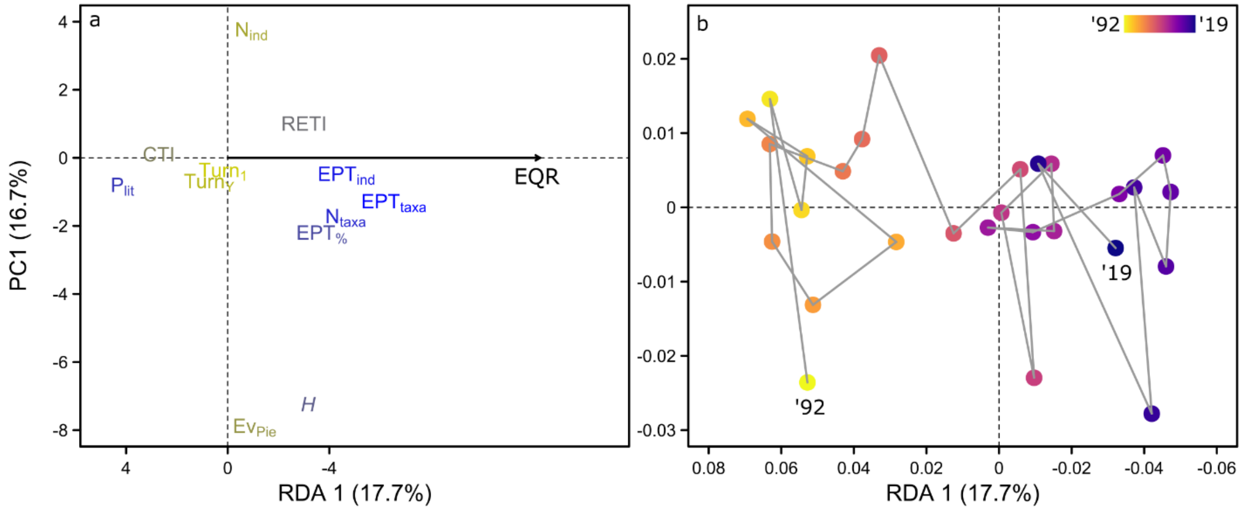
Country	Number of sites	Start year	End year	Sampling years	Total length
Austria	1	2008	2019	8	12
Belgium	67	1995	2014	9	20
Bulgaria	5	2010	2019	9	10
Cyprus	2	2006	2018	8	13
Czech Republic	1	2002	2016	8	15
Denmark	248	1996	2018	21	23
Estonia	10	2010	2019	8	10
Finland	10	2000	2014	15	15
France	265	1995	2016	14	22
Germany	12	2005	2016	10	11
Hungary	84	2006	2017	11	12
Ireland	16	2003	2019	17	17
Italy	5	2010	2018	8	9
Latvia	3	1996	2015	19	20
Luxembourg	20	2007	2017	10	11
Netherlands	46	1999	2017	13	20
Norway	63	2004	2018	11	15
Portugal	2	1993	2019	27	27
Spain	245	2000	2014	17	18
Sweden	91	2004	2018	14	15
Switzerland	1	1995	2018	8	24
UK	37	2006	2018	13	13



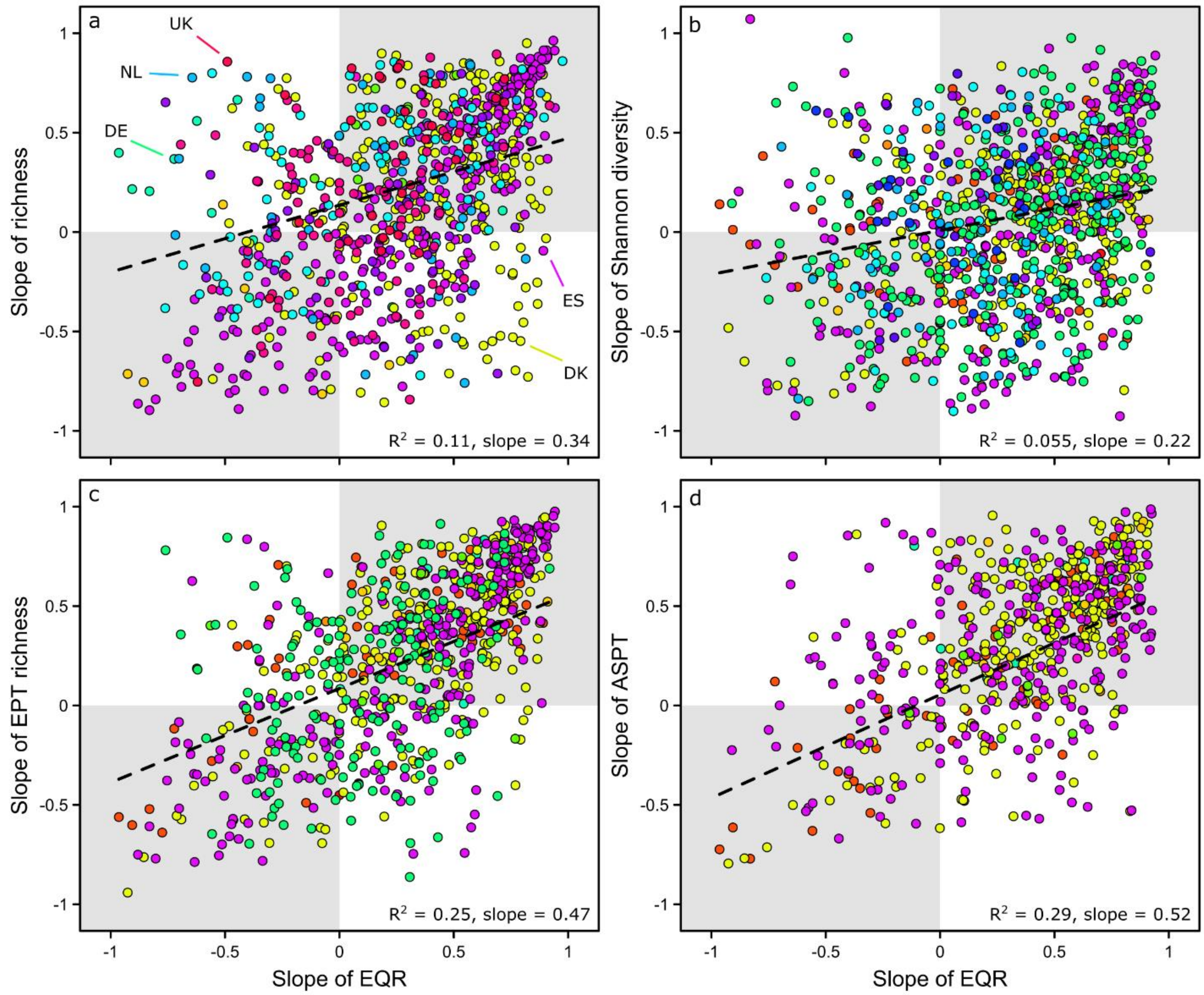
Supplementary Fig. 1: Sensitivity of trends in (**a**) Ecological Quality Ratios (EQRs) and (**b**) Ecological Quality Classes (EQCs; 'Mod' = moderate) to the exclusion of countries with datasets shorter than the mean time series length of 18 years (see Supplementary Table 2). Black points and vertical grey lines respectively indicate the annual means and standard deviations. Fitted relationships (black lines) and confidence intervals (grey background) were based on the output from generalized additive mixed models. The European Union Water Framework Directive target of a 'good' EQC for all waterbodies is indicated by a green line in (**b**). Note that the 'bad' EQC (class 5) is not plotted.

These results show that the plateau in quality is not driven by adding more countries to the dataset in later years (see Fig. 4). We also found little influence of individual countries on these trends based on iteratively re-running the analysis with a different country removed in each iteration (i.e., a 'leave-one-out' approach).

Supplementary Information 3 – Circular community metrics and biomonitoring indices



Supplementary Fig. 2: Effect of removing sites that calculate Ecological Quality Ratios ('EQRs'; black arrow) using any of the community metrics or biomonitoring indices involved in our analyses (based on the methods reported in Supplementary Table 1). This analysis includes only sites from Denmark, Estonia, Germany, the Netherlands, and Spain (562 out of 1,234 sites or 45% of the dataset). The results show the same general relationships compared to our analysis of the full dataset (see Fig. 3), specifically that (**a**) richness is the community metric with the strongest relationship to the EQRs and the EPT indices exhibit the strongest relationships for the biomonitoring indices. We also found the same (**b**) temporal changes, specifically that the metrics/indices associated with the EQRs tend to show a directional movement from the left to right in the ordination, but there has been little overall change since the early-2010s.



Supplementary Fig. 3: Effect of removing sites that calculate Ecological Quality Ratios ('EQRs') using (**a**) taxon richness (31% of sites removed), (**b**) Shannon diversity (14% removed), (**c**) the richness of Ephemeroptera, Plecoptera, and Trichoptera (37% removed), and (**d**) the Average Score Per Taxon (ASPT) index (33% removed from a total of 898 sites for which ASPT can be calculated). The other community metrics and biomonitoring indices are never (or almost never) used to calculate EQRs and so are not plotted because their results would remain the same as in Fig. 6 and Extended Data Fig. 3.

We found that these removals had little overall influence on our results. Specifically, richness was the community metric with the most consistent site-level relationship (albeit somewhat weaker compared to Fig. 6a), and a similar proportion of sites exhibiting matching (20% with matching positive or negative slopes that do not overlap 0) versus no (36%) or opposing (3%) relationships to the EQRs. The relationship with Shannon diversity is weaker compared to Fig. 6b, but we do not present this as a potentially reliable metric in our main text. Similarly, the EPT and ASPT relationships remain generally unchanged (compared to Extended Data Fig. 3), further supporting our conclusion that improving ecological quality is likely caused by improvements in water/habitat conditions.

Supplementary Information 4 – Country-scale generalized additive mixed models

Supplementary Table 3: Coefficients for the effect of year from the generalized additive mixed models of temporal changes in the Ecological Quality Ratio (EQR) for each of 14 countries.

Country	***n***	**edf**	**F**	***P***
Belgium	633	1.00	33.04	<0.001**
Denmark	5,112	1.00	63.85	<0.001**
Estonia	81	2.05	0.95	0.42
Finland	150	1.00	2.57	0.11
France	3,677	3.15	47.75	<0.001**
Germany	125	1.00	1.93	0.17
Hungary	920	1.65	1.63	0.12
Ireland	269	1.00	0.002	0.97
Luxembourg	200	1.00	2.81	0.095*
Netherlands	618	1.49	0.40	0.73
Norway	685	2.05	7.37	<0.001**
Spain	4,118	1.00	86.28	<0.001**
Sweden	1,284	1.00	0.80	0.37
UK	467	1.00	3.41	0.065*

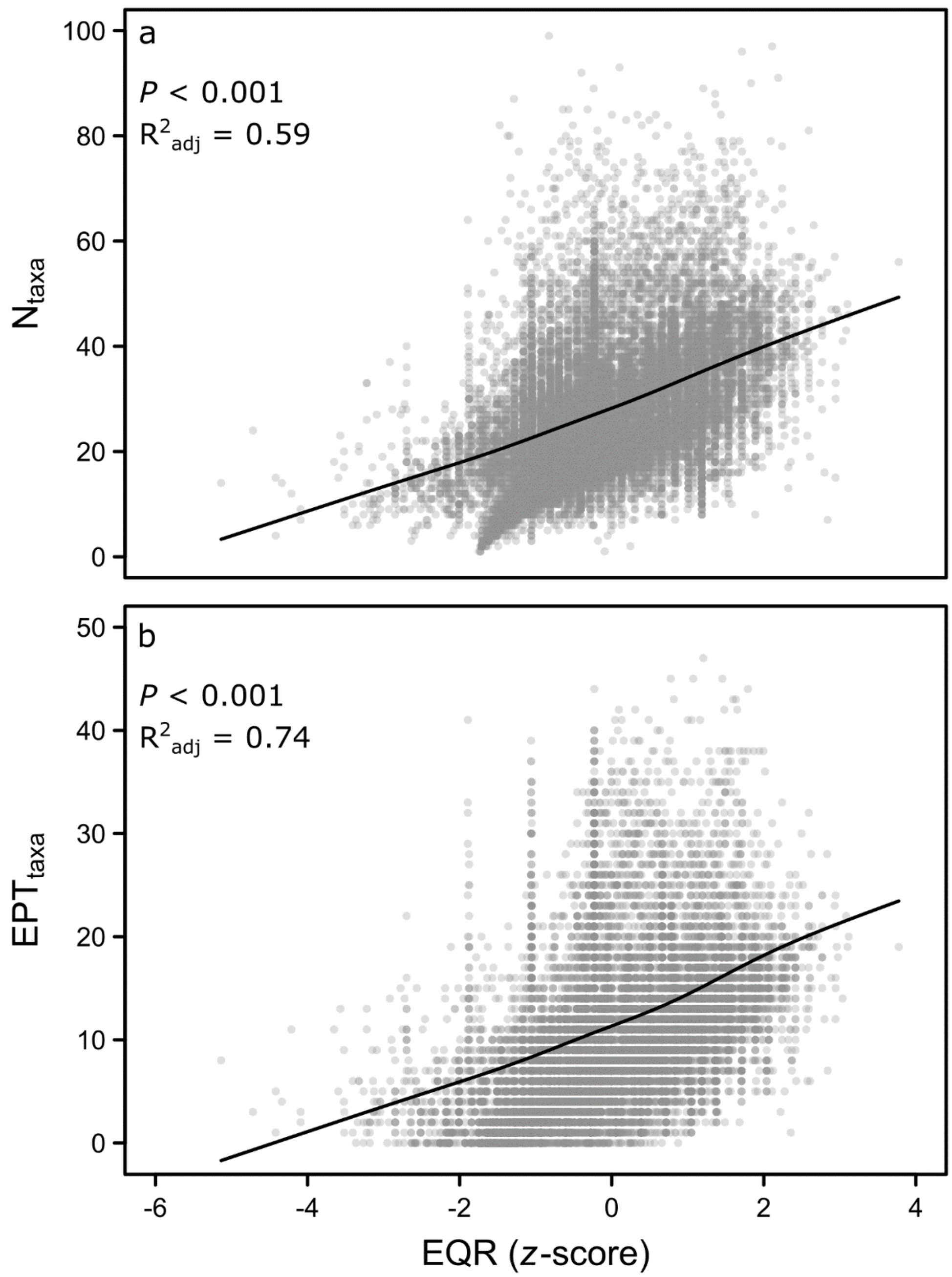
**P*<0.1 but >0.05 so provides no strong evidence for change but still marginally non-significant
***P*<0.05 and most are <0.001 so considered fairly strong evidence for change

Supplementary Table 4: Coefficients for the effect of year from the generalized additive mixed models of temporal changes in the Ecological Quality Class (EQC) for each of 14 countries.

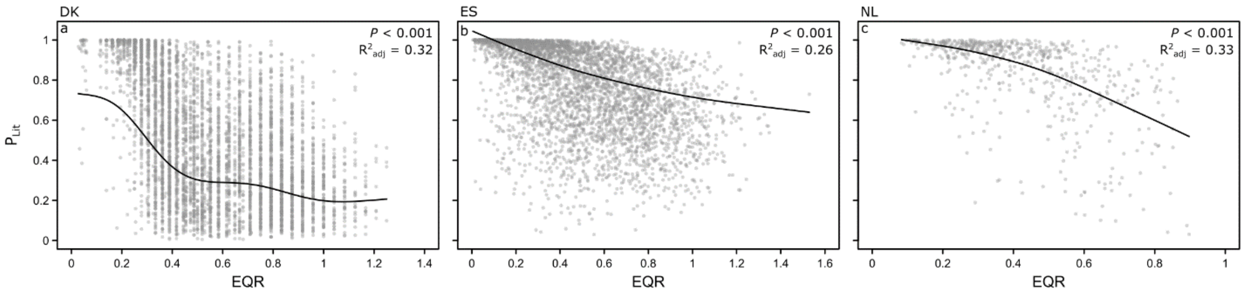
Country	***n***	**edf**	**F**	***P***
Belgium	633	1.00	27.67	<0.001**
Denmark	5,112	1.00	62.91	<0.001**
Estonia	81	1.57	0.65	0.62
Finland	150	1.00	2.16	0.14
France	3,677	2.87	56.45	<0.001**
Germany	134	1.00	0.66	0.42
Hungary	920	1.26	3.34	0.041**
Ireland	269	1.00	0.002	0.97
Luxembourg	200	1.00	1.63	0.20
Netherlands	618	1.09	0.012	0.94
Norway	685	1.00	7.42	<0.001**
Spain	4,118	1.00	105.58	<0.001**
Sweden	1,284	1.00	0.26	0.61
UK	467	1.00	3.47	0.063*

**P*<0.1 but >0.05 so provides no strong evidence for change but still marginally non-significant
***P*<0.05 and most are <0.001 so considered fairly strong evidence for change

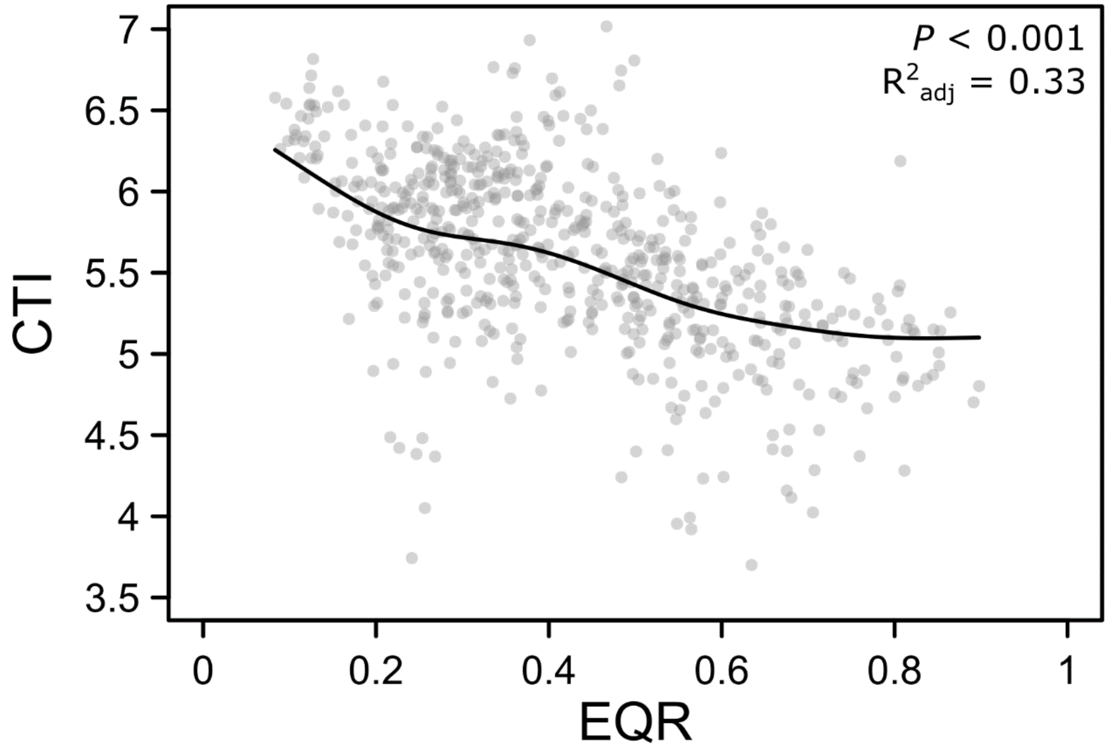
Supplementary Information 5 – Relationships between ecological quality and individual community metrics or biomonitoring indices.



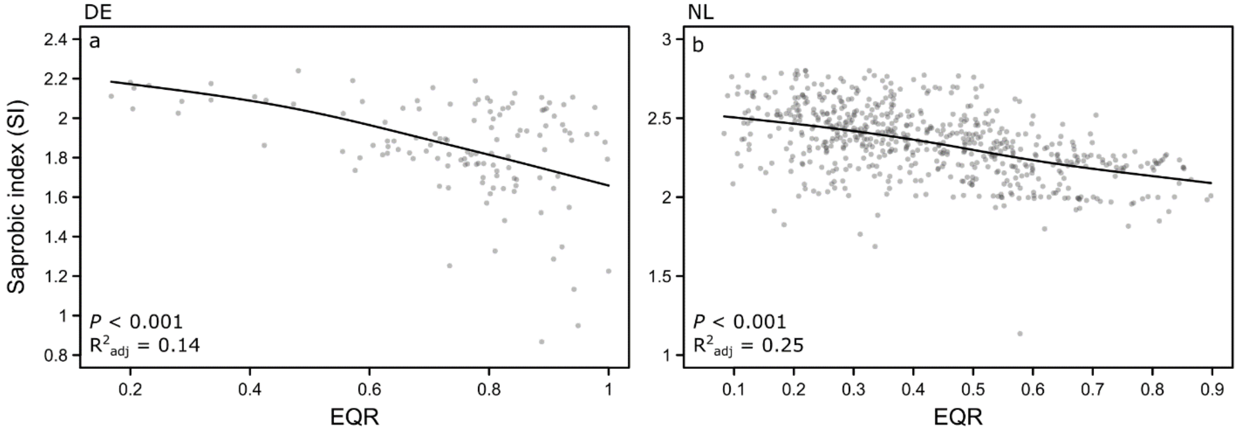
Supplementary Fig. 4: Relationships between the Ecological Quality Ratios (EQRs) and (**a**) taxon richness (N_{taxa}) and (**b**) the richness of Ephemeroptera, Plecoptera, and Trichoptera taxa (EPT_{taxa}) across all countries.



Supplementary Fig. 5: Relationships between the Ecological Quality Ratios (EQRs) and the proportion of littoral taxa (P_{lit}) in (**a**) Denmark (DK), (**b**) Spain (ES), and (**c**) the Netherlands (NL). Higher P_{lit} values indicate communities comprised of more littoral taxa.

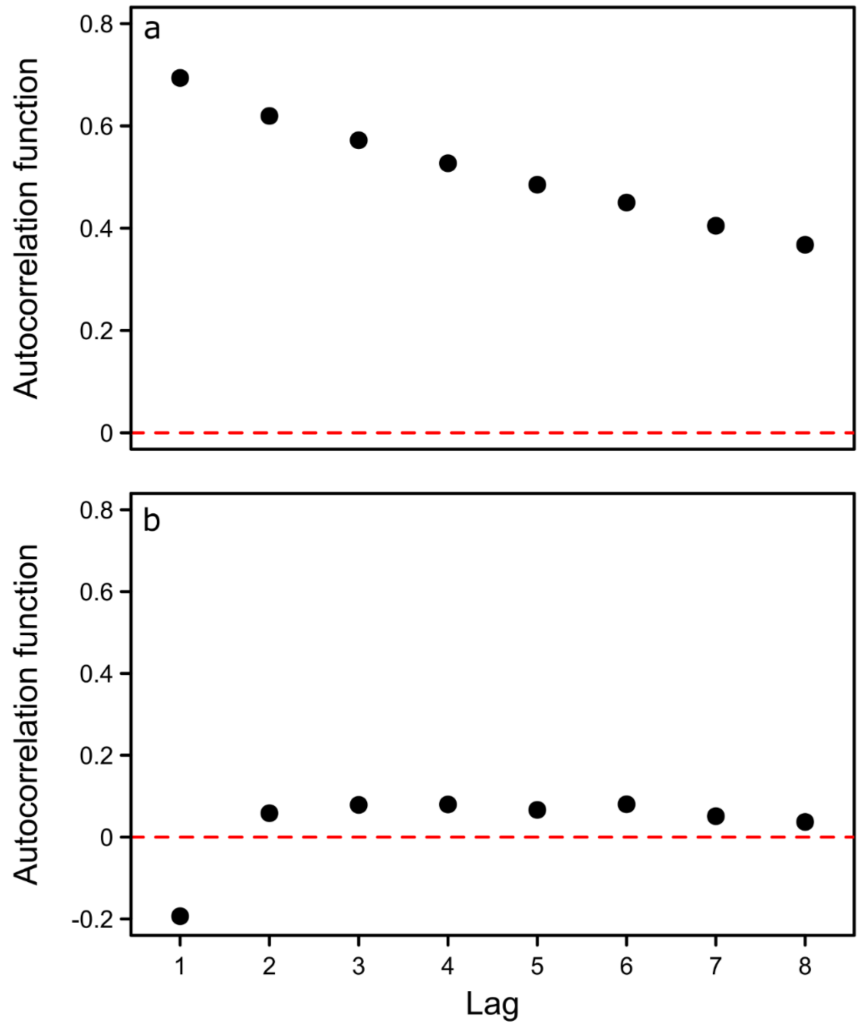


Supplementary Fig. 6: Relationship between the Ecological Quality Ratios (EQRs) and the Community Temperature Index (CTI) in the Netherlands. Higher CTI values indicate communities with warmer and wider temperature preferences.

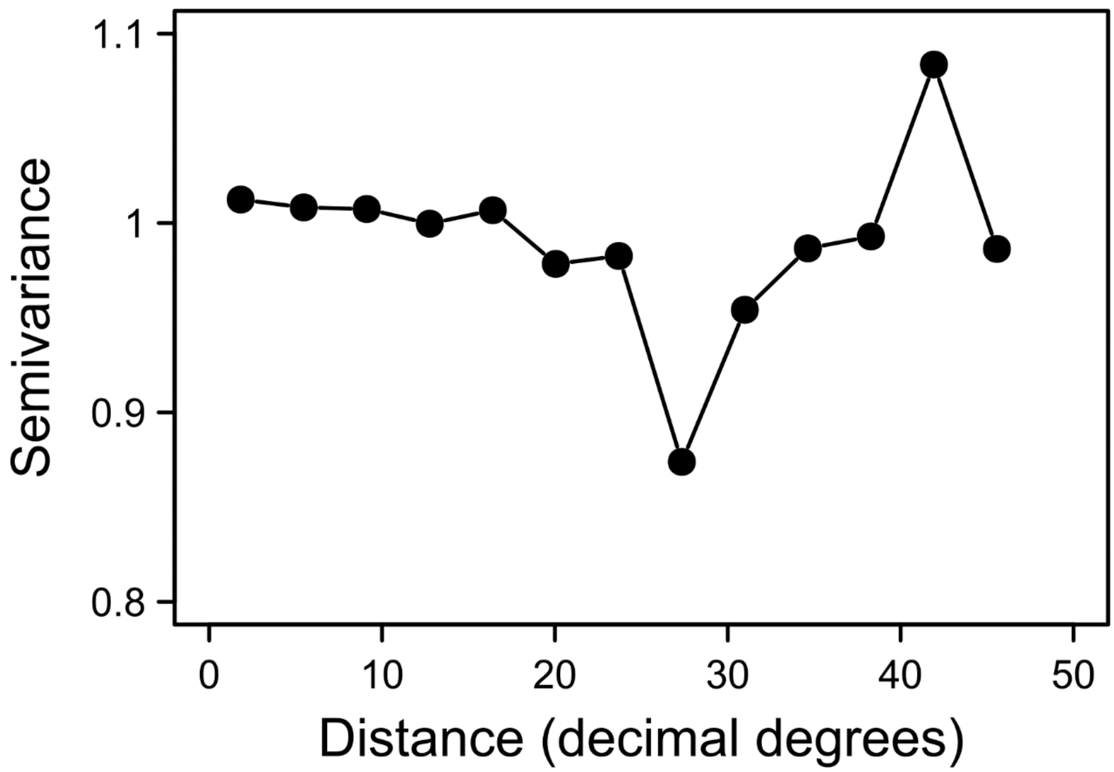


Supplementary Fig. 7: Relationships between the Ecological Quality Ratios (EQRs) and the Saprobic Index (SI) in (**a**) Germany (DE) and (**b**) the Netherlands (NL). Higher SI values indicate communities that are more tolerant of organic pollution.

Supplementary Information 6 – Temporal and spatial autocorrelation



Supplementary Fig. 8: Temporal autocorrelation in the continent-scale generalized additive mixed model for the Ecological Quality Ratio (EQR; see Fig. 2a). In (**a**), no site-level temporal correlation structure is included in the model and so it exhibits relatively high (between 0.4–0.7) autocorrelation across time lags of 1–8 years (all time series have at least eight years of data). In (**b**), adding a first-order autoregressive structure to the model controls for this autocorrelation.



Supplementary Fig. 9: Change in the semivariance (i.e., similarity) of the Ecological Quality Ratios among sites at closer versus further geographic distances (in decimal degrees; based on WGS84 latitude and longitude coordinates). The overall change in semivariance with distance is minor (generally between 0.9–1.1), indicating little spatial autocorrelation.

References

1. Ofenböck, T., Moog, O., Gerritsen, J. & Barbour, M. A stressor specific multimetric approach for monitoring running waters in Austria using benthic macro-invertebrates. in *Integrated Assessment of Running Waters in Europe* (eds. Hering, D., Verdonschot, P. F. M., Moog, O. & Sandin, L.) 251–268 (Springer Netherlands, 2004). doi:10.1007/978-94-007-0993-5_15.
2. Gabriels, W., Lock, K., De Pauw, N. & Goethals, P. L. M. Multimetric Macroinvertebrate Index Flanders (MMIF) for biological assessment of rivers and lakes in Flanders (Belgium). *Limnologica - Ecology and Management of Inland Waters* **40**, 199–207 (2010).
3. Cheshmedjiev, S. & Varadinova, E. Demersal macroinvertabrates. in *Biological analysis and ecological assessment of surface water types in Bulgaria* (eds. Belkinova, D. et al.) 147–162 (P. Hilendarski University Publishing House, 2013).
4. Feio, M. J. *et al.* Comparability of ecological quality boundaries in the Mediterranean basin using freshwater benthic invertebrates. Statistical options and implications. *Science of The Total Environment* **476–477**, 777–784 (2014).
5. Mičaník, T. *et al.* Hodnocení stavu útvarů povrchových vod v České republice pro 3. plánovací období plánů povodí. *Vodohospodářské technicko-ekonomické informace* **62**, 4–18 (2020).
6. Andersen, J. H. *et al.* Approaches for integrated assessment of ecological and eutrophication status of surface waters in Nordic Countries. *Ambio* **45**, 681–691 (2016).
7. Friberg, N., Skriver, J., Larsen, S. E., Pedersen, M. L. & Buffagni, A. Stream macroinvertebrate occurrence along gradients in organic pollution and eutrophication. *Freshwater Biology* **55**, 1405–1419 (2010).

8. Käiro, K., Möls, T., Timm, H., Virro, T. & Järvekülg, R. The effect of damming on biological quality according to macroinvertebrates in some Estonian streams, Central—Baltic Europe: A pilot study. *River Research and Applications* **27**, 895–907 (2011).
9. Mondy, C. P., Villeneuve, B., Archaimbault, V. & Usseglio-Polatera, P. A new macroinvertebrate-based multimetric index (I2M2) to evaluate ecological quality of French wadeable streams fulfilling the WFD demands: A taxonomical and trait approach. *Ecological Indicators* **18**, 452–467 (2012).
10. Berger, E. *et al.* Water quality variables and pollution sources shaping stream macroinvertebrate communities. *Science of The Total Environment* **587–588**, 1–10 (2017).
11. Bozóki, T., Krasznai-Kun, E. Á., Csercsa, A., Várbíró, G. & Boda, P. Temporal and spatial dynamics in aquatic macroinvertebrate communities along a small urban stream. *Environmental Earth Sciences* **77**, 559 (2018).
12. Donohue, I., McGarrigle, M. L. & Mills, P. Linking catchment characteristics and water chemistry with the ecological status of Irish rivers. *Water Research* **40**, 91–98 (2006).
13. Ozoliņš, D. *et al.* The impact of forest fertilization on the ecological quality of two hemiboreal streams. *Forests* **13**, 196 (2022).
14. Leitão, F. *et al.* Habitat-oriented sampling of macroinvertebrates affects the determination of ecological status in temporary mediterranean river systems. *River Research and Applications* **30**, 1233–1247 (2014).
15. Munné, A. & Prat, N. Use of macroinvertebrate-based multimetric indices for water quality evaluation in Spanish Mediterranean rivers: an intercalibration approach with the IBMWP index. *Hydrobiologia* **628**, 203–225 (2009).

16. Dahl, J. & Johnson, R. K. A multimetric macroinvertebrate index for detecting organic pollution of streams in southern Sweden. *Archiv für Hydrobiologie* 487–513 (2004) doi:10.1127/0003-9136/2004/0160-0487.

17. Bighiu, M. A., Höss, S., Traunspurger, W., Kahlert, M. & Goedkoop, W. Limited effects of pesticides on stream macroinvertebrates, biofilm nematodes, and algae in intensive agricultural landscapes in Sweden. *Water Research* **174**, 115640 (2020).

18. Paisley, M. F., Trigg, D. J. & Walley, W. J. Revision of the Biological Monitoring Working Party (BMWP) score system: derivation of present-only and abundance-related scores from field data. *River Research and Applications* **30**, 887–904 (2014).