# Appendix

## Non-linearity and temporal variability are overlooked components of global population dynamics

## SM1: Temporal, geographical, and taxonomic extent of the analyzed database

In the main text, we analyzed a subset of the Living Planet Database. We omitted populations which had less than twenty time points of monitoring data. This resulted in a final database constituted of 6,437 population time series. However, among these, only 6 were invertebrates population time series, relative to only one species in the same geographical region. Thus, for all analyses relative to taxonomic patterns, we omitted these populations.

In this appendice, we present the temporal (Fig. S1.1), biogeographical and taxonomic extent (Fig. S1.2, S1.3) of the analyzed database. First, this reveals that very few population time series were monitored more than 45 years (Fig. S1.1). Second, this highlights the fact that the database is highly biased geographically (73.2% of the population time series are monitored in North America and Europe, Fig. S1.2C, S1.3). Similarly, the taxonomic coverage is not satisfactory (Birds represent 67.3% of the analyzed time series, Fig. S1.2B).

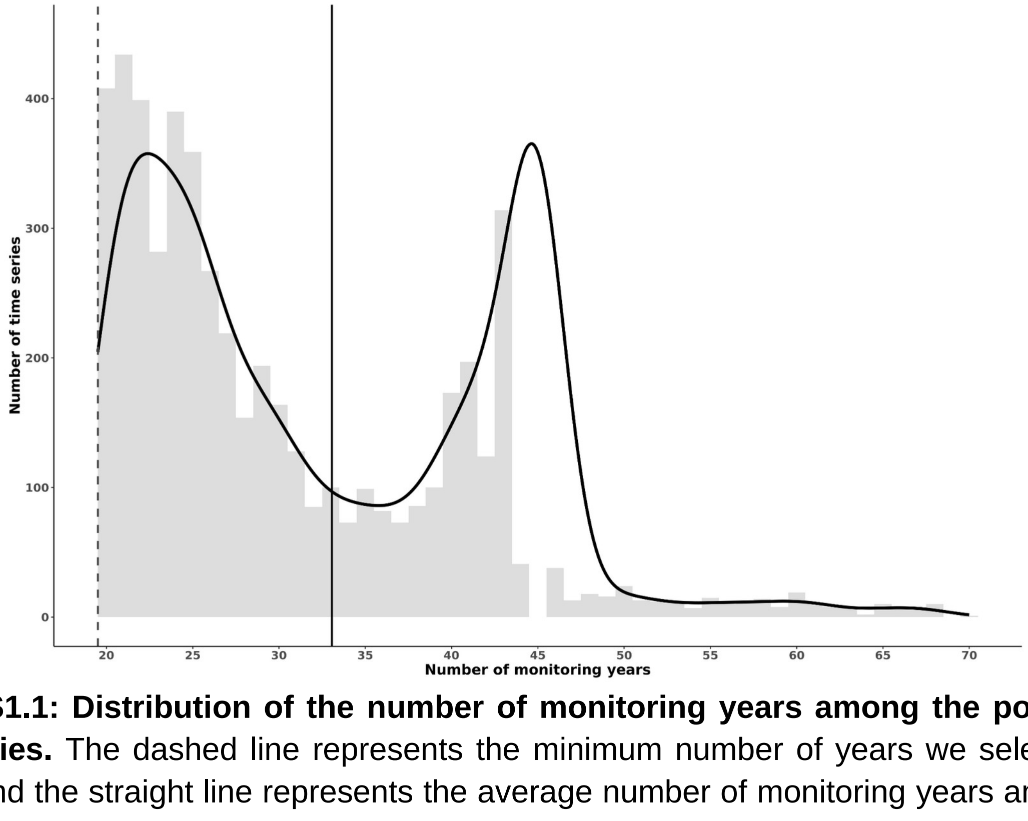

**Figure S1.1: Distribution of the number of monitoring years among the population time series.** The dashed line represents the minimum number of years we selected (20 years) and the straight line represents the average number of monitoring years among the 6,437 population time series.

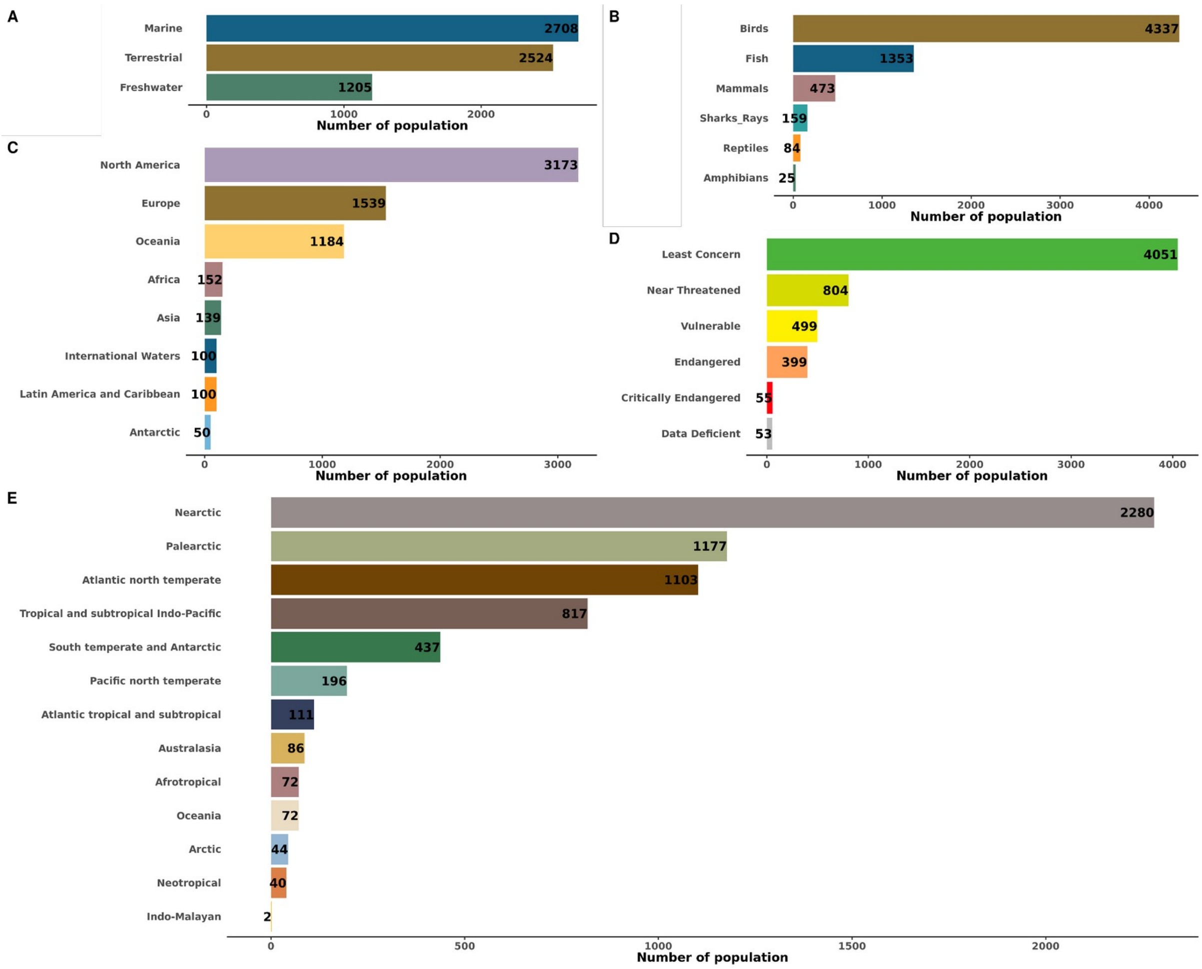

**Figure S1.2: Distribution of time series across biogeographic and taxonomic groups.** (A) Habitat types, (B) Taxonomic groups, (C) Regions, (D) IUCN Red List Categories and (E) Realms. The exact number of populations within each category are written in black.

**Table S1.1: Cross-distribution of population time series across habitat types and regions in the analyzed dataset.**

| | Freshwater | Marine | Terrestrial |
|---|---|---|---|
| Africa | 17 | 77 | 58 |
| Antarctic | 0 | 50 | 0 |
| Asia | 26 | 62 | 51 |
| Europe | 391 | 428 | 720 |
| International Waters | 0 | 100 | 0 |
| Latin America and Caribbean | 25 | 59 | 16 |
| North America | 698 | 894 | 1581 |
| Oceania | 48 | 1038 | 98 |

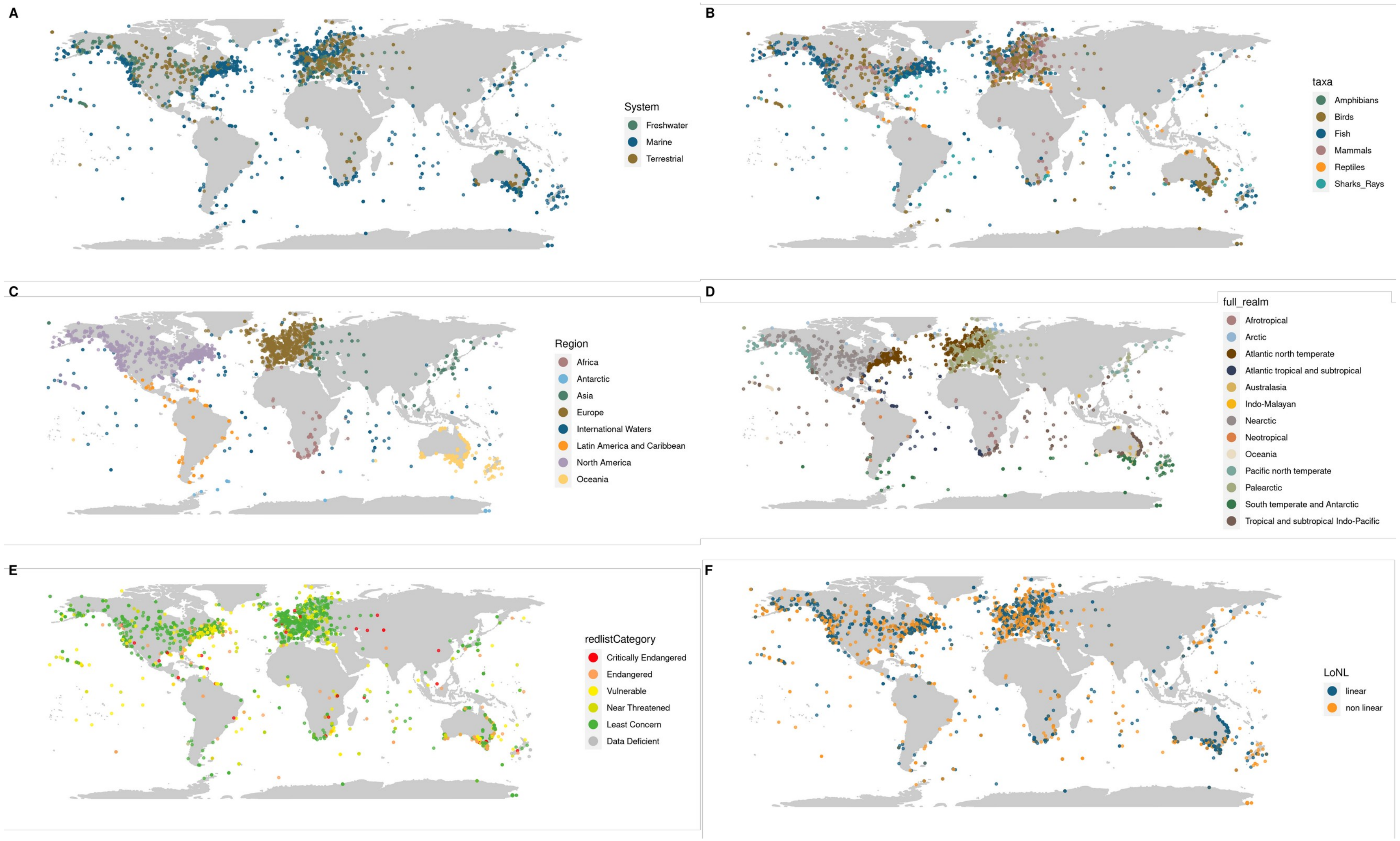

**Figure S1.3: Geographical distribution of population time series, colored according to different biogeographic and taxonomic patterns.** (A) Habitat types, (B) Taxonomic groups, (C) Regions, (D) Realms, (E) IUCN Red List Categories and (F) Linear or Non-linear trajectory.

## SM2: Impact of the duration, number of years sampled, and starting year of the time series on the proportion of non-linearity

The population time series we studied range from 1950 to 2020, with both duration of monitoring and the frequency of surveys varying across time series. Eventhough we selected time series with twenty time points of monitoring data, previous studies demonstrated that capturing directional trends in population abundance depends on the length of the time series (Wauchope et al., 2019). Additionnally, recent studies highlighted the fact that trends should be interpreted in the light of the temporal window covered by the analyzed time series (Daskalova et al., 2020; Duchenne et al., 2022). We thus examined how the temporal baseline and the duration of the time series we analyzed influenced the proportion of non-linearity. To do so, we simply looked at how the proportion of non-linearity varied according to the strating year (Fig. S2A) and the number of points (Fig. S2B) of the time series we analyzed. This revealed that longer time-series capture more non-linearity that shorter time series (Fig. S2B). As longer time series (e.g. those having 65-70 years of data) necessarily start sooner (around 1955 on average) (Fig. S2C), the proportion of non-linearity decreases with the starting year of the time series (Fig. S2A). This suggests that in future research, the proportion of non-linearity should be examined relatively to specific periods of monitoring. Still, this reinforces the importance of non-linear modeling for long-term monitoring data.

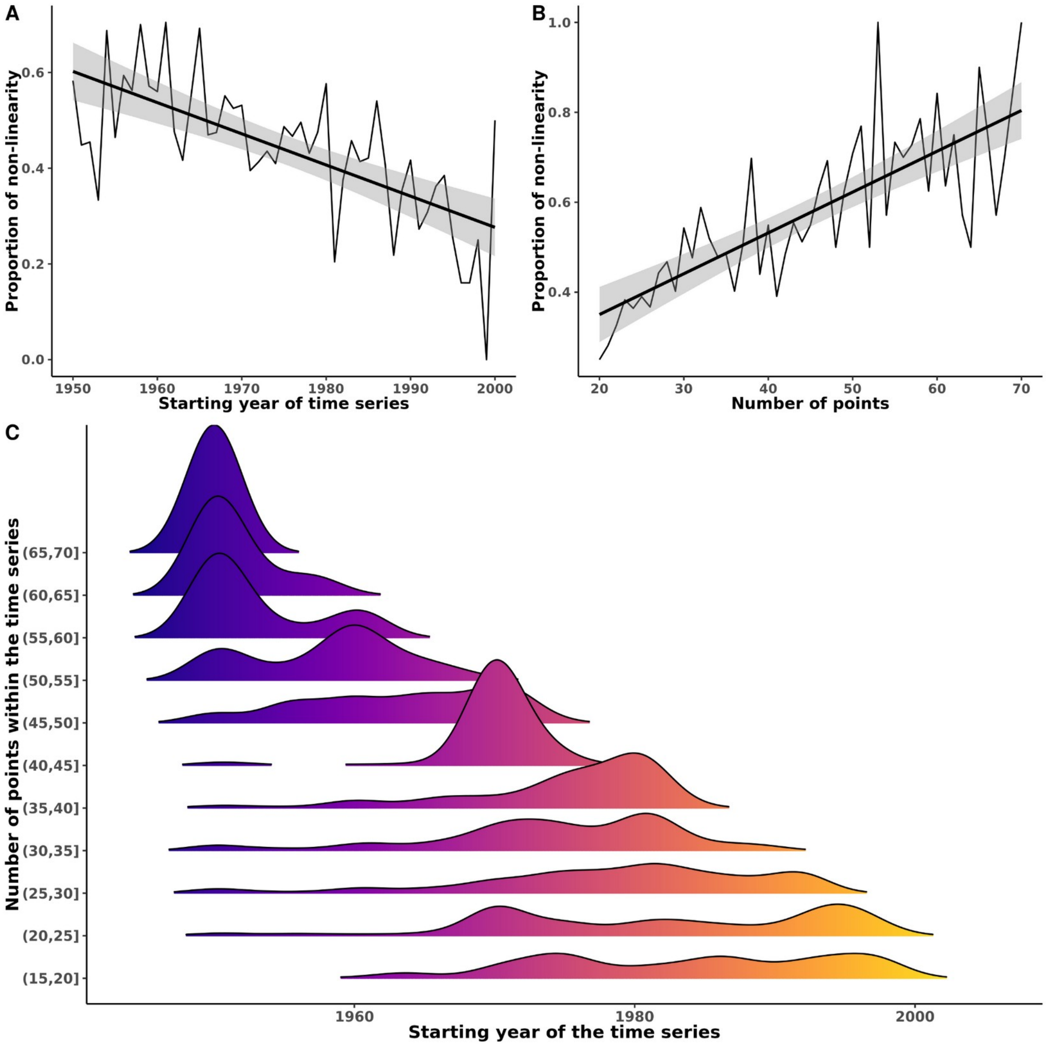

**Figure S2: Impact of the starting year and number of years sampled on the proportion of non-linearity.** Proportion of non-linearity depending on (A) the starting year of the time series and (B) the number of points within the time series. Figure (C) shows the distribution of the starting years among time series for several groups of duration.

# SM3: Detailed analysis of non-linearity among biogeographic and taxonomic patterns

**Table S3.1: Model outputs for all Z-test analyses.** Each row corresponds to the following test: $H_0 : \hat{p} = \bar{p} ; H_1 : \hat{p} \neq \bar{p}$; $\hat{p}$ being the estimate of the proportion of non-linearity observed within the tested category (e.g. marine habitats for the first row), and $\bar{p}$ being the mean proportion of non-linearity among all populations (0.448). We used $\alpha$=5%. Significant tests are highlighted in bold.

| | **estimate** | **p-value** | **conf.low** | **conf.high** | **n.pop** |
|---|---|---|---|---|---|
| **Habitat types** | | | | | |
| **Marine** | **0.3977105** | **1.578221e-07** | **0.3792514** | **0.4164623** | **2708** |
| **Terrestrial** | **0.4837559** | **3.277830e-04** | **0.4641020** | **0.5034598** | **2524** |
| **Freshwater** | **0.4887967** | **4.819792e-03** | **0.4602403** | **0.5174254** | **1205** |
| **Regions** | | | | | |
| **Oceania** | **0.2711149** | **2.744241e-34** | **0.2461558** | **0.2975790** | **1184** |
| Africa | 0.4539474 | 9.474616e-01 | 0.3737466 | 0.5365117 | 152 |
| **North America** | **0.4821935** | **1.155630e-04** | **0.4646820** | **0.4997484** | **3173** |
| **Europe** | **0.4905783** | **8.582676e-04** | **0.4653332** | **0.5158710** | **1539** |
| Asia | 0.5323741 | 5.548256e-02 | 0.4461397 | 0.6167928 | 139 |
| Antarctic | 0.5400000 | 2.436234e-01 | 0.3945281 | 0.6793659 | 50 |
| Latin America and Caribbean | 0.5500000 | 5.110734e-02 | 0.4475426 | 0.6485719 | 100 |
| **International Waters** | **0.5600000** | **3.142352e-02** | **0.4573588** | **0.6579781** | **100** |
| **Taxonomic groups** | | | | | |
| Invertebrates | 0.1666667 | 0.3294181017 | 0.008762291 | 0.6351774 | 6 |
| Amphibians | 0.2400000 | 0.0587244969 | 0.101580568 | 0.4552084 | 25 |
| Sharks_Rays | 0.3773585 | 0.0869912844 | 0.302796333 | 0.4579454 | 159 |
| Birds | 0.4362463 | 0.1232485405 | 0.421435114 | 0.4511711 | 4337 |
| Reptiles | 0.4404762 | 0.9768950468 | 0.333687402 | 0.5527565 | 84 |
| Fish | 0.4730229 | 0.0682208651 | 0.446166090 | 0.5000346 | 1353 |
| **Mammals** | **0.5306554** | **0.0003588341** | **0.484560177** | **0.5762451** | **473** |
| **Realms** | | | | | |
| Indo-Malayan | 0.0000000 | 5.733790e-01 | 0.0000000 | 0.8021325 | 2 |
| **Tropical and subtropical Indo-** | **0.2888617** | **8.103148e-20** | **0.2582387** | **0.3214997** | **817** |

| | | | | | |
|---|---|---|---|---|---|
| **Pacific** | | | | | |
| **South temperate and Antarctic** | **0.3066362** | **3.759977e-09** | **0.2641558** | **0.3525752** | **437** |
| Australasia | 0.3837209 | 2.755904e-01 | 0.2827311 | 0.4952042 | 86 |
| Atlantic north temperate | 0.4614687 | 3.847187e-01 | 0.4317840 | 0.4914251 | 1103 |
| Palearctic | 0.4664401 | 2.139207e-01 | 0.4376734 | 0.4954284 | 1177 |
| Oceania | 0.4861111 | 5.948648e-01 | 0.3677856 | 0.6059261 | 72 |
| **Nearctic** | **0.4947368** | **7.947790e-06** | **0.4740218** | **0.5154698** | **2280** |
| Atlantic tropical and subtropical | 0.5225225 | 1.379641e-01 | 0.4260259 | 0.6174406 | 111 |
| **Pacific north temperate** | **0.5663265** | **1.116525e-03** | **0.4937822** | **0.6362281** | **196** |
| Neotropical | 0.5750000 | 1.453319e-01 | 0.4100777 | 0.7257554 | 40 |
| Afrotropical | 0.5833333 | 2.847269e-02 | 0.4612444 | 0.6964792 | 72 |
| **Arctic** | **0.6590909** | **7.718808e-03** | **0.4999894** | **0.7906642** | **44** |

## IUCN Red List Category

| | | | | | |
|---|---|---|---|---|---|
| **Near Threatened** | **0.3258706** | **4.261321e-12** | **0.29376443** | **0.3596646** | **804** |
| **Endangered** | **0.3408521** | **2.104012e-05** | **0.29485793** | **0.3899629** | **399** |
| Critically Endangered | 0.4727273 | 8.156144e-01 | 0.33857201 | 0.6106808 | 55 |
| **Least Concern** | **0.4764256** | **2.919241e-04** | **0.46095214** | **0.4919440** | **4051** |
| Data Deficient | 0.4905660 | 6.276476e-01 | 0.35251085 | 0.6299827 | 53 |
| **Vulnerable** | **0.5050100** | **1.187317e-02** | **0.46027666** | **0.5496651** | **499** |
| Extinct in the Wild | 1.0000000 | 9.167194e-01 | 0.05462076 | 1.0000000 | 1 |

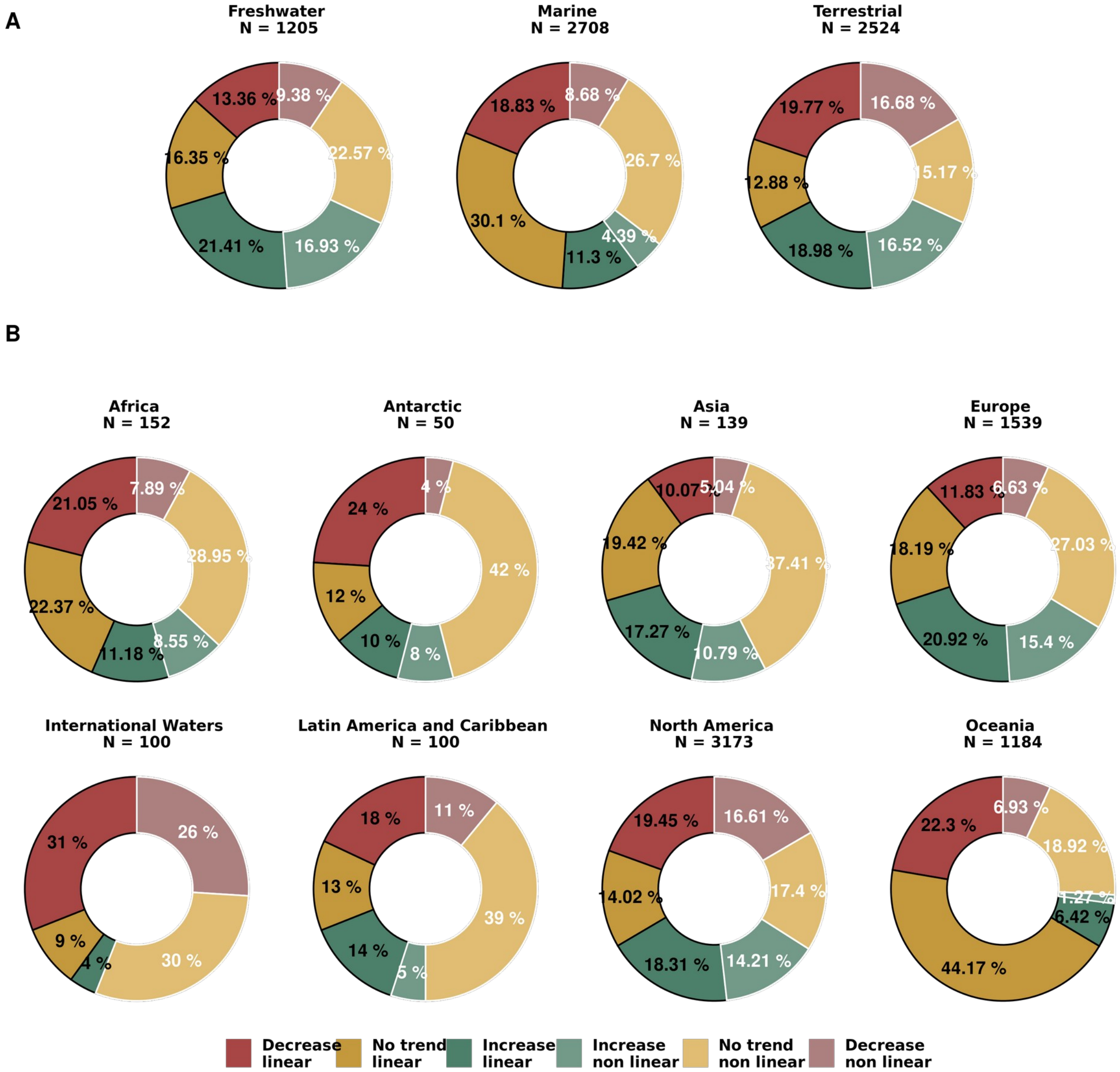

**Figure S3.1: Representation of the proportion of linear or non-linear increases, decreases or no trends among (A) habitat types, (B) Regions.** "N" represents the number of populations within each category. Information relative to the linear trajectories are written in black whereas information relative to the non linear trajectories are written in white.

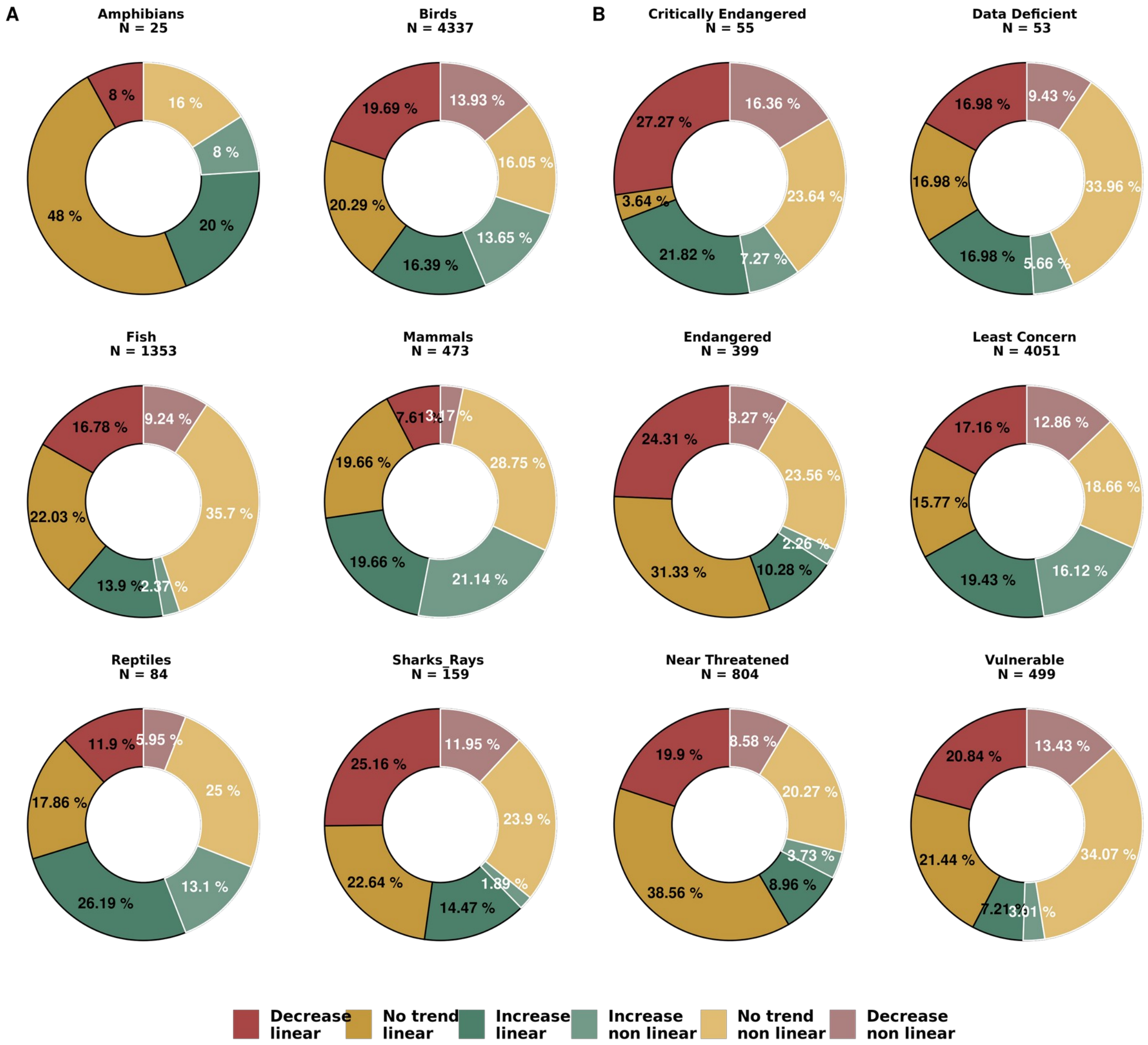

**Figure S3.2: Representation of the proportion of linear or non-linear increases, decreases or no trends among (A) taxonomic groups, (B) IUCN Red List Categories.** “N” represents the number of populations within each category. Information relative to the linear trajectories are written in black whereas information relative to the non linear trajectories are written in white.

# SM4: Detailed analysis of populations’ temporal variability

## 1. Investigating temporal variability according to biogeographic and taxonomic patterns

To test if population temporal variability varied according to biogeographic and taxonomic patterns, we used a generalized linear mixed-effect framework. The models were structured as followed:

$$R_{i,j,k} = \beta_0 + \beta_k E_{i,j,k} + \mu_{0,j} + \varepsilon_{i,j,k}$$

Where $R_{i,j,k}$ is the response variability metric (either D, CV or MSE) for the $i^{th}$ population time series from the $j^{th}$ species from the $k^{th}$ category of the explanatory variable, $E_{i,j,k}$ is the category of the explanatory variable of the $i^{th}$ time series from the $j^{th}$ species, $\beta_0$ the global intercept, $\beta_k$ the global slope estimates for the $k^{th}$ category of the explanatory variable (fixed effect), $\mu_{0,j}$ is the species-level departure from 0 (random effect), and $\varepsilon_{i,j,k}$ the random error (unreliable measurements, random fluctuations). All mixed-effect models were fitted using maximum likelihood as implemented in the R package “lme4” (Bates et al., 2015). When differences were detected, we performed post-hoc tests using the *ghlt* function from the “multcomp” package (Hothorn et al., 2008).

In the present appendix, we present the models outputs for all analyses. In total, we performed three models (corresponding to the three variability metrics we tested) for each explanatory variable (habitat type, regions, taxonomic groups, IUCN Red List Categories, and trajectory types), resulting in 15 models in total. The outputs present the estimates, corresponding to the effect size for the intercept (first row of each model) and to the relative deviation from the intercept for the other rows. The estimates thus represent ($\beta_0 + \mu_{0,j}$) from the equation above for the intercepts and ($\beta_k + \mu_{0,j}$) for the other rows. In the main text and the main figures, we presented the effect size, thus ($\beta_0 + \beta_k + \mu_{0,j}$).

Post-hoc tests were performed for each model using the *ghlt* function from the ‘’multcomp’’ package (Hothorn et al., 2008). In the present appendix, we only present the letters of these pairwise comparisons that were obtained using the *cld* function from the ‘’lsmeans’’ package (Piepho, 2004).

**Table S4.1. Model outputs for habitat types analyses.**

| Habitat type | Variability metric | Estimate | Std Error | t-value | p-value | post-hoc |
|---|---|---|---|---|---|---|
| **Freshwater** | **D** | 0.20350443 | 0.01863231 | 10.9221286 | 7.528100e-27 | a |
| **Marine** | **D** | 0.10141422 | 0.02321998 | 4.3675409 | 1.321026e-05 | b |
| **Terrestrial** | **D** | -0.05032771 | 0.02246197 | -2.2405742 | 2.518791e-02 | a |
| **Freshwater** | **CV** | 0.28806132 | 0.02786639 | 10.3372310 | 1.570451e-24 | a |
| **Marine** | **CV** | 0.14593425 | 0.03514889 | 4.1518875 | 3.402504e-05 | b |
| **Terrestrial** | **CV** | -0.04538011 | 0.03359696 | -1.3507206 | 1.769134e-01 | a |
| **Freshwater** | **MSE** | 0.26442466 | 0.02753112 | 9.6045722 | 1.963586e-21 | a |
| **Marine** | **MSE** | 0.01629220 | 0.03492463 | 0.4664961 | 6.409060e-01 | a |
| **Terrestrial** | **MSE** | -0.17156345 | 0.03322067 | -5.1643584 | 2.621565e-07 | b |

Variability differed among habitat types, with marine populations being significantly more variable than freshwater and terrestrial ones when using D or CV as a proxy of temporal variability (Table S4.1). This was not consistent when using the MSE, in which case terrestrial populations were significantly less variable than populations from the other habitat types (Table S4.1).

**Table S4.2. Model outputs for regions analyses.**

| Region | Variability metric | Estimate | Std Error | t-value | p-value | post-hoc |
|---|---|---|---|---|---|---|
| **Africa** | **D** | 0.247299542 | 0.03929770 | 6.29297807 | 3.524431e-10 | a |
| **Antarctic** | **D** | -0.144066988 | 0.08747252 | -1.64699708 | 9.968089e-02 | a |
| **Asia** | **D** | -0.040930211 | 0.05364695 | -0.76295510 | 4.455276e-01 | a |
| **Europe** | **D** | -0.076457091 | 0.04160113 | -1.83786112 | 6.617296e-02 | a |
| **International Waters** | **D** | -0.111826312 | 0.06627812 | -1.68722823 | 9.166079e-02 | a |
| **Latin America and Caribbean** | **D** | -0.081362231 | 0.05869021 | -1.38629981 | 1.657207e-01 | a |
| **North America** | **D** | -0.047903306 | 0.04078319 | -1.17458460 | 2.402495e-01 | a |
| **Oceania** | **D** | 0.248422263 | 0.04854936 | 5.11690116 | 3.291917e-07 | b |
| **Africa** | **CV** | 0.286650268 | 0.06097077 | 4.70143775 | 2.658100e-06 | ab |
| **Antarctic** | **CV** | -0.115886264 | 0.13249269 | -0.87466154 | 3.818178e-01 | ab |
| **Asia** | **CV** | -0.082247194 | 0.08550956 | -0.96184797 | 3.361675e-01 | ab |
| **Europe** | **CV** | -0.088777276 | 0.06444341 | -1.37760042 | 1.683946e-01 | a |
| **International Waters** | **CV** | -0.064875080 | 0.10149714 | -0.63918138 | 5.227428e-01 | ab |
| **Latin America and Caribbean** | **CV** | -0.088522174 | 0.09351753 | -0.94658375 | 3.438916e-01 | ab |
| **North America** | **CV** | 0.030949602 | 0.06300761 | 0.49120422 | 6.233062e-01 | b |
| **Oceania** | **CV** | 0.643962401 | 0.07444659 | 8.64999242 | 7.493160e-18 | c |
| **Africa** | **MSE** | 0.235306590 | 0.06714894 | 3.50424879 | 4.618667e-04 | ab |
| **Antarctic** | **MSE** | -0.126479558 | 0.14281944 | -0.88559062 | 3.758977e-01 | ab |
| **Asia** | **MSE** | 0.109506187 | 0.09546871 | 1.14703743 | 2.514137e-01 | bc |
| **Europe** | **MSE** | 0.001707522 | 0.07082393 | 0.02410939 | 9.807663e-01 | b |
| **International Waters** | **MSE** | -0.132444621 | 0.11017069 | -1.20217656 | 2.293655e-01 | ab |
| **Latin America and Caribbean** | **MSE** | 0.012064598 | 0.10448218 | 0.11547039 | 9.080763e-01 | abc |
| **North America** | **MSE** | -0.118709379 | 0.06917136 | -1.71616370 | 8.619599e-02 | a |
| **Oceania** | **MSE** | 0.271788875 | 0.08032380 | 3.38366546 | 7.234362e-04 | c |

Variability differed among regions, with populations from Oceania being significantly more variable than populations from other regions, no matter the metric used (Table S4.2). However, 87 % of populations monitored in Oceania are marine populations (Table S1.1). These results may reflect the marine variability more than a region-specific variability. Populations from other regions were slighlty different in their variability level (Table S4.2).

**Table S4.3. Model outputs for taxonomic groups analyses.**

| Taxonomic group | Variability metric | Estimate | Std Error | t-value | p-value | post-hoc |
|---|---|---|---|---|---|---|
| **Amphibians** | **D** | 0.182928665 | 0.09272528 | 1.97280260 | 0.04859556 | ab |
| **Birds** | **D** | -0.024723510 | 0.09348699 | -0.26445937 | 0.79144167 | a |
| **Fish** | **D** | 0.125822920 | 0.09466379 | 1.32915579 | 0.18388559 | bc |
| **Mammals** | **D** | 0.073165170 | 0.09716788 | 0.75297688 | 0.45151776 | bc |
| **Reptiles** | **D** | -0.055574077 | 0.11453461 | -0.48521645 | 0.62756192 | ac |
| **Sharks_Rays** | **D** | 0.221667877 | 0.10569434 | 2.09725396 | 0.03605935 | b |
| **Amphibians** | **CV** | 0.152507201 | 0.14855844 | 1.02658053 | 0.30466557 | a |
| **Birds** | **CV** | 0.152352273 | 0.14956872 | 1.01861056 | 0.30843568 | a |
| **Fish** | **CV** | 0.197391999 | 0.15124650 | 1.30510127 | 0.19191741 | a |
| **Mammals** | **CV** | 0.100103828 | 0.15487035 | 0.64637181 | 0.51806847 | a |
| **Reptiles** | **CV** | 0.005809561 | 0.18011163 | 0.03225534 | 0.97426994 | a |
| **Sharks_Rays** | **CV** | 0.327317429 | 0.16681841 | 1.96211820 | 0.04981061 | a |
| **Amphibians** | **MSE** | 0.172236321 | 0.16202502 | 1.06302299 | 0.28781496 | ab |
| **Birds** | **MSE** | -0.008613353 | 0.16288232 | -0.05288083 | 0.95782866 | a |
| **Fish** | **MSE** | 0.093730301 | 0.16440936 | 0.57010320 | 0.56862982 | b |
| **Mammals** | **MSE** | 0.016118841 | 0.16787126 | 0.09601906 | 0.92350881 | ab |
| **Reptiles** | **MSE** | -0.020554817 | 0.19175893 | -0.10719093 | 0.91464190 | ab |
| **Sharks_Rays** | **MSE** | -0.034763733 | 0.17874894 | -0.19448357 | 0.84580481 | ab |

Variability did not differ that much between the different taxonomic groups, no matter the metric used (Table S4.3), even when the lmer test was significant (which was the case for models with CV and D). However, as highlighted before, the taxonomic extent of our database is highly biased, which may not allow consistent comparisons between groups.

**Table S4.4. Model outputs for IUCN Red List Categories analyses.**

| IUCN Red List Category | Variability metric | Estimate | Std Error | t-value | p-value | post-hoc |
|---|---|---|---|---|---|---|
| **Critically Endangered** | **D** | 2.604285e-01 | 0.07090886 | 3.672722158 | 0.0002467468 | ab |
| **Endangered** | **D** | 4.403682e-02 | 0.08602930 | 0.511881673 | 0.6088052965 | ab |
| **Vulnerable** | **D** | -1.685413e-02 | 0.07868741 | -0.214190939 | 0.8304249489 | ab |
| **Near Threatened** | **D** | 6.239178e-02 | 0.08152927 | 0.765268488 | 0.4442312170 | a |
| **Least Concern** | **D** | -8.004060e-02 | 0.07173665 | -1.115756005 | 0.2646727747 | b |
| **Data Deficient** | **D** | -1.121528e-01 | 0.11608917 | -0.966091629 | 0.3341638137 | ab |
| **Critically Endangered** | **CV** | 3.835281e-01 | 0.11240565 | 3.412000267 | 0.0006527684 | ab |
| **Endangered** | **CV** | 6.035612e-02 | 0.13464325 | 0.448266933 | 0.6539968008 | ab |
| **Vulnerable** | **CV** | -8.394315e-02 | 0.12356723 | -0.679331836 | 0.4969827169 | b |
| **Near Threatened** | **CV** | 1.953914e-01 | 0.12729780 | 1.534915742 | 0.1249247594 | a |
| **Least Concern** | **CV** | -1.014754e-01 | 0.11359433 | -0.893313535 | 0.3717564511 | b |
| **Data Deficient** | **CV** | -1.949489e-01 | 0.17994969 | -1.083352212 | 0.2787644797 | ab |
| **Critically Endangered** | **MSE** | 1.966466e-01 | 0.11600913 | 1.695095907 | 0.0901370953 | ab |
| **Endangered** | **MSE** | 1.064840e-01 | 0.13562820 | 0.785117290 | 0.4324513193 | ab |
| **Vulnerable** | **MSE** | 4.221216e-04 | 0.12574778 | 0.003356891 | 0.9973217957 | ab |
| **Near Threatened** | **MSE** | 1.730321e-01 | 0.12830348 | 1.348615925 | 0.1775653003 | a |
| **Least Concern** | **MSE** | -4.061497e-02 | 0.11706690 | -0.346938083 | 0.7286568497 | b |
| **Data Deficient** | **MSE** | 3.380956e-05 | 0.17851537 | 0.000189393 | 0.9998489021 | ab |

Variability differed among Red List Categories, but the pairwise comparisons revealed that only populations from « Least Concern » species were less variable than populations from « Near Threatened » species. This result was consitent no matter the metric of temporal variability that was used (Table S4.4).

## 2. Testing the complementarity bewteen non-linearity and temporal variability

To test wether variability differed among the different types of trajectories, we used the same model as presented above, with the explanatory variable being the type of trajectory.

**Table S4.5. Model outputs for trajectory types analyses.**

| Trajectory type | Variability metric | Estimate | Std Error | t-value | p-value | post-hoc |
|---|---|---|---|---|---|---|
| **Decrease linear** | **D** | 0.193754659 | 0.01395202 | 13.88721046 | 7.181121e-43 | a |
| **Decrease non linear** | **D** | -0.092966069 | 0.01902177 | -4.88735061 | 1.047018e-06 | b |
| **Increase linear** | **D** | 0.008867684 | 0.01768007 | 0.50156389 | 6.159916e-01 | a |
| **Increase non linear** | **D** | -0.067827900 | 0.02020858 | -3.35639062 | 7.942533e-04 | b |
| **No trend linear** | **D** | 0.235029733 | 0.01642083 | 14.31290120 | 9.382218e-46 | c |
| **No trend non linear** | **D** | -0.010211608 | 0.01619664 | -0.63047708 | 5.284052e-01 | a |
| **Decrease linear** | **CV** | 0.131333203 | 0.02240335 | 5.86221175 | 4.855472e-09 | a |
| **Decrease non linear** | **CV** | 0.084756748 | 0.03178690 | 2.66640456 | 7.685928e-03 | ab |
| **Increase linear** | **CV** | 0.086510771 | 0.02951286 | 2.93129020 | 3.387462e-03 | b |
| **Increase non linear** | **CV** | 0.179687105 | 0.03352526 | 5.35975243 | 8.626179e-08 | bc |
| **No trend linear** | **CV** | 0.556519847 | 0.02749530 | 20.24054606 | 2.357958e-88 | d |
| **No trend non linear** | **CV** | 0.175649818 | 0.02709379 | 6.48302941 | 9.658079e-11 | c |
| **Decrease linear** | **MSE** | 0.202098530 | 0.02478561 | 8.15386494 | 4.362844e-16 | a |
| **Decrease non linear** | **MSE** | -0.156751022 | 0.03690855 | -4.24701105 | 2.197034e-05 | b |
| **Increase linear** | **MSE** | -0.002289654 | 0.03417899 | -0.06699011 | 9.465917e-01 | a |
| **Increase non linear** | **MSE** | -0.137213304 | 0.03839385 | -3.57383570 | 3.544741e-04 | b |
| **No trend linear** | **MSE** | 0.193992204 | 0.03201457 | 6.05949736 | 1.442795e-09 | c |
| **No trend non linear** | **MSE** | -0.026552209 | 0.03151394 | -0.84255432 | 3.995091e-01 | a |

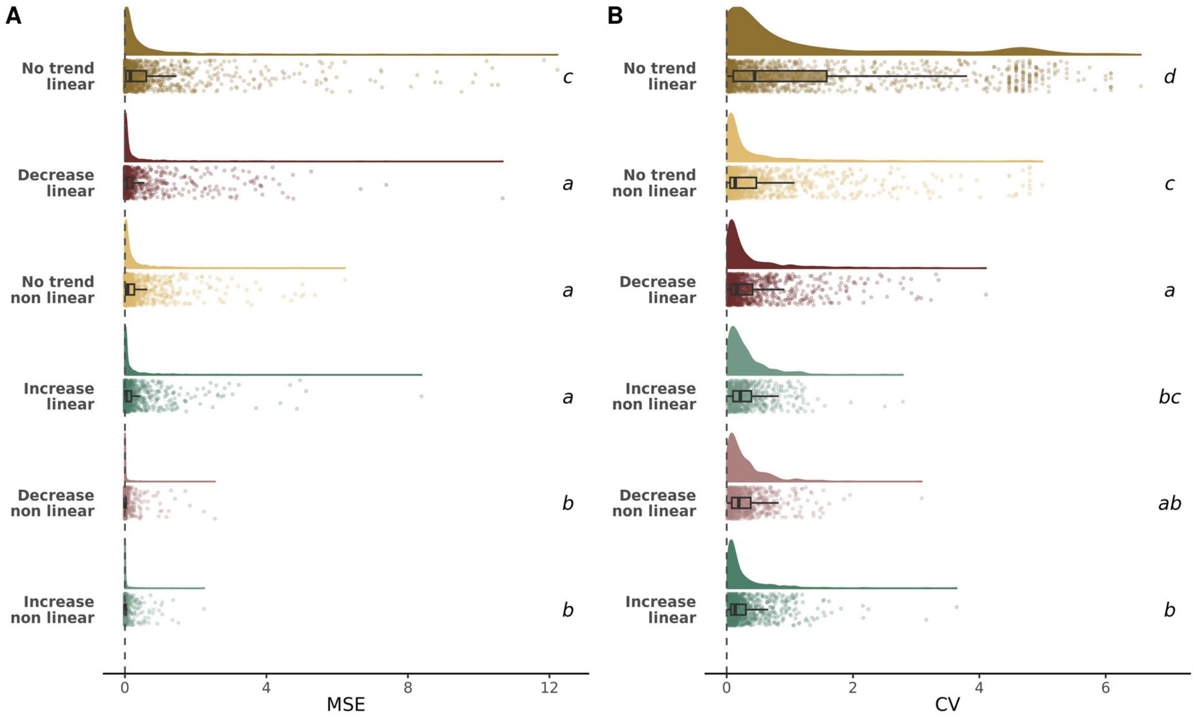

**Figure S4.1: Temporal variability in population change differs according to trajectory types.** Either the MSE (A) or the CV (B) is used here as a proxy of temporal variability. Half violins represent the density distribution of temporal variability in populations for each trajectory type, points represent the raw values, boxplots are represented including the median, first and third quartiles. Letters indicate the significance of pairwise comparisons, calculated with post-hoc tests after running the linear mixed effect model.

Variability differed among the different types of trajectories, populations classified as « no trend linear » being consistently significantly more variable than other types of trajectories, no matter the metric that was used.

## 3. Exploring the role of the trajectory types among biogeographic patterns of temporal variability

Our results revealed for instance that marine populations were the ones expressing the lowest proportion of non-linearity while being the ones expressing the highest variability. However, we also showed that ‘’no trend linear’’ trajectories were the ones with the highest variability, followed by the other linear types of trajectories. As marine populations expressed a higher percentage of ‘’no trend linear’’ trajectories, we wondered whether the variability observed emerged from the marine characteristic of those populations, or wether this was a consequence of the types of trajectories observed.

To investigate this question, we plotted the raw values of D according to each habitat types and trajectory types (Fig. S4.1). This already suggested that globally, marine populations still seemed to express higher variability, even within the same types of trajectory. For instance, among all ‘’no trend linear’’ trajectories, marine populations were the ones showing the highest variability.

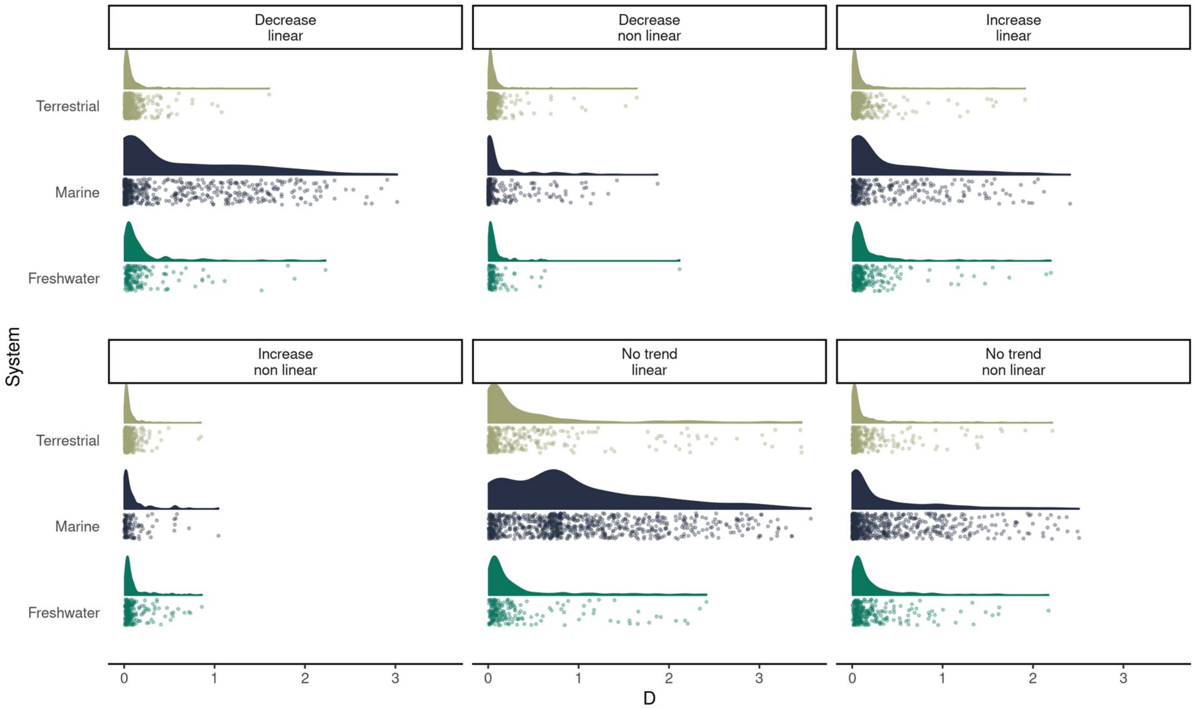

**Figure S4.1: Illustration of temporal variability among habitat types within each type of trajectories.** The consecutive disparity index (D) is used here as a proxy of temporal variability. Half violins represent the density distribution of temporal variability in populations for each trajectory type and system, points reprensent the raw values.

In order to test this prediction, we used an additionnal generalized linear mixed-effect model. We took the consecutive disparity index (D) as the response variable and the habitat types as the explanatory variable (fixed effect). Only in this analysis, we included both species and trajectory types as random effects, to account for the possible correlation between populations from the same species and trajectory type. This analysis confirmed that populations from marine habitats were the ones experiencing the highest variability (Table S4.6).

**Table S4.6. Model outputs for GLMM with both species and type of trajectory as random effects.** Freshwater category was the intercept, thus estimates from marine and terrestrial represent the deviation from the intercept. The mean column respresent the effect sizes.

| Habitat type | Estimate | Std Error | mean | t-value | p-value |
|---|---|---|---|---|---|
| **Freshwater** | 0.20442126 | 0.04951662 | 0.2044213 | -2.414555 | 0.0158659268 |
| **Marine** | 0.08263943 | 0.02189254 | 0.2870607 | 4.128337 | 0.0054435371 |
| **Terrestrial** | -0.05080407 | 0.02104076 | 0.1536172 | 3.774775 | 0.0001649935 |

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