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SUPPLEMENTARY INFORMATION

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Species better track climate warming in the oceans than on land

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Supplementary Information for:

"Species better track climate warming in the oceans than on land"

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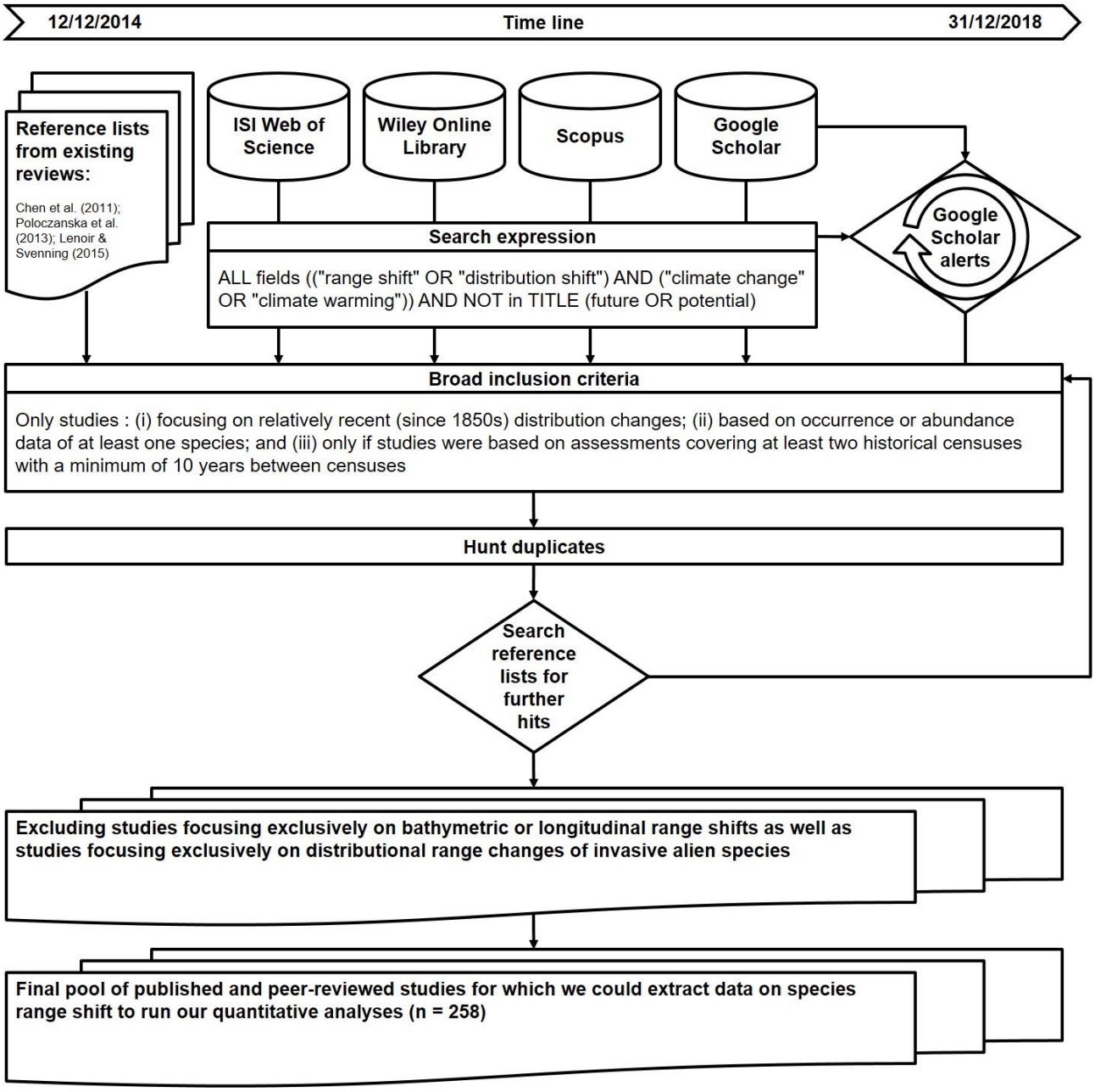
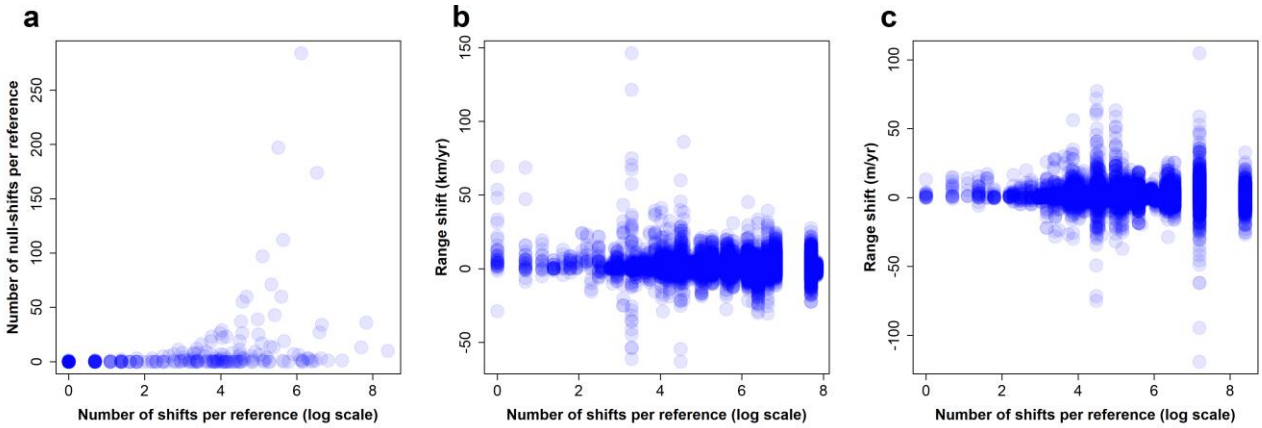
Brief editorial summary of the paper: "Compiling a global geo-database of >30,000 range shifts, the authors show that marine species closely track shifting isotherms whereas terrestrial species lag behind, likely due to wider thermal safety margins and movement constraints imposed by human activities."

Supplementary Figures

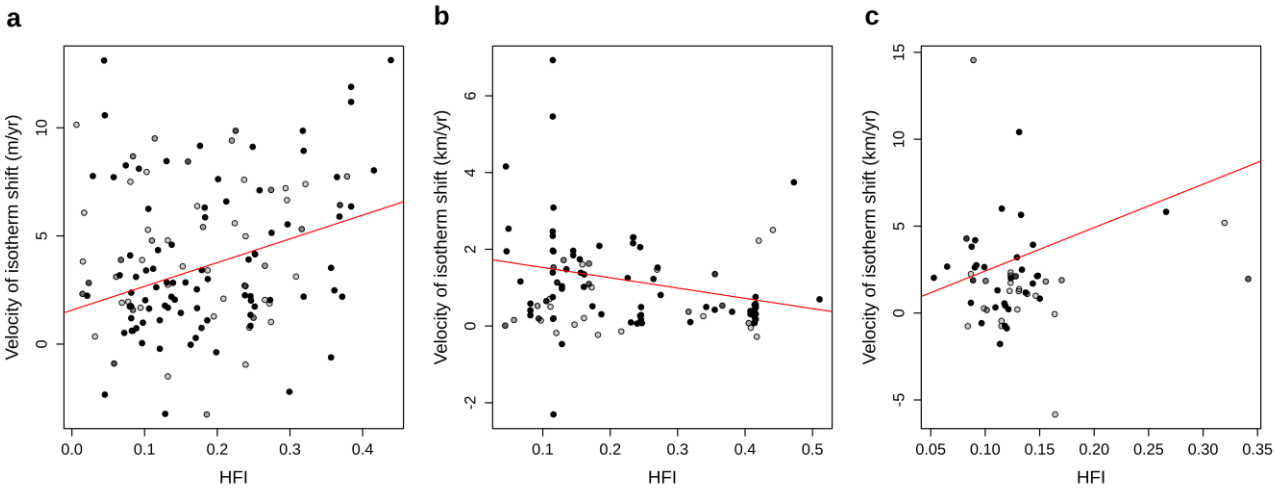
Three Supplementary Figures are listed below together with the captions.



Supplementary Figure 1 | Flowchart of the literature review strategy used to extract information on species range shifts. A total of 258 studies for which we could extract data on species range shifts were finally included in our quantitative analyses.



Supplementary Figure 2 | Impacts of some methodological attributes on the magnitude of the shifts. Total number of range shifts reported per study (mind the x-axis in log-scale) with (**a**) the frequency of null-shifts per study as well as its effects on the magnitude of the shift in (**b**) latitude and in (**c**) elevation.



Supplementary Figure 3 | Correlation between the velocity of isotherm shift and the human footprint index (HFI). Linear relationships (red lines) observed along the elevational (**a**; $R^2 = 0.14$) and latitudinal gradients in both the terrestrial (**b**; $R^2 = 0.09$) and marine realms (**c**; $R^2 = 0.05$).

Supplementary Tables

Two Supplementary Tables are provided as separate Excel spreadsheets (.xlsx files). Please find below the captions of the two Supplementary Tables.

Supplementary Table 1 | Models to estimate the velocity of range shifts aggregated at the taxonomic class level. Full factorial design of spatial gradient (latitude vs. elevation) × positional parameter (centroid vs. margins) × biological systems (marine vs. terrestrial) × hemisphere (north vs. south) (N = 12 combinations). A total of 10 linear mixed-effects models and one linear model were calibrated to assess the mean rate of range shift per taxonomic class and at a given position within the range (centroid, leading edge and trailing edge). Model formulas are provided as used with the function "lmer" from the package "lme4" in the R programming language[300], except for the model of elevational range shifts at the margins of the distribution in terrestrial systems of the southern hemisphere for which there is no random effect structure. For this particular factorial model, the "lm" function was used instead. In total, 20 different taxonomic classes with more than 30 observations were considered in the analysis. Sample size per taxonomic class is given in parentheses. Summary statistics are provided for each model: the mean and standard deviation of the marginal and conditional R^2 values across the 5,000 bootstrap iterations as well as the total contribution (%) of methodological variables which is the difference between the mean conditional and mean marginal R^2 values.

Supplementary Table 2 | Models relating the velocity of species range shifts against the velocity of isotherm shifts. Outputs from the best candidate model along the elevational and latitudinal gradient, while accounting for the effect of other covariates and their potential interaction with the velocity of isotherm shifts (*VIS*): baseline temperature conditions (*BT*); the standardised human footprint index (*HFI*); and life forms (*LF*: ectotherms; endotherms; cryptogams; and phanerogams). A bootstrap approach based on 5,000 iterations was used to calculate the summary statistics (mean, median, standard deviation and 95% confidence interval) for each of the R^2 values. Stars show significant effects (*: $P < 0.05$; **: $P < 0.01$; ***: $P < 0.001$) determined from the bootstrap distributions for the two alternative hypotheses of a mean coefficient estimate being greater or lower than zero (i.e. the null hypothesis).