

## **Supplementary Information for “Representation of global change drivers across biodiversity datasets”**

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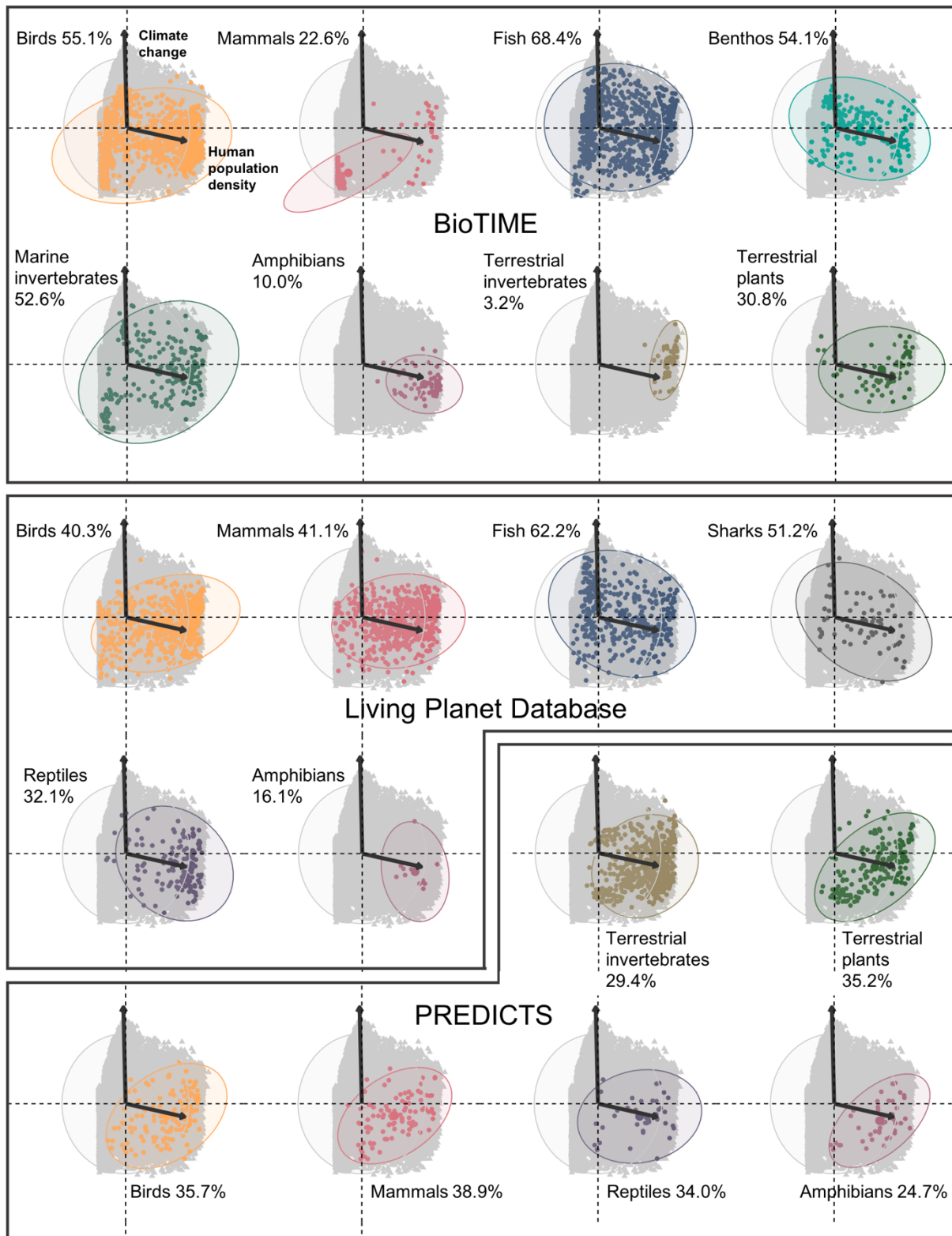
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**Extended Data Figure 1. Global change representation varies across taxa.** Figure shows Principal Component Analysis of the magnitudes of human use, climate change, human

population density, pollution and invasion potential across the locations of the Living Planet, BioTIME and PREDICTS databases, split by taxa, as well as one million randomly sampled locations across the full extent of the globe (in grey). For example, in the Living Planet Database, amphibians occupy the part of global change space that corresponds with moderate to high human population density and relatively low climate change. PCA axes omitted for visual clarity. Upwards PCA arrow shows climate change, arrow pointing right shows human population density. Arrows show direction and magnitude of PCA scores. Human use, pollution and invasion potential were correlated with human population density. For details on the global change driver layers, see Bowler et al. 2020. Annotations show the percentage overlap between the 95% prediction ellipses covered by random sampling of global change space and the variation in global change sampled by the different databases across taxa.

**Extended Data Table S1. Model outputs for all statistical analyses.** Term names starting with “b” refer to fixed effects and sigma indicates the residual variance. Continuous variables (intensities of global change drivers) were scaled between zero and one to make them comparable. We used Bayesian general linear models and we analyzed the terrestrial and marine data separately.

Model	Term	Estimate	Lower 95% CI	Upper 95% CI	Rhat
Terrestrial global change drivers across databases and the world	b_intercept	0.518	0.507	0.528	1.002
	b_samplivingplanet	0.070	0.058	0.081	1.001
	b_samplivingplanet	-0.144	-0.157	-0.131	1.002
	b_samplivingplanet	-0.024	-0.038	-0.010	1.001
	b_drivercumulative	-0.109	-0.123	-0.094	1.002
	b_driverhuman_population	-0.379	-0.393	-0.365	1.002
	b_driverhuman_use	-0.113	-0.127	-0.098	1.001
	b_driverinvasions	-0.350	-0.365	-0.336	1.001
	b_driverpollution	-0.290	-0.305	-0.276	1.001
	b_samplivingplanet.drivercumulative	0.072	0.056	0.089	1.001
	b_samplivingplanet.drivercumulative	0.391	0.372	0.409	1.002
	b_samplivingplanet.drivercumulative	0.199	0.179	0.218	1.001
	b_samplivingplanet.driverhuman_population	0.298	0.282	0.315	1.001
	b_samplivingplanet.driverhuman_population	0.723	0.706	0.742	1.002
	b_samplivingplanet.driverhuman_population	0.568	0.549	0.588	1.001
	b_samplivingplanet.driverhuman_use	-0.061	-0.077	-0.044	1.001
	b_samplivingplanet.driverhuman_use	0.328	0.311	0.347	1.001
	b_samplivingplanet.driverhuman_use	0.198	0.179	0.219	1.001
	b_samplivingplanet.driverinvasions	0.362	0.345	0.378	1.001
	b_samplivingplanet.driverinvasions	0.787	0.767	0.805	1.002
	b_samplivingplanet.driverinvasions	0.551	0.531	0.571	1.000

Marine global change drivers across databases and the world	b_samplinglivingplanet.driverpollution	0.219	0.204	0.236	1.000
	b_samplingbiotime.driverpollution	0.675	0.657	0.693	1.001
	b_samplingpredicts.driverpollution	0.432	0.413	0.453	1.000
	sigma	0.231	0.230	0.232	1.000
	b_intercept	0.484	0.460	0.507	1.000
	b_samplinglivingplanet	0.002	-0.024	0.027	1.000
	b_samplingbiotime	0.013	-0.010	0.037	1.000
	b_drivercumulative	-0.030	-0.064	0.004	1.001
	b_driverhuman_population	-0.194	-0.226	-0.157	1.001
	b_driverhuman_use	-0.110	-0.144	-0.076	1.000
	b_driverinvasions	-0.133	-0.168	-0.101	1.000
	b_driverpollution	-0.155	-0.188	-0.121	1.000
	b_samplinglivingplanet.drivercumulative	0.121	0.085	0.160	1.001
	b_samplingbiotime.drivercumulative	0.107	0.073	0.141	1.001
	b_samplinglivingplanet.driverhuman_population	0.158	0.123	0.196	1.001
	b_samplingbiotime.driverhuman_population	0.006	-0.028	0.041	1.001
	b_samplinglivingplanet.driverhuman_use	0.212	0.175	0.248	1.001
	b_samplingbiotime.driverhuman_use	0.228	0.194	0.262	1.000
	b_samplinglivingplanet.driverinvasions	0.201	0.165	0.236	1.000
	b_samplingbiotime.driverinvasions	0.134	0.100	0.168	1.000
Terrestrial temperature change (Living Planet Database)	b_samplinglivingplanet.driverpollution	0.192	0.156	0.229	1.000
	b_samplingbiotime.driverpollution	0.166	0.132	0.199	1.000
	sigma	0.274	0.273	0.274	1.000
	b_intercept	0.011	0.009	0.013	1.000
	b_periodduringmonitoring	0.017	0.015	0.020	1.000
	sigma	0.080	0.080	0.081	1.000
	b_intercept	0.004	0.001	0.007	1.000

Marine	b_periodduringmonitoring	0.013	0.009	0.017	1.000
temperature					
change (Living	sigma	0.050	0.048	0.051	1.000
Planet Database)					
Terrestrial	b_intercept	0.027	0.024	0.031	1.000
temperature					
change	b_periodduringmonitoring	-0.011	-0.017	-0.007	1.000
(BioTIME)	sigma	0.104	0.102	0.105	1.000
Marine	b_intercept	0.010	0.009	0.012	1.000
temperature					
change	b_periodduringmonitoring	0.008	0.007	0.010	1.000
(BioTIME)	sigma	0.058	0.057	0.058	1.000

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**Extended Data Table S2. Metadata and web links for each variable dataset included in the global change driver layers used to quantify global change space and extract driver information for the sites represented by the Living Planet, BioTIME and PREDICTS databases.** The table is extracted from Bowler et al. 2020<sup>3</sup> where there are additional driver data details. In the “Realm” column “T” stands for terrestrial and “M” for marine.

Variable	Realm	Data Layer	Time series	Resolution	Description/Url/Reference
Temperature	T	CRU v 4.02	Yes	0.5°	mean monthly and yearly temperatures (°C) <a href="https://crudata.uea.ac.uk/cru/data/hrg/">https://crudata.uea.ac.uk/cru/data/hrg/</a> (Harris <i>et al.</i> 2014)
Aridity change	T	CRU v 4.02	Yes	0.5°	ratio of mean monthly and yearly pet (mm day <sup>-1</sup> ) and precipitation (mm) <a href="https://crudata.uea.ac.uk/cru/data/hrg/">https://crudata.uea.ac.uk/cru/data/hrg/</a> (Harris <i>et al.</i> 2014)
Sea surface temperature	M	HadISST	Yes	1°	mean monthly and yearly sea surface temperatures (°C) <a href="https://www.metoffice.gov.uk/hadobs/hadisst/data/download.html">https://www.metoffice.gov.uk/hadobs/hadisst/data/download.html</a> ! (Rayner <i>et al.</i> 2003)

<b>Ocean acidification</b>	M	Ocean Acidification	Yes* (2000-2009 vs 1870)	1 km <sup>2</sup>	change in aragonite saturation state <a href="https://www.nceas.ucsb.edu/globalmarine/impactbyactivity">https://www.nceas.ucsb.edu/globalmarine/impactbyactivity</a> (Halpern <i>et al.</i> 2008)
<b>Pasture</b>	T	Pasture fraction	No (2000)	5'	fraction of cell area (0-1) based on agricultural inventory data and satellite-derived land cover data <a href="http://www.earthstat.org/">http://www.earthstat.org/</a> (Ramankutty <i>et al.</i> 2008)
<b>Cropland</b>	T	Cropland fraction	No (2005)	5'	fraction of cell area (0-1) based on national and subnational agricultural data and satellite-derived land cover data (Fritz <i>et al.</i> 2015)
<b>Cattle density</b>		Gridded Livestock of the World	No (2005)	1 km	FAOSTAT national estimates and modelled downscaling (Robinson <i>et al.</i> 2014)
<b>Forest loss</b>	T	Land-Use Harmonization 2 (primary forest cover)	Yes	0.25°	fraction of cell area (0-1) using FAO national wood harvest volume data and an ecosystem model <a href="http://luh.umd.edu/">http://luh.umd.edu/</a> (Hurt <i>et al.</i> (in prep))
<b>Urban cover</b>	T	MODIS	No (2001)	5'	Urban cover (0 or 1) based on satellite-derived land cover data <a href="http://glcf.umd.edu/data/lc/">http://glcf.umd.edu/data/lc/</a>



(Friedl <i>et al.</i> 2010)					
<b>Fishing</b>	M	Commercial fishing layers	No (1999-2003)	1 km <sup>2</sup>	tons of caught fish per ton of carbon <a href="https://www.nceas.ucsb.edu/globalmarine/impactbyactivity">https://www.nceas.ucsb.edu/globalmarine/impactbyactivity</a> (Halpern <i>et al.</i> 2008)
<b>Population density</b>	T	SEDAC population data v4	No (2000)	30"	UN-adjusted population density <a href="http://sedac.ciesin.columbia.edu/data/set/gpw-v4-population-density/data-download">http://sedac.ciesin.columbia.edu/data/set/gpw-v4-population-density/data-download</a> (Center for International Earth Science Information Network - CIESIN - Columbia University 2017)
<b>Coastal population</b>	M	Coastal population	No (1992-2002)	1 km <sup>2</sup>	number of people within 25 km radius <a href="https://www.nceas.ucsb.edu/globalmarine/impactbyactivity">https://www.nceas.ucsb.edu/globalmarine/impactbyactivity</a> (Halpern <i>et al.</i> 2008)
<b>N deposition</b>	T	Atmospheric nitrogen deposition	No (1993)	5° x 3.75°	mg N/m <sup>2</sup> of total inorganic nitrogen (N), NH <sub>x</sub> (NH <sub>3</sub> and NH <sub>4</sub> <sup>+</sup> ), and NO <sub>y</sub> <a href="http://webmap.ornl.gov/ogcdown/dataset.jsp?ds_id=830">http://webmap.ornl.gov/ogcdown/dataset.jsp?ds_id=830</a> (Dentener 2006)

<b>Fertilizer application</b>	T	Nitrogen fertilizer application (v1)	No (1994-2001)	0.5°	kg of Nitrogen fertilizer per hectare of cropland <a href="http://sedac.ciesin.columbia.edu/data/set/ferman-v1-nitrogen-fertilizer-application">http://sedac.ciesin.columbia.edu/data/set/ferman-v1-nitrogen-fertilizer-application</a> (Potter <i>et al.</i> 2010)
<b>Pesticides</b>	T	Riverthreat.net: Pesticide loading	No (2000)	0.5°	kg of pesticide per hectare of cropland <a href="http://www.riverthreat.net/data.html">http://www.riverthreat.net/data.html</a> (Vorosmarty <i>et al.</i> 2010)
<b>Light pollution</b>	T/M	NOACC NGDC stable night lights	No (2006)	1 km	radiance values <a href="https://knb.ecoinformatics.org/#view/doi:10.5063/F15718ZN">https://knb.ecoinformatics.org/#view/doi:10.5063/F15718ZN</a> (Halpern <i>et al.</i> 2008)
<b>Coastal pollution</b>	M	Pesticide, Fertilizer	No (1993-2002)	1 km <sup>2</sup>	average annual use in agricultural land <a href="https://knb.ecoinformatics.org/#view/doi:10.5063/F15718ZN">https://knb.ecoinformatics.org/#view/doi:10.5063/F15718ZN</a> (Halpern <i>et al.</i> 2008)
<b>Shipping pollution</b>	M	Shipping pollution	No (2004-2005)	1 km <sup>2</sup>	ship activity (number of ships) <a href="https://knb.ecoinformatics.org/#view/doi:10.5063/F15718ZN">https://knb.ecoinformatics.org/#view/doi:10.5063/F15718ZN</a> (Halpern <i>et al.</i> 2008)
<b>Invasions</b>	T	Accessibility (Travel time)	No (2000)	30"	travel time to major cities (in hours and days) <a href="http://forobs.jrc.ec.europa.eu/products/gam/">http://forobs.jrc.ec.europa.eu/products/gam/</a>

(Nelson 2008)					
Invasions	M	Port volume (cargo volume at ports)	No (1999- 2003)	1 km <sup>2</sup>	amount of cargo traffic at ports <a href="https://knb.ecoinformatics.org/#view/doi:10.5063/F15718ZN">https://knb.ecoinformatics.org/#view/doi:10.5063/F15718ZN</a> (Halpern <i>et al.</i> 2008)