1 **On the time-lag between human activity and biodiversity in Europe at the national scale**

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Supplementary material

Name of variable	Explanation, unit and source	Main model including the variable	Summary of variations of the variable
GDPc.2000	Gross Domestic Product per inhabitant in 2000 (unit: 100,000 International Geary–Khamis dollar)	Eco & Kuznets	Untransformed: 16.06 (± 6.63) [3.00; 24.36] Log: 2.65 (± 0.57) [1.10; 3.19]
GDPa.2000	Gross Domestic Product per 1 ha in 2000 (unit: 100,000 International Geary–Khamis dollar)	Kuznets	Untransformed: 2363.55 (± 2455.17) [273.18; 9802.31] Log: 7.27 (± 1.05) [5.61; 9.19]
GDPc.2000^2	Gross Domestic Product per inhabitant in 2000 (unit: 100,000 International Geary–Khamis dollar)	Eco & Kuznets	Untransformed: 299.87 (± 188.19) [9.01; 593.60] Log: 5.30 (± 1.15) [2.20; 6.39]
GDPa.2000^2	Gross Domestic Product per 1 ha in 2000 (unit: 100,000 International Geary–Khamis dollar)	Kuznets	Untransformed: 1.1e+07 (± 2.2e+07) [74628.41;

			9.6e+07]
			Log: 14.54 (± 2.11) [11.22; 18.38]
HPD.2000	Population density in 2000 (unit: inhabitants/ha)	Eco	Untransformed: 138.18 (± 106.34) [14; 454] Log: 4.62 (± 0.89) [2.64; 6.12]
HANPP.2000	Human Appropriation of Primary Productivity in 2000 (unit: %, with 100% corresponding to 1)	Eco	Untransformed: 0.43 (± 0.21) [0.058; 0.92] Log: -0.99 (± 0.59) [-2.85; -0.079]
GDPc.1950	Gross Domestic Product per inhabitant in 1950 (unit: 100,000 International Geary–Khamis dollar)	Eco & Kuznets	Untransformed: 4.25 (± 1.98) [1.65; 9.06] Log: 1.34 (± 0.47) [0.50; 2.20]
GDPa.1950	Gross Domestic Product per 1 ha in 1950 (unit: 100,000 International Geary–Khamis dollar)	Kuznets	Untransformed: 483.71 (± 502.35) [51.04; 1690.87] Log: 5.68 (± 1.04) [3.93; 7.43]
GDPc.1950^2	Gross Domestic Product per inhabitant in 1950	Eco & Kuznets	Untransformed: 21.83 (± 19.98)

| | | | [2.73; 82.16] |
| | | | Log: 2.69 (± 0.94) |
			[1.00; 4.41]
GDPa.1950^2	Gross Domestic Product per 1 ha in 1950 (unit: 100,000 International Geary–Khamis dollar)	Kuznets	Untransformed: 474856.35 (± 837766.19) [2604.67; 2859048.12] Log: 11.36 (± 2.08) [7.87; 14.87]
HPD.1950	Population density in 1950 (unit: inhabitants/ha)	Eco	Untransformed: 104.59 (± 77.79) [10; 282] Log: 4.34 (± 0.90) [2.30; 5.64]
HANPP.1950	Human Appropriation of Primary Productivity in 1950 (unit: %, with 100% corresponding to 1)	Eco	Untransformed: 0.33 (± 0.18) [0.067; 0.73] Log: -1.24 (± 0.58) [-2.70; -0.31]
GDPc.1900	Gross Domestic Product per inhabitant in 1900 (unit: 100,000 International Geary–Khamis dollar)	Eco & Kuznets	Untransformed: 2.36 (± 0.94) [1.22; 4.49] Log: 0.79 (± 0.39) [0.20; 1.50]

GDPa.1900	Gross Domestic Product per 1 ha in 1900 (unit: 100,000 International Geary–Khamis dollar)	Kuznets	Untransformed: 217.81 (± 224.68) [13.34; 817.09] Log: 4.85 (± 1.15) [2.59; 6.71]
GDPc.1900^2	Gross Domestic Product per inhabitant in 1900 (unit: 100,000 International Geary–Khamis dollar)	Eco & Kuznets	Untransformed: 6.43 (± 5.05) [1.50; 20.18] Log: 1.57 (± 0.78) [0.40; 3.00]
GDPa.1900^2	Gross Domestic Product per 1 ha in 1900 (unit: 100,000 International Geary–Khamis dollar)	Kuznets	Untransformed: 95625.60 (± 180503.21) [178.06; 667634.43] Log: 9.70 (± 2.30) [5.18; 13.41]
HPD.1900	Population density in 1900 (unit: inhabitants/ha)	Eco	Untransformed: 79.05 (± 54.86) [7; 219] Log: 4.06 (± 0.92) [1.95; 5.39]
HANPP.1900	Human Appropriation of Primary Productivity in 1900 (unit: %, with 100% corresponding to 1)	Eco	Untransformed: 0.32 (± 0.17) [0.06; 0.76] Log: -1.29 (± 0.58) [-2.81; -

			0.28]

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Table SM1. List of economic variables included in the statistical models (cf. Table 2). The summary

of the variations for the variables include the mean (+/- the standard deviation) and in square brackets

the minimum and maximum for the variable in the model for Extinct species (these summary statistics

do not include the repetition of data when a single country is included repeatedly in the analysis). All

the data come from [Dullinger, 2013 ^ny #120369] (2013).

Name of variable	Explanation, unit and source	Summary of variations of the variable
Extinct	Number of Extinct species for various taxonomic groups and countries (data from Essl et al. 2013)	Summary statistics for the proportion of Extinct species for each taxonomic group: Vascular Plants: 0.018 ($\pm$ 0.018) [0.0016; 0.088] Bryophytes: 0.024 ($\pm$ 0.02) [0.00; 0.056] Mammals: 0.035 ($\pm$ 0.032) [0.00; 0.13] Birds: 0.031 ($\pm$ 0.023) [0.00; 0.087] Freshwater Fishes: 0.056 ($\pm$ 0.056) [0.00; 0.15] Reptiles: 0.015 ($\pm$ 0.032) [0.00; 0.12] Amphibians: 0.0025 ($\pm$ 0.012) [0.00; 0.056] Dragonflies: 0.035 ($\pm$ 0.037) [0.00; 0.10] Grasshoppers: 0.051 ($\pm$ 0.057) [0.00; 0.22]
Threatened	Number of Threatened species for various taxonomic groups and countries (data from Essl et al. 2013)	Summary statistics for the proportion of Threatened species (excluding Extinct species) for each taxonomic group: Vascular Plants: 0.22 ($\pm$ 0.13) [0.065; 0.56] Bryophytes: 0.23 ($\pm$ 0.097) [0.072; 0.37] Mammals: 0.23 ($\pm$ 0.10) [0.10; 0.44] Birds: 0.29 ($\pm$ 0.11) [0.15; 0.55] Freshwater Fishes: 0.33 ($\pm$ 0.15) [0.093; 0.57] Reptiles: 0.39 ($\pm$ 0.26) [0.00; 0.79] Amphibians: 0.34 ($\pm$ 0.24) [0.00; 0.89] Dragonflies: 0.30 ($\pm$ 0.17) [0.036; 0.57] Grasshoppers: 0.22 ($\pm$ 0.11) [0.069; 0.40]
SEAL	Percent area of country considered as sealed in 2009	2.81 ($\pm$ 1.98) [0.29; 8.22]

	(source: http://www.eea.europa.eu/data-and-maps/indicators/imperviousness-change/assessment)	
iSEAL	Annual percent increase in the country area that was sealed between 2006 and 2009 (source: http://www.eea.europa.eu/data-and-maps/indicators/imperviousness-change/assessment	0.033 (± 0.019) [0.01; 0.089]
PA1	Proportional area of country in IUCN Category 1	0.011 (± 0.025) [0.00; 0.086]
PA2	Proportional area of country in IUCN Category 2	0.024 (± 0.03) [0.00; 0.10]
PA3	Proportional area of country in IUCN Category 3	0.0021 (± 0.0062) [0.00; 0.029]
PA4	Proportional area of country in IUCN Category 4	0.031 (± 0.04) [0.00038; 0.16]

14 Table SM2. List of the biodiversity indicators used in this paper. The summary of the variations for

15 the variables include the mean (+/- the standard deviation) and in square brackets the minimum and

16 maximum for the variable.

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Model name	SEAL	iSEAL
Null	44.51	18.34
Economic.2000	17.45	**<u>0.00</u>**
Log Economic.2000	**0.00**	**4.87**
Economic.1950	13.20	**2.17**
Log Economic.1950	**2.65**	6.07
GDPa.2000	24.30	**5.36**
Log GDPa.2000	18.54	8.46
HPD.2000	17.70	**0.75**
Log HPD.2000	**<u>-2.21</u>**	**2.54**
HPD.1950	11.76	**5.38**
Log HPD.1950	**0.07**	**5.53**
HANPP.2000	11.93	8.93
Log HANPP.2000	9.31	10.61

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Table SM3. Statistical comparison of additional univariate models (rows) to predict the two

pressure biodiversity indicators (columns). Difference between Leave-one-out Information

Criterion (LOOIC) of the model and the LOOIC of the best model in Table 2 for the

proportion of Sealed area in 2009 (SEAL) and the increase in that proportion between 2006

and 2009 (iSEAL) (columns). The lower the LOOIC, the better the model. The best model is

underlined and models with an LOOIC within six units of the best model – i.e. relatively close

to the best model – are in bold. Only the models pertaining to the same target variable

(column heading) are comparable. See Tables 1 and SM1 for the content of the models.

Variable name	Taxon	Summary statistics of the estimator – mean (standard deviation)	p-value	Summary impact in log odds ratio of an increase of 1 standard deviation of the variable
Log GDPa.1900	Vascular Plants	0.356 (0.128)	0.00359	0+
Log GDPa.1900	Bryophytes	0.509 (0.161)	0.00061	0+
Log GDPa.1900	Mammals	0.516 (0.139)	0.00023	0+
Log GDPa.1900	Birds	0.292 (0.151)	0.0298	0
Log GDPa.1900	Fishes	0.544 (0.157)	0.00045	0+
Log GDPa.1900	Reptiles	0.299 (0.263)	0.12923	0
Log GDPa.1900	Amphibians	0.498 (0.297)	0.03758	
Log GDPa.1900	Dragonflies	0.623 (0.217)	0.00042	+
Log GDPa.1900	Grasshoppers	0.691 (0.232)	0.00008	+
Log GDPa.1950	Vascular Plants	0.391 (0.133)	0.0032	0+
Log GDPa.1950	Bryophytes	0.464 (0.159)	0.0032	0+
Log GDPa.1950	Mammals	0.488 (0.141)	0.00046	0+
Log GDPa.1950	Birds	0.336 (0.156)	0.02077	0
Log GDPa.1950	Fishes	0.536 (0.158)	0.00021	0+
Log GDPa.1950	Reptiles	0.314 (0.255)	0.10858	0
Log GDPa.1950	Amphibians	0.5 (0.268)	0.024	+
Log GDPa.1950	Dragonflies	0.585 (0.209)	0.00035	+
Log GDPa.1950	Grasshoppers	0.589 (0.203)	0.00049	+
Log GDPa.2000	Vascular Plants	0.272 (0.157)	0.04517	0

Log GDPa.2000	Bryophytes	0.446 (0.16)	0.00285	0+
Log GDPa.2000	Mammals	0.419 (0.147)	0.00285	0+
Log GDPa.2000	Birds	0.339 (0.155)	0.01933	0
Log GDPa.2000	Fishes	0.448 (0.157)	0.00224	0+
Log GDPa.2000	Reptiles	0.317 (0.213)	0.07399	0
Log GDPa.2000	Amphibians	0.418 (0.234)	0.0305	0
Log GDPa.2000	Dragonflies	0.491 (0.199)	0.00299	0+
Log GDPa.2000	Grasshoppers	0.483 (0.192)	0.00358	0+

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29 Table SM4. Analysis of the estimators of the best socio-economic variables at different dates

30 for the proportion of Extinct species, by taxonomic group. For magnitude analyses (last

31 column), the results of the analyses of adding one standard variable of the best variate on odds

32 ratios were conclusive if 95% of the odds ratio effects were in the interval $[-0.1; 0.1]$

33 (denoted as 000 and qualified as a strongly negligible effect), $[-0.5; 0.5]$ (denoted as 00 and

34 qualified as a moderately negligible effect), $[-1; 1]$ (denoted as 0 and qualified as a weakly

35 negligible effect), $[0.1; +\infty)$ (denoted as + and qualified as a weakly positive effect),

36 $[0.5; +\infty)$ (denoted as ++ and qualified as a moderately positive effect), $[1; +\infty)$ (denoted as

37 +++ and qualified as a strongly positive effect) (as in e.g. Daniels 1983). The best model was

38 the hierarchical model at date 1900. For each taxonomic group, estimated tend to decrease

39 with date, except for Birds and Reptiles, for which they tend to increase with date, and

40 vascular plants and amphibians, for which 1900 and 1950 estimators were very close and

41 greater than 2000 estimator.

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Model name	Extinct species	Threatened species
Null	22.83	17.53
Log Economic.2000	0.0	2.93
Log Kuznets.2000a	1.89	**0.0**
HPD2000l	-1.68	<u>**-4.65**</u>
Log GDPa.2000	-2.21	**-1.03**
Log SEAL	<u>**-10.67**</u>	**-0.28**

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45   Table SM5. Statistical comparison of additional univariate models in 2000 (rows) to predict

46   the two state biodiversity indicators (columns). Difference in Leave-one-out Information

47   Criterion (LOOIC) values with the LOOIC of the best model with current values of socio-

48   economic variables in Table 2, for additional univariate models involving only current values

49   of variables for the proportion of Extinct and Threatened species. The lower the LOOIC, the

50   better the model. The best model is underlined and models with an LOOIC within six units of

51   the best model – i.e. relatively close to the best model – are in bold. Only the models

52   pertaining to the same target variable (column heading) are comparable. It should be noted

53   that for extinct species, the best present model was the bivariate model involving

54   untransformed SEAL and iSEAL (Difference in LOOIC of -14.18). See Tables 1 and SM1 for

55   the content of the models.

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variable clustering (varclus) - with correlations
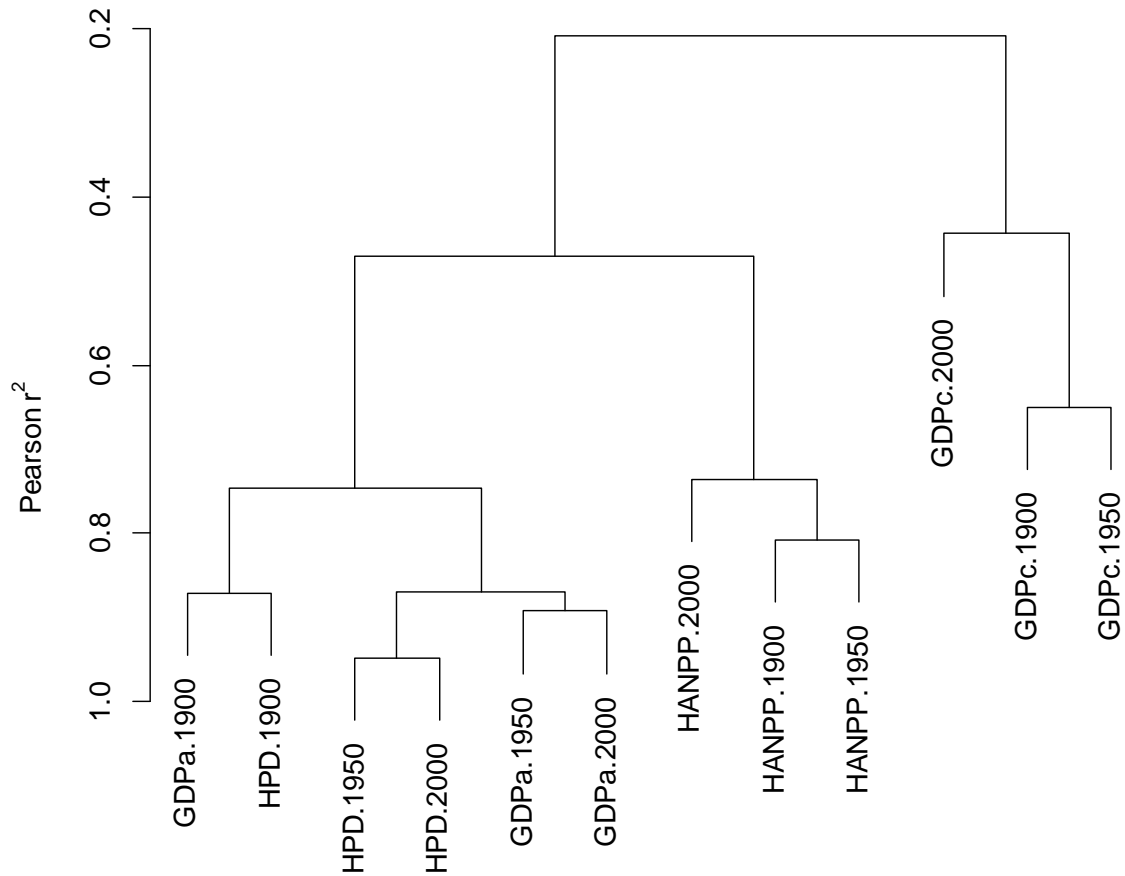
method : average

60 Figure SM1. Variable clustering for the explanatory variables used in the paper. The correlation metric

61 was the Pearson correlation and the method used to summarize multiple correlations was the average

62 method. Variables linked at a value close to one are on average closely correlated while variables

63 linked at a value close to zero have a low level of correlation.