

Naturalised neobiota in Norwegian counties and European countries

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This Appendix provides a summary and analysis of the county-wise (country-wise) numbers of naturalised alien species in Norway (and Europe, respectively). The input data used for Norwegian counties are provided in Table A1, with results listed in Table A2. Input data for European countries are provided in Table A3.

The figures in Table A1 are based on county borders as they were in 2017, except that the two counties of Oslo and Akershus were treated as one unit. Jan Mayen and Svalbard, although under Norwegian sovereignty, are not counties of Norway, but are shown here for comparison. Latitude and longitude represent the centre of each county. The data used were obtained from the Norwegian Mapping Authority (www.kartverket.no) and Statistics Norway (www.ssb.no), except for the last column, which was taken from Online Resource 1 (List I). Note that a species was treated as alien to a county only if it was alien to mainland Norway as a whole. Jan Mayen and Svalbard, however, represented a separate assessment area, and species status in this area was thus determined independently from mainland Norway (e.g., a species can be alien to Svalbard and native to mainland Norway).

The figures in Table A1 were used to define additional variables, viz. population density (inhabitants divided by area) and relative coastline (coastline divided by inhabitants). Species number and all covariates except for latitude and longitude were log-transformed. Model selection was based on Akaike's Information Criterion corrected for small sample size (AIC_C) and was done for the 18 counties alone (Table A2a) or with Svalbard included (Table A2b). Jan Mayen was not included, because no naturalised species were recorded on this island.

Each row in Table A2 represents one model, consisting of the parameters for which estimates are provided. Model "0" signifies the null model (i.e. intercept only). The best (top) model in both analyses contained two parameters, viz. latitude and either population density (Table A2a) or population size (Table A2b). In Table A2a, model 3 obtained a fit almost as good as the top model (i.e. with population size instead of population density, corresponding to the top model of Table A2b). None of the other models obtained a comparable fit, because they had more parameters and/or $\Delta AIC_C > 10$.

Table A1 Norwegian counties and their alien species. The data were used as input for linear regressions

County	Area (km ²)	Population (inhabitants)	Coastline (km)	Latitude (°N)	Longitude (°E)	Naturalised neobiota
AA Aust-Agder	9,155	117,000	2,275	58.5	8.6	384
BU Buskerud	14,912	280,000	232	60.0	9.6	466
FI Finnmark	48,631	76,000	8,120	70.0	25.0	64
HE Hedmark	27,398	196,000	0	61.1	11.4	312
HO Hordaland	15,437	520,000	11,189	60.4	6.1	341
MR Møre og Romsdal	15,101	266,000	9,545	62.7	7.2	298
NO Nordland	38,475	243,000	26,734	67.0	14.6	190
NT Nord-Trøndelag	22,418	137,000	7,403	64.5	11.9	193
OA Oslo + Akershus	5,372	1,271,000	598	60.0	11.2	671
ØF Østfold	4,187	293,000	1,791	59.4	11.3	491
OP Oppland	25,192	189,000	0	61.1	10.1	218
RO Rogaland	9,377	472,000	4,975	59.0	6.0	431
SF Sogn og Fjordane	18,622	110,000	7,896	61.5	5.9	257
ST Sør-Trøndelag	18,848	317,000	8,434	63.3	10.3	302
TE Telemark	15,298	173,000	1,446	59.5	8.6	398
TR Troms	25,877	166,000	7,100	69.2	19.2	163
VA Vest-Agder	7,279	184,000	2,782	58.3	7.4	421
VF Vestfold	2,225	247,000	1,855	59.2	10.3	479
JM Jan Mayen	377	20	150	71.0	−8.5	0
SV Svalbard	61,022	2,000	8,829	78.0	18.0	5

Table A2 Linear regression models explaining the geographical variation in number of naturalised neo-biota in Norway. Models comprise the 18 Norwegian counties (a) excluding and (b) including Svalbard. All estimates (\pm standard error) are multiplied by 1000. Also given are the number of parameters (K), Akaike's Information Criterion corrected for small sample size (AIC_C) and the variance explained (R^2). Models are sorted by decreasing fit (increasing ΔAIC_C). Asterisks indicate significance levels ($0.5 > P^* \geq 0.01 > P^{**} \geq 0.001 > P^{***}$)

Model	Popul. (inhabitants)	Pop. density (inhab./km ²)	Rel. coastl. (km/inhab.)	Latitude (°N)	Longitude (°E)	K	ΔAIC_C	R^2
<i>(a) Model selection excluding Svalbard (N = 18 counties)</i>								
1		217±46***		−36±7***		3	0.0	0.909
2	13±12	148±79		−39±7***		4	2.5	0.916
3	315±76***			−48±6***		3	2.6	0.895
4		225±47***		−27±11*	−7±7	4	2.6	0.915
5		215±48***	−18±35	−35±8***		4	3.6	0.911
6				−58±8***		2	13.0	0.774
7		379±56***				2	15.6	0.740
8			−34±53	−54±10***		3	15.9	0.780
9				−56.15**	−2±11	3	16.3	0.775
10					−36±8*	2	25.1	0.556
11	553±157**					2	29.5	0.436
12			−203±72*			2	32.5	0.333
0						1	36.9	0.000
<i>(b) Model selection including Svalbard (N = 19 counties + regions)</i>								
1	425±60***			−51±6***		3	0.0	0.968
2	404±63***			−58±10***	7±7	4	2.4	0.970
3	367±105**	60±87		−48±8***		4	3.2	0.969
4	433±66***		14±53	−52±8***		4	3.6	0.968
5		310±66***		−44±10		3	10.7	0.943
6		544±48***				2	21.5	0.881
7				−103±12	23±13	3	23.8	0.887
8				−86±8***		2	24.0	0.865
9			−87±77	−74±13		3	25.8	0.875
10	786±83***					2	27.1	0.841
11			−426±80***			2	43.4	0.624
12					−60±18	2	52.2	0.402
0						1	59.1	0.000

No exhaustive analysis of European countries was attempted. Rather, we used the data compiled by Lambdon et al. (2008) for naturalised neophytes. In some cases, these data were supplemented or updated. Where these sources allowed the estimation of the overall number of naturalised neobiota (not only plants), the latter figures are included, too (Table A3).

For naturalised plants, a linear regression between country area and species number (both log-transformed) explained 32% of the variance (the regression line is shown in Fig. 8; $F_{21} = 9.99$, $p = 0.0047$). When excluding one outlier (Liechtenstein), still 24% of the variance were explained ($F_{20} = 6.35$, $p = 0.020$). When including Svalbard, however, the pattern disappeared ($F_{22} = 2.76$, $p = R^2 = 0.11$).

Table A3 Selected European countries and their naturalised alien species

Country	Area (km ²)	Naturalised species	Naturalised plants	Source
AT Austria	83,900	638	276	Essl and Rabitsch (2002)
BE Belgium	30,500	–	447	Lambdon et al. (2008)
CH Switzerland	41,300	512	170	Wittenberg et al. 2006
CY Cyprus	9,250	–	133	Lambdon et al. (2008)
CZ Czechia	78,900	–	257	Pyšek et al. (2012)
DE Germany	357,100	626	450	Nehring et al. (2013, 2015, 2017)
EE Estonia	45,200	–	125	Lambdon et al. (2008)
ES Spain	506,000	297	167	Capdevila Argüelles et al. (2006)
GB Great Britain	242,500	–	857	Lambdon et al. (2008)
GR Greece	132,000	–	112	Lambdon et al. (2008)
HU Hungary	93,000	–	145	Lambdon et al. (2008)
IT Italy	301,300	–	440	Lambdon et al. (2008)
LI Liechtenstein	160	115	85	Staub (2006)
LT Lithuania	65,300	–	256	Lambdon et al. (2008)
LU Luxembourg	2,690	–	118	Ries et al. (2013)
NL Netherlands	41,900	–	154	Lambdon et al. (2008)
PL Poland	312,700	–	300	Lambdon et al. (2008)
PT Portugal	92,100	–	500	de Almeida (2012)
RO Romania	238,400	–	113	Lambdon et al. (2008)
SE Sweden	450,300	677	544	Strand et al. (2018)
SK Slovakia	49,000	–	182	Lambdon et al. (2008)
UA Ukraine	603,500	–	297	Lambdon et al. (2008)
NO Norway	323,800	1,039	734	this paper
(SV Svalbard)	61,000	5	2	this paper