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Suivi temporel des oiseaux communs (STOC)

Analysis of the common breeding birds in France 2013-2017

Thierry Onkelinx

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Set-up of the analyses

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1 METHODOLOGY

Naturaconsta provided the raw observations made during the *Suivi Temporel des Oiseaux Communs (STOC)*. It consists of 52726 observations during 6446 visits over 123 sites and 214 species. The birds are counted during a fixed period at a stationary point. The distance between the bird and the observer is recorded in four classes: "0-25m", "25-100m", ">100m" and "passing". These distance classes were too broad to estimate a distance based detection function. Especially the lack of an upper bound makes this very hard. Therefore, we aggregated all the distances classes into a single class. One observation in the data contain the total number of bird of a given species at a given point and at date.

1.1 STATISTICAL MODELS

In order to get comparable results, we fit the same set of models to each species. The model estimates the average number of birds at a point at a given site in a given year and period. The first period ranges for the beginning of April to mid May. The second period from mid May to the end of June.

The base model (1.1) with a non-linear trend along year contains following terms:

- β_0: the overall intercept during the first period
- β_1: the difference between the second and the first period
- b_y: effect of year y, modelled as a first order random walk with variance σ_y^2 (1.2)
- b_s: effect of site s, modelled as a random intercept with variance σ_s^2 (1.3)
- b_p: effect of point p, nested in site s, modelled as a random intercept with variance σ_p^2 (1.4)

$$\eta_{yisp} = \beta_0 + \beta_1 + b_y + b_s + b_p \tag{1.1}$$

$$\Delta_{b_y} = b_y - b_{y-1} \sim \mathcal{N}(0, \sigma_y^2) \tag{1.2}$$

$$b_s \sim \mathcal{N}(0, \sigma_s^2) \tag{1.3}$$

$$b_p \sim \mathcal{N}(0, \sigma_p^2) \tag{1.4}$$

The η_{yisp} of the base model is linked to the observed counts Y_{yisp} via either a Poisson distribution (1.5) or a negative binomial distribution (1.6). Both distributions use the log link between η and μ (1.7).

The negative binomial distribution can capture overdispersion which is often present in count data of animals. The fit of both distributions is compared based on the Watanabe–Akaike information criterion (WAIC) (Gelman et al, 2014). We can use the WAIC to compare the fit of several models on the same dataset. Lower WAIC values imply a better model fit, while taking the model complexity into account. We select the negative binomial distribution for a species if its WAIC the base model (1.1) is at least 2 units smaller than the WAIC for the same model with the Poisson distribution.

$$Y_{yisp} \sim Pois(\mu_{yisp}) \tag{1.5}$$

$$Y_{yisp} \sim NB(\mu_{yisp}, n) \tag{1.6}$$

$$\log(\mu_{yisp}) = \eta_{yisp} \tag{1.7}$$

Once the optimal distribution is selected, we fit a model with a linear trend along year (1.8) with this optimal distribution. It uses the same terms as (1.1) except that the non-linear effect of year (b_y) is replaced with a linear trend (β_1).

$$\eta_{yisp} = \beta_0 + \beta_1 + \beta_2 \text{year} + b_s + b_p \tag{1.8}$$

1.2 FITTING THE MODEL

The models are fit the statistical software R version 3.6.1 (R Core Team, 2019) using the INLA package version 18.07.12 (Rue et al, 2017). It fits Bayesian models using Integrated Nested Laplace Approximation (INLA). Fitting Bayesian models imply select prior distributions for a number of parameters.

- β_0, β_1 and β_2 use a Gaussian prior with 0 mean and variance 1000 $\mathcal{N}(0, 1000)$
- σ_y^2 uses a PC prior with $u = 0.25$ and $\alpha = 0.5$
- σ_s^2 uses a PC prior with $u = 0.6$ and $\alpha = 0.5$
- σ_p^2 uses a PC prior with $u = 0.3$ and $\alpha = 0.5$
- n is modelled as $n = e^{\theta}$ with a $\theta \sim \Gamma(e^{-7}, e^{-7})$

A PC (penalised complexity) prior is defined by two parameters u and α. u defines a threshold value for σ, and α defines the probability that the estimated σ exceeds this threshold value (1.9). The density of this prior is given in (1.10).

$$P(\sigma > u) = \alpha \tag{1.9}$$

$$\pi(\tau) = \frac{\lambda}{2}\tau^{-3/2} exp(-\lambda\tau^{-1/2}) \tag{1.10}$$

$$\lambda = -\frac{\log(\alpha)}{u} \tag{1.11}$$

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2 DATA SELECTION

This chapter explores the full dataset. We will try to estimates trends for as much species as possible. Stable models require sufficient data. Therefore, we apply a set of rules on the available data of each species. These rules are partly based on common statistical knowledge and our experience with similar data in the past. And partly based on the data analysed in this project. If a model for a given species turns out to be unstable, then we make the rules more strict. We apply the same set of rules for every species so the results are comparable among the species.

This chapter shows both the rule and the summary of the data on which the rule applies. This illustrates the available data and how the rule restricts the data. Note that these rules will remove data for some species or some sites. When volunteers collect more data in the future for such species and sites, they might have sufficient data to pass all the rules.

2.1 RULE 1: A SITE MUST BE SAMPLED DURING AT LEAST 3 YEARS

The models take both a site and a year effect into account. When a site is sampled during only one or two years, then model has a hard time separating the site and year effect. This can lead to an unstable model. Therefore it is safer to restrict the data to sites with a sufficient number of visits over several years.

Table 2.1 displays how many sites have data from 1, 2, 3, ... different years. 37 sites have data from less than 3 different years and are currently ignored.

Table 2.1: Number of sites with data from a number of years.

year	sites
1	25
2	12
3	24
4	27
5	35

2.2 RULE 2: USE ONLY RELEVANT SITES FOR A SPECIES

Some species at not present at every site. When a species is absent at a site, the counts are always zero. The numbers are not changing at that site, so locally there is no trend. If we would take such site into account, the overall trend will be biased towards zero.

Species that are rarely seen at a site pose a problem too. Imaging a species is only seen at the first year with on average 10 individuals. The model tries to fit the first year at this site as $\log(10) = 2.303$. All other years at this site should be $\log(0) = -\infty$. This results is a strong negative local trend, which again biases the global trend.

Therefore, we require that a species is observed at a site during at least 3 different years before taking that site into account for this species. Table 2.2 is a very large table because it contains a row for each of the 206 species observed in the data. 76 species at so rare that there is not a single site at which they are observed during 3 different years.

Table 2.2: Number of sites at which a species was observed split by the number of years (columns) during which the species was observed at a site.

scientific	1	2	3	4	5	sufficient
Columba palumbus	0	0	25	26	34	85
Turdus merula	1	4	19	29	31	79
Corvus corone	6	5	13	27	30	70
Sturnus vulgaris	7	12	18	24	22	64
Fringilla coelebs	8	8	7	26	31	64
Phylloscopus collybita	10	10	11	26	26	63
Parus major	8	10	17	24	22	63
Sylvia atricapilla	4	11	7	31	24	62
Turdus philomelos	6	11	13	33	15	61
Cyanistes caeruleus	11	6	16	25	16	57
Troglodytes troglodytes	10	8	4	28	23	55
Alauda arvensis	9	3	7	21	24	52
Erithacus rubecula	13	10	14	23	15	52
Phasianus colchicus	10	7	14	20	17	51
Streptopelia decaocto	6	11	13	17	21	51
Hirundo rustica	18	12	20	11	16	47
Linaria cannabina	16	10	15	16	15	46
Emberiza citrinella	11	7	11	24	11	46
Picus viridis	11	16	22	14	8	44
Passer domesticus	13	10	13	12	18	43
Pica pica	11	10	15	13	14	42
Garrulus glandarius	13	20	20	16	4	40
Carduelis carduelis	16	14	27	8	3	38
Motacilla alba	21	12	10	20	6	36
Buteo buteo	26	19	11	15	8	34
Prunella modularis	11	14	16	9	9	34
Sylvia communis	12	13	17	12	5	34
Cuculus canorus	10	19	9	18	5	32
Luscinia megarhynchos	10	5	19	8	3	30
Streptopelia turtur	21	19	15	10	3	28
Chloris chloris	18	12	10	12	6	28
Anas platyrhynchos	14	18	13	11	2	26
Falco tinnunculus	19	22	16	5	5	26
Dendrocopos major	7	19	13	11	2	26
Perdix perdix	11	8	9	6	9	24
Motacilla flava	15	13	10	8	5	23
Turdus viscivorus	21	16	13	9	1	23
Phoenicurus ochruros	11	14	9	9	3	21
Phylloscopus trochilus	13	8	7	14	0	21
Sitta europaea	16	14	10	10	1	21
Certhia brachydactyla	16	12	6	13	0	19
Ardea cinerea	25	14	9	5	4	18

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scientific	1	2	3	4	5	sufficient
Sylvia borin	17	15	7	10	1	18
Corvus frugilegus	12	10	9	4	5	18
Emberiza calandra	16	9	7	3	7	17
Saxicola rubicola	9	4	6	9	0	15
Aegithalos caudatus	17	13	12	2	1	15
Cettia cetti	2	1	10	2	2	14
Oriolus oriolus	10	14	9	5	0	14
Fulica atra	1	4	3	7	3	13
Corvus monedula	17	5	7	3	3	13
Gallinula chloropus	11	13	6	1	5	12
Serinus serinus	9	5	12	0	0	12
Regulus ignicapilla	9	7	4	7	0	11
Poecile palustris	12	8	4	7	0	11
Pyrrhula pyrrhula	14	8	7	4	0	11
Vanellus vanellus	11	2	2	3	5	10
Apus apus	18	16	9	1	0	10
Egretta garzetta	4	2	7	0	2	9
Delichon urbicum	23	10	6	2	1	9
Cisticola juncidis	1	1	9	0	0	9
Acrocephalus schoenobaenus	1	1	2	3	4	9
Acrocephalus scirpaceus	8	2	4	3	2	9
Regulus regulus	12	8	8	1	0	9
Cygnus olor	5	3	2	4	2	8
Larus ridibundus	6	0	1	1	6	8
Sylvia curruca	14	2	5	2	1	8
Coccothraustes coccothraustes	5	5	3	5	0	8
Milvus migrans	7	3	2	4	1	7
Circus aeruginosus	4	6	6	1	0	7
Larus michahellis	1	0	7	0	0	7
Galerida cristata	2	1	7	0	0	7
Lullula arborea	1	5	7	0	0	7
Anthus pratensis	20	8	6	1	0	7
Tadorna tadorna	5	3	5	1	0	6
Columba livia	5	5	4	2	0	6
Upupa epops	2	3	6	0	0	6
Sylvia melanocephala	2	2	6	0	0	6
Circus cyaneus	10	3	3	2	0	5
Larus argentatus	9	3	1	2	2	5
Dryocopus martius	11	4	5	0	0	5
Anthus trivialis	17	9	2	3	0	5
Hippolais polyglotta	25	3	5	0	0	5
Emberiza schoeniclus	6	5	3	2	0	5
Himantopus himantopus	2	3	2	1	1	4
Jynx torquilla	9	2	4	0	0	4
Phylloscopus sibilatrix	2	0	4	0	0	4
Phalacrocorax carbo	16	6	0	0	3	3
Coturnix coturnix	11	5	1	1	1	3
Charadrius hiaticula	2	0	2	0	1	3
Oenanthe oenanthe	14	4	1	1	1	3
Certhia familiaris	9	3	3	0	0	3

scientific	1	2	3	4	5	sufficient
Passer montanus	5	3	2	1	0	3
Tachybaptus ruficollis	3	1	0	2	0	2
Ardea alba	7	4	2	0	0	2
Ciconia ciconia	4	0	0	1	1	2
Alopochen aegyptiaca	4	1	2	0	0	2
Anas strepera	3	2	2	0	0	2
Spatula querquedula	2	1	1	1	0	2
Haematopus ostralegus	2	0	1	0	1	2
Recurvirostra avosetta	2	0	1	0	1	2
Columba oenas	12	9	2	0	0	2
Turdus pilaris	11	1	1	1	0	2
Acrocephalus arundinaceus	4	0	2	0	0	2
Sylvia cantillans	2	0	2	0	0	2
Poecile montanus	9	1	1	1	0	2
Podiceps cristatus	1	1	0	1	0	1
Bubulcus ibis	2	1	1	0	0	1
Anser anser	1	1	1	0	0	1
Spatula clypeata	5	0	0	1	0	1
Alectoris rufa	6	4	1	0	0	1
Syrmaticus reevesii	3	0	1	0	0	1
Burhinus oedicnemus	4	3	1	0	0	1
Charadrius dubius	5	1	1	0	0	1
Numenius arquata	2	2	0	1	0	1
Actitis hypoleucos	3	1	1	0	0	1
Clamator glandarius	9	0	1	0	0	1
Coracias garrulus	2	3	1	0	0	1
Picus canus	3	0	1	0	0	1
Riparia riparia	2	0	1	0	0	1
Luscinia svecica	0	3	0	1	0	1
Oenanthe hispanica	0	0	1	0	0	1
Locustella naevia	3	1	0	1	0	1
Sylvia undata	0	1	1	0	0	1
Panurus biarmicus	1	0	1	0	0	1
Lophophanes cristatus	13	5	1	0	0	1
Periparus ater	10	2	0	1	0	1
Lanius collurio	7	8	0	1	0	1
Emberiza cirlus	9	3	1	0	0	1
Emberiza hortulana	0	0	1	0	0	1
Phalacrocorax aristotelis	1	0	0	0	0	0
Ardeola ralloides	1	0	0	0	0	0
Ardea purpurea	1	1	0	0	0	0
Plegadis falcinellus	1	0	0	0	0	0
Platalea leucorodia	2	0	0	0	0	0
Phoenicopterus roseus	0	1	0	0	0	0
Branta canadensis	3	1	0	0	0	0
Branta leucopsis	1	0	0	0	0	0
Aix galericulata	0	1	0	0	0	0
Anas penelope	1	0	0	0	0	0
Anas crecca	2	0	0	0	0	0
Anas acuta	2	0	0	0	0	0

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scientific	1	2	3	4	5	sufficient
Netta rufina	0	1	0	0	0	0
Aythya ferina	1	0	0	0	0	0
Aythya fuligula	1	0	0	0	0	0
Pernis apivorus	6	0	0	0	0	0
Milvus milvus	6	6	0	0	0	0
Circus pygargus	3	2	0	0	0	0
Accipiter gentilis	2	0	0	0	0	0
Accipiter nisus	23	6	0	0	0	0
Pandion haliaetus	2	0	0	0	0	0
Falco subbuteo	12	3	0	0	0	0
Falco peregrinus	2	2	0	0	0	0
Rallus aquaticus	2	4	0	0	0	0
Tetrax tetrax	0	1	0	0	0	0
Pluvialis apricaria	1	0	0	0	0	0
Calidris pugnax	3	0	0	0	0	0
Gallinago gallinago	7	1	0	0	0	0
Limosa limosa	3	1	0	0	0	0
Numenius phaeopus	1	1	0	0	0	0
Tringa totanus	6	1	0	0	0	0
Tringa nebularia	4	0	0	0	0	0
Tringa ochropus	6	2	0	0	0	0
Larus melanocephalus	4	3	0	0	0	0
Larus canus	3	0	0	0	0	0
Larus fuscus	1	0	0	0	0	0
Larus marinus	1	0	0	0	0	0
Sterna hirundo	1	0	0	0	0	0
Sternula albifrons	1	0	0	0	0	0
Otus scops	0	1	0	0	0	0
Bubo bubo	1	0	0	0	0	0
Athene noctua	5	0	0	0	0	0
Strix aluco	4	1	0	0	0	0
Tachymarptis melba	1	0	0	0	0	0
Alcedo atthis	11	3	0	0	0	0
Merops apiaster	3	3	0	0	0	0
Dendropicos medius	5	4	0	0	0	0
Dryobates minor	9	3	0	0	0	0
Galerida theklae	1	0	0	0	0	0
Anthus campestris	4	0	0	0	0	0
Anthus petrosus	0	1	0	0	0	0
Motacilla cinerea	9	2	0	0	0	0
Cinclus cinclus	1	0	0	0	0	0
Phoenicurus phoenicurus	14	4	0	0	0	0
Saxicola rubetra	12	3	0	0	0	0
Monticola saxatilis	0	1	0	0	0	0
Monticola solitarius	2	0	0	0	0	0
Turdus torquatus	3	0	0	0	0	0
Turdus iliacus	3	1	0	0	0	0
Acrocephalus melanopogon	2	0	0	0	0	0
Acrocephalus palustris	9	2	0	0	0	0
Hippolais icterina	4	0	0	0	0	0

scientific	1	2	3	4	5	sufficient
Sylvia hortensis	0	1	0	0	0	0
Phylloscopus bonelli	5	1	0	0	0	0
Muscicapa striata	6	4	0	0	0	0
Ficedula albicollis	2	1	0	0	0	0
Ficedula hypoleuca	4	0	0	0	0	0
Lanius excubitor	2	0	0	0	0	0
Lanius senator	3	1	0	0	0	0
Corvus corax	3	1	0	0	0	0
Sturnus unicolor	1	0	0	0	0	0
Petronia petronia	0	1	0	0	0	0
Fringilla montifringilla	2	0	0	0	0	0
Spinus spinus	3	0	0	0	0	0
Loxia curvirostra	2	0	0	0	0	0
Emberiza cia	1	0	0	0	0	0

2.3 RULE 3: THERE ARE AT LEAST 10 OCCURRENCES IN EACH YEAR

An occurrence is non-zero observation at unique combination of site, point and date. When there are less than 10 of those occurrence in a year for a given species, then that species is too rare to fit a stable model.

Note that some species have no occurrences or few occurrence during the early years and more data from later years (tab. 2.3). Therefore we apply the rule to the most recent year first. If the year we are checking has at least 10 occurrences, we check the earlier year. Otherwise we stop the check and keep only the more recent years. This rule keeps 84 out of the remaining 130 species.

Table 2.3: Number of occurrences per year. Period with at least 10 occurrences per year. Number of relevant occurrences with the period.

scientific	2013	2014	2015	2016	2017	period	relevant
Turdus merula	363	696	811	809	785	2013-2017	3464
Columba palumbus	329	563	726	714	778	2013-2017	3110
Fringilla coelebs	305	617	637	601	656	2013-2017	2816
Corvus corone	283	530	640	578	642	2013-2017	2673
Sylvia atricapilla	189	486	470	401	471	2013-2017	2017
Alauda arvensis	259	405	444	417	379	2013-2017	1904
Phylloscopus collybita	153	373	422	414	425	2013-2017	1787
Troglodytes troglodytes	100	345	397	376	376	2013-2017	1594
Parus major	115	294	359	298	314	2013-2017	1380
Turdus philomelos	89	214	289	294	298	2013-2017	1184
Cyanistes caeruleus	73	280	330	212	286	2013-2017	1181
Sturnus vulgaris	85	204	267	265	312	2013-2017	1133
Phasianus colchicus	144	176	269	256	270	2013-2017	1115
Erithacus rubecula	49	180	289	245	292	2013-2017	1055
Emberiza citrinella	88	224	230	194	217	2013-2017	953
Streptopelia decaocto	100	144	189	158	202	2013-2017	793

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scientific	2013	2014	2015	2016	2017	period	relevant
Linaria cannabina	56	126	158	139	117	2013-2017	596
Passer domesticus	78	98	127	130	148	2013-2017	581
Luscinia megarhynchos	21	66	147	200	136	2013-2017	570
Hirundo rustica	74	70	126	144	149	2013-2017	563
Pica pica	45	71	127	120	135	2013-2017	498
Sylvia communis	55	104	80	101	119	2013-2017	459
Picus viridis	43	76	112	105	85	2013-2017	421
Motacilla alba	38	55	77	97	108	2013-2017	375
Cuculus canorus	28	105	85	81	75	2013-2017	374
Dendrocopos major	10	38	76	109	130	2013-2017	363
Garrulus glandarius	31	46	84	86	107	2013-2017	354
Prunella modularis	48	72	74	71	83	2013-2017	348
Carduelis carduelis	15	43	74	65	119	2013-2017	316
Buteo buteo	31	49	82	84	66	2013-2017	312
Perdix perdix	56	59	57	75	58	2013-2017	305
Motacilla flava	34	53	55	68	74	2013-2017	284
Sitta europaea	12	51	65	68	74	2013-2017	270
Emberiza calandra	35	30	68	58	74	2013-2017	265
Phylloscopus trochilus	9	51	57	71	83	2014-2017	262
Streptopelia turtur	30	34	51	51	59	2013-2017	225
Corvus frugilegus	33	31	42	54	59	2013-2017	219
Certhia brachydactyla	1	36	30	77	75	2014-2017	218
Chloris chloris	23	39	43	50	52	2013-2017	207
Anas platyrhynchos	10	36	50	56	52	2013-2017	204
Turdus viscivorus	13	32	36	51	48	2013-2017	180
Cisticola juncidis	0	0	61	61	58	2015-2017	180
Cettia cetti	3	6	60	56	51	2015-2017	167
Vanellus vanellus	32	37	31	33	30	2013-2017	163
Falco tinnunculus	16	16	42	41	45	2013-2017	160
Larus ridibundus	17	31	34	38	40	2013-2017	160
Regulus ignicapilla	1	26	53	28	53	2014-2017	160
Sylvia borin	16	31	35	42	29	2013-2017	153
Poecile palustris	0	17	30	55	49	2014-2017	151
Coccothraustes coccothraustes	0	16	26	48	57	2014-2017	147
Corvus monedula	15	11	34	42	42	2013-2017	144
Serinus serinus	1	1	40	47	48	2015-2017	135
Ardea cinerea	12	24	30	39	29	2013-2017	134
Acrocephalus schoenobaenus	11	22	27	33	34	2013-2017	127
Phoenicurus ochruros	6	21	29	37	40	2014-2017	127
Gallinula chloropus	18	16	31	31	24	2013-2017	120
Larus michahellis	0	0	36	47	35	2015-2017	118
Oriolus oriolus	1	13	39	30	34	2014-2017	116
Saxicola rubicola	5	15	29	33	32	2014-2017	109
Fulica atra	7	19	33	22	33	2014-2017	107
Milvus migrans	1	20	24	22	39	2014-2017	105
Sylvia melanocephala	0	0	27	37	37	2015-2017	101
Larus argentatus	15	14	25	24	20	2013-2017	98
Regulus regulus	1	11	25	36	25	2014-2017	97
Aegithalos caudatus	3	11	18	23	38	2014-2017	90
Pyrrhula pyrrhula	5	8	19	38	30	2015-2017	87

scientific	2013	2014	2015	2016	2017	period	relevant
Apus apus	7	1	25	38	23	2015-2017	86
Lullula arborea	0	0	31	25	25	2015-2017	81
Acrocephalus scirpaceus	8	9	24	27	17	2015-2017	68
Galerida cristata	0	0	19	23	20	2015-2017	62
Cygnus olor	3	13	13	17	10	2014-2017	53
Sylvia curruca	1	12	6	21	30	2016-2017	51
Tadorna tadorna	3	5	14	17	14	2015-2017	45
Egretta garzetta	8	8	19	14	12	2015-2017	45
Columba livia	0	8	13	10	18	2015-2017	41
Upupa epops	0	0	14	12	10	2015-2017	36
Anthus pratensis	1	9	15	11	10	2015-2017	36
Jynx torquilla	0	0	6	17	16	2016-2017	33
Anthus trivialis	1	10	8	14	18	2016-2017	32
Circus aeruginosus	2	1	8	16	13	2016-2017	29
Periparus ater	0	7	6	14	13	2016-2017	27
Dryocopus martius	0	1	5	15	12	2016-2017	27
Delichon urbicum	6	11	12	9	11	2017-2017	11
Phalacrocorax carbo	19	11	12	9	10	2017-2017	10
Circus cyaneus	4	5	6	3	9	NA	NA
Emberiza schoeniclus	1	11	9	13	8	NA	NA
Hippolais polyglotta	1	4	6	3	8	NA	NA
Sylvia cantillans	0	0	5	9	7	NA	NA
Himantopus himantopus	2	5	11	7	7	NA	NA
Certhia familiaris	0	0	3	9	5	NA	NA
Phylloscopus sibilatrix	0	3	3	7	5	NA	NA
Alectoris rufa	0	0	2	6	5	NA	NA
Ciconia ciconia	6	3	4	3	5	NA	NA
Emberiza hortulana	0	0	4	7	4	NA	NA
Coturnix coturnix	5	4	7	4	4	NA	NA
Anas strepera	0	0	3	2	4	NA	NA
Riparia riparia	2	0	0	2	4	NA	NA
Passer montanus	0	3	3	5	3	NA	NA
Anser anser	0	0	2	5	3	NA	NA
Luscinia svecica	0	4	1	5	3	NA	NA
Turdus pilaris	0	4	6	4	3	NA	NA
Panurus biarmicus	0	0	5	4	3	NA	NA
Ardea alba	0	0	4	4	3	NA	NA
Charadrius hiaticula	2	4	5	3	3	NA	NA
Oenanthe oenanthe	6	7	3	3	3	NA	NA
Recurvirostra avosetta	1	2	3	3	3	NA	NA
Alopochen aegyptiaca	0	2	2	3	3	NA	NA
Locustella naevia	0	4	2	2	3	NA	NA
Numenius arquata	0	3	1	2	3	NA	NA
Oenanthe hispanica	0	0	1	6	2	NA	NA
Acrocephalus arundinaceus	0	1	2	5	2	NA	NA
Haematopus ostralegus	2	3	6	4	2	NA	NA
Lanius collurio	0	1	3	3	2	NA	NA
Clamator glandarius	0	0	2	3	2	NA	NA
Poecile montanus	0	5	6	2	2	NA	NA
Coracias garrulus	0	0	2	2	2	NA	NA

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scientific	2013	2014	2015	2016	2017	period	relevant
Lophophanes cristatus	0	0	1	1	2	NA	NA
Bubulcus ibis	0	0	2	4	1	NA	NA
Columba oenas	4	1	1	3	1	NA	NA
Syrmaticus reevesii	0	0	1	3	1	NA	NA
Spatula clypeata	0	1	2	2	1	NA	NA
Spatula querquedula	2	2	1	2	1	NA	NA
Podiceps cristatus	0	1	1	2	1	NA	NA
Charadrius dubius	0	0	1	2	1	NA	NA
Emberiza cirlus	0	0	4	1	1	NA	NA
Actitis hypoleucos	0	0	3	1	1	NA	NA
Tachybaptus ruficollis	4	3	2	1	1	NA	NA
Sylvia undata	0	0	1	1	1	NA	NA
Picus canus	0	2	1	0	1	NA	NA
Burhinus oedicnemus	1	0	1	2	0	NA	NA

2.4 RULE 4: THE DATA CONTAINS AT LEAST 100 OCCURRENCES

The full data should contain a reasonable amount of data. This rule removes another 22 species (tab. 2.3). The final data contains relevant observations for 62 species. We fit the models (1.1) and (1.8) to each of those species. Part II gives the results for each of those species.

3 AVAILABLE OUTPUT

3.1 TABLE WITH LINEAR TRENDS

Part II starts with table 3.1 which lists the linear trend for all species. 'model' indicates which model is best based on WAIC. L indicates that the trend is linear, which implies that the change is constant. A trend is linear when the linear model has a lower WAIC than the non-linear model. NL indicates that the trend is non-linear. The change between consecutive years is not constant. Thus one should interpret the given linear change with caution. A trend is non-linear when the WAIC of the non-linear model is more than 2 units smaller than that of the linear model. When the WAIC of the non-linear model is less than 2 units smaller than the linear model, we state that the model is possibly non-linear. This is indicated as NL?. Trends of non-linear models are best interpreted based on the trend figures.

3.2 CREDIBLE INTERVALS

Because we apply a Bayesian model, all intervals are credible intervals. Credible intervals are conceptually different from confidence intervals. However, both indicate a similar uncertainty of an estimate. A layperson can use credible intervals as if they are confidence intervals. Therefore we will not elaborate on the difference between credible and confidence intervals. Just know that they are credible intervals, not confidence intervals.

3.3 TREND CLASSIFICATION

We compare the 95% credible intervals with a reference, upper and lower threshold to classify the strength of the effect into 10 classes. The change of a linear trend is converted into a change over the length of the data. The change of an index is the actual change between the two years. The reference is set to 0 (no change). The credible interval of a significant effect does not contain 0. We selected a change of -25% (3/4 of the initial value) as the lower threshold. We use the complement[1] of that (+33% or 4/3 of the initial value) as the upper threshold. A -25% or +33% change over 5 years is equivalent to an average yearly change of -5.6% or +5.9% in case of a linear trend.

Below are the symbols, interpretations and rules for each of the 10 classes.

- ++ **strong increase**: A significant positive trend and significantly stronger than the upper threshold.
- +~ **moderate increase**: A significant positive trend and significantly weaker than the upper threshold.
- + **increase**: A significant positive trend, not significantly different from the upper threshold.
- ~ **stable**: A non-significant trend and significantly between the lower and upper threshold.
- − **increase**: A significant negative trend, not significantly different from the lower threshold.
- −~ **moderate decrease**: A significant negative trend and significantly weaker than the lower threshold.
- −− **strong decrease**: A significant negative trend and significantly stronger than the lower threshold.

[1] $\log(3/4) = -0.2877$ and $\log(4/3) = 0.2877$

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- ?+ **potential increase**: A non-significant trend, significantly above the lower threshold.
- ?- **potential decrease**: A non-significant trend, significantly above the upper threshold.
- ? **unknown**: A non-significant trend, both the lower and upper threshold are probable.

One of the benefits is that we distinguish ~ (stable) and ? (unknown). Both are non-significant. The main difference between both cases is the uncertainty. We set the thresholds at important changes. If the uncertainty is large, then the credible interval contains both the lower and the upper threshold. So we have no clue what is happening, hence the unknown class. If the uncertainty is small, then the credible interval contains neither the lower nor the upper threshold. In this case we do known that the change is less extreme that the thresholds. So if there is a change, it will be smaller than important changes (the thresholds). This is informative, even though the change is not significant.

3.4 FIGURES

Each modelled species gets its own chapter with results. All results are display in a graphical format.

3.4.1 Estimated number of birds

The results start with a figure showing the estimated number of birds an observer would encounter at an average point on an average site during the first period. The line displays the point estimate for each year. This is the most likely value for the average number of birds. The three ribbons display the uncertainty around this point estimate. They are, from small/dark to wide/light, the 30%, 60% and 90% credible intervals. These numbers in the figure are always based on the non-linear model (1.1). The caption indicates whether the model is non-linear and how strong the linear trend is.

3.4.2 Indices

An index is a change compared to a baseline. This baseline is typically the estimate for some reference winter. E.g we use 2014 as a baseline and compare 2015 with 2013 or 2016 with 2014. However we cannot use the figure with 2014 as baseline to compare 2015 with 2016. For that we need a figure with either 2015 or 2016 as baseline. To facilitate any pairwise comparison among years, we display one figure for every winter using that winter as baseline.

3.4.3 Index raster

Currently a separate index figure for each reference winter is doable since the data contains only 5 winters. The number of index figures will grow over the years, making it harder to interpret them. The third plot summarises the information on a raster. The x axis holds the winter we want to interpret. The y axis holds the reference winter The dots given the relative change from the baseline (y axis) to the other winter (x axis). Their colour indicates the strength of the change. Stronger changes have darker dots, white dots indicate no change. Red dots indicate a decrease from the baseline, blue dots an increase. A baseline with all red (blue) dots indicates the winter with the largest (smallest) numbers. The shape of the dots indicates the classification of the effect. Informative dots (significant or non-significant but stable) get solid shapes.

Part II

Trends

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Table 3.1: Average yearly change according to a linear model. Model indicates with model is appropriate. L a linear model is best, NL a non-linear model is best. NL? a non-linear is possibly better.

euring	scientific	french	class	model	change
15910	*Passer domesticus*	Moineau domestique	++	NL	24.5%, (18.0%; 31.3%)
13120	*Phylloscopus trochilus*	Pouillot fitis	+	NL?	14.7%, (4.6%; 26.1%)
1860	*Anas platyrhynchos*	Canard colvert	+	L	12.7%, (1.1%; 25.6%)
3670	*Perdix perdix*	Perdrix grise	+	NL?	9.1%, (2.8%; 15.8%)
11870	*Turdus merula*	Merle noir	+	NL?	8.0%, (5.8%; 10.2%)
9920	*Hirundo rustica*	Hirondelle rustique	+	NL	7.2%, (1.4%; 13.4%)
16360	*Fringilla coelebs*	Pinson des arbres	+	NL	6.8%, (4.5%; 9.2%)
10990	*Erithacus rubecula*	Rougegorge familier	+	NL?	6.4%, (1.8%; 11.3%)
6840	*Streptopelia decaocto*	Tourterelle turque	+	L	5.8%, (1.3%; 10.5%)
12770	*Sylvia atricapilla*	Fauvette a tete noire	+	L	5.0%, (2.1%; 8.1%)
14640	*Parus major*	Mesange charbonniere	+	NL	4.5%, (0.9%; 8.4%)
6700	*Columba palumbus*	Pigeon ramier	+	NL	3.8%, (1.4%; 6.3%)
13110	*Phylloscopus collybita*	Pouillot veloce	~	L	2.6%, (-0.7%; 5.9%)
15670	*Corvus corone*	Corneille noire	~	NL?	2.3%, (-0.3%; 5.1%)
9760	*Alauda arvensis*	Alouette des champs	~	L	2.0%, (-0.3%; 4.4%)
10660	*Troglodytes troglodytes*	Troglodyte mignon	~	NL?	1.8%, (-1.7%; 5.4%)
18570	*Emberiza citrinella*	Bruant jaune	~	NL?	0.4%, (-3.8%; 4.7%)
3940	*Phasianus colchicus*	Faisan de Colchide	~	NL?	0.3%, (-3.2%; 4.0%)
5926	*Larus michahellis*	Goeland leucophee	-	L	-16.5%, (-30.3%; -0.0%)
16400	*Serinus serinus*	Serin cini	?+	L	12.3%, (-3.5%; 30.9%)
15600	*Corvus monedula*	Choucas des tours	?+	L	9.9%, (-1.9%; 23.1%)
5820	*Larus ridibundus*	Mouette rieuse	?+	L	9.6%, (-4.6%; 26.1%)
8760	*Dendrocopos major*	Pic epeiche	?+	L	8.4%, (-0.7%; 18.5%)
13150	*Regulus ignicapilla*	Roitelet a triple bandeau	?+	L	7.2%, (-5.4%; 21.7%)
18820	*Emberiza calandra*	Bruant proyer	?+	NL?	6.2%, (-1.8%; 14.8%)
14790	*Sitta europaea*	Sittelle torchepot	?+	L	5.0%, (-4.1%; 15.0%)
16600	*Linaria cannabina*	Linotte melodieuse	?+	NL?	4.9%, (-0.5%; 10.6%)
15820	*Sturnus vulgaris*	Etourneau sansonnet	?+	NL	4.8%, (-0.8%; 10.6%)
16490	*Chloris chloris*	Verdier d'Europe	?+	L	4.6%, (-4.3%; 14.6%)
16530	*Carduelis carduelis*	Chardonneret elegant	?+	L	4.2%, (-2.6%; 11.7%)
10170	*Motacilla flava*	Bergeronnette printaniere	?+	L	4.2%, (-2.8%; 11.8%)
15490	*Pica pica*	Pie bavarde	?+	L	3.9%, (-2.3%; 10.5%)
12000	*Turdus philomelos*	Grive musicienne	?+	L	3.7%, (-0.5%; 8.0%)
10840	*Prunella modularis*	Accenteur mouchet	?+	L	3.6%, (-3.8%; 11.6%)
11040	*Luscinia megarhynchos*	Rossignol philomele	?+	NL?	3.3%, (-3.1%; 10.2%)
7240	*Cuculus canorus*	Coucou gris	?+	L	2.9%, (-4.9%; 11.5%)
12750	*Sylvia communis*	Fauvette grisette	?+	L	2.7%, (-3.3%; 9.2%)
14620	*Cyanistes caeruleus*	Mesange bleue	?+	L	2.4%, (-1.5%; 6.4%)
10200	*Motacilla alba*	Bergeronnette grise	?+	L	1.9%, (-5.0%; 9.3%)
15390	*Garrulus glandarius*	Geai des chenes	?-	L	-2.2%, (-9.0%; 5.3%)
15630	*Corvus frugilegus*	Corbeau freux	?-	NL	-6.9%, (-18.0%; 5.7%)
14400	*Poecile palustris*	Mesange nonnette	?	L	5.9%, (-8.3%; 22.9%)
17170	*Coccothraustes coccothraustes*	Grosbec casse-noyaux	?	NL?	5.6%, (-7.0%; 20.4%)
1870	*Certhia brachydactyla*	Grimpereau des jardins	?	L	4.8%, (-6.8%; 18.2%)
12670	*Sylvia melanocephala*	Fauvette melanocephale	?	NL?	3.0%, (-16.4%; 27.4%)
4290	*Fulica atra*	Foulque macroule	?	NL?	2.3%, (-11.7%; 18.8%)

euring	scientific	french	class	model	change
11210	*Phoenicurus ochruros*	Rougequeue noir	?	L	1.7%, (-12.8%; 19.0%)
12020	*Turdus viscivorus*	Grive draine	?	L	1.2%, (-8.9%; 12.6%)
2870	*Buteo buteo*	Buse variable	?	L	0.9%, (-7.2%; 9.9%)
8561	*Picus viridis*	Pic vert	?	L	-0.1%, (-7.2%; 7.6%)
3040	*Falco tinnunculus*	Faucon crecerelle	?	L	-0.3%, (-11.1%; 12.2%)
12260	*Cisticola juncidis*	Cisticole des joncs	?	NL	-0.9%, (-13.7%; 13.7%)
12760	*Sylvia borin*	Fauvette des jardins	?	L	-1.2%, (-12.7%; 12.0%)
4240	*Gallinula chloropus*	Gallinule poule-d'eau	?	L	-1.6%, (-13.4%; 12.1%)
11390	*Saxicola rubicola*	Tarier patre	?	L	-1.8%, (-16.5%; 15.7%)
6870	*Streptopelia turtur*	Tourterelle des bois	?	L	-2.2%, (-10.4%; 7.0%)
15080	*Oriolus oriolus*	Loriot d'Europe	?	L	-2.3%, (-18.3%; 16.8%)
12430	*Acrocephalus schoenobaenus*	Phragmite des joncs	?	NL?	-2.4%, (-12.4%; 8.8%)
4930	*Vanellus vanellus*	Vanneau huppe	?	NL	-2.5%, (-11.4%; 7.2%)
2380	*Milvus migrans*	Milan noir	?	NL	-2.9%, (-15.4%; 11.6%)
12200	*Cettia cetti*	Bouscarle de Cetti	?	NL?	-5.4%, (-19.4%; 10.7%)
1220	*Ardea cinerea*	Heron cendre	?	L	-5.7%, (-16.4%; 6.5%)

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4 *ARDEA CINEREA* (HERON CENDRE)

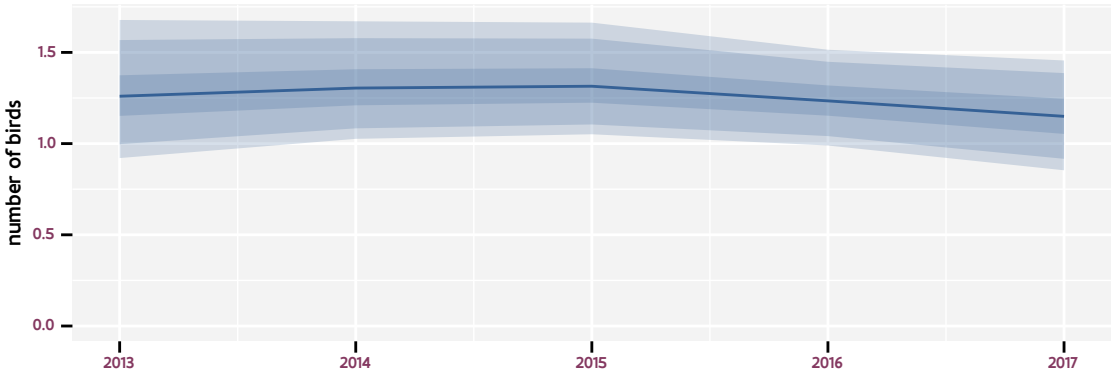

Figure 4.1: Estimated number of birds for an average point for *Ardea cinerea* (Heron cendre) based on a non-linear model. The linear yearly change (?) is -5.7% (-16.4%; +6.5%). The trend is linear.

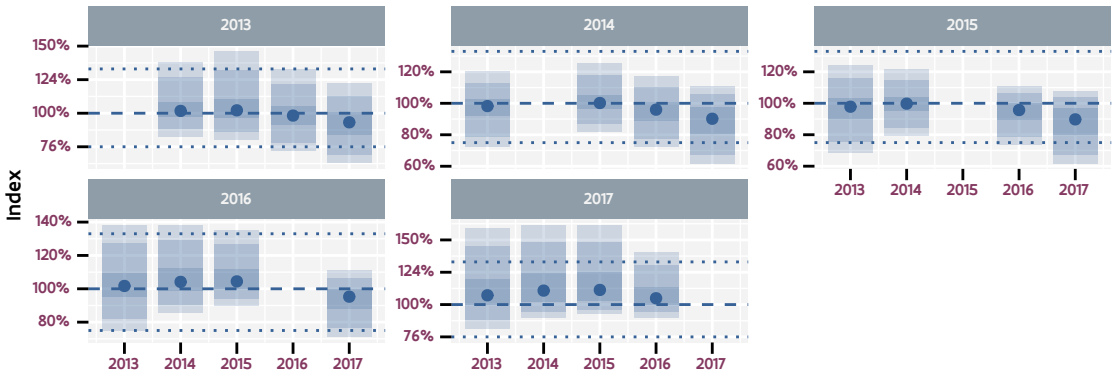

Figure 4.2: Indices for different reference years.

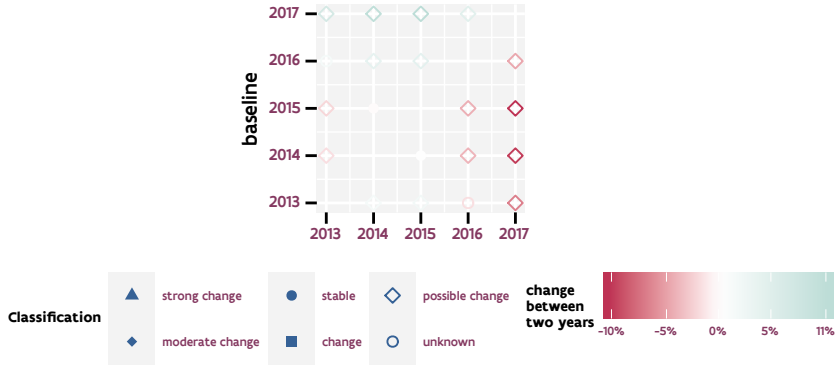

Figure 4.3: Relative change between years

5 *ANAS PLATYRHYNCHOS* (CANARD COLVERT)

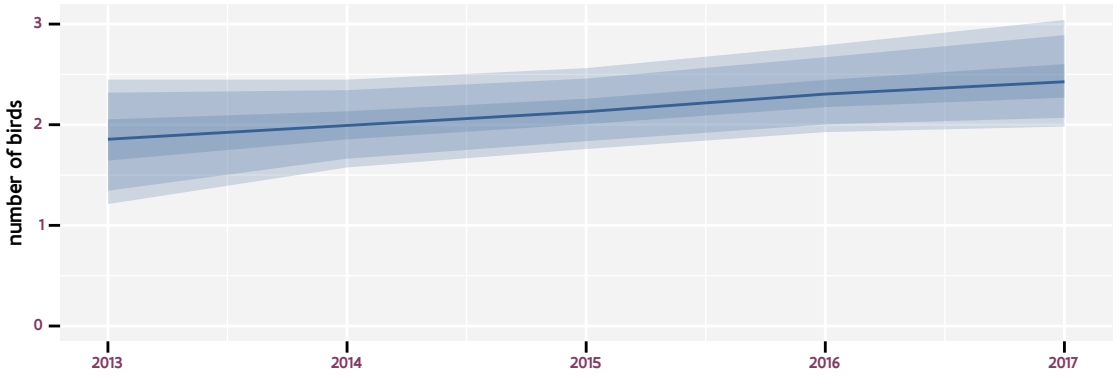

Figure 5.1: Estimated number of birds for an average point for *Anas platyrhynchos* (Canard colvert) based on a non-linear model. The linear yearly change (+) is +12.7% (+1.1%; +25.6%). The trend is linear.

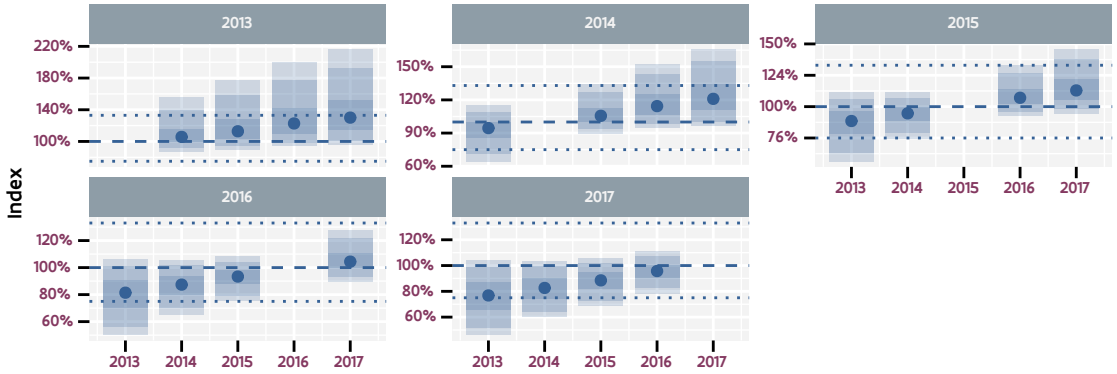

Figure 5.2: Indices for different reference years.

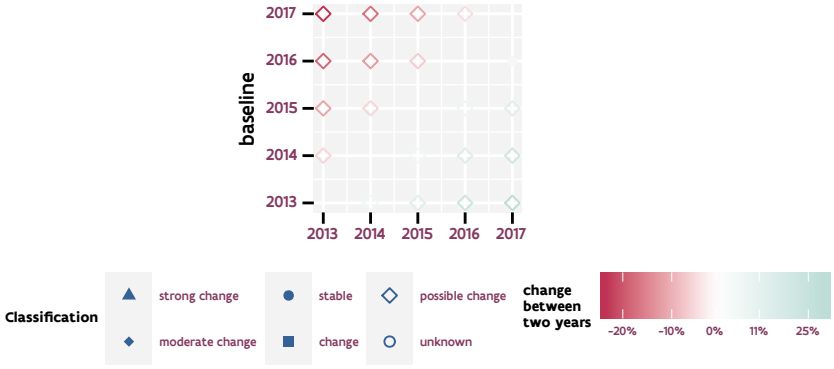

Figure 5.3: Relative change between years

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6 *CERTHIA BRACHYDACTYLA* (GRIMPEREAU DES JARDINS)

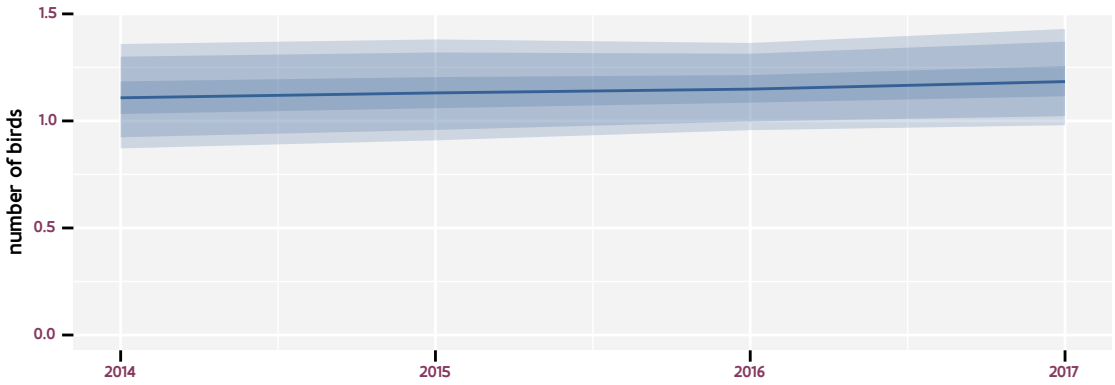

Figure 6.1: Estimated number of birds for an average point for *Certhia brachydactyla* (Grimpereau des jardins) based on a non-linear model. The linear yearly change (?) is +4.8% (-6.8%; +18.2%). The trend is linear.

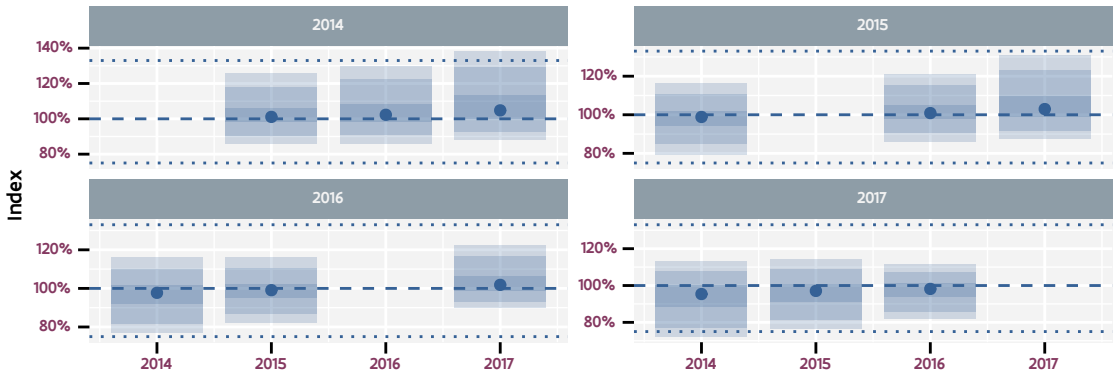

Figure 6.2: Indices for different reference years.

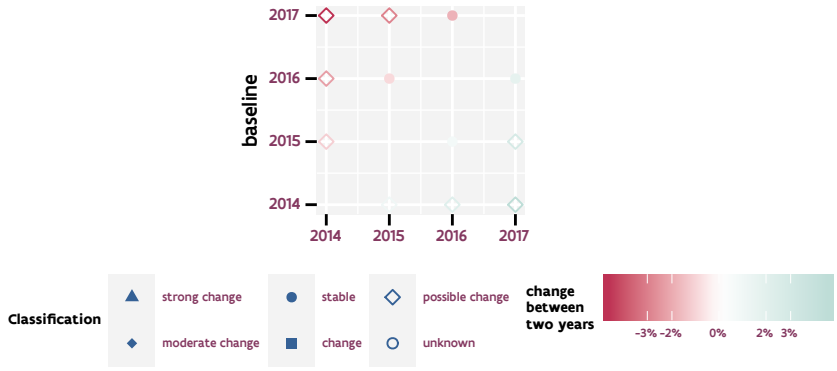

Figure 6.3: Relative change between years

7 *MILVUS MIGRANS* (MILAN NOIR)

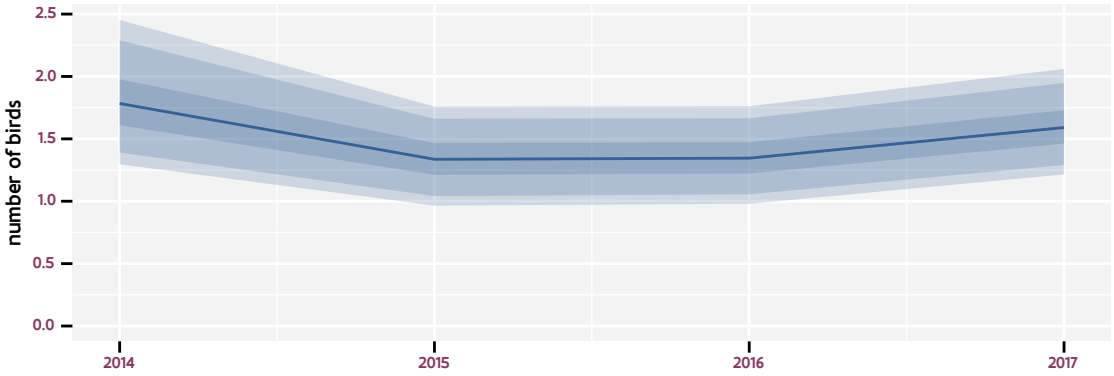

Figure 7.1: Estimated number of birds for an average point for *Milvus migrans* (Milan noir) based on a non-linear model. The linear yearly change (?) is -2.9% (-15.4%; +11.6%). The trend is non-linear.

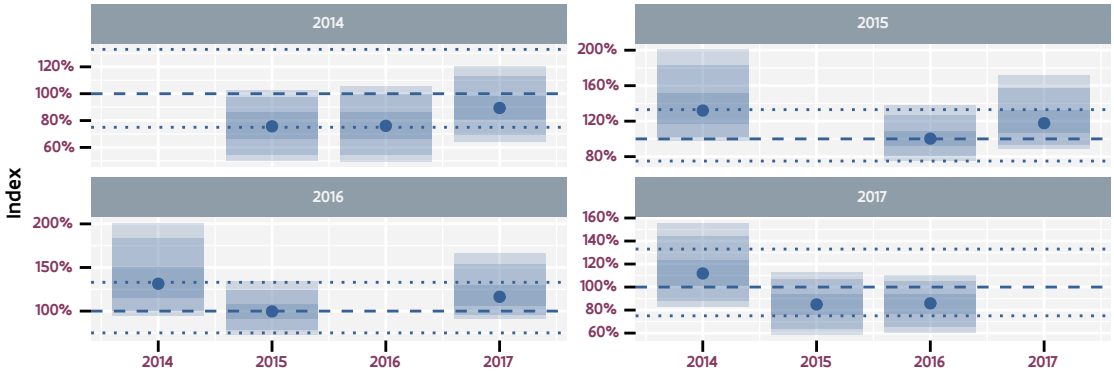

Figure 7.2: Indices for different reference years.

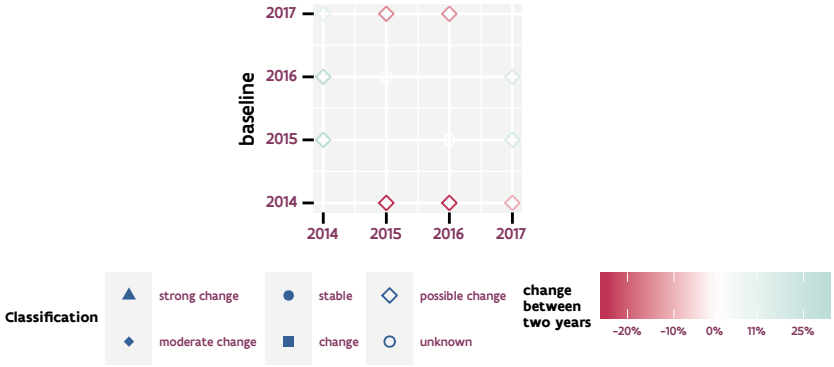

Figure 7.3: Relative change between years

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8 *BUTEO BUTEO* (BUSE VARIABLE)

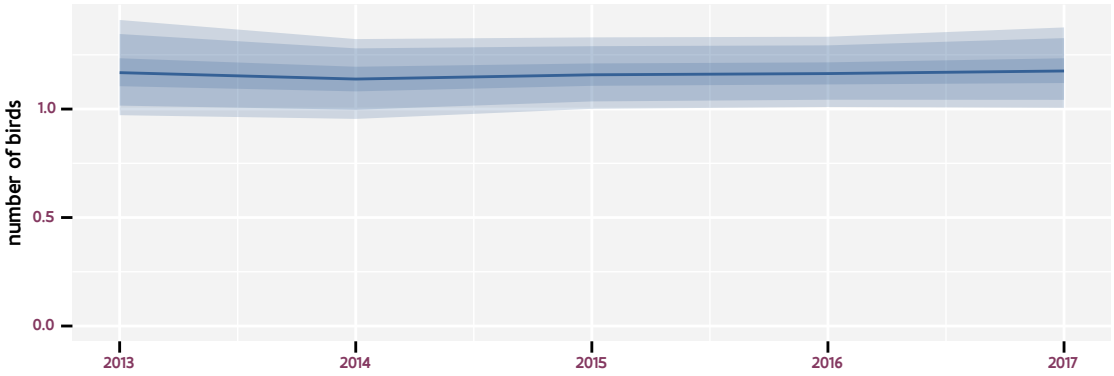

Figure 8.1: Estimated number of birds for an average point for *Buteo buteo* (Buse variable) based on a non-linear model. The linear yearly change (?) is +0.9% (-7.2%; +9.9%). The trend is linear.

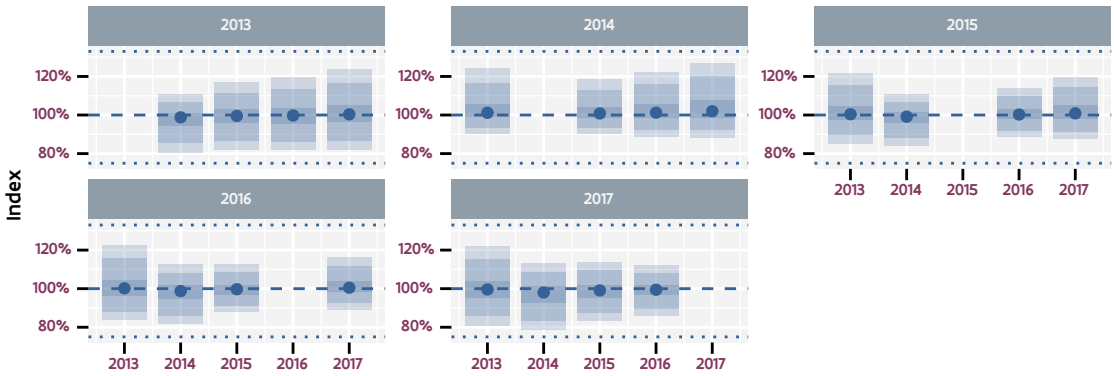

Figure 8.2: Indices for different reference years.

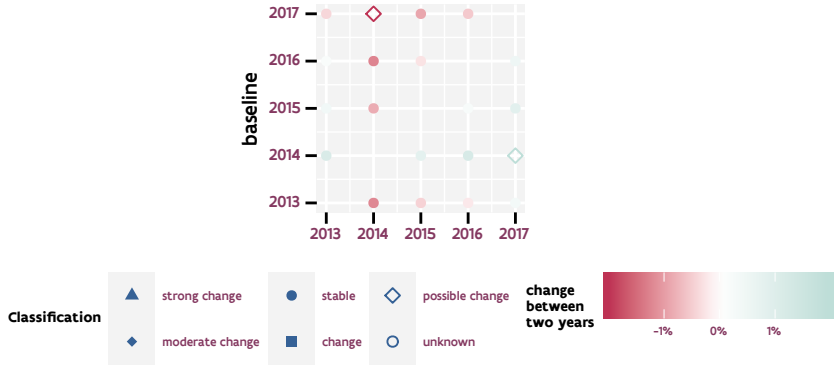

Figure 8.3: Relative change between years

9 *FALCO TINNUNCULUS* (FAUCON CRECERELLE)

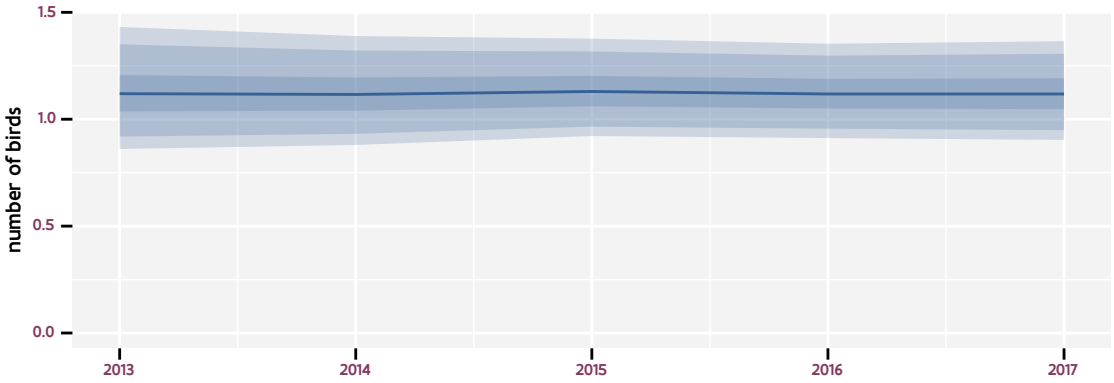

Figure 9.1: Estimated number of birds for an average point for *Falco tinnunculus* (Faucon crecerelle) based on a non-linear model. The linear yearly change (?) is -0.3% (-11.1%; +12.2%). The trend is linear.

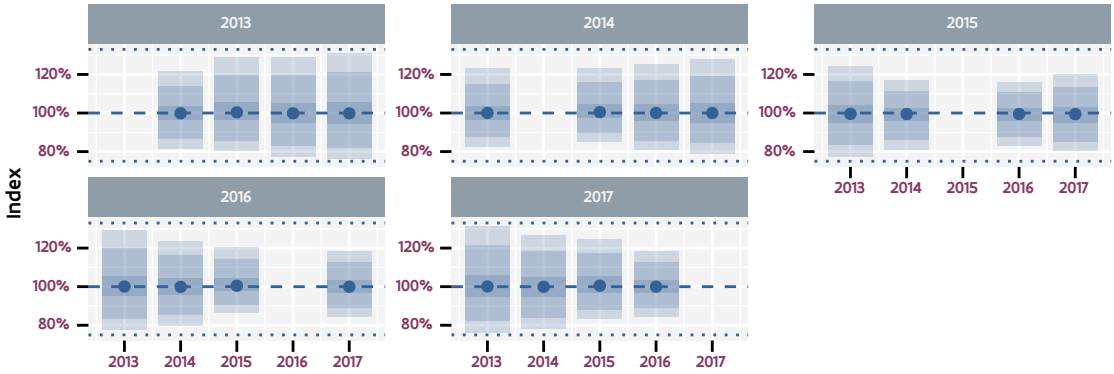

Figure 9.2: Indices for different reference years.

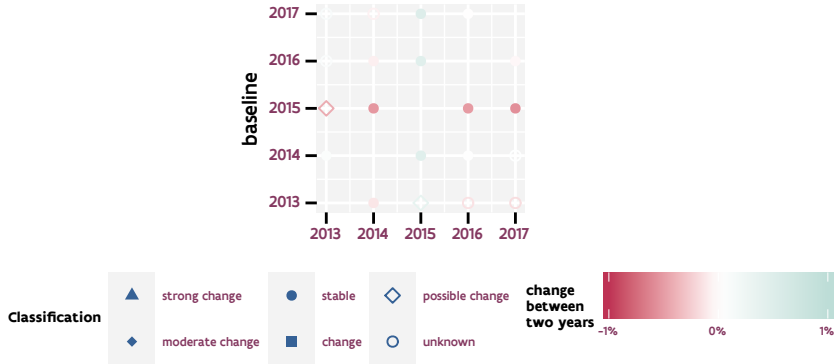

Figure 9.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

10 *PERDIX PERDIX* (PERDRIX GRISE)

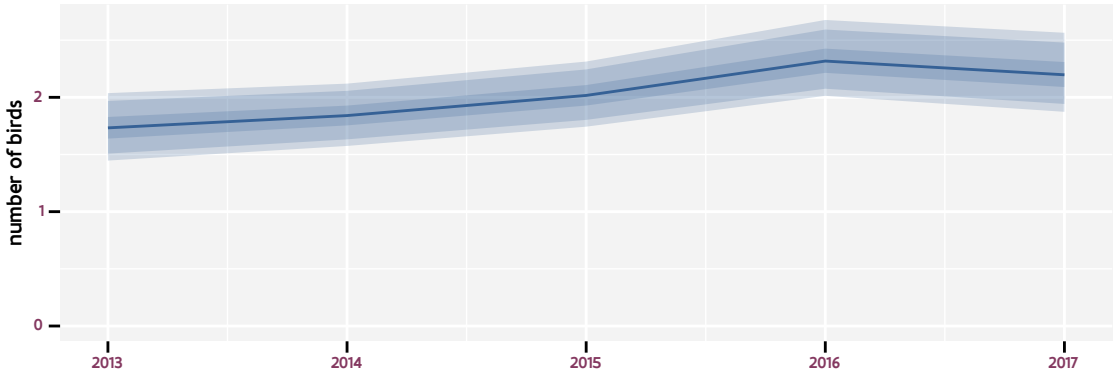

Figure 10.1: Estimated number of birds for an average point for *Perdix perdix* (Perdrix grise) based on a non-linear model. The linear yearly change (+) is +9.1% (+2.8%; +15.8%). The trend is possibly non-linear.

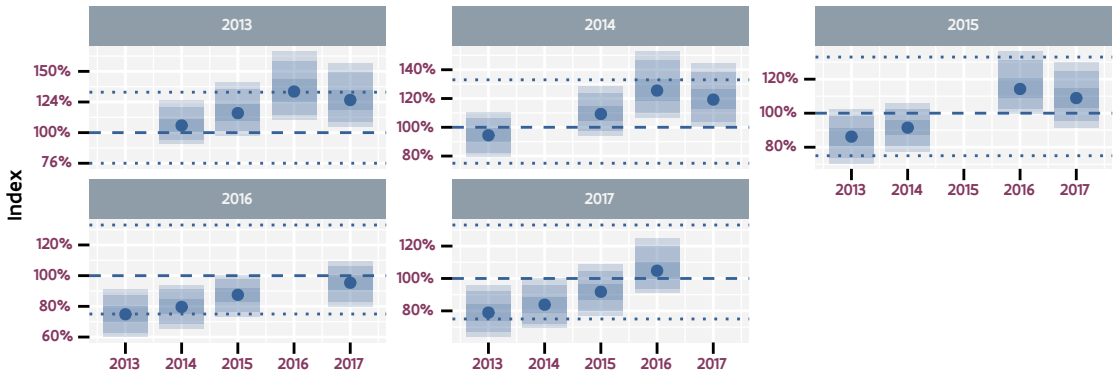

Figure 10.2: Indices for different reference years.

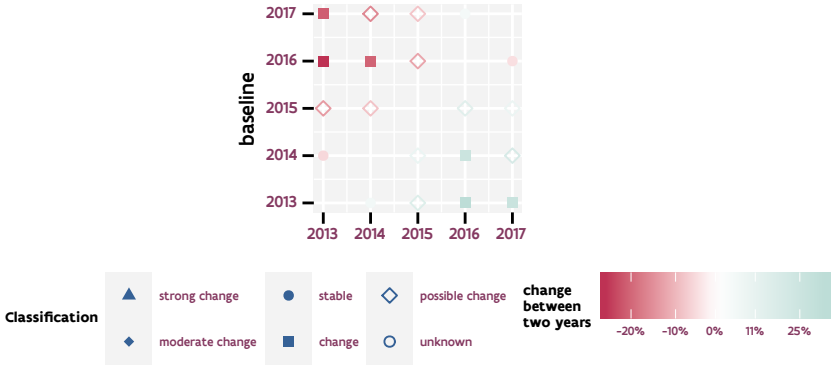

Figure 10.3: Relative change between years

11 *PHASIANUS COLCHICUS* (FAISAN DE COLCHIDE)

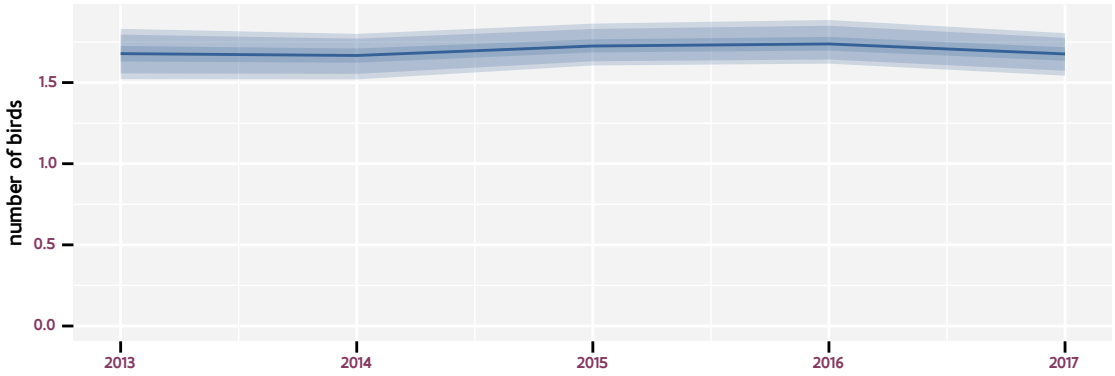

Figure 11.1: Estimated number of birds for an average point for *Phasianus colchicus* (Faisan de Colchide) based on a non-linear model. The linear yearly change (~) is +0.3% (-3.2%; +4.0%). The trend is possibly non-linear.

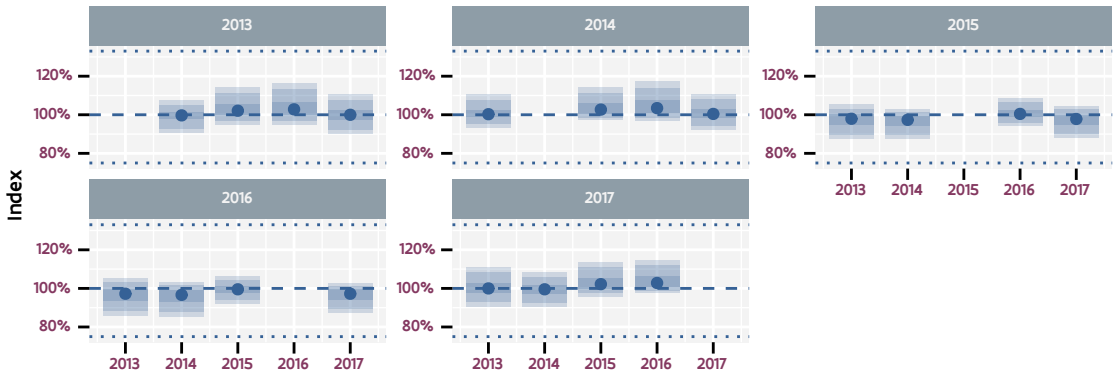

Figure 11.2: Indices for different reference years.

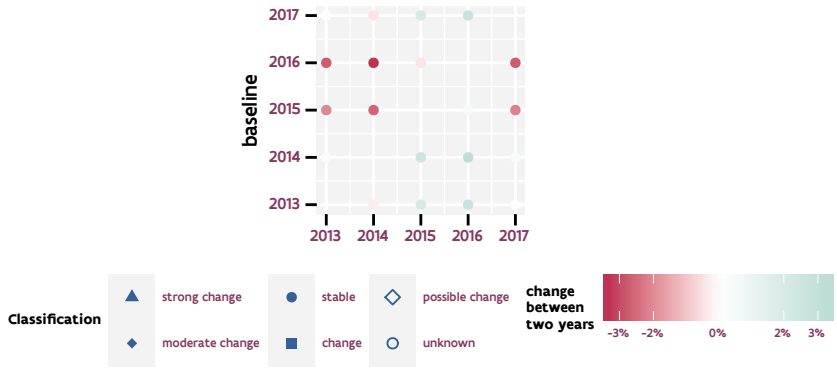

Figure 11.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

12 *GALLINULA CHLOROPUS* (GALLINULE POULE-D'EAU)

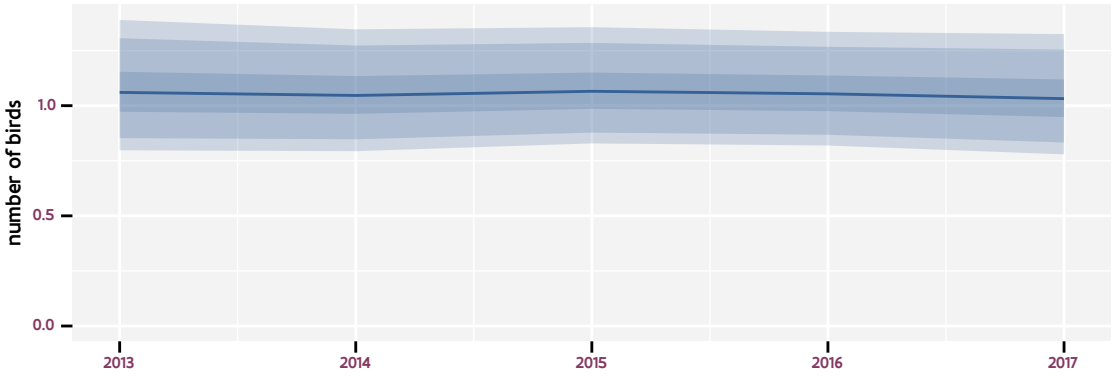

Figure 12.1: Estimated number of birds for an average point for *Gallinula chloropus* (Gallinule poule-d'eau) based on a non-linear model. The linear yearly change (?) is -1.6% (-13.4%; +12.1%). The trend is linear.

Figure 12.2: Indices for different reference years.

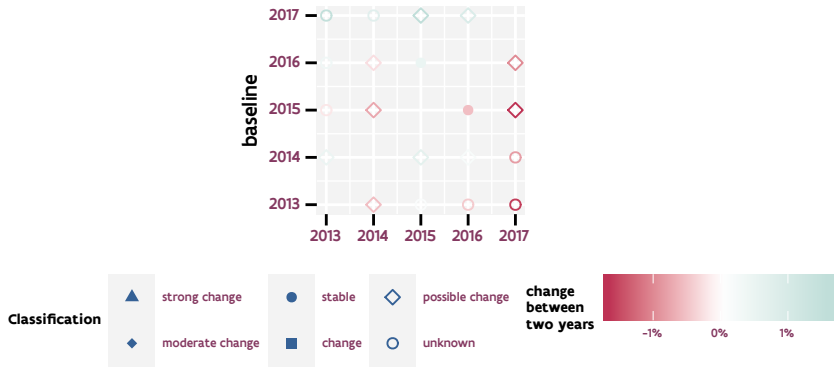

Figure 12.3: Relative change between years

13 *FULICA ATRA* (FOULQUE MACROULE)

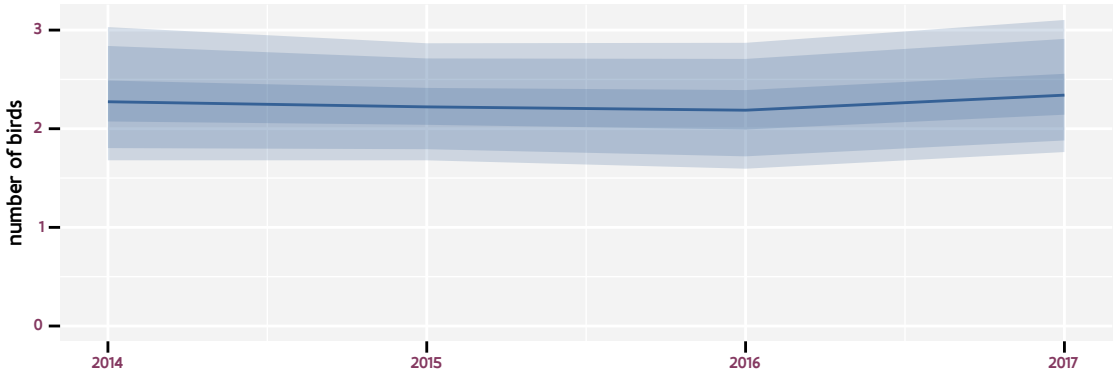

Figure 13.1: Estimated number of birds for an average point for *Fulica atra* (Foulque macroule) based on a non-linear model. The linear yearly change (?) is +2.3% (-11.7%; +18.8%). The trend is possibly non-linear.

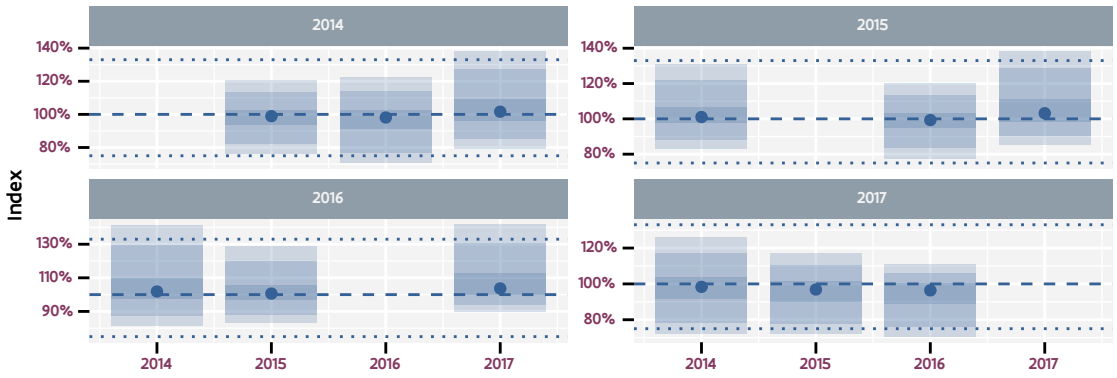

Figure 13.2: Indices for different reference years.

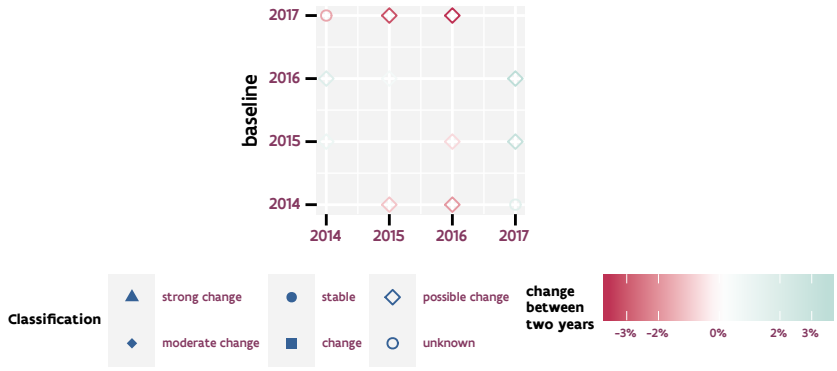

Figure 13.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

14 *VANELLUS VANELLUS* (VANNEAU HUPPE)

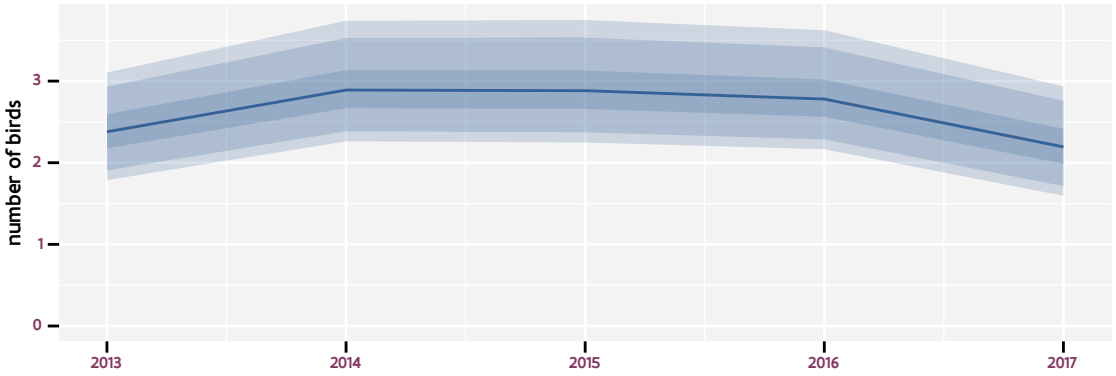

Figure 14.1: Estimated number of birds for an average point for *Vanellus vanellus* (Vanneau huppe) based on a non-linear model. The linear yearly change (?) is -2.5% (-11.4%; +7.2%). The trend is non-linear.

Figure 14.2: Indices for different reference years.

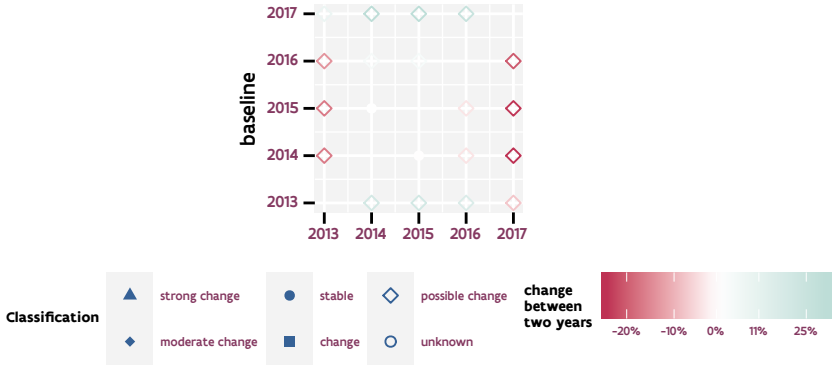

Figure 14.3: Relative change between years

15 *LARUS RIDIBUNDUS* (MOUETTE RIEUSE)

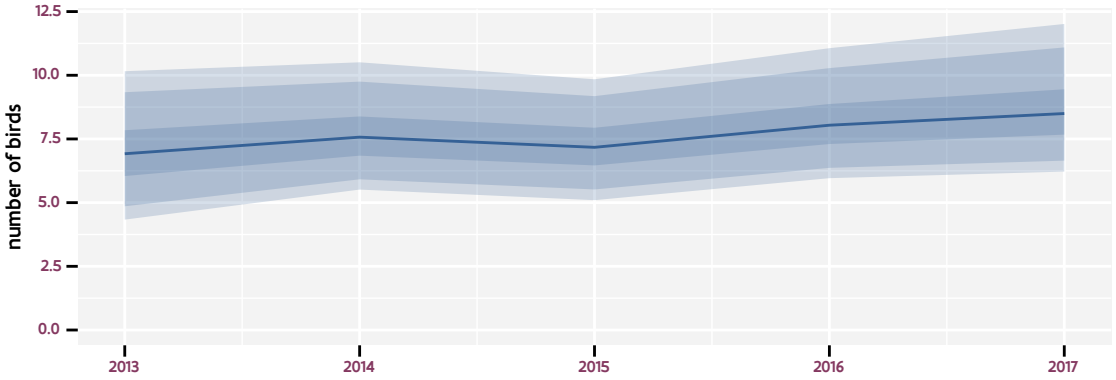

Figure 15.1: Estimated number of birds for an average point for *Larus ridibundus* (Mouette rieuse) based on a non-linear model. The linear yearly change (?+) is +9.6% (-4.6%; +26.1%). The trend is linear.

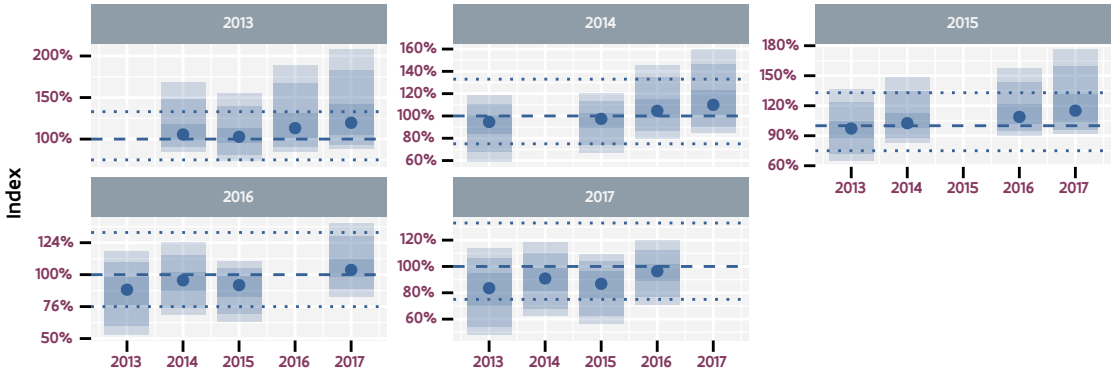

Figure 15.2: Indices for different reference years.

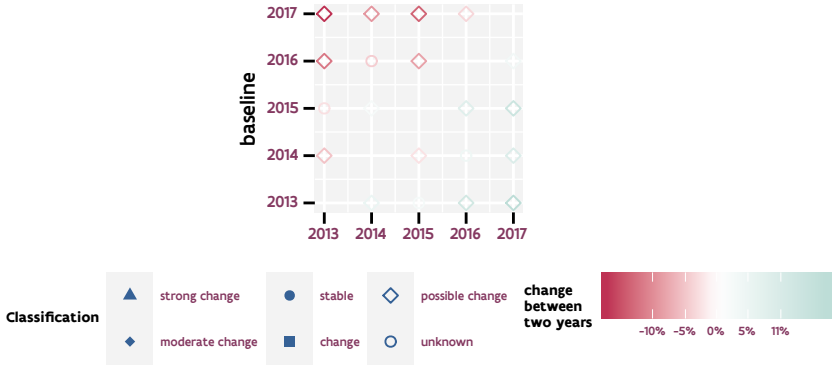

Figure 15.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

16 *LARUS MICHAHELLIS* (GOELAND LEUCOPHEE)

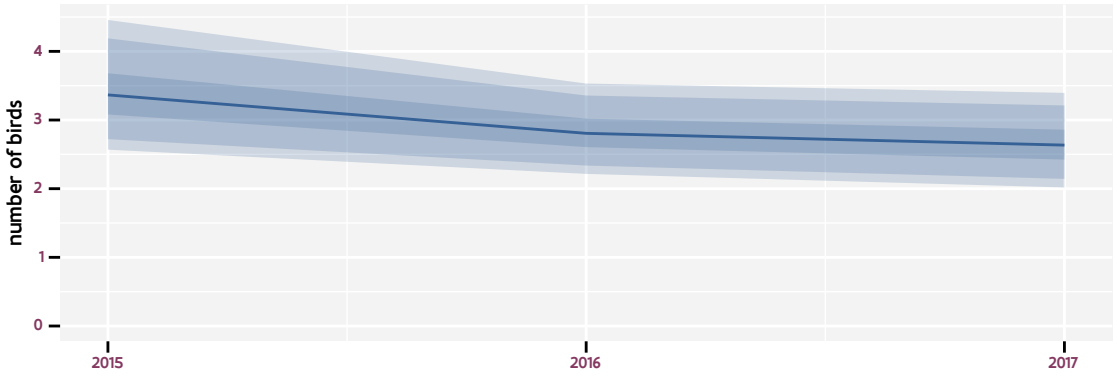

Figure 16.1: Estimated number of birds for an average point for *Larus michahellis* (Goeland leucophee) based on a non-linear model. The linear yearly change (-) is -16.5% (-30.3%; -0.0%). The trend is linear.

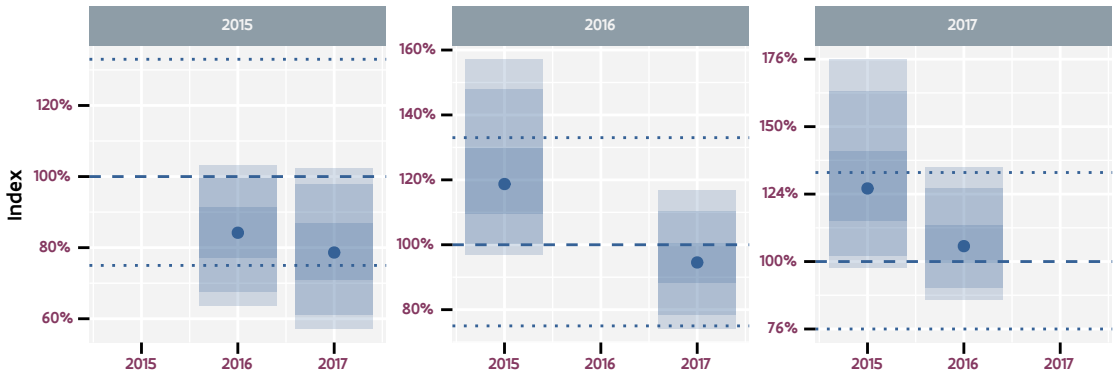

Figure 16.2: Indices for different reference years.

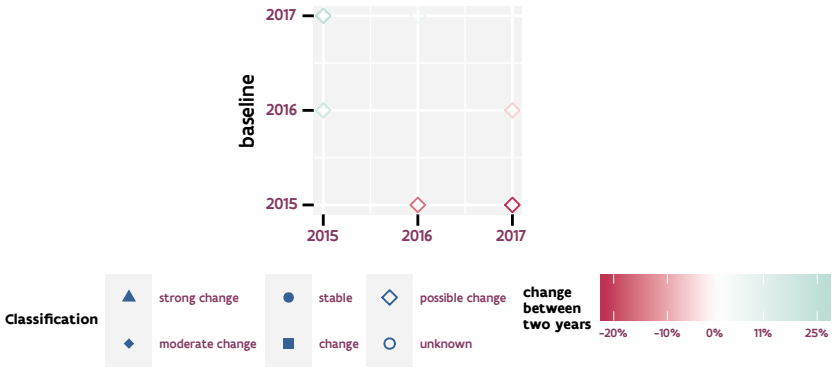

Figure 16.3: Relative change between years

17 *COLUMBA PALUMBUS* (PIGEON RAMIER)

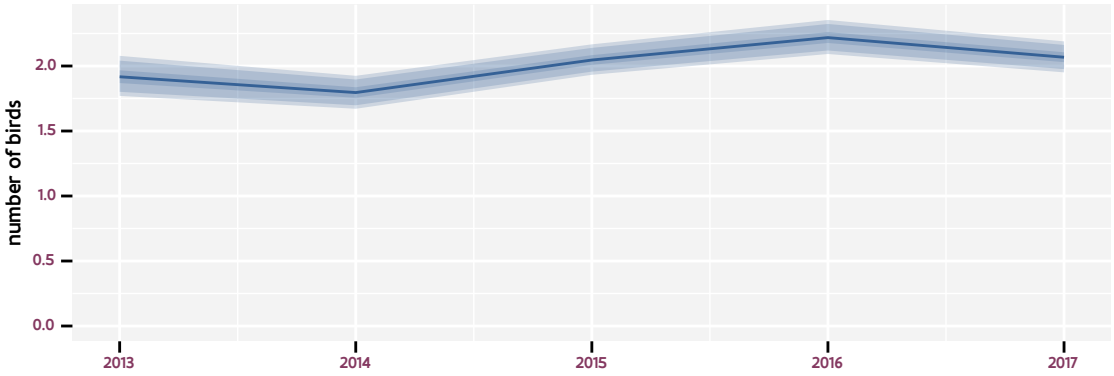

Figure 17.1: Estimated number of birds for an average point for *Columba palumbus* (Pigeon ramier) based on a non-linear model. The linear yearly change (+) is +3.8% (+1.4%; +6.3%). The trend is non-linear.

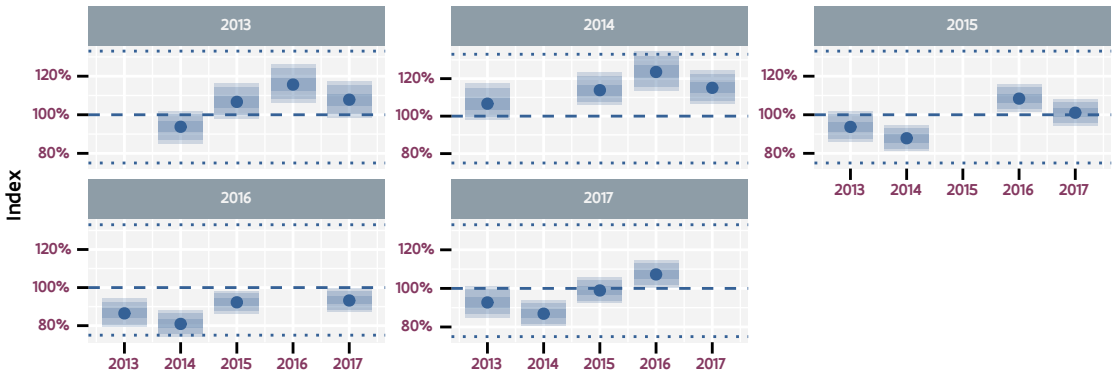

Figure 17.2: Indices for different reference years.

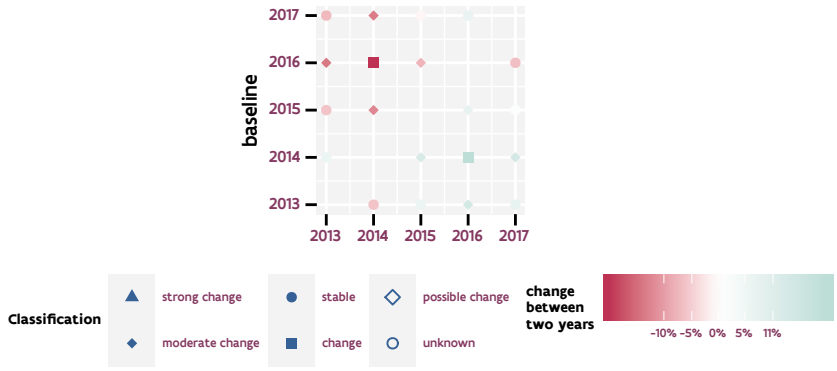

Figure 17.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

18 *STREPTOPELIA DECAOCTO* (TOURTERELLE TURQUE)

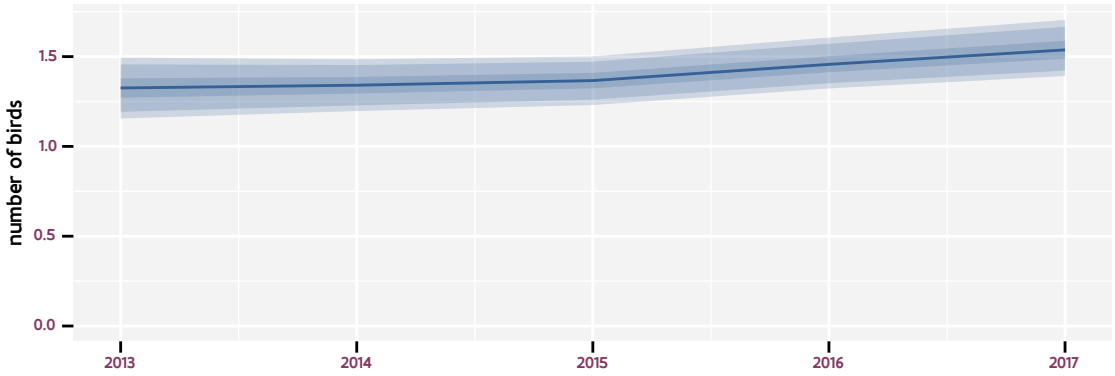

Figure 18.1: Estimated number of birds for an average point for *Streptopelia decaocto* (Tourterelle turque) based on a non-linear model. The linear yearly change (+) is +5.8% (+1.3%; +10.5%). The trend is linear.

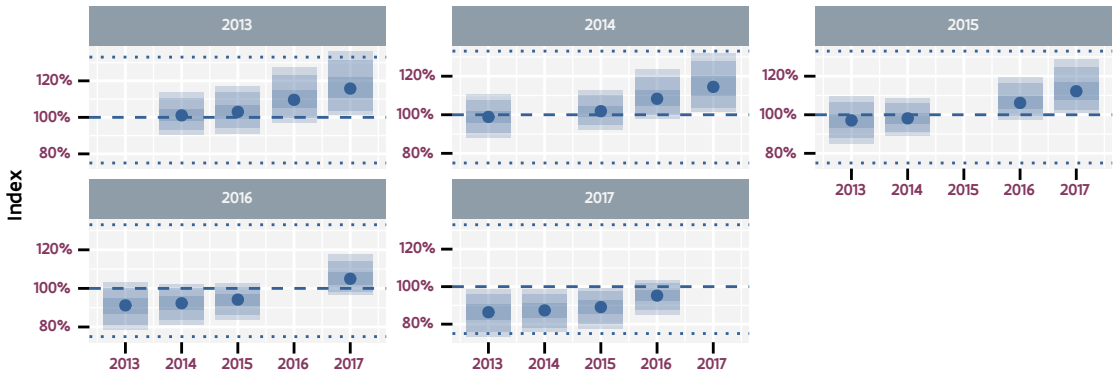

Figure 18.2: Indices for different reference years.

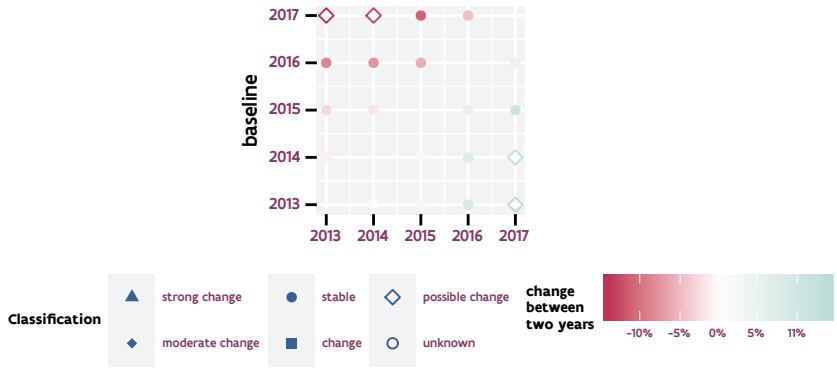

Figure 18.3: Relative change between years

19 *STREPTOPELIA TURTUR* (TOURTERELLE DES BOIS)

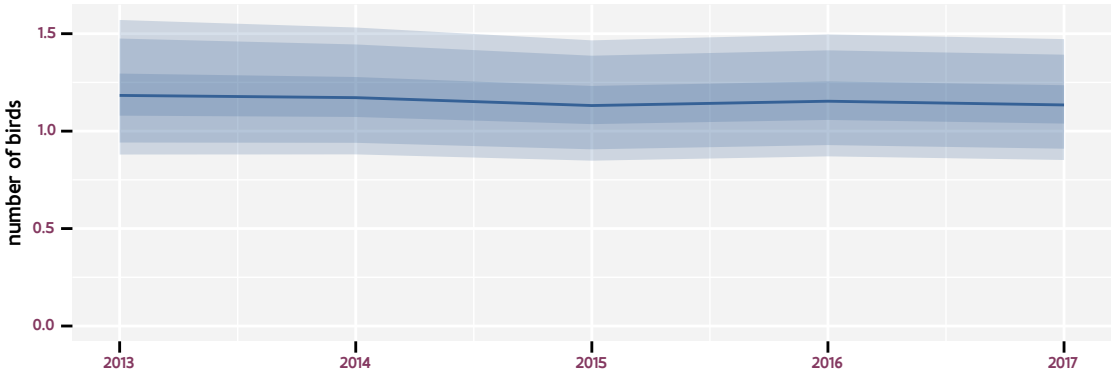

Figure 19.1: Estimated number of birds for an average point for *Streptopelia turtur* (Tourterelle des bois) based on a non-linear model. The linear yearly change (?) is -2.2% (-10.4%; +7.0%). The trend is linear.

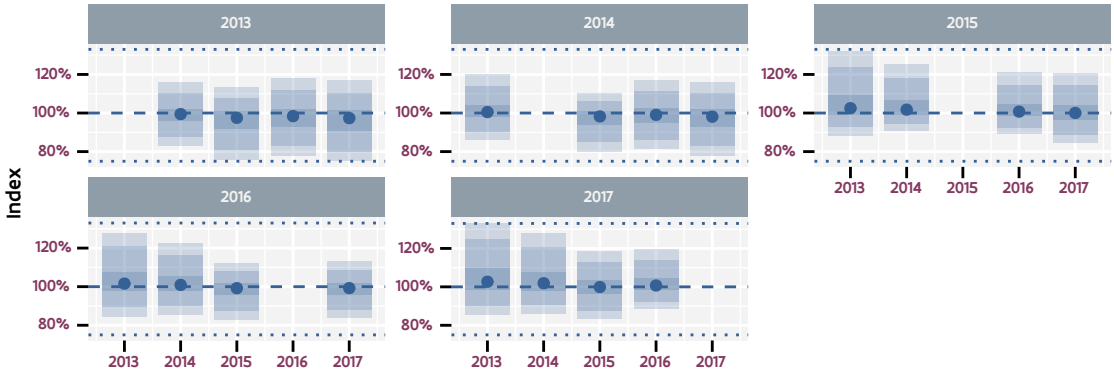

Figure 19.2: Indices for different reference years.

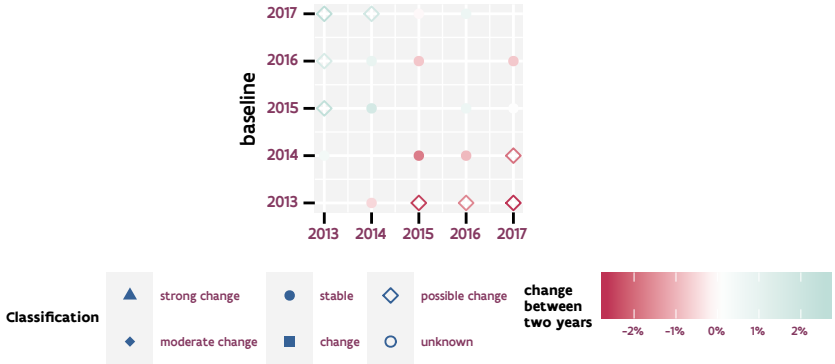

Figure 19.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

20 *CUCULUS CANORUS* (COUCOU GRIS)

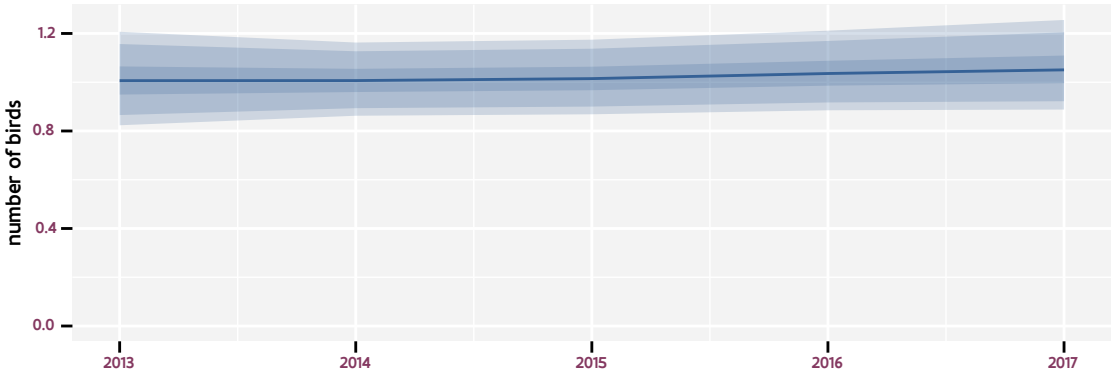

Figure 20.1: Estimated number of birds for an average point for *Cuculus canorus* (Coucou gris) based on a non-linear model. The linear yearly change (?+) is +2.9% (-4.9%; +11.5%). The trend is linear.

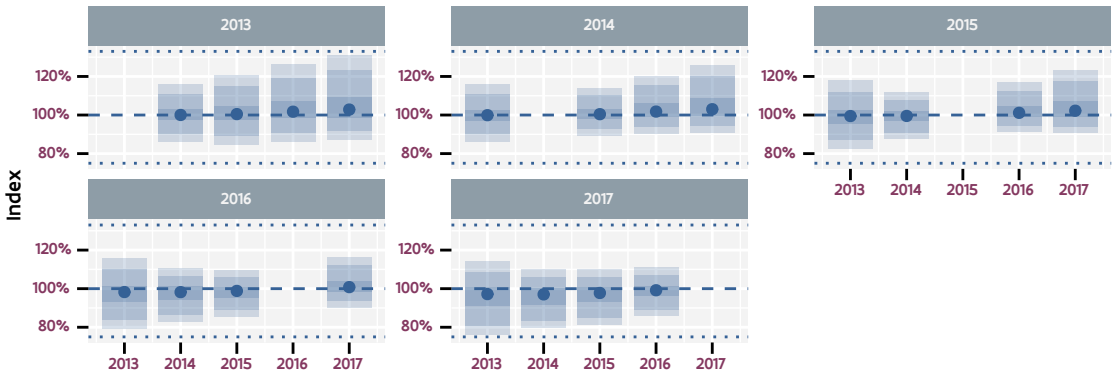

Figure 20.2: Indices for different reference years.

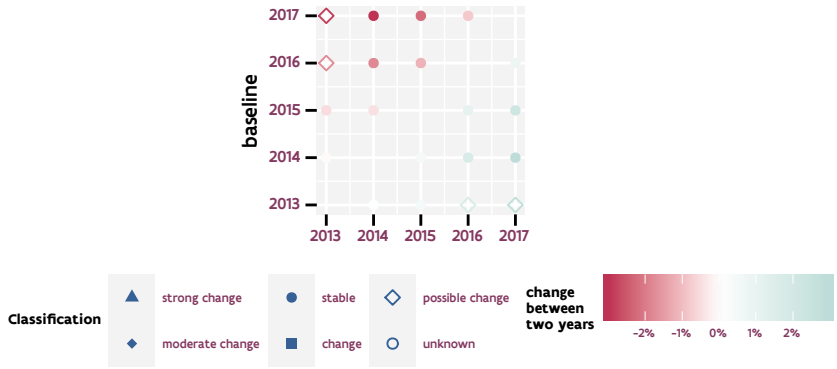

Figure 20.3: Relative change between years

21 *PICUS VIRIDIS* (PIC VERT)

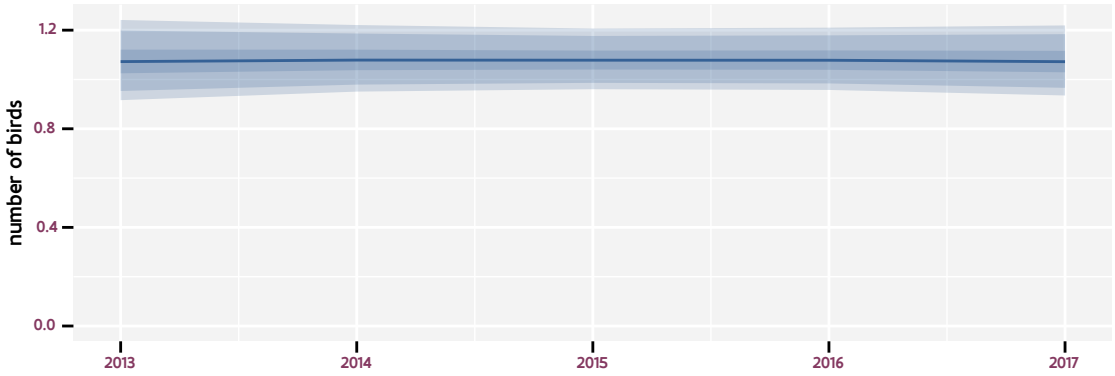

Figure 21.1: Estimated number of birds for an average point for *Picus viridis* (Pic vert) based on a non-linear model. The linear yearly change (?) is -0.1% (-7.2%; +7.6%). The trend is linear.

Figure 21.2: Indices for different reference years.

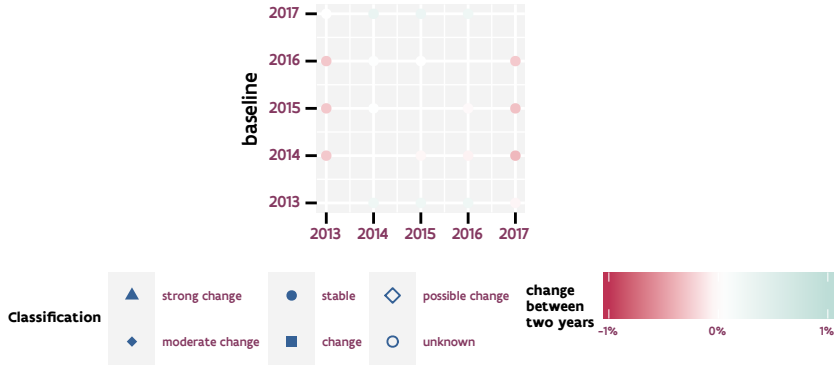

Figure 21.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

22 *DENDROCOPOS MAJOR* (PIC EPEICHE)

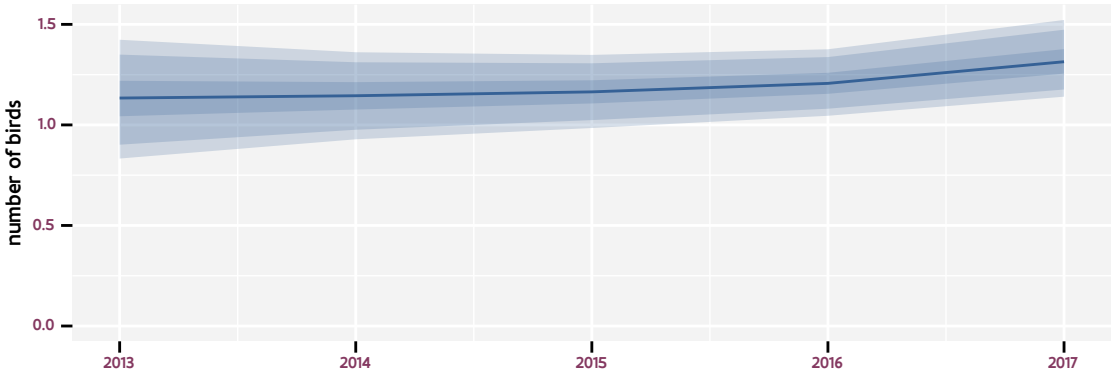

Figure 22.1: Estimated number of birds for an average point for *Dendrocopos major* (Pic epeiche) based on a non-linear model. The linear yearly change (?+) is +8.4% (-0.7%; +18.5%). The trend is linear.

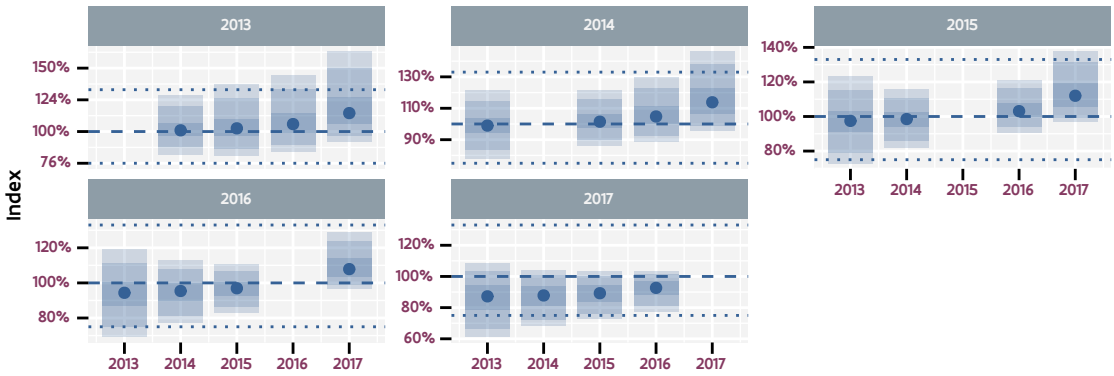

Figure 22.2: Indices for different reference years.

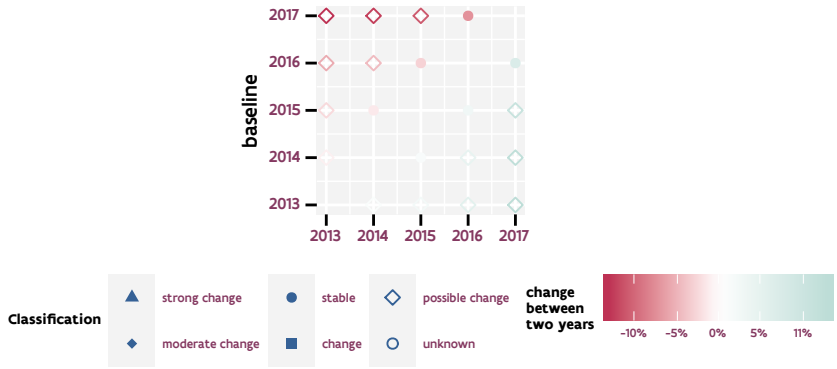

Figure 22.3: Relative change between years

23 *ALAUDA ARVENSIS* (ALOUETTE DES CHAMPS)

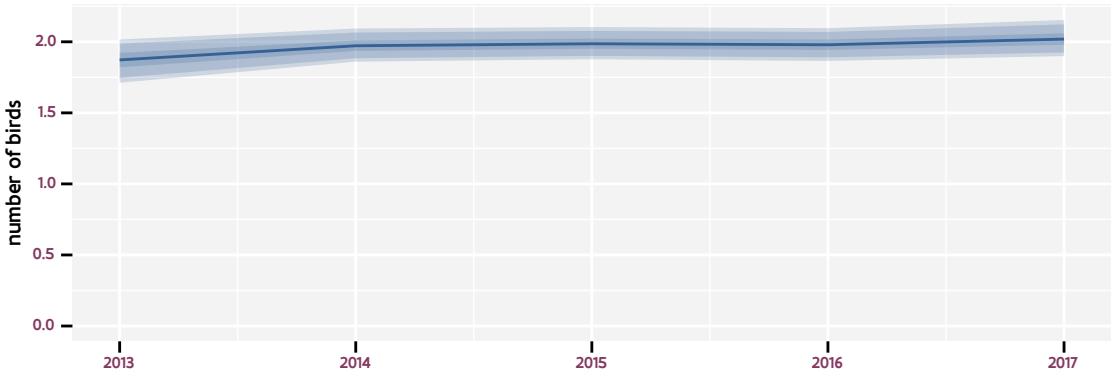

Figure 23.1: Estimated number of birds for an average point for *Alauda arvensis* (Alouette des champs) based on a non-linear model. The linear yearly change (~) is +2.0% (-0.3%; +4.4%). The trend is linear.

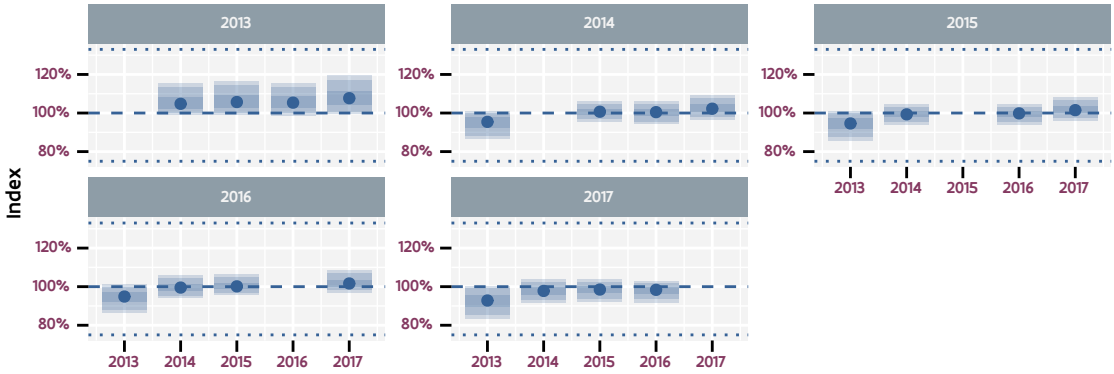

Figure 23.2: Indices for different reference years.

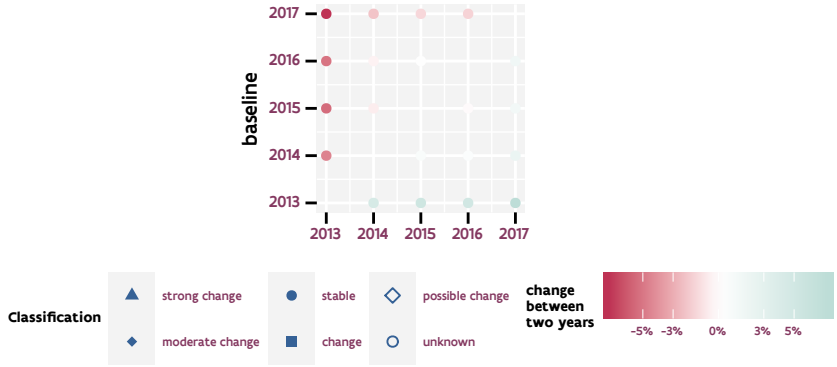

Figure 23.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

24 *HIRUNDO RUSTICA* (HIRONDELLE RUSTIQUE)

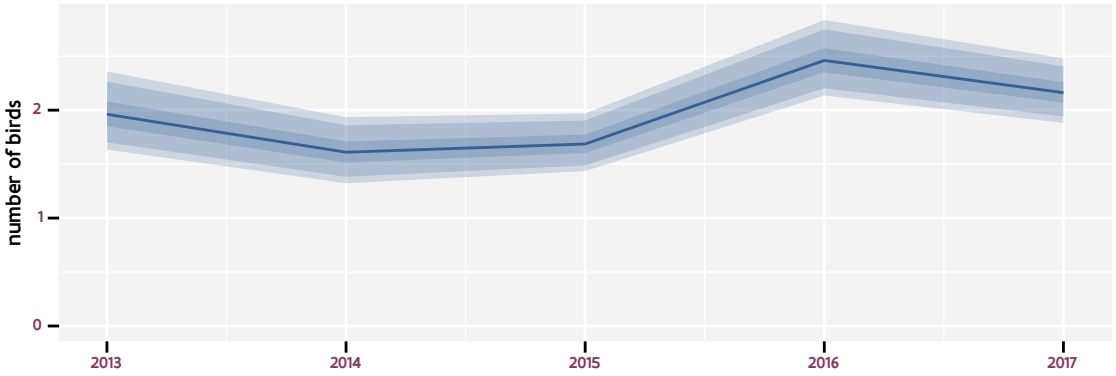

Figure 24.1: Estimated number of birds for an average point for *Hirundo rustica* (Hirondelle rustique) based on a non-linear model. The linear yearly change (+) is +7.2% (+1.4%; +13.4%). The trend is non-linear.

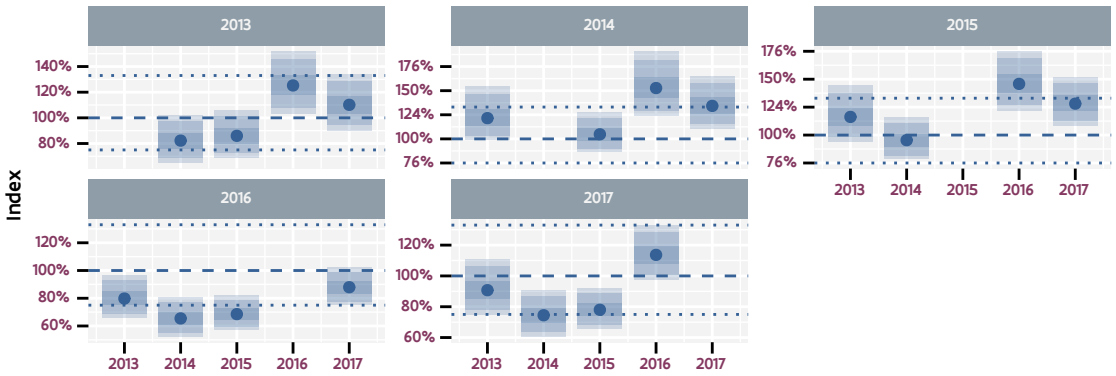

Figure 24.2: Indices for different reference years.

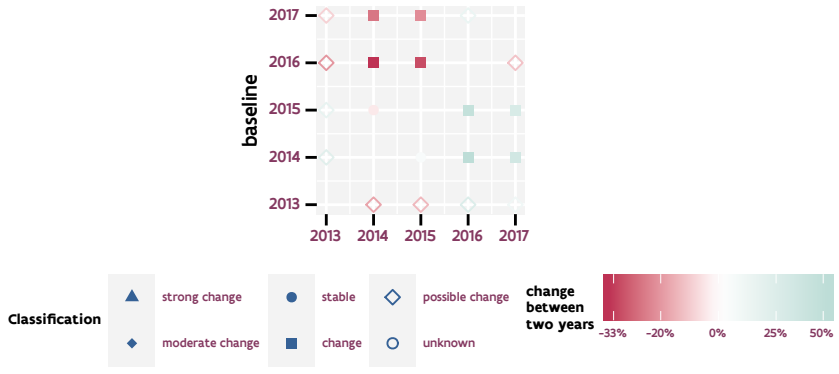

Figure 24.3: Relative change between years

25 *MOTACILLA FLAVA* (BERGERONNETTE PRINTANIERE)

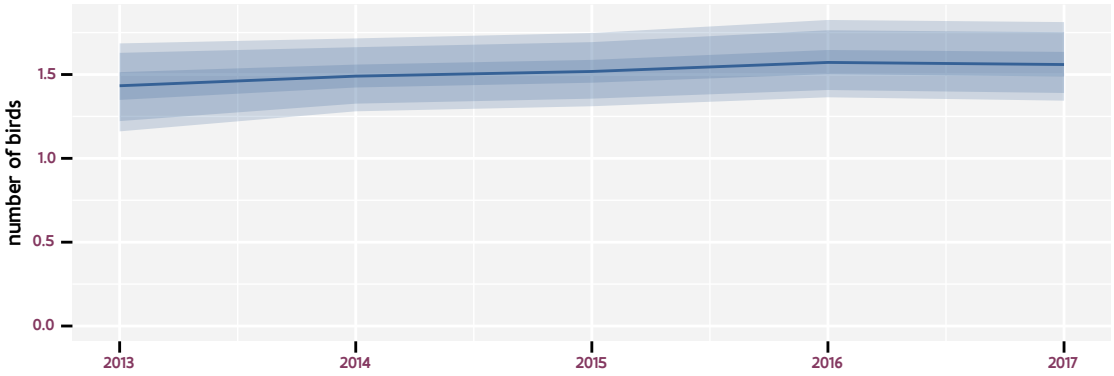

Figure 25.1: Estimated number of birds for an average point for *Motacilla flava* (Bergeronnette printaniere) based on a non-linear model. The linear yearly change (?+) is +4.2% (-2.8%; +11.8%). The trend is linear.

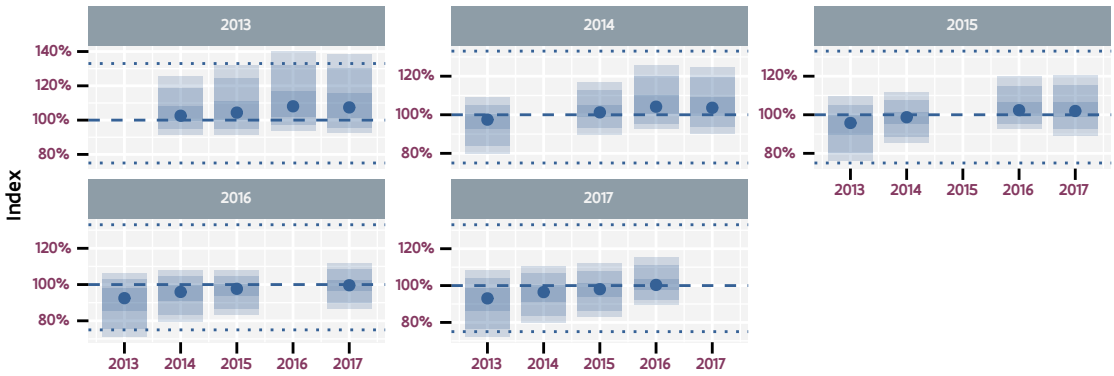

Figure 25.2: Indices for different reference years.

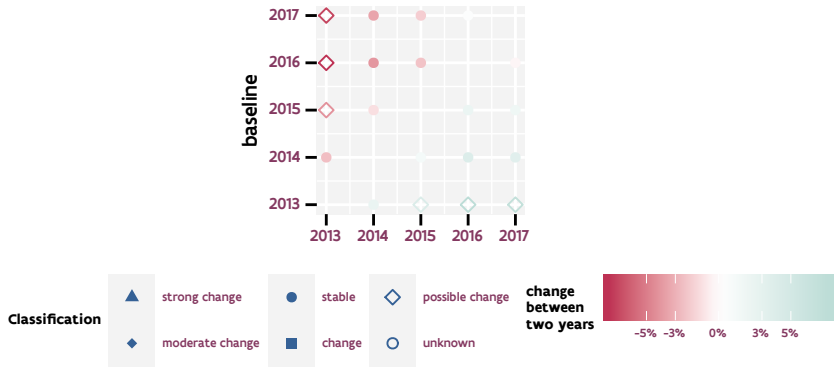

Figure 25.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

26 *MOTACILLA ALBA* (BERGERONNETTE GRISE)

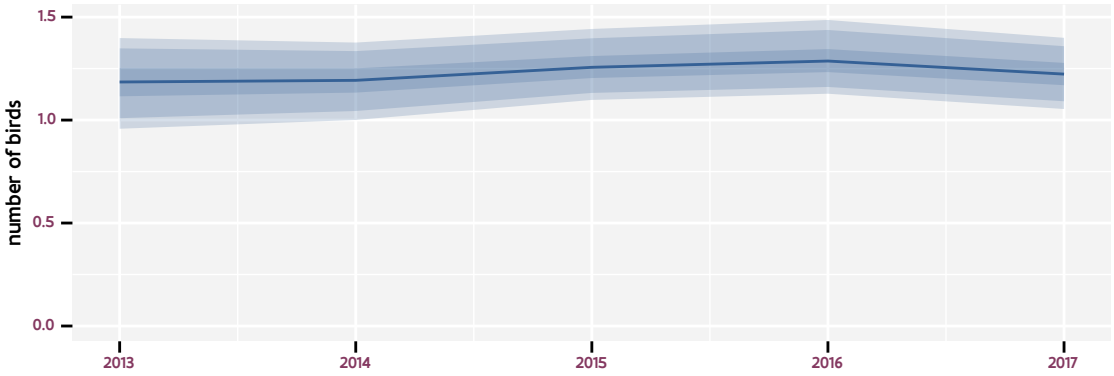

Figure 26.1: Estimated number of birds for an average point for *Motacilla alba* (Bergeronnette grise) based on a non-linear model. The linear yearly change (?+) is +1.9% (-5.0%; +9.3%). The trend is linear.

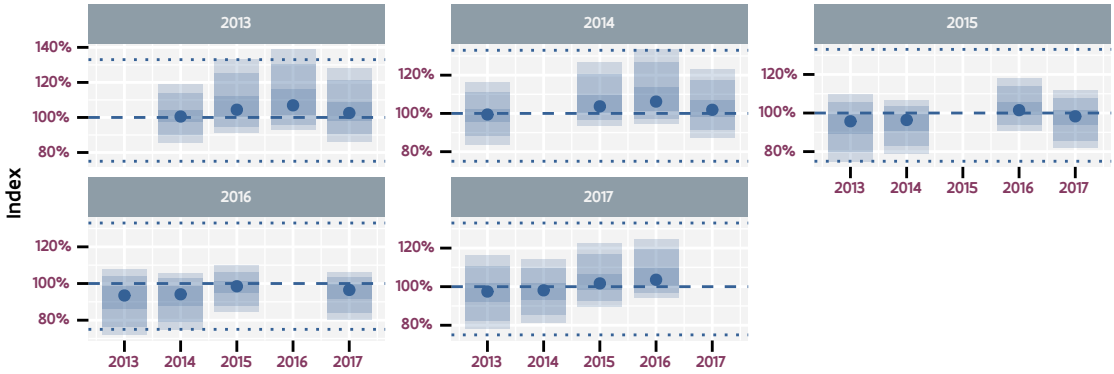

Figure 26.2: Indices for different reference years.

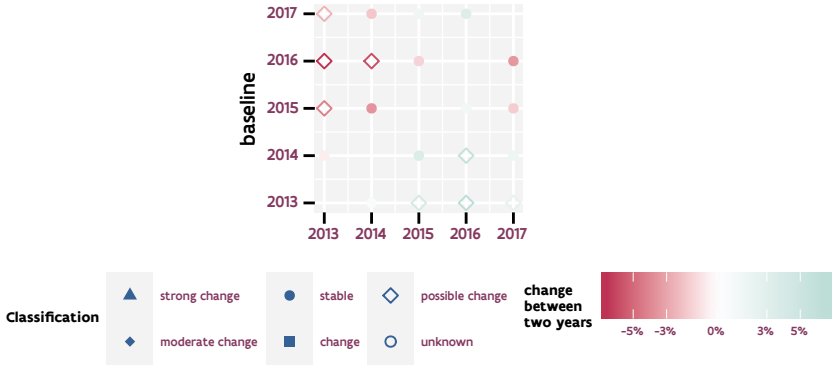

Figure 26.3: Relative change between years

27 *TROGLODYTES TROGLODYTES* (TROGLODYTE MIGNON)

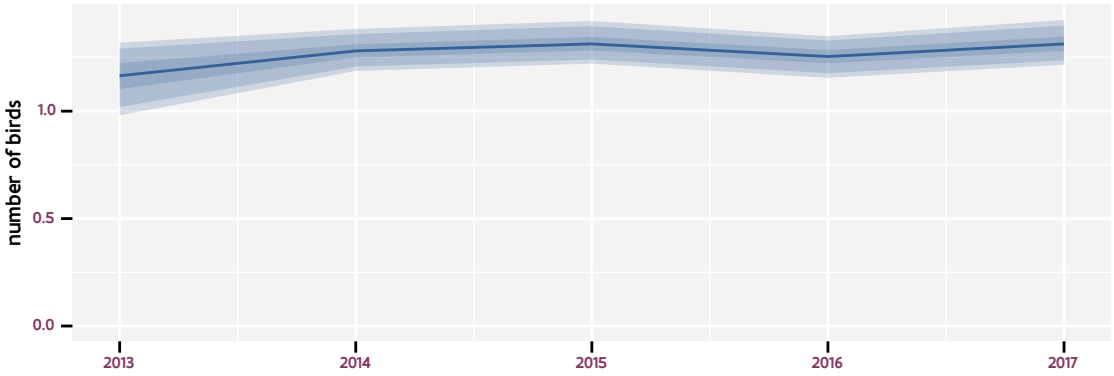

Figure 27.1: Estimated number of birds for an average point for *Troglodytes troglodytes* (Troglodyte mignon) based on a non-linear model. The linear yearly change (~) is +1.8% (-1.7%; +5.4%). The trend is possibly non-linear.

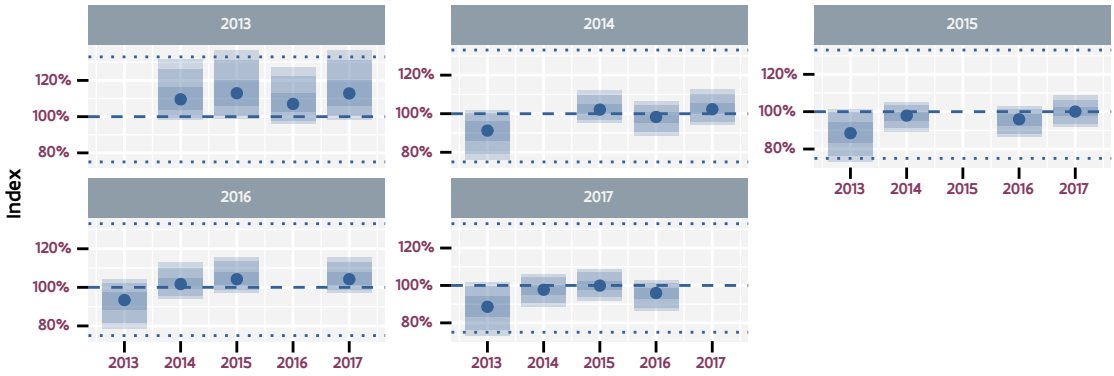

Figure 27.2: Indices for different reference years.

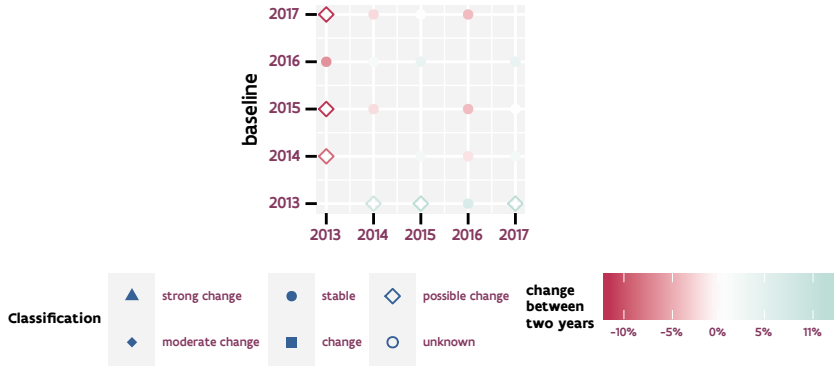

Figure 27.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

28 *PRUNELLA MODULARIS* (ACCENTEUR MOUCHET)

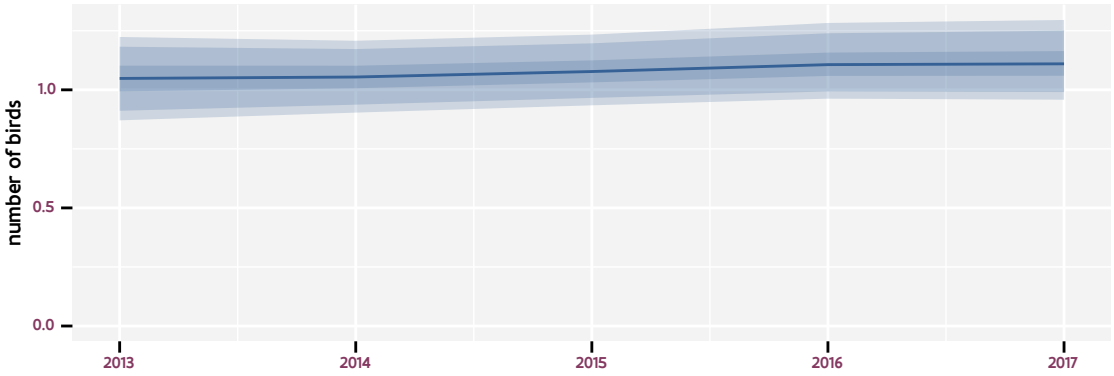

Figure 28.1: Estimated number of birds for an average point for *Prunella modularis* (Accenteur mouchet) based on a non-linear model. The linear yearly change (?+) is +3.6% (-3.8%; +11.6%). The trend is linear.

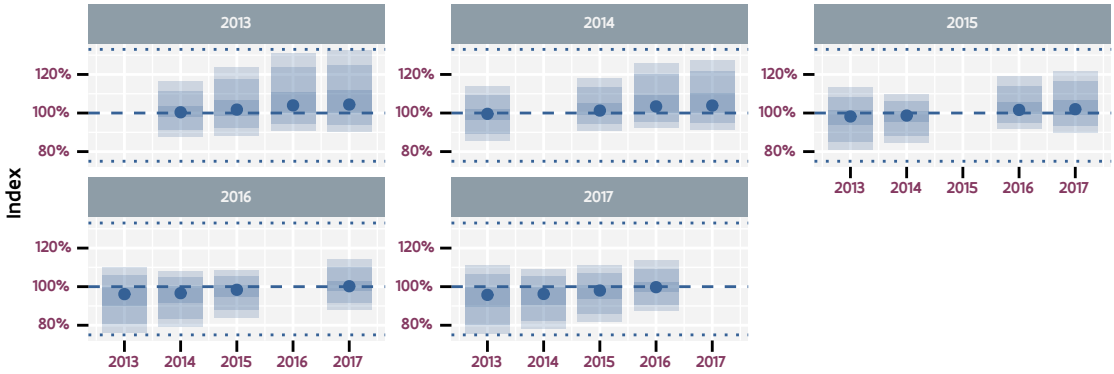

Figure 28.2: Indices for different reference years.

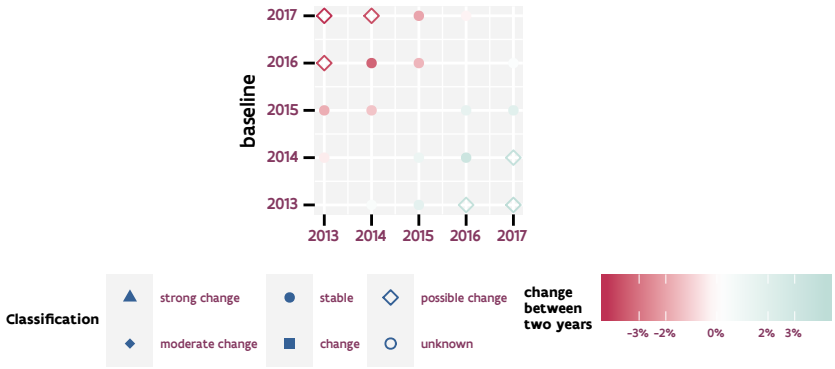

Figure 28.3: Relative change between years

29 *ERITHACUS RUBECULA* (ROUGEGORGE FAMILIER)

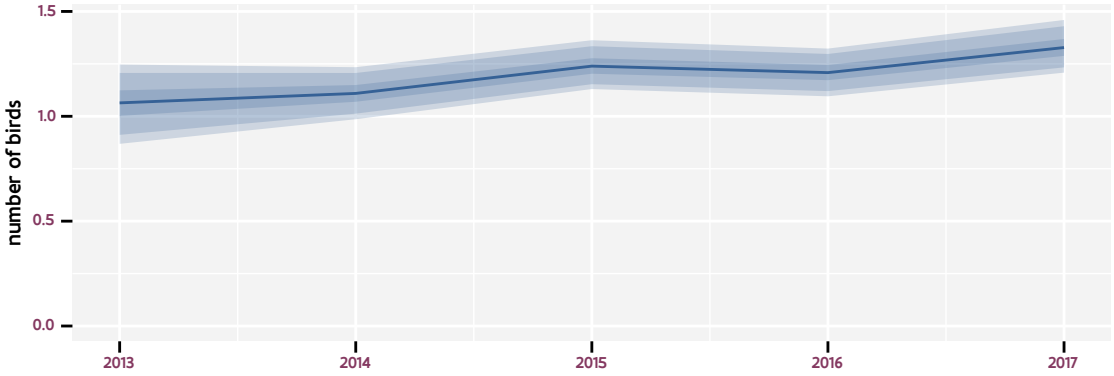

Figure 29.1: Estimated number of birds for an average point for *Erithacus rubecula* (Rougegorge familier) based on a non-linear model. The linear yearly change (+) is +6.4% (+1.8%; +11.3%). The trend is possibly non-linear.

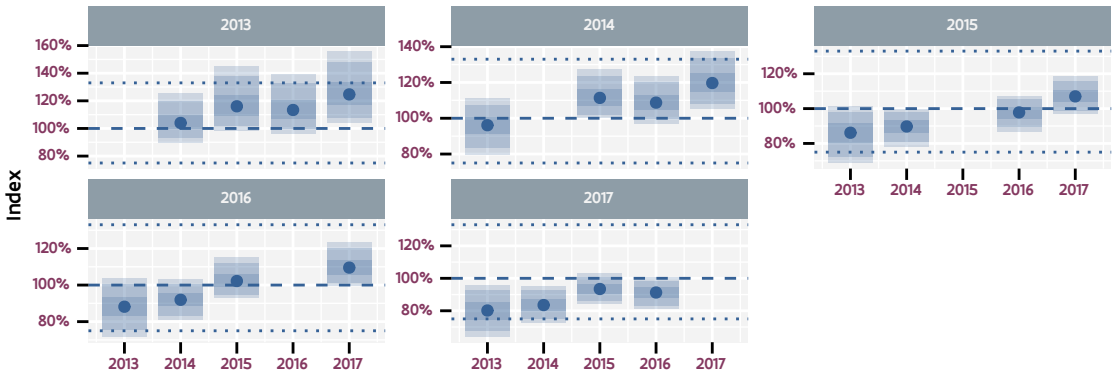

Figure 29.2: Indices for different reference years.

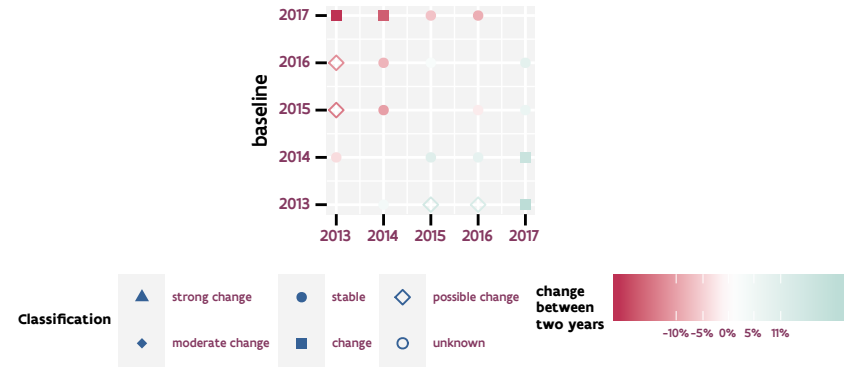

Figure 29.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

30 *LUSCINIA MEGARHYNCHOS* (ROSSIGNOL PHILOMELE)

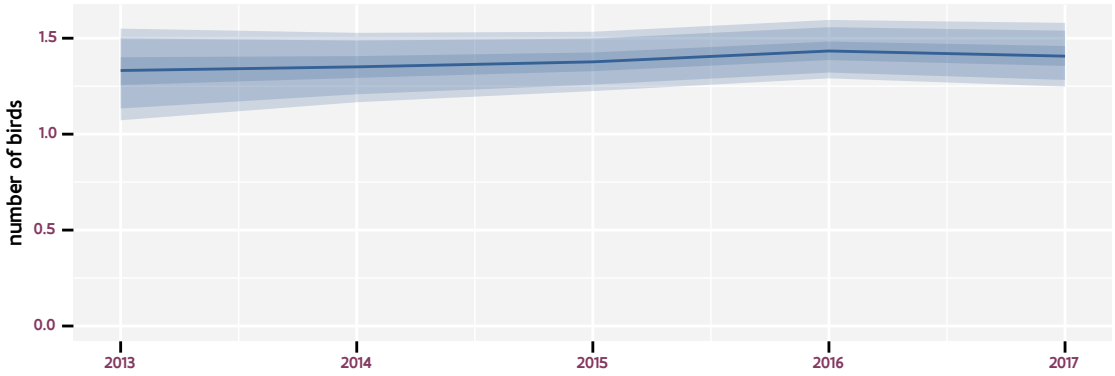

Figure 30.1: Estimated number of birds for an average point for *Luscinia megarhynchos* (Rossignol philomele) based on a non-linear model. The linear yearly change (?+) is +3.3% (-3.1%; +10.2%). The trend is possibly non-linear.

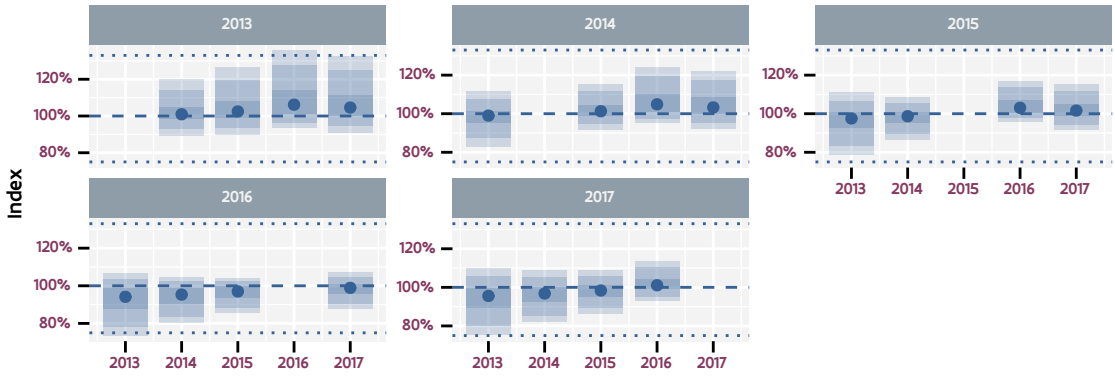

Figure 30.2: Indices for different reference years.

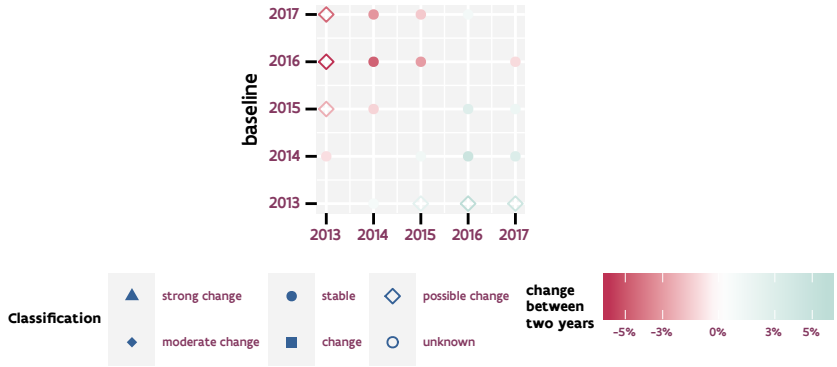

Figure 30.3: Relative change between years

31 *PHOENICURUS OCHRUROS* (ROUGEQUEUE NOIR)

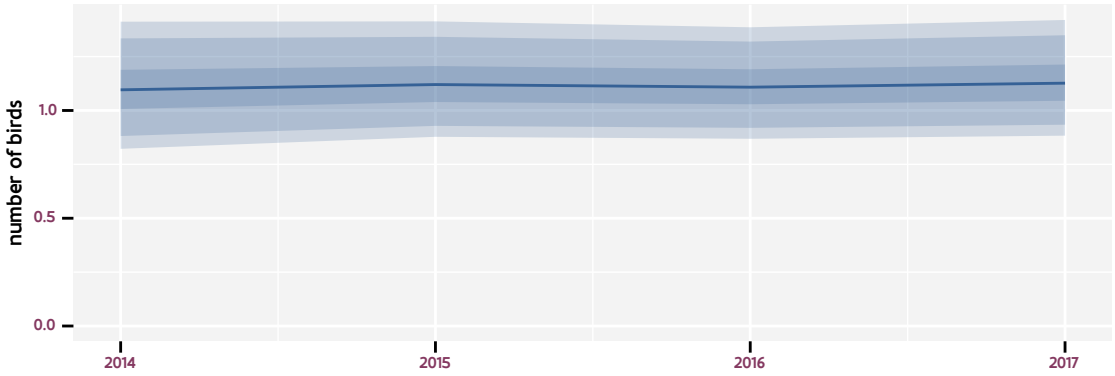

Figure 31.1: Estimated number of birds for an average point for *Phoenicurus ochruros* (Rougequeue noir) based on a non-linear model. The linear yearly change (?) is +1.7% (-12.8%; +19.0%). The trend is linear.

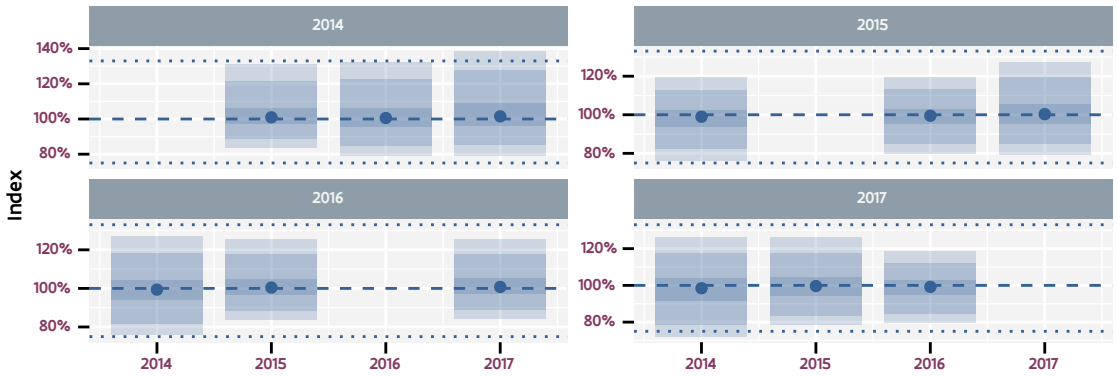

Figure 31.2: Indices for different reference years.

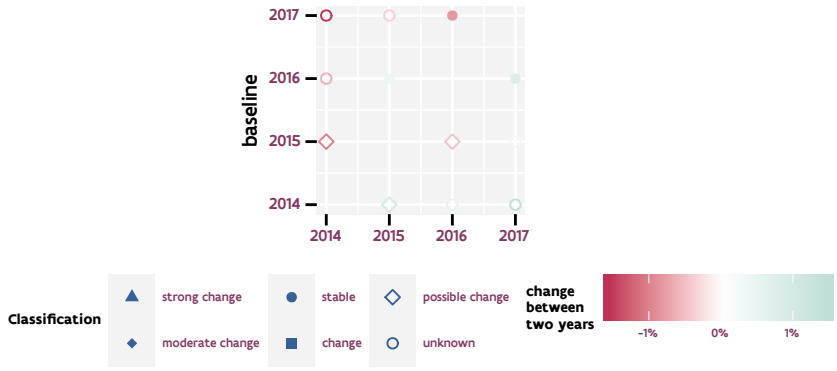

Figure 31.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

32 *SAXICOLA RUBICOLA* (TARIER PATRE)

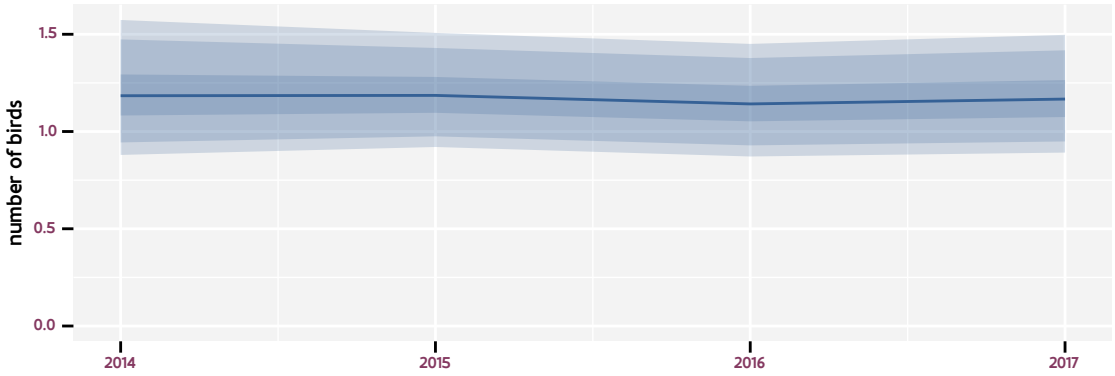

Figure 32.1: Estimated number of birds for an average point for *Saxicola rubicola* (Tarier patre) based on a non-linear model. The linear yearly change (?) is -1.8% (-16.5%; +15.7%). The trend is linear.

Figure 32.2: Indices for different reference years.

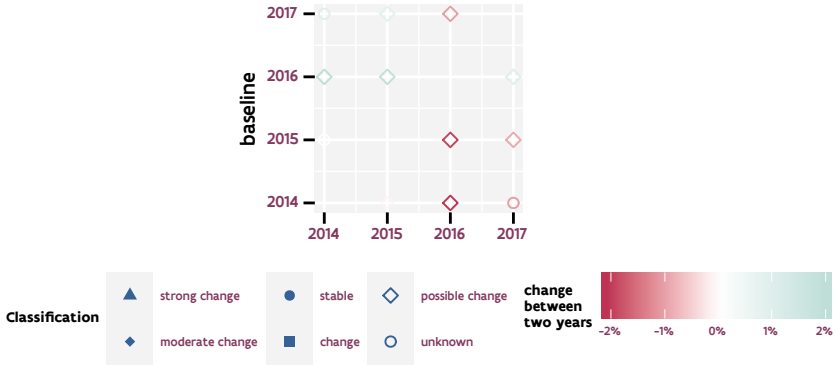

Figure 32.3: Relative change between years

33 *TURDUS MERULA* (MERLE NOIR)

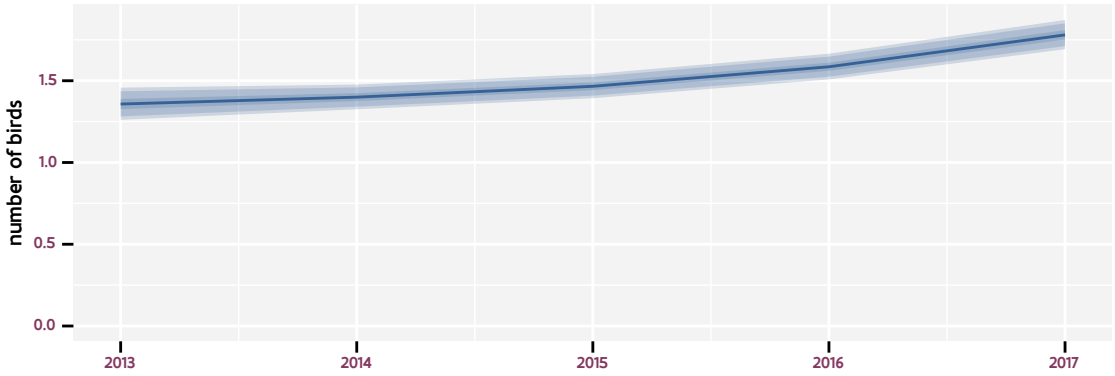

Figure 33.1: Estimated number of birds for an average point for *Turdus merula* (Merle noir) based on a non-linear model. The linear yearly change (+) is +8.0% (+5.8%; +10.2%). The trend is possibly non-linear.

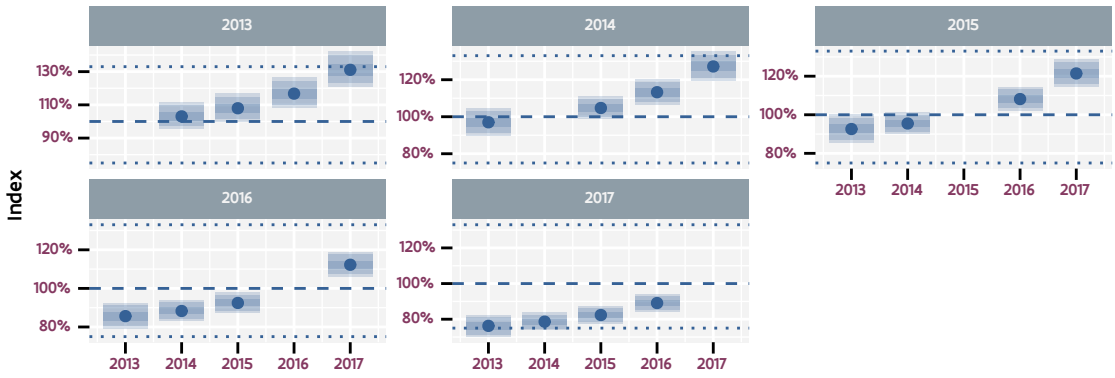

Figure 33.2: Indices for different reference years.

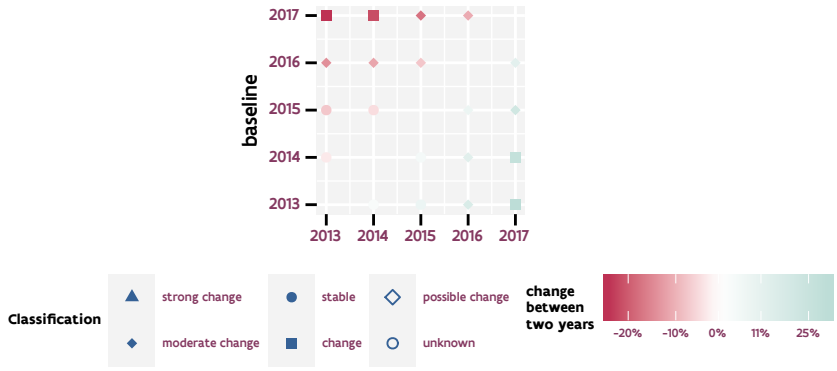

Figure 33.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

34 *TURDUS PHILOMELOS* (GRIVE MUSICIENNE)

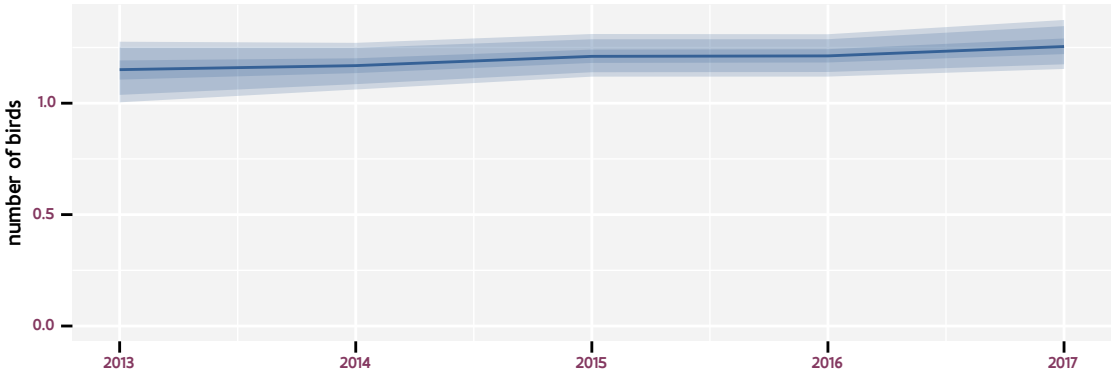

Figure 34.1: Estimated number of birds for an average point for *Turdus philomelos* (Grive musicienne) based on a non-linear model. The linear yearly change (?+) is +3.7% (-0.5%; +8.0%). The trend is linear.

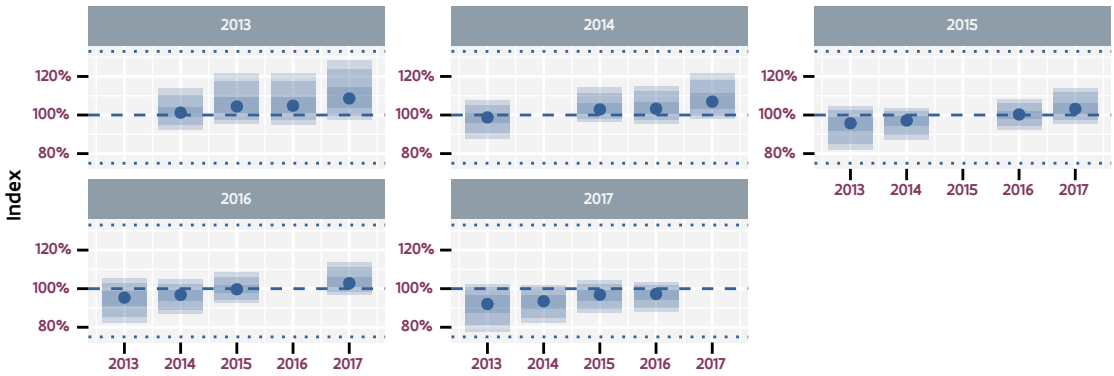

Figure 34.2: Indices for different reference years.

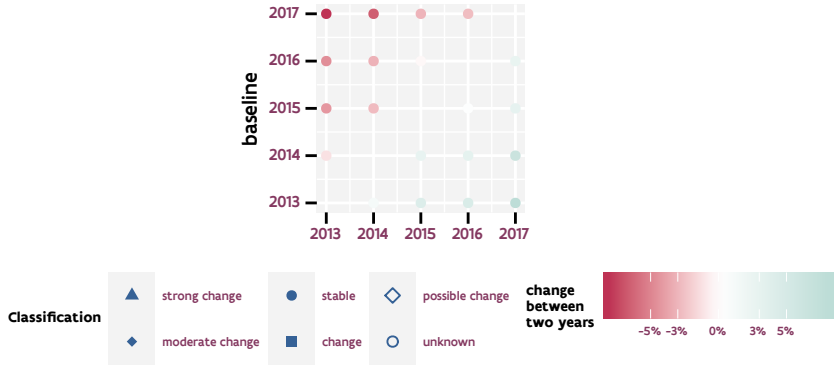

Figure 34.3: Relative change between years

35 *TURDUS VISCIVORUS* (GRIVE DRAINE)

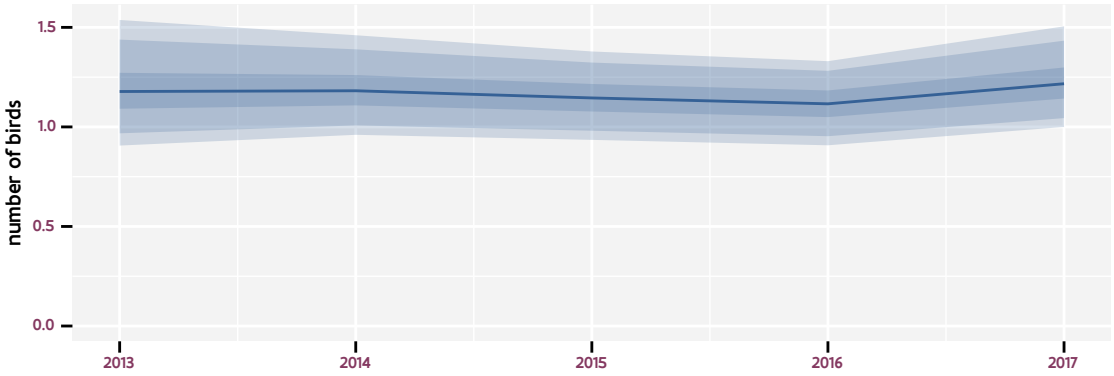

Figure 35.1: Estimated number of birds for an average point for *Turdus viscivorus* (Grive draine) based on a non-linear model. The linear yearly change (?) is +1.2% (-8.9%; +12.6%). The trend is linear.

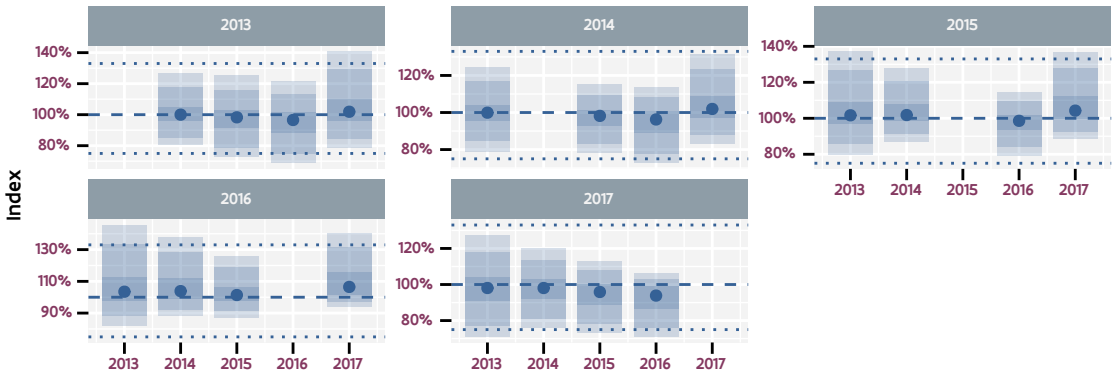

Figure 35.2: Indices for different reference years.

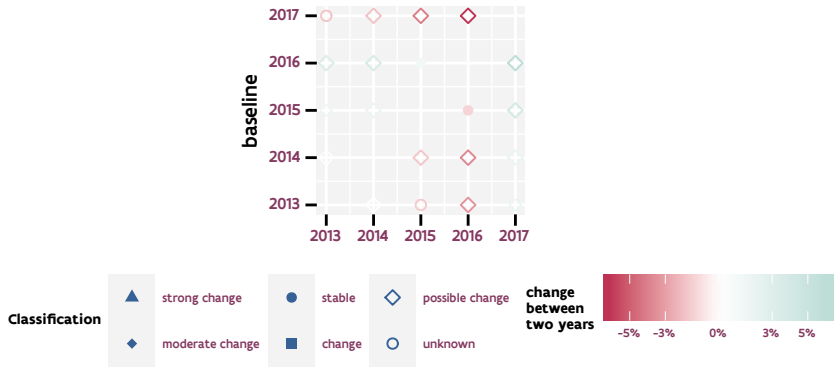

Figure 35.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

36 *CETTIA CETTI* (BOUSCARLE DE CETTI)

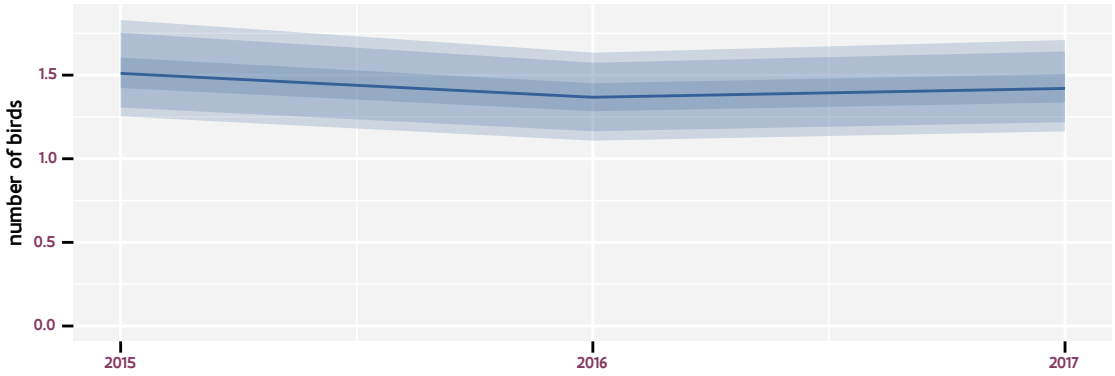

Figure 36.1: Estimated number of birds for an average point for *Cettia cetti* (Bouscarle de Cetti) based on a non-linear model. The linear yearly change (?) is -5.4% (-19.4%; +10.7%). The trend is possibly non-linear.

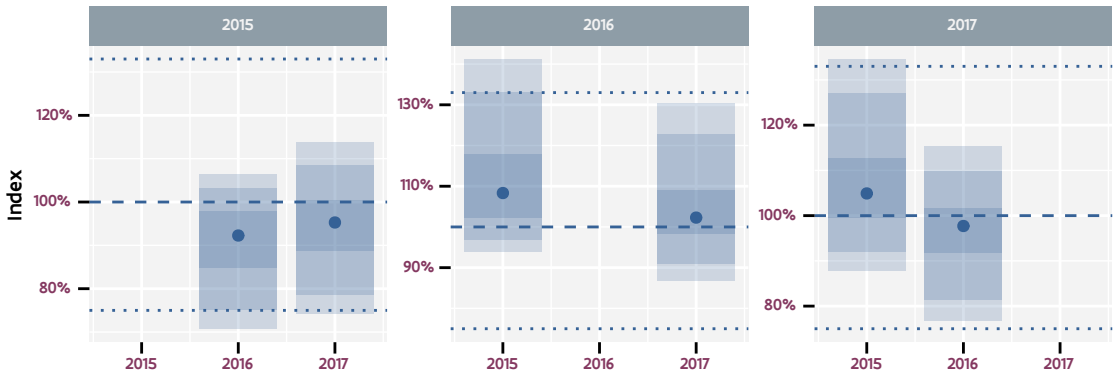

Figure 36.2: Indices for different reference years.

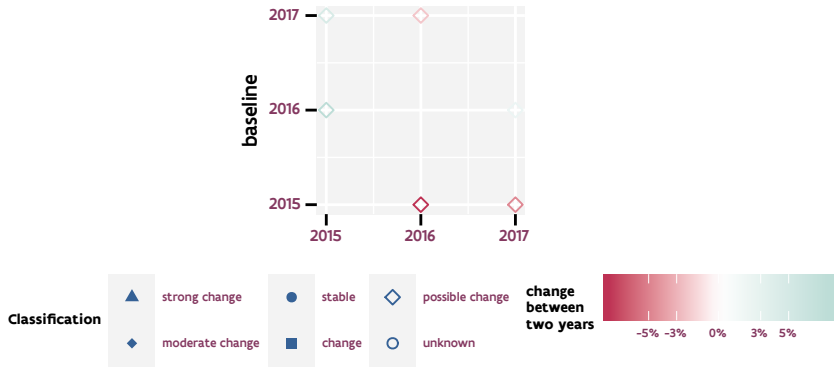

Figure 36.3: Relative change between years

37 *CISTICOLA JUNCIDIS* (CISTICOLE DES JONCS)

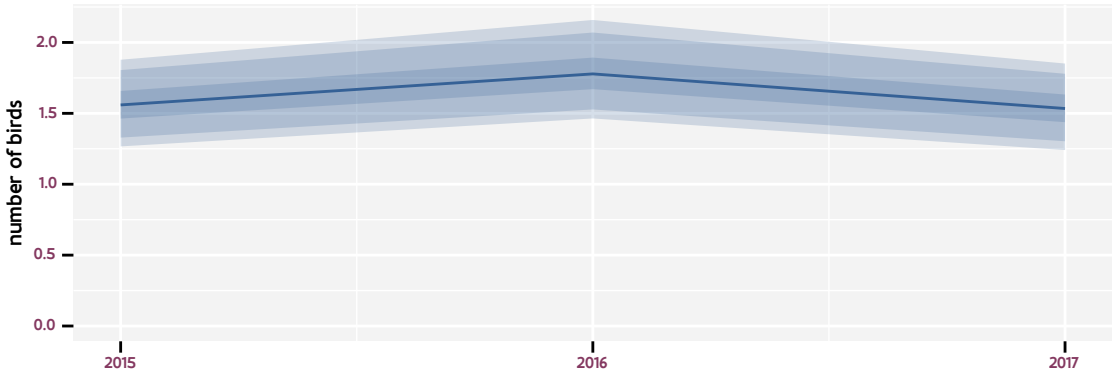

Figure 37.1: Estimated number of birds for an average point for *Cisticola juncidis* (Cisticole des joncs) based on a non-linear model. The linear yearly change (?) is -0.9% (-13.7%; +13.7%). The trend is non-linear.

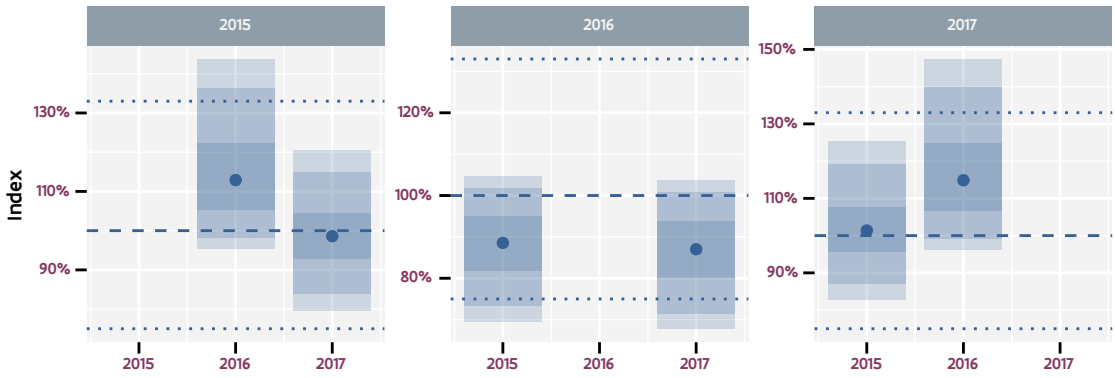

Figure 37.2: Indices for different reference years.

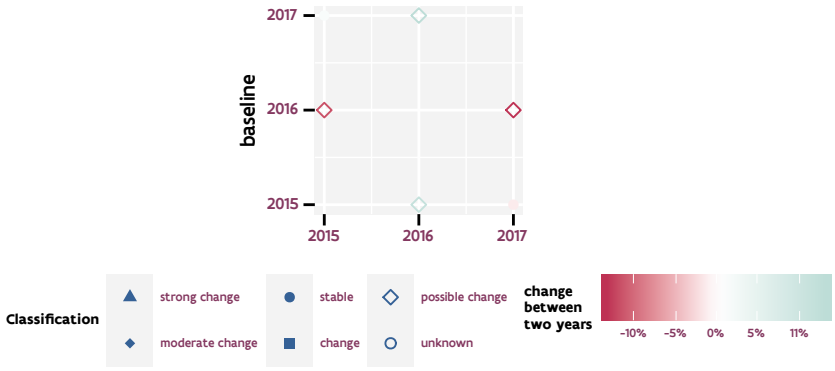

Figure 37.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

38 *ACROCEPHALUS SCHOENOBAENUS* (PHRAGMITE DES JONCS)

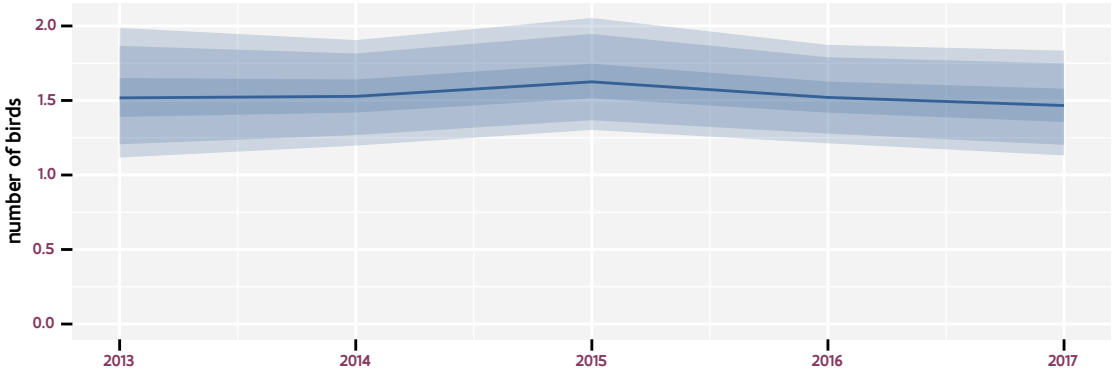

Figure 38.1: Estimated number of birds for an average point for *Acrocephalus schoenobaenus* (Phragmite des joncs) based on a non-linear model. The linear yearly change (?) is -2.4% (-12.4%; +8.8%). The trend is possibly non-linear.

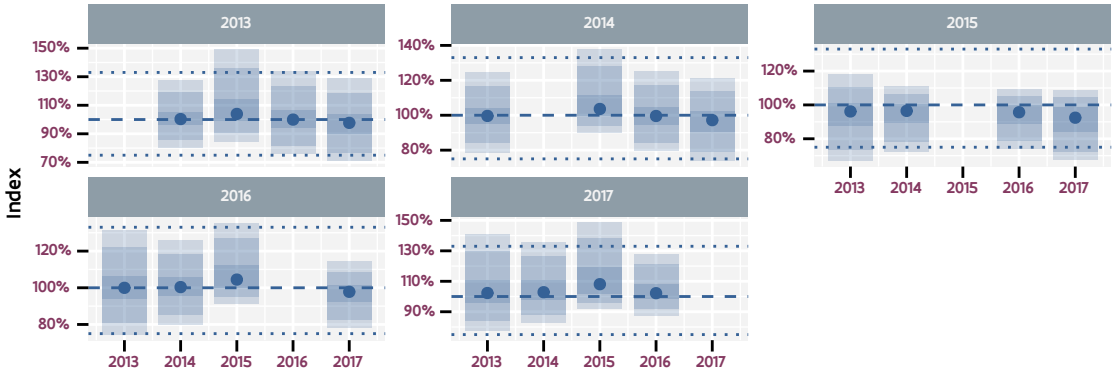

Figure 38.2: Indices for different reference years.

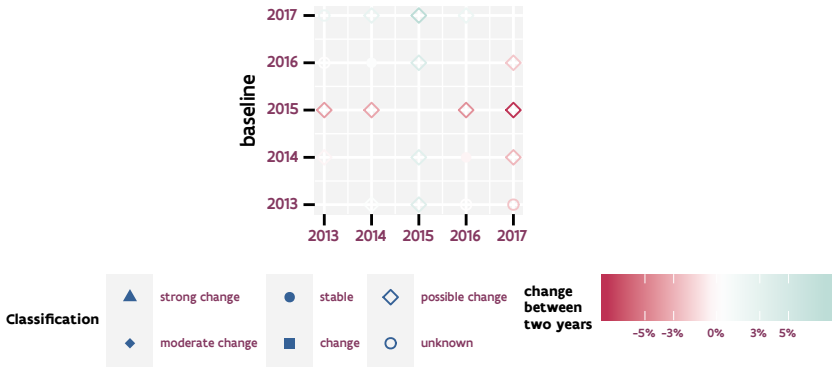

Figure 38.3: Relative change between years

39 *SYLVIA MELANOCEPHALA* (FAUVETTE MELANOCEPHALE)

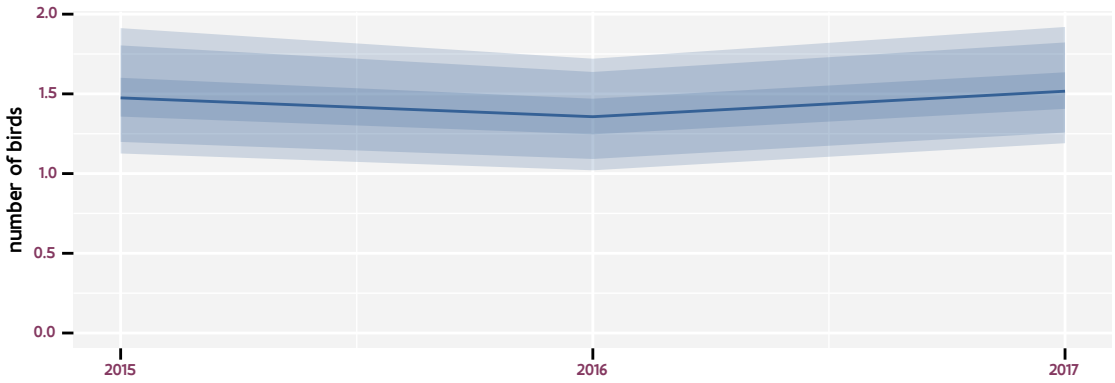

Figure 39.1: Estimated number of birds for an average point for *Sylvia melanocephala* (Fauvette melanocephale) based on a non-linear model. The linear yearly change (?) is +3.0% (-16.4%; +27.4%). The trend is possibly non-linear.

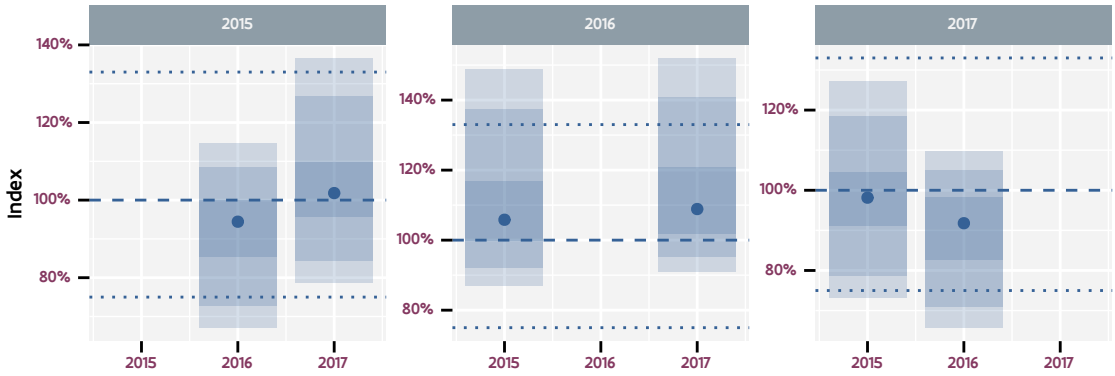

Figure 39.2: Indices for different reference years.

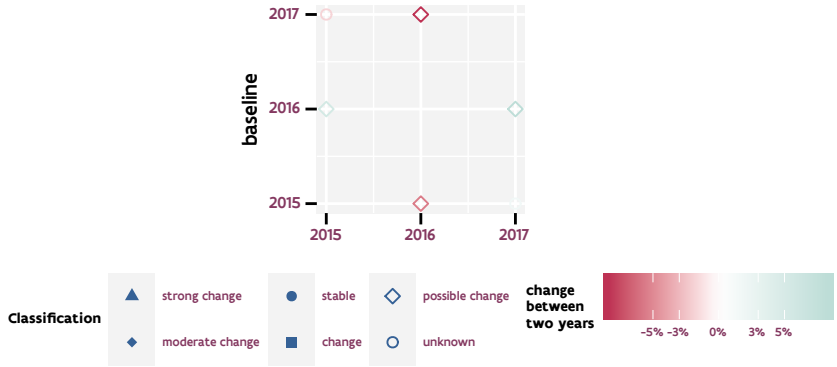

Figure 39.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

40 *SYLVIA COMMUNIS* (FAUVETTE GRISETTE)

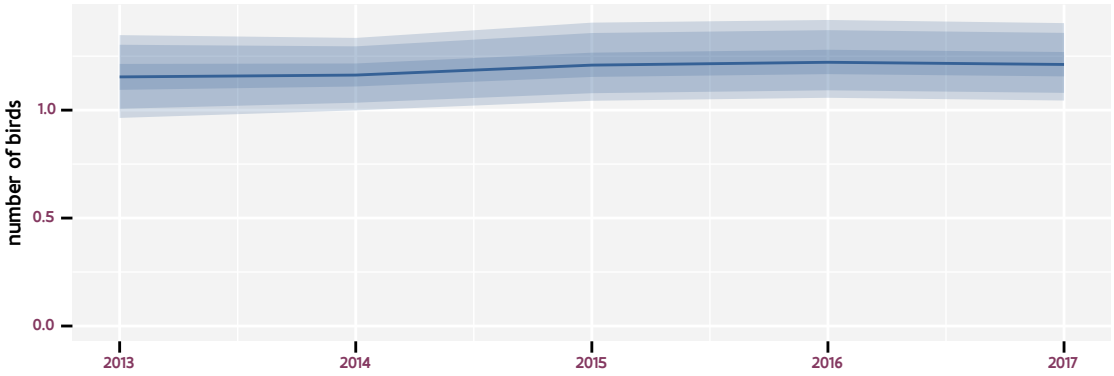

Figure 40.1: Estimated number of birds for an average point for *Sylvia communis* (Fauvette grisette) based on a non-linear model. The linear yearly change (?+) is +2.7% (-3.3%; +9.2%). The trend is linear.

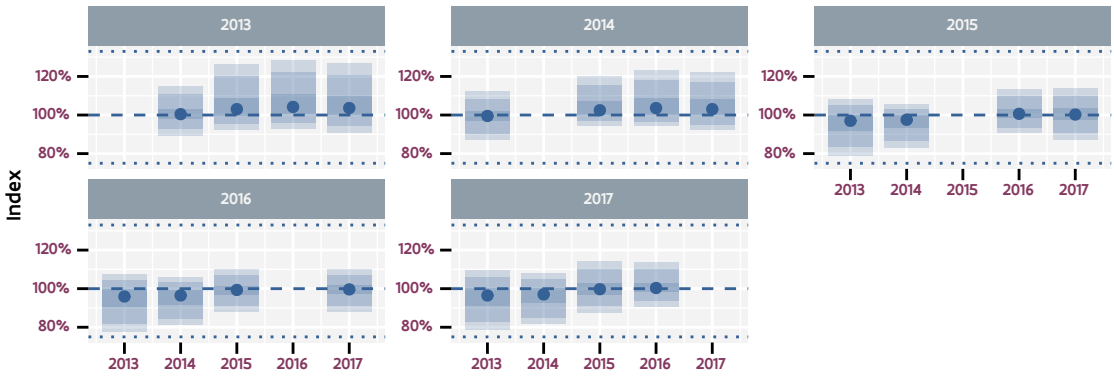

Figure 40.2: Indices for different reference years.

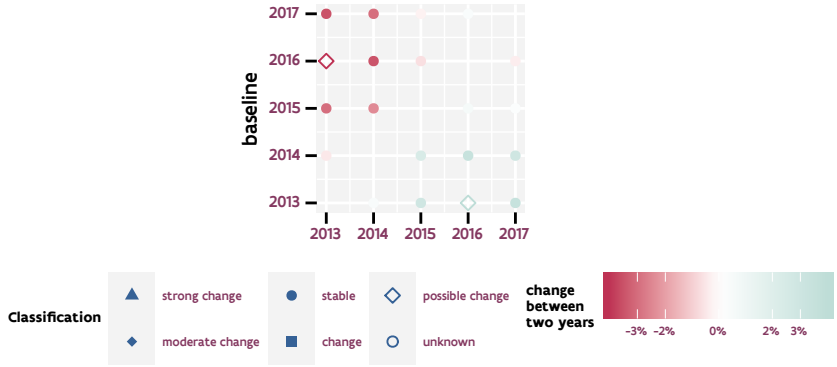

Figure 40.3: Relative change between years

41 *SYLVIA BORIN* (FAUVETTE DES JARDINS)

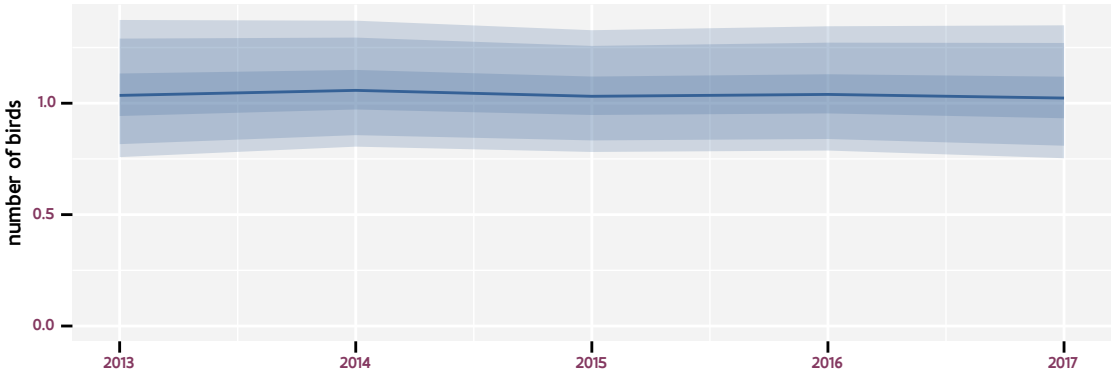

Figure 41.1: Estimated number of birds for an average point for *Sylvia borin* (Fauvette des jardins) based on a non-linear model. The linear yearly change (?) is -1.2% (-12.7%; +12.0%). The trend is linear.

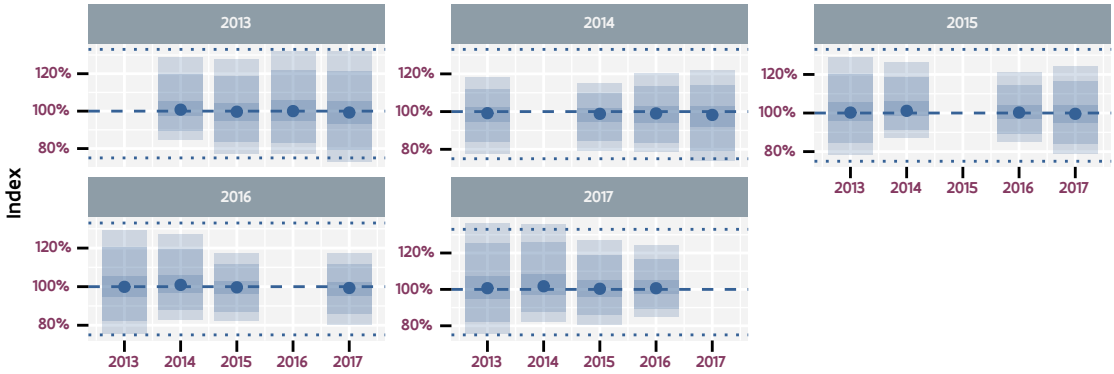

Figure 41.2: Indices for different reference years.

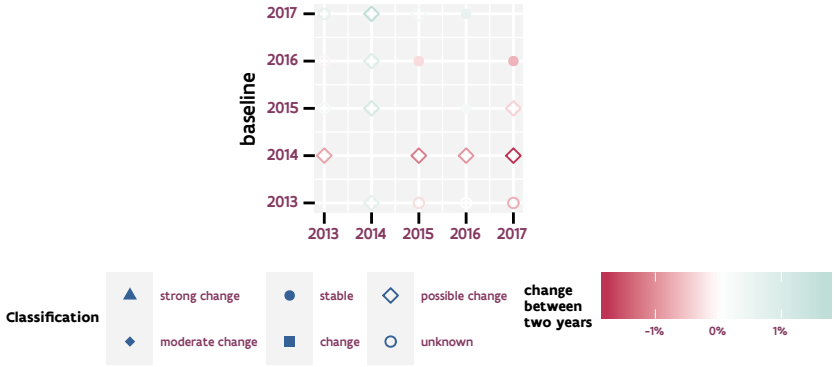

Figure 41.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

42 *SYLVIA ATRICAPILLA* (FAUVETTE A TETE NOIRE)

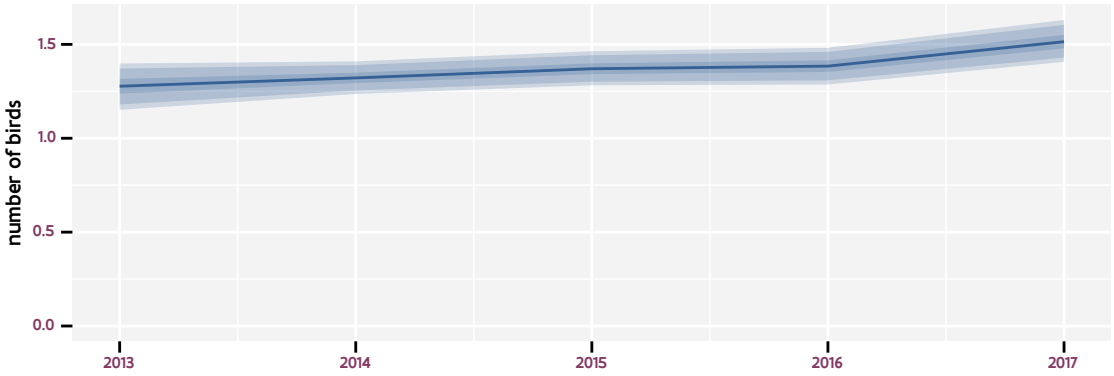

Figure 42.1: Estimated number of birds for an average point for *Sylvia atricapilla* (Fauvette a tete noire) based on a non-linear model. The linear yearly change (+) is +5.0% (+2.1%; +8.1%). The trend is linear.

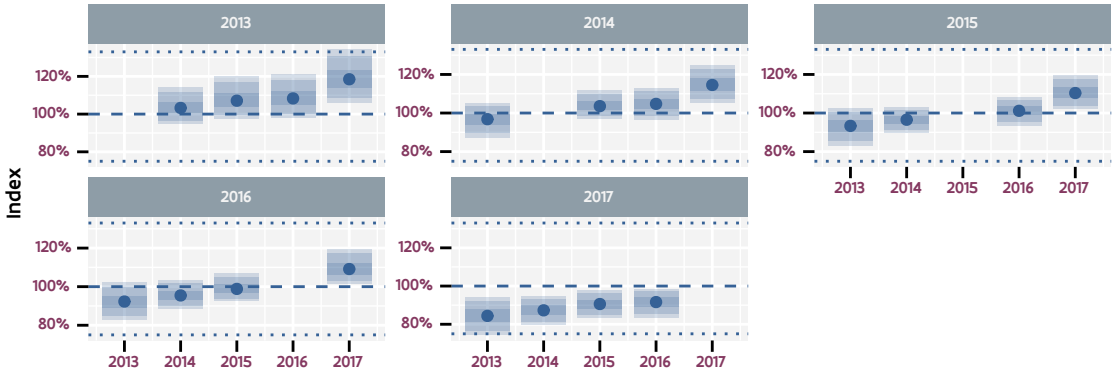

Figure 42.2: Indices for different reference years.

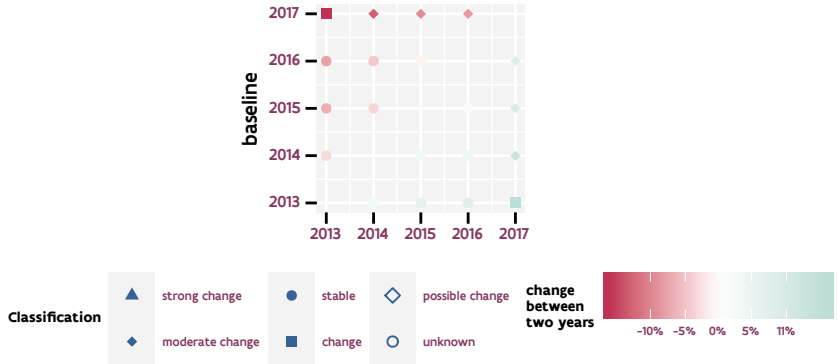

Figure 42.3: Relative change between years

43 *PHYLLOSCOPUS COLLYBITA* (POUILLOT VELOCE)

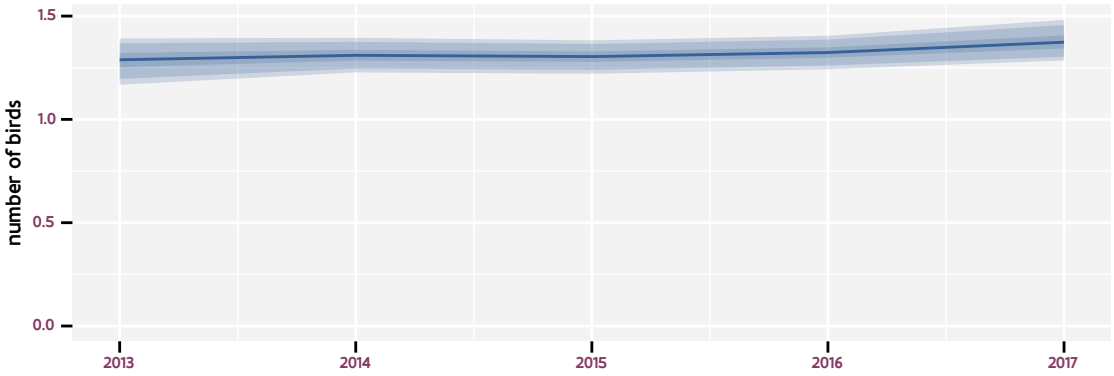

Figure 43.1: Estimated number of birds for an average point for *Phylloscopus collybita* (Pouillot veloce) based on a non-linear model. The linear yearly change (~) is +2.6% (-0.7%; +5.9%). The trend is linear.

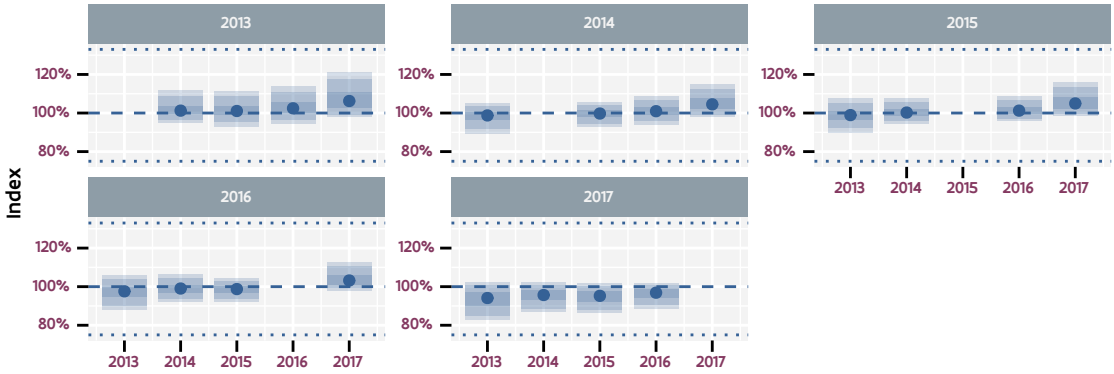

Figure 43.2: Indices for different reference years.

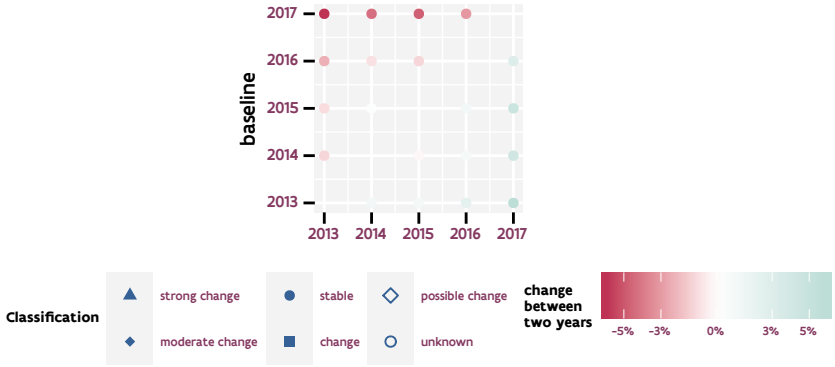

Figure 43.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

44 *PHYLLOSCOPUS TROCHILUS* (POUILLOT FITIS)

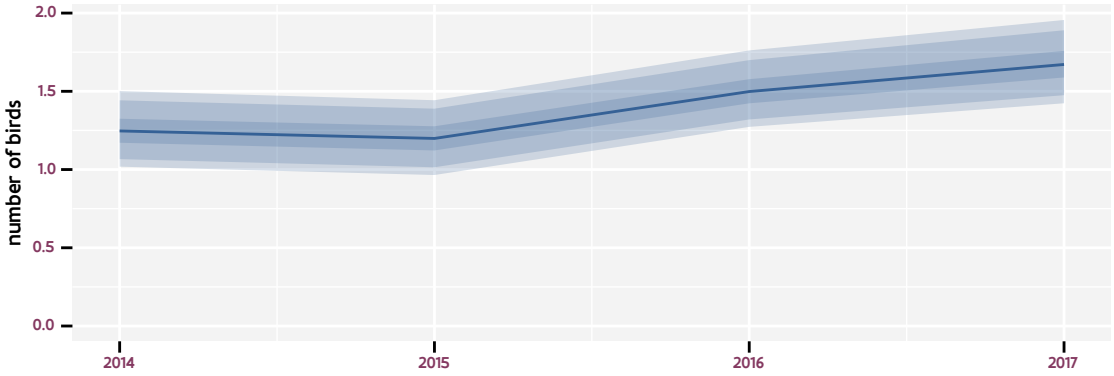

Figure 44.1: Estimated number of birds for an average point for *Phylloscopus trochilus* (Pouillot fitis) based on a non-linear model. The linear yearly change (+) is +14.7% (+4.6%; +26.1%). The trend is possibly non-linear.

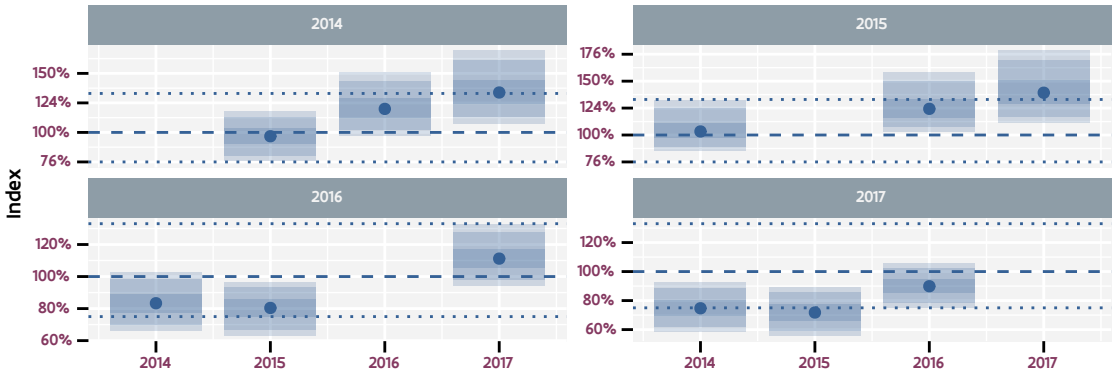

Figure 44.2: Indices for different reference years.

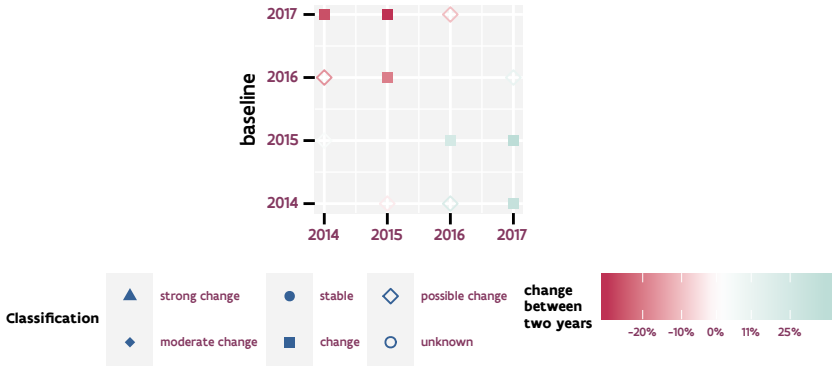

Figure 44.3: Relative change between years

45 *REGULUS IGNICAPILLA* (ROITELET A TRIPLE BANDEAU)

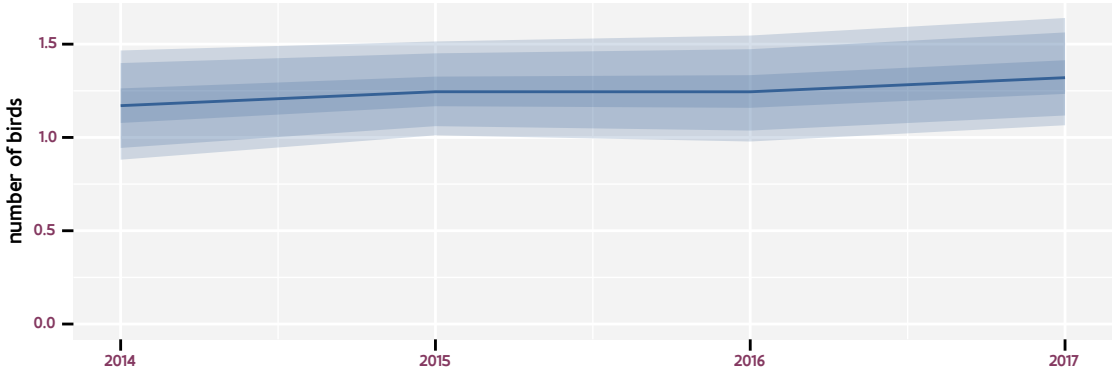

Figure 45.1: Estimated number of birds for an average point for *Regulus ignicapilla* (Roitelet a triple bandeau) based on a non-linear model. The linear yearly change (?+) is +7.2% (-5.4%; +21.7%). The trend is linear.

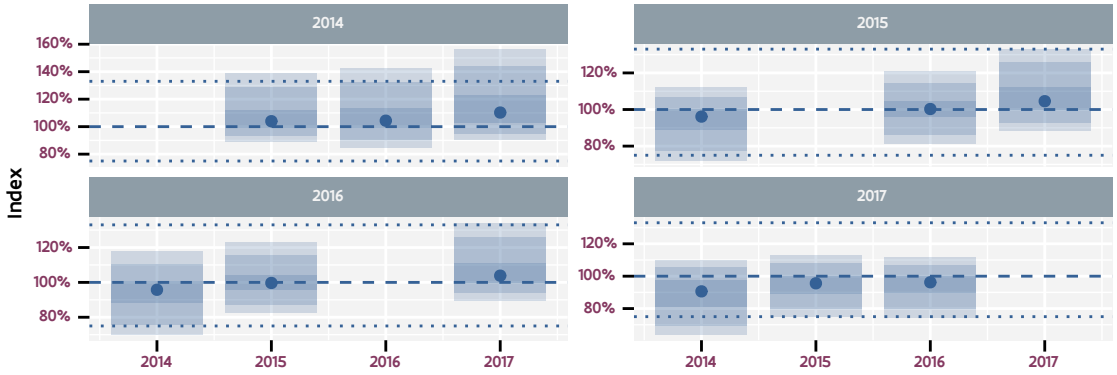

Figure 45.2: Indices for different reference years.

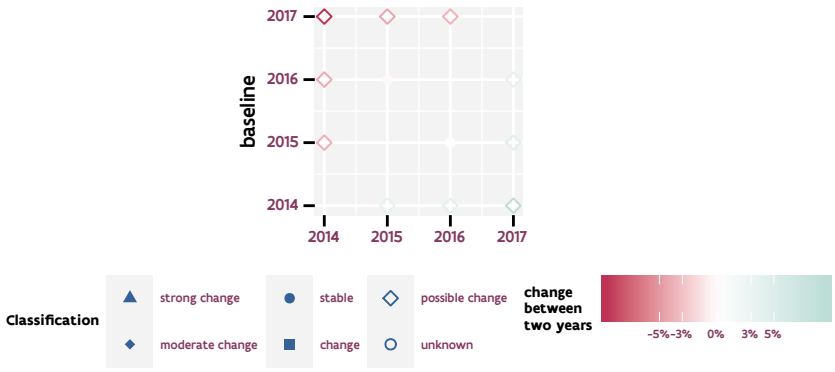

Figure 45.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

46 *POECILE PALUSTRIS* (MESANGE NONNETTE)

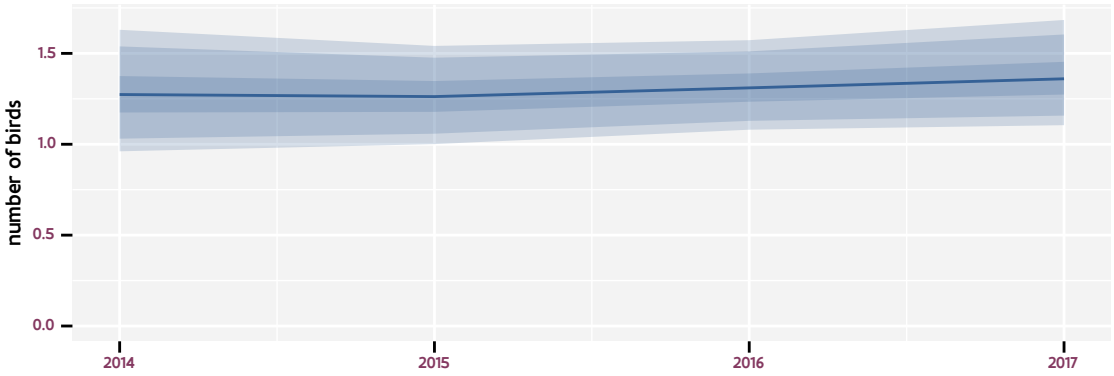

Figure 46.1: Estimated number of birds for an average point for *Poecile palustris* (Mesange nonnette) based on a non-linear model. The linear yearly change (?) is +5.9% (-8.3%; +22.9%). The trend is linear.

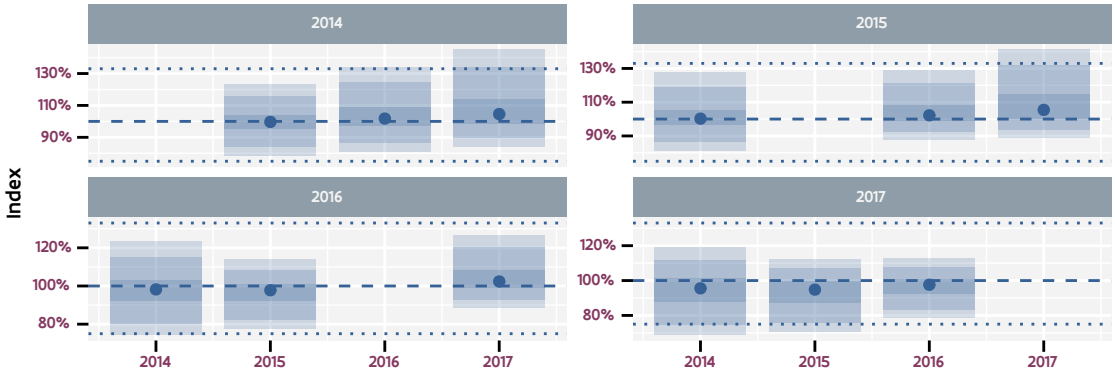

Figure 46.2: Indices for different reference years.

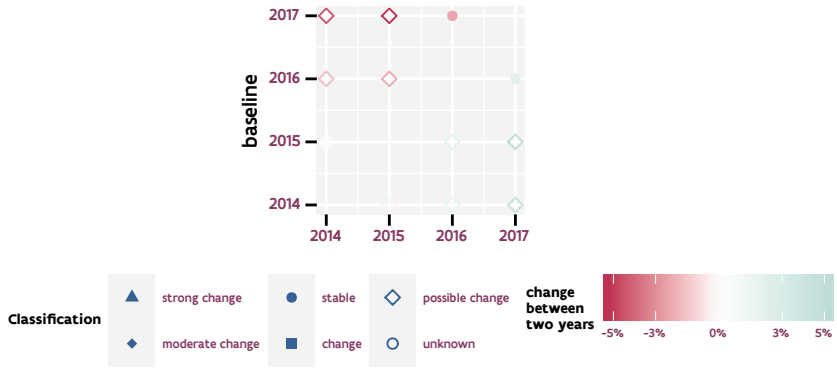

Figure 46.3: Relative change between years

47 *CYANISTES CAERULEUS* (MESANGE BLEUE)

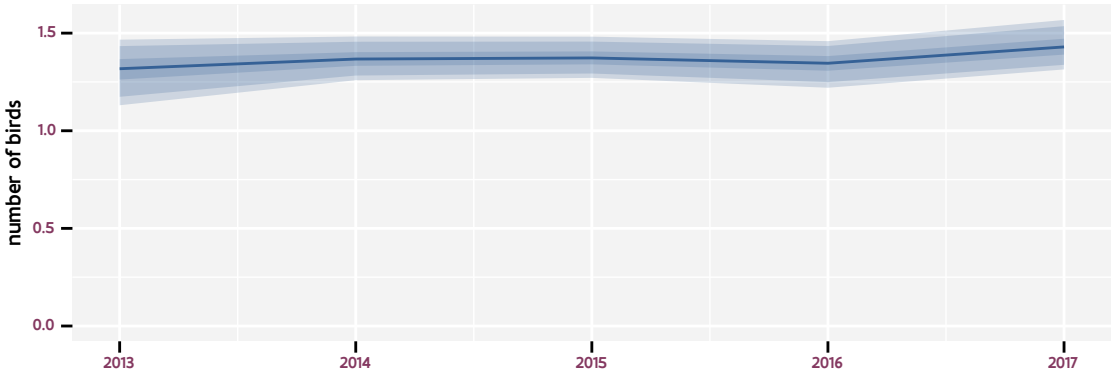

Figure 47.1: Estimated number of birds for an average point for *Cyanistes caeruleus* (Mesange bleue) based on a non-linear model. The linear yearly change (?+) is +2.4% (-1.5%; +6.4%). The trend is linear.

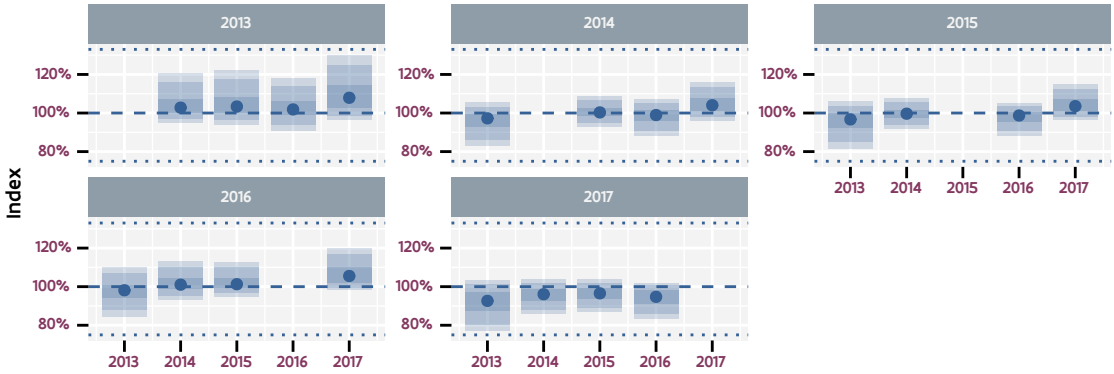

Figure 47.2: Indices for different reference years.

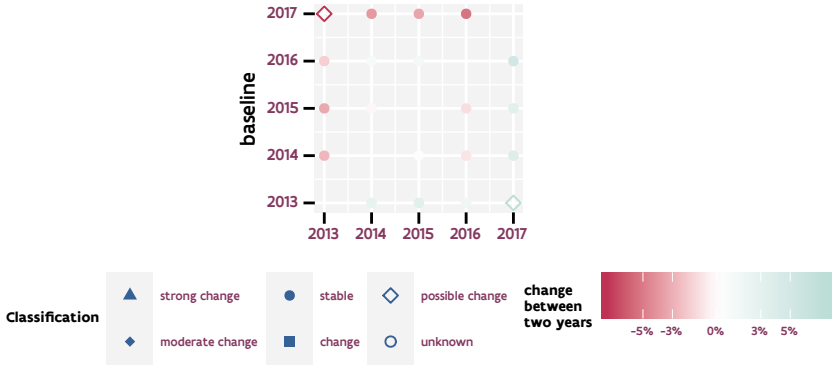

Figure 47.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

48 *PARUS MAJOR* (MESANGE CHARBONNIERE)

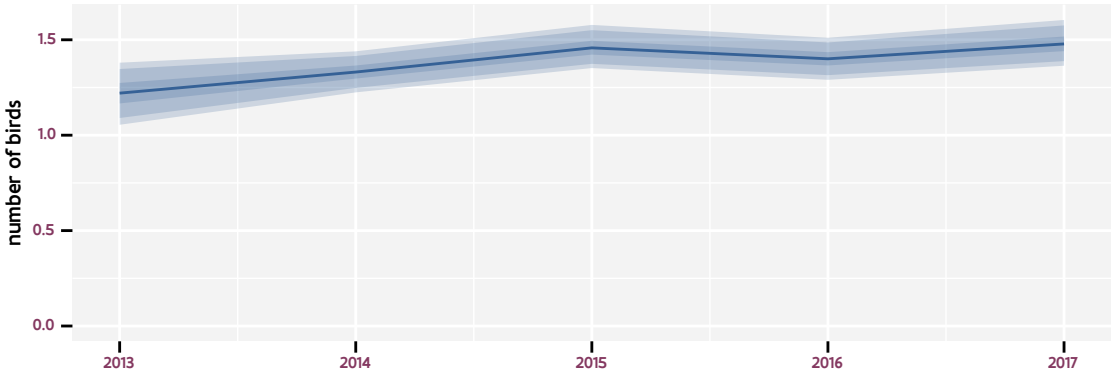

Figure 48.1: Estimated number of birds for an average point for *Parus major* (Mesange charbonniere) based on a non-linear model. The linear yearly change (+) is +4.5% (+0.9%; +8.4%). The trend is non-linear.

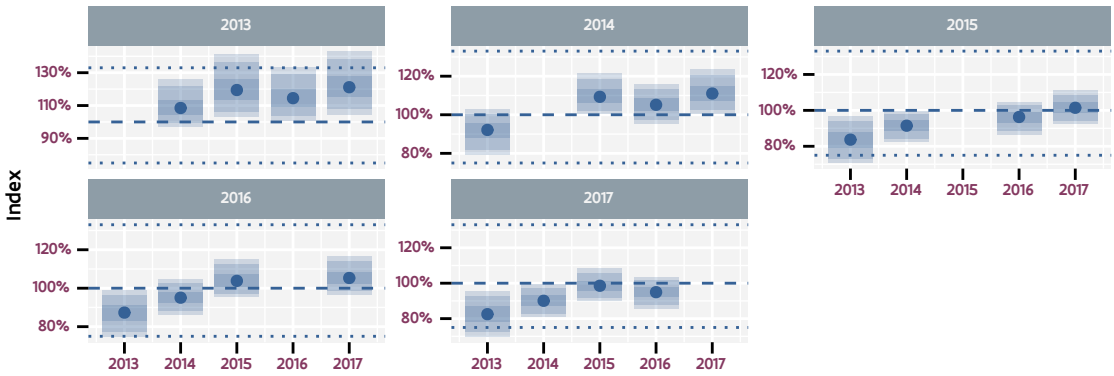

Figure 48.2: Indices for different reference years.

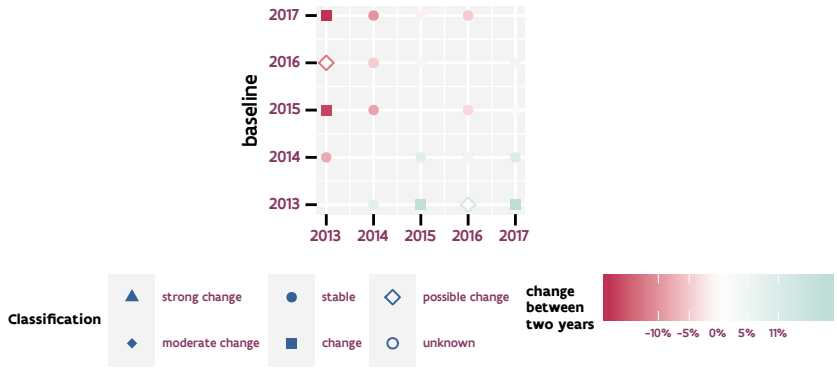

Figure 48.3: Relative change between years

49 *SITTA EUROPAEA* (SITTELLE TORCHEPOT)

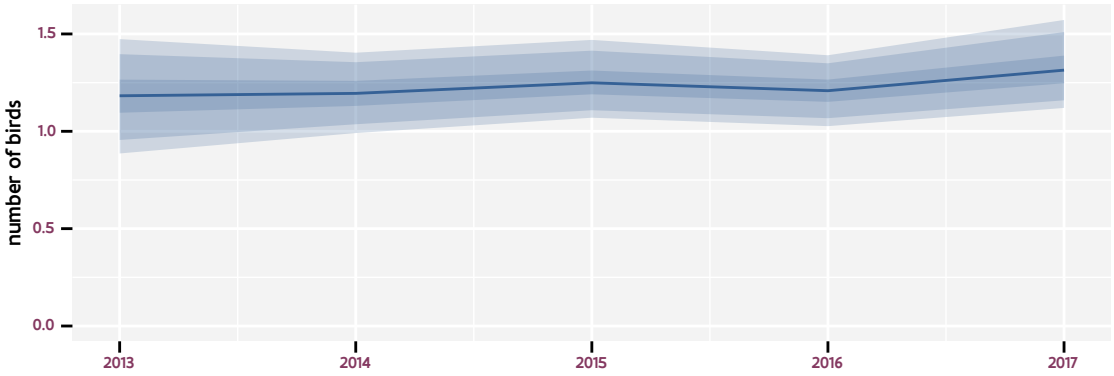

Figure 49.1: Estimated number of birds for an average point for *Sitta europaea* (Sittelle torchepot) based on a non-linear model. The linear yearly change (?+) is +5.0% (-4.1%; +15.0%). The trend is linear.

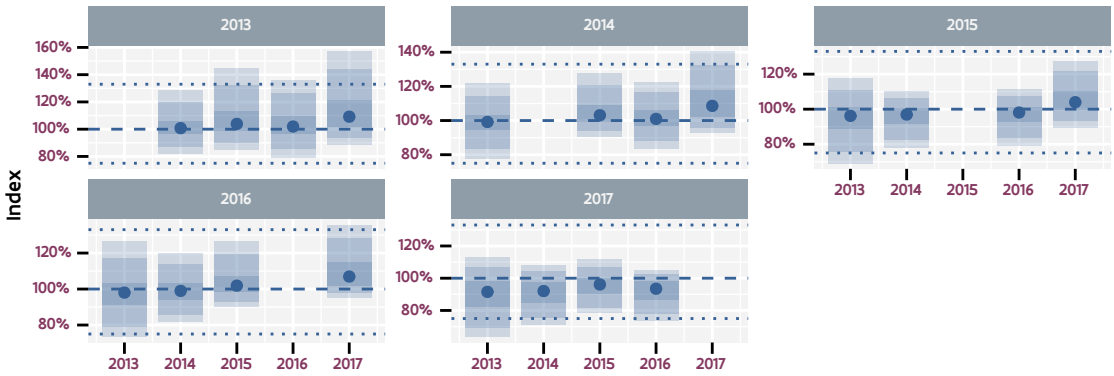

Figure 49.2: Indices for different reference years.

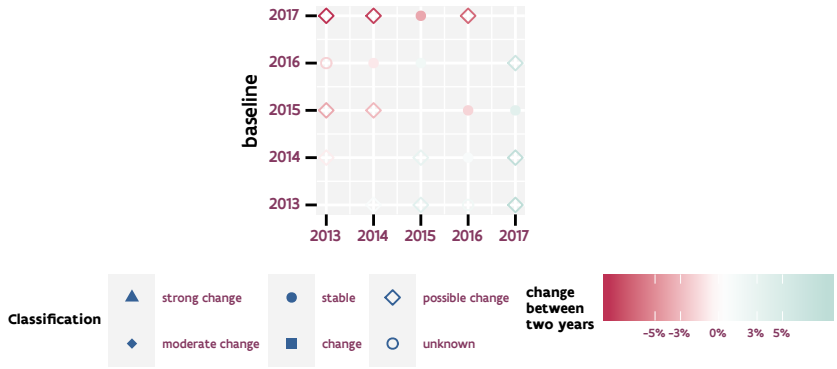

Figure 49.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

50 *ORIOLUS ORIOLUS* (LORIOT D'EUROPE)

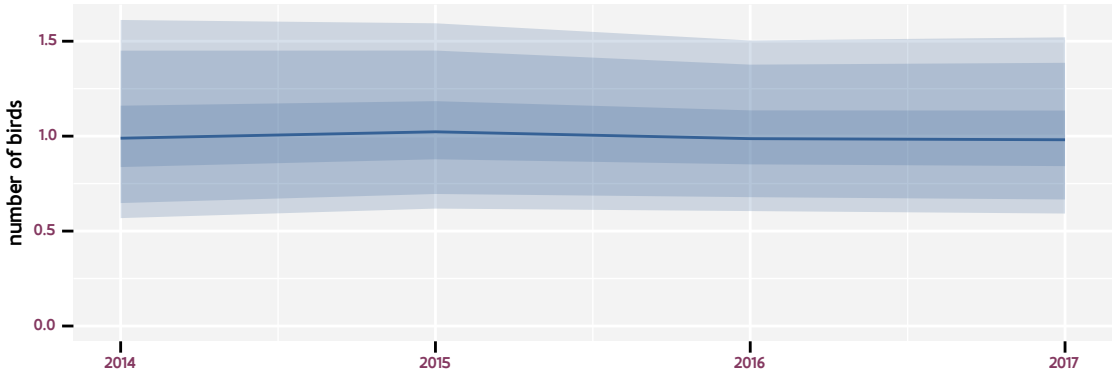

Figure 50.1: Estimated number of birds for an average point for *Oriolus oriolus* (Loriot d'Europe) based on a non-linear model. The linear yearly change (?) is -2.3% (-18.3%; +16.8%). The trend is linear.

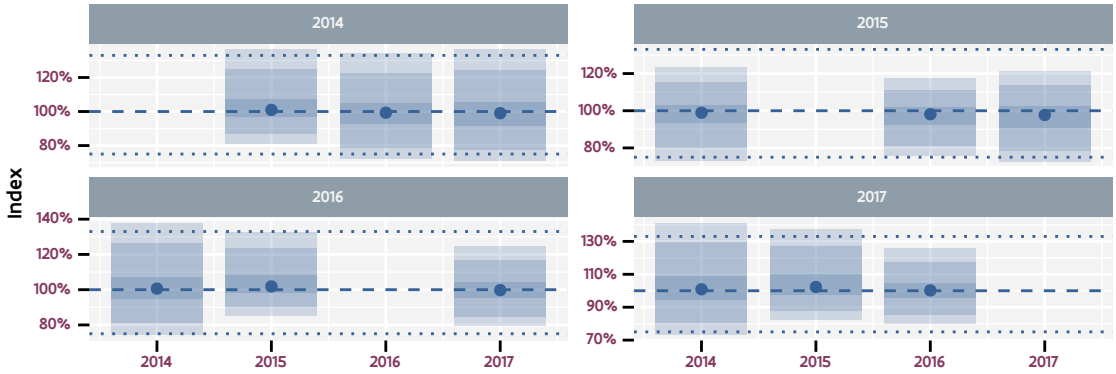

Figure 50.2: Indices for different reference years.

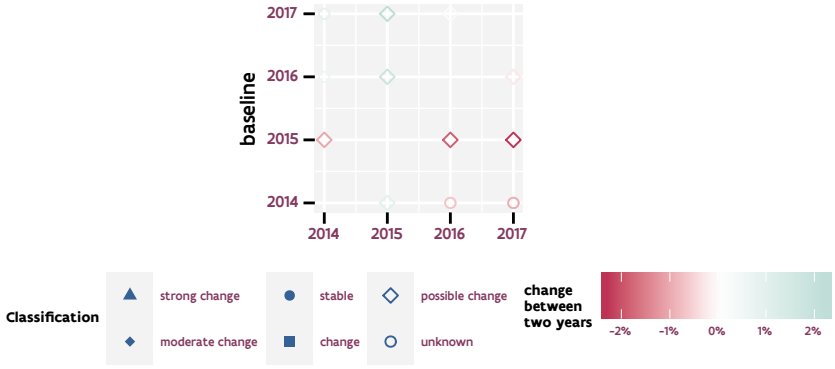

Figure 50.3: Relative change between years

51 *GARRULUS GLANDARIUS* (GEAI DES CHENES)

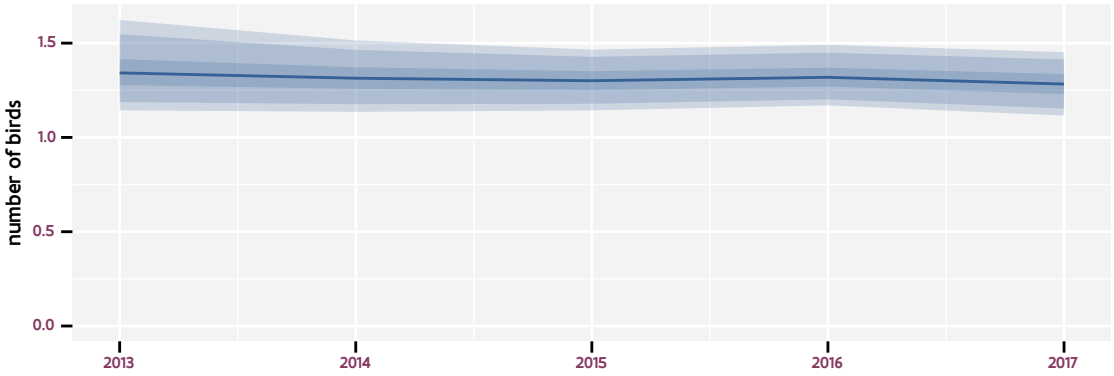

Figure 51.1: Estimated number of birds for an average point for *Garrulus glandarius* (Geai des chenes) based on a non-linear model. The linear yearly change (?-) is -2.2% (-9.0%; +5.3%). The trend is linear.

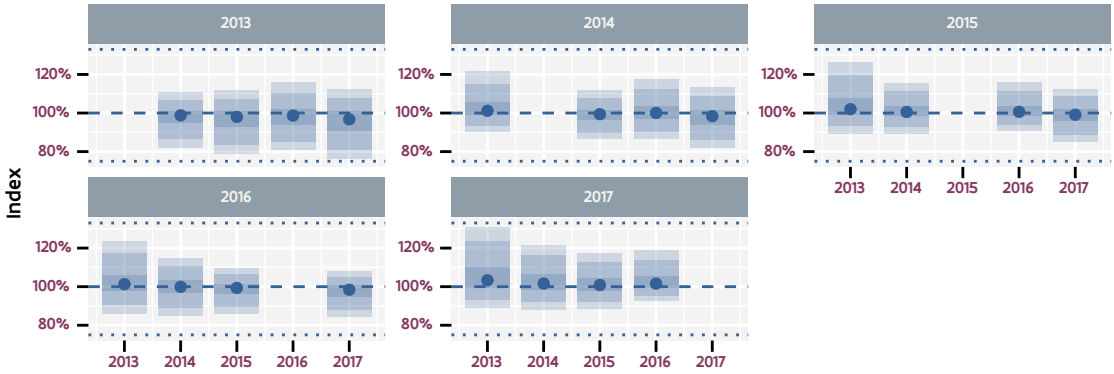

Figure 51.2: Indices for different reference years.

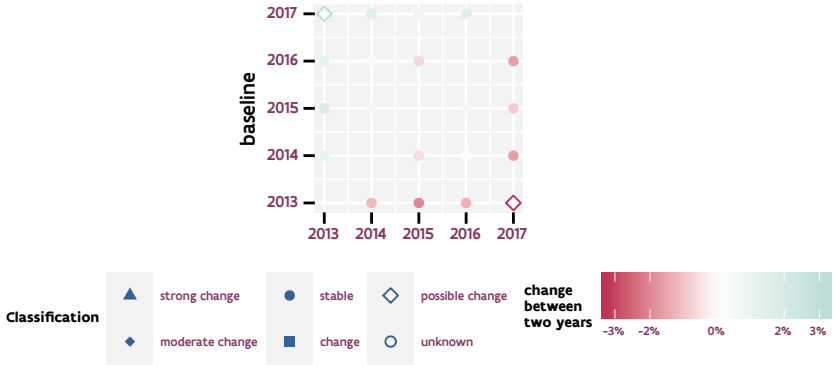

Figure 51.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

52 *PICA PICA* (PIE BAVARDE)

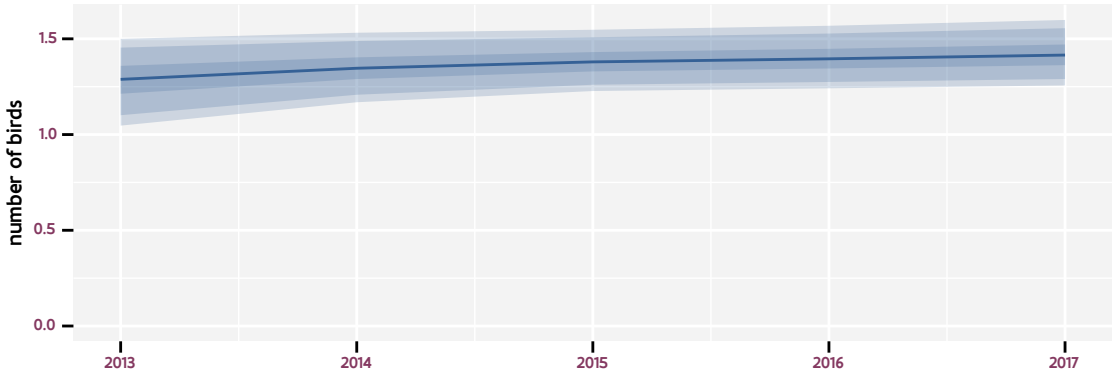

Figure 52.1: Estimated number of birds for an average point for *Pica pica* (Pie bavarde) based on a non-linear model. The linear yearly change (?+) is +3.9% (-2.3%; +10.5%). The trend is linear.

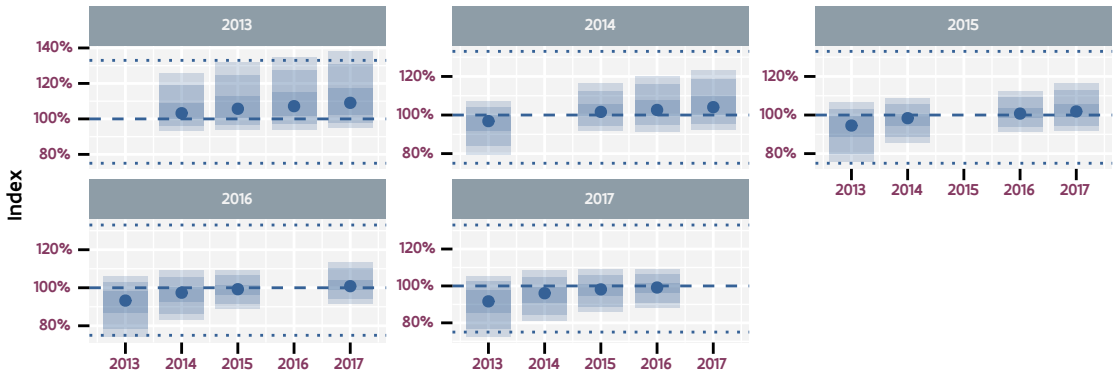

Figure 52.2: Indices for different reference years.

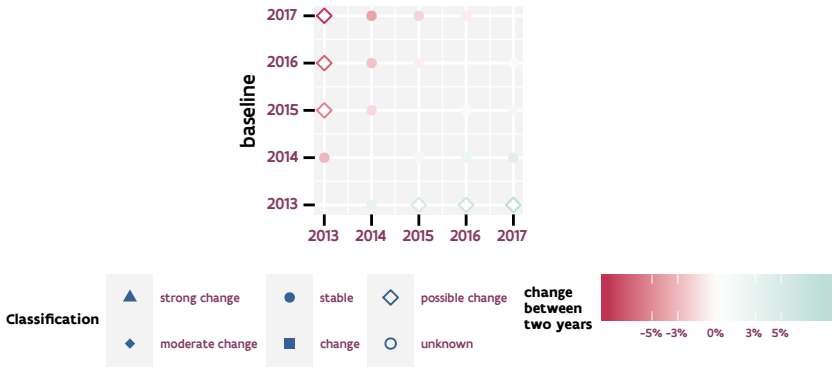

Figure 52.3: Relative change between years

53 *CORVUS MONEDULA* (CHOUCAS DES TOURS)

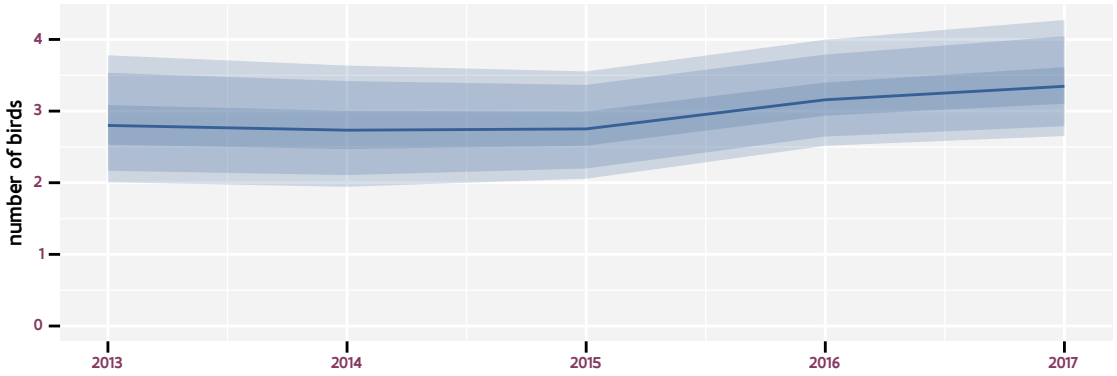

Figure 53.1: Estimated number of birds for an average point for *Corvus monedula* (Choucas des tours) based on a non-linear model. The linear yearly change (?+) is +9.9% (-1.9%; +23.1%). The trend is linear.

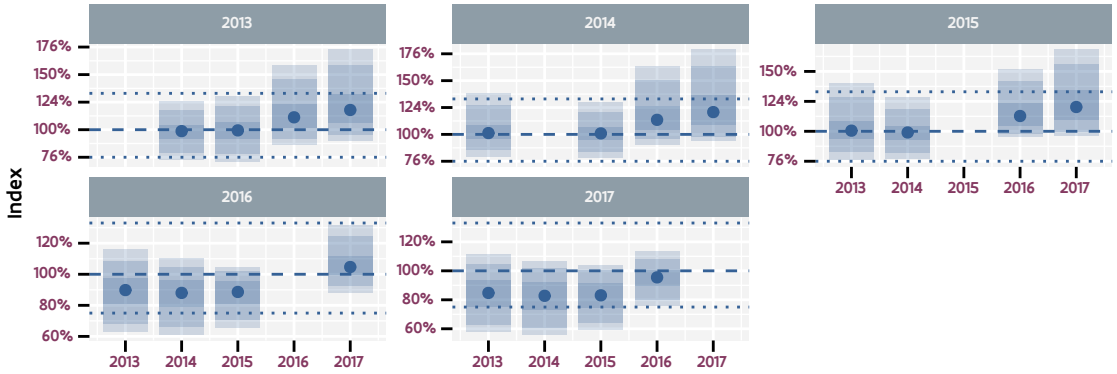

Figure 53.2: Indices for different reference years.

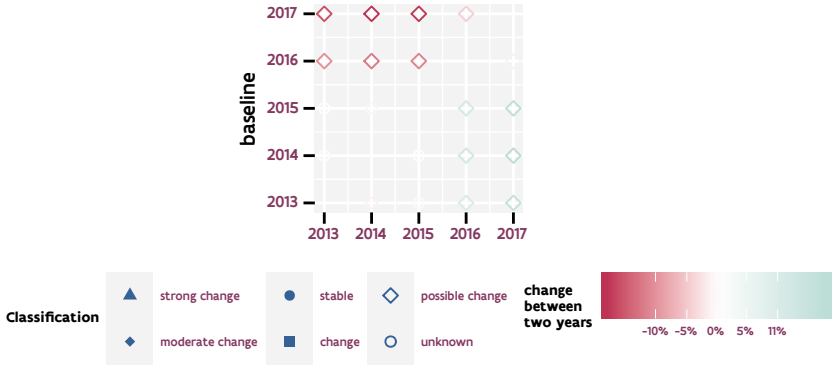

Figure 53.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

54 *CORVUS FRUGILEGUS* (CORBEAU FREUX)

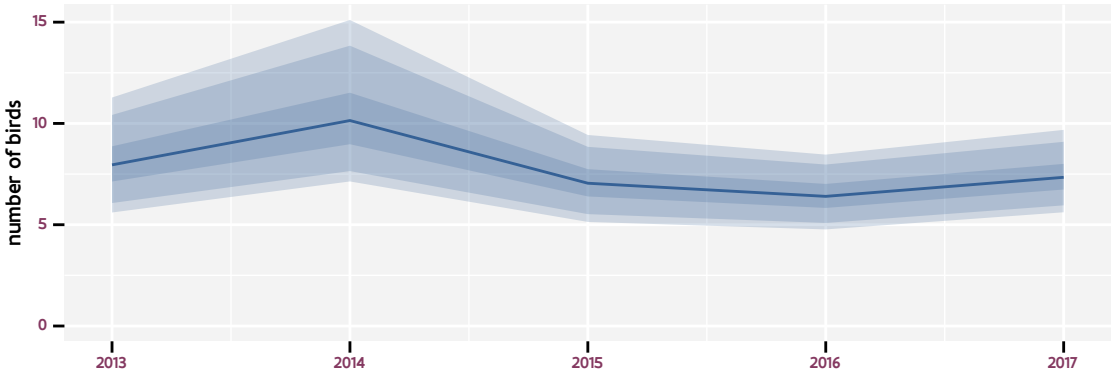

Figure 54.1: Estimated number of birds for an average point for *Corvus frugilegus* (Corbeau freux) based on a non-linear model. The linear yearly change (?-) is -6.9% (-18.0%; +5.7%). The trend is non-linear.

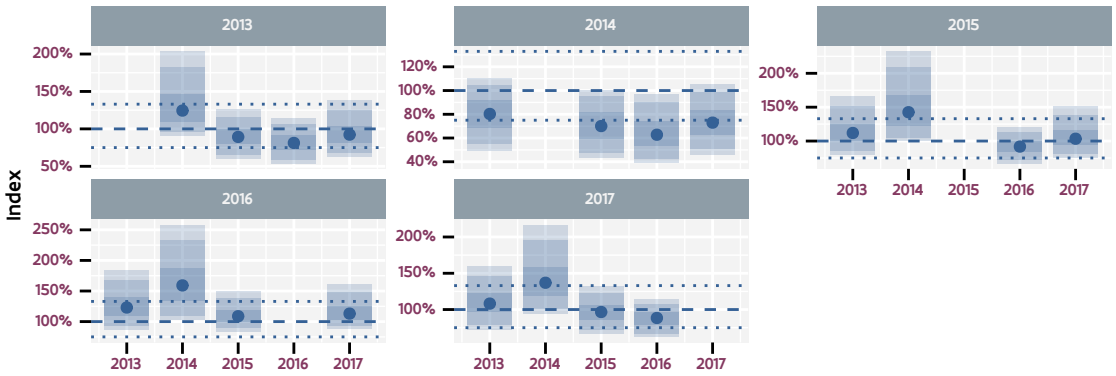

Figure 54.2: Indices for different reference years.

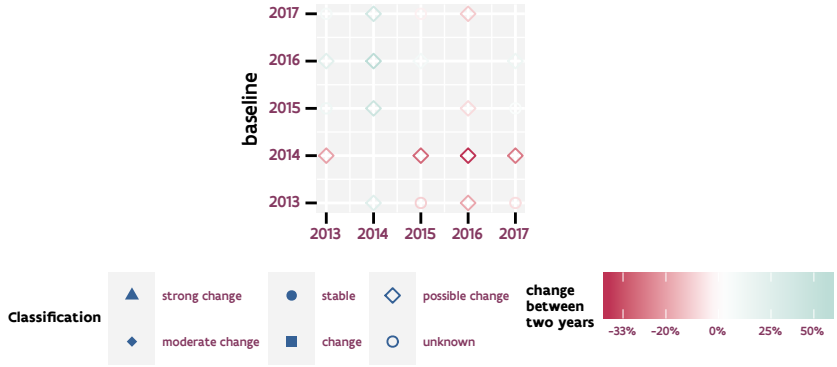

Figure 54.3: Relative change between years

55 *CORVUS CORONE* (CORNEILLE NOIRE)

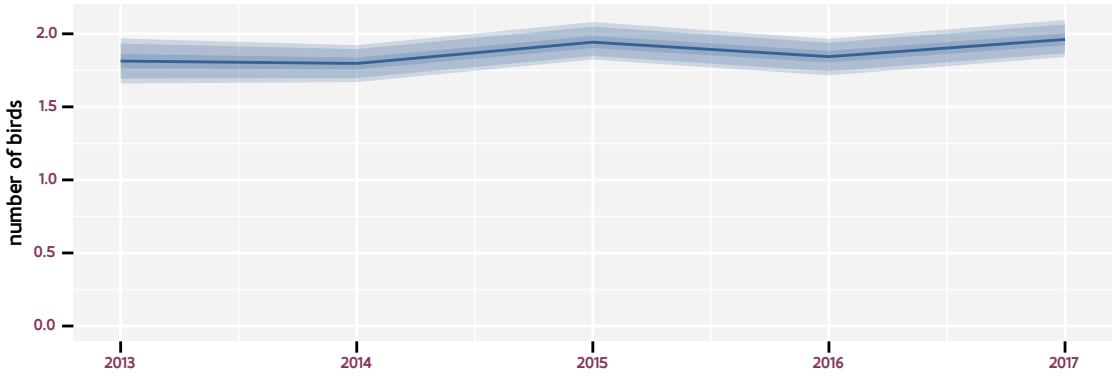

Figure 55.1: Estimated number of birds for an average point for *Corvus corone* (Corneille noire) based on a non-linear model. The linear yearly change (~) is +2.3% (-0.3%; +5.1%). The trend is possibly non-linear.

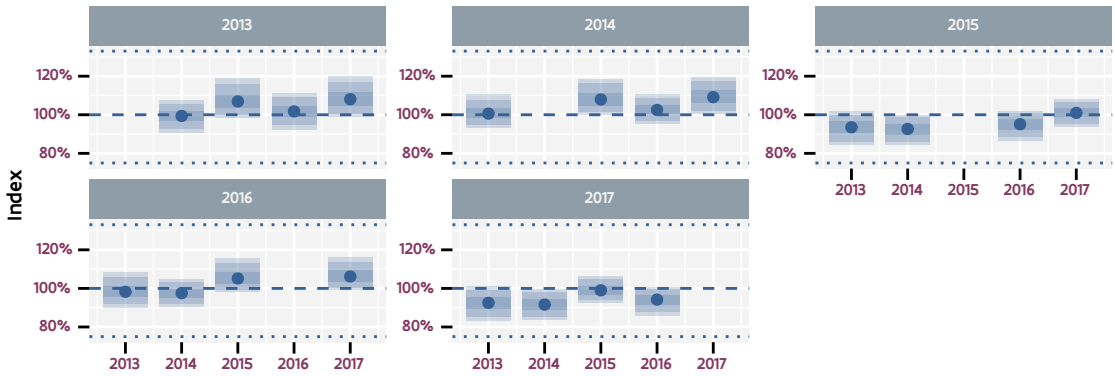

Figure 55.2: Indices for different reference years.

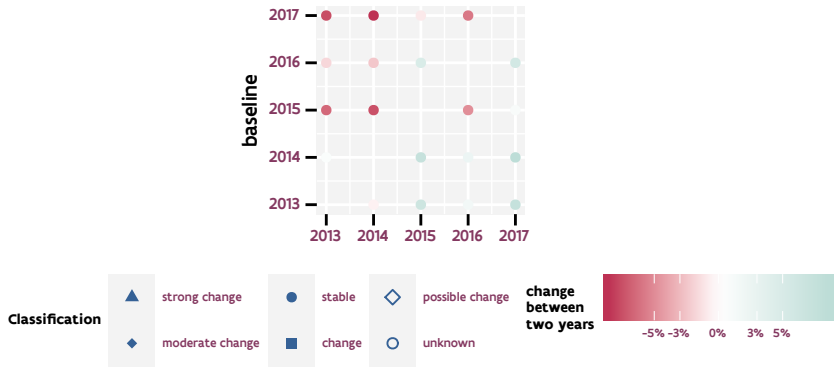

Figure 55.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

56 *STURNUS VULGARIS* (ETOURNEAU SANSONNET)

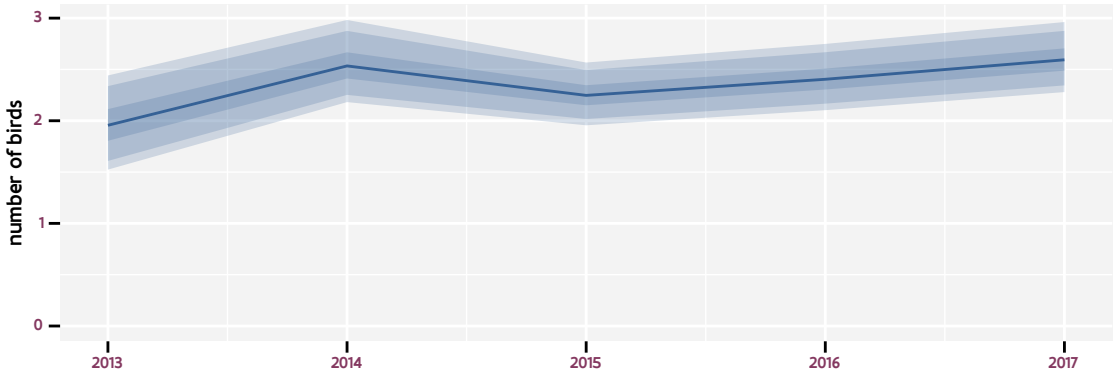

Figure 56.1: Estimated number of birds for an average point for *Sturnus vulgaris* (Etourneau sansonnet) based on a non-linear model. The linear yearly change (?+) is +4.8% (-0.8%; +10.6%). The trend is non-linear.

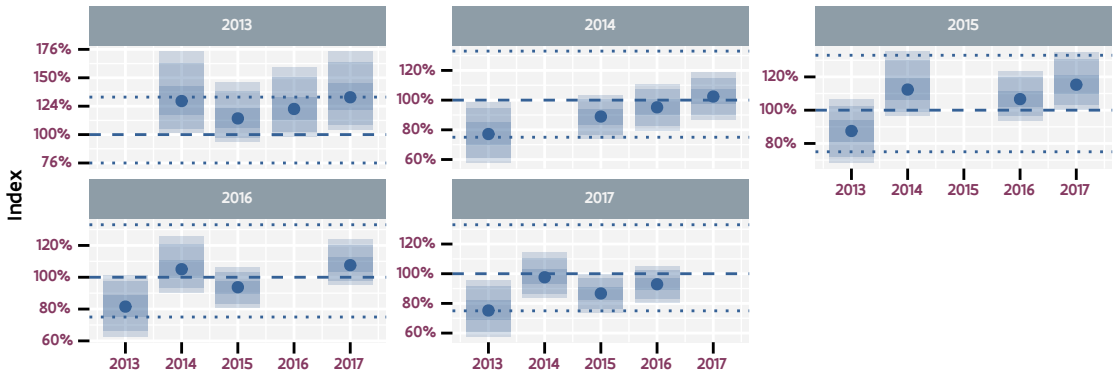

Figure 56.2: Indices for different reference years.

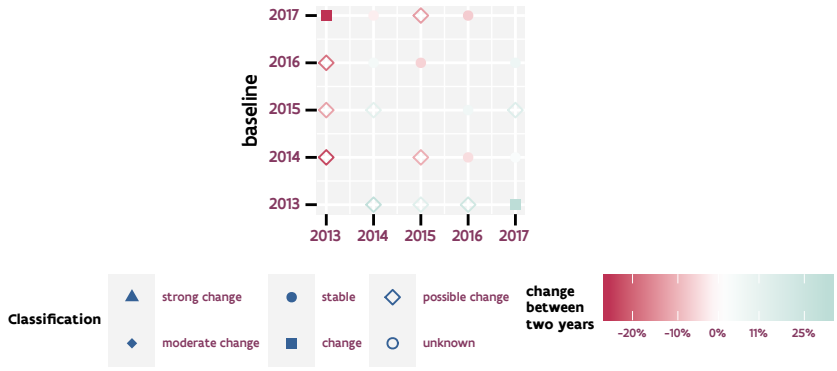

Figure 56.3: Relative change between years

57 *PASSER DOMESTICUS* (MOINEAU DOMESTIQUE)

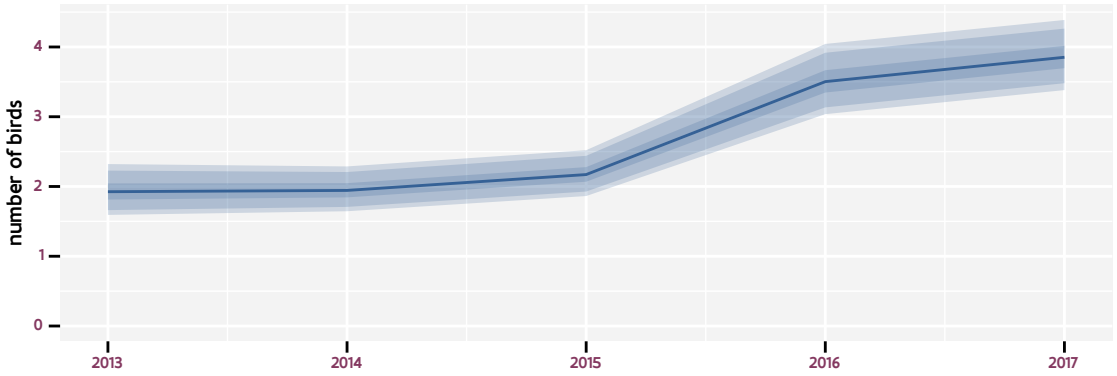

Figure 57.1: Estimated number of birds for an average point for *Passer domesticus* (Moineau domestique) based on a non-linear model. The linear yearly change (++) is +24.5% (+18.0%; +31.3%). The trend is non-linear.

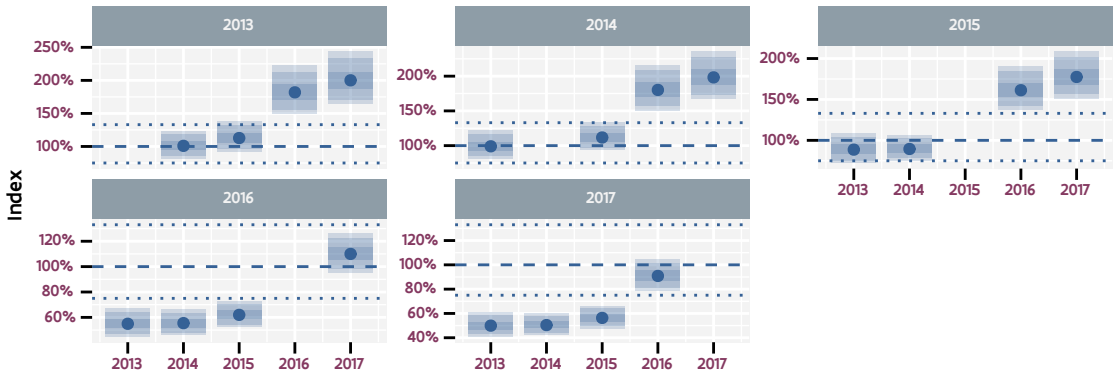

Figure 57.2: Indices for different reference years.

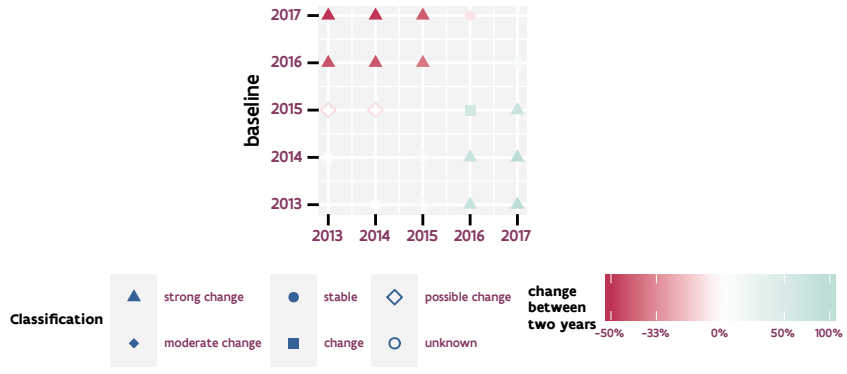

Figure 57.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

58 *FRINGILLA COELEBS* (PINSON DES ARBRES)

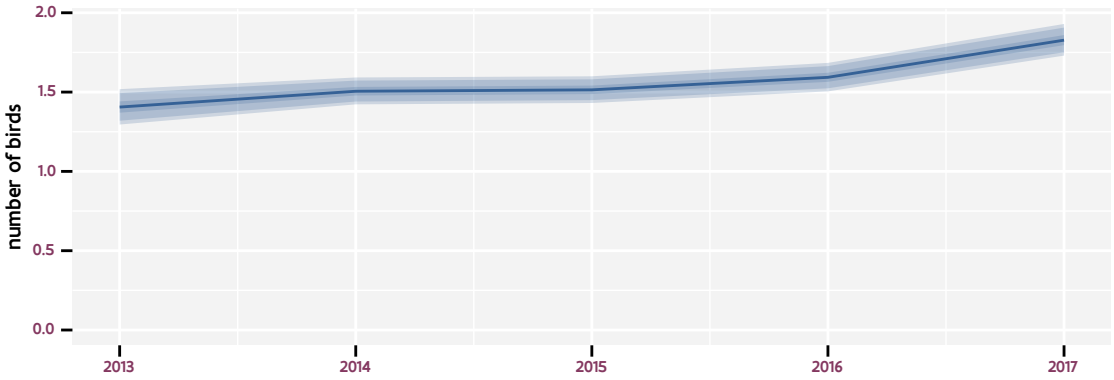

Figure 58.1: Estimated number of birds for an average point for *Fringilla coelebs* (Pinson des arbres) based on a non-linear model. The linear yearly change (+) is +6.8% (+4.5%; +9.2%). The trend is non-linear.

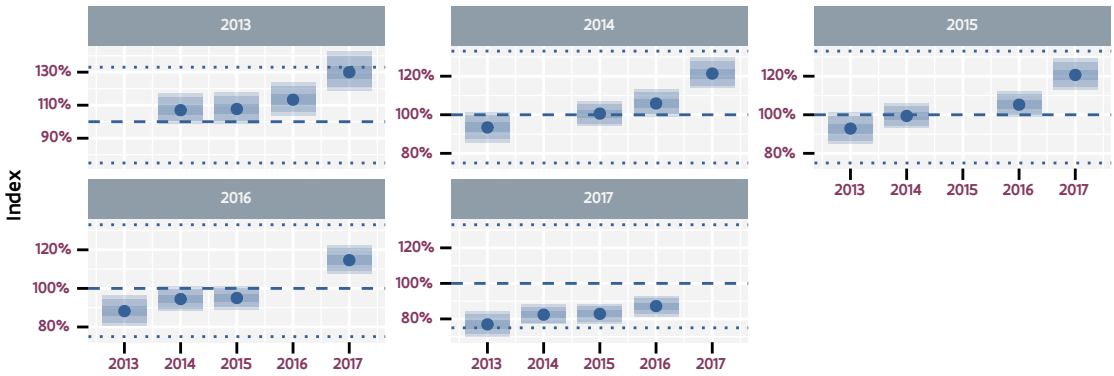

Figure 58.2: Indices for different reference years.

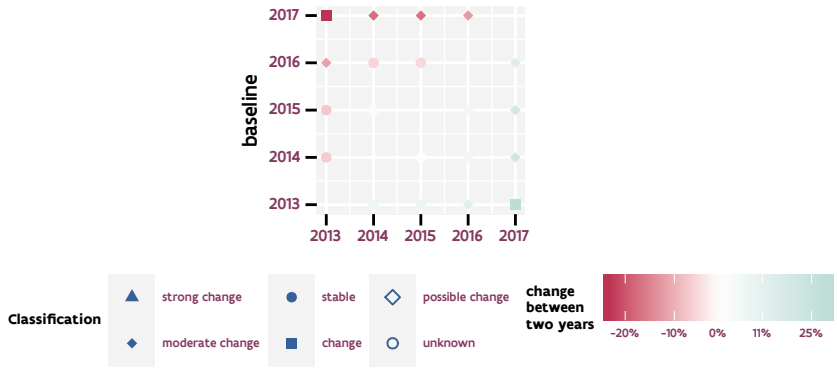

Figure 58.3: Relative change between years

59 *SERINUS SERINUS* (SERIN CINI)

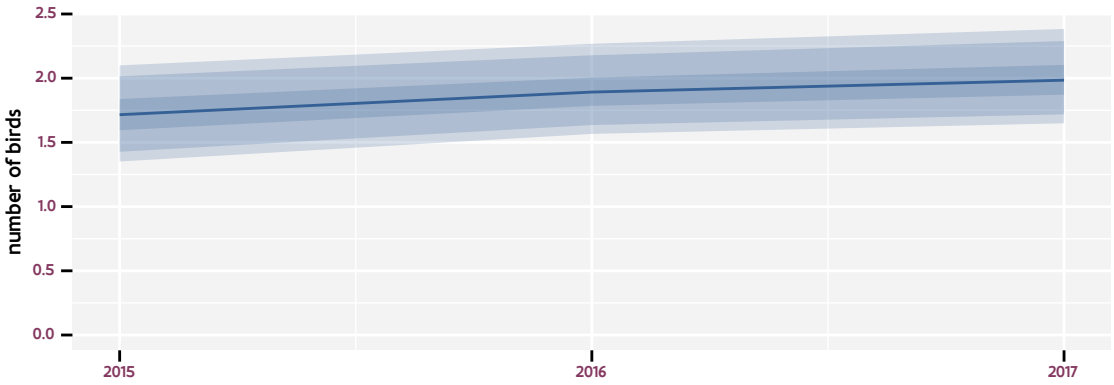

Figure 59.1: Estimated number of birds for an average point for *Serinus serinus* (Serin cini) based on a non-linear model. The linear yearly change (?+) is +12.3% (-3.5%; +30.9%). The trend is linear.

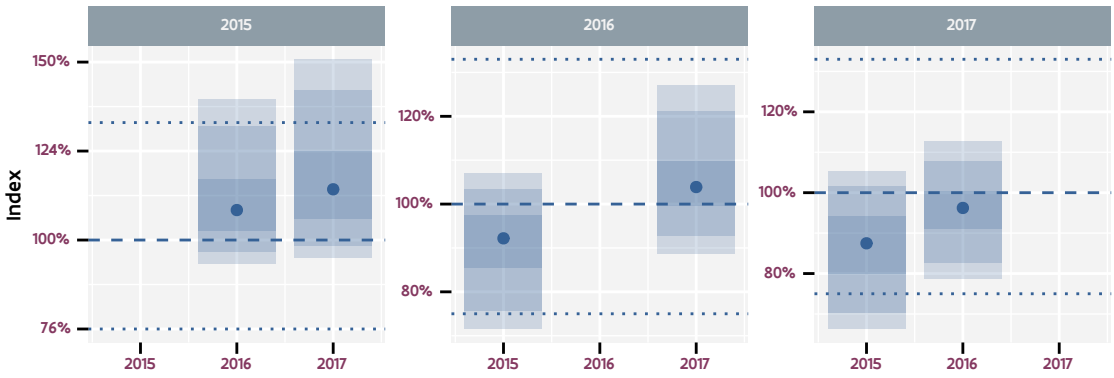

Figure 59.2: Indices for different reference years.

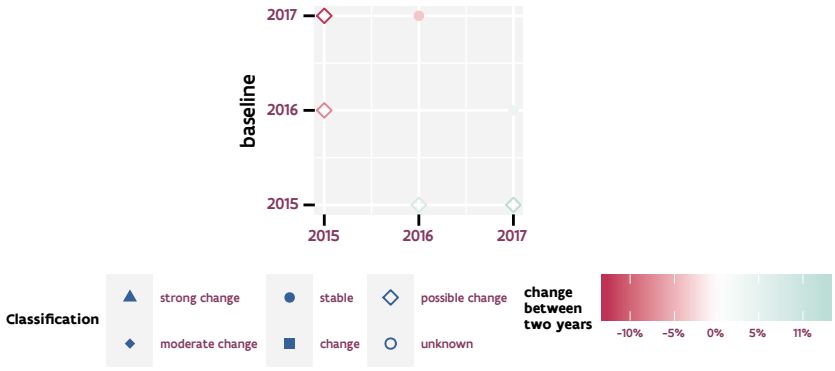

Figure 59.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

60 *CHLORIS CHLORIS* (VERDIER D'EUROPE)

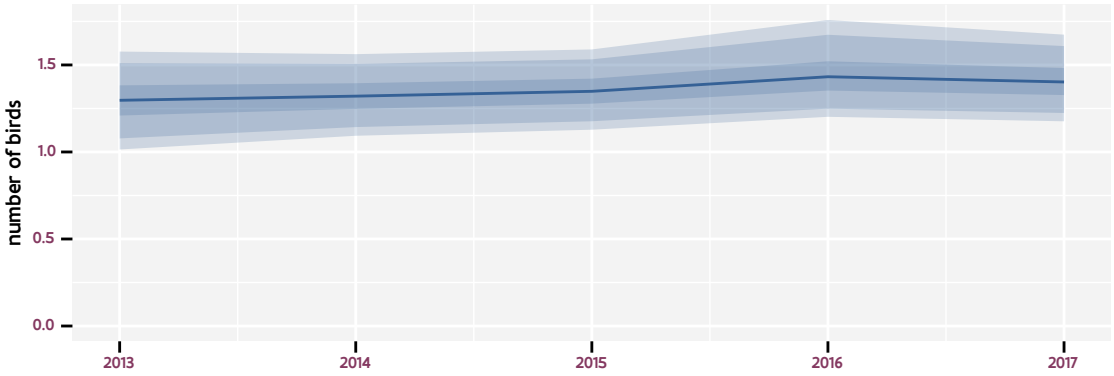

Figure 60.1: Estimated number of birds for an average point for *Chloris chloris* (Verdier d'Europe) based on a non-linear model. The linear yearly change (?+) is +4.6% (-4.3%; +14.6%). The trend is linear.

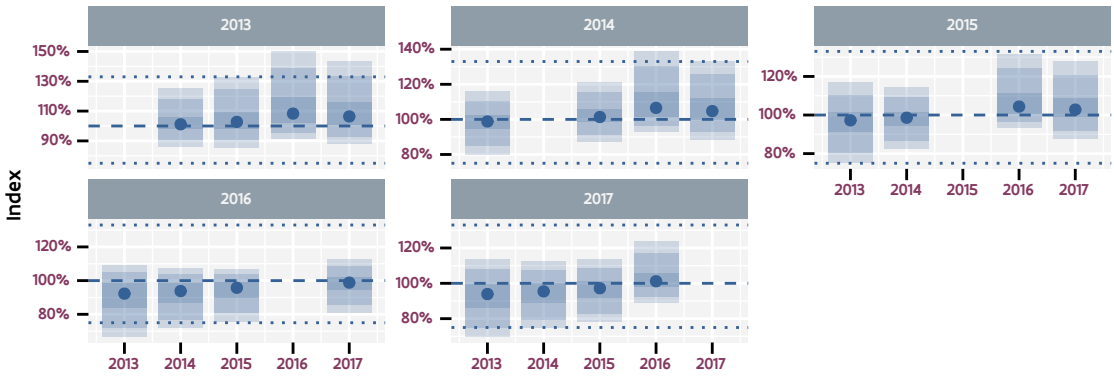

Figure 60.2: Indices for different reference years.

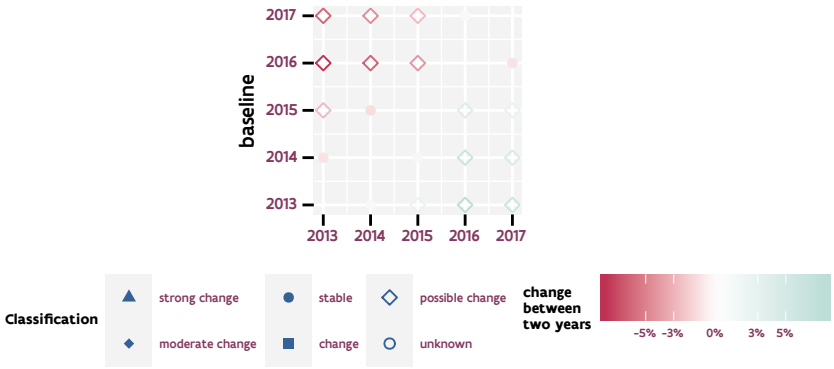

Figure 60.3: Relative change between years

61 *CARDUELIS CARDUELIS* (CHARDONNERET ELEGANT)

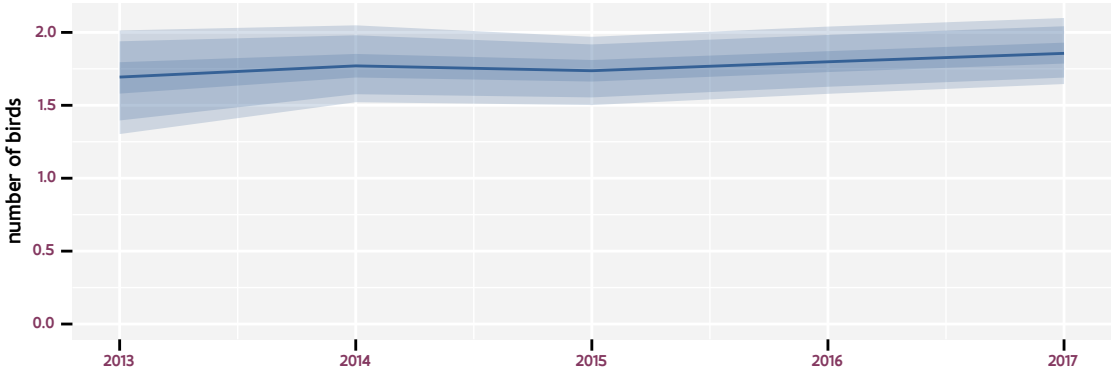

Figure 61.1: Estimated number of birds for an average point for *Carduelis carduelis* (Chardonneret elegant) based on a non-linear model. The linear yearly change (?+) is +4.2% (-2.6%; +11.7%). The trend is linear.

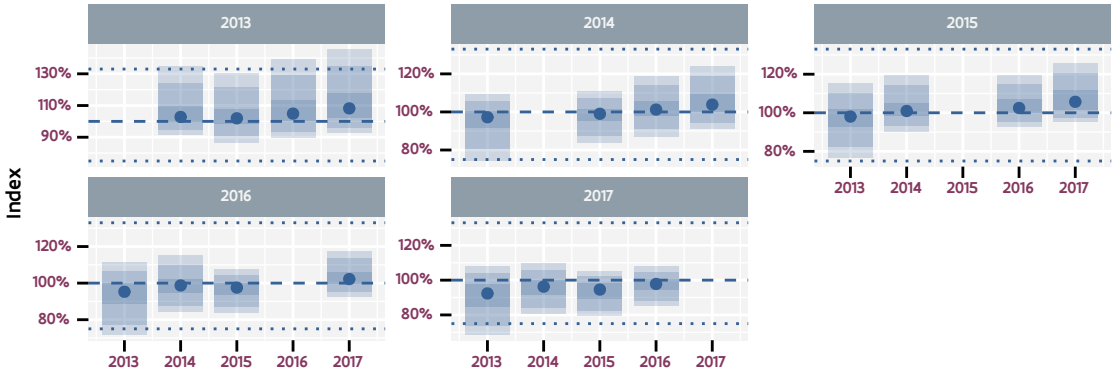

Figure 61.2: Indices for different reference years.

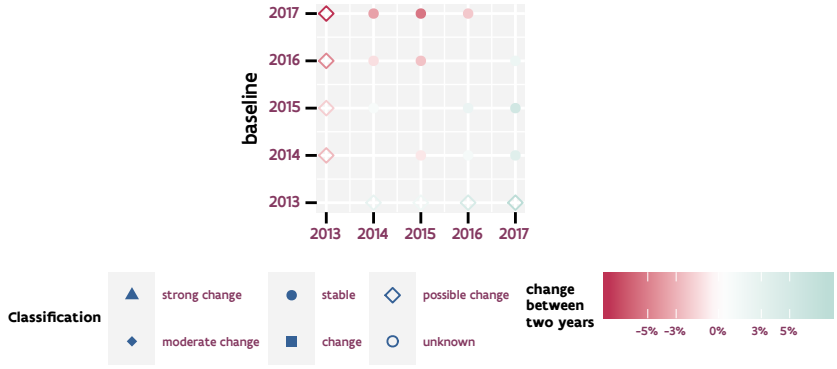

Figure 61.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

62 *LINARIA CANNABINA* (LINOTTE MELODIEUSE)

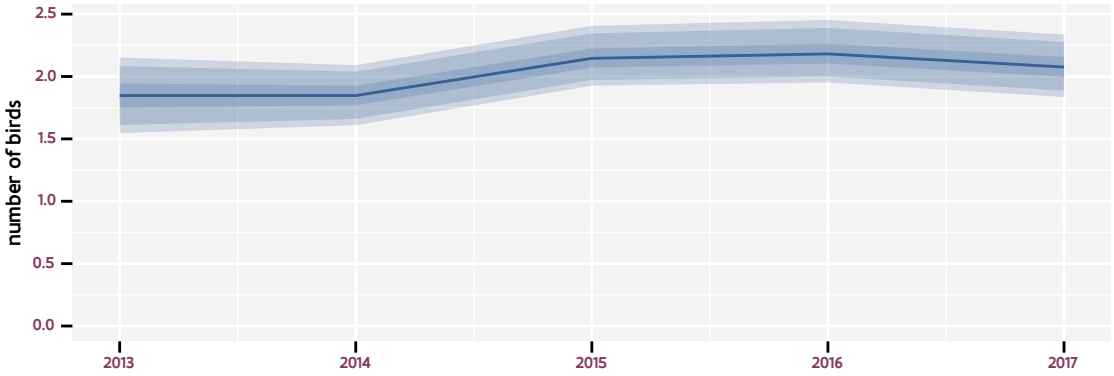

Figure 62.1: Estimated number of birds for an average point for *Linaria cannabina* (Linotte melodieuse) based on a non-linear model. The linear yearly change (?+) is +4.9% (-0.5%; +10.6%). The trend is possibly non-linear.

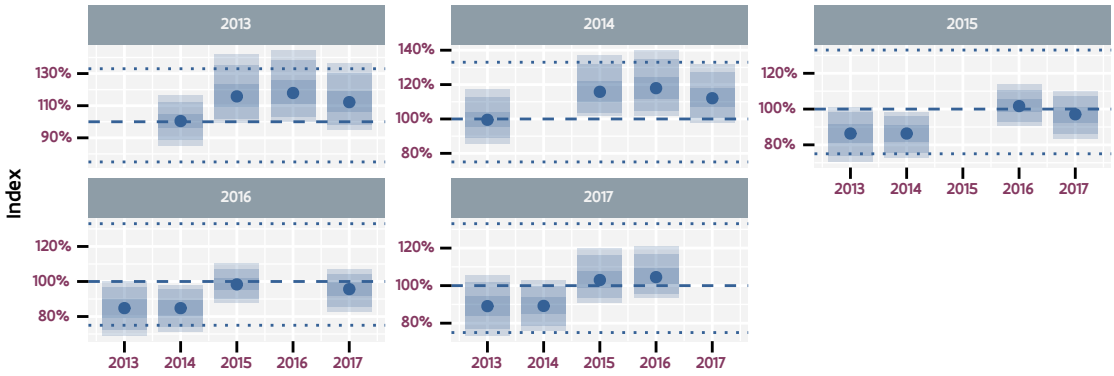

Figure 62.2: Indices for different reference years.

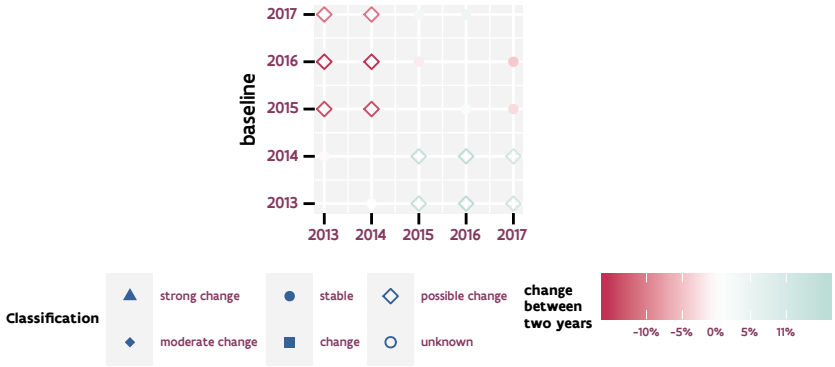

Figure 62.3: Relative change between years

63 *COCCOTHRAUSTES COCCOTHRAUSTES* (GROSBEC CASSE-NOYAUX)

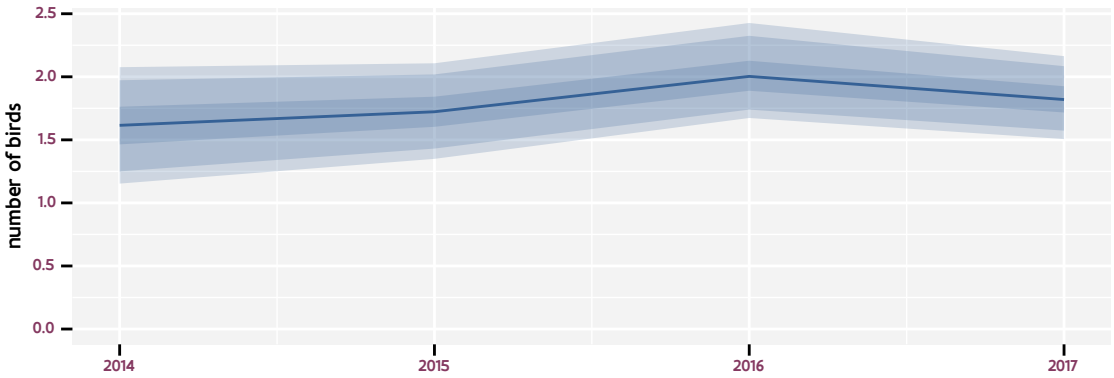

Figure 63.1: Estimated number of birds for an average point for *Coccothraustes coccothraustes* (Grosbec casse-noyaux) based on a non-linear model. The linear yearly change (?) is +5.6% (-7.0%; +20.4%). The trend is possibly non-linear.

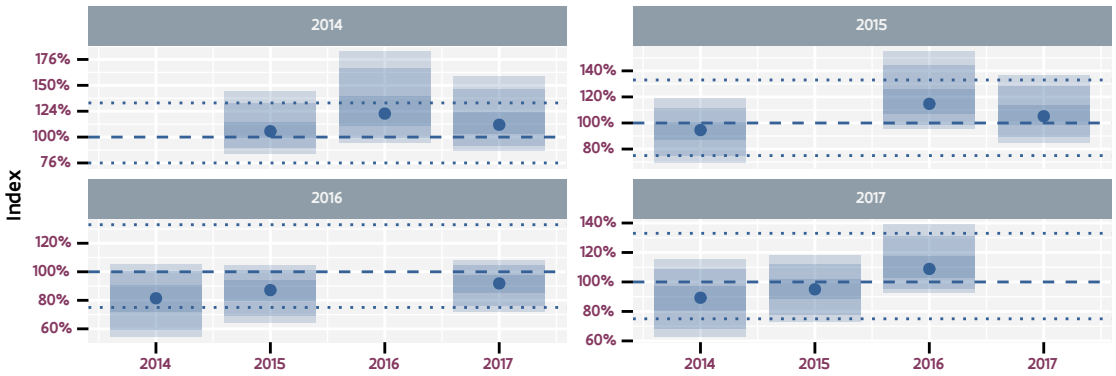

Figure 63.2: Indices for different reference years.

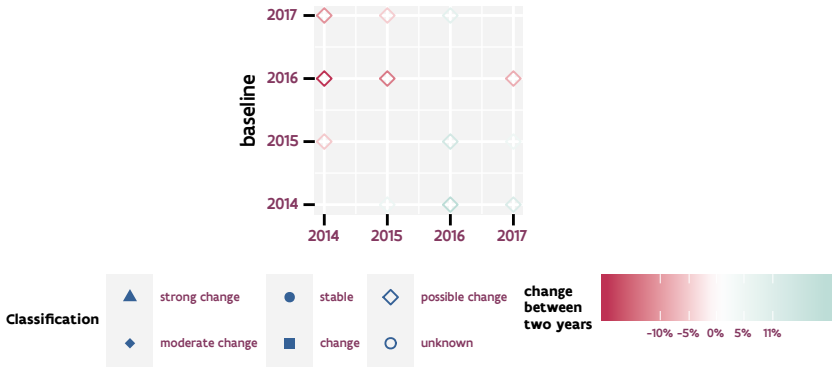

Figure 63.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

64 *EMBERIZA CITRINELLA* (BRUANT JAUNE)

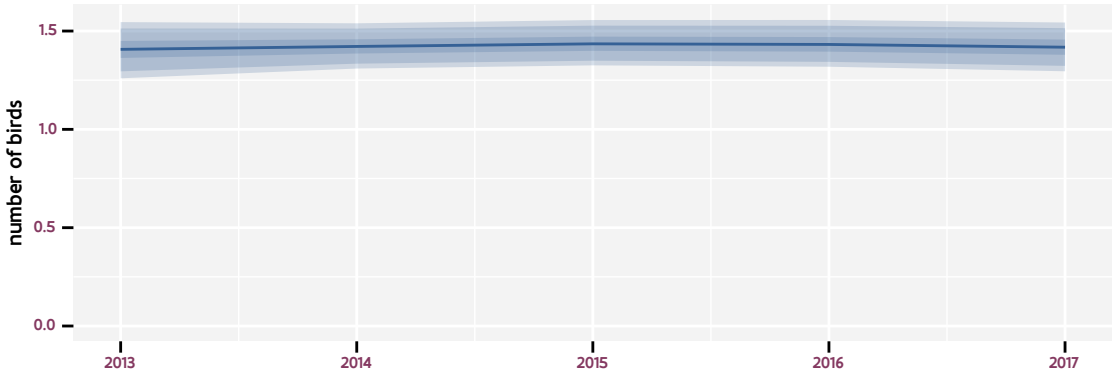

Figure 64.1: Estimated number of birds for an average point for *Emberiza citrinella* (Bruant jaune) based on a non-linear model. The linear yearly change (~) is +0.4% (-3.8%; +4.7%). The trend is possibly non-linear.

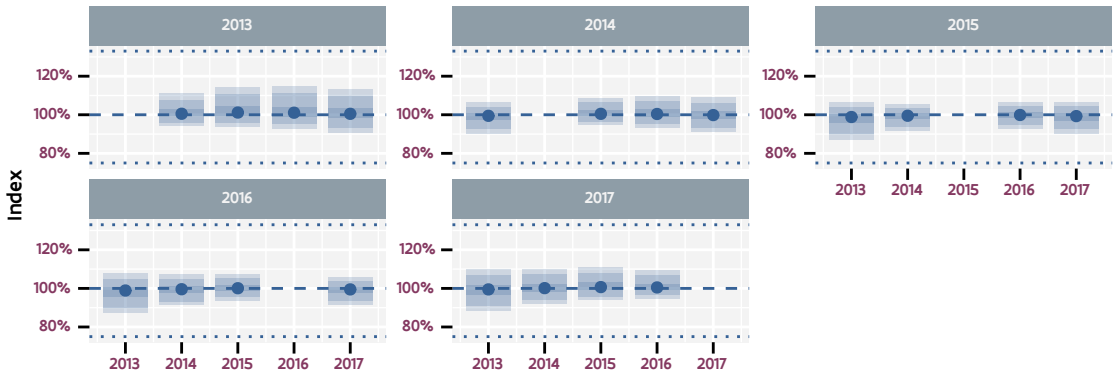

Figure 64.2: Indices for different reference years.

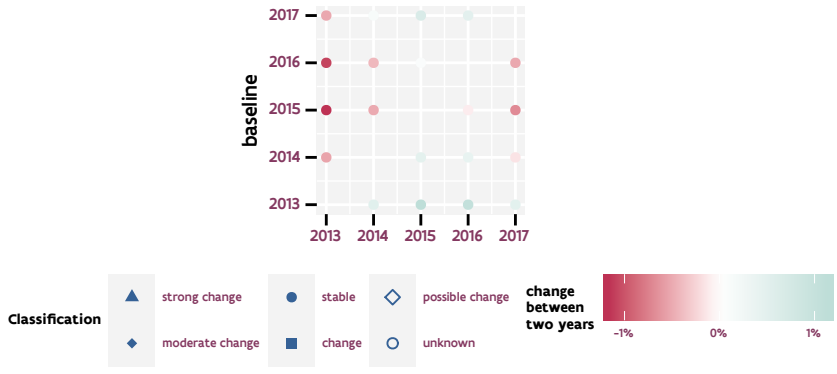

Figure 64.3: Relative change between years

65 *EMBERIZA CALANDRA* (BRUANT PROYER)

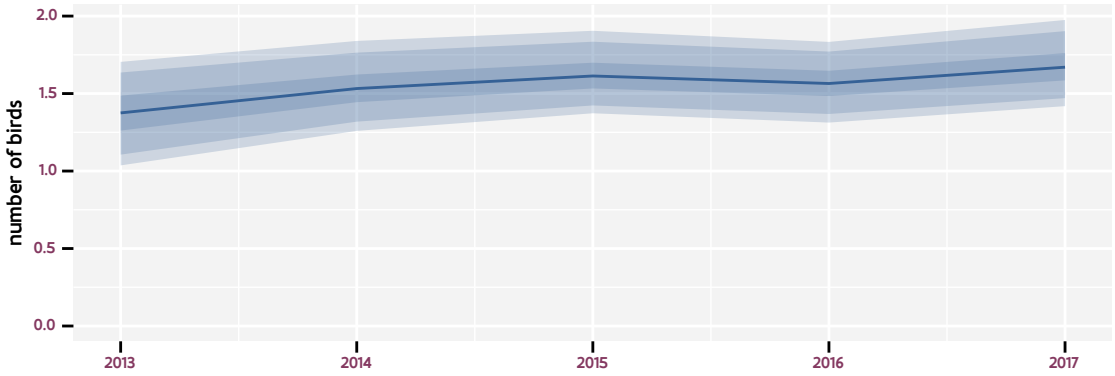

Figure 65.1: Estimated number of birds for an average point for *Emberiza calandra* (Bruant proyer) based on a non-linear model. The linear yearly change (?+) is +6.2% (-1.8%; +14.8%). The trend is possibly non-linear.

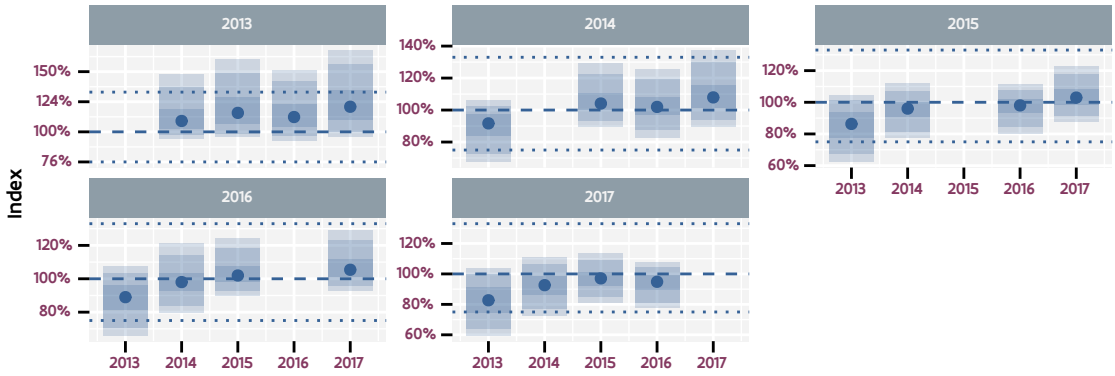

Figure 65.2: Indices for different reference years.

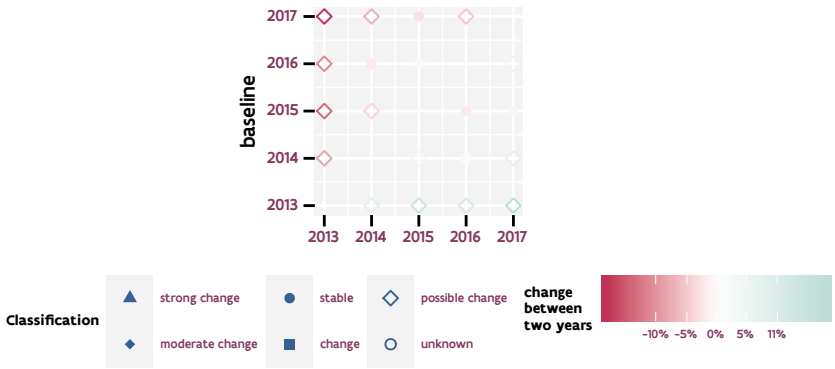

Figure 65.3: Relative change between years

https://doi.org/10.21436/inbor.16917100

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