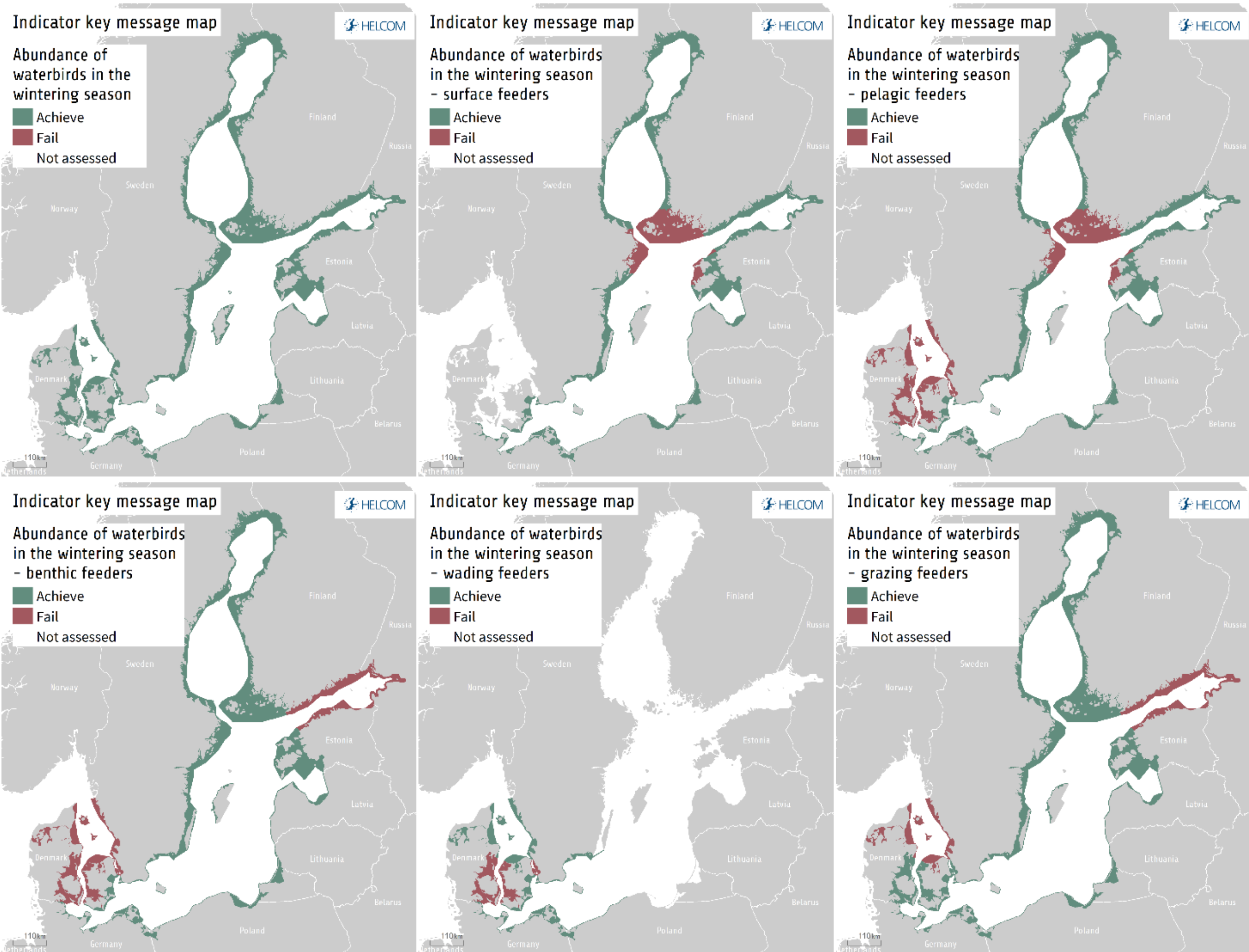
HELCOM core indicator report

July 2018

Abundance of waterbirds in the wintering season

Key Message

This core indicator evaluates the status of abundance of wintering waterbirds in the Baltic Sea region. The wintering waterbirds are considered to reflect good status when at least 75% of the considered species deviate less than 30% downwards (species laying more than one egg per year) or 20% downwards (species laying one egg per year) from the baseline condition during the reference period 1991-2000.



Key message figure 1. Status of the indicator 'abundance of waterbirds in the wintering season'. The assessment is only carried out for coastal areas (not offshore). Since harmonized offshore monitoring could not be conducted for this assessment period and several species show strong declines in the whole offshore area (Skov et al. 2011), an overall assessment of birds is not possible and the data and results are based only on land based observations. The assessment is for the entire Baltic Sea – including all species currently assessed (top left, Scale 1 HELCOM assessment units, defined in the HELCOM Monitoring and Assessment Strategy Attachment 4) and for seven sudivisions of the Baltic Sea (see Assessment unit figure 1). Results for the species groups are based on the trends of individual species: surface feeders (top middle), pelagic feeders (top right), benthic feeders (bottom left), wading feeders (bottom middle) and grazing feeders (bottom right). NOTE: due to the size of figures within the composite image details in some coastal areas are better visualised via the HELCOM Map and Data Service (MADS). Click here to access interactive **at the HELCOM Map and Data Service:** Abundance of waterbirds in the breeding season, surface feeders, pelagic feeders, benthic feeders, wading feeders, grazing feeders.

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The current evaluation is based on data from coastal surveys of 22 waterbird species for the assessment period 2011-2016. Waterbirds wintering in offshore parts of the Baltic are currently not represented in the indicator due to lacking data, but the inclusion of those birds is under development with the aim to have data from offshore surveys included by 2019.

In the period 2011-2016, the abundance of wintering waterbirds in the Baltic Sea was in a good status, because 82% of the species assessed achieved the threshold value (at least 75% of species meeting threshold value indicates good status). The evaluation could be applied to five species groups of which three groups, namely surface feeders, pelagic feeders and wading feeders, achieved good status (≥75% of species meeting threshold value), whereas benthic feeders and grazing feeders did not reach the threshold value. These assessments only reflect the status of coastal waters, because waterbird species wintering predominantly in the open sea are not considered.

The indicator was also applied to seven subdivisions (aggregations of up to four sub-basins). A good status of wintering waterbirds was observed in four of the subdivisions (Bornholm Group, Gotland Group. Gulf of Finland, Bothnian Group, but could not be achieved in three subdivisions (Kattegat, Belt Group, Aland Group). Subdivision assessments for species groups mostly reflect the same pattern as the overall assessment, but showed more variation.

The confidence of the evaluations is estimated to be **intermediate**.

The indicator is applicable in the waters of all the countries bordering the Baltic Sea.

Relevance of the core indicator

As predators at high levels in the food web, but also as herbivores that may remove large proportions of macrophytes by grazing, waterbirds are an integral part of the Baltic marine ecosystem.

The indicator follows temporal changes in the abundance of key waterbird species, which have functional significance in the marine ecosystem and respond to numerous pressures, many of them caused by human activities. Thus, the indicator gives an overall view of the state of marine birds in the Baltic Sea and reflects the cumulative impact of pressures.

Policy relevance of the core indicator

	BSAP Segment and Objectives	MSFD Descriptors and Criteria
Primary link	Biodiversity • Viable populations of species. • Thriving and balanced communities of plants and animals.	D1 Biodiversity D1C2 The population abundance of the species is not adversely affected due to anthropogenic pressures, such that its long-term viability is ensured.
Secondary link	Eutrophication • Natural Distribution and occurrence of plants and animals.	D1 Biodiversity D1C4 The species distributional range, where relevant, pattern is in line with prevailing physiographic and climatic conditions. D4 Food-web D4C1 The diversity of the trophic guild is not adversely affected due to anthropogenic pressures. D4C2 The balance of total abundance between the trophic guilds is not adversely affected due to anthropogenic pressures.
Other relevant legislation: EU Birds Directive (migrating species Article 4 (2); red-throated diver, black-throated diver, Slavonian grebe, whooper swan, Steller's eider, smew, little gull listed in Annex I); BD Article 12 report, parameter "Population trend"; Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA).		

Cite this indicator

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Abundance of waterbirds in the wintering season HELCOM core indicator 2018 (pdf)

Results and Confidence

Abundance – Whole Baltic Sea scale

The abundance of wintering waterbirds in the entire Baltic Sea achieved good status in the assessment period 2011-2016, because the result shows that 82% of the species' abundance deviated less than 30% from the baseline, the threshold value is 75% of species.

The evaluation is based on monitoring data of 22 species, which are collected in the frame of International Waterbird Census (IWC) as well as boat surveys in parts of Polish and Finnish waters (Results table 1).

Only 4 of the 22 species assessed did not meet the threshold value in the assessment period 2011-2016, namely the common pochard, Steller's eider, Bewick's swan and the Eurasian coot. These four species' index values deviated more than 30% downwards from the baseline value, i.e. the average index value in the ten-year reference period 1991-2000 (Results table 1). The other 18 species that were assessed (i.e. 82%) indicate good status, as the species' index values deviated less than 30% from the baseline value.

In some species, the average index value for the assessment period exceeded the reference value by more than 30%. While still representing good status, the very high results for black-headed gull, smew, great cormorant, common goldeneye and Eurasian teal may indicate imbalance in the environment (including climate change).

Regarding species groups, the evaluation results are not consistent. Species groups indicating good status, i.e. at least 75% of species deviate less than 30% from the baseline are:

- surface feeders: 4 out of 4 species (100%) indicate good status,
- pelagic feeders: 5 out of 5 species (100%) indicate good status and
- wading feeders: 1 out of 1 species (100%) indicates good status.

Species groups that did not achieve the threshold value:

- benthic feeders: 3 out of 5 species (60%) indicate good status, and
- grazing feeders: 5 out of 7 species (71%) indicate good status.

Detailed results per species are provided (Results table 1).

In addition to index values, Results table 1 shows trends calculated for the entire period 1991-2016 as supporting information to interpret the status evaluation results for the assessment period 2011-2016. Almost all species (from all species groups) indicating good status are increasing or stable, only goosander is significantly declining. A strong increase is only seen in smew. Out of the four species not achieving good status, three are significantly declining, most strongly Steller's eider. The trend of Bewick's swan is uncertain, though the slope also indicates a decrease. Altogether, out of the 22 species assessed, five show significant positive trends and four significant negative trends, while all the other species appear to be stable or show non-significant trends.

It is important to consider that the results reflect the status of waterbirds along the coastlines (except for some Polish and Finish offshore counts included). Therefore, species only marginally wintering in coastal marine areas – four species of seaducks (common eider, long-tailed duck, common scoter, velvet scoter), two species of grebes (red-necked grebe, Slavonian grebe), two species of divers (red-throated diver, black-throated diver) and three species of alcids (razorbill, common guillemot, black guillemot) are not considered in the indicator (this 2018 version), because only a very small fraction of their Baltic Sea winter population is covered by the data which is currently restricted to land-based counts and does not represent birds wintering offshore. For example, the strong declines reported for red-throated diver, long-tailed duck and velvet scoter in the Baltic (Skov al. 2011) and leading to the classification as endangered species by HELCOM (2013) were not reflected in an earlier analysis of this indicator (HELCOM 2017).

Graphs showing index values and trends are provided in Results figure 1.

Results table 1. Evaluation of the status of wintering waterbirds in the entire Baltic Sea for the period 2011-2016. Index values (single years and mean) are scaled to the average of the reference period (1991-2000, index value set to 1). Good status is shown by green colour, if the threshold level of 0.7 (0.8 in species laying only one egg per year) is met by the geometric mean 2011-2016. If the index value exceeds 1.3 indicating a large abundance increase the status is still considered good but indicated in orange. Red colour means that the species is not in good status. Trends for the period 1991-2016 are shown as ↑↑ (strong increase), ↑ (moderate increase), → (stable), ↓ (moderate decline) and ↓↓ (strong decline), with * when p<0.05 and ** when p<0.01 (for details see Results table 2). In species marked (wt) the GAM was calculated without temperature as a covariate.

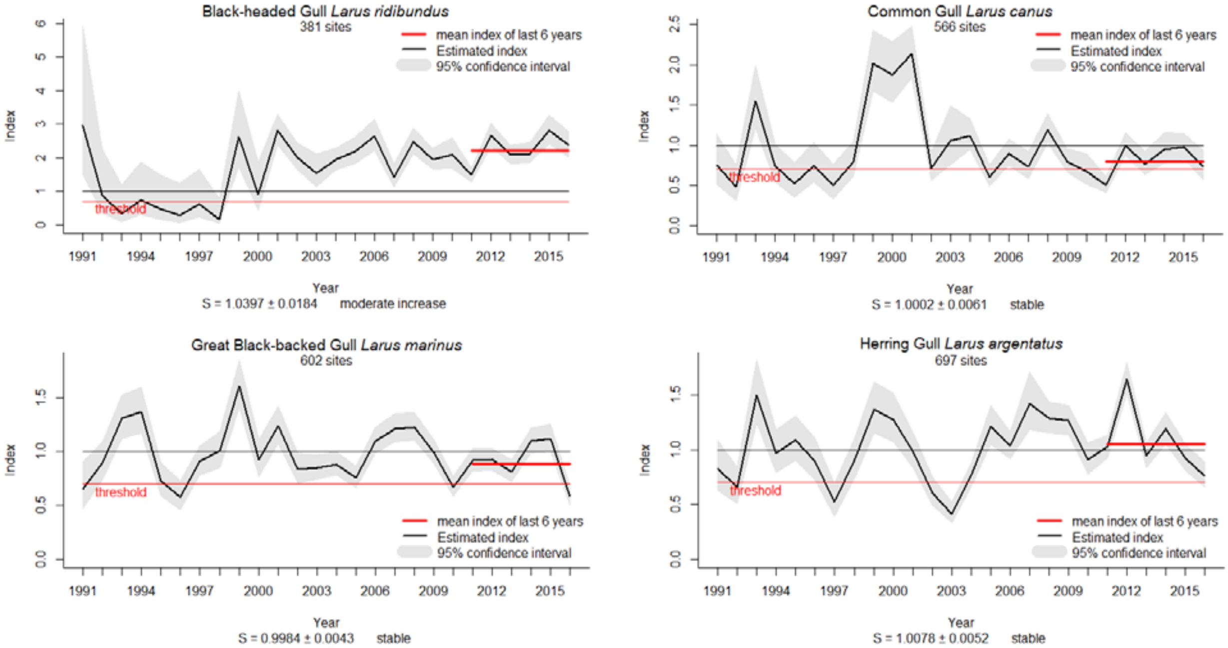
group	species	number of sites	index values 2011	2012	2013	2014	2015	2016	mean 2011-2016	good status?	trend 1991-2016
surface feeders	black-headed gull	381	1.482	2.660	2.083	2.125	2.809	2.374	**2.209**	yes	↑
	common gull	566	0.504	0.997	0.764	0.948	0.972	0.734	**0.799**	yes	→
	great black-backed gull (wt)	602	0.922	0.923	0.814	1.096	1.121	0.587	**0.891**	yes	→
	herring gull	697	1.024	1.644	0.942	1.187	0.925	0.762	**1.048**	yes	→
pelagic feeders	smew (wt)	845	1.664	3.038	3.119	2.863	3.377	2.810	**2.746**	yes	↑↑**
	goosander	1473	0.669	0.721	1.353	1.498	1.047	0.761	**0.959**	yes	↓*
	red-breasted merganser	985	0.869	1.178	0.864	0.961	0.956	1.077	**0.978**	yes	→
	great crested grebe	829	0.208	2.393	1.097	1.331	1.264	2.599	**1.156**	yes	↑
	great cormorant (wt)	1074	0.877	1.296	1.181	1.764	1.599	1.900	**1.389**	yes	↑**
benthic feeders	common pochard	513	0.207	0.622	0.677	1.370	0.698	0.342	**0.553**	no	↓**
	tufted duck	1106	0.771	0.984	1.048	1.032	1.195	0.564	**0.906**	yes	→
	greater scaup (wt)	634	0.512	0.917	0.439	2.317	1.827	0.481	**0.865**	yes	→
	Steller's eider (wt)	67	0.314	0.130	0.179	0.284	0.389	0.151	**0.223**	no	↓↓**
	common goldeneye	1456	1.618	1.308	1.416	1.293	1.539	1.365	**1.418**	yes	↑**
wading f.	Eurasian teal	339	0.550	8.959	0.795	2.208	3.591	0.337	**1.479**	yes	→
grazing feeders	mute swan	1394	0.817	0.849	1.099	0.903	1.164	0.978	**0.960**	yes	→
	whooper swan	937	0.740	1.694	1.430	0.899	1.767	1.096	**1.209**	yes	↑**
	Bewick's swan (wt)	86	0.546	0.877	0.305	1.034	0.170	0.426	**0.471**	no	?
	Eurasian wigeon	398	0.417	2.409	1.241	1.374	2.347	0.693	**1.186**	yes	↑
	mallard	1407	0.897	1.360	1.269	0.975	1.110	0.923	**1.075**	yes	↑**
	northern pintail (wt)	224	0.188	1.449	0.574	1.040	0.999	0.992	**0.738**	yes	→
	Eurasian coot	726	0.487	0.668	0.692	0.639	0.548	0.460	**0.575**	no	↓**

Results table 2. Trends observed in wintering waterbirds in the Baltic 1991-2016. Trend slopes and standard errors result from GAM analyses. In species marked (wt) the GAM was calculated without temperature as a covariate.

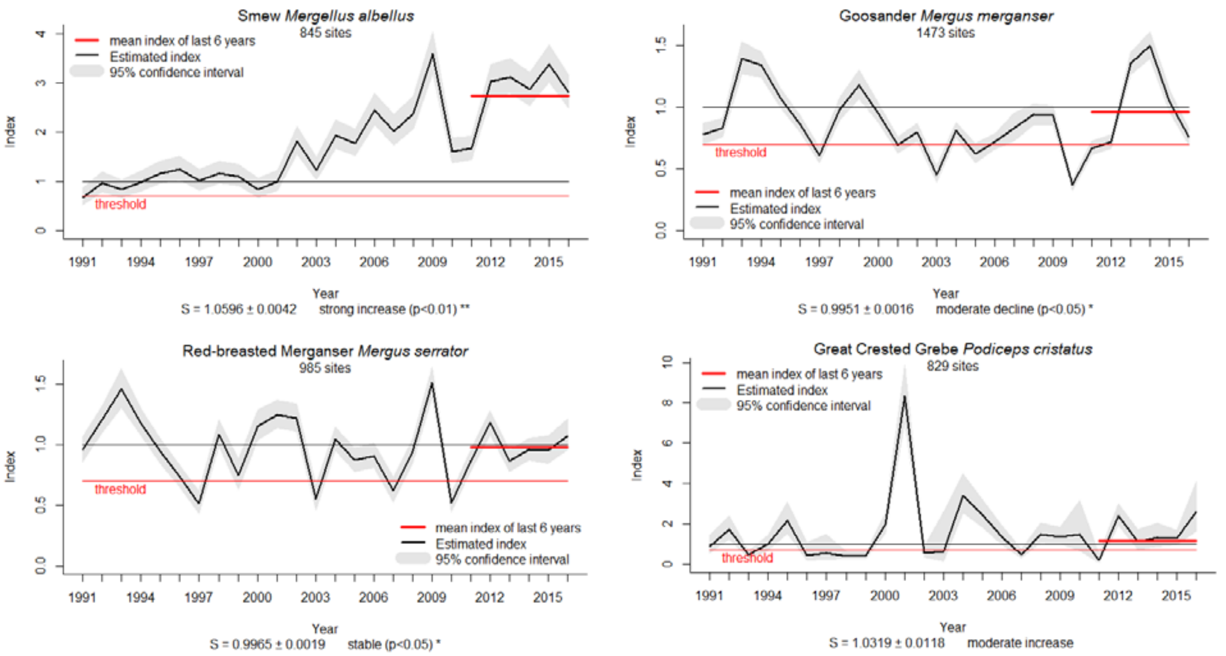
group	species	number of sites	trend slope	S.E.	p	status
surface feeders	black-headed gull	381	1.0397	0.0184		moderate increase
	common gull	566	1.0002	0.0061		stable
	great black-backed gull (wt)	602	0.9984	0.0043		stable
	herring gull	697	1.0078	0.0052		stable
pelagic feeders	smew (wt)	845	1.0596	0.0042	<0.01	strong increase
	goosander	1473	0.9951	0.0016	<0.05	moderate decline
	red-breasted merganser	985	0.9965	0.0019	<0.05	stable
	great crested grebe	829	1.0319	0.0118		moderate increase
	great cormorant (wt)	1074	1.0260	0.0030	<0.01	moderate increase
benthic feeders	common pochard	513	0.9729	0.0031	<0.01	moderate decline
	tufted duck	1106	0.9958	0.0028	<0.01	stable
	greater scaup (wt)	634	0.9974	0.0033	<0.01	stable
	Steller's eider (wt)	67	0.9222	0.0104	<0.01	steep decline
	common goldeneye	1456	1.0203	0.0014	<0.01	moderate increase
wading f.	Eurasian teal	339	0.9915	0.0119	<0.01	stable
grazing feeders	mute swan	1394	1.0005	0.0011	<0.01	stable
	whooper swan	937	1.0213	0.0026	<0.01	moderate increase
	Bewick's swan (wt)	86	0.9745	0.0233		uncertain
	Eurasian wigeon	398	1.0220	0.0057		moderate increase
	mallard	1407	1.0045	0.0014	<0.01	moderate increase
	northern pintail (wt)	224	0.9962	0.0074	<0.01	stable
	Eurasian coot	726	0.9678	0.0022	<0.01	moderate decline

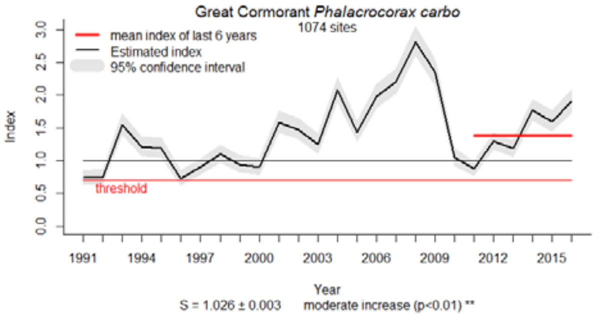
Results figure 1. Index graphs showing annual index values for wintering waterbirds in the entire Baltic (black line) and 95% confidence intervals (grey shading) resulting from GAM analyses with reference level where average of index values 1991-2000 is 1 (thin black line). Further shown are thresholds for good status (70% of baseline, 80% of baseline in species laying only one egg per year, thin red line) and the average index values 2011-2016 (geometric mean) used for the evaluation (red line). In addition, trend slopes and s.e. as well as the status of the species are given below the graphs. Models for great black-backed gull, smew, great cormorant, greater scaup, Steller's eider, Bewick's swan and northern pintail do not include temperature as a covariate.

Surface feeders

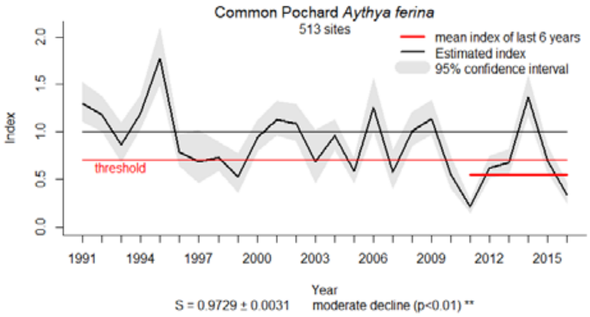


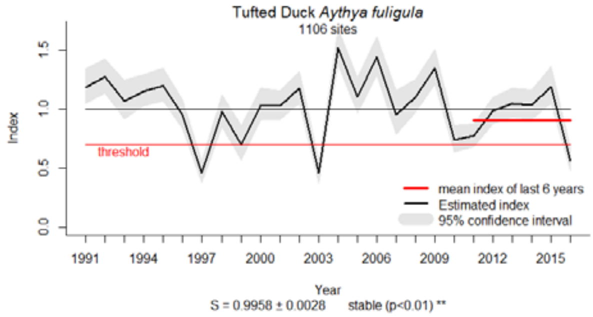
Pelagic feeders

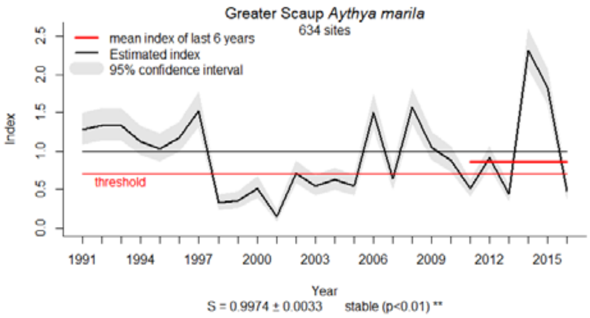


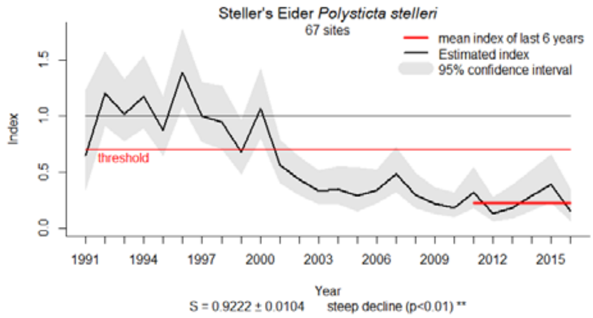


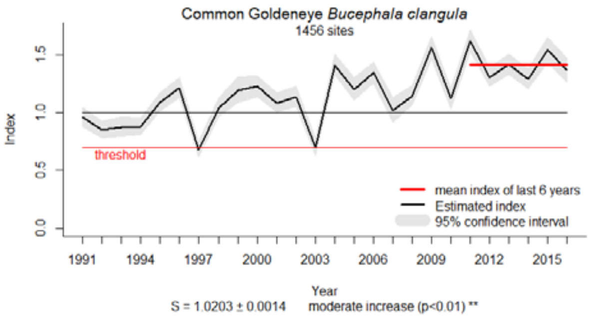
Benthic feeders



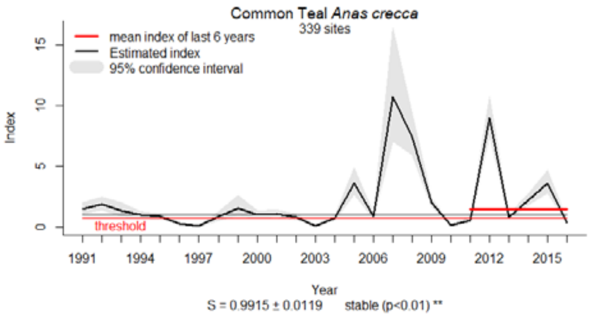




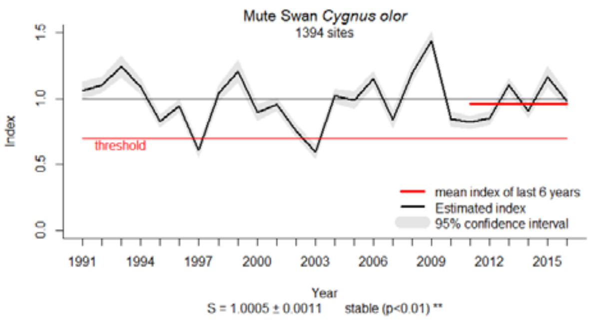


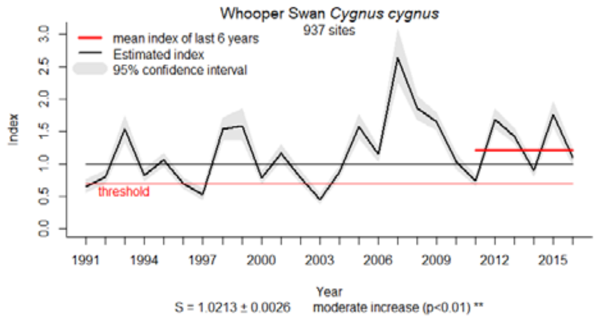


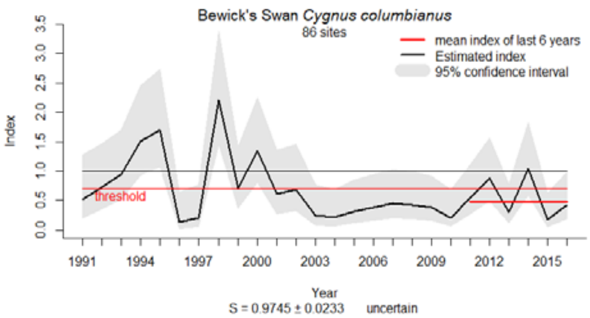
Wading feeders

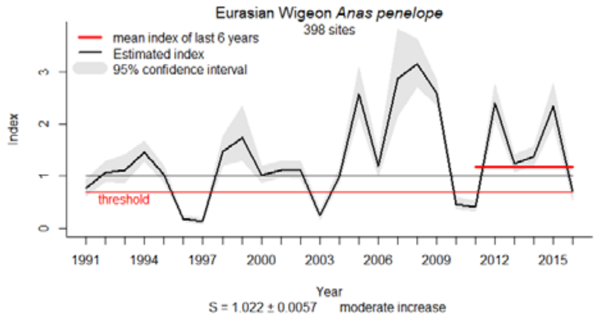


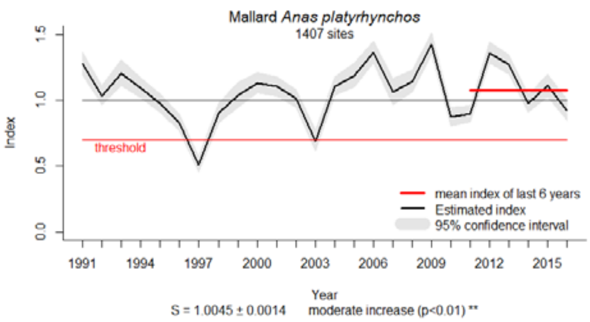
Grazing feeders

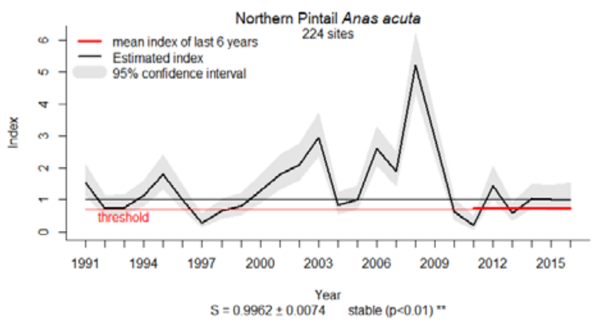


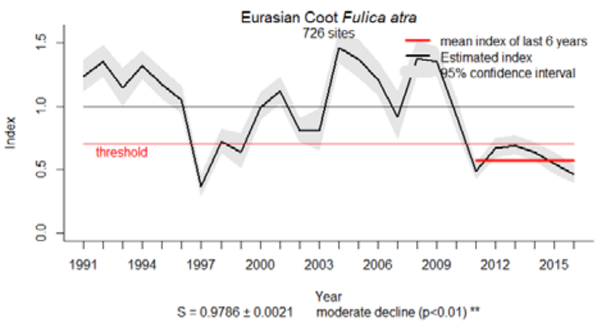












Abundance – Baltic Sea sub-divisions

The status assessment for wintering waterbirds was also applied at the scale of seven subdivisions of the Baltic Sea. The subdivisions are based on aggregations of subbasins (HELCOM assessment unit level 2, see Assessment Protocol). Owing to the distribution pattern of the individual waterbird species, the number of species assessed per subdivision is smaller than for the entire Baltic Sea. The analyses followed the same protocol as for the entire Baltic Sea.

Kattegat

In the period 2011-2016, only 7 out of 16 (44%) wintering waterbird species assessed in the Kattegat represented a good status, thus in total the indicator failed (Results table 3). This result also applies to most functional groups. While surface feeders were not assessed due to lacking data and wading feeders with the Eurasian teal as the only species achieved a good status, the threshold of 75% of species in good status was not reached by pelagic feeders (60%, 5 species), benthic feeders (25%, 4 species) and grazing feeders (33%, 6 species).

Results table 3. Evaluation of the status of wintering waterbirds in the Kattegat for the period 2011-2016. Index values (single years and mean) are scaled to the average of the reference period (1991-2000, index value set to 1). For explanation see Results table 1.

group	species	number of sites	index values 2011	2012	2013	2014	2015	2016	mean 2011-2016	good status?	trend 1991-2016
pelagic feeders	smew (wt)	37	3.414	5.925	15.692	2.079	10.902	3.359	**5.377**	yes	↑
	goosander	85	0.008	0.171	0.040	0.005	0.209	0.002	**0.021**	no	↓↓*
	red-breasted merganser	91	1.313	1.382	1.211	1.177	0.592	3.778	**1.340**	yes	↑*
	great crested grebe	59	0.014	2.330	0.004	0.004	1.338	0.000	**0.023**	no	↓↓**
	great cormorant	97	0.298	0.764	1.070	1.542	0.376	2.421	**0.836**	yes	→
benthic feeders	common pochard	28	0.033	0.386	0.027	0.000	0.218	0.001	**0.015**	no	↓↓**
	tufted duck	64	0.207	0.493	0.210	0.205	1.137	0.045	**0.247**	no	↓↓**
	greater scaup	29	0.018	1.310	0.144	0.022	7.255	0.000	**0.071**	no	↓↓**
	common goldeneye	100	0.728	1.586	1.161	0.901	1.478	0.607	**1.014**	yes	→*
wading f.	Eurasian teal (wt)	42	2.007	26.046	2.948	6.610	7.718	2.304	**5.124**	yes	↑
grazing feeders	mute swan	96	0.931	0.872	1.469	1.382	0.463	0.967	**0.951**	yes	→
	whooper swan	70	0.193	0.768	0.669	0.155	2.639	0.228	**0.458**	no	↓
	Eurasian wigeon	44	0.129	2.809	0.575	0.661	5.746	0.046	**0.576**	no	↓↓**
	mallard	97	0.526	0.817	1.094	0.516	0.775	0.613	**0.698**	no	↓**
	northern pintail	24	1.335	0.065	3.371	1.180	2.319	22.236	**1.618**	yes	?
	Eurasian coot	63	0.186	0.567	0.272	0.119	0.280	0.089	**0.209**	no	↓↓**

All species not in good status showed a negative trend, which is significant in all but one species. Seven species from three functional groups even declined steeply. The species in good status either increased moderately or showed stable population sizes (see details in Results table 4). The trends of individual species are depicted in Results figure 2 (Annex 1).

Results table 4. Trends observed in wintering waterbirds in the Kattegat 1991-2016. Trend slopes and standard errors result from GAM analyses. In species marked (wt) the GAM was calculated without temperature as a covariate.

group	species	number of sites	trend slope	S.E.	p	status
pelagic feeders	smew (wt)	37	1.1513	0.0574		moderate increase
	goosander	85	0.9117	0.0081	<0.05	steep decline
	red-breasted merganser	91	1.0183	0.0070	<0.05	moderate increase
	great crested grebe	59	0.8123	0.0379	<0.01	steep decline
	great cormorant	97	0.9949	0.0102		stable
benthic feeders	common pochard	28	0.6738	0.0212	<0.01	steep decline
	tufted duck	64	0.8918	0.0104	<0.01	steep decline
	greater scaup	29	0.8044	0.0500	<0.01	steep decline
	common goldeneye	100	0.9990	0.0050	<0.05	stable
wading f.	Eurasian teal (wt)	42	1.0970	0.0376		moderate increase
grazing feeders	mute swan	96	0.9957	0.0042	<0.01	stable
	whooper swan	70	0.9582	0.0171		moderate decline
	Eurasian wigeon	44	0.8970	0.0207	<0.01	steep decline
	mallard	97	0.9905	0.0046	<0.01	moderate decline
	northern pintail	24	0.9889	0.0641		uncertain
	Eurasian coot	63	0.9175	0.0078	<0.01	steep decline

Belt Group

In the Belt Group (Great Belt and The Sound), 53% (8 out of 15) of all waterbird species assesses achieved a good status, meaning that the threshold of 75% of species in good status was not reached (Results table 5). Regarding the functional groups, failure was also noted in pelagic feeders (60%, 5 species), benthic feeders (25%, 4 species) and wading feeders (0%, 1 species). As 4 out of 5 (80%) grazing feeders were in good status, this group matched the requirements for a good status of the group. Surface feeders were not assessed due to a lack of data.

Results table 5. Evaluation of the status of wintering waterbirds in the Belt Group for the period 2011-2016. Index values (single years and mean) are scaled to the average of the reference period (1991-2000, index value set to 1). For explanation see Results table 1.

group	species	number of sites	index values 2011	2012	2013	2014	2015	2016	mean 2011-2016	good status?	trend 1991-2016
pelagic feeders	smew (wt)	38	1.579	4.339	8.660	5.393	2.465	1.875	**3.375**	yes	↑↑
	goosander	50	0.564	0.651	0.344	0.670	0.727	0.159	**0.462**	no	↓**
	red-breasted merganser (wt)	46	0.718	1.053	0.575	0.803	0.781	0.836	**0.781**	yes	↓*
	great crested grebe	48	0.062	1.746	0.175	0.030	1.797	0.003	**0.119**	no	↓↓**
	great cormorant (wt)	51	0.867	2.945	1.244	1.457	1.524	1.123	**1.412**	yes	↑
benthic feeders	common pochard	41	0.064	0.251	0.477	1.162	0.334	0.380	**0.323**	no	→
	tufted duck (wt)	49	0.675	0.400	0.398	0.611	0.541	0.178	**0.430**	no	↓**
	greater scaup (wt)	39	0.012	0.294	0.108	0.449	0.901	0.004	**0.091**	no	?
	common goldeneye (wt)	51	1.382	0.791	0.899	1.022	0.701	0.686	**0.886**	yes	↓
wading f.	Eurasian teal	40	0.281	3.800	0.434	0.572	2.445	0.161	**0.686**	no	↓**
grazing feeders	mute swan	51	1.090	1.110	1.000	0.793	1.022	0.305	**0.818**	yes	↓**
	whooper swan (wt)	45	1.226	2.344	1.473	1.300	1.002	1.309	**1.390**	yes	↑
	Eurasian wigeon (wt)	46	0.439	1.547	1.224	1.317	1.411	1.233	**1.113**	yes	↑
	mallard	51	1.005	1.064	0.960	0.613	0.576	0.599	**0.775**	yes	↓**
	Eurasian coot (wt)	50	0.710	0.600	0.810	0.321	0.571	0.435	**0.550**	no	↓**

Most species in bad status also declined, most steeply so in great crested grebe (Results table 6). However, common pochard remained stable in a bad status, and the trend was uncertain in greater scaup. Another four species showed a moderate decline though still representing good status. A strong increase was observed in the smew. The trends of individual species are depicted in Results figure 3 (Annex 1).

Results table 6. Trends observed in wintering waterbirds in the Belt Group 1991-2016. Trend slopes and standard errors result from GAM analyses. In species marked (wt) the GAM was calculated without temperature as a covariate.

group	species	number of sites	trend slope	S.E.	p	status
pelagic feeders	smew (wt)	38	1.0792	0.0140		strong increase
	goosander	50	0.9486	0.0133	<0.01	moderate decline
	red-breasted merganser (wt)	46	0.9803	0.0046	<0.05	moderate decline
	great crested grebe	48	0.8884	0.0287	<0.01	steep decline
	great cormorant (wt)	51	1.0240	0.0102		moderate increase
benthic feeders	common pochard	41	1.0357	0.0187		stable
	tufted duck (wt)	49	0.9578	0.0057	<0.01	moderate decline
	greater scaup (wt)	39	0.9460	0.0321		uncertain
	common goldeneye (wt)	51	0.9936	0.0031		moderate decline
wading f.	Eurasian teal	40	0.9181	0.0256	<0.01	moderate decline
grazing feeders	mute swan	51	0.9832	0.0054	<0.01	moderate decline
	whooper swan (wt)	45	1.0351	0.0079		moderate increase
	Eurasian wigeon (wt)	46	1.0261	0.0083		moderate increase
	mallard	51	0.9856	0.0058	<0.01	moderate decline
	Eurasian coot (wt)	50	0.9744	0.0038	<0.01	moderate decline

Bornholm Group

In the Bornholm Group (Kiel Bay, Bay of Mecklenburg, Arkona Basin, Bornholm Basin), the waterbirds in total (16 out of 18 species, 89%), as well as all functional groups, represented a good status in the assessment period (2011-2016, Results table 7). Only two species (common pochard, Bewick's swan) did not pass, and only three species (smew, great cormorant, Eurasian wigeon) exceeded the baseline level by more than 30%.

Results table 7. Evaluation of the status of wintering waterbirds in the Bornholm Group for the period 2011-2016. Index values (single years and mean) are scaled to the average of the reference period (1991-2000, index value set to 1). For explanation see Results table 1.

group	species	number of sites	index values 2011	2012	2013	2014	2015	2016	mean 2011-2016	good status?	trend 1991-2016
surf. f.	great black-backed gull (wt)	188	0.892	0.863	0.688	1.126	0.863	0.442	**0.781**	yes	→
pelagic feeders	smew	291	1.142	1.415	2.265	2.777	1.372	2.038	**1.747**	yes	↑**
	goosander	363	0.477	0.599	1.410	1.027	0.645	1.009	**0.804**	yes	↓*
	red-breasted merganser	299	0.830	1.014	0.825	0.915	0.676	1.359	**0.914**	yes	→
	great crested grebe	347	0.506	0.850	0.844	2.098	1.487	2.211	**1.165**	yes	↑**
	great cormorant	368	1.100	1.237	1.008	1.391	1.744	2.582	**1.431**	yes	↑**
benthic feeders	common pochard (wt)	267	0.342	0.753	0.600	0.656	0.645	0.297	**0.519**	no	↓**
	tufted duck	344	0.948	1.616	1.337	1.257	1.250	0.415	**1.050**	yes	→
	greater scaup (wt)	264	0.762	1.475	0.466	3.165	0.911	0.228	**0.837**	yes	→
	common goldeneye	367	1.056	0.903	1.267	0.825	1.061	1.374	**1.064**	yes	↑**
wading f.	Eurasian teal (wt)	153	0.723	8.208	0.688	1.225	1.219	0.778	**1.296**	yes	↑*
grazing feeders	mute swan (wt)	369	0.947	1.106	1.433	1.136	1.108	1.414	**1.178**	yes	↑**
	whooper swan (wt)	248	0.957	0.752	1.521	1.166	1.189	1.243	**1.112**	yes	↑
	Bewick's swan (wt)	59	0.846	1.071	0.358	1.171	0.122	0.516	**0.537**	no	↓**
	Eurasian wigeon (wt)	191	0.621	3.364	1.709	1.565	2.581	1.207	**1.610**	yes	↑**
	mallard	371	1.140	1.515	1.116	1.072	0.985	1.028	**1.131**	yes	↑
	northern pintail	116	0.229	1.272	0.905	2.347	0.649	4.476	**1.103**	yes	?
	Eurasian coot	319	0.344	1.180	0.580	1.684	0.782	1.017	**0.825**	yes	↑

In addition to the waterbirds in bad status, goosander was the only species which passed the indicator, but declined moderately (Results table 8). All the other species were increasing or showed stability. The trends of individual species are depicted in Results figure 4 (Annex 1).

Results table 8. Trends observed in wintering waterbirds in the Bornholm Group 1991-2016. Trend slopes and standard errors result from GAM analyses. In species marked (wt) the GAM was calculated without temperature as a covariate.

group	species	number of sites	trend slope	S.E.	p	status
surf. f.	great black-backed gull (wt)	188	1.0006	0.0036		stable
pelagic feeders	smew	291	1.0423	0.0064	<0.01	moderate increase
	goosander	363	0.9919	0.0032	<0.05	moderate decline
	red-breasted merganser	299	0.9977	0.0033		stable
	great crested grebe	347	1.0210	0.0040	<0.01	moderate increase
	great cormorant (wt)	368	1.0260	0.0040	<0.01	moderate increase
benthic feeders	common pochard (wt)	267	0.9687	0.0050	<0.01	moderate decline
	tufted duck	344	1.0043	0.0059		stable
	greater scaup (wt)	264	0.9962	0.0048	<0.01	stable
	common goldeneye	367	1.0099	0.0025	<0.01	moderate increase
wading f.	Eurasian teal (wt)	153	1.0193	0.0098	<0.05	moderate increase
grazing feeders	mute swan (wt)	369	1.0104	0.0018	<0.01	moderate increase
	whooper swan (wt)	248	1.0104	0.0038		moderate increase
	Bewick's swan (wt)	59	0.9088	0.0290	<0.01	moderate decline
	Eurasian wigeon (wt)	191	1.0441	0.0070	<0.01	moderate increase
	mallard	371	1.0078	0.0038		moderate increase
	northern pintail	116	0.9802	0.0198		uncertain
	Eurasian coot	319	1.0094	0.0047		moderate increase

Gotland Group

In the Gotland Group (Gdansk Basin, Eastern Gotland Basin, Western Gotland Basin, Gulf of Riga), 14 out of 17 species (82%) were in good status in the period 2011-2016, meaning that the indicator passed. The same holds true for all four functional groups assessed, as 3 out of 4 surface feeders, all 5 pelagic feeders, 3 of 4 benthic feeders and 3 of 4 grazing feeders met the threshold level (Results table 9). Wading feeders are not represented among waterbirds wintering in this section of the Baltic Sea.

Results table 9. Evaluation of the status of wintering waterbirds in the Gotland Group for the period 2011-2016. Index values (single years and mean) are scaled to the average of the reference period (1991-2000, index value set to 1). For explanation see Results table 1.

group	species	number of sites	index values 2011	2012	2013	2014	2015	2016	mean 2011-2016	good status?	trend 1991-2016
surface feeders	black-headed gull	99	3.147	2.417	8.354	9.987	1.913	12.050	**4.945**	yes	?
	common gull	125	0.408	0.817	0.621	0.640	1.006	0.701	**0.674**	no	?
	great black-backed gull	122	0.882	0.829	0.528	0.486	1.749	0.451	**0.727**	yes	?
	herring gull	124	0.962	1.369	1.147	1.532	0.552	1.576	**1.124**	yes	?
pelagic feeders	smew (wt)	330	2.124	3.862	3.825	3.189	4.890	3.365	**3.437**	yes	↑↑**
	goosander	507	0.680	0.633	1.516	1.867	0.811	0.610	**0.919**	yes	↓
	red-breasted merganser	410	0.671	1.094	1.075	1.205	1.742	0.934	**1.075**	yes	↑
	great crested grebe	274	1.870	1.068	1.948	3.423	2.126	1.504	**1.869**	yes	↑**
	great cormorant	388	0.683	1.343	1.275	2.343	5.879	2.051	**1.791**	yes	↑
benthic feeders	common pochard	152	0.107	0.387	0.225	0.634	0.675	0.167	**0.295**	no	↓
	tufted duck	405	0.514	1.078	1.309	1.304	1.680	1.017	**1.083**	yes	↑
	greater scaup	231	0.313	0.488	0.496	3.765	4.362	3.521	**1.279**	yes	↑↑
	common goldeneye (wt)	518	1.730	1.260	1.975	2.248	1.898	2.310	**1.867**	yes	↑**
grazing feeders	mute swan	494	0.541	0.775	1.245	1.183	1.750	1.946	**1.132**	yes	↑
	whooper swan	278	0.540	3.388	3.489	2.243	2.302	3.434	**2.199**	yes	↑
	mallard (wt)	488	0.839	2.284	2.261	2.245	2.025	1.601	**1.778**	yes	↑**
	Eurasian coot (wt)	207	0.071	0.449	0.749	1.085	0.439	0.567	**0.431**	no	↓**

Apart from the gulls, of which the trend remained uncertain, all species showing a good status increased (most pronounced in smew and greater scaup, Results table 10). Common pochard and Eurasian coot were the only declining species, underlining their bad status. The trends of individual species are depicted in Results figure 5 (Annex 1).

Results table 10. Trends observed in wintering waterbirds in the Gotland Group 1991-2016. Trend slopes and standard errors result from GAM analyses. In species marked (wt) the GAM was calculated without temperature as a covariate.

group	species	number of sites	trend slope	S.E.	p	status
surface feeders	black-headed gull	99	1.0486	0.0404		uncertain
	common gull	125	0.9941	0.0262		uncertain
	great black-backed gull	122	1.0619	0.0980		uncertain
	herring gull	124	1.0305	0.0824		uncertain
pelagic feeders	smew (wt)	330	1.0715	0.0084	<0.01	strong increase
	goosander	507	0.9921	0.0034		moderate decline
	red-breasted merganser	410	1.0127	0.0048		moderate increase
	great crested grebe	274	1.0470	0.0047	<0.01	moderate increase
	great cormorant	388	1.0687	0.0157		moderate increase
benthic feeders	common pochard	152	0.9696	0.0135		moderate decline
	tufted duck	405	1.0120	0.0054		moderate increase
	greater scaup	231	1.0898	0.0201		strong increase
	common goldeneye (wt)	518	1.0366	0.0032	<0.01	moderate increase
grazing feeders	mute swan	494	1.0223	0.0028		moderate increase
	whooper swan	278	1.0590	0.0077		moderate increase
	mallard (wt)	488	1.0321	0.0032	<0.01	moderate increase
	Eurasian coot (wt)	207	0.9806	0.0050	<0.01	moderate decline

Aland Group

In the Aland Group (Northern Baltic Proper, Aland Sea), wintering waterbirds did not achieve good status, because only 9 out of 15 species (67%) reached the threshold level (Results table 11). The results are differing in the functional groups. The indicator was passed by benthic feeders (75%, 4 species) and grazing feeders (100%, 4 species), but failed in surface feeders (33%, 3 species) and pelagic feeders (50%, 4 species). Wading feeders could not be assessed, because no species of this group provided data for the wintering season.

Results table 11. Evaluation of the status of wintering waterbirds in the Aland Group for the period 2011-2016. Index values (single years and mean) are scaled to the average of the reference period (1991-2000, index value set to 1). For explanation see Results table 1.

group	species	number of sites	index values							good status?	trend 1991-2016
			2011	2012	2013	2014	2015	2016	mean 2011-2016		
surf. f.	common gull	101	0.632	1.830	0.748	0.418	1.322	0.584	**0.809**	yes	→
	great black-backed gull	118	0.466	0.719	0.513	0.272	1.291	0.286	**0.508**	no	→
	herring gull	129	0.091	0.304	0.112	0.124	0.448	0.131	**0.168**	no	↓↓**
pelagic feeders	smew	77	6.596	11.480	15.089	26.761	3.607	161.296	**16.156**	yes	?
	goosander	230	1.912	1.304	1.257	0.732	1.819	1.191	**1.307**	yes	↑
	red-breasted merganser	78	0.638	0.816	0.346	0.135	1.553	0.488	**0.514**	no	→
	great cormorant (wt)	96	1.298	0.180	0.201	0.283	0.407	0.399	**0.360**	no	?
benthic feeders	tufted duck	168	7.332	5.641	13.844	13.996	6.713	21.340	**10.233**	yes	↑↑**
	greater scaup (wt)	49	0.775	0.367	0.526	11.473	2.744	1.758	**1.422**	yes	?
	Steller's eider (wt)	22	0.405	0.143	0.143	0.216	0.309	0.118	**0.200**	no	↓**
	common goldeneye	196	4.955	3.440	2.566	1.273	4.071	2.417	**2.860**	yes	↑↑*
grazing feeders	mute swan	211	0.736	0.712	0.747	0.638	1.976	0.899	**0.873**	yes	→
	whooper swan	150	0.978	5.299	1.885	1.697	5.280	3.223	**2.561**	yes	↑**
	mallard	209	2.888	2.579	3.329	2.576	1.795	4.547	**2.837**	yes	↑↑**
	Eurasian coot	60	8.986	9.404	6.428	2.598	0.311	4.236	**3.507**	yes	↑↑

Despite of the unfavourable status in the indicator, only two waterbird species wintering in the Aland group (herring gull, Steller's eider) were significantly declining from 1991 to 2016, whereas six species were increasing (three of them significantly). In three species, the trend analyses indicated stable population sizes, uncertainty about the trend was found for two species (Results table 12). The trends of individual species are depicted in Results figure 6 (Annex 1).

Results table 12. Trends observed in wintering waterbirds in the Aland Group 1991-2016. Trend slopes and standard errors result from GAM analyses. In species marked (wt) the GAM was calculated without temperature as a covariate.

group	species	number of sites	trend slope	S.E.	p	status
surf. f.	common gull	101	0.9943	0.0138		stable
	great black-backed gull	118	0.9918	0.0089		stable
	herring gull	129	0.9129	0.0089	<0.01	steep decline
pelagic feeders	smew	77	1.1227	0.0811		uncertain
	goosander	230	1.0132	0.0047		moderate increase
	red-breasted merganser	78	1.0016	0.0130	<0.01	stable
	great cormorant (wt)	96	1.0030	0.0416		uncertain
benthic feeders	tufted duck	168	1.1480	0.0200		strong increase
	greater scaup (wt)	49	0.9749	0.0562	<0.01	uncertain
	Steller's eider (wt)	22	0.9197	0.0366	<0.01	moderate decline
	common goldeneye	196	1.0823	0.0123	<0.05	strong increase
grazing feeders	mute swan	211	1.0045	0.0063	<0.01	stable
	whooper swan	150	1.0701	0.0109	<0.01	moderate increase
	mallard	209	1.0609	0.0052	<0.01	strong increase
	Eurasian coot	60	1.1848	0.0351		strong increase

Gulf of Finland

In only 2 out of 10 species the index values fell below the threshold level, thus wintering waterbirds as a group were in good status in the Gulf of Finland in the assessment period (2011-2016, Results table 13). As all surface feeders (3 species) and all pelagic feeders (2 species) passed, those functional groups also showed good status. In contrast, good status was only achieved by 1 out of 2 (50%) benthic feeders and 2 out of 3 (67%) grazing feeders, meaning that these functional groups failed. Wading feeders were not assessed.

Results table 13. Evaluation of the status of wintering waterbirds in the Gulf of Finland for the period 2011-2016. Index values (single years and mean) are scaled to the average of the reference period (1991-2000, index value set to 1). For explanation see Results table 1.

group	species	number of sites	index values 2011	2012	2013	2014	2015	2016	mean 2011-2016	good status?	trend 1991-2016
surf. f.	common gull (wt)	97	0.172	1.128	0.553	1.135	1.930	1.213	**0.811**	yes	→
	great black-backed gull (wt)	98	0.302	0.876	1.296	1.274	1.160	0.871	**0.872**	yes	→
	herring gull (wt)	129	0.634	3.381	5.231	7.923	2.395	2.001	**2.743**	yes	↑
pel. f.	goosander (wt)	109	0.539	1.192	1.172	2.024	2.707	3.680	**1.574**	yes	↑**
	red-breasted merganser (wt)	43	0.449	0.633	1.404	0.622	2.349	1.895	**1.017**	yes	?
benth. f.	tufted duck	49	0.191	1.647	0.560	0.067	20.209	0.031	**0.442**	no	?
	common goldeneye (wt)	90	3.584	2.151	2.302	2.983	2.177	3.647	**2.737**	yes	↑
grazing feeders	mute swan	96	0.484	0.439	0.603	0.289	2.510	0.468	**0.593**	no	→
	whooper swan (wt)	82	0.494	2.645	0.960	1.120	1.929	5.092	**1.549**	yes	→
	mallard (wt)	116	0.359	0.845	0.733	1.080	1.318	1.319	**0.864**	yes	→

While most species showed stability or uncertainty, positive population trends were observed in herring gull, common goldeneye and goosander, though the trend is only significant in the latter species. Of those species showing bad status, mute swan index values are stable while uncertainty remains in the tufted duck (Results table 14). The trends of individual species are depicted in Results figure 7 (Annex 1).

Results table 14. Trends observed in wintering waterbirds in the Gulf of Finland 1991-2016. Trend slopes and standard errors result from GAM analyses. In species marked (wt) the GAM was calculated without temperature as a covariate.

group	species	number of sites	trend slope	S.E.	p	status
surf. f.	common gull (wt)	97	1.0011	0.0118		stable
	great black-backed gull (wt)	98	0.9978	0.0069		stable
	herring gull (wt)	129	1.0382	0.0132		moderate increase
pel. f.	goosander (wt)	109	1.0248	0.0069	<0.01	moderate increase
	red-breasted merganser (wt)	43	1.0196	0.0256		uncertain
benth. f.	tufted duck	49	1.0179	0.0864		uncertain
	common goldeneye (wt)	90	1.0516	0.0175		moderate increase
grazing feeders	mute swan	96	1.0291	0.0152		stable
	whooper swan (wt)	82	1.0212	0.0116		stable
	mallard (wt)	116	0.9947	0.0044		stable

Bothnian Group

In the Bothnian Group, which includes the Bothnian Sea, The Quark and the Bothnian Bay, only five wintering waterbird species belonging to four functional groups could be assessed (Results table 15). All species were in good status, and formally all functional groups (surface, pelagic, benthic and grazing feeders) gave the same results (100% of species in good status, though in three groups only one species each was assessed). Wading feeders were not included in the Bothnian Group analysis.

Results table 15. Evaluation of the status of wintering waterbirds in the Bothnian Group for the period 2011-2016. Index values (single years and mean) are scaled to the average of the reference period (1991-2000, index value set to 1). For explanation see Results table 1.

group	species	number of sites	index values 2011	2012	2013	2014	2015	2016	mean 2011-2016	good status?	trend 1991-2016
surf. f.	great black-backed gull (wt)	48	0.279	1.620	1.075	1.075	1.411	0.922	**0.938**	yes	→
	herring gull (wt)	73	0.294	5.922	2.248	4.771	2.271	2.190	**2.128**	yes	↑
pel. f.	goosander	128	4.922	13.608	1.553	1.799	3.901	9.740	**4.385**	yes	↑
benth. f.	common goldeneye (wt)	133	0.075	9.248	0.075	7.519	6.767	172.180	**2.776**	yes	?
graz. f.	mallard (wt)	74	1.101	0.518	1.655	0.522	0.839	1.381	**0.911**	yes	↑

A positive (non-significant) trend was observed in herring gull, goosander and mallard while great black-backed gull showed stability. The trend of common goldeneye remained uncertain (Results table 16). The trends of individual species are depicted in Results figure 8 (Annex 1).

Results table 16. Trends observed in wintering waterbirds in the Bothnian Group 1991-2016. Trend slopes and standard errors result from GAM analyses. In species marked (wt) the GAM was calculated without temperature as a covariate.

group	species	number of sites	trend slope	S.E.	p	status
surf. f.	great black-backed gull (wt)	48	1.0277	0.0193		stable
	herring gull	73	1.0457	0.0177		moderate increase
pel. f.	goosander	128	1.0910	0.0225		moderate increase
benth. f.	common goldeneye (wt)	133	1.0043	0.0872		uncertain
graz. f.	mallard (wt)	74	1.0248	0.0124		moderate increase

Overview of Baltic Sea sub-divisions scale assessment

Owing to the number of species and no less than seven areas considered, the results of the many species group assessments are variable. No species group shows a consistent result across all subdivisions, highlighting the importance of the assessment scale used: The conditions for wintering waterbirds are certainly not uniform all over the Baltic Sea. Relatively many species groups (and species) failed to achieve good status in the westernmost part of the Baltic (Kattegat, Belt Group), whereas in the central and eastern part an increased number achieving the threshold were observed. Though winter temperature was included in the majority of models in this analysis, effects of climate change with warmer winters were probably not completely removed and it appears likely that the wintering of waterbirds in the Baltic Sea has partly shifted from the southwest to the northeast. This is in line with similar findings of Lehikoinen et al. (2013) for three duck species and underlines that the Baltic Sea (and especially its northeastern parts) are increasingly important for wintering waterbirds.

Even when looking at individual species, there is inconsistency in the results, indicating that conditions for given wintering waterbirds vary spatially. Finding reasons for the trends needs careful analysis, because waterbirds underlie a number of pressures in their marine wintering habitats. Scoping possible threats for waterbirds, JWGBIRD experts identified mostly human activities having impact rather than natural drivers. Most impact is thought to stem from direct and indirect effects of fishery activities (including bycatch in fishing gear), but a number of species are exposed to the extraction of minerals, offshore wind farms, shipping and hunting. Prey availability is thought to be the main natural driver for the development of population sizes (OSPAR/HELCOM/ICES 2018). Given those many impact factors, the results of this indicator have to be interpreted carefully with respect to conclusions.

Confidence of the indicator status evaluation

The overall confidence of the indicator is currently **intermediate**.

The temporal coverage is good, as most of the sites were counted annually for the mid-January International Waterbird Census in the period 1991-2016 and all years of the six-year assessment period (2011-2016) are covered.

The spatial representability is low, owing to counting sites often covering long stretches of coastline completely, but currently lacking data for some benthic, surface and pelagic feeders from offshore parts of the Baltic. As wading and grazing feeders are only occurring close to the coast, the assessments of these functional groups have a high confidence.

The accuracy of the evaluation is high, because the results clearly show whether the threshold values for good status are met for species groups or all birds. Methodological confidence is intermediate: though IWC data are collected for decades by internationally coordinated methods, these methods are awaiting to be entered in HELCOM guidelines.

Thresholds and Status evaluation

The status is evaluated by examining the proportion of wintering waterbird species for which the abundance deviates more than 30% (20% in species laying only one egg per year) downwards from the abundance in the reference period. Upward deviations (>30% above abundance at the baseline) are not considered to reflect a failure to achieve the threshold value indicating good status, however they are reported as possible indications of imbalance in the ecosystem. This approach can be used for status evaluations i) as a multi-species assessment or ii) for species groups of waterbirds separately, the latter is used in MSFD assessments according to the COM Decision 2017/848/EU about criteria and methodological standards on Good Environmental Status. In the multi-species assessment, the threshold value is achieved when 75% of the species deviate ≤30% (≤20% respectively) from the baseline. The concept is aligned with that of the OSPAR Indicator 'Marine bird abundance', where the same graduation of thresholds is used (ICES 2013). Good status is possible to achieve also for species identified as being threatened in the Baltic Sea (HELCOM 2013), when the species maintained its population size on a low level or even increased while still being under pressure from anthropogenic influence.

As it is difficult to identify a reference level representing pristine conditions, bird abundances from the beginning of data compilation (typically 1991-2000) are used to define the baseline state as a pragmatic approach. Any single year is prone to random events influencing the number of birds in that year, and therefore the baseline status is defined by the mean abundances of the relevant species during the period 1991-2000. So far, data before 1991 have not been used, because major gaps are very likely to occur in the eastern Baltic owing to only restricted accessibility to large parts of the coast. The use of data before 1991 will be explored in future and may help to define more appropriate species-specific baseline values.

The multi-species assessment can be conducted using all species without any weighting, but then the results are biased with regard to the numbers of species in the species groups. More meaningful results are obtained when the status evaluation is based on species groups, the threshold value of 75% of species not being 30%/20% below the baseline level can directly be converted to the number of species included in each species group. For marine habitats in Europe, ICES (2015) has defined terminology and composition of functional species groups, which are defined mainly by the way of foraging (see Thresholds table 1). OSPAR/HELCOM/ICES (2016) have identified bird species suitable for serving the wintering waterbird abundance indicator, and during the current evaluation it turned out that two more species (Bewick’s swan, Eurasian teal, black-headed gull) could be added to the species set. Thus, this indicator would provide five evaluations when applied to

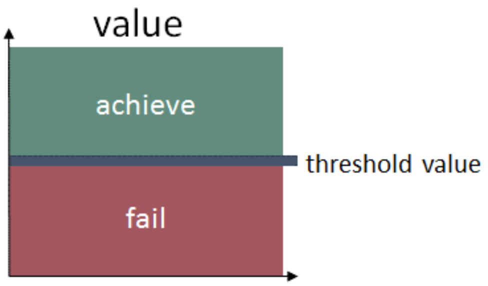
- surface feeders (four species: black-headed gull, common gull, great black-backed gull, herring gull),
- water column feeders (five species: smew, goosander, red-breasted merganser, great crested grebe, great cormorant),
- benthic feeders (five species: common pochard, tufted duck, greater scaup, Steller’s eidercommon goldeneye),
- wading feeders (one species: Eurasian teal) and
- grazing feeders (seven species: mute swan, whooper swan, Bewick’s swan, Eurasian teal, mallard, northern pintail, Eurasian coot).

Given the composition of the species groups, the five possible assessments are based on different numbers of species. For example, in water column feeders, nine out of 12 species would need to be above the threshold value in order to reach good status, while in surface feeders three out of four species would have to be above threshold value, because two out of four species would mean that only 50% of the species do not deviate from the baseline too much (but 75% is required).

The selection of species assessed in the indicator was related only to occurrence in Baltic marine habitats and data availability, but independent of threat status. The indicator currently does not assess species predominantly living offshore, because the fraction of the populations covered by the coastal counts of IWC is considered not to be representative for the wintering populations of the Baltic Sea (OSPAR/ICES/HELCOM 2018). Therefore, most seaducks and grebes as well as all divers and alcids are not included in the current assessment but will be considered as soon as data from aerial and ship-based offshore surveys can be integrated in the analysis. Accordingly, the current assessment is biased towards coastal species and the conditions in the coastal environment.

Thresholds 1: Species groups of waterbirds as defined by ICES (2015).

Species group	Typical feeding behaviour	Typical food types	Additional guidance
Wading feeders	Walk/wade in shallow waters	Invertebrates (molluscs, polychaetes, etc.)	
Surface feeders	Feed within the surface layer (within 1–2 m of the surface)	Small fish, zooplankton and other invertebrates	"Surface layer" defined in relation to normal diving depth of plunge-divers (except gannets)
Pelagic feeders	Feed at a broad depth range in the water column	Pelagic and demersal fish and invertebrates (e.g. squid, zooplankton)	Include only spp. that usually dive by actively swimming underwater; but including gannets. Includes species feeding on benthic fish (e.g. flatfish).
Benthic feeders	Feed on the seafloor	Invertebrates (e.g. molluscs, echinoderms)	
Grazing feeders	Grazing in intertidal areas and in shallow waters	Plants (e.g. eelgrass, saltmarsh plants), algae	Geese, swans and dabbling ducks, coot



Thresholds figure 1. Schematic representation of the threshold value. Determination of acceptable deviation from baseline (condition during the reference period), where the threshold is achieved if 75% of the considered populations are not more than 30% below the baseline level (20% in species laying only one egg per year). Upward deviations (>30% above abundance at the baseline) are not considered to reflect a failure to achieve the threshold, but rather indicate possible imbalance in the ecosystem.

A high number of wintering waterbirds does not automatically indicate a good status. For instance, piscivorous waterbird species benefit from a high availability of small fish, which in turn may point to an imbalance in the food web due to overfishing of large fish species that results in high abundance of small fish. These competitive interactions between fish-feeding birds and large predatory fish affect the setting of a baseline and defining good status for instance with respect to the current long-term management plan of cod, since increased cod stocks would likely affect (negatively) the food availability for birds.

Assessment Protocol

The indicator includes several waterbird species and the assessment approach is sensitive to the number of species represented. In order to evaluate if good status is achieved in the Baltic Sea, all species occurring in the area should be considered. Currently the aim is to include as many representative species for the Baltic Sea environment as possible, however, the species selection process must take into account that some species (e.g. mallard, Eurasian coot, some gull species) exhibit strong connections to other (non-marine) habitats and may therefore not be appropriate to include in an indicator addressing the status of the Baltic Sea. Currently, only waterbird species wintering close to the shore have been considered in the indicator as the majority of site level data come from land-based counts. Only relatively small number of sites currently available come from boat surveys in Polish offshore and Finnish Archipelago. Species with low proportions of the wintering populations of the Baltic Sea covered by land-based counts (all divers and alcids, most seaducks and grebes) are not included in the analyses, since it is questionable whether coastal data is representative. Future expansions of monitoring efforts in offshore areas of the Baltic Sea may allow for inclusion of species wintering offshore.

The approach used for defining good status has been developed by the OSPAR Inter-sessional Correspondence Group on Co-ordination of Biodiversity Assessment and Monitoring (ICG-COBAM MSFD) and used in the OSPAR indicator 'Marine bird abundance' (ICES 2013, OSPAR 2017).

This HELCOM core indicator incorporates further developed aspects of the evaluation method that have been carried out within the EU LIFE project 'Innovative approaches for marine biodiversity monitoring and assessment of conservation status of nature values in the Baltic Sea' (MARMONI; LIFE09 NAT/LV/000238), by correcting the numbers of birds counted for effects of climate change, i.e. winter temperature (Aunins et al. 2013b). The main progress has been to replace the classical TRIM analyses (van Strien et al. 2004) by generalized additive modelling (GAM) which includes winter air temperature as a covariate (Aunins et al. 2013b). This procedure gives yearly single species indices corrected for the temperature and thus - in a long view - for effects of climate change.

Site level raw data was used for each species to calculate the annual indices and trends. The national IWC coordinators of the HELCOM countries provided data for the monitoring sites that were located at the coast, bays and lagoons, and in the case of Poland and Finland also part of offshore habitats. The data was collected according to the Wetlands International field protocol (Wetlands International 2010). Each site level data for each species consisted of site code, coordinates of the site, year of survey and recorded abundance. There was a separate entry for each year the site was visited. Each site was assigned a code indicating to which country and assessment unit it belongs.

Temperature data was obtained from the E-OBS gridded dataset (Haylock et al. 2008), version 13.1 that included data from 1950 to 2012. The data was used to calculate the mean temperature for the week prior to the central IWC counting dates of each year (1991-2016). For each site, where birds had been counted, the temperature values were extracted. The inclusion of temperature data is an important progress, especially with respect to the predicted milder winters (due to the effects of climate change) and subsequent redistributions of sea ice and waterbirds.

To calculate the yearly indices and trends, Generalised Additive Modelling framework (Hastie & Tibshirani 1990; Wood 2006) was used. Models explaining the observed abundance in each site by site, year and mean temperature a week before the counts was created for each species using approach similar to the one suggested by Fewster et al. (2000), but accounting for serial correlation in the data. Inclusion of the temperature data allowed to reduce the variation in observed abundance due to observation conditions. If temperature effects were not significant, the model without temperature in the model formula was calculated.

The mean predicted abundance in the period 1991-2000 was used as the point of reference (when the index is 1). To obtain the index, predicted abundances in each separate year were divided by this reference value. Thus, an index above 1 (or 100%) means population increase compared to the reference and an index below 1 represents a decline. The confidence intervals for each index value were obtained analytically. The geometric mean of index values from 2011-2016 was used to assess the status of a species compared to the reference level. MSI tool (Soldaat et al. 2017) was used to calculate and classify the linear trends from the GAM-based indices.

The multiplicative overall slope estimate calculated by the MSI-tool is converted into one of the following categories, depending on the overall slope as well as its 95% confidence interval (= slope +/- 1.96 times the standard error of the slope) (Pannekoek & van Strien 2001):

- Strong increase - increase significantly more than 5% per year (5% meaning a doubling in abundance within 15 years). Criterion: lower limit of confidence interval >1.05.
- Moderate increase - significant increase, but not significantly more than 5% per year. Criterion: 1.00< lower limit of confidence interval <1.05.
- Stable - no significant increase or decline, and it is certain that trends are less than 5% per year. Criterion: confidence interval encloses 1.00 but lower limit >0.95 and upper limit <1.05.
- Moderate decline - significant decline, but not significantly more than 5% per year. Criterion: 0.95< upper limit of confidence interval <1.00.
- Steep decline - decline significantly more than 5% per year (5% meaning a halving in abundance within 15 years). Criterion: upper limit of confidence interval <0.95.

The GAM-based indices can serve to calculate the composite indices to get an overall wintering waterbird index (following Gregory et al. 2005) or to aggregate species according to their role in the food web, i.e. by species groups (surface feeders, pelagic feeders, benthic feeders, wading feeders, grazing feeders). Such multi-species indices are calculated as the geometric mean of the single species indices, with every species treated equally and standard errors used to show the variability of data. As an option for the future, such composite indices could serve as assessment tools. It remains to be tested whether the single species approach or the aggregated indices is more robust and better suited to assess good status with respect to population sizes of wintering waterbirds.

The concept of the indicator is well developed, based on long-running monitoring through International Waterbird Census (IWC), i.e. land-based waterbird counts in January. Further modules, such as monitoring and assessment of waterbirds wintering in offshore sections of the Baltic Sea, can be added in the future.

Further development of the indicator

The main objective of further development in the wintering waterbird abundance indicator is the inclusion of offshore living species and parts of populations, respectively. Currently, the indicator only covers coastal areas (with Polish and Finnish boat data as an exception), thus inclusion of offshore data from line and strip transect boat and plane surveys would expand its scope and explanatory power. A concept for monitoring waterbirds in offshore parts of the Baltic and a methodology for analyses have been developed by the Joint

OSPAR/HELCOM/ICES Working Group on Seabirds and is outlined in more detail in the section 'Description of optimal monitoring'.

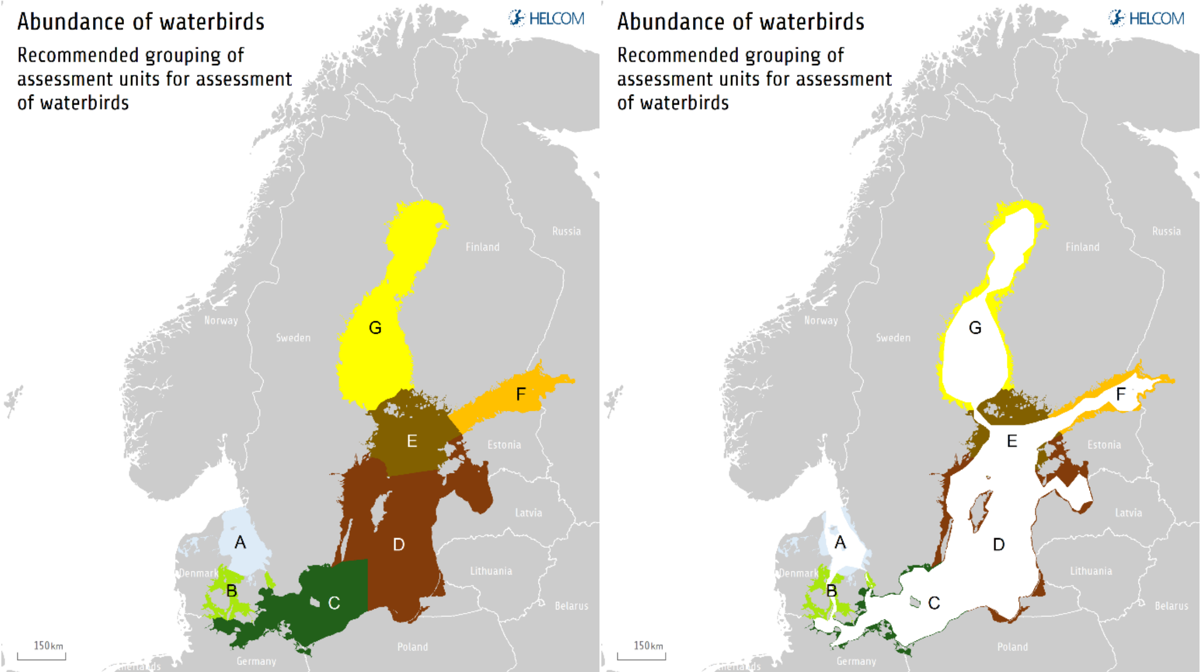
The explanatory power of the indicator would increase with species-specific settings of baselines, allowing to identify the effects of human activities on waterbird population more precisely through comparison with pristine conditions. Further, the choice of species assessed could be more selective, meaning that species directly connected to the environmental conditions in the Baltic Sea are preferred over those distributed across a wider spectrum of habitats.

Assessment units

The current evaluation is made for the entire Baltic Sea using HELCOM assessment unit scale 1 and for seven subdivisions, which are defined by the merging of up to four of the 17 sub-basins of the Baltic Sea (i.e. HELCOM assessment unit scale 2), the latter following a recommendation by the Joint OSPAR/HELCOM/ICES Working Group on Seabirds (Assessment units figure 1). The use of an even finer scale does not make sense in view of the high mobility of waterbirds, i.e. movements during a given winter and distributional changes between winters, which may go across the borders of individual sub-basins. The use of the seven subdivisions shall make it easier to localize problems and to implement necessary regional or local measures to improve the status. These smaller scale assessments are better suited to reflect the conditions of a given part of the Baltic Sea rather than downscaling the results from the entire Baltic Sea to everywhere. Further, subdivision assessments serve better the national reporting according to Article 8 of MSFD, because there is much less influence from other parts of the Baltic on the national assessments. The seven subdivisions are preliminarily named as follows:

- A: Kattegat (Kattegat),
- B: Belt Group (Great Belt, The Sound),
- C: Bornholm Group (Kiel Bay, Bay of Mecklenburg, Arkona Basin, Bornholm Basin),
- D: Gotland Group (Gdansk Basin, Eastern Gotland Basin, Western Gotland Basin, Gulf of Riga),
- E: Aland Group (Northern Baltic Proper, Aland Sea),
- F: Gulf of Finland (Gulf of Finland),
- G: Bothnian Group (Bothnian Sea, The Quark, Bothnian Bay).

The HELCOM assessment unit scales are defined in the HELCOM Monitoring and Assessment Strategy Annex 4.



Assessment units figure 1. Grouping of 17 sub-basins (HELCOM assessment unit scale 2) to seven subdivisions as spatial units for wintering waterbird abundance evaluations as recommended by OSPAR/HELCOM/ICES (2017). The left figure shows the entire subdivision coloured, and the right figure shows the coastal areas, as used in the current assessment, coloured by the seven subdivisions.

Relevance of the Indicator

Biodiversity assessment

The status of biodiversity is assessed using several core indicators. Each indicator focuses on one important aspect of the complex issue. In addition to providing an indicator-based evaluation of the abundance of waterbirds in the wintering season, this indicator contributes to the overall biodiversity assessment along with the other biodiversity core indicators.

Policy relevance

The indicator on abundance of waterbirds in the wintering season addresses the Baltic Sea Action Plan (BSAP) Biodiversity and nature conservation segment's ecological objectives 'Thriving and balanced communities of plants and animals' and 'Viable populations of species' as well as the eutrophication segment's ecological objective 'Natural distribution and occurrence of plants and animals'.

The core indicator is relevant to the following action of the 2013 HELCOM Ministerial Declaration:

- 4 (B). WE DECIDE to… protect seabirds in the Baltic Sea, taking into consideration migratory species and need for co-operation with other regions through conventions and institutions such as the Agreement on Conservation of African Eurasian Migratory Waterbirds (AEWA) under the Convention on Migratory Species (CMS), and particularly in the North Sea (OSPAR) and Arctic (Arctic Council) areas.

The core indicator also addresses the following qualitative descriptors of the MSFD for determining good environmental status (European Commission 2008):

Descriptor 1: 'Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions';

Descriptor 4: 'All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity'

and the following criteria of the Commission Decision (EU) 2017/848 (European Commission 2017):

- Criterion D1C2 (population abundance)
- Criterion D1C4 (species distribution)
- Criterion D4C1 (diversity of trophic guild)
- Criterion D4C2 (balance of total abundance between trophic guilds)

The EU Birds Directive (a) lists in Annex 1 red-throated diver, black-throated diver, Slavonian grebe (these three species currently not assessed), whooper swan, Steller's eider and smew as subject of special conservation measures and (b) generally covers all migratory species and they have to be reported (European Commission 2010). Thus, all species included in the concept of the indicator are also covered by the EU Birds Directive, which requires conservation of habitats in a way that allows birds to breed, moult, stage during migration and spend the winter.

Furthermore, the Baltic Sea is located in the agreement area of the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA). Contracting parties (all HELCOM member countries except Poland and Russia) are obliged to undertake measures warranting the conservation of migratory waterbirds and their habitats.

The goals of the BSAP, EU MSFD, AEWA and EU Birds Directive are largely overlapping and the data needed for the indicator are roughly the same as needed for reporting within the framework of the EU Birds Directive.

In order to protect migrating birds in the Baltic Sea region, HELCOM has adopted the Recommendation 34/E-1 'Safeguarding important bird habitats and migration routes in the Baltic Sea from negative effects of wind and wave energy production at sea'. Since some species included in this indicator are vulnerable to habitat loss caused by wind farms and others are prone to collisions (e.g. Furness et al. 2013; Dierschke et al. 2016), the indicator is also linked to the intentions of the Recommendation.

Role of waterbirds in the ecosystem

Waterbirds are an integral part of the Baltic marine ecosystem. They are predators of fish and macroinvertebrates, scavengers of carcasses and fishery discards and herbivores of littoral vegetation. Most species are specialized on certain species and/or size classes of prey and their abundance is affected by the availability of prey. As they cannot survive without a sufficient food supply, changes in the number of waterbirds reflect conditions in the food web of the Baltic Sea.

As predators at, or close to, the top of the food web, waterbirds accumulate contaminants, and their abundance may reflect the degree of contamination. Contaminants ingested in winter may have carry-over effects on breeding success. Moreover, several waterbird species are predated by white-tailed sea eagles, transferring the loads of contaminants to a higher level in the food web.

Some waterbird species do not only winter, but also breed in the Baltic Sea. For several reasons, those species are potentially included in the concepts of both the breeding and wintering waterbird abundance indicators. First, the intention of the indicators is to support the assessment of environmental status of marine areas rather than the state of bird populations per se. This is most obvious in species differing in distribution patterns between breeding and wintering seasons (e.g. alcids). Second, most wintering waterbird species aggregate in suitable feeding habitats, often far from the breeding sites. In addition, there is a turnover of individuals within species, meaning that some individuals of a given species leave the Baltic Sea for wintering in other marine areas, whereas others live in the Baltic Sea only in winter. In general, the explanatory power of the indicator is constrained by factors acting on the waterbirds in the breeding season, either in the Baltic Sea or in other breeding areas in northern Eurasia or as far east as the Siberian Taimyr Peninsula.

Waterbirds use all ice-free areas of the Baltic Sea as a wintering areas and therefore the distribution varies per year depending on ice conditions. The HELCOM supporting parameter 'Ice season' provides insight into the highly variable coverage of ice in the Baltic Sea during the past few centuries.

Human pressures linked to the indicator

	General	MSFD Annex III, Table 2a
Strong link	The most important anthropogenic threats to wintering waterbirds are incidental bycatch in fishing gear (gill nets), hunting, prey depletion, oil pollution, intake of hazardous substances and habitat loss owing to offshore wind farms, aggregate extraction and shipping.	Biological pressures: - disturbance of species (e.g. where they breed, rest and feed) due to human presence. - extraction of, or mortality/injury to, wild species (by commercial and recreational fishing and other activities). Physical pressures: - physical disturbance to seabed (temporary or reversible). - physical loss (due to permanent change of seabed substrate or morphology and to extraction of seabed substrate). Pressures by substances, litter and energy - input of nutrients – diffuse sources, point sources, atmospheric deposition. - input of organic matter – diffuse sources and point sources. - input of other substances (e.g. synthetic substances, non-synthetic substances, radionuclides) – diffuse sources, point sources, atmospheric deposition, acute events.
Weak link		Pressures by substances, litter and energy: - input of litter (solid waste matter, including micro-sized litter). - input of anthropogenic sound (impulsive, continuous). - input of other forms of energy (including electromagnetic fields, light and heat).

The status of waterbird populations is affected by several pressures stemming from human activities, including mortality caused by oil spills, incidental bycatch in fisheries, hunting as well as human-induced eutrophication affecting the food web structure and function. Functional groups of species can potentially reflect - in a more specific manner - which pressures are affecting the status.

In general, waterbirds strongly respond to food availability. Therefore, human activities influencing the food supply of waterbirds are reflected in bird numbers. For fish-eating birds, direct human pressure is posed by the extraction of fish, while physical damage of the seafloor affects primarily benthic feeders. Indirect pressure is caused by eutrophication; in the oligotrophic end of the eutrophication status bird populations are limited by the availability of food sources, whereas towards eutrophic conditions plant and zoobenthos biomass increases, which first benefits seabird populations, but in the extreme end causes decreased food availability.

Among human pressures causing losses of individual waterbirds, drowning in fishing gear (mainly gill nets) is a serious problem. Estimates of the number of birds incidentally caught in fisheries are uncertain, but probably amount to 100,000-200,000 birds annually (Žydelis et al. 2009). In addition, high numbers of seaducks are hunted, with large quotas in particular for common eider and common goldeneye (Mooij 2005, Skov et al. 2011). Though the number of oil spills has decreased, oil pollution causing oiled plumage, hypothermia and finally death still affects waterbirds in the Baltic Sea (Larsson & Tydén 2005; Žydelis et al. 2006). Bird health is constrained also by the intake of contaminants (Broman et al. 1990; Rubarth et al. 2011; Pilarczyk et al. 2012).

Some waterbird species are prone to habitat loss caused by human activities, which perhaps reduce the carrying capacity of certain wintering sites. Avoidance of offshore wind farms has been observed to affect the spatial distribution of divers and long-tailed ducks (Petersen et al. 2011; Dierschke et al. 2016). These species, as well as other seaducks, also avoid shipping lanes (Bellebaum et al. 2006; Schwemmer et al. 2011). For benthic feeders, additional habitat loss is caused by physical damage of the seafloor caused by both fisheries and aggregate extraction.

It is important to note that all the above-mentioned human activities have a cumulative impact on waterbird populations, not only in the wintering season, but also carry over to the breeding season (e.g. affecting breeding success). On the other hand, waterbirds wintering in the Baltic can be influenced by pressures in the breeding areas and during migration (OSPAR/HELCOM/ICES 2017). The cumulative impact on waterbirds has been reviewed by the example of red-throated diver and black-throated diver (Dierschke et al. 2012). This indicator addressing the abundance of wintering waterbirds combines the effects of different pressures.

Monitoring Requirements

Monitoring methodology

Monitoring of wintering waterbirds in the Contracting Parties of HELCOM is described on a general level in the **HELCOM Monitoring Manual in the sub-programme: Marine wintering birds abundance and distribution**.

Guidelines for monitoring methods needed for this indicator have been developed by the HELCOM BALSAM project. The adoption of the guidelines is on-going.

Currently monitoring practices vary and are described for offshore censuses by Camphuysen et al. (2004), Skov et al. (2007, 2011) and Nilsson (2012), whereas for coastal areas census methods are standardized by Wetlands International for the International Waterbird Census (IWC; Wetlands International 2010).

The indicator is primarily based on mid-winter counts of waterbirds along the shoreline, carried out as national monitoring, i.e. the indicator is restricted to coastal staging areas. Additionally, data from boat surveys in Polish offshore and Finnish Archipelago are included. The aim is to expand the indicator by including waterbirds wintering in offshore areas of the Baltic Sea by adding more data collected in Baltic offshore (OSPAR/HELCOM/ICES 2017).

Current monitoring

Monitoring of wintering waterbirds is running in all countries bordering the Baltic Sea and specifications are provided in the monitoring concepts table in the **HELCOM Monitoring Manual**.

Sub-programme: Marine wintering birds abundance and distribution

Monitoring Concepts table

Monitoring of coastal wintering waterbirds (i.e. the IWC) is organized by Wetlands International (Wageningen) and has been carried out annually in mid-January for more than 50 years, with high coverage of the Baltic Sea since 1991.

There is no coordinated monitoring for offshore areas, but national programmes are implemented in several countries and efforts were started to coordinate surveys on a regional level (HELCOM 2014, OSPAR/HELCOM/ICES 2017). The coverage of offshore area monitoring is far from complete, and intervals of monitoring as well as methods and platforms differ between programmes. All past and ongoing offshore surveys are included in a metadatabase developed in the BALSAM project (HELCOM 2014). More details are listed in the HELCOM Monitoring Manual.

Description of optimal monitoring

Concerning coastal waterbirds, the land-based IWC already serves as a geographically wide spread monitoring system. It can continue as it is, but future surveys should take into account that the relevance of Bothnian Bay and eastern Gulf of Finland may increase after a few years due to the predicted milder winters as a consequence of climate change.

It would be desirable to include offshore parts of the Baltic in the evaluation of wintering waterbird numbers. Important components of the avian community concentrate in marine areas not covered by land-based surveys, i.e. divers, grebes, seaducks, gulls and alcids. Monitoring of offshore areas requires the use of ships and/or aircrafts as observation platforms for manned transect counts or the use of digital imagery. Currently, offshore monitoring has only been implemented in a few parts of the Baltic Sea, but the Joint OSPAR/HELCOM/ICES Working Group on Seabirds has outlined a strategy for offshore monitoring in northern Europe including the whole HELCOM area and addressing questions of coordination, periods of surveys and methods applied (OSPAR/HELCOM/ICES 2017). International coordination is necessary in order to integrate national monitoring schemes into Baltic-wide surveys. Where reasonable, special programmes such as the visual observation of waterbird migration at exposed sites (Hario et al. 2009, Ellermaa & Lindén 2015) would add valuable information to support the explanatory power of the monitoring results. It has to be noted that so far only two data points for total numbers of waterbirds wintering in the Baltic are available (Durinck et al. 1994; Skov et al. 2011), with another one (based on a coordinated survey in early 2016) awaiting analysis.

Depending on weather conditions and other (e.g. dietary) reasons, the distribution of some species show variability between years, creating a need for simultaneous surveys in all parts of the Baltic Sea. Simultaneous surveys are possible and already carried out in the land-based IWC. Owing to high costs, there is no capacity for full-coveragesurveys in the offshore parts of the Baltic Sea on a yearly basis. Instead, monitoring programmes should aim at carrying out these surveys at a lower frequency, e.g. once or twice within a six-year reporting cycle of the EU MSFD or Birds Directive. It is recommended to survey the entire Baltic Sea coordinatedly at least every three years with additional surveys of sub-areas at a higher frequency to increase accuracy of indicator results. It is further proposed that digital methods for aerial surveys are further developed (OSPAR/HELCOM/ICES 2017).

Data and updating

Access and use

The data and resulting data products (tables, figures and maps) available on the indicator web page can be used freely given that the source is cited. The indicator should be cited as following:

HELCOM (2018) Abundance waterbirds in the wintering season. HELCOM core indicator report. Online. [Date Viewed], [Web link].

ISSN 2343-2543

Metadata

Result: Abundance of waterbirds in the wintering season

Data: Abundance of waterbirds in the wintering season

Result: Abundance of waterbirds in the wintering season - surface

Result: Abundance of waterbirds in the wintering season - pelagic

Result: Abundance of waterbirds in the wintering season - benthic

Result: Abundance of waterbirds in the wintering season – grazing

Result: Abundance of waterbirds in the wintering season - wading

The current evaluation is based on national monitoring data from coastal mid-winter counts (International Waterbird Census organized by Wetlands International) from all HELCOM Contracting Parties. Data for the years 1991-2016 were supplied by national dataholders following a data call in May 2017. Data sets consisted of site code, year, species and abundance (bird numbers). Data were supplied for a total of 18131778 sites, but each species had different numbers of sites used in the analysis.

We acknowledge the E-OBS dataset from the EU-FP6 project ENSEMBLES (http://ensembles-eu.metoffice.com) and the data providers in the ECA&D project (http://www.ecad.eu)".

Contributors and references

Contributors

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Building on the work of the CORESET I indicator report

Other recognized contributors: Markus Ahola, Tomasz Chodkiewicz, Preben Clausen, Mindaugas Dagys, Gennady Grishanov, Antti Lappalainen, Meelis Leivits, Aleksi Lehikoinen, Leho Luigujoe, Wlodzimierz Meissner, Markku Mikkola-Roos, Ian Mitchell, Ib Krag Petersen, Jukka Rintala, Antra Stipniece, Johannes Wahl.

Archive

This version of the HELCOM core indicator report was published in July 2018:

Abundance of waterbirds in the wintering season HELCOM core indicator 2018 (pdf)

Older versions of the report:

HOLAS II component - Core indicator report – web-based version July 2017 (pdf)

2013 Indicator report

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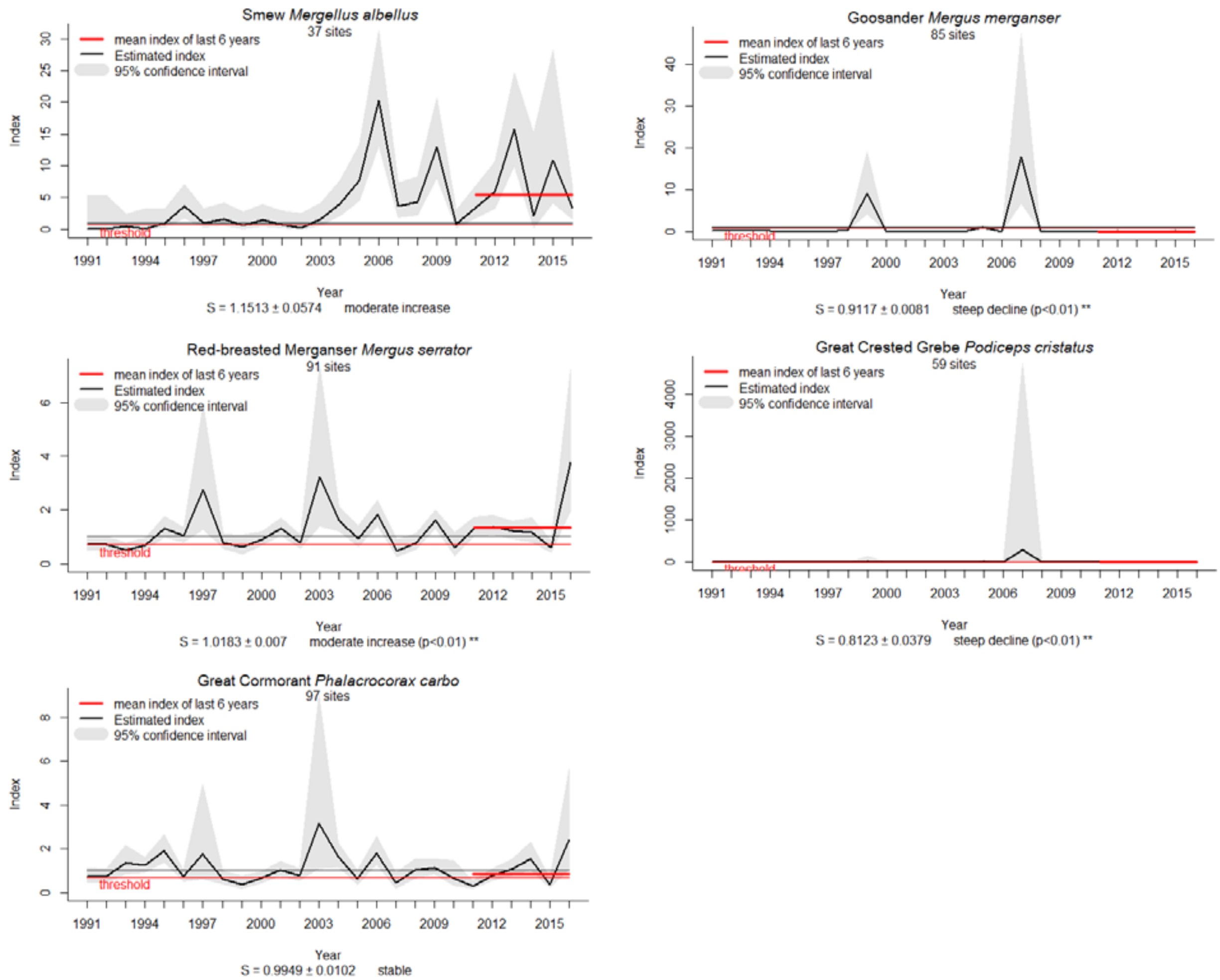
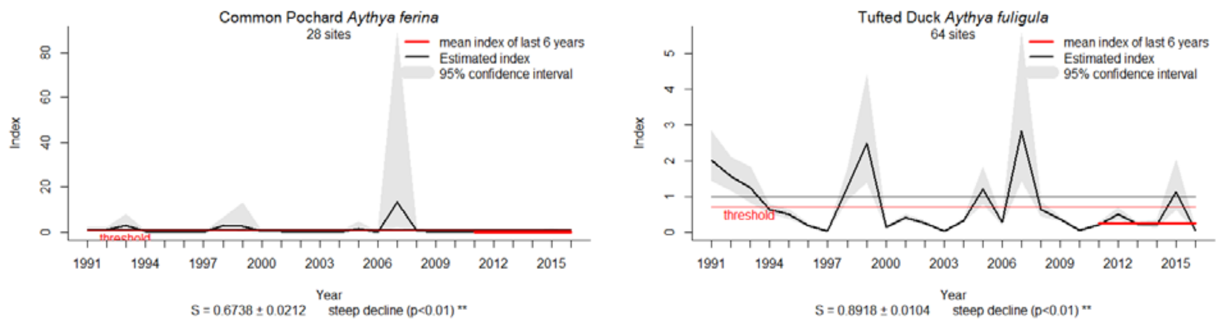
Annex 1

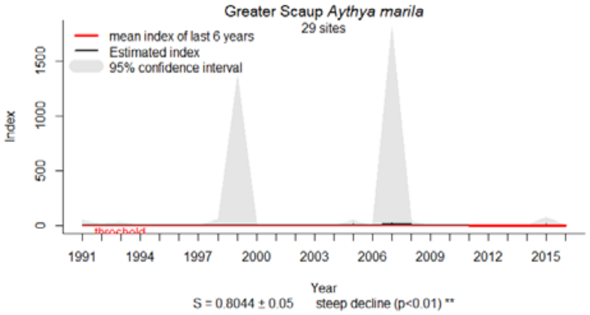
Results figure 2: Index graphs showing annual index values for wintering waterbirds in the **Kattegat** (black line) and 95% confidence intervals (grey shading) resulting from GAM analyses with reference level where average of index values 1991-2000 is 1 (thin black line). Further shown are thresholds for good status (70% of baseline, thin red line) and the average index values 2011-2016 (geometric mean) used for the evaluation (red line). In addition, trend slopes and s.e. as well as the status of the species regarding the trend are given below the graphs. **Models for smew and Eurasian teal do not include temperature as a covariate.**

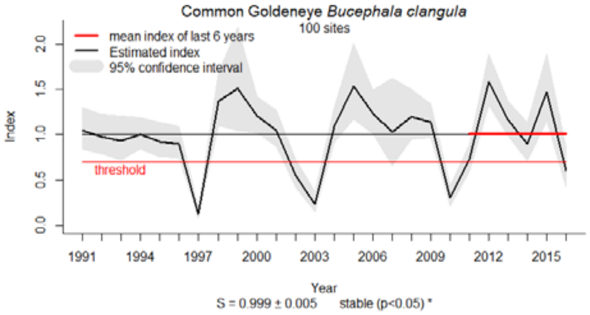
Pelagic feeders



Benthic feeders







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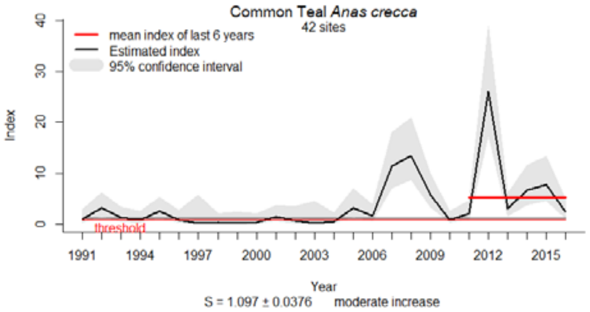

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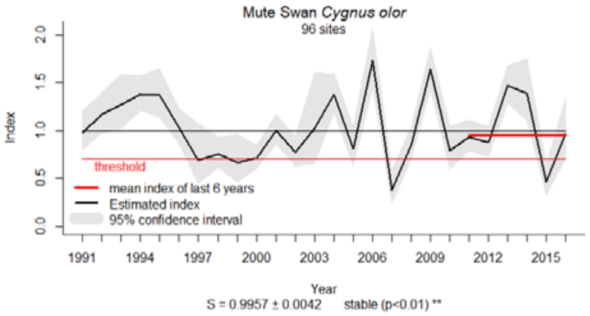
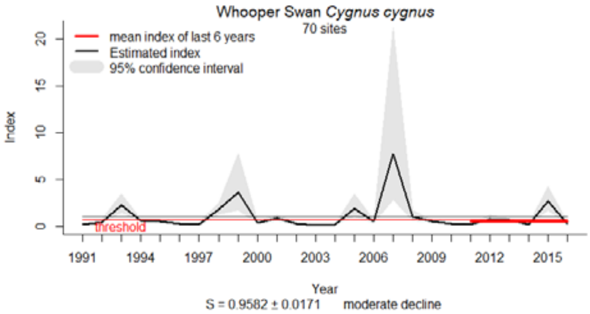
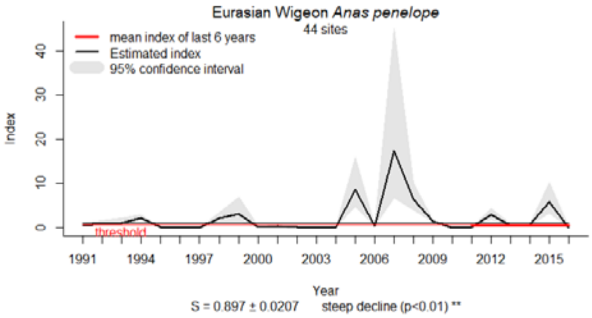
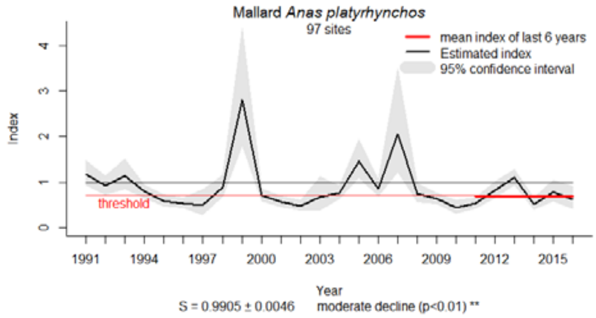
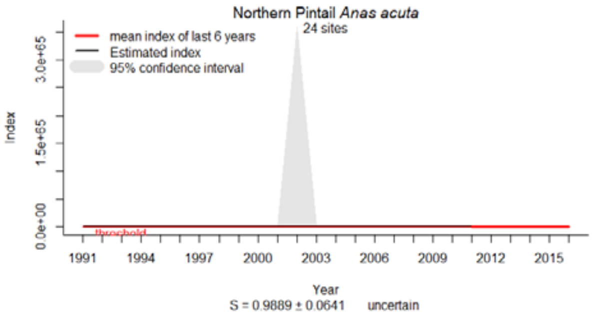
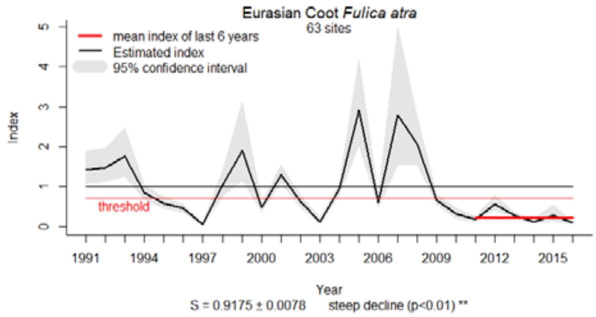






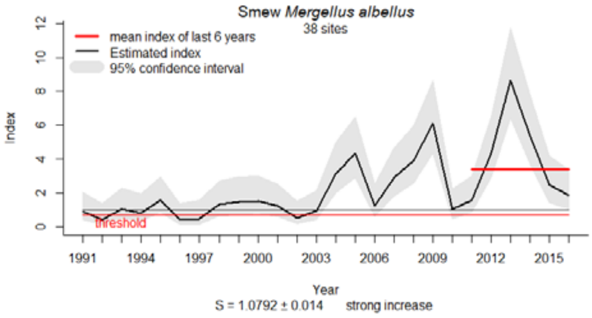


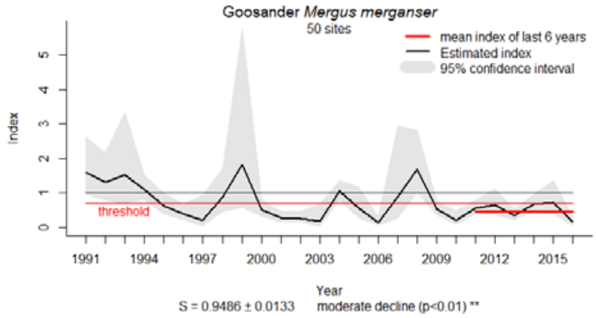


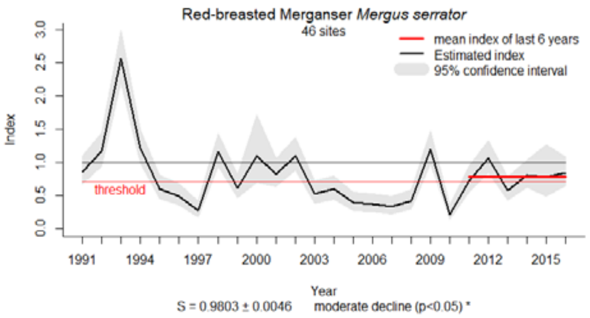


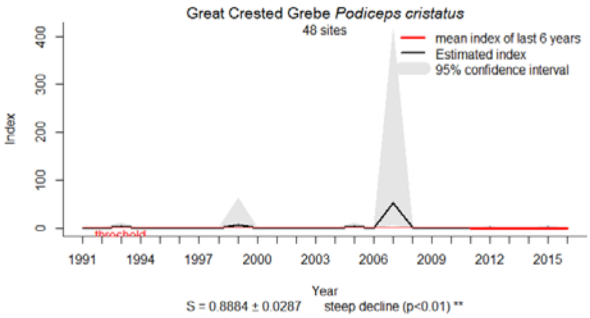
Results figure 3: Index graphs showing annual index values for wintering waterbirds in the **Belt Group** (Great Belt, The Sound; black line) and 95% confidence intervals (grey shading) resulting from GAM analyses with reference level where average of index values 1991-2000 is 1 (thin black line). Further shown are thresholds for good status (70% of baseline, thin red line) and the average index values 2011-2016 (geometric mean) used for the evaluation (red line). In addition, trend slopes and s.e. as well as the status of the species are given below the graphs. **Models for smew, red-breasted merganser, great cormorant, tufted duck, greater scaup, whooper swan, Eurasian wigeon and Eurasian coot do not include temperature as a covariate.**

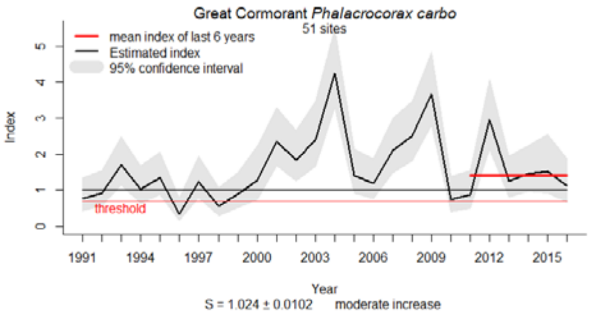
Pelagic feeders











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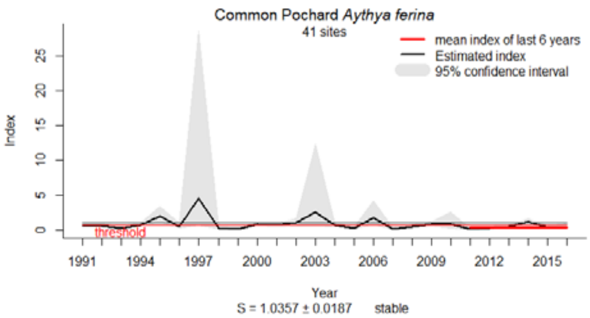
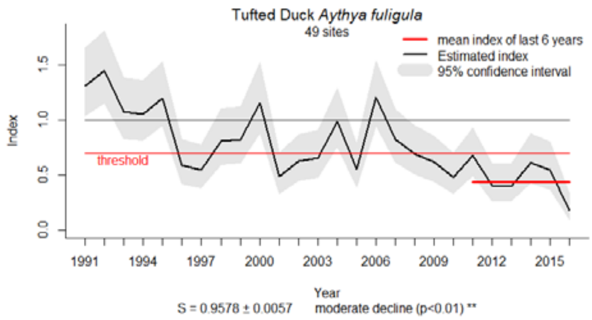
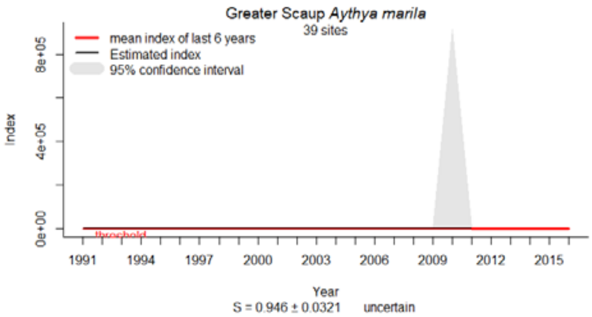
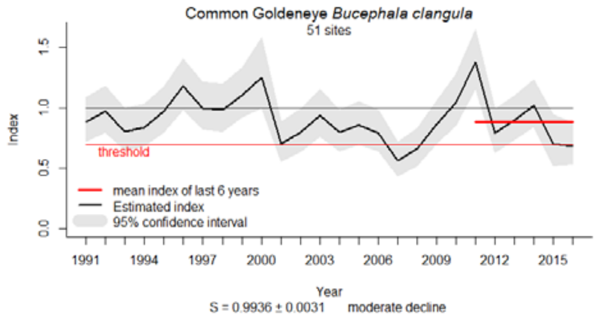
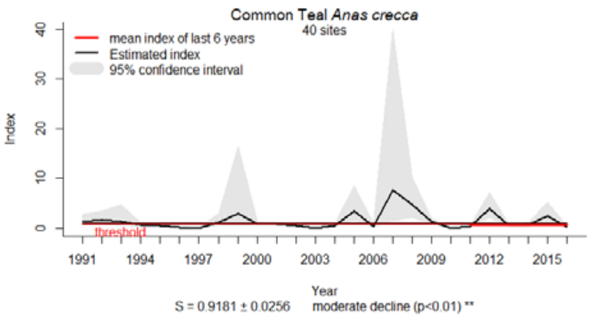




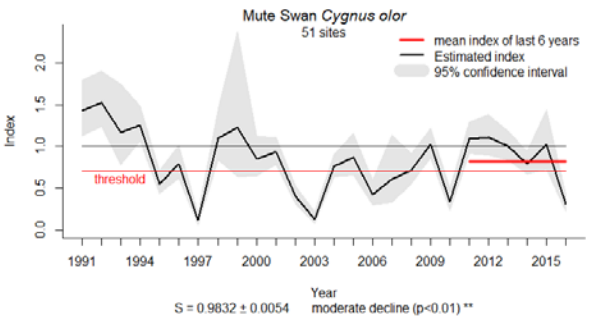


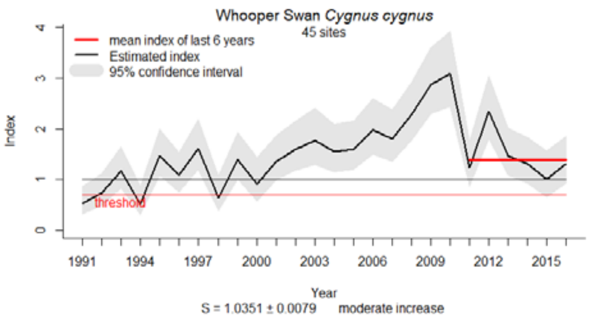


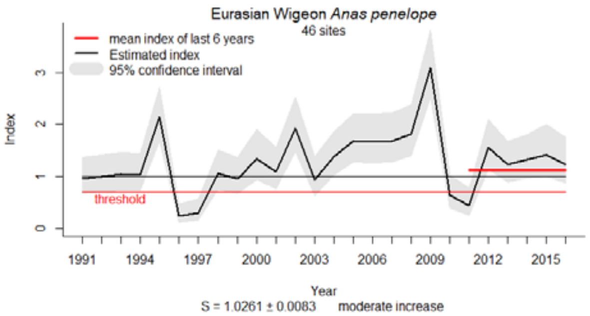
Wading feeders

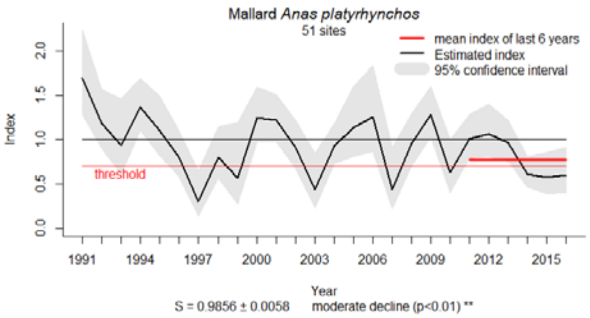


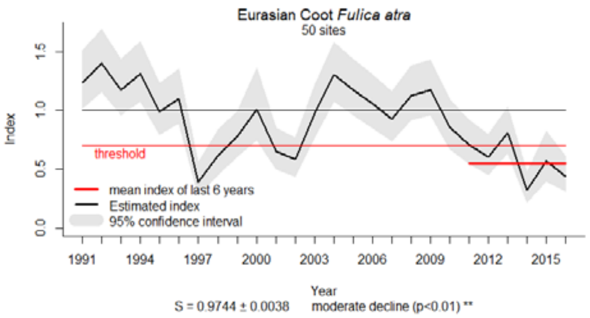
Grazing feeders





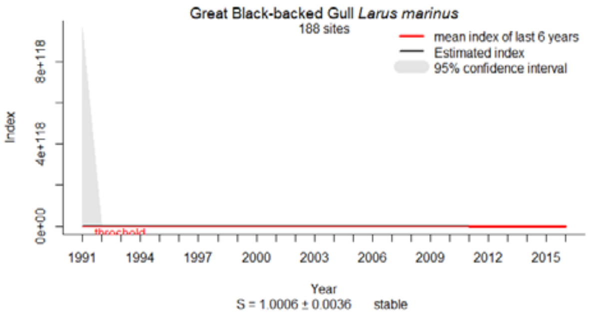




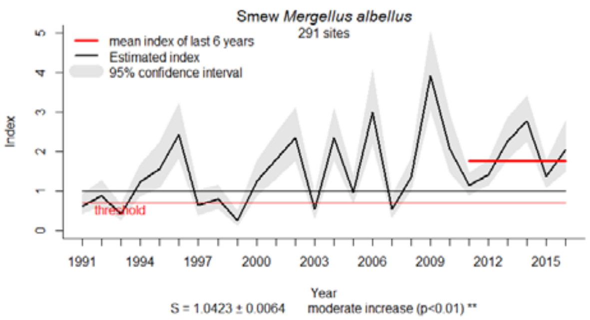


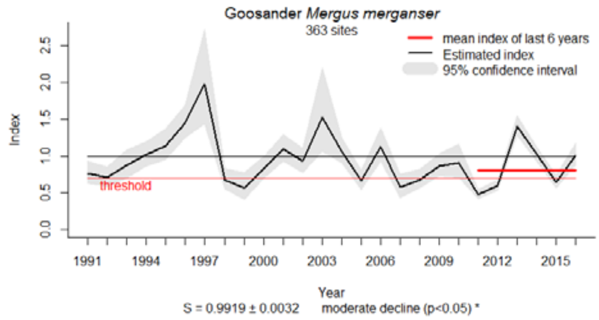
Results figure 4: Index graphs showing annual index values for wintering waterbirds in the **Bornholm Group** (Kiel Bay, Bay of Mecklenburg, Arkona Basin, Bornholm Basin; black line) and 95% confidence intervals (grey shading) resulting from GAM analyses with reference level where average of index values 1991-2000 is 1 (thin black line). Further shown are thresholds for good status (70% of baseline, thin red line) and the average index values 2011-2016 (geometric mean) used for the evaluation (red line). In addition, trend slopes and s.e. as well as the status of the species are given below the graphs. **Models for great black-backed gull, common pochard, greater scaup, Eurasian teal, mute swan, whooper swan, Bewick's swan and Eurasian wigeon do not include temperature as a covariate.**

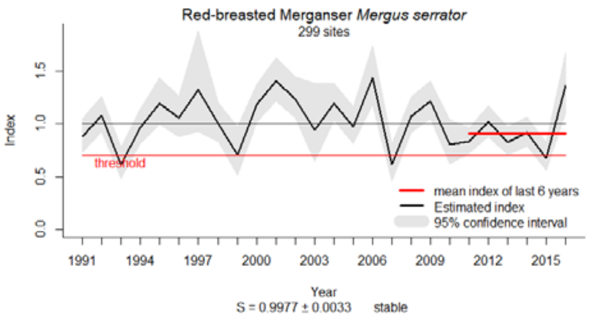
Surface feeders

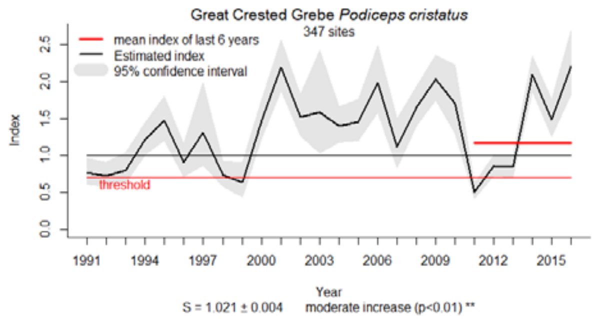


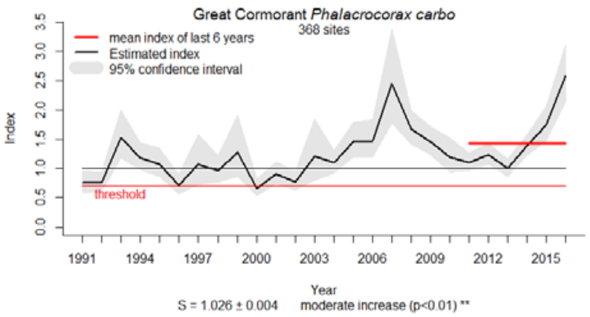
Pelagic feeders











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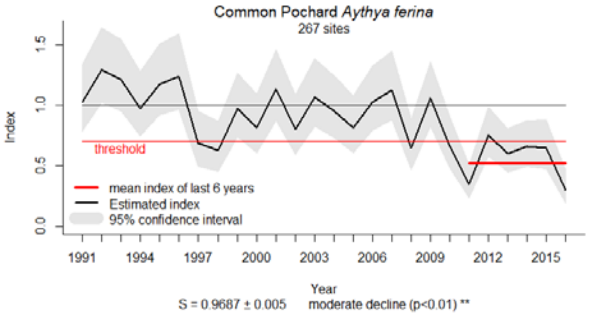
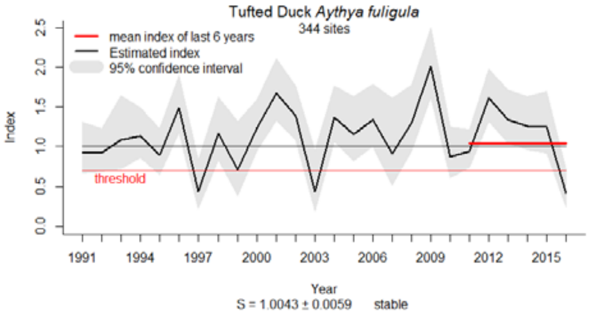
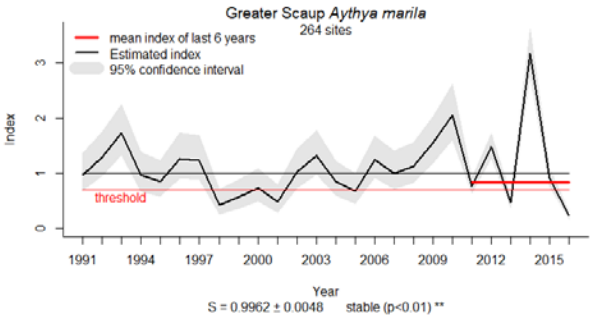
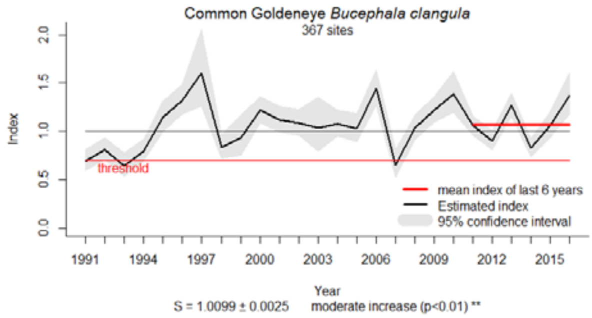
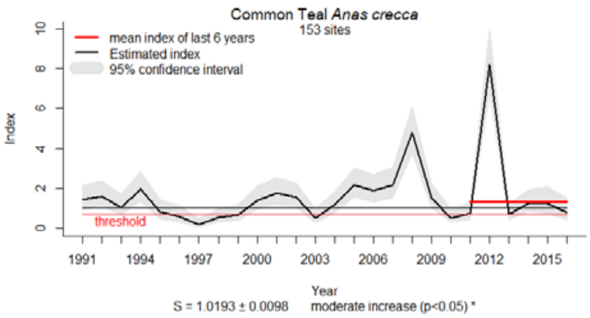




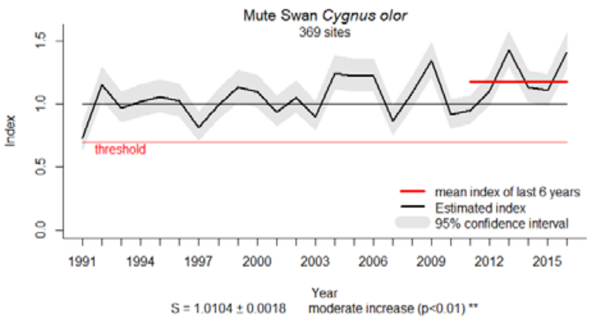


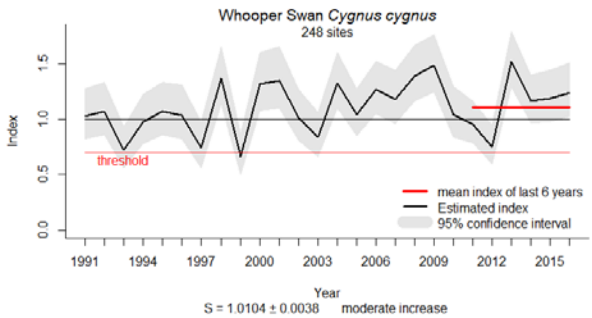


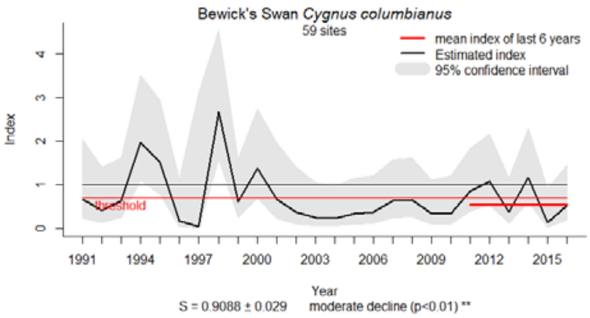
Wading feeders

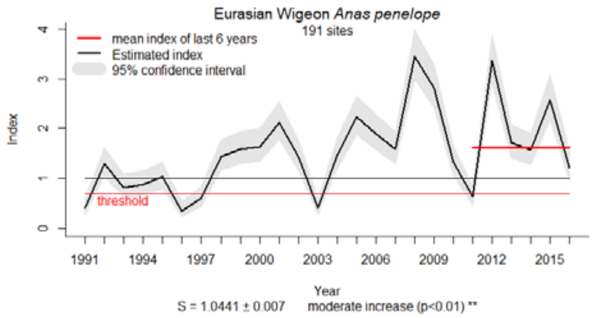


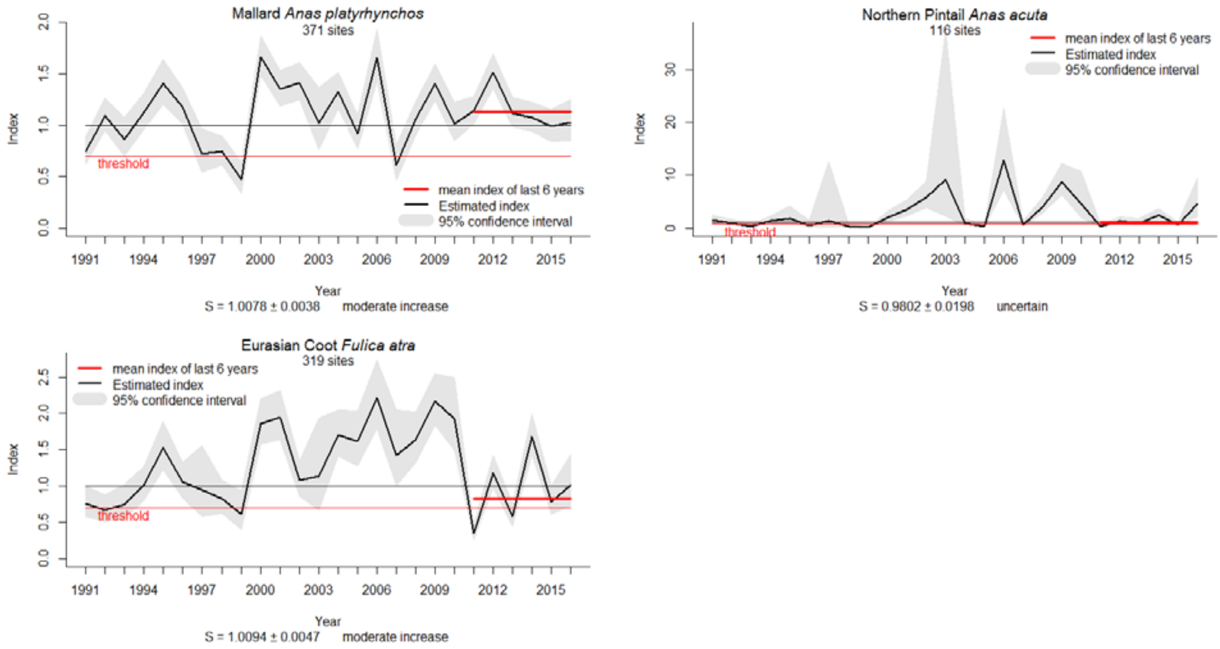
Grazing feeders





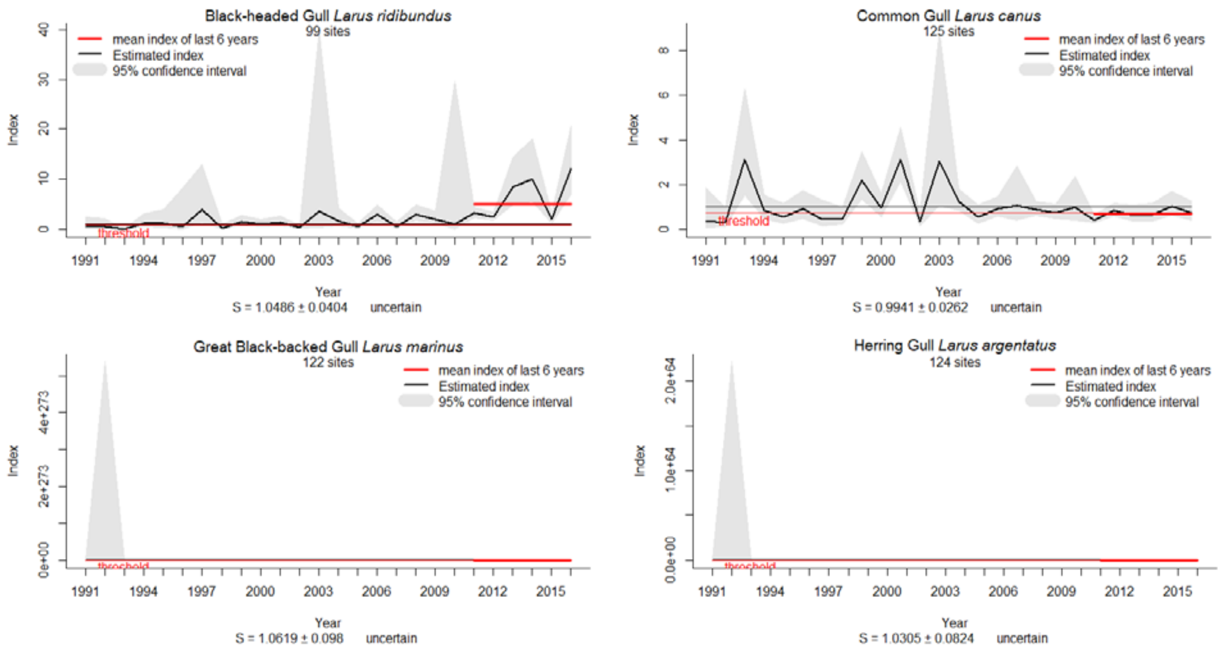




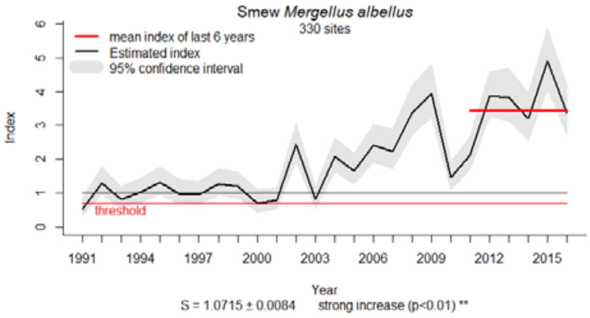


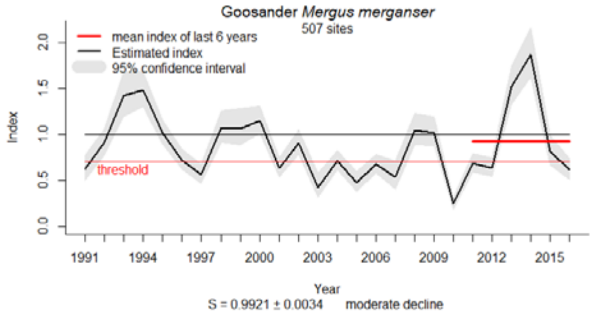
Results figure 5: Index graphs showing annual index values for wintering waterbirds in the **Gotland Group** (Gdansk Basin, Eastern Gotland Basin, Western Gotland Basin, Gulf of Riga; black line) and 95% confidence intervals (grey shading) resulting from GAM analyses with reference level where average of index values 1991-2000 is 1 (thin black line). Further shown are thresholds for good status (70% of baseline, thin red line) and the average index values 2011-2016 (geometric mean) used for the evaluation (red line). In addition, trend slopes and s.e. as well as the status of the species are given below the graphs. **Models for smew, common goldeneye, mallard and Eurasian coot do not include temperature as a covariate.**

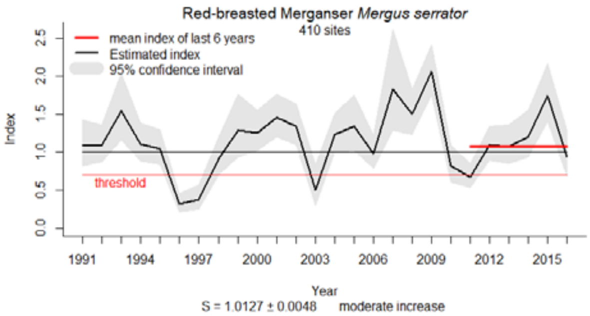
Surface feeders

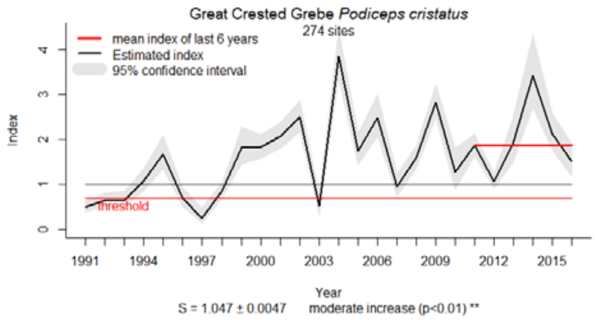


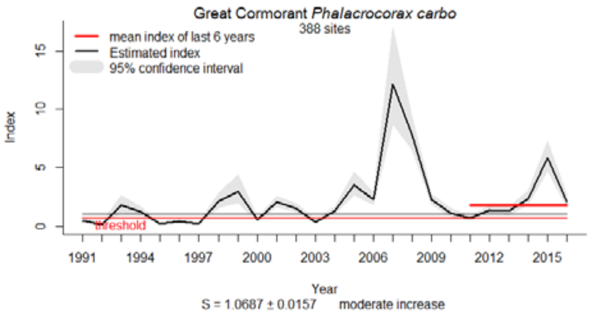
Pelagic feeders



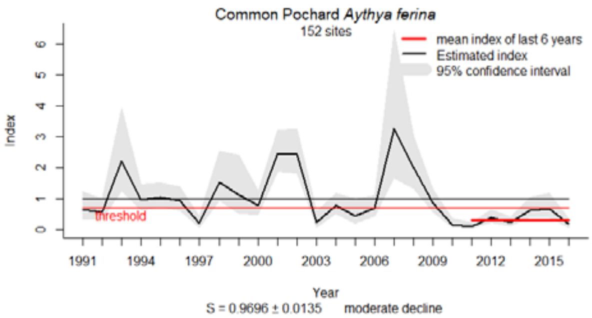


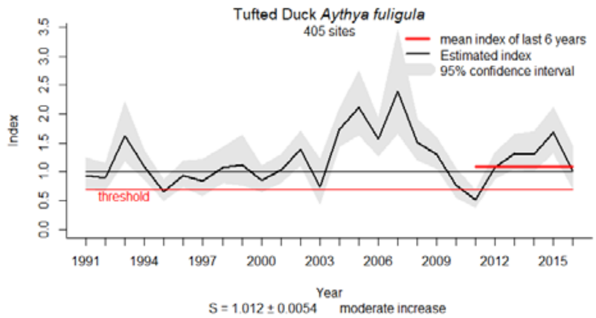


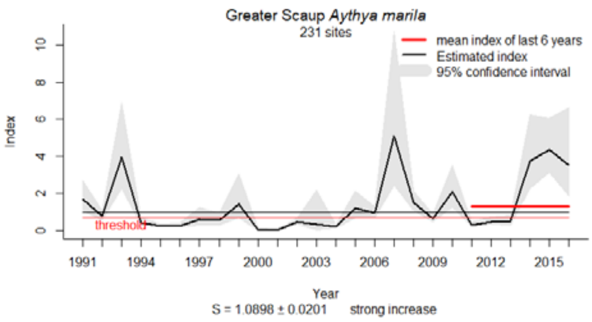


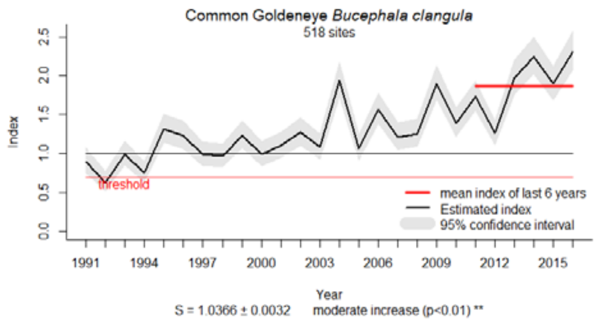


Benthic feeders

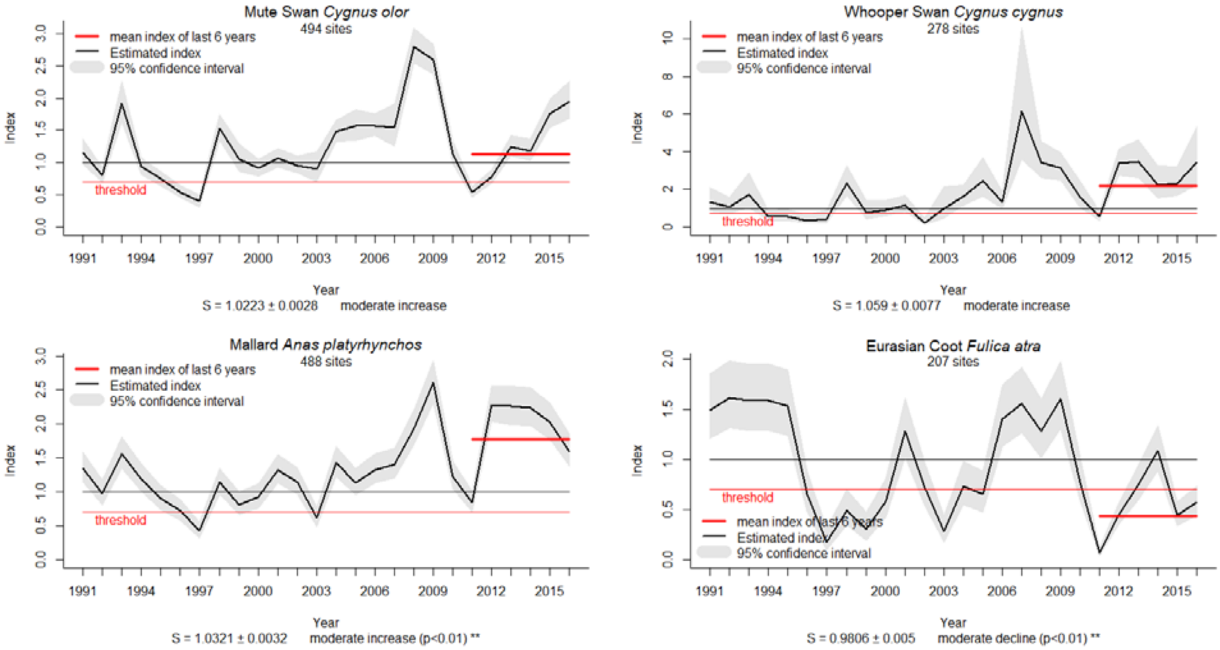






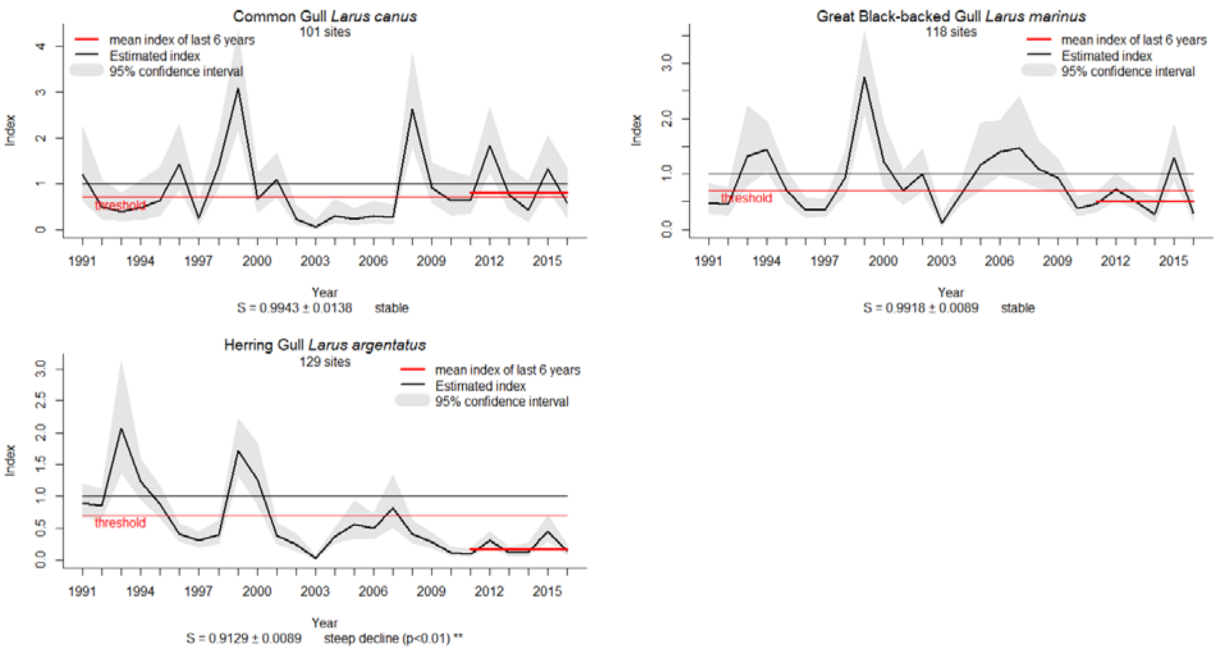


Grazing feeders

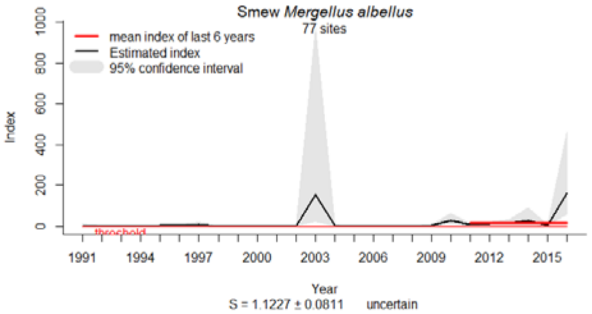


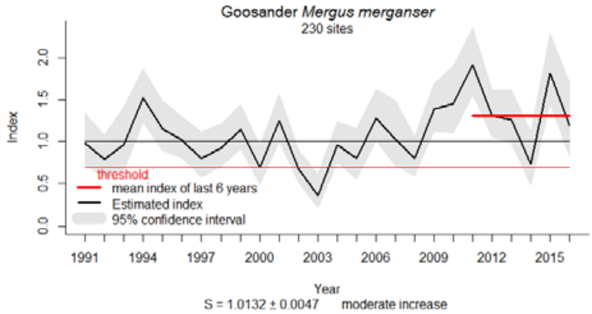
Results figure 6: Index graphs showing annual index values for wintering waterbirds in the **Aland Group** (Northern Baltic Proper, Aland Sea; black line) and 95% confidence intervals (grey shading) resulting from GAM analyses with reference level where average of index values 1991-2000 is 1 (thin black line). Further shown are thresholds for good status (70% of baseline, thin red line) and the average index values 2011-2016 (geometric mean) used for the evaluation (red line). In addition, trend slopes and s.e. as well as the status of the species are given below the graphs. **Models for great cormorant, greater scaup and Steller's eider do not include temperature as a covariate.**

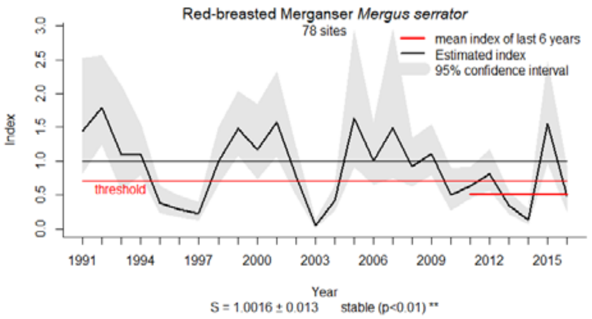
Surface feeders

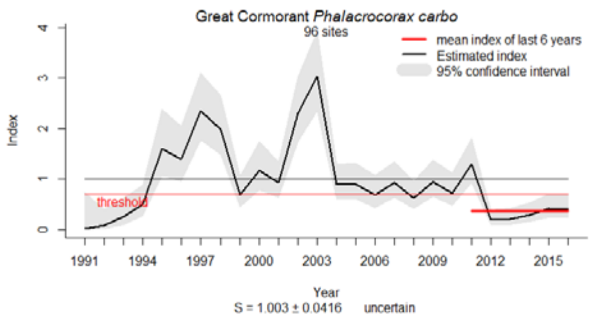


Pelagic feeders

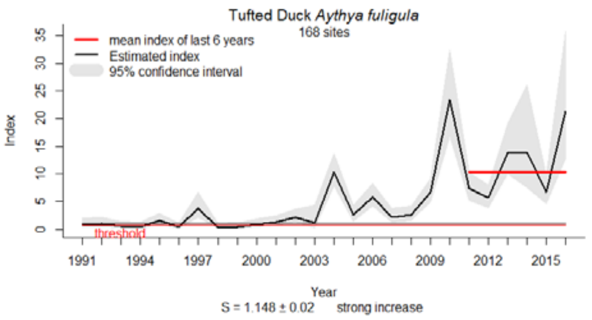


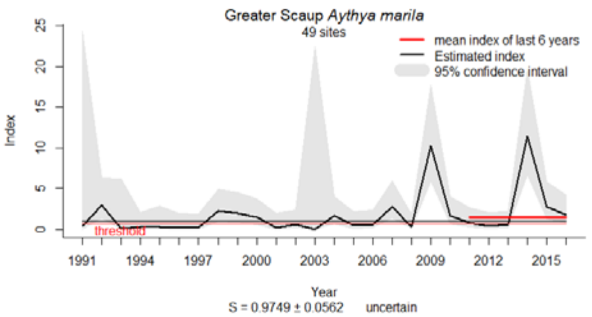


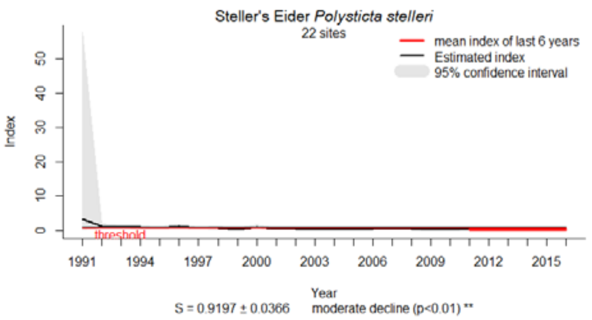


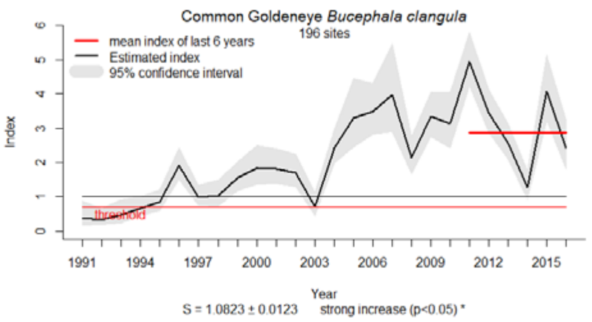


Benthic feeders

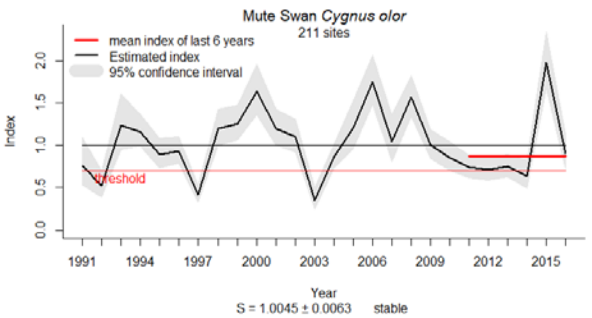


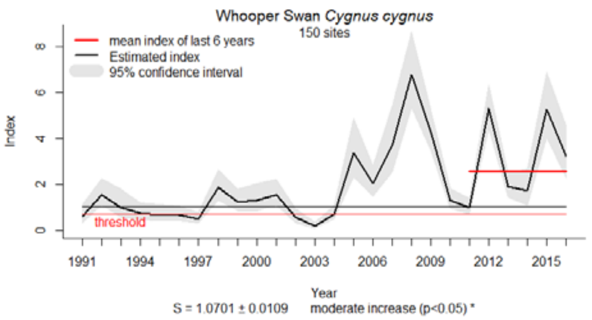


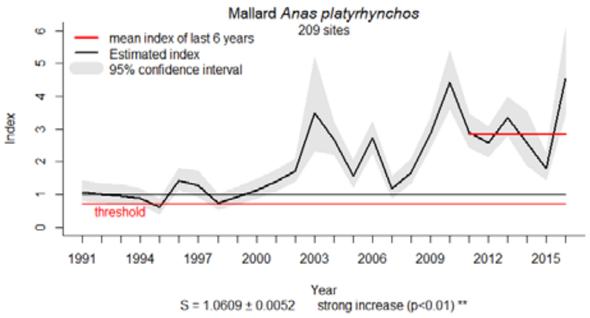


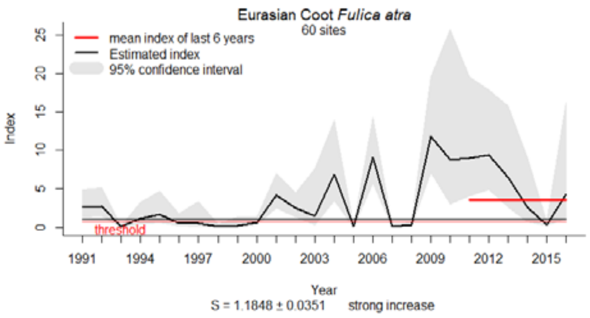


Grazing feeders



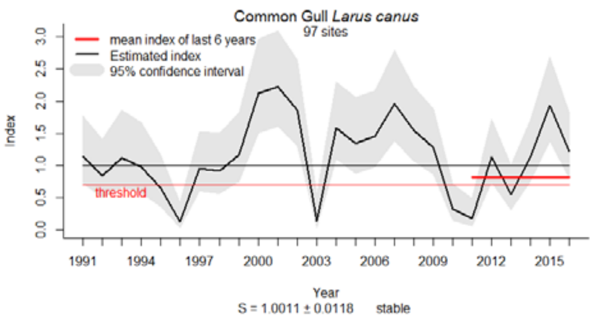


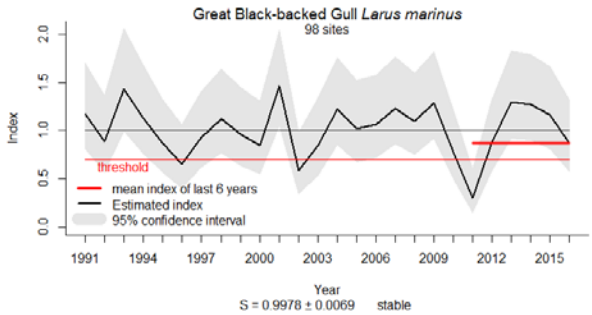


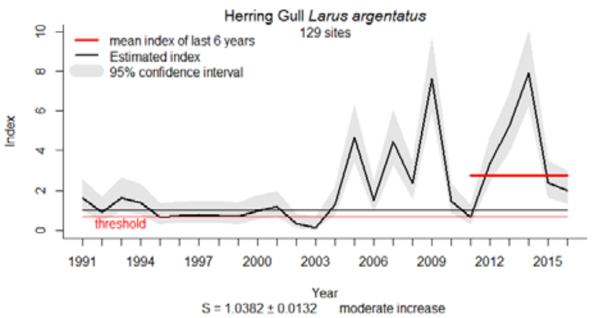


Results figure 7: Index graphs showing annual index values for wintering waterbirds in the **Gulf of Finland** (black line) and 95% confidence intervals (grey shading) resulting from GAM analyses with reference level where average of index values 1991-2000 is 1 (thin black line). Further shown are thresholds for good status (70% of baseline, thin red line) and the average index values 2011-2016 (geometric mean) used for the evaluation (red line). In addition, trend slopes and s.e. as well as the status of the species are given below the graphs. **Models for common gull, great black-backed gull, herring gull, goosander, red-breasted merganser, common goldeneye, whooper swan and mallard do not include temperature as a covariate.**

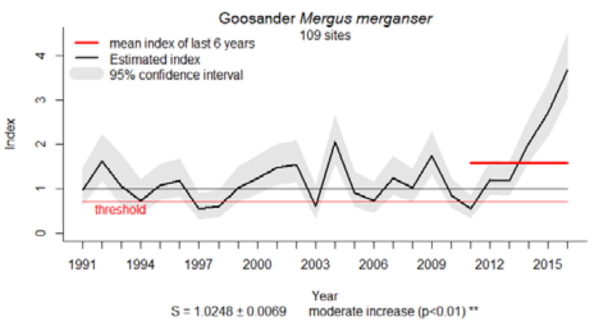
Surface feeders

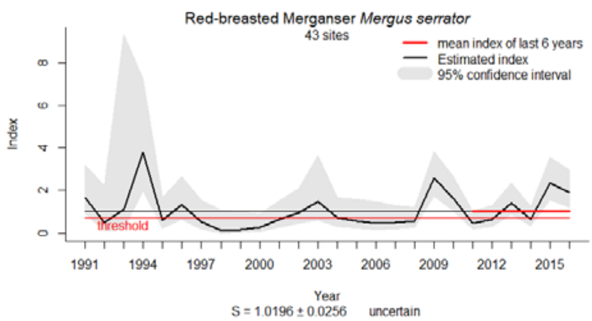




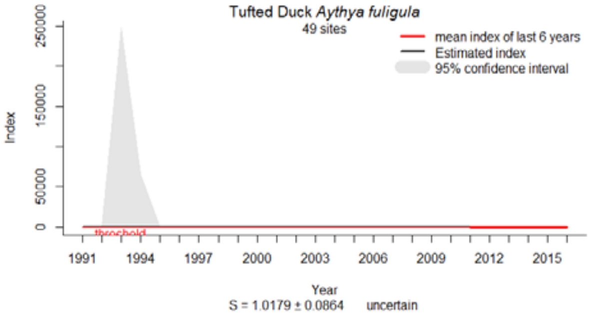


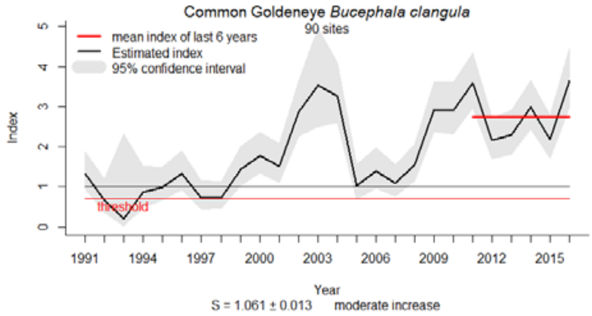
Pelagic feeders



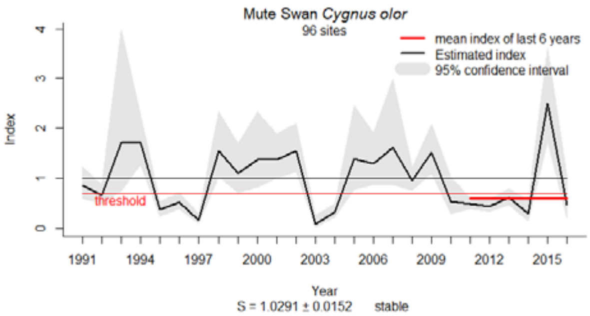


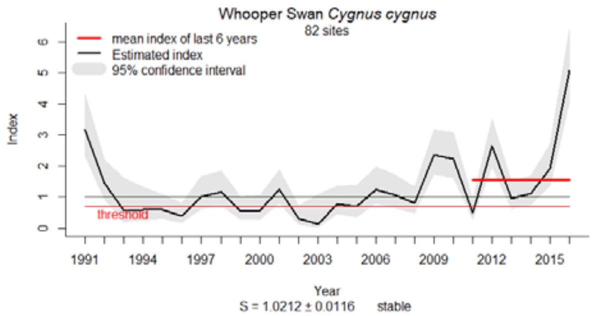
Benthic feeders

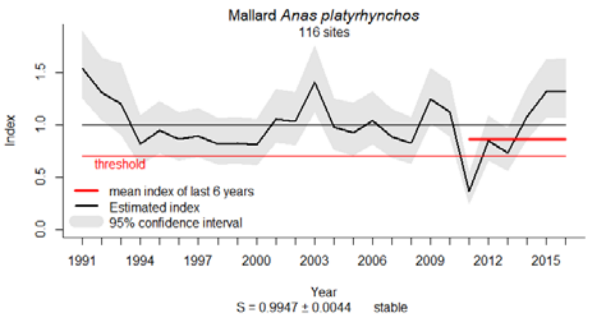




Grazing feeders

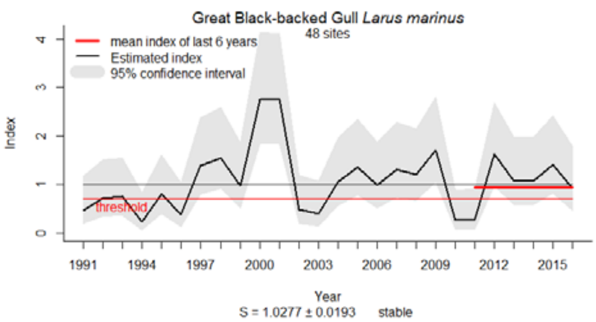


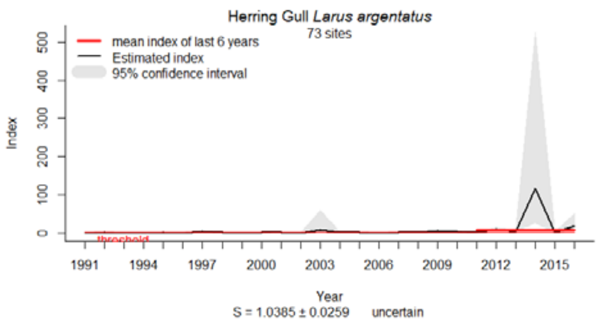




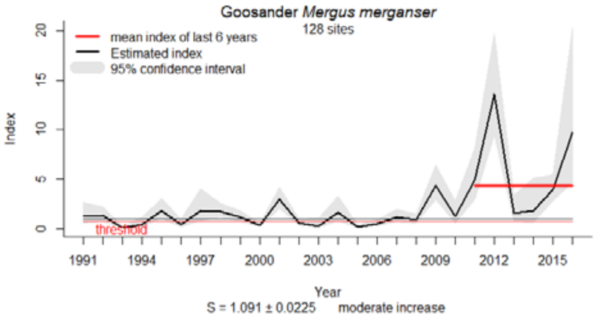
Results figure 8: Index graphs showing annual index values for wintering waterbirds in the **Bothnian Group** (Bothnian Sea, The Quark, Bothnian Bay; black line) and 95% confidence intervals (grey shading) resulting from GAM analyses with reference level where average of index values 1991-2000 is 1 (thin black line). Further shown are thresholds for good status (70% of baseline, thin red line) and the average index values 2011-2016 (geometric mean) used for the evaluation (red line). In addition, trend slopes and s.e. as well as the status of the species are given below the graphs. **Models for great black-backed gull, common goldeneye and mallard do not include temperature as a covariate.**

Surface feeders

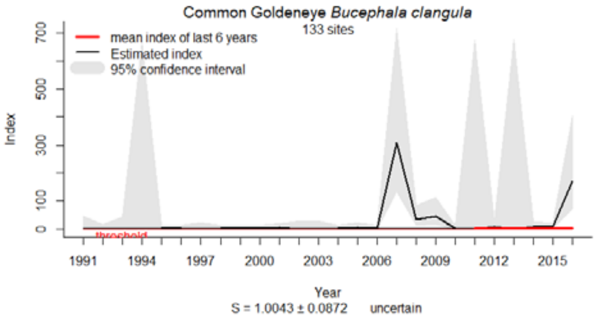




Pelagic feeders



Benthic feeders



Grazing feeders