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Comparison of fen orchid (*Liparis loeselii*) populations inside and outside Forsmark

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Abstract

Fen orchid, a red listed orchid species also listed in the Habitats Directive, may be negatively affected by anticipated water level changes in the Forsmark area due to the construction of a deep repository by SKB. Yearly inventories of the fen orchid are conducted within the Forsmark investigation area in order to register natural variation in the populations before the construction starts. Starting in 2022, yearly inventories were also conducted outside the Forsmark investigation area. The inventories will be used to detect possible negative effects due to expected water level changes on the populations following the start of construction.

We compared fen orchid populations outside the Forsmark area that were previously inventoried, mainly by Uppsala County Administrative Board, *Sw. Länsstyrelsen Uppsala*, with populations at Forsmark in order to evaluate the usage of outside populations as reference wetlands and to identify suitable reference wetlands for monitoring.

Using correlations and a cluster analysis, we identified two wetlands that are suitable reference wetlands. We further noted three wetlands with fen orchids within the Forsmark area that have not been inventoried by SKB until now and we could extend existing time series for four SKB wetlands with older inventories.

Using population changes, calculated as year-to-year differences in population size within a wetland, and Bayesian statistics, we show that populations within and outside of the Forsmark investigation area are rather stable and that populations inside Forsmark have a slight increase over the investigation period.

We demonstrate that past inventory results can be used as reference data and that the wetlands outside as well as potentially unaffected wetlands inside Forsmark can be used as reference wetlands when construction starts. However, already existing differences will have to be accounted for in future analyses. Hence, all inventories together will allow performing a before-after control-impact (BACI) design which will aid in disentangling natural yearly variation in population sizes from the possible effect due to SKB's constructions in future analyses.

Sammanfattning

Gulyxne, en rödlistad orkidéart, listad i EU:s art- och habitatdirektiv, riskerar att påverkas negativt av förväntade vattennivåförändringar i Forsmarksområdet i samband med att SKB:s bygge av ett Kärnbränsleförvar. Arten inventeras av SKB årligen inom, och sedan 2022 även utanför, Forsmarksområdet för att registrera naturliga variationer hos populationerna innan bygget startar. Därefter kommer inventeringarna att användas för att upptäcka eventuella negativa effekter på populationerna. Vi jämförde gulyxnepopulationer utanför Forsmarksområdet som tidigare inventerats, främst av Länsstyrelsen i Uppsala län, med Forsmarkspopulationer för att utvärdera användningen av utomstående populationer som referensvåtmarker och för att identifiera lämpliga referensvåtmarker för övervakning. Med hjälp av korrelationer och en klusteranalys identifierade vi våtmarker som är lämpliga referensvåtmarker till våtmarkerna i Forsmarksområdet. Vi upptäckte dessutom tre våtmarker inom Forsmark med gulyxne som inte har inventerats av SKB tidigare. Med hjälp av populationsförändringar, beräknade som skillnader i populationsstorlek från år till år inom en våtmark, och Bayesiansk statistik visade vi att populationerna inom och utanför är ganska stabila, men att populationerna i Forsmark ökar något. Vi visarvisade också att tidigare inventeringsresultat kan användas som referensdata och att våtmarkerna utanför Forsmark kan användas som referensvåtmarker när bygget startar. Redan befintliga skillnader måste dock beaktas i framtida analyser. Således kommer alla inventeringar tillsammans att möjliggöra en before-after control-impact (BACI)-analys för att särskilja den naturliga årliga variationen i populationsstorlek från effekter av vattennivåförändringar kopplade till SKB:s byggverksamhet i framtida analyser.

Contents

1 Introduction

The Swedish Nuclear Fuel and Waste Management Company (SKB; Svensk Kärnbränslehantering AB) is performing site characterisation in the Forsmark area with the objective to build a deep geological repository for spent nuclear fuel. Part of the ongoing ecological monitoring is to regularly inventory several species inside and outside of the Forsmark investigation area. One species that is monitored closely is the fen orchid (*Liparis loeselii (L.)*); a red listed species that is classified as Vulnerable (VU, SLU 2020) and listed in the Habitats Directive.

In order to detect possible future changes in the fen orchid populations in Forsmark, SKB has recently started inventory populations outside the Forsmark area (Holmgren et al. 2022). Additionally, we have downloaded all openly accessible abundance data for fen orchid populations inventoried outside of Forsmark that are stored in the citizen science data base Swedish Species Observation System (Artportalen). Before analyses could be conducted, these data had to be evaluated and integrated with the inventories performed by SKB. The resulting extended data set is described in this report.

The aim of this report is to investigate the fen orchid population dynamics in wetlands, mainly in northern Uppland. Specifically, we ask if there are indications of differences between wetlands inside and outside the Forsmark area. Wetlands within the Forsmark area were also divided into two categories: either potentially affected or potentially unaffected by anticipated water level changes. These water level changes are expected due to groundwater diversion from the deep-rock repository (Werner 2022, Werner et al. 2010). Water level is highly relevant since inventories of the fen orchid show that populations can rapidly expand or disappear if environmental conditions like water levels change (Jones 1998, Wheeler 1998).

How population dynamics between outside and both inside categories relate to each other will be very useful for future analyses that will investigate possible changes in fen orchid population dynamics due to SKB´s building activities. We approached this question as follows:

First, we performed an *Individual comparison* by comparing wetlands within and outside Forsmark in order to identify wetlands that may be similar to the wetlands at Forsmark. We compared fen orchid abundances within wetlands by (i) summarizing abundances per year and per wetland, (ii) correlating the yearly fen orchid abundance within a wetland against the yearly abundances within all other wetlands and finally by (iii) performing a cluster analysis to group similar wetlands together. Additionally, we correlated potentially affected *vs* unaffected wetlands within Forsmark to check how suitable the unaffected wetlands may be as references for the affected wetlands in the future.

Second, we performed a *General comparison* of the wetlands in order to estimate how likely it is that wetlands within and outside the Forsmark investigation area are different. We compared wetlands by assigning them into groups and then (i) compared these groups to one-another and (ii) compared changes over time within these groups. Contrary to the individual comparison, we did not use observed abundances but rather calculated year-to-year differences in abundance for each wetland. This was done since recorded abundances are always only an attempt to represent the true population size, but the recoding can vary due to sampling effort, wetland size, and other unknown causes. Using year-to-year abundance difference makes it easier to compare wetlands with generally low abundances to wetlands with generally high abundances. Hence, the year-to-year differences in abundance was used as an indicator to quantify the changes in population size as positive (population growth from one to the next year), negative (population decrease), or no change.

We modelled these population changes with respect to two groups. *Group 1* consists of two categories: wetlands inside and outside Forsmark. In *Group 2* we further divide the wetlands within the Forsmark investigation area into the categories potentially affected or potentially unaffected by anticipated water level changes.

Specifically, this study aims to answer the following questions:

1. Which wetlands outside the Forsmark investigation area show yearly fen orchid abundances similar to those of the wetlands in the Forsmark investigation area?
2. Do fen orchid population changes generally differ between wetlands located inside or outside Forsmark (*Group 1*)? Do we see similar results if we further assign the wetlands inside Forsmark into the categories *affected* and *unaffected* (*Group 2*)?
3. If the categories for *Group 1* and *2* are compared over time, do populations co-vary, meaning do they show synchronous positive and negative year-to-year population changes over time?

2 Material and Methods

2.1 Data preparation

2.1.1 Citizen science and SKB data

All fen orchid citizen science data were downloaded from the Swedish Species Observation System (www.artportalen.se) on 2023-09-07. The original download consisted of 4396 observations, reported between 2007-06-23 and 2023-08-16.

Several steps were undertaken to clean the data, select trustworthy observations, and to merge them with the SKB inventory data (Appendix A1). Individual observations were assigned to populations, with observations within larger wetlands split into different populations. For simplicity, we still referred to wetlands, not populations or metapopulations (Oostermeijer and Hartman 2014).

A total of 753 records of abundance (Artportalen: 449; SKB: 304) within 172 wetlands (Artportalen: 123; SKB: 49) over 17 years were available after selecting trustworthy and new observations to be merged with the SKB inventory data (Figure 2-1; Appendix A2, A3).

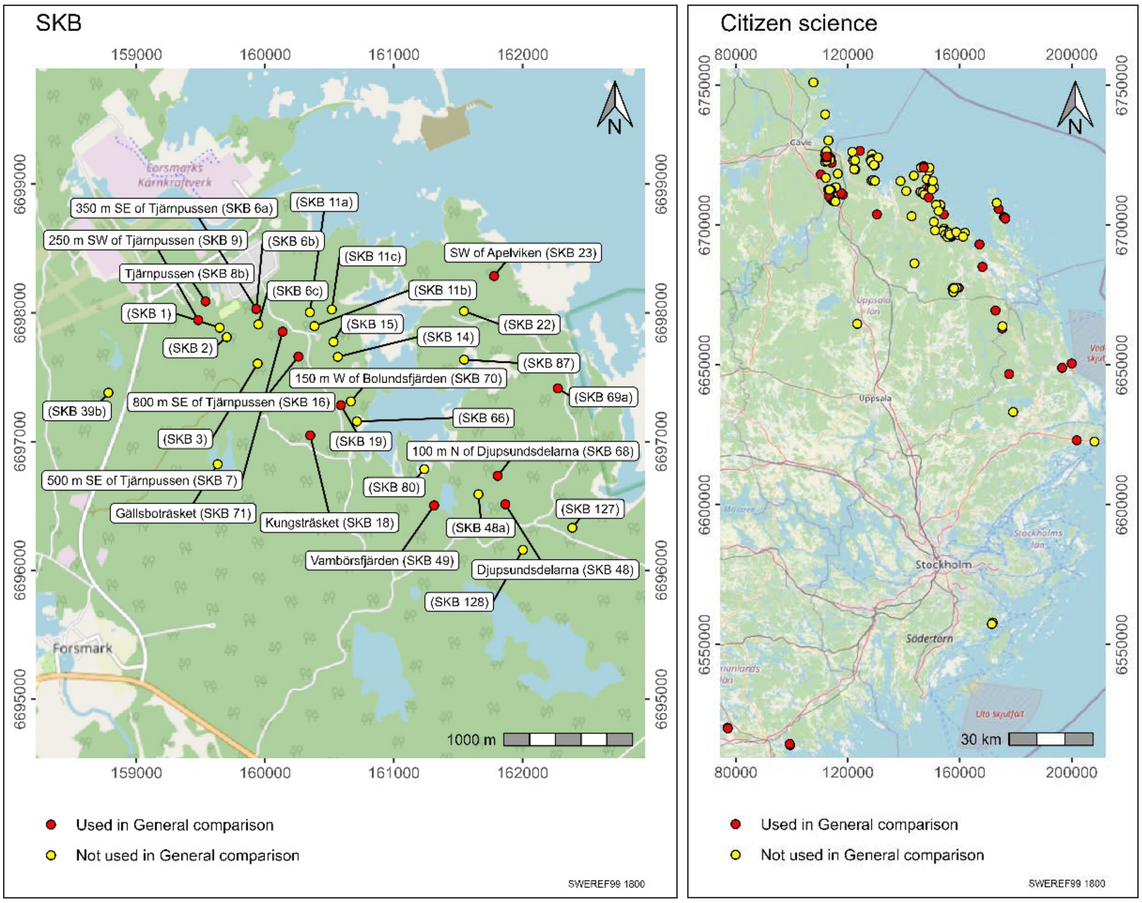

Figure 2-1. Location of inventoried fen orchid populations within Forsmark (left) and verified Citizen science observations (right). Shown are all populations with the colour indicating if year-to-year differences for the general comparison could be calculated (red) or not (yellow).

2.1.2 Abundances for the Individual comparison

The number of years a wetland was inventoried varied, meaning that each wetland had different years in common with other wetlands. Hence, of the 17 years that were available (2007 to 2023) we could use between 1 and 13 years, depending on the combination of wetlands. Combinations that had less than 3 data points (common years) were excluded from the analysis. Hence, the individual comparison was performed with 13 SKB wetlands versus 35 wetlands outside Forsmark (Appendix A3).

2.1.3 Yearly abundance differences for the General comparison

From all citizen science and SKB wetlands in- and outside the Forsmark area, we identified 52 wetlands (*Forsmark[affect]* = 8, *Forsmark[unaff]* = 4, *Outside[unaff]* = 40) that could be used to calculate population changes, as the fen orchid was detected in at least two consecutive years (Appendix A4). We subtracted the previous year's abundance, resulting in positive/negative population changes. In these subtractions, at least one year had to be non-zero, meaning we did exclude zero differences that were due to two zero abundances. Consequently, wetlands that are frequently monitored but no fen orchid has been found were removed entirely. Plotting these original data with respect to *Group 1* and *2* indicates that populations may behave similarly in many *year-to-year* comparisons, mostly after 2014 (Appendix A4). Between 2012 and 2013 wetlands *Tjärnpussen (SKB 8b)* and *250 m SW of Tjärnpussen (SKB 9)* were flooded, which lead to a crash of the populations (Appendix A3). The differences for both wetlands for this particular year-to-year were therefore excluded from the calculations.

2.2 Data analysis

2.2.1 Individual comparison of wetlands

In order to compare individual wetlands, we summarised the fen orchid abundances, performed a correlation analysis, and a cluster analysis based on Euclidian distances. Additionally, we calculated the flight distance of each wetland to a wetland in the centre of Forsmark *(SKB 15)*.

Correlation analysis

For the Pearson linear correlations analyses between all combinations of wetlands, we compared the yearly abundance between two respective wetlands. Only correlations between wetlands within and outside the Forsmark investigation area are shown, as well as correlations between potentially affected and unaffected within Forsmark (Appendix A5).

Cluster analysis

In order to find wetlands that show similar fen orchid abundances we used a hierarchical cluster analysis, which is a statistical method that groups units into clusters based on similar characteristics. In this cluster analyses, we faced the dilemma that only a complete data set can be used. This would mean excluding wetlands and/or years completely, down to a set of years and wetlands that are common for all (Appendix A3). Instead, we chose to impute missing values, meaning they got assigned likely abundances given the existing abundances. This has the advantage that all years and wetlands can be utilized, but the disadvantage that wetlands with few replicates (years) will be presented with lower variability than they may actually have. Hence, we scaled the abundances and imputed missing values using chained random forest (in R: missRanger(pmm.k = 30, verbose = 1, num.trees = 500, maxiter = 100 L)) (Mayer 2023). With this complete data set we calculated the Euclidian distances and performed a hierarchical cluster analysis with the complete linkage method in order to find similar clusters (in R: hclust(method = "complete")).

2.2.2 General comparison of wetlands

We built four Bayesian linear regression models, two for each group (Table 3-3, Appendix A6). The response variable was the population change described as year-to-year change in abundance and the true replicate was each wetland. For each wetland, we calculated the mean distance between the wetland in question and all other wetlands. This distance was log-transformed using the natural log, scaled and centred, and included in all models. This was done in order to minimize differences between wetlands due to unmeasured environmental variables. Initial tests showed that a model which included both Group 1 and the Log-Distance as independent variables performed better than models using only Log-Distance or only Group 1 (Appendix A7).

Comparing categories of both groups

The first two models were fitted with *Group 1* (Model 1: two categories) and *Group 2* (Model 2: three categories) as fixed effects and *year-to-year* as random effect, respectively. Hence, all *year-to-years*, even if they were missing in one group, could be included in the analysis (see Appendix A4). The estimates for each group category hence show the population change for a *year-to-year* average. Additionally, the models are able to estimate the variability among group categories and the variability among years. Hence, both estimates can be compared.

Comparing categories of both groups for each year-to-year

The second two models were fitted with the combination of the group categories and each *year-to-year* as fixed effect for the two/three groups (e.g. in *Group 1*: *2011_2012_Outside*). Here, only the population changes that were present in both/all three categories of the groups could be included (Appendix A4). These models can be directly used for comparisons between inside and outside across time by comparing the groups for each *year-to-year (Group 1*: Model 3: 24 categories; *Group 2*: Model 4: 33 categories).

In order to check for temporal trends, we (i) investigated if the population changes show similar responses for a specific *year-to-year* and if there is a consistent trend over time, (ii) if the difference between the categories show a consistent patter over the years. Bothe measures are needed and show different things. For example, inside and outside Forsmark may show a positive response indicating an increase in population size from this to the previous year. A positive difference may further indicate that one increase was stronger than the other.

Predictions and pair-wise comparisons

Posterior densities were predicted for each category using the fixed and random effects of the model. These were compared to zero in order to estimate the extend and probability of an increase, decrease, or no population change.

The difference between categories were estimated by subtracting the posterior of one category from the posterior of another category. We consistently subtracted the smaller values from the larger values, which means that all differences between population changes are positive.

For the categories and their comparison, the percent of the posterior densities above zero provides the probability that the difference is larger than zero. For example, a probability of 60 % indicates no difference as it is not different from chance (50 %). All posteriors were described with posterior mean and 95 % credibility intervals (CI using highest posterior density intervals).

Pair-wise comparisons were performed between all group categories for all models, but we only show the most relevant comparisons. All comparisons are shown for Model 1 and 2, but we only show comparisons for the same *year-to-year* with *Forsmark vs Outside* and *Forsmark[unaff] vs Forsmark[affect]* for Model 3 and 4.

Model fitting

Data management and analysis was performed using R (R Core Team 2022, version 4.2.1) and STAN (Stan Development Team 2019, version 2.32.2) and the R-packages rstan (Stan Development Team 2023), rethinking (McElreath 2020), MCMCvis (Youngflesh 2018), and others. All models used minimal informative priors and the posterior were generated with Hamiltonian Monte Carlo (HMC) with 37,500 iterations; 35,000 of these iterations were the warmup. Models were validated by inspecting (i) the potential scale reduction factor (Gelman et al. 2021), (ii) the percent overlap between prior and posterior, (iii) the effective number of independent samples from the chains, (iv) the correlations among posteriors, and by performing posterior predictive checks. Model performance was evaluated by calculating the Widely Applicable Information Criterion (WAIC) and the Pareto-smoothed importance-sampling cross-validation estimate (PSIS). Using the observed and predicted (posterior mean) values, we also calculated the R^2 and the Root Mean Square Error (RMSE).

3 Results

3.1 Individual comparisons of wetlands

We selected 16 wetlands as potential reference wetlands outside Forsmark as they had high abundance, high number of inventories, and small distance to Forsmark wetlands (3.1.1) and were similar to the SKB wetlands based on the correlation (3.1.2) and cluster (3.1.4) analysis (Table 3-1). Hence, only frequently inventoried wetlands with high number of fen orchid that could be compared to wetlands inside Forsmark are shown.

Table 3-1. Summary for all Individual comparison methods. ´Summary´ indicates if the wetland was inventoried frequently, if a correlation with wetlands inside Forsmark was possible, if the variability of the Euclidian distances to all wetlands inside Forsmark is high or low, and the distance to a wetland in the centre of Forsmark (SKB 15). ´Abundances´ describes the number of inventories, the maximum abundance in any year, and summed abundance across all years. ´Correlation´ shows the number of positive/negative correlations with wetlands inside Forsmark. ´Eucl. Dist.´ summarizes the Euclidian distances to all wetlands inside Forsmark using mean, standard deviation, and coefficient of variation. Wetlands are ordered by number of positive correlations (# pos.).

	Summary					Abundances			Correlation		Eucl. dist.		
	Inv. frequently	Corr. poss.	Eucl. dist. vari-ability	Dist. [km]	County	# Inv.	Max Abund.	Tot. Abund.	# pos.	# neg.	Mean	SD	CV
Bolhamnsänden	Yes	Yes	high	8	Östhammar	12	549	2275	12	0	5.27	0.93	0.18
NW of Dalarna	Yes	Yes	high	19	Tierp	11	211	806	11	0	5.11	0.99	0.19
700 m SSE Bålgrundsfjärden	Yes	Yes	high	16	Östhammar	11	125	617	9	3	5.65	0.90	0.16
Ambricka E	Yes	Yes	low	44	Älvkarleby	6	2142	3893	9	3	6.13	0.68	0.11
Marörspussarna S (SKB 201)	Yes	Yes	high	39	Älvkarleby	13	170	636	9	3	4.55	1.57	0.35
Olsbäcken	Yes	Yes	high	46	Älvkarleby	11	260	1049	7	4	4.79	0.88	0.18
Källfjärden Tångsåmurarna E	Yes	Yes	high	48	Älvkarleby	11	1462	6839	6	5	4.94	1.02	0.21
Gäddalen	Yes	Yes	low	19	Tierp	11	330	1267	5	6	5.59	0.83	0.15
Lerorna (SKB 202)	Yes	Yes	high	17	Tierp	13	736	2694	5	8	4.92	1.64	0.33
Romsmaren S	Yes	Yes	high	26	Tierp	11	81	229	3	8	4.73	1.12	0.24
Storön	Yes	Yes	low	47	Älvkarleby	3	105	123	3	8	5.39	0.77	0.14
300 m SW of Bålgrundsfjärden (SKB 203a)	Yes	Yes	high	16	Östhammar	15	25	154	2	11	5.62	1.58	0.28
Ambricka N	Yes	Yes	low	45	Älvkarleby	6	830	1703	2	10	6.17	0.52	0.08
Gubbenshöllsjön S	Yes	Yes	high	19	Tierp	11	117	647	2	9	5.82	0.92	0.16
Skrevträsket (SKB 204)	Yes	Yes	high	15	Östhammar	12	596	2545	2	10	5.00	1.65	0.33
Öjaren	Yes	Yes	low	31	Östhammar	5	48	133	2	10	5.46	0.82	0.15

3.1.1 Summary of abundances

Summarizing fen orchid abundances showed a wide range of abundances per year and per wetland with observations from 2007 to 2023 (Appendix A3). For four wetlands that are inventoried by SKB yearly we could add new abundance that are predating the SKB timeseries. Furthermore, within the Forsmark area we found three wetlands (*Fräkengropen, Djupträsket, Stocksjön*) with fen orchids, which SKB had not inventoried until now (Appendix A3).

Selecting only wetlands that (i) had been inventoried at least three times, (ii) had a yearly maximum of at least 20 individuals in any year, (iii) had at least 100 individuals across all years, and (iv) were not further away than 50 km resulted in a subset of 26 wetlands (Table 3-2).

Table 3-2. Fen orchid abundance within wetlands located outside Forsmark that have been inventoried frequently and have high abundances (see text). Distance shows distance to a wetland in the middle of the Forsmark area (SKB 15).

Wetland	Dist [m]	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Bruksdammen Nyckelholmen E	3 871	134	4											73				
Bruksdammen Nyckelholmen N	4 424	610												49				212
Bruksdammen Björnholmen E	5 246	1 818												214				263
Bruksdammen Björnholmen N	5 647	82	43											16				
Bolhamnsänden	8 049	71	209			216	335	4	28	28	23	77	263	549	472			
Skrevträsket (SKB 204)	15 495	596				166	160	189	190	260	304	204	202	130	143			1
300 m SW of Bålgrundsfjärden (SKB 203a)	16 055	1	3			8	17	12	25	10	19	16	24	5	0	4	1	9
Tolträsket	16 163	339			304									62				
700 m SSE Bålgrundsfjärden	16 351		30			28	29	30	45	55	48	67	125	70	90			
Lerorna (SKB 202)	16 657	736	33			263	201	154	152	247	199	104		108	10		312	175
NW of Dalarna	18 592	167			211	198	12	60	27	1	14	6		89		21		
Gäddalen	18 710	260			10	10	155			154	330	18	31	196	78	25		
Gubbenshöllsjön S	18 911	98				117	87	96	33	51	51	31	33	33	17			
Romsmaren S	26 326	81				33	30	4	26	9	24	3	0	0	19			
Barsjön	30 709	342	458												64			
Öjaren	30 918									48				16	12	12		45
Marörspussarna S (SKB 201)	38 865	170				10	22	10	21	27	12	32	9	102	62		93	66
Marörspussarna N	38 889		6					35										327
Ambricka E	44 257								227	436	705				2 142		314	69
Ambricka N	45 040						78		427	830		133	230					5
Komossen	45 613	35				8		865										
Olsbäcken	46 256	171				116	260	86	114	25	56	15	41	112	53			
Storön	46 557								8		105				10			
Källfjärden Tångsåmurarna E	47 791	1 462				773	1 042	539	515	581	395	268	132	507	625			
Sör-Klyxen	48 112	240														0	0	
Källfjärden Tångsåtorpet N	48 957	819	21						3 072									

[0 = inventoried, but non found]

3.1.2 Correlations between Forsmark and outside wetlands

In total, we could correlate 13 yearly fen orchid abundances inside Forsmark against 35 wetlands outside Forsmark as the wetland combinations had at least three years in common (Figure 3-1, Appendix A5). The correlations ranged from −1 to 1. In three instances up to 13 of the 17 years could be used as they were in common. However one has to mind that zeros are correlated against zeros as well.

3.1.3 Correlations among Forsmark wetlands

A comparison between potentially affected and unaffected wetlands within Forsmark indicated mostly positive, or no correlations between the abundances within the wetlands (Figure 3-2). However, one wetland (*250 m SW of Tjärnpussen (SKB 9)*) was negatively correlated with the four unaffected wetlands and *800 m SE of Tjärnpussen (SKB 16)* was negatively correlated with *(SKB 69a)*. Negative correlations were mainly due to abundances of zero (Figure 3-2 Right).

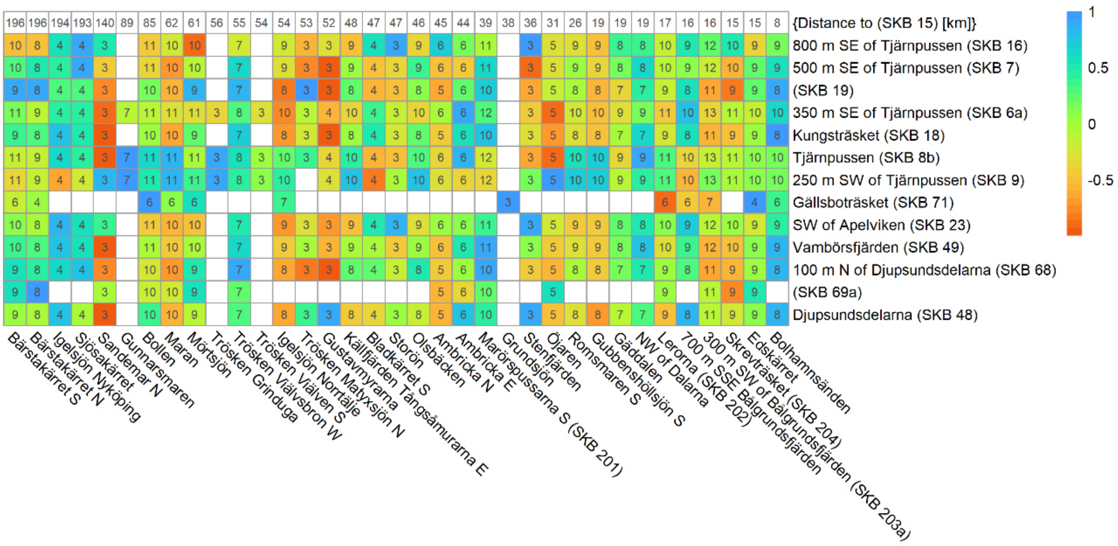

Figure 3-1. *Correlations among wetlands inside (rows) and outside (columns) Forsmark. Colour indicates the correlation coefficient and the numbers within the cells indicate the number of replicates used for the correlation among the respective wetlands (minimum of three common years). White indicates that correlation was not possible. Wetlands outside are ordered by their distance to wetland (SKB 15), with respective distance shown in the first row.*

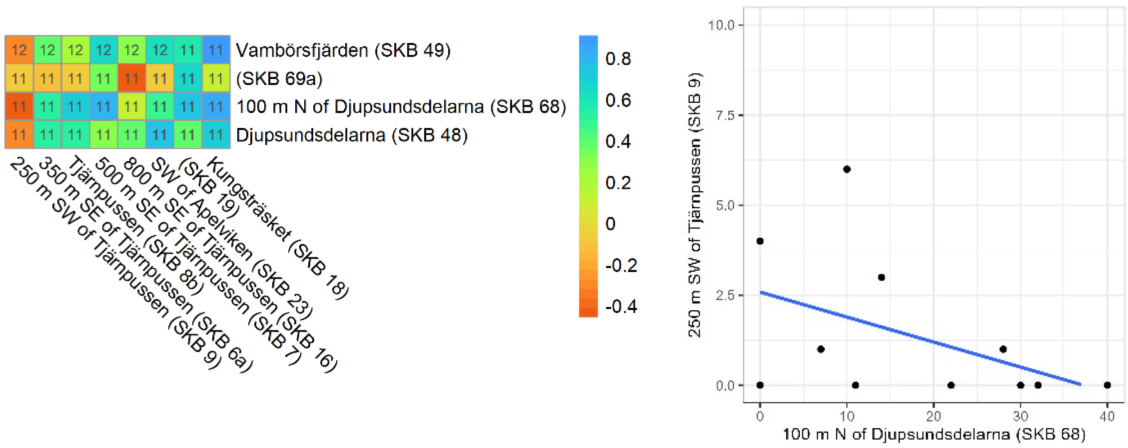

Figure 3-2. *Left: Correlations among wetlands Forsmark[unaff] (rows) and Forsmark[affect] (columns). Colour indicates the correlation coefficient and the numbers within the cells indicate the number of replicates used. Right: Example of negative correlation, which were mainly due to zero abundances.*

3.1.4 Cluster analysis

The cluster analysis found large variation among wetlands, indicated by the large heights between individual wetlands compared to the remaining hierarchy (Figure 3-3). For visual aid, we coloured the tree in four clusters. Most SKB wetlands were assigned to Cluster 1, however we found no indication of outside or inside wetlands, regardless of potentially affected or unaffected in the future, to generally differ as all groupings are spread over all clusters.

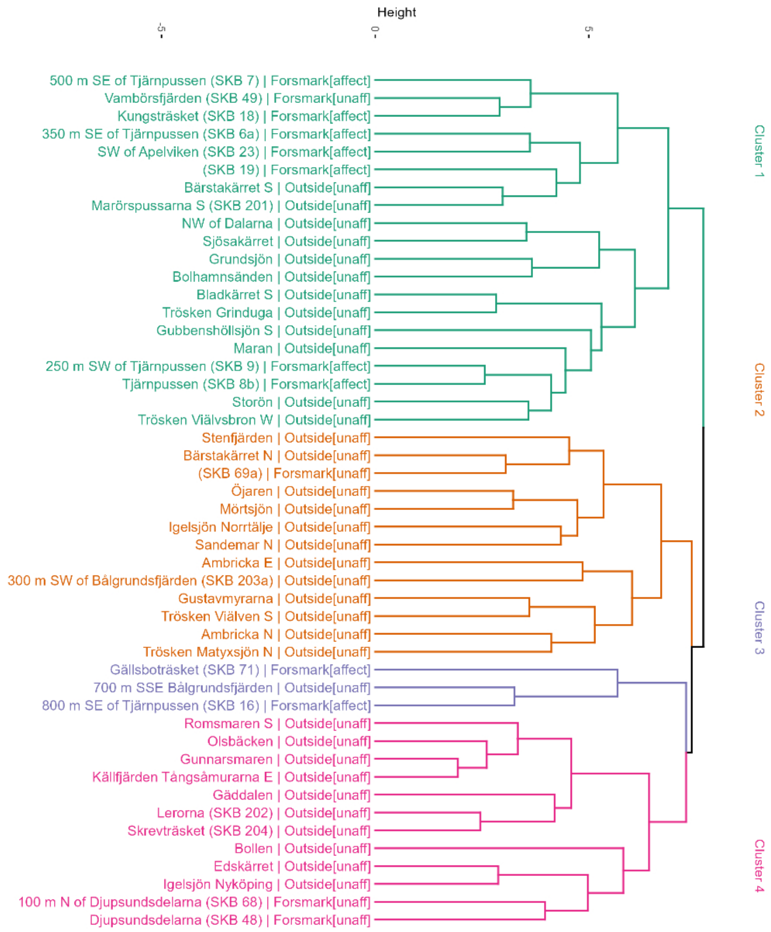

Figure 3-3. *Complete linkage cluster of Euclidean distances of all wetlands from correlation analysis. Cluster heights indicate similarity between wetlands and clusters.*

3.2 General comparison of wetlands

By comparing wetlands from all years, we found that fen orchid population changes generally differ between wetlands inside and outside Forsmark, with Forsmark wetlands having a more positive population change. We further found that population changes were more positive for wetlands that are potentially unaffected compared to those that are potentially affected. The comparison over time showed no consistent trends over the year-to-years.

All models converged (Appendix A6) and the models explained up to around 22 % of the variability in the population changes (Table 3-3).

Table 3-3. Performance of the four models testing for differences in population changes across years-to-years (Model 1 and 2) and for each year-to-year (Model 3 and 4).

Model	Fixed effect 1	Fixed effect 2	Random effects	RMSE	R^2	PSIS	WAIC
1	Group 1	Log Distance	Year to Year	133	0.132	5245	5260
2	Group 2	Log Distance	Year to Year	133	0.133	5248	5267
3	Group 1 – Year to Year	Log Distance		117	0.174	4327	4356
4	Group 2 – Year to Year	Log Distance		112	0.221	3984	4011

3.2.1 Difference between categories of both groups

Model 1, that compared wetlands in- and outside the Forsmark area, indicated very low chances that population changes outside (P[Outside > 0)] = 42 %) and inside Forsmark (P[Forsmark > 0)] = 56 %) are different than zero (Table 3-4, Figure 3-4). However, we found a 99 % chance that the population change in *Forsmark* is more positive than *Outside*, with a difference of around 17 fen orchids. We further found that the variability in the population changes between the group categories and between the different *year-to-years* were quite similar (Appendix A6).

Model 2, where the Forsmark category was further divided into affected and unaffected, indicated a small chance that the potentially unaffected populations have a positive population change (P[*Forsmark[unaff]* > 0)] = 68 %; Table 3-4, Figure 3-5). Besides the confirmed strong support for outside wetlands having lower population changes than wetlands inside Forsmark, we also found strong support for the potentially unaffected wetlands having a more positive population change than the potentially affected wetlands.

Table 3-4. Categories and pair-wise comparisons between categories. Shown are posterior mean (95 % CI) and probability of the posterior being larger than zero or larger than the compared category.

Group	Model	Year to year	Group Category	Comparison	Mean	2.5 %	97.5 %	Probabiltiy[%]
1	1	All	Outside	P[Outside > 0]	−10.27	−96.36	71.51	42
1	1	All	|Outside-Forsmark|	P[Forsmark > Outside]	17.26	2.64	30.33	99
1	1	All	Forsmark	P[Forsmark > 0]	6.99	−72.50	100.38	56
2	2	All	Outside[unaff]	P[Outside[unaff] > 0]	−10.03	−102.39	71.78	42
2	2	All	Forsmark[unaff]	P[Forsmark[unaff] > 0]	19.85	−68.71	103.44	68
2	2	All	Forsmark[affect]	P[Forsmark[affect] > 0]	2.10	−90.18	82.61	51
2	2	All	|Outside[unaff]-Forsmark[affect]|	P[Forsmark[affect] > Outside[unaff]]	12.13	−3.21	27.72	94
2	2	All	|Outside[unaff]-Forsmark[unaff]|	P[Forsmark[unaff] > Outside[unaff]]	29.88	9.54	49.33	100
2	2	All	|Forsmark[unaff]-Forsmark[affect]|	P[Forsmark[unaff] > Forsmark[affect]]	17.75	−1.87	39.77	95

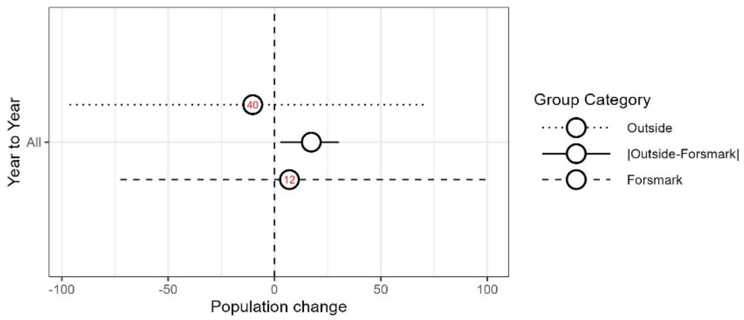

Figure 3-4. *Average population change (year-to-year fen orchid abundance increase/decrease within wetlands) located outside or inside Forsmark. Shown are posterior predictions (mean, 95 % CI) for both categories of Group 1 as well as the difference between both categories. Red numbers indicate number of replications (wetlands within the group).*

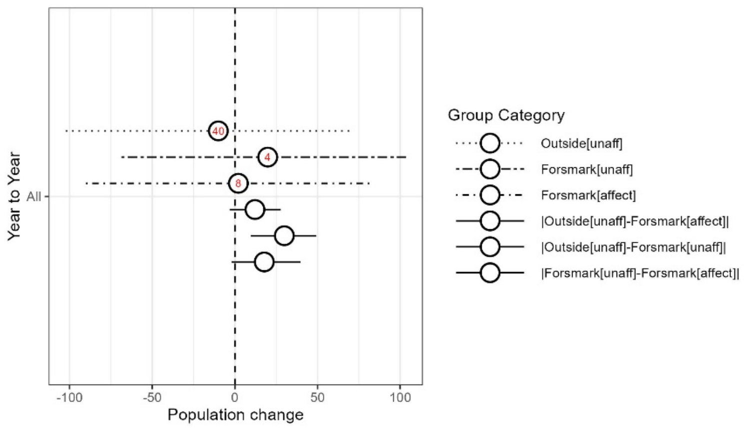

Figure 3-5. *Average population change (year-to-year fen orchid abundance increase/decrease within wetlands) located outside or inside Forsmark, either affected or unaffected. Shown are posterior predictions (mean, 95 % CI) for all three categories of Group 2 as well as the differences between all categories. Red numbers indicate number of replications (wetlands within the group).*

3.2.2 Difference between categories of both groups for each year-to-year

With respect to temporal trends, we compared if categories showed the same response in a given *year-to-year* (positive, negative, or no population change) and if the difference between the categories showed any trend over time.

Model 3, that compared population changes inside and outside Forsmark for each year-to-year, showed that in four *year-to-years* wetlands in- and outside showed similar responses by simultaneously having a positive, negative, or no population change (Figure 3-6, Table 3-5). With regard to the difference between categories we found that in four *year-to-years*, population changes were more positive in Forsmark than Outside, in three *year-to-years* it was the opposite, and in five *year-to-years* we did not find a high chance of a difference (Table 3-5, Figure 3-6, Appendix A8). Hence, no consistent trend over time was indicated, neither by the category responses, nor by the differences between the categories.

Model 4 confirmed these differences and we further found that potentially unaffected wetlands on six *year-to-years* had a more positive population change than potentially affected wetlands (Table 3-5, Figure 3-7, Appendix A8).

Table 3-5. Summary of population changes of categories of Group 1 and 2 and differences between them over time. The +/−/0 signs indicate if the category shows a positive/negative/no response. The </>/= sign indicates if the responses of both categories were likely to be different or the same. All signs were calculated at a probability of 95 %. For Model 4 only comparisons between Forsmark[unaff] and Forsmark[affect] are shown.

<table>
<tr><th>Model</th><th>Group</th><th>Year to year</th><th>Response || Relationship || Response</th></tr>
<tr><td>3</td><td>1</td><td>2022_2023</td><td>0 || Outside = Forsmark || 0</td></tr>
<tr><td>3</td><td>1</td><td>2021_2022</td><td>+ || Outside > Forsmark || +</td></tr>
<tr><td>3</td><td>1</td><td>2020_2021</td><td>0 || Outside = Forsmark || −</td></tr>
<tr><td>3</td><td>1</td><td>2019_2020</td><td>0 || Outside > Forsmark || −</td></tr>
<tr><td>3</td><td>1</td><td>2018_2019</td><td>+ || Outside = Forsmark || +</td></tr>
<tr><td>3</td><td>1</td><td>2017_2018</td><td>0 || Outside < Forsmark || +</td></tr>
<tr><td>3</td><td>1</td><td>2016_2017</td><td>− || Outside = Forsmark || 0</td></tr>
<tr><td>3</td><td>1</td><td>2015_2016</td><td>0 || Outside < Forsmark || +</td></tr>
<tr><td>3</td><td>1</td><td>2014_2015</td><td>+ || Outside = Forsmark || +</td></tr>
<tr><td>3</td><td>1</td><td>2013_2014</td><td>0 || Outside < Forsmark || +</td></tr>
<tr><td>3</td><td>1</td><td>2012_2013</td><td>− || Outside < Forsmark || 0</td></tr>
<tr><td>3</td><td>1</td><td>2011_2012</td><td>+ || Outside > Forsmark || −</td></tr>
<tr><td>4</td><td>2</td><td>2022_2023</td><td>0 || Forsmark[unaff] = Forsmark[affect] || 0</td></tr>
<tr><td>4</td><td>2</td><td>2021_2022</td><td>+ || Forsmark[unaff] > Forsmark[affect] || 0</td></tr>
<tr><td>4</td><td>2</td><td>2020_2021</td><td>− || Forsmark[unaff] < Forsmark[affect] || 0</td></tr>
<tr><td>4</td><td>2</td><td>2019_2020</td><td>− || Forsmark[unaff] > Forsmark[affect] || −</td></tr>
<tr><td>4</td><td>2</td><td>2018_2019</td><td>+ || Forsmark[unaff] = Forsmark[affect] || +</td></tr>
<tr><td>4</td><td>2</td><td>2017_2018</td><td>+ || Forsmark[unaff] > Forsmark[affect] || +</td></tr>
<tr><td>4</td><td>2</td><td>2016_2017</td><td>0 || Forsmark[unaff] > Forsmark[affect] || −</td></tr>
<tr><td>4</td><td>2</td><td>2015_2016</td><td>+ || Forsmark[unaff] > Forsmark[affect] || +</td></tr>
<tr><td>4</td><td>2</td><td>2014_2015</td><td>+ || Forsmark[unaff] = Forsmark[affect] || +</td></tr>
<tr><td>4</td><td>2</td><td>2013_2014</td><td>+ || Forsmark[unaff] > Forsmark[affect] || +</td></tr>
<tr><td>4</td><td>2</td><td>2012_2013</td><td>0 || Forsmark[unaff] < Forsmark[affect] || 0</td></tr>
</table>

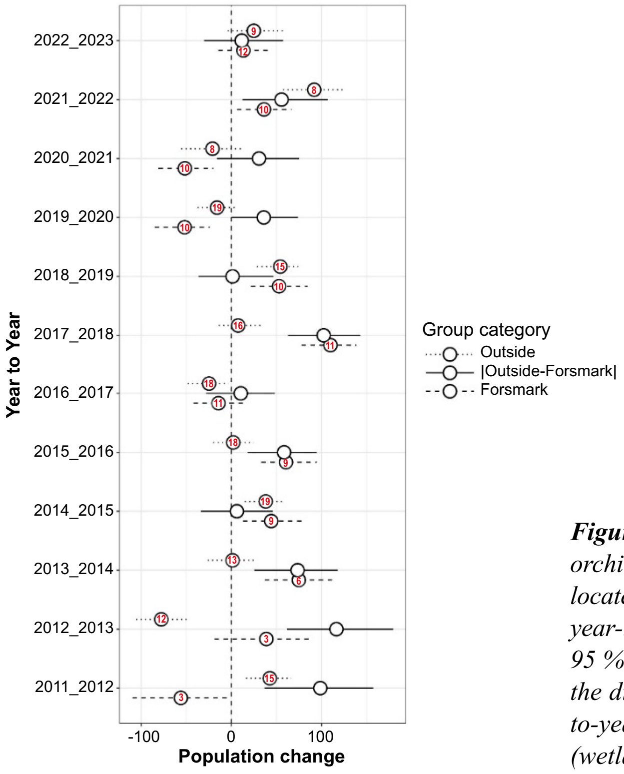

Figure 3-6. *Population change (year-to-year fen orchid abundance increase/decrease within wetlands) located outside or inside Forsmark with respect to year-to-year. Shown are posterior predictions (mean, 95 % CI) for both categories of Group 1 as well as the difference between both categories for each year-to-year. Red numbers indicate number of replications (wetlands within the groups for each year-to-year).*

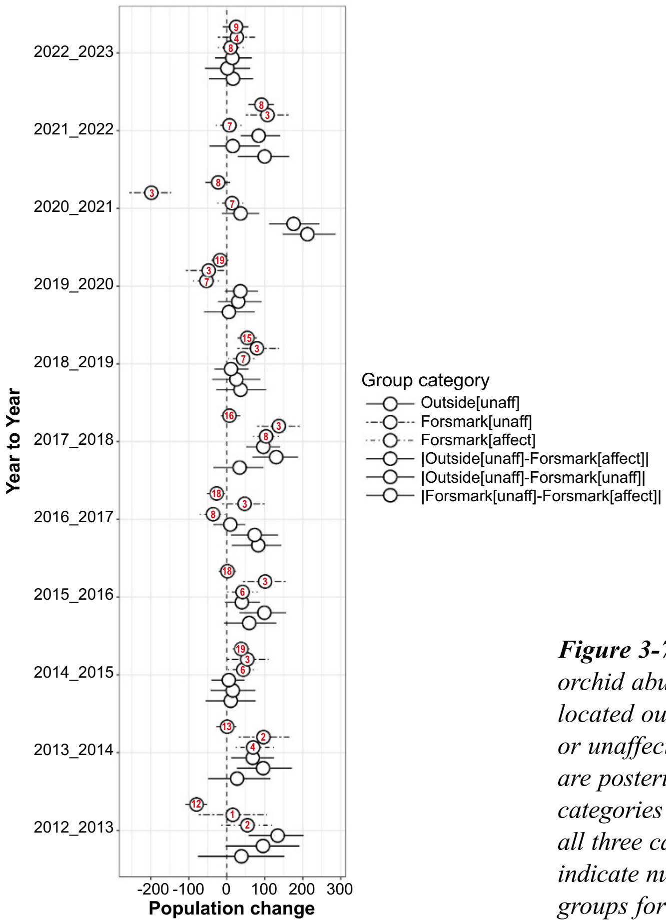

Figure 3-7. *Population change (year-to-year fen orchid abundance increase/decrease within wetlands) located outside or inside Forsmark, either affected or unaffected, with respect to year-to-year. Shown are posterior predictions (mean, 95 % CI) for all three categories of Group 2 as well as the differences between all three categories for each year-to-year. Red numbers indicate number of replications (wetlands within the groups for each year-to-year).*

4 Discussion

Continuous monitoring of fen orchid populations is needed, both in- and outside the Forsmark area in order to evaluate if and how fen orchid populations in the Forsmark area are affected by groundwater level drawdown during the construction of a deep geological repository.

With the individual comparison we successfully identified wetlands that are, from a fen orchid population development perspective, suitable reference wetlands to the wetlands inside Forsmark. We further discovered three wetlands with fen orchids within the Forsmark area that have not been inventoried by SKB earlier.

In the general comparison we found that fen orchid populations in and outside Forsmark are rather stable as the population change did not differ from zero and we did not detect a trend over time. However, population changes varied greatly from year to year and between wetlands. The populations in Forsmark have a higher population change with a difference of around 17 individuals. This means, averaged over all years and wetlands, SKB wetlands have a higher abundance of 17 individuals compared to wetlands outside.

4.1 Integration of citizen science data

The first step of our analysis, namely integrating citizen science data with the SKB inventory, revealed three wetlands in the Forsmark area (*Fräkengropen, Djupträsket, Stocksjön*) with fen orchids that have not been inventoried by SKB previously. Henceforth, currently SKB plans to include these wetlands to the monitoring program.

Additionally, four new abundance estimations from the citizens' science data could be added to the SKB time series for four wetlands. These inventories took place in 2008 and 2011, i.e. prior to the onset of the SKB inventories, in potentially affected wetlands (*350 m SE of Tjärnpussen (SKB 6a), Tjärnpussen (SKB 8b), 250 m SW of Tjärnpussen (SKB 9), Gällsboträsket (SKB 71)*).

Lastly, in two cases we realized that the same wetland was inventoried in the same year twice. In both cases the external count was around twice as high (*Marörspussarna S (SKB 201)*: 66 *vs* 131; *300 m SW of Bålgrundsfjärden (SKB 203a)*: 1 *vs* 2) than the SKB count. An instance where different inventories show different results is not surprising since all inventories are only attempts to estimate the true population size. Inventories are biased by observer effects (e.g. experience, current attention of the personnel), extent of the surveyed area (although it may be similar here, see Appendix A9), date of the inventory, and intensity of the search. We appreciate this coincidence as it will enable us to better describe the uncertainty in the estimation of the true population size in future analyses.

4.2 Identification of suitable reference wetlands

Mostly from the number of positive correlations with wetlands inside Forsmark, but also the number of years the wetlands were inventoried, it seems that *Bolhamnsänden* is the best candidate to serve as an outside reference wetland. However, part of this wetland may have been used pasture land. Hence, the second (*NW of Dalarna*) and the third most suitable wetland (*700 m SSE Bålgrundsfjärden*) should be considered. Currently, the plan is that both of these wetlands will be inventoried in 2024 in order to verify the presence of fen orchid populations (new names: *NW of Dalarna (SKB 205), 700 m SSE Bålgrundsfjärden (SKB 203c)*).

With respect to the comparison between potentially affected and unaffected wetlands within Forsmark, we could show that populations are behaving mostly similarly. One exception was *250 m SW of Tjärnpussen (SKB 9)*, where fen orchid abundances were negatively correlated with all four unaffected wetlands. However, *250 m SW of Tjärnpussen (SKB 9)* was flooded by Forsmarks Kraftgrupp AB (FKA) in 2013 and in *(SKB 69a)* we detected fen orchids for the first time in 2023. Hence, these correlations are due to zeros and do not indicate that the populations behave differently than the other populations in Forsmark.

The cluster analysis adds to the general pattern that fen orchid populations are quite variable among years and wetlands. Many Forsmark wetlands may be more similar since they are in the same cluster, which also contains the most likely candidate as a new reference (*NW of Dalarna*). The second best (*700 m SSE Bålgrundsfjärden*) is close to a wetland with a high and stable population (*800 m SE of Tjärnpussen (SKB 16)*). Hence, either would be suitable reference wetlands. These results did not change if only one common year was used and no data were imputed (not shown here).

4.3 Comparing groups and variability among wetlands

Populations inside, regardless if subdivided, and outside Forsmark are rather stable as we did not detect large population changes averaged over the years. This is a positive result as it indicates that the overall abundance of fen orchids seems not to decrease, which is the most important result from a species protection perspective. Further analysis could use the real abundances or focus on the spatial distribution by using number of wetlands the species has been found to verify this first assessment.

Our finding that fen orchid populations inside Forsmark are having a higher population change could have several reasons. One of the main reasons may be that SKB has four wetlands (*(SW of Apelviken (SKB 23), Djupsundsdelarna (SKB 48), Vambörsfjärden (SKB 49), 100 m N of Djupsundsdelarna (SKB 68)*) where measures to facilitate fen orchids are perform[1]. Mowing and removing vegetation are common measures to promote fen orchid populations (Sundberg 2006, Zingstra et al. 2006) and SKB also runs an experiment in the wetland *Djupsundsdelarna (SKB 48)*, where one part of the experiment is mown (Eriksson et al. 2023). The mowing may also be the reason why potentially unaffected wetlands have a higher population change than potentially affected as three of the four potentially unaffected wetlands experience mowing. Furthermore, although the SKB inventory was built upon the approach used by Uppsala County Administrative Board (sw. Länsstyrelsen i Uppsala) that inventoried the majority of the outside populations, slight differences in the approaches could contribute to the differences.

Generally, we found a high variability among wetlands. This was indicated by the cluster heights that were largest between individual wetlands compared to inter-cluster heights, but also by our general comparison showing that population changes between wetlands vary by around 170 individuals (Outside: ~−100 to ~70; Forsmark: ~−70 to 100). This is important to remember in the comparison of the difference we found between outside and within Forsmark wetlands (~17 ± 3 fen orchids), which is rather small compared to how variable the abundances can be. Furthermore, although Bayesian statistics is less biased by the number of replications than frequentist statistics, one also has to bear in mind that many estimates are based on very few replicates. This difference is most pronounced between outside (40 wetlands) and within Forsmark (12), but even more between potentially affected (8) and unaffected (4) within Forsmark.

4.4 Trends over time and temporal variability

That populations are rather stable is further indicated by our investigation over time, which revealed no consistent co-variation or consistent trend over time. In some years populations have increased compared to the previous year only in Forsmark, in some years it is the opposite or neither have changed. In one case (2021–2022) populations sizes have even increased in- and outside, but the increase outside was larger than in Forsmark.

Fen orchid population sizes vary over time and there are potentially many environmental conditions modulating these changes (Jones 1998, Wheeler 1998). What factors contribute how to this temporal and spatial fluctuation was beyond the scope of this study. To partly account for this variation and remove its effect on our comparisons, we used abundance differences between years and included the average distance to all other wetlands in our analysis.

[1] SKBdoc 1996714 ver 1.0. (In Swedish.)

Adding to the variability among wetlands is the variability among years. We estimated that among wetland and among year variability were about the same, indicating that abundance increases and decreases are as strong between wetlands as they are between years.

4.5 Summary and future perspectives

Our results demonstrate that wetlands outside Forsmark can generally be used as a reference to wetlands inside Forsmark for future comparisons and that potentially unaffected wetlands can be used as references for potentially affected wetlands. However, in both cases, the already existing differences will have to be accounted for.

Future analyses should investigate drivers of population dynamics, which was already started by SKB (Jacobson 2022). This will aid in discriminating natural variation in population sizes from potentially negative effects due to building the deep geological repository for spent nuclear fuel.

The fact that we can use references from external and SKB inventories, but also past and current inventories until the start of the building, will enable us to perform a before-after control-impact (BACI) designs in future analyses (Chevalier et al. 2019, Klein et al. 2022). This analysis is the most valid method to test if observed changes in impact sites is different from observed changes in control sites.

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Appendix

A1 Citizen science data

Cleaning of citizen science data

The citizen science data consisted of rows of individual fen orchid observations. Each row has an ID and is characterized by several columns; e.g. abundance, date, time, coordinates, comments, observer (person that made the observation), reporter (person that made the data entry), editor, project.

Cleaning and selection of the citizen science data was performed in the following steps:

1. **Removal of an unlikely abundance** of 154 440 individuals in a wetland. Hence, 4 395 observations remain.
2. Many observations were obvious duplicates. For example, this occurred as the same observations was reported by two members of an inventory team. **Merging of duplicated observations** was done as follows:
   a. Creation of a real ID using coordinates, date, abundance, and life stage (e.g.: 1594318_6727002_2019-07-27_4_blomning).
   b. Merging of cells of duplicate observations.
   c. Out of the 4 395 observations 3 737 remained. Hence, for 658 duplicates all information in all columns were merged.
3. In cases the abundance column was empty or stated "noted" **comments were checked for abundance information**. Abundances were updated if possible, or specified "found" if not possible.
4. The inconsistency of naming populations (or lack of any information) made it necessary to **assign observations to fen orchid populations**. This was done as follows:
   a. **Automatic assigning**: Every observation was spatially grouped and given an ID-number, with a threshold distance of 100 m.
   b. **Manually assigning**: The ID-numbers were plotted on a map and assigned to the same population if they occurred in the same wetland or on the same side of a larger wetland. During this manually assigning
      i. the population names were kept close to possibly existing location names in the original data,
      ii. individual ID-numbers were checked in a table for consistency in location information,
      iii. wetlands that were also inventoried by SKB additionally received the SKB ID,
      iv. the naming of population within larger wetlands followed a hierarchy from large to small area descriptions (e.g.: "Bruksdammen Björnholmen N", "Bruksdammen Kungssätraviken NE"),
      v. one observation (forsamling = "Valö") received new coordinates based on the comments.
   c. The wetlands Marörspussarna and Tjärnpussen were split into two different population each as in both cases two populations could be distinguished in different wetlands.

Selection a trustworthy subset

After the data cleaning a subset of the available data was used for the general and the individual comparisons. This was done in order to (i) avoid *ad libitum* observations that were not part of a monitoring program, (ii) avoid using original reported observations as well as their summaries that are also listed in the data, and (iii) only work with data from trusted observers.

1. After communication with Sebastian Sundberg, Environmental Assessment Specialist at the Swedish Species Information Centre, we decided to only use observations that stated "Floraväkteri Sverige" in the column project name. This selection represents summaries per wetland.

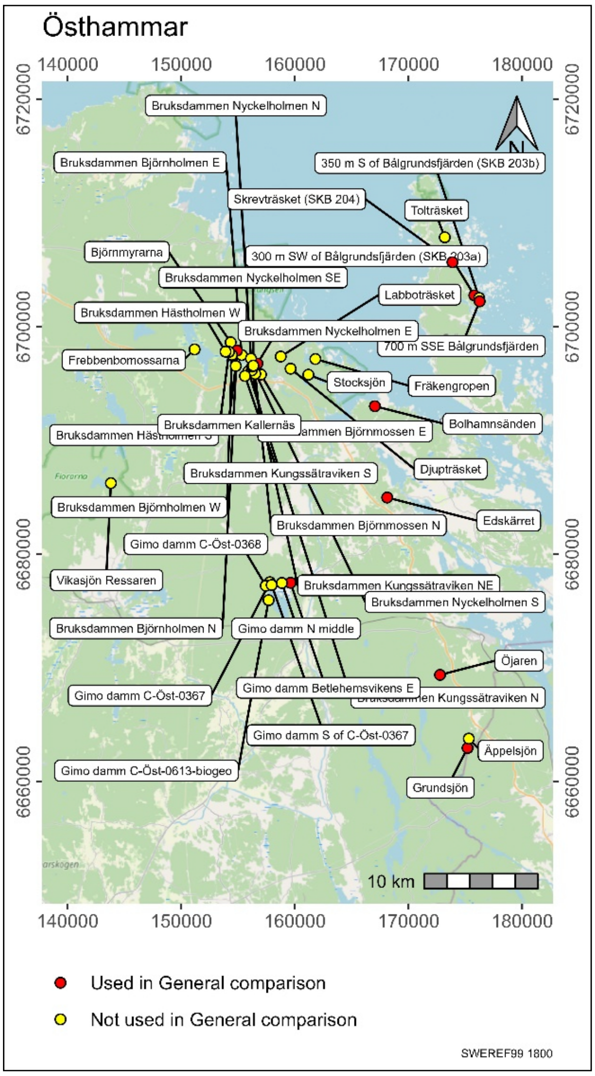
Merging with SKB data

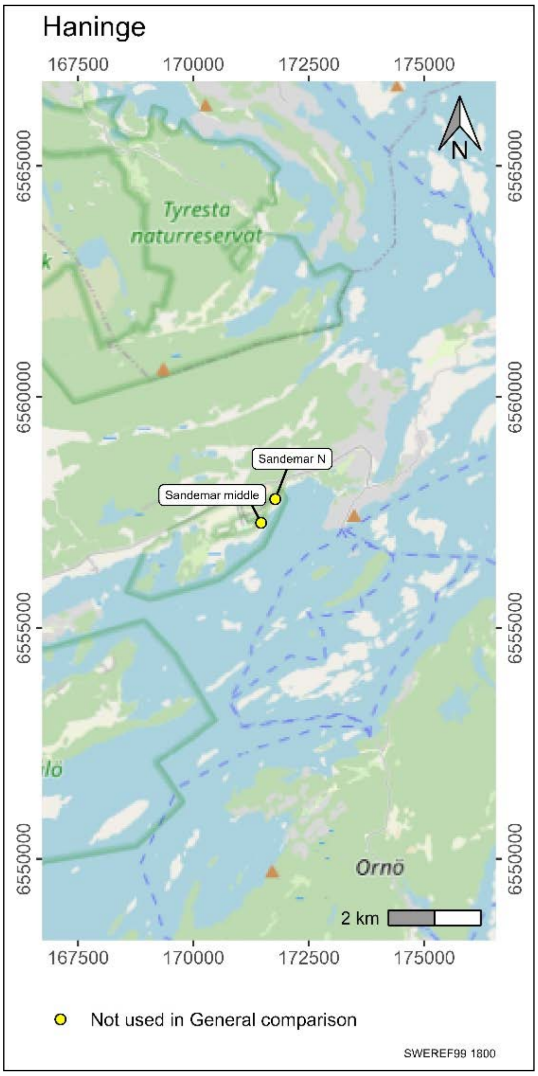
Before the individual and general comparisons of wetlands with respect to fen orchid abundances both data sets were combined:

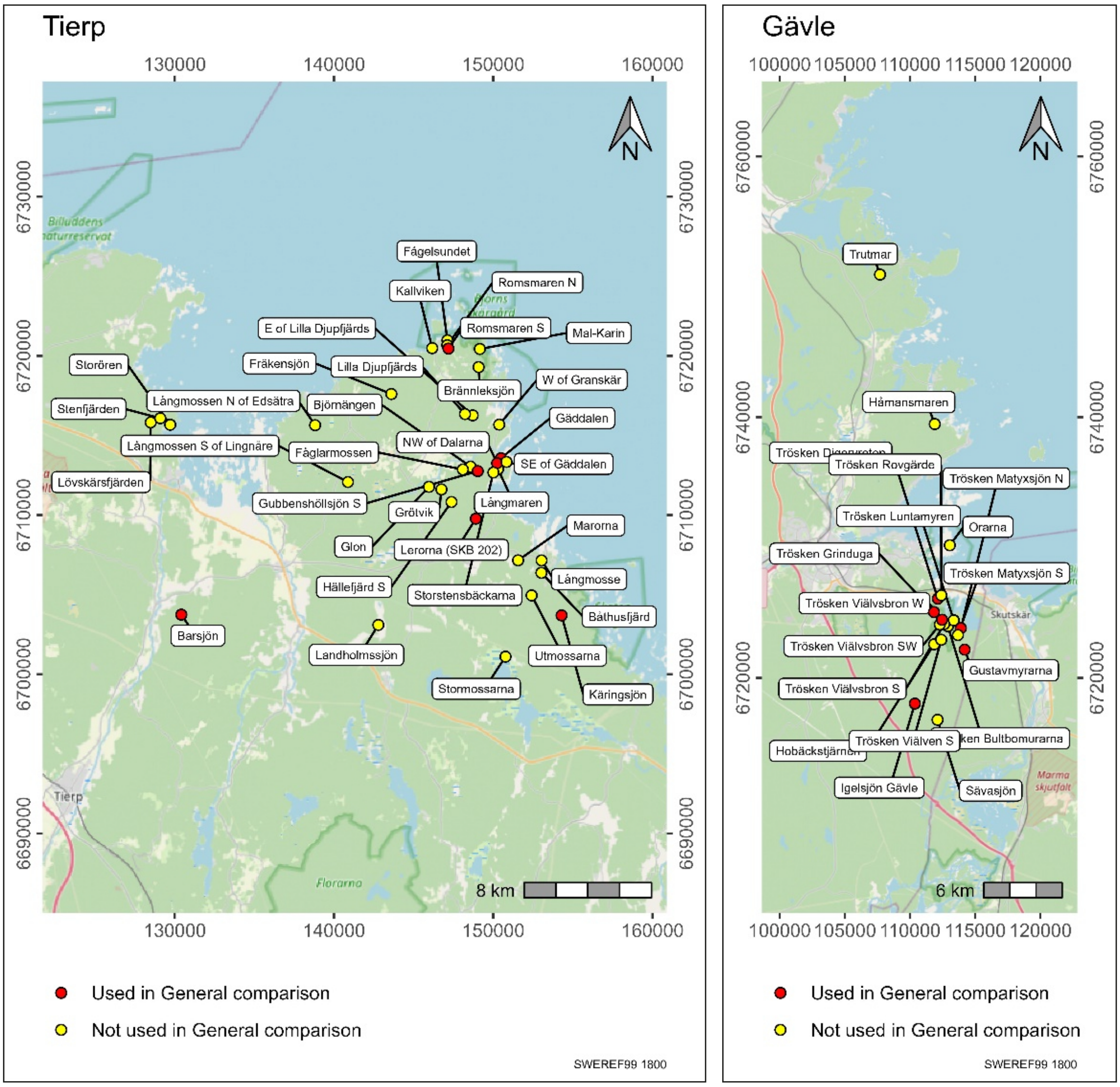
1. Abundances in the citizen science data that only stated "found" were removed.
2. SKB observations that were present in the citizen science data were removed to avoid duplicates.
3. Coordinate systems were harmonized.
4. Observations were summed over populations and years.
5. SKB wetlands received the same name as given in the citizen science data.

A2 Maps

Fen orchid locations of all available citizen science data for each county.







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Romsmaren S
Mal-Karin
Storören
Fräkensjön
Lilla Djupfjärds
Brännleksjön
W of Granskär
Stenfjärden
Långmossen N of Edsätra
Björnängen
Gäddalen
Långmossen S of Lingnäre
Fåglarmossen
NW of Dalarna
SE of Gäddalen
Lövskärsfjärden
Gubbenshöllsjön S
Grölvik
Långmaren
Marorna
Glon
Lerorna (SKB 202)
Hällefjärd S
Storstensbäckarna
Långmosse
Barsjön
Båthusfjärd
Landholmssjön
Utmossarna
Stormossarna
Käringsjön
Tierp
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Used in General comparison
Not used in General comparison
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Gävle
100000 105000 110000 115000 120000
6760000
6740000
6720000
N
Trutmar
Håmansmaren
Trösken Rovgärde
Trösken Matyxsjön N
Trösken Luntamyren
Orarna
Trösken Grinduga
Trösken Matyxsjön S
Trösken Viälvsbron W
Trösken Viälvsbron SW
Gustavmyrarna
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Sävasjön
6 km
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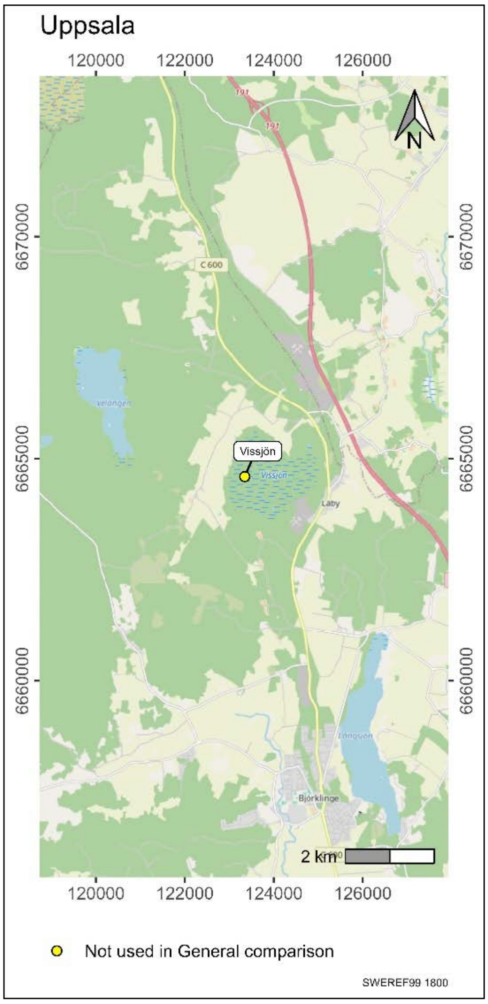
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6660000
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Vissjön
2 km
Not used in General comparison
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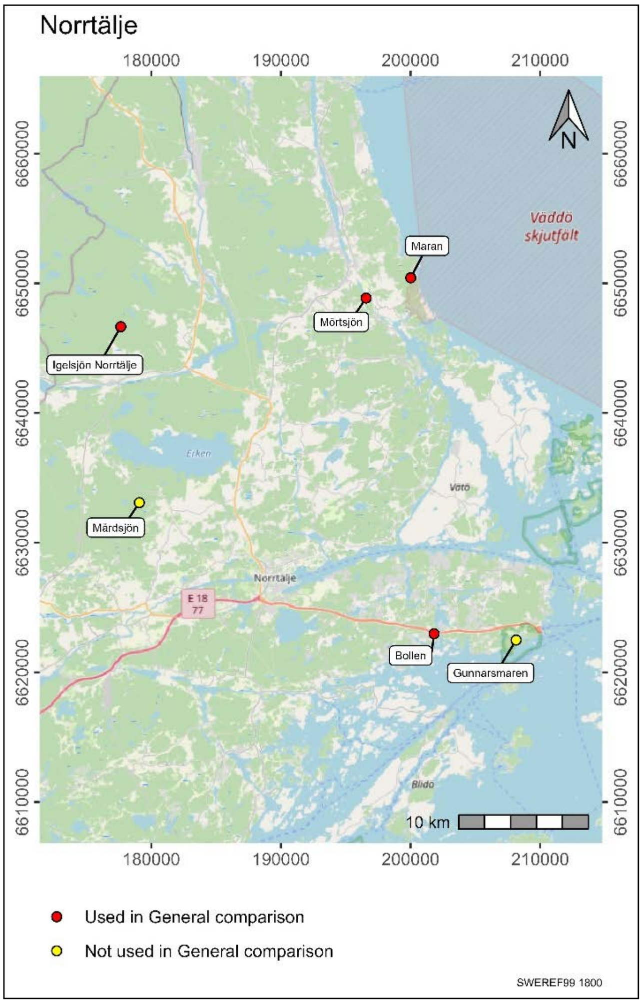
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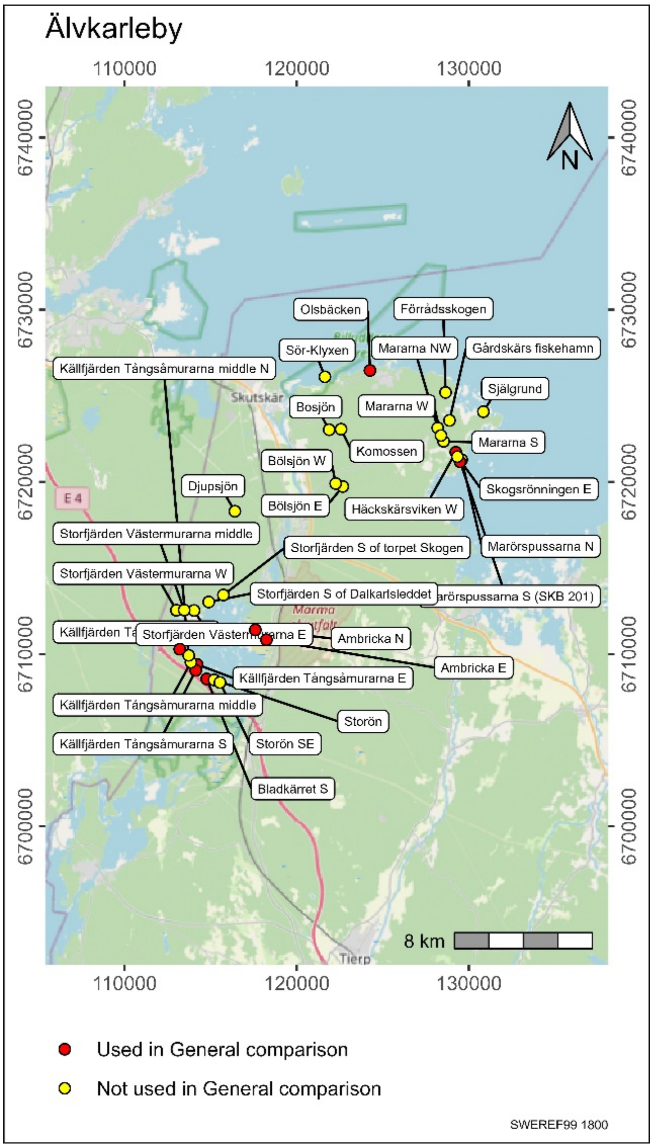
6525000
6520000
6515000
6510000
N
Bärstakärret N
Bärstakärret S
Sjösakärret
Igelsjön Nyköping
Stockholm-Skavsta flygplats
Nyköping
Strandstuvikens naturreservat
Norskogen
Långhalsen
E 4
52
53
6 km
Used in General comparison
SWEREF99 1800



A3 Observations per year

The tables show the fen orchid abundance within wetlands per year, located inside Forsmark (Table 1; Group 1 = Forsmark) or outside Forsmark (Table 1 and 2; Group 1 = Outside). Forsmark wetlands are further divided into (potentially) *affected* or *unaffected* by water level changes (Group 2: Forsmark[affect] vs Forsmark[unaff] vs Outside[unaff]). The distance show the flight distance to wetland (SKB 15). Yellow cells indicate inventories performed by SKB and blue cells indicate inventories from Artportalen in wetlands that were also inventoried by SKB or that are within the Forsmark area. Wetlands are order by distance to (SKB 15).

Forsmark area

Group 1	Group 2	Wetland	Dist. [m]	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Forsmark	Forsmark[affect]	(SKB 14)	121							0	0	0	0	0	0	0	0	0	0	0
Forsmark	Forsmark[affect]	(SKB 11b)	192								0	0	0							
Forsmark	Forsmark[affect]	(SKB 11c)	252								0	0	0	0	0	0	0	0	0	0
Forsmark	Forsmark[affect]	(SKB 11a)	293						0	0	0	0	0	0	0	0	0	0	0	0
Forsmark	Forsmark[affect]	800 m SE of Tjärnpussen (SKB 16)	296						76	158	328	374	422	158	443	506	243	267	118	90
Forsmark	Forsmark[affect]	500 m SE of Tjärnpussen (SKB 7)	409						11	2	21	0	11	3	11	33	9	18	14	24
Forsmark	Forsmark[affect]	150 m W of Bolundsfjärden (SKB 70)	484							0	0	0								
Forsmark	Forsmark[affect]	(SKB 19)	492							0	0	0	0	1	6	12	20	14	15	27
Forsmark	Forsmark[affect]	(SKB 6c)	600						0	0	0	0	0	0	0	0	0	0	0	0
Forsmark	Forsmark[affect]	(SKB 3)	613							0			0					0		
Forsmark	Forsmark[affect]	(SKB 66)	645							0	0	0	0					0		
Forsmark	Forsmark[affect]	(SKB 6b)	651						0											
Forsmark	Forsmark[affect]	350 m SE of Tjärnpussen (SKB 6a)	653					13	0	0	4	7	11	4	25	19	24	32	8	10
Forsmark	Forsmark[affect]	Kungsträsket (SKB 18)	755							0	0	28	37	14	96	201	128	99	94	91
Forsmark	Forsmark[affect]	(SKB 2)	830							0	0	0	0					0		
Forsmark	Forsmark[affect]	(SKB 1)	891							0	0	0	0					0		
Forsmark	Forsmark[affect]	(SKB 87)	1 024							0	0	0	0	0	0	0	0	0	0	0
Forsmark	Forsmark[affect]	Tjärnpussen (SKB 8b)	1 038					280	45	0	0	0	0	2	1	18	17	10	4	4
Forsmark	Forsmark[affect]	(SKB 22)	1 042							0	0	0	0					0		
Forsmark	Forsmark[affect]	250 m SW of Tjärnpussen (SKB 9)	1 050					44	48	0	6	1	3	4	0	0	0	0	0	1
Forsmark	Forsmark[affect]	Gällsboträsket (SKB 71)	1 292		39				0	0	0	0	0					0		
Forsmark	Forsmark[affect]	SW of Apelviken (SKB 23)	1 372						0	0	0	93	158	9	290	250	92	54	154	90
Forsmark	Forsmark[affect]	(SKB 39b)	1 793						0	0	0	0	0	0	0	0	0	0	0	0
Forsmark	Forsmark[affect]	(SKB 128)	2 185							0	0	0	0					0		
Forsmark	Forsmark[affect]	(SKB 127)	2 351							0	0	0	0	0	0	0	0	0	0	0
Forsmark	Forsmark[affect]	(SKB 15)								0	0	0	0	0	0	0	0	0	0	0
Forsmark	Forsmark[unaff]	(SKB 80)	1 214							0	0	0	0					0		
Forsmark	Forsmark[unaff]	Fräkengropen	1 423													2				
Forsmark	Forsmark[unaff]	Vambörsfjärden (SKB 49)	1 571						2	0	0	1	12	1	38	224	118	17	95	72
Forsmark	Forsmark[unaff]	(SKB 48a)	1 634							0	0	0	0	0	0	0	0	0	0	
Forsmark	Forsmark[unaff]	100 m N of Djupsundsdelarna (SKB 68)	1 648							0	10	7	14	0	11	40	22	30	32	28
Forsmark	Forsmark[unaff]	Djupträsket	1 735															44		
Forsmark	Forsmark[unaff]	(SKB 69a)	1 780							0	0	0	0	0	0	0	0	0	0	3
Forsmark	Forsmark[unaff]	Djupsundsdelarna (SKB 48)	1 828							72	222	334	577	693	1 008	986	905	334	532	587
Forsmark	Forsmark[unaff]	Stocksjön	2 100															17		

[0 = inventoried, but non found]

Outside

County	Group 1	Group 2	Wetland	Dist. [m]	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Östhammar	Outside	Outside[unaff]	Bruksdammen Nyckelholmen E	3 871	134	4											73				
Östhammar	Outside	Outside[unaff]	Bruksdammen Björnmossen E	4 026													13				
Östhammar	Outside	Outside[unaff]	Bruksdammen Björnmossen N	4 292													11				
Östhammar	Outside	Outside[unaff]	Bruksdammen Nyckelholmen SE	4 356													147				
Östhammar	Outside	Outside[unaff]	Bruksdammen Nyckelholmen N	4 424	610												49				212
Östhammar	Outside	Outside[unaff]	Bruksdammen Nyckelholmen S	4 504													229				
Östhammar	Outside	Outside[unaff]	Bruksdammen Kungssätraviken NE	4 614													13				
Östhammar	Outside	Outside[unaff]	Bruksdammen Kungssätraviken N	4 917													57				
Östhammar	Outside	Outside[unaff]	Bruksdammen Björnholmen E	5 246	1 818												214				263
Östhammar	Outside	Outside[unaff]	Bruksdammen Kungssätraviken S	5 349													51				
Östhammar	Outside	Outside[unaff]	Bruksdammen Björnholmen N	5 647	82	43											16				
Östhammar	Outside	Outside[unaff]	Bruksdammen Kallernäs	5 855													4				
Östhammar	Outside	Outside[unaff]	Bruksdammen Hästholmen S	6 310		169											21				
Östhammar	Outside	Outside[unaff]	Bruksdammen Hästholmen W	6 625		98															
Östhammar	Outside	Outside[unaff]	Bolhamnsänden	8 049	71	209			216	335	4	28	28	23	77	263	549	472			
Tierp	Outside	Outside[unaff]	Käringsjön	9 092	12	36								6							
Tierp	Outside	Outside[unaff]	Utmossarna	10 844	93																
Tierp	Outside	Outside[unaff]	Båthusfjärd	11 391		1															
Tierp	Outside	Outside[unaff]	Långmosse	12 005		1															
Tierp	Outside	Outside[unaff]	Marorna	12 816	65				20					4							
Östhammar	Outside	Outside[unaff]	Edskärret	14 879		24	11		3			0	0		7	0	4	0	3	0	6
Östhammar	Outside	Outside[unaff]	Skrevträsket (SKB 204)	15 495	596				166	160	189	190	260	304	204	202	130	143			1
Östhammar	Outside	Outside[unaff]	300 m SW of Bålgrundsfjärden (SKB 203a)	16 055	1	3			8	17	12	25	10	19	16	24	5	0	4	1(2)	9
Östhammar	Outside	Outside[unaff]	Tolträsket	16 163	339			304									62				
Östhammar	Outside	Outside[unaff]	700 m SSE Bålgrundsfjärden	16 351		30			28	29	30	45	55	48	67	125	70	90			
Östhammar	Outside	Outside[unaff]	350 m S of Bålgrundsfjärden (SKB 203b)	16 384																0	
Tierp	Outside	Outside[unaff]	Lerorna (SKB 202)	16 657	736	33			263	201	154	152	247	199	104		108	10		312	175
Tierp	Outside	Outside[unaff]	Storstensbäckarna	18 240	16																
Tierp	Outside	Outside[unaff]	Långmaren	18 249	103					72											
Tierp	Outside	Outside[unaff]	Landholmssjön	18 527	33																
Tierp	Outside	Outside[unaff]	Hällefjärd S	18 556	209									14							
Tierp	Outside	Outside[unaff]	NW of Dalarna	18 592	167			211	198	12	60	27	1	14	6		89		21		
Tierp	Outside	Outside[unaff]	Gäddalen	18 710	260			10	10	155			154	330	18	31	196	78	25		
Tierp	Outside	Outside[unaff]	Gubbenshöllsjön S	18 911	98				117	87	96	33	51	51	31	33	33	17			
Tierp	Outside	Outside[unaff]	Björnängen	19 392	8																
Tierp	Outside	Outside[unaff]	Grötvik	19 529	36																

County	Group 1	Group 2	Wetland	Dist. [m]	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Tierp	Outside	Outside[unaff]	Fåglarmossen	19 554	63																
Tierp	Outside	Outside[unaff]	Glon	20 203	67																
Östhammar	Outside	Outside[unaff]	Gimo damm Betlehemsvikens E	20 284	35	11												22			
Östhammar	Outside	Outside[unaff]	Vikasjön Ressaren	20 304		0															
Östhammar	Outside	Outside[unaff]	Gimo damm N middle	20 374	124													289			
Östhammar	Outside	Outside[unaff]	Gimo damm C-Öst-0367	20 419	48													162			
Tierp	Outside	Outside[unaff]	W of Granskär	20 571	2			0	0	0											
Östhammar	Outside	Outside[unaff]	Gimo damm C-Öst-0368	20 775		108												932			
Tierp	Outside	Outside[unaff]	E of Lilla Djupfjärds	21 952	27																
Östhammar	Outside	Outside[unaff]	Gimo damm C-Öst-0613-biogeo	22 047		26												128			
Tierp	Outside	Outside[unaff]	Lilla Djupfjärds	22 275															6		
Tierp	Outside	Outside[unaff]	Långmossen S of Lingnåre	24 306		1															
Tierp	Outside	Outside[unaff]	Brännleksjön	24 381	27																
Tierp	Outside	Outside[unaff]	Mal-Karin	25 354														14			
Tierp	Outside	Outside[unaff]	Fräkensjön	26 072	2																
Tierp	Outside	Outside[unaff]	Romsmaren S	26 326	81				33	30	4	26	9	24	3	0	0	19			
Tierp	Outside	Outside[unaff]	Fågelsundet	26 799	0													12			
Tierp	Outside	Outside[unaff]	Kallviken	26 872														5			
Tierp	Outside	Outside[unaff]	Långmossen N of Edsätra	28 124	1																
Tierp	Outside	Outside[unaff]	Barsjön	30 709	342	458												64			
Östhammar	Outside	Outside[unaff]	Öjaren	30 918									48				16	12	12		45
Tierp	Outside	Outside[unaff]	Storören	35 635										9							
Tierp	Outside	Outside[unaff]	Stenfjärden	36 401								5		33					0		
Tierp	Outside	Outside[unaff]	Lövskärsfjärden	36 779								4							7		
Östhammar	Outside	Outside[unaff]	Äppelsjön	37 064				12												0	
Östhammar	Outside	Outside[unaff]	Grundsjön	37 778		1	0	1		0			0				0			0	
Älvkarleby	Outside	Outside[unaff]	Marörspussarna S (SKB 201)	38 865	170				10	22	10	21	27	12	32	9	102	62		93	66(131)
Älvkarleby	Outside	Outside[unaff]	Marörspussarna N	38 889		6					35										327
Älvkarleby	Outside	Outside[unaff]	Skogsrönningen E	39 172											1						
Älvkarleby	Outside	Outside[unaff]	Häckskärsviken W	39 400										19	30						
Älvkarleby	Outside	Outside[unaff]	Själgrund	39 646	108																0
Älvkarleby	Outside	Outside[unaff]	Mararna S	40 350											8						
Älvkarleby	Outside	Outside[unaff]	Mararna W	40 675	10																
Älvkarleby	Outside	Outside[unaff]	Gårdskärs fiskehamn	40 834	0																
Älvkarleby	Outside	Outside[unaff]	Mararna NW	41 100	13																10
Älvkarleby	Outside	Outside[unaff]	Förrådsskogen	42 055	3																
Älvkarleby	Outside	Outside[unaff]	Bölsjön E	43 769	35								17				5				
Älvkarleby	Outside	Outside[unaff]	Bölsjön W	44 207	37				1												

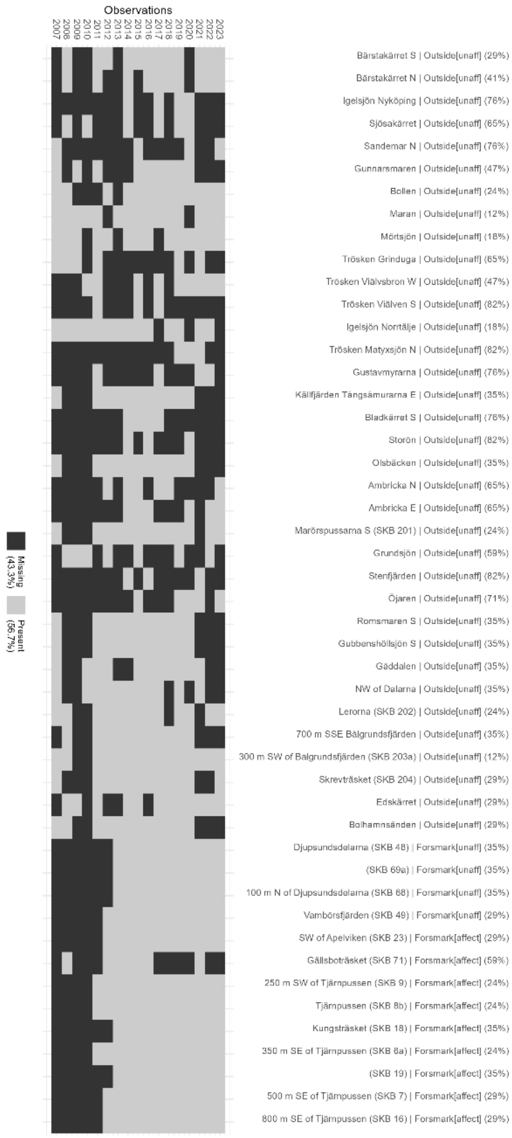
County	Group 1	Group 2	Wetland	Dist. [m]	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Älvkarleby	Outside	Outside[unaff]	Ambricka E	44 257								227	436	705				2 142		314	69
Älvkarleby	Outside	Outside[unaff]	Ambricka N	45 040						78		427	830		133	230					5
Älvkarleby	Outside	Outside[unaff]	Komossen	45 613	35				8		865										
Älvkarleby	Outside	Outside[unaff]	Bosjön	46 169										8							
Älvkarleby	Outside	Outside[unaff]	Storön SE	46 208	8																
Älvkarleby	Outside	Outside[unaff]	Olsbäcken	46 256	171				116	260	86	114	25	56	15	41	112	53			
Älvkarleby	Outside	Outside[unaff]	Storön	46 557								8		105				10			
Älvkarleby	Outside	Outside[unaff]	Bladkärret S	47 015								17	30	20	15						
Älvkarleby	Outside	Outside[unaff]	Storfjärden S of torpet Skogen	47 441						79											
Älvkarleby	Outside	Outside[unaff]	Källfjärden Tångsåmurarna S	47 662								2	16								
Älvkarleby	Outside	Outside[unaff]	Källfjärden Tångsåmurarna E	47 791	1 462				773	1 042	539	515	581	395	268	132	507	625			
Älvkarleby	Outside	Outside[unaff]	Storfjärden S of Dalkarlsleddet	48 071							685										
Älvkarleby	Outside	Outside[unaff]	Källfjärden Tångsåmurarna middle	48 112	132							8									
Älvkarleby	Outside	Outside[unaff]	Sör-Klyxen	48 112	240														0	0	
Älvkarleby	Outside	Outside[unaff]	Källfjärden Tångsåmurarna middle N	48 362	75							4 651									
Älvkarleby	Outside	Outside[unaff]	Djupsjön	48 664										18					3		
Älvkarleby	Outside	Outside[unaff]	Storfjärden Västermurarna E	48 780						141				276							
Älvkarleby	Outside	Outside[unaff]	Källfjärden Tångsåtorpet N	48 957	819	21						3 072									
Älvkarleby	Outside	Outside[unaff]	Storfjärden Västermurarna W	49 764							598										
Uppsala	Outside	Outside[unaff]	Vissjön	49 835	9					5											
Gävle	Outside	Outside[unaff]	Sävasjön	52 016	1													30			
Gävle	Outside	Outside[unaff]	Gustavmyrarna	52 403					100						498				100	129	
Gävle	Outside	Outside[unaff]	Trösken Matyxsjön S	53 350											79						
Gävle	Outside	Outside[unaff]	Trösken Matyxsjön N	53 410													1	25	1		
Norrtälje	Outside	Outside[unaff]	Igelsjön Norrtälje	53 914	69	82	63	48	58	69	63	83	58	53		0	24		5	10	
Gävle	Outside	Outside[unaff]	Igelsjön Gävle	54 105				30	30									122			
Gävle	Outside	Outside[unaff]	Trösken Luntamyren	54 179		3															
Gävle	Outside	Outside[unaff]	Trösken Viälven S	54 341					1 000				879		1 115						
Gävle	Outside	Outside[unaff]	Trösken Bultbomurarna	54 351													846				
Gävle	Outside	Outside[unaff]	Hobäckstjärnen	54 643					9									27			
Gävle	Outside	Outside[unaff]	Trösken Viälvsbron S	54 678																3	
Gävle	Outside	Outside[unaff]	Trösken Viälvsbron SW	54 951																77	
Gävle	Outside	Outside[unaff]	Trösken Viälvsbron W	54 997				100	159				3		12		100	101	91	140	103
Gävle	Outside	Outside[unaff]	Trösken Grinduga	55 810	72	49	15		106								10		50		
Gävle	Outside	Outside[unaff]	Trösken Rovgärde	55 958	3																
Gävle	Outside	Outside[unaff]	Trösken Digervreten	56 067	11	35															
Gävle	Outside	Outside[unaff]	Orarna	57 482											16						
Norrtälje	Outside	Outside[unaff]	Mörtsjön	60 747	285	590	42		140	574		32	201	51		42	113	282	286	352	396
Norrtälje	Outside	Outside[unaff]	Maran	61 651	18	10	14	0	44		24	3	12	2	10	1	0		0	0	0

County	Group 1	Group 2	Wetland	Dist. [m]	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Gävle	Outside	Outside[unaff]	Håmansmaren	64 051														131			
Norrtälje	Outside	Outside[unaff]	Mårdsjön	67 297	0													0			
Gävle	Outside	Outside[unaff]	Trutmar	74 943																27	
Norrtälje	Outside	Outside[unaff]	Bollen	85 435	193	47				4		0	0	0	3	0	0	5	0	0	0
Norrtälje	Outside	Outside[unaff]	Gunnarsmaren	89 089	305		143		50				0	0	0	0	0	0			
Haninge	Outside	Outside[unaff]	Sandemar N	140 444	20								3 197					1 124			2 057
Haninge	Outside	Outside[unaff]	Sandemar middle	140 859														1 412			801
Nyköping	Outside	Outside[unaff]	Sjösakärret	193 354		70		133				120			20		136	90			
Nyköping	Outside	Outside[unaff]	Igelsjön Nyköping	193 688								3			8		13	6			
Nyköping	Outside	Outside[unaff]	Bärstakärret N	196 205		130			140			166		23	56	122	322		182	300	1 202
Nyköping	Outside	Outside[unaff]	Bärstakärret S	196 406		100			240	90		125	50	62	345	406	331		678	1 432	1 345

[0 = inventoried, but non found]

Missing wetland-year-combinations

The figure shows the missing observations of fen orchid by wetland and year for the 13 SKB and the 35 Outside wetlands that were used in the Individual comparison. Colour indicates that inventory data are available (grey) or not available (black)), with percentages showing percent of years with observations. Wetlands are order by distance to wetland (SKB 15) with furthest distance at the top.



A4 Abundance differences for General comparison

The table shows the fen orchid year-to-year abundance differences (aka population change) within wetlands located inside or outside Forsmark (Group 1). Wetlands are further divided into (potentially) affected or unaffected by water level changes (Group 2). In the General comparison, all year-to- years were used to estimate general differences among the group categories (Group 1 with Model 1; Group 2 with Model 2). For Model 3 (Group 1) only year-to-year differences from 2011_2012 onward could be used as fixed effects. For Model 4 (Group 2) only year-to-year differences from 2012_2013 onward could be used as fixed effects.

Year-to- year abundance differences for each wetland

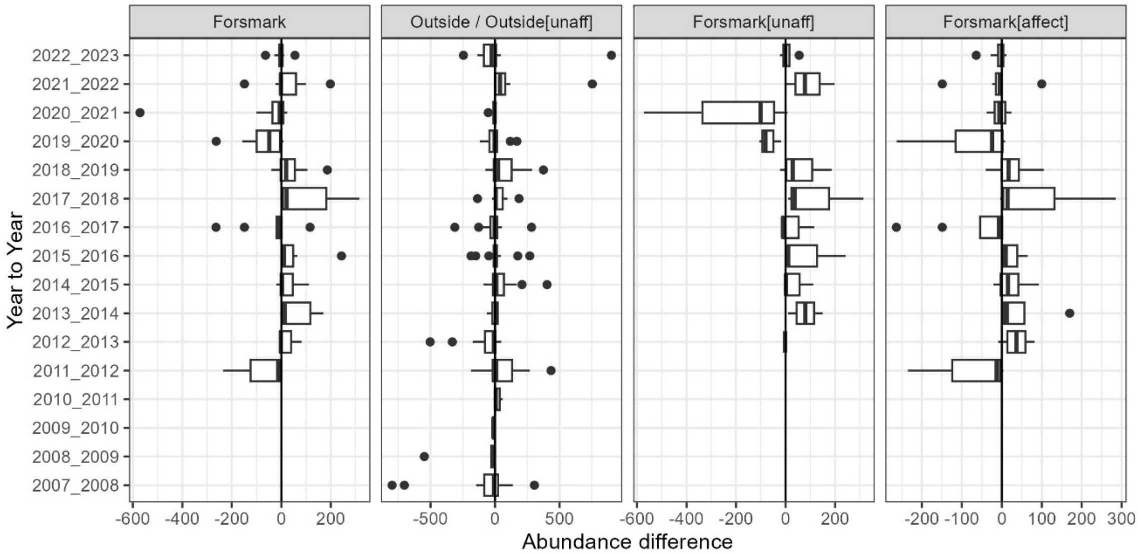
Group 1	Group 2	Wetland	2007_2008	2008_2009	2009_2010	2010_2011	2011_2012	2012_2013	2013_2014	2014_2015	2015_2016	2016_2017	2017_2018	2018_2019	2019_2020	2020_2021	2021_2022	2022_2023
Forsmark	Forsmark[affect]	250 m SW of Tjärnpussen (SKB 9)					4		6	−5	2	1	−4					1
Forsmark	Forsmark[affect]	350 m SE of Tjärnpussen (SKB 6a)					−13		4	3	4	−7	21	−6	5	8	−24	2
Forsmark	Forsmark[affect]	Tjärnpussen (SKB 8b)					−235					2	−1	17	−1	−7	−6	0
Forsmark	Forsmark[affect]	500 m SE of Tjärnpussen (SKB 7)						−9	19	−21	11	−8	8	22	−24	9	−4	10
Forsmark	Forsmark[affect]	800 m SE of Tjärnpussen (SKB 16)						82	170	46	48	−264	285	63	−263	24	−149	−28
Forsmark	Forsmark[affect]	Kungsträsket (SKB 18)								28	9	−23	82	105	−73	−29	−5	−3
Forsmark	Forsmark[affect]	SW of Apelviken (SKB 23)								93	65	−149	281	−40	−158	−38	100	−64
Forsmark	Forsmark[affect]	(SKB 19)										1	5	6	8	−6	1	12
Forsmark	Forsmark[unaff]	Vambörsfjärden (SKB 49)						−2		1	11	−11	37	186	−106	−101	78	−23
Forsmark	Forsmark[unaff]	100 m N of Djupsundsdelarna (SKB 68)							10	−3	7	−14	11	29	−18	8	2	−4
Forsmark	Forsmark[unaff]	Djupsundsdelarna (SKB 48)							150	112	243	116	315	−22	−81	−571	198	55
Forsmark	Forsmark[unaff]	(SKB 69a)																3
Outside	Outside[unaff]	300 m SW of Bålgrundsfjärden (SKB 203a)	2				9	−5	13	−15	9	−3	8	−19	−5	4	−3	8
Outside	Outside[unaff]	Barsjön	116															
Outside	Outside[unaff]	Bolhamnsänden	138				119	−331	24	0	−5	54	186	286	−77			
Outside	Outside[unaff]	Bollen	−146									3	−3		5	−5		
Outside	Outside[unaff]	Bruksdammen Björnholmen N	−39															
Outside	Outside[unaff]	Bruksdammen Nyckelholmen E	−130															
Outside	Outside[unaff]	Gimo damm Betlehemsvikens E	−24															
Outside	Outside[unaff]	Igelsjön Norrtälje	13	−19	−15	10	11	−6	20	−25	−5			24			5	
Outside	Outside[unaff]	Källfjärden Tångsåtorpet N	−798															
Outside	Outside[unaff]	Käringsjön	24															
Outside	Outside[unaff]	Lerorna (SKB 202)	−703				−62	−47	−2	95	−48	−95			−98			−137

Group 1	Group 2	Wetland	2007_2008	2008_2009	2009_2010	2010_2011	2011_2012	2012_2013	2013_2014	2014_2015	2015_2016	2016_2017	2017_2018	2018_2019	2019_2020	2020_2021	2021_2022	2022_2023
Outside	Outside[unaff]	Maran	−8	4	−14	44			−21	9	−10	8	−9	−1				
Outside	Outside[unaff]	Mörtsjön	305	−548			434			169	−150			71	169	4	66	44
Outside	Outside[unaff]	Trösken Digervreten	24															
Outside	Outside[unaff]	Trösken Grinduga	−23	−34														
Outside	Outside[unaff]	Edskärret		−13									−7	4	−4	3	−3	6
Outside	Outside[unaff]	Grundsjön		−1	1													
Outside	Outside[unaff]	Gäddalen				0	145				176	−312	13	165	−118	−53		
Outside	Outside[unaff]	Igelsjön Gävle				0												
Outside	Outside[unaff]	NW of Dalarna				−13	−186	48	−33	−26	13	−8						
Outside	Outside[unaff]	Trösken Viälvsbron W				59									1	−10	49	−37
Outside	Outside[unaff]	700 m SSE Bålgrundsfjärden					1	1	15	10	−7	19	58	−55	20			
Outside	Outside[unaff]	Bärstakärret S					−150			−75	12	283	61	−75			754	−87
Outside	Outside[unaff]	Gubbenshöllsjön S					−30	9	−63	18	0	−20	2	0	−16			
Outside	Outside[unaff]	Källfjärden Tångsåmurarna E					269	−503	−24	66	−186	−127	−136	375	118			
Outside	Outside[unaff]	Marörspussarna S (SKB 201)					12	−12	11	6	−15	20	−23	93	−40			−27
Outside	Outside[unaff]	Olsbäcken					144	−174	28	−89	31	−41	26	71	−59			
Outside	Outside[unaff]	Romsmaren S					−3	−26	22	−17	15	−21	−3		19			
Outside	Outside[unaff]	Skrevträsket (SKB 204)					−6	29	1	70	44	−100	−2	−72	13			
Outside	Outside[unaff]	Ambricka E								209	269							−245
Outside	Outside[unaff]	Ambricka N								403			97					
Outside	Outside[unaff]	Bladkärret S								13	−10	−5						
Outside	Outside[unaff]	Källfjärden Tångsåmurarna S								14								
Outside	Outside[unaff]	Bärstakärret N										33	66	200			118	902
Outside	Outside[unaff]	Häckskärsviken W										11						
Outside	Outside[unaff]	Igelsjön Nyköping													−7			
Outside	Outside[unaff]	Sjösakärret													−46			
Outside	Outside[unaff]	Trösken Matyxsjön N													24	−24		
Outside	Outside[unaff]	Öjaren													−4	0		
Outside	Outside[unaff]	Gustavmyrarna															29	

[0 = inventoried, but non found]

The figure shows boxplots of the year-to- year abundance differences for Group 1 (left: Forsmark vs Outside) and Group 2, where Forsmark is split into two groups (right: Forsmark[unaff], Forsmark[affect]). Note different scales on the x-axes.

Year-to- year abundance differences figure



A5 Correlations between wetlands

Shown are correlations between SKB (13) and not SKB (35) wetlands with number of common years (N), the estimate, and the significance (.p ≤ 0.1, *p ≤ 0.05, ** p ≤ 0.01, ***p ≤ 0.001).

Side 1				Side 2			
SKB	Not SKB	N	Est.	SKB	Not SKB	N	Est.
(SKB 19)	Ambricka E	6	0.2	800 m SE of Tjärnpussen (SKB 16)	Igelsjön Norrtälje	9	−0.21
(SKB 19)	Bladkärret S	4	−0.55	800 m SE of Tjärnpussen (SKB 16)	Källfjärden Tångsåmurarna E	9	−0.52
(SKB 19)	Igelsjön Nyköping	4	0.3	800 m SE of Tjärnpussen (SKB 16)	Lerorna (SKB 202)	10	−0.17
(SKB 19)	Stenfjärden	3	−0.62	800 m SE of Tjärnpussen (SKB 16)	Maran	10	−0.26
(SKB 19)	Storön	3	−0.48	800 m SE of Tjärnpussen (SKB 16)	Marörspussarna S (SKB 201)	11	−0.06
(SKB 19)	Öjaren	5	−0.17	800 m SE of Tjärnpussen (SKB 16)	Mörtsjön	10	−0.88***
(SKB 19)	Trösken Matyxsjön N	3	0.97	800 m SE of Tjärnpussen (SKB 16)	NW of Dalarna	8	0.36
(SKB 19)	300 m SW of Bålgrundsfjärden (SKB 203a)	11	−0.65*	800 m SE of Tjärnpussen (SKB 16)	Olsbäcken	9	−0.4
(SKB 19)	Bolhamnsänden	8	0.92**	800 m SE of Tjärnpussen (SKB 16)	Romsmaren S	9	−0.32
(SKB 19)	Bollen	10	0.18	800 m SE of Tjärnpussen (SKB 16)	Sandemar N	3	0.51
(SKB 19)	Gubbenshöllsjön S	8	−0.57	800 m SE of Tjärnpussen (SKB 16)	Skrevträsket (SKB 204)	10	0.47
(SKB 19)	Gäddalen	7	−0.33	800 m SE of Tjärnpussen (SKB 16)	700 m SSE Bålgrundsfjärden	9	0.48
(SKB 19)	Igelsjön Norrtälje	8	−0.83*	800 m SE of Tjärnpussen (SKB 16)	Bärstakärret N	8	−0.5
(SKB 19)	Källfjärden Tångsåmurarna E	8	0.26	800 m SE of Tjärnpussen (SKB 16)	Bärstakärret S	10	−0.53
(SKB 19)	Lerorna (SKB 202)	9	−0.16	800 m SE of Tjärnpussen (SKB 16)	Edskärret	9	−0.35
(SKB 19)	Maran	10	−0.57.	800 m SE of Tjärnpussen (SKB 16)	Sjösakärret	4	0.88
(SKB 19)	Marörspussarna S (SKB 201)	10	0.71*	800 m SE of Tjärnpussen (SKB 16)	Trösken Viälvsbron W	7	−0.21
(SKB 19)	Mörtsjön	9	0.82**	800 m SE of Tjärnpussen (SKB 16)	Gustavmyrarna	3	−0.32
(SKB 19)	NW of Dalarna	7	0.44	Djupsundsdelarna (SKB 48)	Ambricka E	6	0.78.
(SKB 19)	Olsbäcken	8	0.11	Djupsundsdelarna (SKB 48)	Bladkärret S	4	−0.39
(SKB 19)	Romsmaren S	8	−0.06	Djupsundsdelarna (SKB 48)	Igelsjön Nyköping	4	0.79
(SKB 19)	Sandemar N	3	−0.75	Djupsundsdelarna (SKB 48)	Stenfjärden	3	0.9
(SKB 19)	Skrevträsket (SKB 204)	9	−0.87**	Djupsundsdelarna (SKB 48)	Storön	3	0.04
(SKB 19)	700 m SSE Bålgrundsfjärden	8	0.56	Djupsundsdelarna (SKB 48)	Öjaren	5	−0.47
(SKB 19)	Bärstakärret N	8	0.87**	Djupsundsdelarna (SKB 48)	Trösken Matyxsjön N	3	0.4
(SKB 19)	Bärstakärret S	9	0.87**	Djupsundsdelarna (SKB 48)	300 m SW of Bålgrundsfjärden (SKB 203a)	11	−0.11
(SKB 19)	Edskärret	9	0.22	Djupsundsdelarna (SKB 48)	Bolhamnsänden	8	0.81*
(SKB 19)	Sjösakärret	4	0.29	Djupsundsdelarna (SKB 48)	Bollen	10	0.38
(SKB 19)	Trösken Viälvsbron W	7	0.81*	Djupsundsdelarna (SKB 48)	Gubbenshöllsjön S	8	−0.72*

Side 1				Side 2			
SKB	**Not SKB**	**N**	**Est.**	**SKB**	**Not SKB**	**N**	**Est.**
(SKB 19)	Gustavmyrarna	3	−0.99.	Djupsundsdelarna (SKB 48)	Gäddalen	7	−0.09
(SKB 19)	Ambricka N	5	−0.63	Djupsundsdelarna (SKB 48)	Igelsjön Norrtälje	8	−0.63.
(SKB 69a)	Ambricka E	6	−0.37	Djupsundsdelarna (SKB 48)	Källfjärden Tångsåmurarna E	8	−0.41
(SKB 69a)	Öjaren	5	0.56	Djupsundsdelarna (SKB 48)	Lerorna (SKB 202)	9	−0.47
(SKB 69a)	300 m SW of Bålgrundsfjärden (SKB 203a)	11	−0.09	Djupsundsdelarna (SKB 48)	Maran	10	−0.56.
(SKB 69a)	Bollen	10	−0.16	Djupsundsdelarna (SKB 48)	Marörspussarna S (SKB 201)	10	0.41
(SKB 69a)	Lerorna (SKB 202)	9	0.05	Djupsundsdelarna (SKB 48)	Mörtsjön	9	−0.13
(SKB 69a)	Maran	10	−0.23	Djupsundsdelarna (SKB 48)	NW of Dalarna	7	0.29
(SKB 69a)	Marörspussarna S (SKB 201)	10	0.23	Djupsundsdelarna (SKB 48)	Olsbäcken	8	−0.2
(SKB 69a)	Mörtsjön	9	0.54	Djupsundsdelarna (SKB 48)	Romsmaren S	8	−0.32
(SKB 69a)	Sandemar N	3	−0.06	Djupsundsdelarna (SKB 48)	Sandemar N	3	−0.99.
(SKB 69a)	Skrevträsket (SKB 204)	9	−0.78*	Djupsundsdelarna (SKB 48)	Skrevträsket (SKB 204)	9	−0.21
(SKB 69a)	Bärstakärret N	8	0.96***	Djupsundsdelarna (SKB 48)	700 m SSE Bålgrundsfjärden	8	0.84**
(SKB 69a)	Bärstakärret S	9	0.58	Djupsundsdelarna (SKB 48)	Bärstakärret N	8	−0.01
(SKB 69a)	Edskärret	9	0.49	Djupsundsdelarna (SKB 48)	Bärstakärret S	9	0.03
(SKB 69a)	Trösken Viälvsbron W	7	0.21	Djupsundsdelarna (SKB 48)	Edskärret	9	0.13
(SKB 69a)	Ambricka N	5	−0.56	Djupsundsdelarna (SKB 48)	Sjösakärret	4	−0.01
100 m N of Djupsundsdelarna (SKB 68)	Ambricka E	6	0.03	Djupsundsdelarna (SKB 48)	Trösken Viälvsbron W	7	0.27
100 m N of Djupsundsdelarna (SKB 68)	Bladkärret S	4	0.21	Djupsundsdelarna (SKB 48)	Gustavmyrarna	3	0.87
100 m N of Djupsundsdelarna (SKB 68)	Igelsjön Nyköping	4	0.65	Djupsundsdelarna (SKB 48)	Ambricka N	5	−0.57
100 m N of Djupsundsdelarna (SKB 68)	Stenfjärden	3	−0.46	Gällsboträsket (SKB 71)	700 m SSE Bålgrundsfjärden	6	−0.41
100 m N of Djupsundsdelarna (SKB 68)	Storön	3	−0.17	Gällsboträsket (SKB 71)	Bärstakärret N	4	0.04
100 m N of Djupsundsdelarna (SKB 68)	Öjaren	5	−0.58	Gällsboträsket (SKB 71)	Bärstakärret S	6	−0.17
100 m N of Djupsundsdelarna (SKB 68)	Trösken Matyxsjön N	3	−0.83	Gällsboträsket (SKB 71)	Edskärret	4	0.99**
100 m N of Djupsundsdelarna (SKB 68)	300 m SW of Bålgrundsfjärden (SKB 203a)	11	−0.63*	Gällsboträsket (SKB 71)	Grundsjön	3	1***
100 m N of Djupsundsdelarna (SKB 68)	Bolhamnsänden	8	0.85**	Gällsboträsket (SKB 71)	300 m SW of Bålgrundsfjärden (SKB 203a)	7	−0.54
100 m N of Djupsundsdelarna (SKB 68)	Bollen	10	−0.22	Gällsboträsket (SKB 71)	Bolhamnsänden	6	0.38
100 m N of Djupsundsdelarna (SKB 68)	Gubbenshöllsjön S	8	−0.47	Gällsboträsket (SKB 71)	Bollen	6	1***
100 m N of Djupsundsdelarna (SKB 68)	Gäddalen	7	0.17	Gällsboträsket (SKB 71)	Igelsjön Norrtälje	7	0.38
100 m N of Djupsundsdelarna (SKB 68)	Igelsjön Norrtälje	8	−0.62.	Gällsboträsket (SKB 71)	Lerorna (SKB 202)	6	−0.88*
100 m N of Djupsundsdelarna (SKB 68)	Källfjärden Tångsåmurarna E	8	0.25	Gällsboträsket (SKB 71)	Maran	6	0.08
100 m N of Djupsundsdelarna (SKB 68)	Lerorna (SKB 202)	9	0.06	Gällsboträsket (SKB 71)	Mörtsjön	6	0.6
100 m N of Djupsundsdelarna (SKB 68)	Maran	10	−0.73*	Kungsträsket (SKB 18)	Ambricka E	6	0.56
100 m N of Djupsundsdelarna (SKB 68)	Marörspussarna S (SKB 201)	10	0.89***	Kungsträsket (SKB 18)	Bladkärret S	4	0.53

Side 1				Side 2			
SKB	**Not SKB**	**N**	**Est.**	**SKB**	**Not SKB**	**N**	**Est.**
100 m N of Djupsundsdelarna (SKB 68)	Mörtsjön	9	0.52	Kungsträsket (SKB 18)	Igelsjön Nyköping	4	0.76
100 m N of Djupsundsdelarna (SKB 68)	NW of Dalarna	7	0.52	Kungsträsket (SKB 18)	Stenfjärden	3	−0.28
100 m N of Djupsundsdelarna (SKB 68)	Olsbäcken	8	0.48	Kungsträsket (SKB 18)	Storön	3	−0.22
100 m N of Djupsundsdelarna (SKB 68)	Romsmaren S	8	−0.03	Kungsträsket (SKB 18)	Öjaren	5	−0.69
100 m N of Djupsundsdelarna (SKB 68)	Sandemar N	3	−0.73	Kungsträsket (SKB 18)	Trösken Matyxsjön N	3	−0.24
100 m N of Djupsundsdelarna (SKB 68)	Skrevträsket (SKB 204)	9	−0.58	Kungsträsket (SKB 18)	300 m SW of Bålgrundsfjärden (SKB 203a)	11	−0.57.
100 m N of Djupsundsdelarna (SKB 68)	700 m SSE Bålgrundsfjärden	8	0.28	Kungsträsket (SKB 18)	Bolhamnsänden	8	0.96***
100 m N of Djupsundsdelarna (SKB 68)	Bärstakärret N	8	0.44	Kungsträsket (SKB 18)	Bollen	10	0.05
100 m N of Djupsundsdelarna (SKB 68)	Bärstakärret S	9	0.57	Kungsträsket (SKB 18)	Gubbenshöllsjön S	8	−0.49
100 m N of Djupsundsdelarna (SKB 68)	Edskärret	9	0.06	Kungsträsket (SKB 18)	Gäddalen	7	0
100 m N of Djupsundsdelarna (SKB 68)	Sjösakärret	4	0.77	Kungsträsket (SKB 18)	Igelsjön Norrtälje	8	−0.73*
100 m N of Djupsundsdelarna (SKB 68)	Trösken Viälvsbron W	7	0.88**	Kungsträsket (SKB 18)	Källfjärden Tångsåmurarna E	8	0.06
100 m N of Djupsundsdelarna (SKB 68)	Gustavmyrarna	3	−0.99.	Kungsträsket (SKB 18)	Lerorna (SKB 202)	9	−0.26
100 m N of Djupsundsdelarna (SKB 68)	Ambricka N	5	−0.41	Kungsträsket (SKB 18)	Maran	10	−0.62.
250 m SW of Tjärnpussen (SKB 9)	Gustavmyrarna	4	−0.28	Kungsträsket (SKB 18)	Marörspussarna S (SKB 201)	10	0.77**
250 m SW of Tjärnpussen (SKB 9)	Trösken Viälven S	3	0.08	Kungsträsket (SKB 18)	Mörtsjön	9	0.25
250 m SW of Tjärnpussen (SKB 9)	Ambricka N	6	−0.33	Kungsträsket (SKB 18)	NW of Dalarna	7	0.63
250 m SW of Tjärnpussen (SKB 9)	Ambricka E	6	−0.36	Kungsträsket (SKB 18)	Olsbäcken	8	0.24
250 m SW of Tjärnpussen (SKB 9)	Bladkärret S	4	−0.84	Kungsträsket (SKB 18)	Romsmaren S	8	−0.32
250 m SW of Tjärnpussen (SKB 9)	Igelsjön Nyköping	4	−0.66	Kungsträsket (SKB 18)	Sandemar N	3	−1.
250 m SW of Tjärnpussen (SKB 9)	Stenfjärden	3	0.14	Kungsträsket (SKB 18)	Skrevträsket (SKB 204)	9	−0.47
250 m SW of Tjärnpussen (SKB 9)	Storön	3	−0.02	Kungsträsket (SKB 18)	700 m SSE Bålgrundsfjärden	8	0.56
250 m SW of Tjärnpussen (SKB 9)	Öjaren	5	0.99***	Kungsträsket (SKB 18)	Bärstakärret N	8	0.27
250 m SW of Tjärnpussen (SKB 9)	300 m SW of Bålgrundsfjärden (SKB 203a)	13	0.13	Kungsträsket (SKB 18)	Bärstakärret S	9	0.34
250 m SW of Tjärnpussen (SKB 9)	Bolhamnsänden	10	0.15	Kungsträsket (SKB 18)	Edskärret	9	0.05
250 m SW of Tjärnpussen (SKB 9)	Bollen	11	0.5	Kungsträsket (SKB 18)	Sjösakärret	4	0.53
250 m SW of Tjärnpussen (SKB 9)	Gubbenshöllsjön S	10	0.71*	Kungsträsket (SKB 18)	Trösken Viälvsbron W	7	0.7.
250 m SW of Tjärnpussen (SKB 9)	Gunnarsmaren	7	1***	Kungsträsket (SKB 18)	Gustavmyrarna	3	−1**
250 m SW of Tjärnpussen (SKB 9)	Gäddalen	9	−0.12	Kungsträsket (SKB 18)	Ambricka N	5	−0.47
250 m SW of Tjärnpussen (SKB 9)	Igelsjön Norrtälje	10	0.45	SW of Apelviken (SKB 23)	Ambricka N	6	0.05
250 m SW of Tjärnpussen (SKB 9)	Källfjärden Tångsåmurarna E	10	0.77**	SW of Apelviken (SKB 23)	Ambricka E	6	0.1
250 m SW of Tjärnpussen (SKB 9)	Lerorna (SKB 202)	11	0.32	SW of Apelviken (SKB 23)	Bladkärret S	4	0.51
250 m SW of Tjärnpussen (SKB 9)	Maran	11	0.83**	SW of Apelviken (SKB 23)	Igelsjön Nyköping	4	0.85
250 m SW of Tjärnpussen (SKB 9)	Marörspussarna S (SKB 201)	12	−0.36	SW of Apelviken (SKB 23)	Stenfjärden	3	0.89

Side 1				Side 2			
SKB	Not SKB	N	Est.	SKB	Not SKB	N	Est.
250 m SW of Tjärnpussen (SKB 9)	Mörtsjön	11	0.37	SW of Apelviken (SKB 23)	Storön	3	0.83
250 m SW of Tjärnpussen (SKB 9)	NW of Dalarna	9	0.45	SW of Apelviken (SKB 23)	Öjaren	5	−0.2
250 m SW of Tjärnpussen (SKB 9)	Olsbäcken	10	0.77**	SW of Apelviken (SKB 23)	Trösken Matyxsjön N	3	−0.33
250 m SW of Tjärnpussen (SKB 9)	Romsmaren S	10	0.72*	SW of Apelviken (SKB 23)	300 m SW of Bålgrundsfjärden (SKB 203a)	12	−0.07
250 m SW of Tjärnpussen (SKB 9)	Sandemar N	3	0.84	SW of Apelviken (SKB 23)	Bolhamnsänden	9	0.46
250 m SW of Tjärnpussen (SKB 9)	Skrevträsket (SKB 204)	11	−0.06	SW of Apelviken (SKB 23)	Bollen	11	−0.43
250 m SW of Tjärnpussen (SKB 9)	Trösken Grinduga	3	0.91	SW of Apelviken (SKB 23)	Gubbenshöllsjön S	9	−0.43
250 m SW of Tjärnpussen (SKB 9)	700 m SSE Bålgrundsfjärden	10	−0.55	SW of Apelviken (SKB 23)	Gäddalen	8	0.2
250 m SW of Tjärnpussen (SKB 9)	Bärstakärret N	9	−0.18	SW of Apelviken (SKB 23)	Igelsjön Norrtälje	9	−0.7*
250 m SW of Tjärnpussen (SKB 9)	Bärstakärret S	11	−0.35	SW of Apelviken (SKB 23)	Källfjärden Tångsåmurarna E	9	−0.5
250 m SW of Tjärnpussen (SKB 9)	Edskärret	10	0.11	SW of Apelviken (SKB 23)	Lerorna (SKB 202)	10	0.1
250 m SW of Tjärnpussen (SKB 9)	Sjösakärret	4	−0.25	SW of Apelviken (SKB 23)	Maran	10	−0.53
250 m SW of Tjärnpussen (SKB 9)	Trösken Viälvsbron W	8	0.46	SW of Apelviken (SKB 23)	Marörspussarna S (SKB 201)	11	0.34
350 m SE of Tjärnpussen (SKB 6a)	Gustavmyrarna	4	−0.59	SW of Apelviken (SKB 23)	Mörtsjön	10	−0.49
350 m SE of Tjärnpussen (SKB 6a)	Trösken Viälven S	3	−0.31	SW of Apelviken (SKB 23)	NW of Dalarna	8	0.49
350 m SE of Tjärnpussen (SKB 6a)	Ambricka N	6	−0.03	SW of Apelviken (SKB 23)	Olsbäcken	9	−0.29
350 m SE of Tjärnpussen (SKB 6a)	Ambricka E	6	0.93**	SW of Apelviken (SKB 23)	Romsmaren S	9	−0.46
350 m SE of Tjärnpussen (SKB 6a)	Bladkärret S	4	0.38	SW of Apelviken (SKB 23)	Sandemar N	3	0.38
350 m SE of Tjärnpussen (SKB 6a)	Igelsjön Nyköping	4	0.4	SW of Apelviken (SKB 23)	Skrevträsket (SKB 204)	10	0.04
350 m SE of Tjärnpussen (SKB 6a)	Stenfjärden	3	−0.41	SW of Apelviken (SKB 23)	700 m SSE Bålgrundsfjärden	9	0.73*
350 m SE of Tjärnpussen (SKB 6a)	Storön	3	−0.15	SW of Apelviken (SKB 23)	Bärstakärret N	8	−0.05
350 m SE of Tjärnpussen (SKB 6a)	Öjaren	5	−0.92*	SW of Apelviken (SKB 23)	Bärstakärret S	10	0.13
350 m SE of Tjärnpussen (SKB 6a)	Trösken Matyxsjön N	3	−0.13	SW of Apelviken (SKB 23)	Edskärret	9	−0.23
350 m SE of Tjärnpussen (SKB 6a)	300 m SW of Bålgrundsfjärden (SKB 203a)	13	−0.35	SW of Apelviken (SKB 23)	Sjösakärret	4	0.58
350 m SE of Tjärnpussen (SKB 6a)	Bolhamnsänden	10	0.63.	SW of Apelviken (SKB 23)	Trösken Viälvsbron W	7	0.51
350 m SE of Tjärnpussen (SKB 6a)	Bollen	11	−0.13	SW of Apelviken (SKB 23)	Gustavmyrarna	3	−0.69
350 m SE of Tjärnpussen (SKB 6a)	Gubbenshöllsjön S	10	−0.47	Tjärnpussen (SKB 8b)	Gustavmyrarna	4	−0.38
350 m SE of Tjärnpussen (SKB 6a)	Gunnarsmaren	7	−0.09	Tjärnpussen (SKB 8b)	Trösken Viälven S	3	0.02
350 m SE of Tjärnpussen (SKB 6a)	Gäddalen	9	−0.31	Tjärnpussen (SKB 8b)	Ambricka N	6	−0.39
350 m SE of Tjärnpussen (SKB 6a)	Igelsjön Norrtälje	10	−0.8**	Tjärnpussen (SKB 8b)	Ambricka E	6	0.87*
350 m SE of Tjärnpussen (SKB 6a)	Källfjärden Tångsåmurarna E	10	−0.38	Tjärnpussen (SKB 8b)	Bladkärret S	4	−0.55
350 m SE of Tjärnpussen (SKB 6a)	Lerorna (SKB 202)	11	−0.41	Tjärnpussen (SKB 8b)	Igelsjön Nyköping	4	0.62
350 m SE of Tjärnpussen (SKB 6a)	Maran	11	−0.3	Tjärnpussen (SKB 8b)	Stenfjärden	3	−0.62
350 m SE of Tjärnpussen (SKB 6a)	Marörspussarna S (SKB 201)	12	0.28	Tjärnpussen (SKB 8b)	Storön	3	−0.48

Side 1				Side 2			
SKB	Not SKB	N	Est.	SKB	Not SKB	N	Est.
350 m SE of Tjärnpussen (SKB 6a)	Mörtsjön	11	−0.27	Tjärnpussen (SKB 8b)	Öjaren	5	−0.89*
350 m SE of Tjärnpussen (SKB 6a)	NW of Dalarna	9	0.18	Tjärnpussen (SKB 8b)	Trösken Matyxsjön N	3	0.4
350 m SE of Tjärnpussen (SKB 6a)	Olsbäcken	10	−0.36	Tjärnpussen (SKB 8b)	300 m SW of Bålgrundsfjärden (SKB 203a)	13	−0.15
350 m SE of Tjärnpussen (SKB 6a)	Romsmaren S	10	−0.23	Tjärnpussen (SKB 8b)	Bolhamnsänden	10	0.14
350 m SE of Tjärnpussen (SKB 6a)	Sandemar N	3	−0.92	Tjärnpussen (SKB 8b)	Bollen	11	0.62*
350 m SE of Tjärnpussen (SKB 6a)	Skrevträsket (SKB 204)	11	−0.13	Tjärnpussen (SKB 8b)	Gubbenshöllsjön S	10	0.68*
350 m SE of Tjärnpussen (SKB 6a)	Trösken Grinduga	3	−0.4	Tjärnpussen (SKB 8b)	Gunnarsmaren	7	1***
350 m SE of Tjärnpussen (SKB 6a)	700 m SSE Bålgrundsfjärden	10	0.79**	Tjärnpussen (SKB 8b)	Gäddalen	9	−0.34
350 m SE of Tjärnpussen (SKB 6a)	Bärstakärret N	9	−0.1	Tjärnpussen (SKB 8b)	Igelsjön Norrtälje	10	0.2
350 m SE of Tjärnpussen (SKB 6a)	Bärstakärret S	11	0.15	Tjärnpussen (SKB 8b)	Källfjärden Tångsåmurarna E	10	0.45
350 m SE of Tjärnpussen (SKB 6a)	Edskärret	10	−0.15	Tjärnpussen (SKB 8b)	Lerorna (SKB 202)	11	0.32
350 m SE of Tjärnpussen (SKB 6a)	Sjösakärret	4	0.4	Tjärnpussen (SKB 8b)	Maran	11	0.82**
350 m SE of Tjärnpussen (SKB 6a)	Trösken Viälvsbron W	8	0.31	Tjärnpussen (SKB 8b)	Marörspussarna S (SKB 201)	12	−0.24
500 m SE of Tjärnpussen (SKB 7)	Ambricka N	6	−0.48	Tjärnpussen (SKB 8b)	Mörtsjön	11	−0.05
500 m SE of Tjärnpussen (SKB 7)	Ambricka E	6	−0.41	Tjärnpussen (SKB 8b)	NW of Dalarna	9	0.89**
500 m SE of Tjärnpussen (SKB 7)	Bladkärret S	4	−0.51	Tjärnpussen (SKB 8b)	Olsbäcken	10	0.28
500 m SE of Tjärnpussen (SKB 7)	Igelsjön Nyköping	4	0.45	Tjärnpussen (SKB 8b)	Romsmaren S	10	0.55
500 m SE of Tjärnpussen (SKB 7)	Stenfjärden	3	−0.91	Tjärnpussen (SKB 8b)	Sandemar N	3	−0.94
500 m SE of Tjärnpussen (SKB 7)	Storön	3	−0.38	Tjärnpussen (SKB 8b)	Skrevträsket (SKB 204)	11	−0.09
500 m SE of Tjärnpussen (SKB 7)	Öjaren	5	−0.32	Tjärnpussen (SKB 8b)	Trösken Grinduga	3	0.9
500 m SE of Tjärnpussen (SKB 7)	Trösken Matyxsjön N	3	−0.79	Tjärnpussen (SKB 8b)	700 m SSE Bålgrundsfjärden	10	−0.38
500 m SE of Tjärnpussen (SKB 7)	300 m SW of Bålgrundsfjärden (SKB 203a)	12	−0.15	Tjärnpussen (SKB 8b)	Bärstakärret N	9	−0.14
500 m SE of Tjärnpussen (SKB 7)	Bolhamnsänden	9	0.57	Tjärnpussen (SKB 8b)	Bärstakärret S	11	−0.18
500 m SE of Tjärnpussen (SKB 7)	Bollen	11	−0.39	Tjärnpussen (SKB 8b)	Edskärret	10	0.1
500 m SE of Tjärnpussen (SKB 7)	Gubbenshöllsjön S	9	−0.34	Tjärnpussen (SKB 8b)	Sjösakärret	4	0.43
500 m SE of Tjärnpussen (SKB 7)	Gäddalen	8	0.2	Tjärnpussen (SKB 8b)	Trösken Viälvsbron W	8	0.54
500 m SE of Tjärnpussen (SKB 7)	Igelsjön Norrtälje	9	−0.27	Vambörsfjärden (SKB 49)	Ambricka E	6	0.52
500 m SE of Tjärnpussen (SKB 7)	Källfjärden Tångsåmurarna E	9	0.03	Vambörsfjärden (SKB 49)	Bladkärret S	4	−0.02
500 m SE of Tjärnpussen (SKB 7)	Lerorna (SKB 202)	10	−0.11	Vambörsfjärden (SKB 49)	Igelsjön Nyköping	4	0.78
500 m SE of Tjärnpussen (SKB 7)	Maran	10	−0.72*	Vambörsfjärden (SKB 49)	Stenfjärden	3	0.09
500 m SE of Tjärnpussen (SKB 7)	Marörspussarna S (SKB 201)	11	0.62*	Vambörsfjärden (SKB 49)	Storön	3	−0.4
500 m SE of Tjärnpussen (SKB 7)	Mörtsjön	10	−0.1	Vambörsfjärden (SKB 49)	Öjaren	5	−0.46
500 m SE of Tjärnpussen (SKB 7)	NW of Dalarna	8	0.61	Vambörsfjärden (SKB 49)	Trösken Matyxsjön N	3	−0.01
500 m SE of Tjärnpussen (SKB 7)	Olsbäcken	9	0.35	Vambörsfjärden (SKB 49)	300 m SW of Bålgrundsfjärden (SKB 203a)	12	−0.58*

Side 1				Side 2			
SKB	**Not SKB**	**N**	**Est.**	**SKB**	**Not SKB**	**N**	**Est.**
500 m SE of Tjärnpussen (SKB 7)	Romsmaren S	9	0.04	Vambörsfjärden (SKB 49)	Bolhamnsänden	9	0.84**
500 m SE of Tjärnpussen (SKB 7)	Sandemar N	3	−0.42	Vambörsfjärden (SKB 49)	Bollen	11	−0.02
500 m SE of Tjärnpussen (SKB 7)	Skrevträsket (SKB 204)	10	−0.57	Vambörsfjärden (SKB 49)	Gubbenshöllsjön S	9	−0.45
500 m SE of Tjärnpussen (SKB 7)	700 m SSE Bålgrundsfjärden	9	0.11	Vambörsfjärden (SKB 49)	Gäddalen	8	0.14
500 m SE of Tjärnpussen (SKB 7)	Bärstakärret N	8	0.49	Vambörsfjärden (SKB 49)	Igelsjön Norrtälje	9	−0.46
500 m SE of Tjärnpussen (SKB 7)	Bärstakärret S	10	0.31	Vambörsfjärden (SKB 49)	Källfjärden Tångsåmurarna E	9	−0.02
500 m SE of Tjärnpussen (SKB 7)	Edskärret	9	0.23	Vambörsfjärden (SKB 49)	Lerorna (SKB 202)	10	−0.29
500 m SE of Tjärnpussen (SKB 7)	Sjösakärret	4	0.9	Vambörsfjärden (SKB 49)	Maran	10	−0.46
500 m SE of Tjärnpussen (SKB 7)	Trösken Viälvsbron W	7	0.67	Vambörsfjärden (SKB 49)	Marörspussarna S (SKB 201)	11	0.87***
500 m SE of Tjärnpussen (SKB 7)	Gustavmyrarna	3	−0.98	Vambörsfjärden (SKB 49)	Mörtsjön	10	−0.05
800 m SE of Tjärnpussen (SKB 16)	Ambricka N	6	0.68	Vambörsfjärden (SKB 49)	NW of Dalarna	8	0.79*
800 m SE of Tjärnpussen (SKB 16)	Ambricka E	6	0.15	Vambörsfjärden (SKB 49)	Olsbäcken	9	0.01
800 m SE of Tjärnpussen (SKB 16)	Bladkärret S	4	0.58	Vambörsfjärden (SKB 49)	Romsmaren S	9	−0.33
800 m SE of Tjärnpussen (SKB 16)	Igelsjön Nyköping	4	0.54	Vambörsfjärden (SKB 49)	Sandemar N	3	−1*
800 m SE of Tjärnpussen (SKB 16)	Stenfjärden	3	0.97	Vambörsfjärden (SKB 49)	Skrevträsket (SKB 204)	10	−0.47
800 m SE of Tjärnpussen (SKB 16)	Storön	3	0.87	Vambörsfjärden (SKB 49)	700 m SSE Bålgrundsfjärden	9	0.38
800 m SE of Tjärnpussen (SKB 16)	Öjaren	5	−0.28	Vambörsfjärden (SKB 49)	Bärstakärret N	8	0.29
800 m SE of Tjärnpussen (SKB 16)	Trösken Matyxsjön N	3	−0.57	Vambörsfjärden (SKB 49)	Bärstakärret S	10	0.34
800 m SE of Tjärnpussen (SKB 16)	300 m SW of Bålgrundsfjärden (SKB 203a)	12	0.23	Vambörsfjärden (SKB 49)	Edskärret	9	0.08
800 m SE of Tjärnpussen (SKB 16)	Bolhamnsänden	9	0.16	Vambörsfjärden (SKB 49)	Sjösakärret	4	0.59
800 m SE of Tjärnpussen (SKB 16)	Bollen	11	−0.45	Vambörsfjärden (SKB 49)	Trösken Viälvsbron W	7	0.61
800 m SE of Tjärnpussen (SKB 16)	Gubbenshöllsjön S	9	−0.51	Vambörsfjärden (SKB 49)	Gustavmyrarna	3	−0.58
800 m SE of Tjärnpussen (SKB 16)	Gäddalen	8	0.38	Vambörsfjärden (SKB 49)	Ambricka N	6	−0.49

A6 Model summaries

The tables show all model parameters (mean, 95 % CI), the standard deviation, the effective number of samples from the chains (n_eff) and the potential scale reduction factor (Rhat4). The parameter sigma_year_year_i describes the variability between Year_to_year and the parameter sigma describes the variability between the group categories. The model formula is shown to the right.

Model 1

Variable	Parameter	mean	sd	2.5%	97.5%	n_eff	Rhat4
Outside	a[1]	-8.51	11.89	-31.67	14.37	820.7	1.01
Forsmark	a[2]	8.75	12.67	-15.24	34.02	847.7	1.01
2007_2008	b[1]	-73.69	16.74	-108.34	-41.44	887.9	1.00
2008_2009	b[2]	-95.20	21.32	-137.20	-55.04	799.0	1.00
2009_2010	b[3]	-23.34	25.49	-72.84	25.10	928.0	1.00
2010_2011	b[4]	13.57	21.04	-26.47	53.92	850.7	1.00
2011_2012	b[5]	29.45	15.68	-2.10	60.39	889.7	1.00
2012_2013	b[6]	-45.81	16.90	-78.85	-13.70	890.3	1.00
2013_2014	b[7]	26.52	15.38	-4.34	55.04	856.0	1.00
2014_2015	b[8]	42.23	14.29	11.72	69.81	984.7	1.00
2015_2016	b[9]	23.76	14.93	-4.60	52.58	823.7	1.01
2016_2017	b[10]	-18.12	14.36	-45.80	10.31	861.1	1.00
2017_2018	b[11]	49.85	14.70	20.13	77.49	824.4	1.00
2018_2019	b[12]	53.58	15.02	22.49	82.70	956.5	1.00
2019_2020	b[13]	-25.97	14.06	-52.61	1.62	877.1	1.00
2020_2021	b[14]	-37.12	15.77	-67.94	-6.74	966.2	1.00
2021_2022	b[15]	56.71	15.41	26.81	87.61	958.9	1.00
2022_2023	b[16]	17.31	15.12	-12.87	46.00	853.4	1.00
	c_log_Dist_i	30.11	3.25	23.51	36.36	980.6	1.00
	mu_year_year_i	-0.06	1.55	-3.18	3.02	962.4	1.00
	sigma_year_year_i	43.66	4.42	33.42	49.68	880.9	1.00
	sigma	49.97	0.03	49.90	50.00	914.0	1.00

$$Difference_i \sim Normal(\mu_i, \sigma)$$

$$\mu_i = \alpha_{Group\_1[i]} + \beta_{Year\_to\_Year[i]} + \gamma_{Distance[i]}$$

$$\alpha_{Group\_1[j]} \sim Normal(0, 150), \text{ for } j = 1..2$$

$$\beta_{Year\_to\_Year\ [j]} \sim Normal(\bar{\beta}, \sigma\beta), \text{ for } j = 1...16$$

$$\gamma_{Distance} \sim Normal(0, 150)$$

$$\bar{\beta} \sim Normal(0, 1.5)$$

$$\sigma\beta \sim Uniform(0,50)$$

$$\sigma \sim Uniform(0,50)$$

Model 2

Variable	Parameter	mean	sd	2.5%	97.5%	n_eff	Rhat4
Outside[unaff]	a[1]	-8.61	12.41	-34.39	14.90	813.6	1
Forsmark[unaff]	a[2]	21.26	14.79	-6.85	50.07	824.9	1
Forsmark[affect]	a[3]	3.52	13.25	-22.32	30.85	858.5	1
2007_2008	b[1]	-73.41	16.95	-105.18	-41.81	912.1	1
2008_2009	b[2]	-96.31	23.11	-143.38	-52.50	980.4	1
2009_2010	b[3]	-24.02	25.57	-71.70	26.39	932.6	1
2010_2011	b[4]	14.41	21.52	-27.91	55.28	944.1	1
2011_2012	b[5]	30.29	15.85	1.12	61.62	837.9	1
2012_2013	b[6]	-45.19	17.08	-78.35	-12.48	791.3	1
2013_2014	b[7]	26.46	15.95	-5.63	57.65	837.4	1
2014_2015	b[8]	41.82	14.28	12.30	71.96	894.1	1
2015_2016	b[9]	24.01	14.70	-3.82	53.82	870.9	1
2016_2017	b[10]	-18.19	14.53	-46.44	10.17	834.1	1
2017_2018	b[11]	50.02	15.06	21.44	80.26	943.4	1
2018_2019	b[12]	53.53	15.25	23.23	82.96	831.1	1
2019_2020	b[13]	-25.62	14.53	-54.52	3.54	870.5	1
2020_2021	b[14]	-36.72	15.95	-68.41	-6.43	841.7	1
2021_2022	b[15]	56.86	16.02	25.77	87.03	917.7	1
2022_2023	b[16]	16.18	15.50	-13.15	48.43	860.0	1
	c_log_Dist_i	29.98	3.22	23.64	36.27	1,066.8	1
	mu_year_year_i	0.01	1.51	-2.77	2.89	970.2	1
	sigma_year_year_i	43.78	4.45	34.21	49.73	1,047.0	1
	sigma	49.97	0.03	49.90	50.00	935.1	1

$$Difference_i \sim Normal(\mu_i, \sigma)$$

$$\mu_i = \alpha_{Group\_2[i]} + \beta_{Year\_to\_Year[i]} + \gamma_{Distance[i]}$$

$$\alpha_{Group\_2[j]} \sim Normal(0, 150), \text{ for } j = 1..3$$

$$\beta_{Year\_to\_Year[j]} \sim Normal(\bar{\beta}, \sigma\beta), \text{ for } j = 1...16$$

$$\gamma_{Distance} \sim Normal(0, 150)$$

$$\bar{\beta} \sim Normal(0, 1.5)$$

$$\sigma\beta \sim Uniform(0,50)$$

$$\sigma \sim Uniform(0,50)$$

Model 3

Variable	Parameter	mean	sd	2.5%	97.5%	n_eff	Rhat4
Forsmark_2011_2012	ab[1]	-56.06	27.95	-109.76	-1.22	1,031.9	1.00
Outside_2011_2012	ab[2]	42.70	13.08	18.65	70.87	985.3	1.00
Outside_2012_2013	ab[3]	-77.76	14.52	-106.43	-50.30	937.7	1.00
Forsmark_2012_2013	ab[4]	38.82	27.40	-14.66	93.53	949.9	1.00
Forsmark_2013_2014	ab[5]	74.88	19.66	37.12	114.03	825.1	1.00
Outside_2013_2014	ab[6]	1.35	13.97	-25.69	27.59	756.5	1.00
Forsmark_2014_2015	ab[7]	44.27	16.75	12.65	78.51	933.7	1.01
Outside_2014_2015	ab[8]	38.13	11.42	15.61	60.16	1,054.5	1.00
Forsmark_2015_2016	ab[9]	60.62	16.13	29.26	92.49	897.8	1.00
Outside_2015_2016	ab[10]	2.07	11.71	-20.23	24.98	939.5	1.00
Forsmark_2016_2017	ab[11]	-14.29	15.00	-44.53	14.76	854.1	1.00
Outside_2016_2017	ab[12]	-24.76	11.65	-47.84	-1.89	966.2	1.01
Forsmark_2017_2018	ab[13]	109.97	15.73	78.23	140.18	915.4	1.00
Outside_2017_2018	ab[14]	7.52	12.43	-17.73	32.32	870.7	1.00
Forsmark_2018_2019	ab[15]	52.95	16.41	20.01	83.66	976.8	1.00
Outside_2018_2019	ab[16]	54.31	12.68	29.59	77.75	950.7	1.00
Forsmark_2019_2020	ab[17]	-51.90	15.52	-82.56	-20.82	1,048.4	1.00
Outside_2019_2020	ab[18]	-15.89	11.15	-37.02	6.10	1,019.0	1.00
Forsmark_2020_2021	ab[19]	-51.61	15.56	-83.22	-21.13	1,006.3	1.00
Outside_2020_2021	ab[20]	-20.90	17.83	-55.35	14.28	903.2	1.00
Forsmark_2021_2022	ab[21]	36.25	15.92	6.76	67.86	1,041.4	1.00
Outside_2021_2022	ab[22]	91.96	18.13	57.35	125.97	986.9	1.00
Forsmark_2022_2023	ab[23]	13.38	14.26	-15.34	41.91	910.5	1.00
Outside_2022_2023	ab[24]	24.90	16.35	-7.79	57.14	1,000.0	1.00
	c_log_Dist_i	27.48	3.52	20.66	34.40	956.7	1.00
	sigma	49.96	0.04	49.86	50.00	1,018.1	1.00

$Difference_i \sim Normal(\mu_i, \sigma)$

$\mu_i = \alpha_{Group\_1\_year\_year[i]} + \gamma_{Distance[i]}$

$\alpha_{Group\_1\_year\_year\ [j]} \sim Normal(0, 100)$, for j = 1..24

$\gamma_{Distance} \sim Normal(0, 150)$

$\sigma \sim Uniform(0,50)$

Model 4

Variable	Parameter	mean	sd	2.5%	97.5%	n_eff	Rhat4
Outside[unaff]_2012_2013	ab[1]	-79.60	14.91	-109.31	-51.51	988.5	1.00
Forsmark[affect]_2012_2013	ab[2]	54.53	35.38	-13.57	124.76	936.2	1.00
Forsmark[unaff]_2012_2013	ab[3]	15.89	47.78	-73.62	108.18	1,017.8	1.00
Forsmark[unaff]_2013_2014	ab[4]	96.81	35.30	27.10	163.89	976.8	1.00
Forsmark[affect]_2013_2014	ab[5]	69.52	25.76	18.98	122.98	1,055.4	1.00
Outside[unaff]_2013_2014	ab[6]	1.05	13.86	-25.18	28.90	929.3	1.00
Forsmark[unaff]_2014_2015	ab[7]	54.00	28.79	-1.01	109.68	982.5	1.00
Forsmark[affect]_2014_2015	ab[8]	43.54	20.17	4.95	82.92	962.4	1.00
Outside[unaff]_2014_2015	ab[9]	38.13	11.28	16.81	61.62	967.6	1.00
Forsmark[unaff]_2015_2016	ab[10]	101.04	29.04	43.29	159.07	805.0	1.00
Forsmark[affect]_2015_2016	ab[11]	41.85	20.02	2.91	83.64	1,130.6	1.00
Outside[unaff]_2015_2016	ab[12]	2.00	11.58	-20.15	25.83	921.8	1.00
Forsmark[affect]_2016_2017	ab[13]	-35.91	17.35	-70.74	-1.89	951.1	1.01
Forsmark[unaff]_2016_2017	ab[14]	47.05	28.70	-12.60	100.70	709.8	1.00
Outside[unaff]_2016_2017	ab[15]	-26.52	12.01	-50.21	-2.90	720.8	1.00
Forsmark[affect]_2017_2018	ab[16]	103.51	18.39	67.82	138.90	913.2	1.00
Forsmark[unaff]_2017_2018	ab[17]	137.38	28.44	80.65	193.94	948.9	1.00
Outside[unaff]_2017_2018	ab[18]	7.16	12.80	-18.67	33.18	995.9	1.00
Forsmark[affect]_2018_2019	ab[19]	43.19	18.56	5.99	79.29	984.1	1.00
Forsmark[unaff]_2018_2019	ab[20]	79.64	28.69	26.73	136.61	949.5	1.00
Outside[unaff]_2018_2019	ab[21]	54.33	13.28	28.49	78.78	1,095.9	1.00
Forsmark[affect]_2019_2020	ab[22]	-53.34	18.85	-90.66	-17.13	1,093.1	1.00
Forsmark[unaff]_2019_2020	ab[23]	-47.61	28.34	-105.54	5.38	1,044.9	1.00
Outside[unaff]_2019_2020	ab[24]	-17.42	11.43	-39.91	4.68	975.2	1.00
Forsmark[affect]_2020_2021	ab[25]	14.02	18.83	-23.49	48.97	1,053.8	1.00
Forsmark[unaff]_2020_2021	ab[26]	-198.45	28.73	-254.28	-144.28	942.0	1.00
Outside[unaff]_2020_2021	ab[27]	-22.47	17.07	-55.02	12.10	1,021.2	1.00
Forsmark[affect]_2021_2022	ab[28]	7.27	18.75	-30.16	43.09	964.8	1.00
Forsmark[unaff]_2021_2022	ab[29]	107.16	29.32	51.77	167.28	1,043.9	1.00
Outside[unaff]_2021_2022	ab[30]	91.35	18.04	56.87	126.94	982.6	1.00
Forsmark[affect]_2022_2023	ab[31]	10.10	17.58	-22.95	44.62	967.6	1.00
Forsmark[unaff]_2022_2023	ab[32]	26.54	24.65	-21.58	76.54	1,100.5	1.00
Outside[unaff]_2022_2023	ab[33]	24.77	17.15	-8.25	60.42	980.9	1.00
	c_log_Dist_i	29.26	3.77	21.63	36.50	1,001.1	1.00
	sigma	49.95	0.05	49.82	50.00	1,003.8	1.00

$Difference_i \sim Normal(\mu_i, \sigma)$

$\mu_i = \alpha_{Group\_2\_year\_year[i]} + \gamma_{Distance[i]}$

$\alpha_{Group\_2\_year\_year\ [j]} \sim Normal(0, 200)$, for j = 1..33

$\gamma_{Distance} \sim Normal(0, 150)$

$\sigma \sim Uniform(0,50)$

A7 Testing Log Distance

Comparing models with the information criterions PSIS and WAIC showed that including both, the group and the distance, results in highest model performance (highest R^2, lowest PSIS/WAIC).

Model	Fixed effect 1	Fixed effect 2	Random effects	RMSE	R^2	PSIS	WAIC
1	Group 1	Log Distance	Year to Year	133	0.132	5245	5260
5	Group 1		Year to Year	136	0.099	5311	5318
6		Log Distance	Year to Year	133	0.130	5247	5262

A8 Table of all pair-wise comparisons for Model 3 and 4

Categories and pair-wise comparisons between categories. Shown are posterior mean (95 % CI) and probability of the posterior being larger than zero or larger than the compared category.

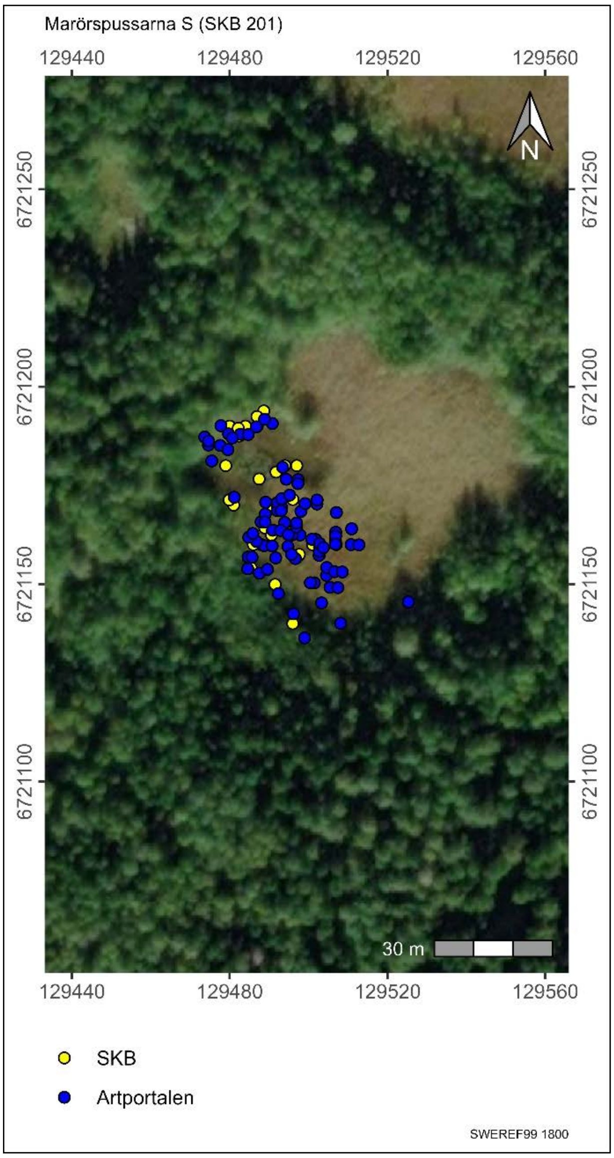
Group	Model	Year to year	Group/Difference	Comparison	Mean	2.5 %	97.5 %	Prob.[%]
1	3	2022_2023	Outside	P[Outside > 0]	24.90	−4.00	60.18	95
1	3	2022_2023	|Outside-Forsmark|	P[Outside > Forsmark]	11.52	−30.31	57.43	70
1	3	2022_2023	Forsmark	P[Forsmark > 0]	13.38	−14.44	42.16	82
1	3	2021_2022	Outside	P[Outside > 0]	91.96	57.34	125.97	100
1	3	2021_2022	|Outside-Forsmark|	P[Outside > Forsmark]	55.71	12.28	106.85	99
1	3	2021_2022	Forsmark	P[Forsmark > 0]	36.25	6.28	67.07	99
1	3	2020_2021	Outside	P[Outside > 0]	−20.90	−55.72	13.04	12
1	3	2020_2021	|Outside-Forsmark|	P[Outside > Forsmark]	30.71	−15.97	75.24	90
1	3	2020_2021	Forsmark	P[Forsmark > 0]	−51.61	−80.95	−19.78	0
1	3	2019_2020	Outside	P[Outside > 0]	−15.89	−37.59	4.68	8
1	3	2019_2020	|Outside-Forsmark|	P[Outside > Forsmark]	36.01	0.57	73.97	97
1	3	2019_2020	Forsmark	P[Forsmark > 0]	−51.90	−85.18	−24.09	0
1	3	2018_2019	Outside	P[Outside > 0]	54.31	28.45	75.80	100
1	3	2018_2019	|Outside-Forsmark|	P[Outside > Forsmark]	1.36	−36.24	46.68	53
1	3	2018_2019	Forsmark	P[Forsmark > 0]	52.95	21.68	84.63	100
1	3	2017_2018	Outside	P[Outside > 0]	7.52	−14.04	34.37	72
1	3	2017_2018	|Outside-Forsmark|	P[Forsmark > Outside]	102.45	62.92	143.14	100
1	3	2017_2018	Forsmark	P[Forsmark > 0]	109.97	77.80	138.65	100
1	3	2016_2017	Outside	P[Outside > 0]	−24.76	−48.48	−3.54	2
1	3	2016_2017	|Outside-Forsmark|	P[Forsmark > Outside]	10.47	−28.28	48.05	72
1	3	2016_2017	Forsmark	P[Forsmark > 0]	−14.29	−42.05	16.43	16
1	3	2015_2016	Outside	P[Outside > 0]	2.07	−20.23	24.99	56
1	3	2015_2016	|Outside-Forsmark|	P[Forsmark > Outside]	58.55	18.24	94.85	100
1	3	2015_2016	Forsmark	P[Forsmark > 0]	60.62	33.24	94.95	100
1	3	2014_2015	Outside	P[Outside > 0]	38.13	14.92	59.52	100
1	3	2014_2015	|Outside-Forsmark|	P[Forsmark > Outside]	6.14	−33.85	45.71	62
1	3	2014_2015	Forsmark	P[Forsmark > 0]	44.27	12.98	78.57	100
1	3	2013_2014	Outside	P[Outside > 0]	1.35	−26.34	26.72	54
1	3	2013_2014	|Outside-Forsmark|	P[Forsmark > Outside]	73.53	25.40	118.01	100
1	3	2013_2014	Forsmark	P[Forsmark > 0]	74.88	37.13	114.15	100

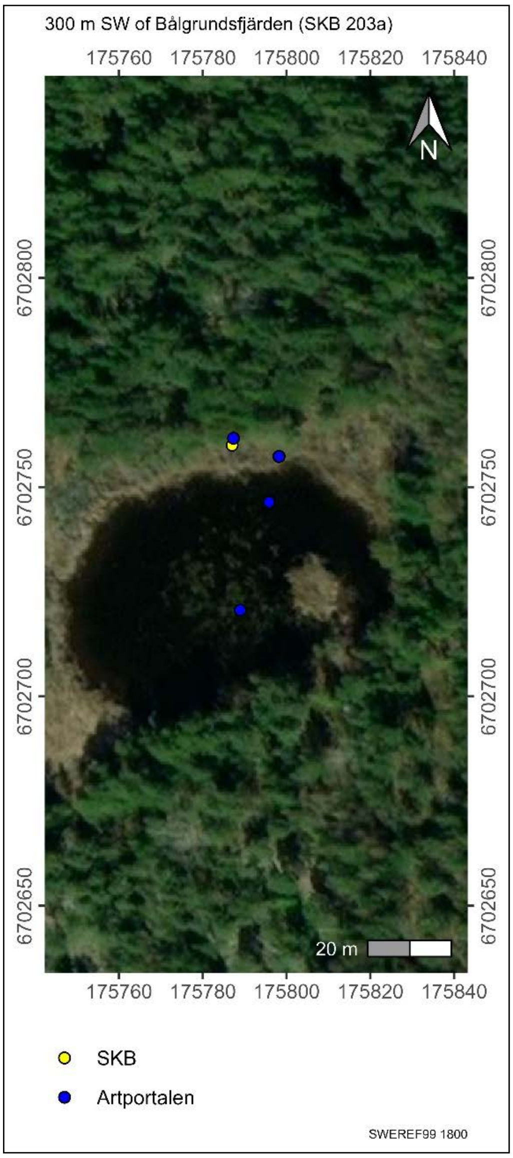
Group	Model	Year to year	Group/Difference	Comparison	Mean	2.5 %	97.5 %	Prob.[%]
1	3	2012_2013	Outside	P[Outside > 0]	−77.76	−105.67	−49.51	0
1	3	2012_2013	|Outside-Forsmark|	P[Forsmark > Outside]	116.59	61.44	179.44	100
1	3	2012_2013	Forsmark	P[Forsmark > 0]	38.82	−18.76	87.08	93
1	3	2011_2012	Outside	P[Outside > 0]	42.70	16.25	66.38	100
1	3	2011_2012	|Outside-Forsmark|	P[Outside > Forsmark]	98.76	36.76	157.54	100
1	3	2011_2012	Forsmark	P[Forsmark > 0]	−56.06	−109.89	−1.23	2
2	4	2022_2023	Outside[unaff]	P[Outside[unaff] > 0]	24.77	−10.54	56.97	92
2	4	2022_2023	Forsmark[unaff]	P[Forsmark[unaff] > 0]	26.54	−23.48	74.20	85
2	4	2022_2023	Forsmark[affect]	P[Forsmark[affect] > 0]	10.10	−23.17	44.60	71
2	4	2022_2023	|Outside[unaff]-Forsmark[affect]|	P[Outside[unaff] > Forsmark[affect]]	14.67	−30.55	65.97	73
2	4	2022_2023	|Outside[unaff]-Forsmark[unaff]|	P[Forsmark[unaff] > Outside[unaff]]	1.76	−57.21	61.65	53
2	4	2022_2023	|Forsmark[unaff]-Forsmark[affect]|	P[Forsmark[unaff] > Forsmark[affect]]	16.43	−46.36	69.40	70
2	4	2021_2022	Outside[unaff]	P[Outside[unaff] > 0]	91.35	56.24	125.02	100
2	4	2021_2022	Forsmark[unaff]	P[Forsmark[unaff] > 0]	107.16	50.22	163.36	100
2	4	2021_2022	Forsmark[affect]	P[Forsmark[affect] > 0]	7.27	−29.08	43.88	65
2	4	2021_2022	|Outside[unaff]-Forsmark[affect]|	P[Outside[unaff] > Forsmark[affect]]	84.08	36.70	140.30	100
2	4	2021_2022	|Outside[unaff]-Forsmark[unaff]|	P[Forsmark[unaff] > Outside[unaff]]	15.81	−45.66	87.35	67
2	4	2021_2022	|Forsmark[unaff]-Forsmark[affect]|	P[Forsmark[unaff] > Forsmark[affect]]	99.89	28.86	164.28	100
2	4	2020_2021	Outside[unaff]	P[Outside[unaff] > 0]	−22.47	−56.66	8.81	9
2	4	2020_2021	Forsmark[unaff]	P[Forsmark[unaff] > 0]	−198.45	−256.05	−146.13	0
2	4	2020_2021	Forsmark[affect]	P[Forsmark[affect] > 0]	14.02	−24.66	46.71	77
2	4	2020_2021	|Outside[unaff]-Forsmark[affect]|	P[Forsmark[affect] > Outside[unaff]]	36.48	−13.05	85.55	93
2	4	2020_2021	|Outside[unaff]-Forsmark[unaff]|	P[Outside[unaff] > Forsmark[unaff]]	175.99	111.26	244.11	100
2	4	2020_2021	|Forsmark[unaff]-Forsmark[affect]|	P[Forsmark[affect] > Forsmark[unaff]]	212.47	147.59	286.60	100
2	4	2019_2020	Outside[unaff]	P[Outside[unaff] > 0]	−17.42	−40.07	4.26	7
2	4	2019_2020	Forsmark[unaff]	P[Forsmark[unaff] > 0]	−47.61	−107.74	1.87	4
2	4	2019_2020	Forsmark[affect]	P[Forsmark[affect] > 0]	−53.34	−89.08	−16.38	0
2	4	2019_2020	|Outside[unaff]-Forsmark[affect]|	P[Outside[unaff] > Forsmark[affect]]	35.92	−4.30	82.33	95
2	4	2019_2020	|Outside[unaff]-Forsmark[unaff]|	P[Outside[unaff] > Forsmark[unaff]]	30.19	−23.14	92.38	83
2	4	2019_2020	|Forsmark[unaff]-Forsmark[affect]|	P[Forsmark[unaff] > Forsmark[affect]]	5.73	−60.07	73.75	56
2	4	2018_2019	Outside[unaff]	P[Outside[unaff] > 0]	54.33	28.50	78.93	100
2	4	2018_2019	Forsmark[unaff]	P[Forsmark[unaff] > 0]	79.64	28.18	137.71	100
2	4	2018_2019	Forsmark[affect]	P[Forsmark[affect] > 0]	43.19	4.18	76.59	99
2	4	2018_2019	|Outside[unaff]-Forsmark[affect]|	P[Outside[unaff] > Forsmark[affect]]	11.14	−32.69	57.49	67
2	4	2018_2019	|Outside[unaff]-Forsmark[unaff]|	P[Forsmark[unaff] > Outside[unaff]]	25.31	−38.21	88.32	80
2	4	2018_2019	|Forsmark[unaff]-Forsmark[affect]|	P[Forsmark[unaff] > Forsmark[affect]]	36.44	−28.02	104.36	85

Group	Model	Year to year	Group/Difference	Comparison	Mean	2.5 %	97.5 %	Prob.[%]
2	4	2017_2018	Outside[unaff]	P[Outside[unaff] > 0]	7.16	−15.09	35.41	71
2	4	2017_2018	Forsmark[unaff]	P[Forsmark[unaff] > 0]	137.38	79.85	193.91	100
2	4	2017_2018	Forsmark[affect]	P[Forsmark[affect] > 0]	103.51	69.06	140.21	100
2	4	2017_2018	|Outside[unaff]-Forsmark[affect]|	P[Forsmark[affect] > Outside[unaff]]	96.36	51.24	140.81	100
2	4	2017_2018	|Outside[unaff]-Forsmark[unaff]|	P[Forsmark[unaff] > Outside[unaff]]	130.22	67.38	188.02	100
2	4	2017_2018	|Forsmark[unaff]-Forsmark[affect]|	P[Forsmark[unaff] > Forsmark[affect]]	33.86	−35.07	96.65	84
2	4	2016_2017	Outside[unaff]	P[Outside[unaff] > 0]	−26.52	−51.98	−4.83	1
2	4	2016_2017	Forsmark[unaff]	P[Forsmark[unaff] > 0]	47.05	−12.61	100.64	95
2	4	2016_2017	Forsmark[affect]	P[Forsmark[affect] > 0]	−35.91	−71.23	−3.70	2
2	4	2016_2017	|Outside[unaff]-Forsmark[affect]|	P[Outside[unaff] > Forsmark[affect]]	9.39	−35.00	48.44	67
2	4	2016_2017	|Outside[unaff]-Forsmark[unaff]|	P[Forsmark[unaff] > Outside[unaff]]	73.58	11.30	135.19	99
2	4	2016_2017	|Forsmark[unaff]-Forsmark[affect]|	P[Forsmark[unaff] > Forsmark[affect]]	82.97	13.46	143.32	99
2	4	2015_2016	Outside[unaff]	P[Outside[unaff] > 0]	2.00	−21.12	23.94	57
2	4	2015_2016	Forsmark[unaff]	P[Forsmark[unaff] > 0]	101.04	42.76	157.96	100
2	4	2015_2016	Forsmark[affect]	P[Forsmark[affect] > 0]	41.85	1.40	81.70	98
2	4	2015_2016	|Outside[unaff]-Forsmark[affect]|	P[Forsmark[affect] > Outside[unaff]]	39.86	−4.50	87.76	95
2	4	2015_2016	|Outside[unaff]-Forsmark[unaff]|	P[Forsmark[unaff] > Outside[unaff]]	99.05	33.39	156.25	100
2	4	2015_2016	|Forsmark[unaff]-Forsmark[affect]|	P[Forsmark[unaff] > Forsmark[affect]]	59.19	−7.40	130.59	96
2	4	2014_2015	Outside[unaff]	P[Outside[unaff] > 0]	38.13	15.65	59.50	100
2	4	2014_2015	Forsmark[unaff]	P[Forsmark[unaff] > 0]	54.00	1.36	110.53	97
2	4	2014_2015	Forsmark[affect]	P[Forsmark[affect] > 0]	43.54	3.73	81.17	99
2	4	2014_2015	|Outside[unaff]-Forsmark[affect]|	P[Forsmark[affect] > Outside[unaff]]	5.42	−40.66	46.68	61
2	4	2014_2015	|Outside[unaff]-Forsmark[unaff]|	P[Forsmark[unaff] > Outside[unaff]]	15.88	−42.43	75.49	69
2	4	2014_2015	|Forsmark[unaff]-Forsmark[affect]|	P[Forsmark[unaff] > Forsmark[affect]]	10.46	−55.76	75.55	63
2	4	2013_2014	Outside[unaff]	P[Outside[unaff] > 0]	1.05	−27.98	25.20	53
2	4	2013_2014	Forsmark[unaff]	P[Forsmark[unaff] > 0]	96.81	31.35	165.10	100
2	4	2013_2014	Forsmark[affect]	P[Forsmark[affect] > 0]	69.52	23.78	126.44	100
2	4	2013_2014	|Outside[unaff]-Forsmark[affect]|	P[Forsmark[affect] > Outside[unaff]]	68.47	12.00	124.87	99
2	4	2013_2014	|Outside[unaff]-Forsmark[unaff]|	P[Forsmark[unaff] > Outside[unaff]]	95.76	26.64	171.48	100
2	4	2013_2014	|Forsmark[unaff]-Forsmark[affect]|	P[Forsmark[unaff] > Forsmark[affect]]	27.29	−49.36	115.17	74
2	4	2012_2013	Outside[unaff]	P[Outside[unaff] > 0]	−79.60	−109.36	−51.53	0
2	4	2012_2013	Forsmark[unaff]	P[Forsmark[unaff] > 0]	15.89	−73.85	105.38	63
2	4	2012_2013	Forsmark[affect]	P[Forsmark[affect] > 0]	54.53	−13.84	124.60	95
2	4	2012_2013	|Outside[unaff]-Forsmark[affect]|	P[Forsmark[affect] > Outside[unaff]]	134.13	57.53	201.77	100
2	4	2012_2013	|Outside[unaff]-Forsmark[unaff]|	P[Forsmark[unaff] > Outside[unaff]]	95.49	−2.89	191.23	97
2	4	2012_2013	|Forsmark[unaff]-Forsmark[affect]|	P[Forsmark[affect] > Forsmark[unaff]]	38.64	−76.18	151.89	73

A9 Maps of two inventories the same year

Shown are locations of all fen orchids found in the two wetlands that were inventoried twice in the same year.





Arkitektkopia AB, Bromma, 2024

SKB is responsible for managing spent nuclear fuel and radioactive waste produced by the Swedish nuclear power plants such that man and the environment are protected in the near and distant future.

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