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Pink-footed Goose Session

Results of analysis on potential bias in PfG population counts

Ryan Germain (EGMP Data Center)

EGM IWG9 * 18-20 June 2024 * Tromsø, Norway

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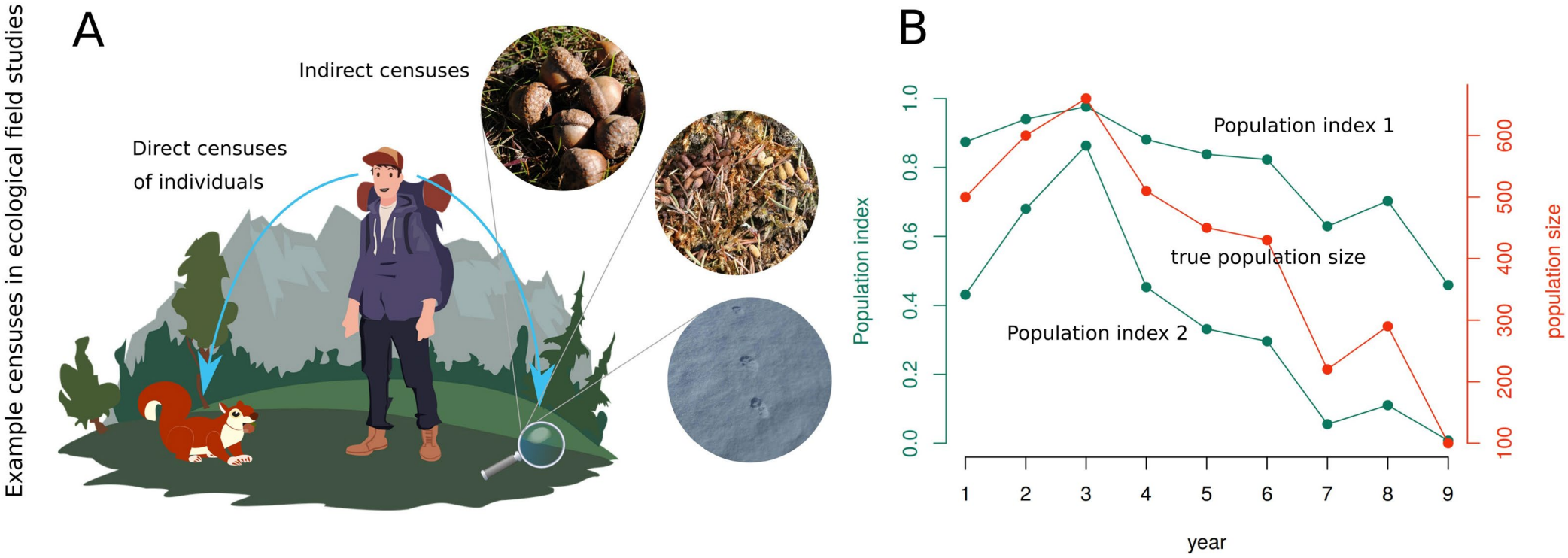
Count bias is pervasive in wildlife ecology and conservation



Numminen *et al.* 2023, *Biological Conservation*

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- Wildlife counts a useful tool to estimate overall population size, but can introduce error when there is
  - Imperfect detection
  - Imperfect counts of detected animals
  - Misidentification of species
  - Non-exhaustive geographic coverage

- Especially prevalent in gregarious species that gather in large groups, but may change behaviours or spatial distribution over time

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Count bias is pervasive in wildlife ecology and conservation

We know that bias exists in nearly every site-based count, but when it varies over time and space it can start to cause negative downstream effects

- Obscure important ecological patterns
  - Reduces ability to detect trends

- Over/underestimate overall population size
  - Inaccurate harvest estimates *etc* leading to long-term problems for management and decision making, especially when population is close to target levels

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Some degree of bias suspected in population counts for several EGMP Species

- Greylag Goose – Estimated population size is far too small to support observed harvest levels (Iceland/Scotland); post-breeding population underestimated (Finland)

- Taiga Bean Goose – Piironen et al (2023) found evidence for negative and positive biases, depending on location

- Pink-footed Goose – Near population target, past harvests restricted based on abundance estimates but further investigation needed

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Detection Probability

Assumed that detection probability (*p*) is perfect (or at least constant) in time and space.

- In Norway in spring, PfG typically roosted in large flocks in the past and were counted easily, now spread out over larger area of hilly fields where flocks are missed
- Leave roosts earlier in the day, potentially missed by counters (similar to situation with Greylag)
- Now mix with large numbers of Barnacle Geese in autumn, particularly in Denmark

Spring counting in Trøndelag, Norway 5-10 years ago

Spring counting in Trøndelag, Norway at present

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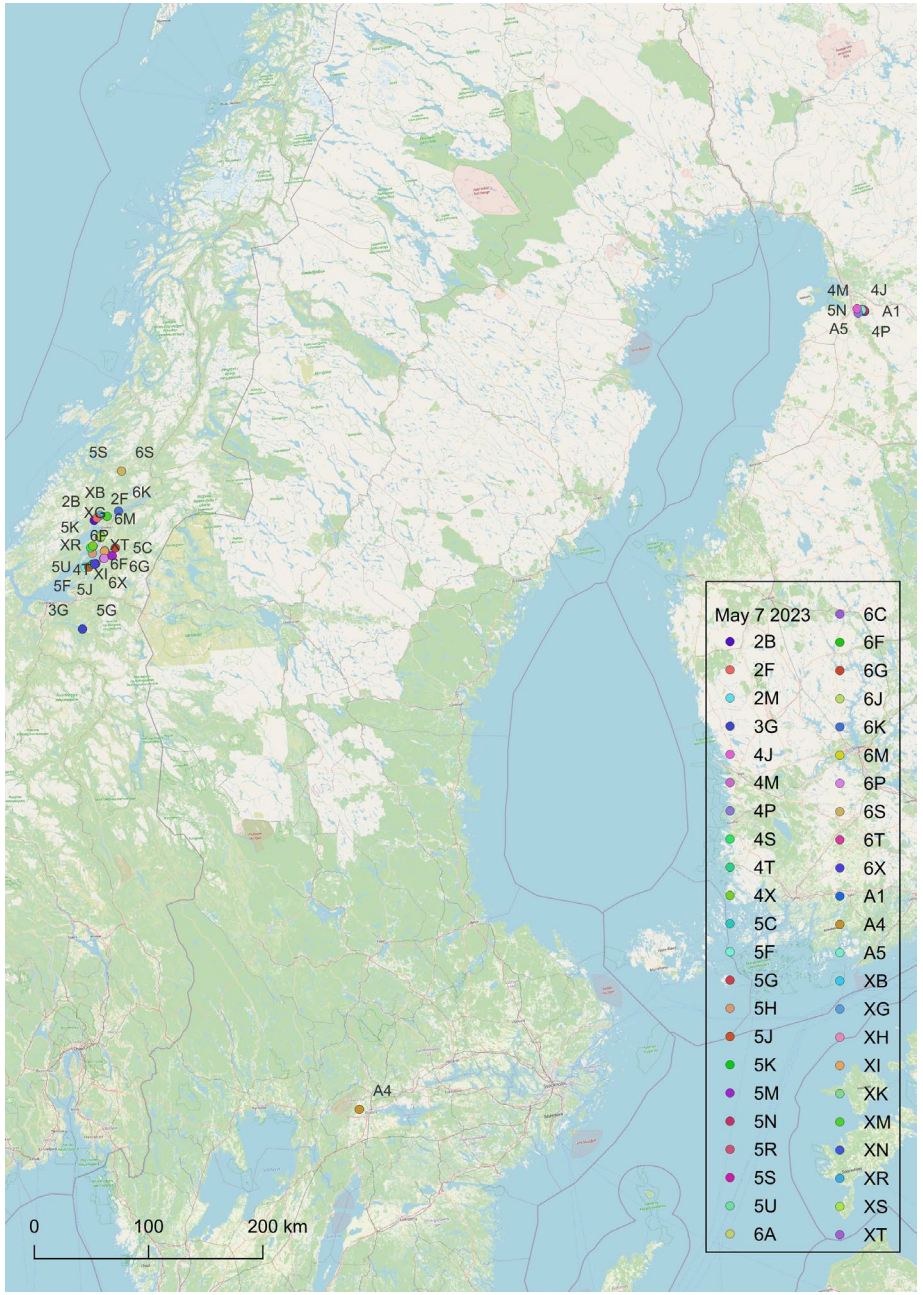
Distribution of 45 GPS tagged individuals on May 7, 2023



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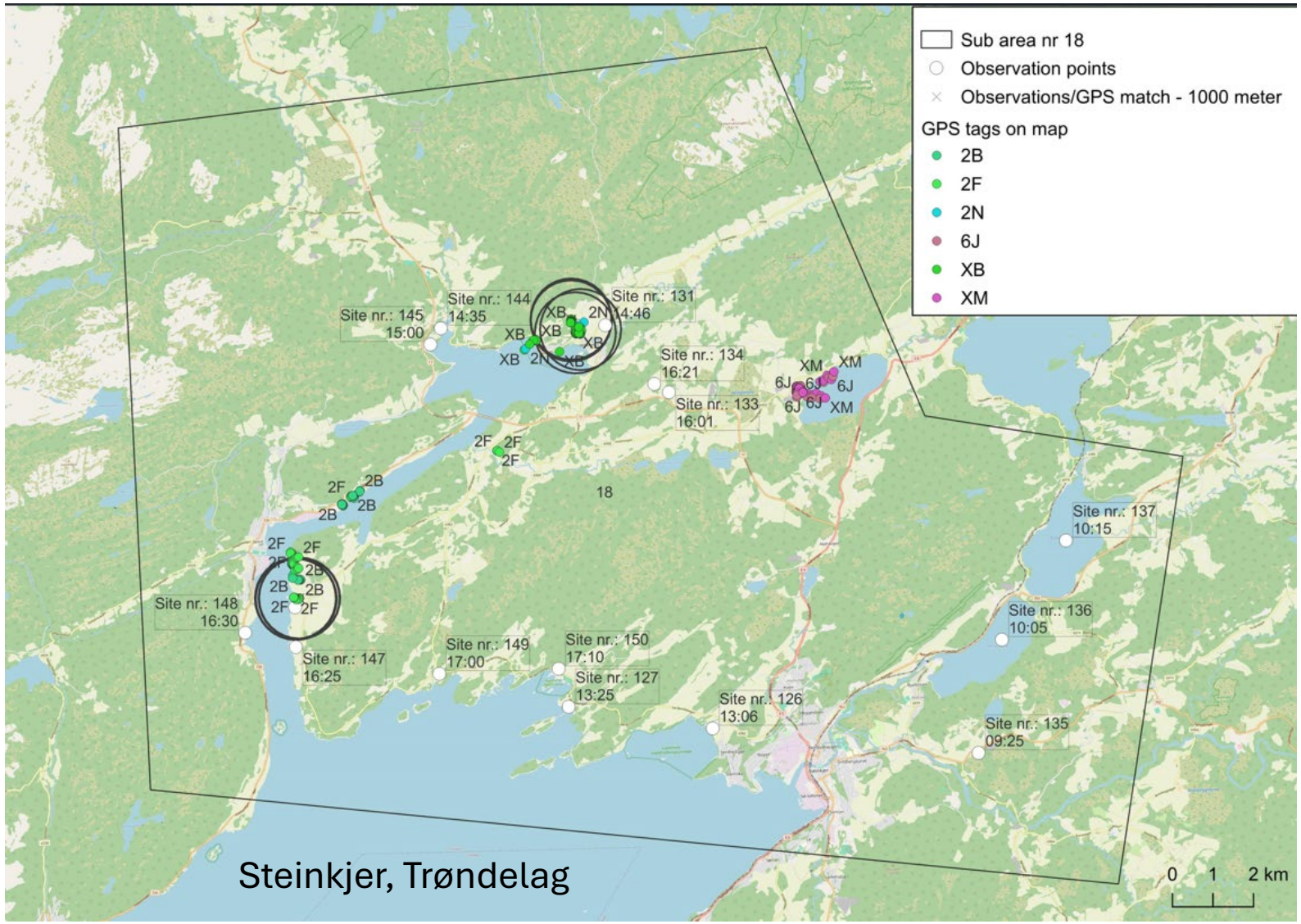

- Time and location data for each count (Norway, Sweden, Finland, Denmark)
- Maximum observation range (2 km buffer)
- Tagged individuals in buffer +/- 30 mins from count = presence

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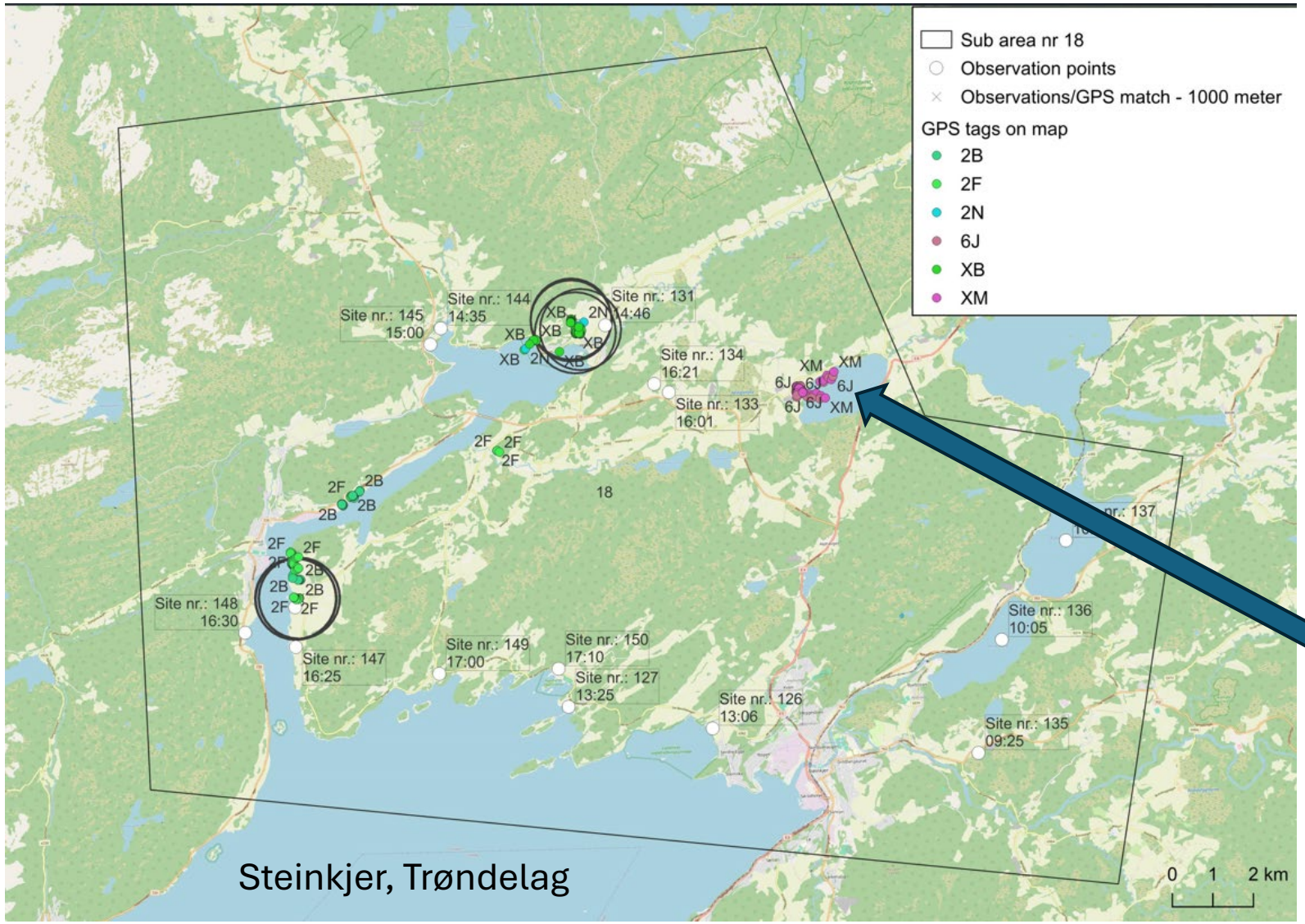

- Time and location data for each count (Norway, Sweden, Finland, Denmark)
- Maximum observation range (2 km buffer)
- Tagged individuals in buffer +/- 30 mins from count = presence

Norway, 7 May 2023:
2 GPS-tagged PfG staying in an area not covered by observers

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Night Roosts

- Polygon around roost sites
- GPS-tagged birds in roost the night before count considered ‘observed’

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Night Roosts

- Polygon around roost sites
- GPS-tagged birds in roost the night before count considered 'observed'

Denmark, 17 November 2023:

Five GPS tagged PfG departing from the roost site to the fjord before the count was performed, not detected by observer

Represents c. 15,000 individuals

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Detection Probability

- K = total number of GPS-tagged birds in population
- k_n = number of tagged birds counted n times at a given location
  k_0 = not occurring, k_1 = counted once, k_2 = counted twice)

- MLEs for the probability of each category
  $p_0 = k_0/K$ (proportion of tags not seen)
  $p_1 = k_1/K$ (tags seen once)
  $p_2 = k_2/K$ (tags seen twice)

- Total detection probability: $\text{Phi} = \frac{1-p_0}{1-p_2}$

- Biased-corrected population estimate: $\widehat{N}$ = count/phi

Svalbard Pink-footed Geese

Census	k0	k1	k2	K	phi
Nov 2022	7	39	2	48	0.89
May 2023	11	33	3	47	0.82
Nov 2023	8	20	0	28	0.71

CMU Taiga Bean Geese

Census	k0	k1	k2	K	phi
Oct 2019	10	6	0	16	0.38
Mar 2020	3	12	1	16	0.87
Mar 2021	13	23	4	40	0.75

Finnish Greylag Geese

Census	k0	k1	k2	K	phi
Aug 2023	18	20	NA	38	0.53

Icelandic Greylag Geese

Census	k0	k1	k2	K	phi
Nov 2022	2	11	NA	13	0.85

Svalbard Pink-footed Geese

Census	k_0	k_1	k_2	K	*phi* (MLE)	*phi* (IPM)
Nov 2022	7	39	2	48	0.89	0.89
Nov 2023	8	20	0	28	0.71	
May 2023	11	33	3	47	0.82	0.87

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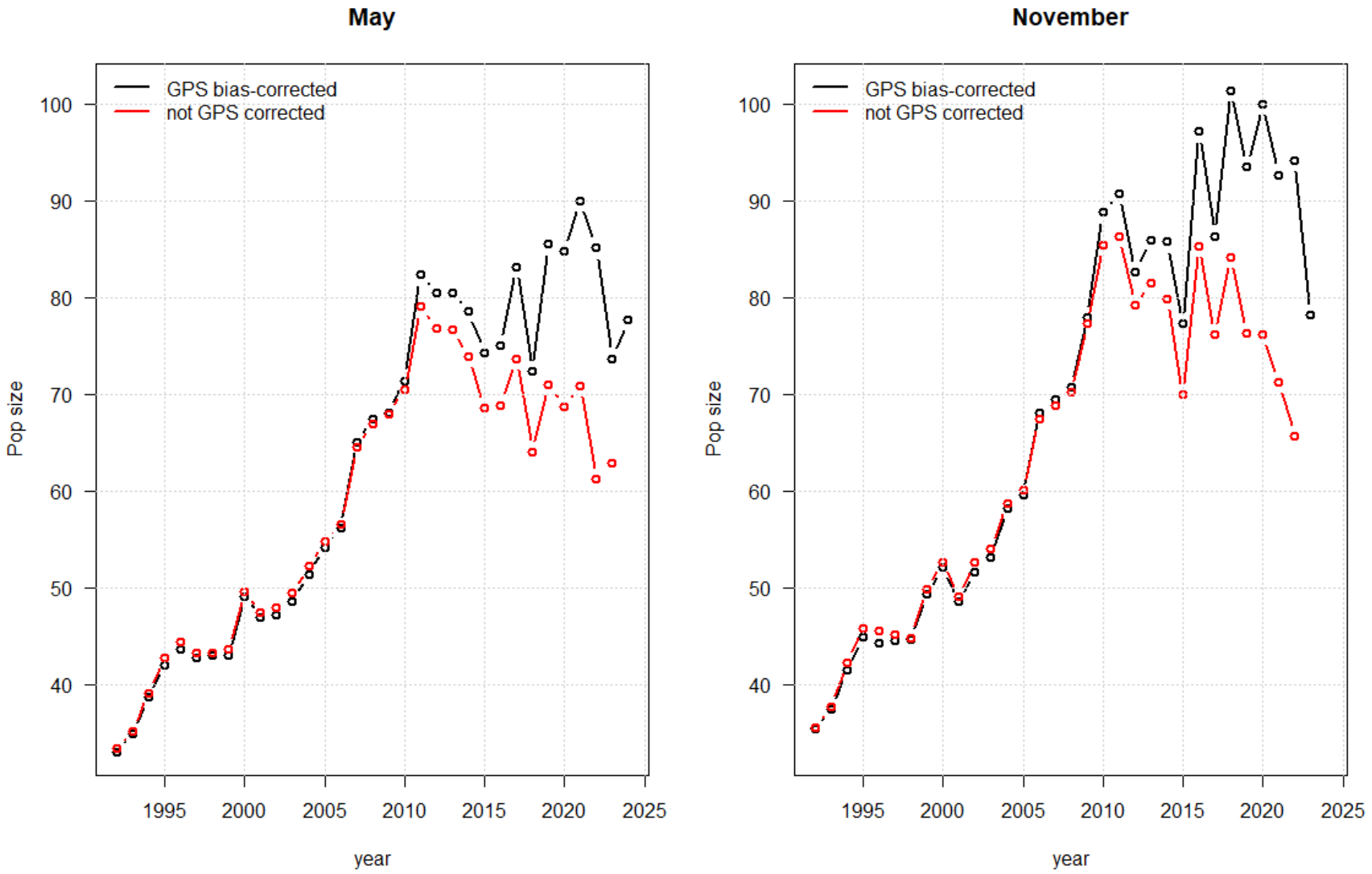

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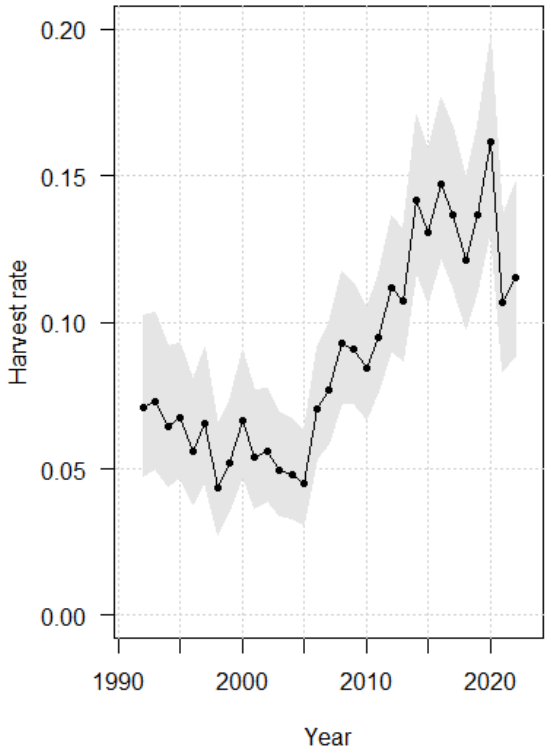
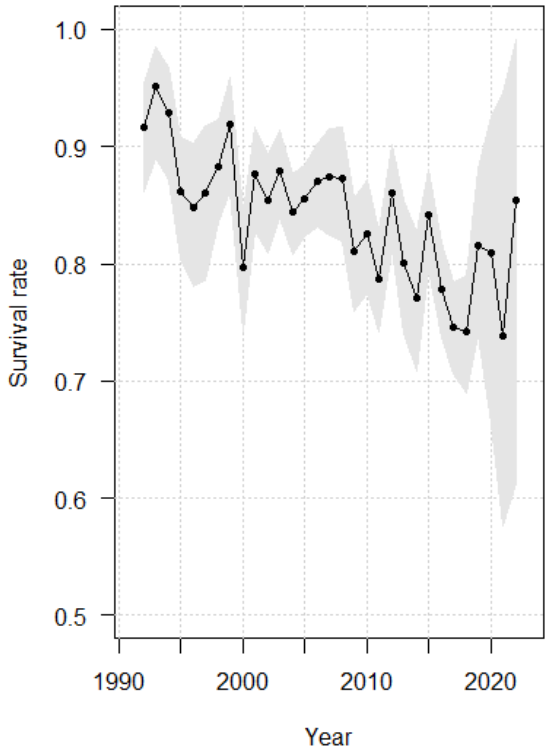
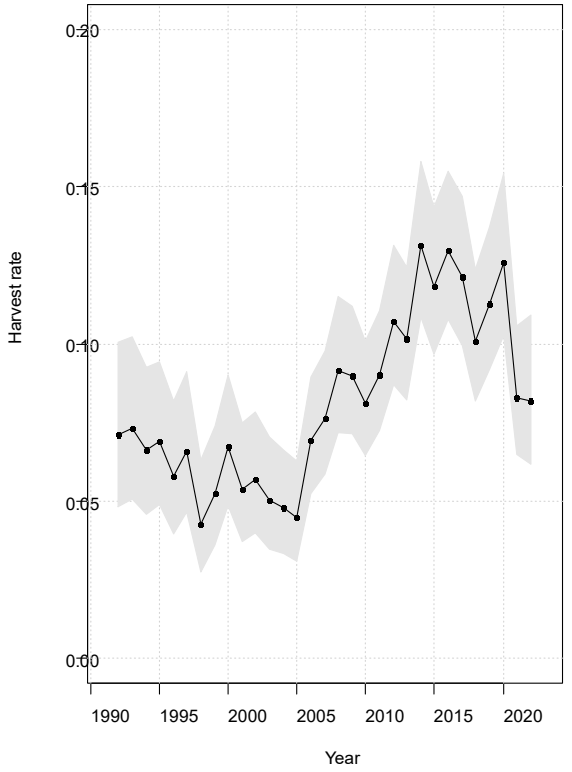
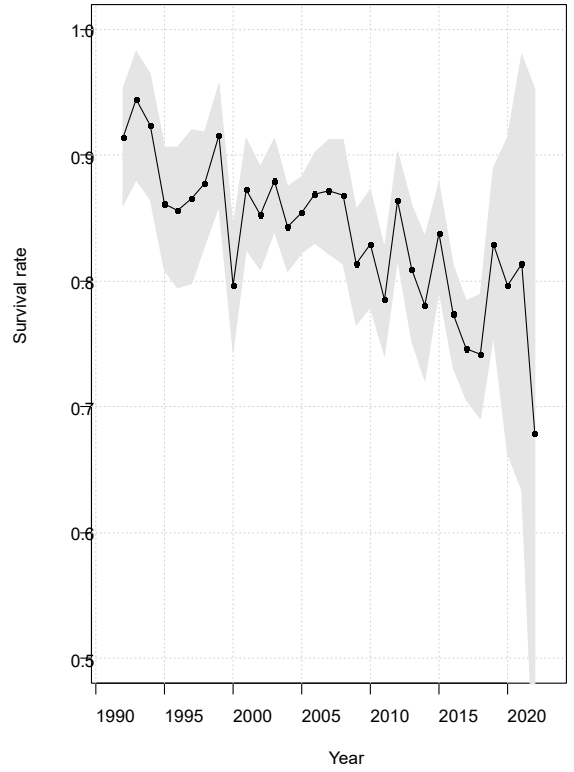
Biased





Bias-corrected





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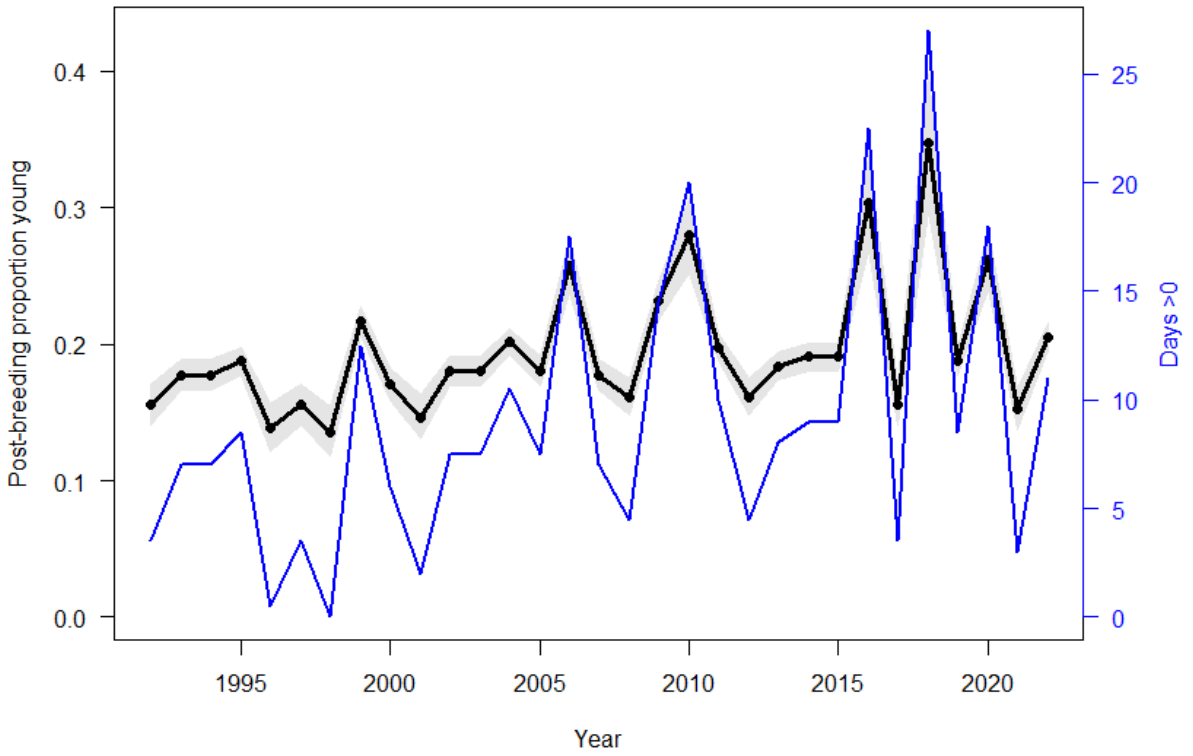

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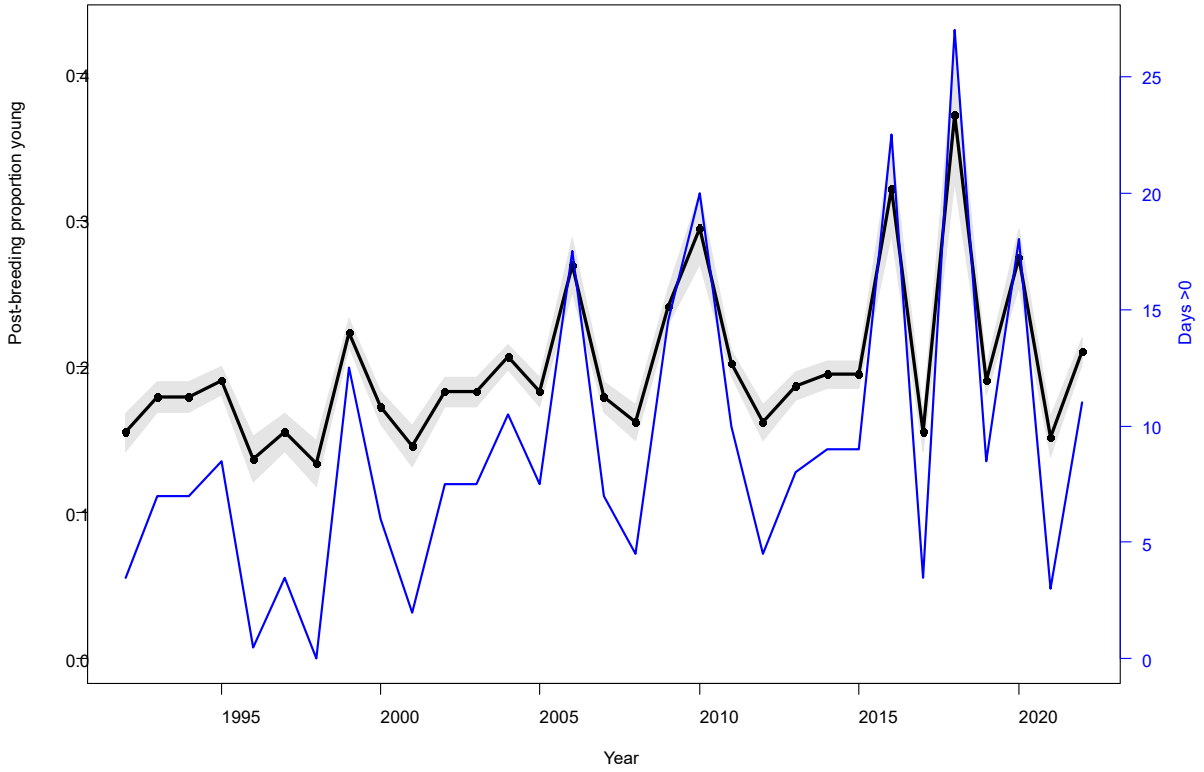

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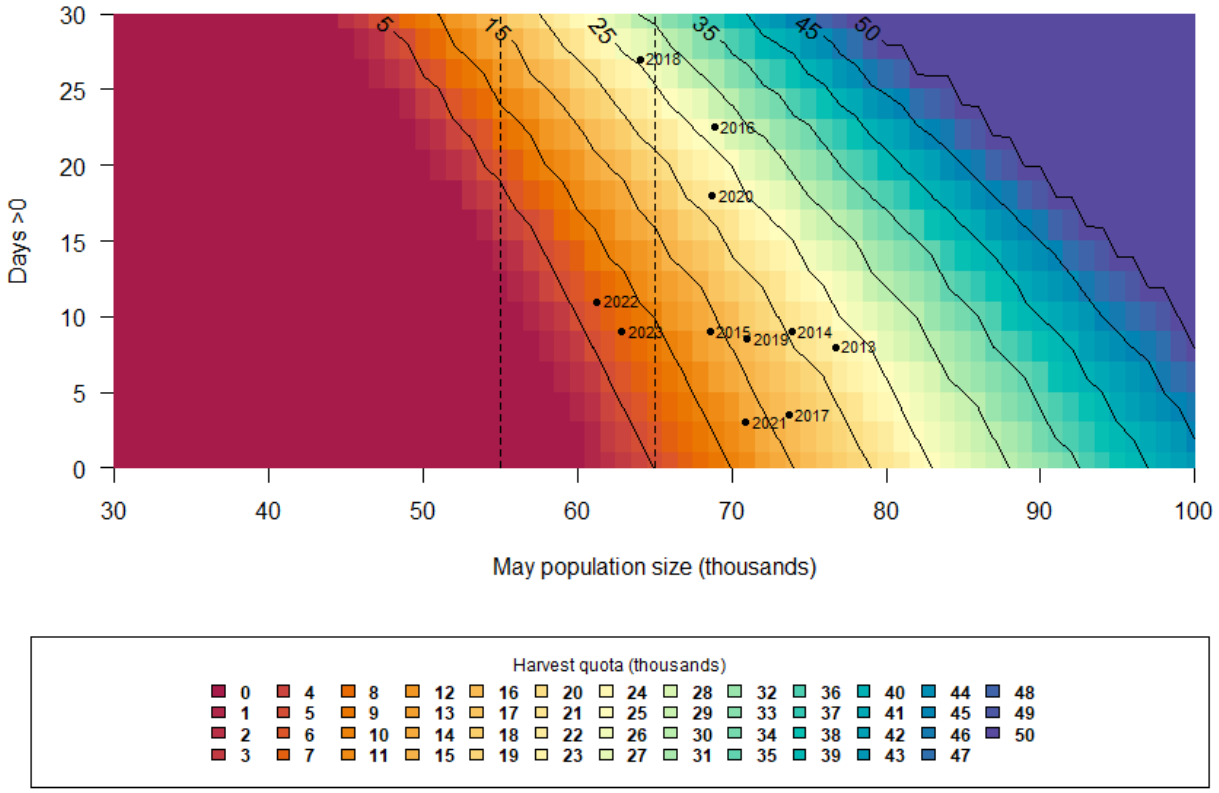
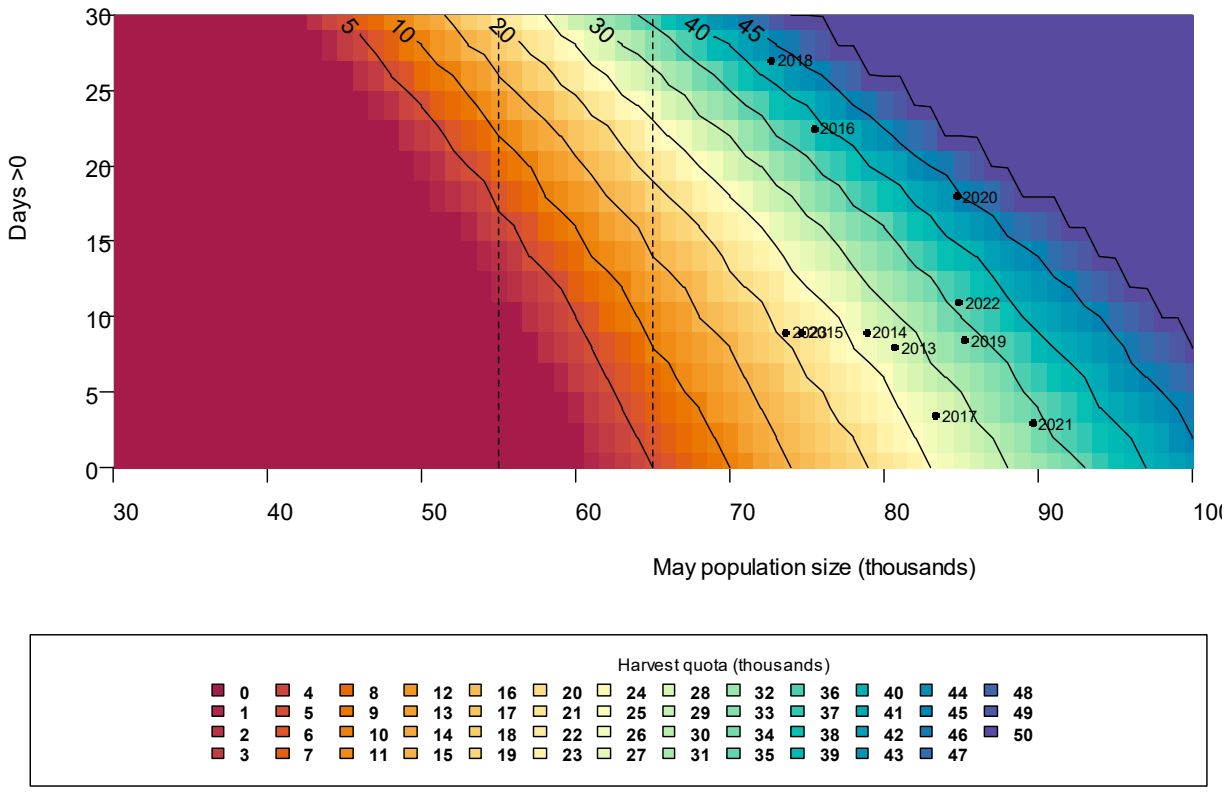
Biased



Bias-corrected



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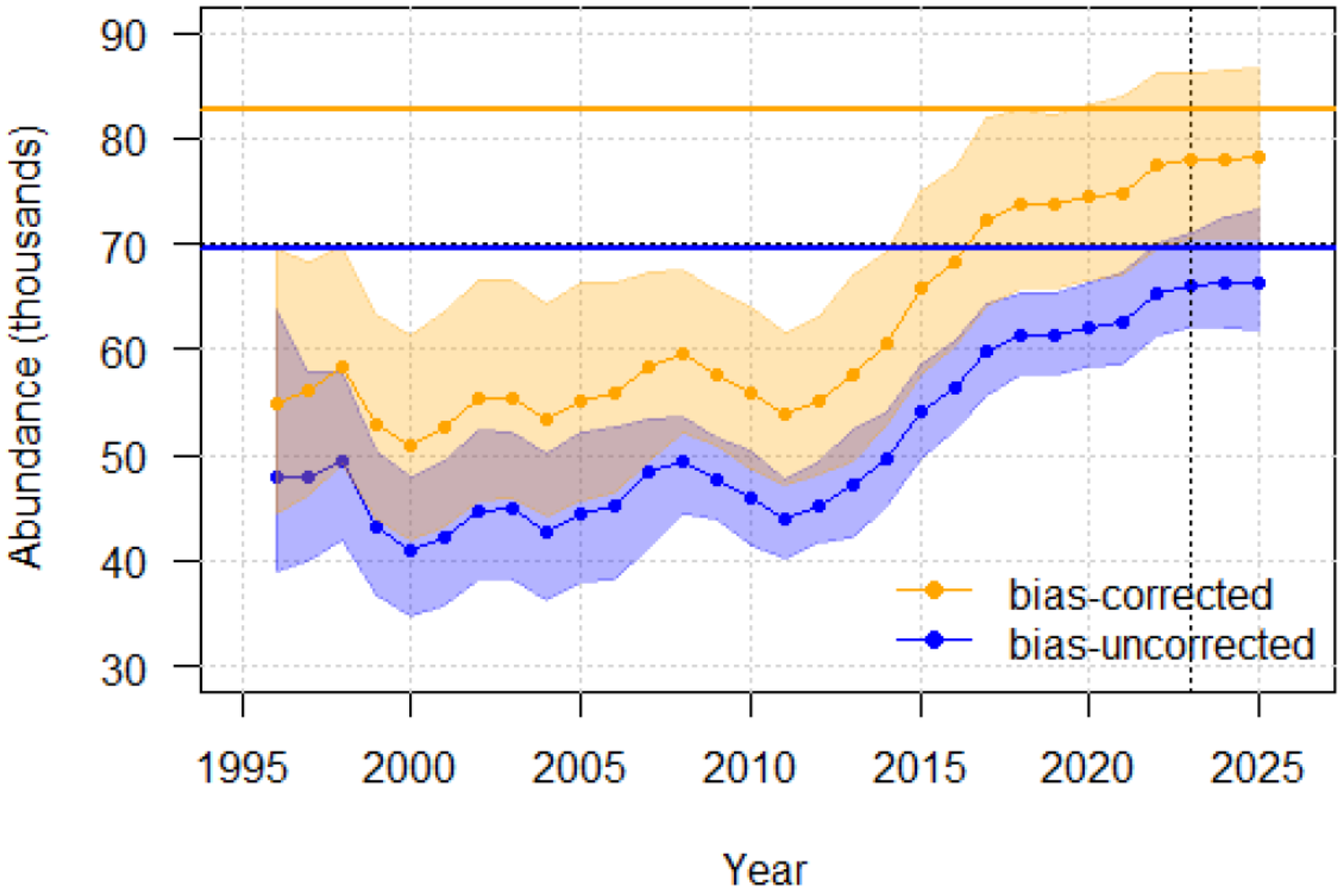
Similar findings in Taiga Bean Geese



Estimated carrying capacities

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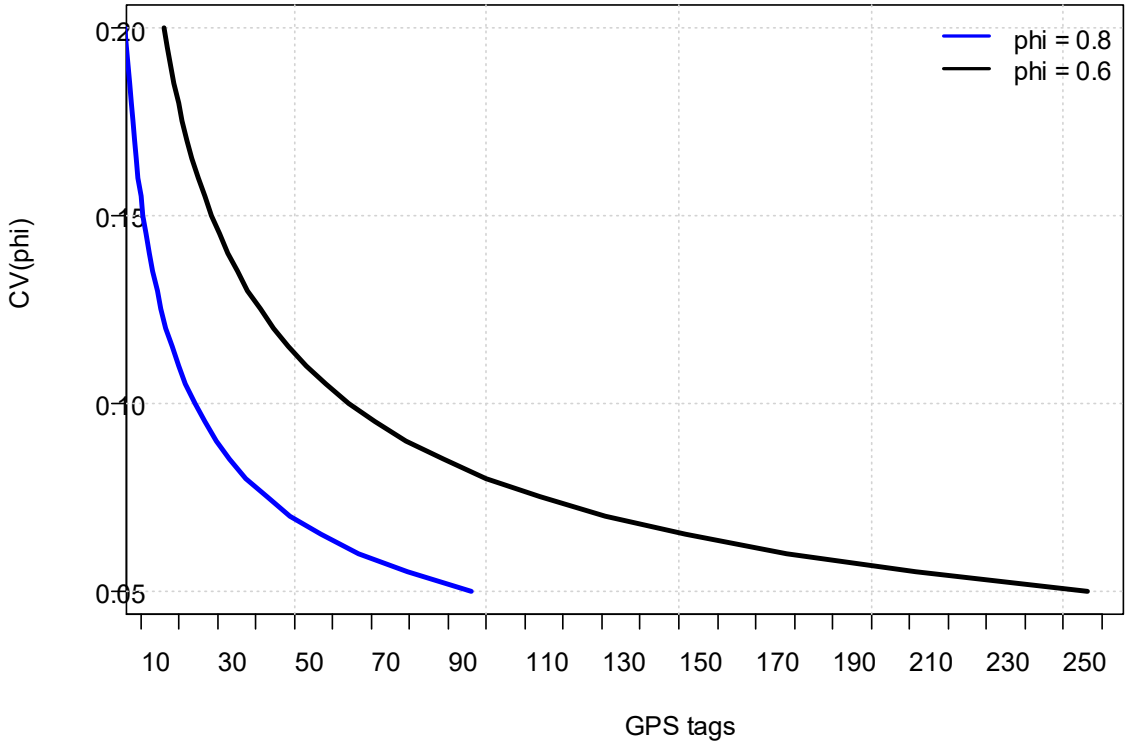
Additional challenges going forward

- Assumes GPS locations are representative of population distribution
- Challenges in aligning GPS locations with counted flocks
- Relatively large numbers of GPS tags needed to precisely estimate phi
- phi likely varies over time & space (can be dealt with somewhat with fixed-year or random-year effects in IPM)



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No missed tags when counters given positions of GPS-tagged individuals (8:00 AM)
Trøndelag, Norway, 5 May 2024

Area	observation points	Number of geese	tags_all	tags_counted	tags_uncounted	Double-counted
1	1	0	0	0	0	
2	1	107	0	0	0	
3	1	3100	0	0	0	
4	28	14308	2	2	0	
5	11	3787	4	4	0	
6	2	149	0	0	0	
7	1	1620	2	2	0	
8	3	11365	3	3	0	
10	8	7311	3	3	0	2
11	8	3462	4	4	0	
12	15	12631	4	4	0	
14	1	3800	0	0	0	
16	1	1672	1	1	0	
17	10	334	0	0	0	
18	9	13238	6	6	0	
total			29	29	0	2
Total: 27 tags present in Norway on 5 May 2024						

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Conclusions

- There is an issue with bias in PfG estimates
  - Bias-correction can make large differences in estimates of population sizes and allowable harvest
  - Does not have much effect on demographic rates other than harvest (i.e., phi is a scaling factor for population size

- If bias is not accounted for it (for this and other species) may have serious implications for management
  - Harvest rates too high/low will lead further away from FRP

- Increasing and maintaining the number of GPS-tagged birds will provide more precise population estimates, and this is especially critical when populations are near targets or FRP's

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Financial support of investigation/analyses:

Ministry of Environment of Denmark
Environmental Protection Agency

AARHUS UNIVERSITY

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