

Supplementary material for: Berteaux D., Thierry A.-M., Alisauskas R., Angerbjörn A., Buchel E., Doronina L., Ehrich D., Eide N.E., Erlandsson R., Flagstad Ø., Fuglei E., Gilg O., Goltsman M., Henttonen H., Ims R.A., Killengreen S.T., Kondratyev A., Kruchenkova E., Kruckenberg H., Kulikova O., Landa A., Lang J., Menyushina I., Mikhnevich J., Niemimaa J., Norén K., Ollila T., Ovsyanikov N., Pokrovskaya L., Pokrovsky I., Rodnikova A., Roth J.D., Sabard B., Samelius G., Schmidt N.M., Sittler B., Sokolov A.A., Sokolova N.A., Stickney A., Unnsteinsdóttir E.R. & White P.A. 2017. Harmonizing circumpolar monitoring of Arctic fox: benefits, opportunities, challenges and recommendations. *Polar Research* 36. Contact: Dominique Berteaux, Canada Research Chair on Northern Biodiversity and Centre for Northern Studies, Université du Québec à Rimouski, 300 Allée des Ursulines, Rimouski, Québec G5L 3A1, Canada. E-mail: dominique_berteaux@uqar.ca

Supplementary Table S1. Summary of Arctic fox monitoring sites with geographic characteristics and indicators of monitoring effort. Values indicating monitoring effort were averaged across the monitoring period when they varied through time. Sites are mapped in Fig. 1.

Site reference number and name	Area	Country	Coordinates	Climate zone ^a				Size of study area (km ²)	Number of known dens ^b	Monitoring period	Fieldwork season	Number of person days/year in the field
				High Arctic	Low Arctic	Sub-Arctic	Montane/alpine					
1. East Iceland	Eastern regions of Iceland ^c	Iceland	65°N, 18°W	●	●		82000	1000	1979–ongoing	all year round	NA ^d	
2. West Iceland	Western regions of Iceland ^c	Iceland	65°N, 21°W	●	●		21000	500	1979–ongoing	all year round	NA ^d	

3. Hornstrandir	Westfjords	Iceland	66°N, 22°W	• •	77	40	1998–ongoing	Jun–Aug	110
4. Kap Rink	Hochstetter Forland	Greenland	75°N, 20°W	•	38	4	2010–ongoing	1 Jul–10 Aug	180
5. Zackenberg Valley	Wollaston Forland	Greenland	74°N, 21°W	•	50	17	1996–ongoing	mid-May–late Oct	330
6. Karupelv Valley	Traill Island	Greenland	72°N, 24°W	•	75	8	1988–ongoing	25 Jun–5 Aug	240
7a. Bylot Island	Nunavut	Canada	73°N, 80°W	•	200	30	1993–2003	1 Jun–5 Aug	100
7b. Bylot Island	Nunavut	Canada	73°N, 80°W	•	600	100	2004–ongoing	10 May–5 Aug	330
8a. Churchill	Manitoba	Canada	59°N, 94°W	• •	600	100	1994–97	Apr, June–Aug	80
8b. Churchill	Manitoba	Canada	59°N, 94°W	• •	700	110	2010–ongoing	Apr, Jun, Aug	200
9. Karrak Lake	Nunavut	Canada	67°N, 100°W	•	70	12	2000–ongoing	10–31 May	60
10. Egg River	Northwest Territories	Canada	72°N, 124°W	•	75	28	1995–98	June	120
11. Prudhoe Bay	Alaska	USA	70°N, 148°W	•	792	51	2005–2014	late Jun–mid-Jul	43
12. Pribilof Islands	Pribilof Islands	USA	57°N, 170°W	•	125	100	1988–ongoing	May–Sep or Jul	30

13. Shemya Island	Aleutian Islands	USA	52°N, 174°E	●	15	15	2006, 2008, 2011–ongoing	Jan–Feb or Jun–Jul 21	
14. Wrangel Island	Chukotka	Russia	71°N, 179°E	●	800	82	1980-2014	May-Sep	140
15. Mednyi Island	Commander Islands	Russia	54°N, 167°E	●	50	45	1976, 1978, 1994–2012	Jun–Aug	320
16. Sabetta	Yamal Peninsula	Russia	71°N, 71°E	● ●	160	29	2012–ongoing	Jul–Sep	35
17. Belyi Island	Yamal Peninsula	Russia	73°N, 70°E	●	40	11	2013, 2015–ongoing	Jul	14
18. Erkuta	Yamal Peninsula	Russia	68°N, 69°E	●	230	56	1989, 1998, 2007–ongoing	nearly year round	400
19. Nenetsky	Nenets Autonomous Okrug	Russia	68°N, 53°E	●	100	12	2007–2011	20 Jun–20 Aug	120
20a. Kolguev Island	Nenets Autonomous Okrug	Russia	69°N, 48°E	●	350	50	2006–08, 2011–12	20 May–15 Aug	540
20b. Kolguev Island	Nenets Autonomous Okrug	Russia	69°N, 48°E	●	350	80	2013, 2015	20 Jun–20 Aug	180

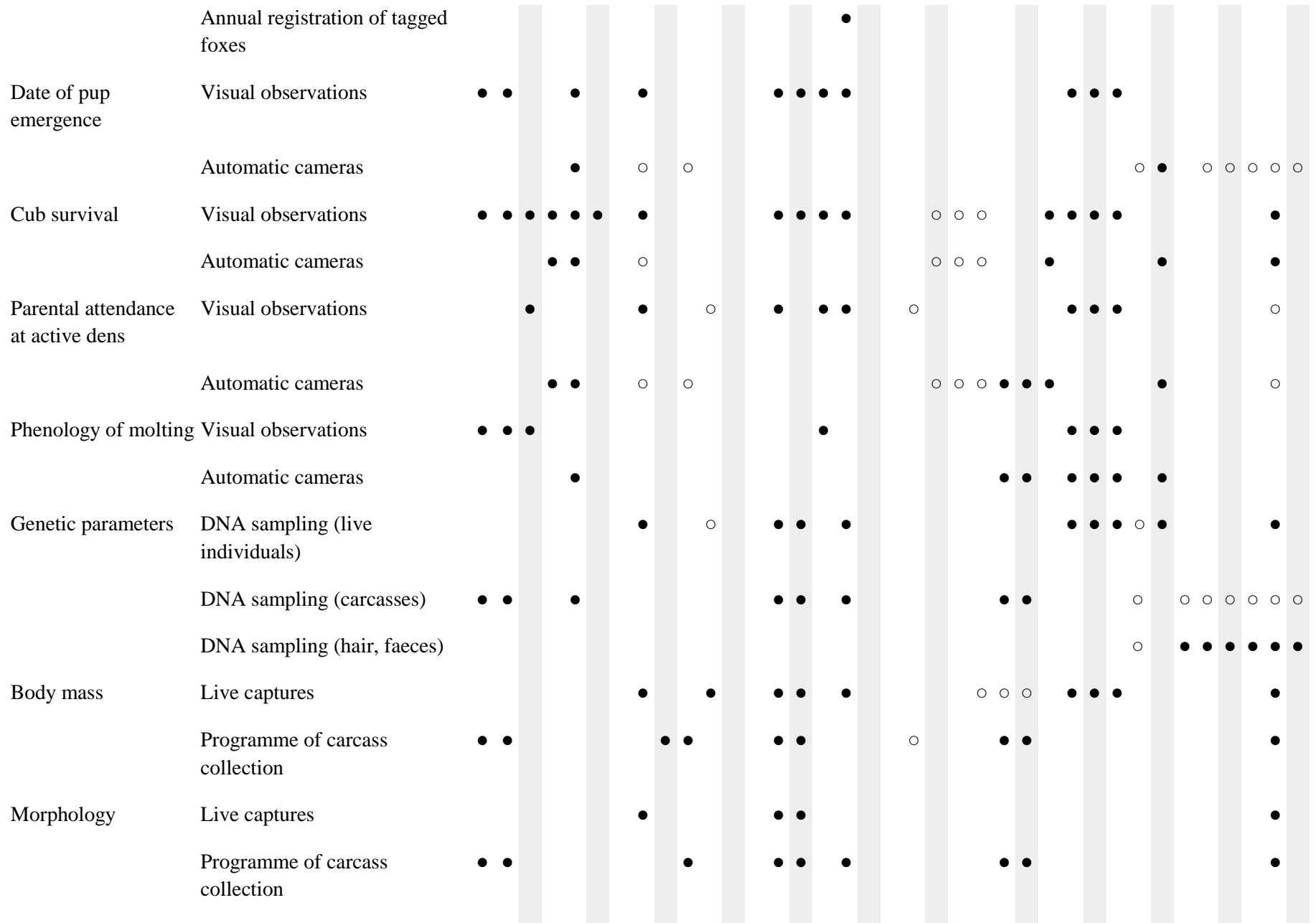
21. Longyear-byen	Svalbard	Norway	78°N, 17°E	•	900	32	1982–1989, 1997–ongoing	25 Jun–27 Jul	60
22. Ny-Ålesund	Svalbard	Norway	79°N, 11°E	•	221	10	1993–ongoing	25 Jun–27 Jul	25
23. Finnish Lapland	Lapland	Finland ^c	69°N, 21–27°E		• 5000	320	1960–ongoing	Apr–Aug	40
24. Helags	Jämtland	Sweden ^c	63°N, 13°E		• 1920	100	1985–ongoing	Apr, 1 Jul–15 Aug	315
25. Borga	Jämtland/ Västbotten	Sweden ^c	65°N, 15°E		• 1676	50	1985–ongoing	Apr, 1 Jul–15 Aug	165
26. Vindel-fjällen/Arjeplog	Västerbotten/ Norrbotten	Sweden ^c	66°N, 16°E		• 2600	130	1985–ongoing	Apr, 1 Jul–15 Aug	315
27. Norrbotten	Norrbotten	Sweden ^c	67–69°N, 17– 21°E		• • 6000	150	1985–ongoing	Apr, 1 Jul–15 Aug	165
28. Varanger	Varanger Peninsula	Norway ^c	70°N, 29°E	• •	2000	40	2001–ongoing	28 Jun–18 Jul, 31 Aug–5 Sep, 15 Mar–1 Apr	200
29. Ifjordfjellet/ Reisa/Dividalen	Troms/ Finnmark	Norway ^c	66–70°N, 15–27°E		• • 15000	163	2001–ongoing	Feb–May late Jun–mid- Aug	21
30. Saltfjellet	Nordland	Norway ^c	66°N, 15°E		• 2500	58	1972–1994,	Feb–May	40

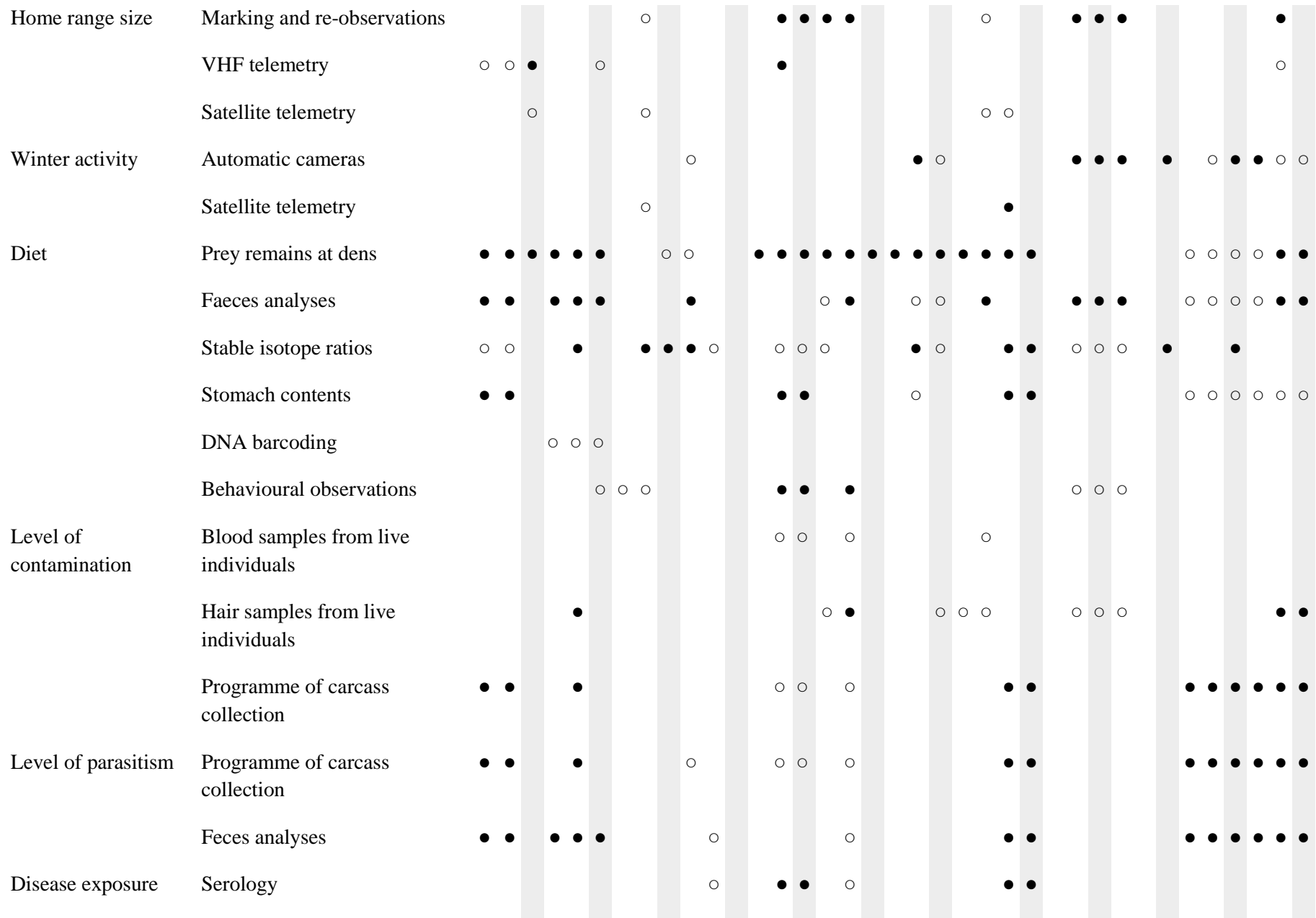
						2001–ongoing	late Jun–mid- Aug	
31. Børgefjell	Nordland/Nord-Trøndelag	Norway ^c	66°N, 15°E	● 2000	43	1977–ongoing	Feb–May late Jun–mid Aug.	110
32. Lierne/Sylane	Nord Trøndelag/Sør Trøndelag	Norway ^c	63-65°N, 11-14°E	● 6000	164	2001–ongoing	Feb–May late Jun–mid- Aug.	55
33. Snøhetta/Knutshø/Finse	Sør-Trøndelag/Oppland/Buskerud	Norway ^d	60-62°N, 7-11°E	● 7000	151	1989–ongoing	Feb - May late Jun–mid- Aug	273
34. Hardangervidda	Buskerud/Sogn/Hordaland	Norway ^d	60°N, 7°E	● 5000	205	1956–1975, 1999–ongoing	Feb–May late Jun–mid- Aug	40

^a Climate zones follow figure 1 in CAFF (2013). ^b Arctic and red fox dens are included when the two species live in the study area. ^c East Iceland includes the Northwestern Region, Northeastern Region, Eastern Region and Southern Region. West Iceland includes the Capital Region, Southern Peninsula, Western Region and Westfjords. ^d The field part of this monitoring project relies mostly on ca. 35 people who hunt Arctic foxes at their dens, all year round but mostly from late winter to late summer, and send fox carcasses and associated information to researchers. ^e In Fennoscandia, Arctic fox distribution is fragmented into >25 units (Herfindal et al. 2010). Our identification of 12 monitoring sites in Fennoscandia reflects our attempt to identify monitoring units that are rather homogeneous in terms of monitoring effort and management regime, and that can be compared to other Arctic fox monitoring sites. The overlap between these nine monitoring sites and the clusters identified in Herfindal et al. (2010) is as follows: Finnish Lapland (clusters 20, 22, 26, 27), Helags (6, 7), Borga (12, 13), Vindelfjällen/Arjeplog (14, 15, 16), Norrbotten (17, 18, 20), Varanger (cluster 28), Ifjordfjellet/Reisa/Dividalen (clusters 15, 18, 19, 20, 21, 22, 24, 23, 25), Saltfjellet (cluster 16), Børgefjell (cluster 13), Lierne/Sylane (clusters 4, 5, 6, 8, 9, 10), Snøhetta/Knutshø/Finse (cluster 3, northern part of cluster 1), Hardangervidda (cluster 1).

27	50	0	10	unclear	strong	0	30	1	2				3				3	1
28	40	0	4	unclear	strong	5	20	1		2							2	
29	62	0	5	decrease	strong	0	≥ 17	1	2	3								
30	43	0	10	increase	strong	0	≥ 3	1	2	3			3				1	1
31	26	0	14	stable	strong	0	≥ 3	1	2	3								
32	48	0	13	increase	strong	0	≥ 5	1	2	3			3				1	2
33	100	0	23	increase	strong	0	≥ 5	1	2	3			3				2	1
34	37	0	2	increase	strong	0	≥ 7	1	2	3			3				2	1

^a The number of monitored dens can differ from the number of known dens reported in Supplementary Table S1 if only a proportion of known dens were monitored. Monitored dens include reproductive and non-reproductive dens, as well as active and inactive dens. ^b Minimum and maximum numbers can reflect multi-annual fluctuations, long-term changes in fox abundance, or variation in monitoring effort. ^c Each monitoring team ranked a maximum of three diet components (1 = main diet component). ^d Includes marine invertebrates and all beachcast marine edibles. ^e Conservation feeding includes regular provisioning of significant quantities of food to enhance fox reproduction and survival. Contribution of conservation feeding to the diet of foxes is not quantified, but is known to be higher when rodents are rare. Other feeding includes provisioning of significant quantities of food with no aim to enhance fox reproduction and survival (e.g., allowing access to human garbage, providing large quantities of baits to attract foxes, providing reindeer carcasses through husbandry practices). Note that “Other feeding” can have negative effects on fox populations, for example, through disease or contaminant transfer. ^f Each monitoring team ranked a maximum of three human interferences (1 = main human interference). We considered humans to interfere with Arctic foxes if they had some measured or suspected effects on population size or trend. To simplify the table, we did not consider distant anthropogenic influences such as climate change or artificial increases in goose densities. ^g Land protection (e.g., national park or reserve) was considered as human interference only if it had measured or suspected effects on Arctic fox population size.





Ecosystem structure

Mammals

Red fox abundance Proportion of dens used by red foxes

Automatic cameras with baits

Other mammal predators abundance (e.g., wolf, wolverine, lynx) Number of observed individuals, active den counts

Small rodent abundance Snap trapping

Live trapping

Surveys of signs of abundance

Hare abundance Transect and area counts

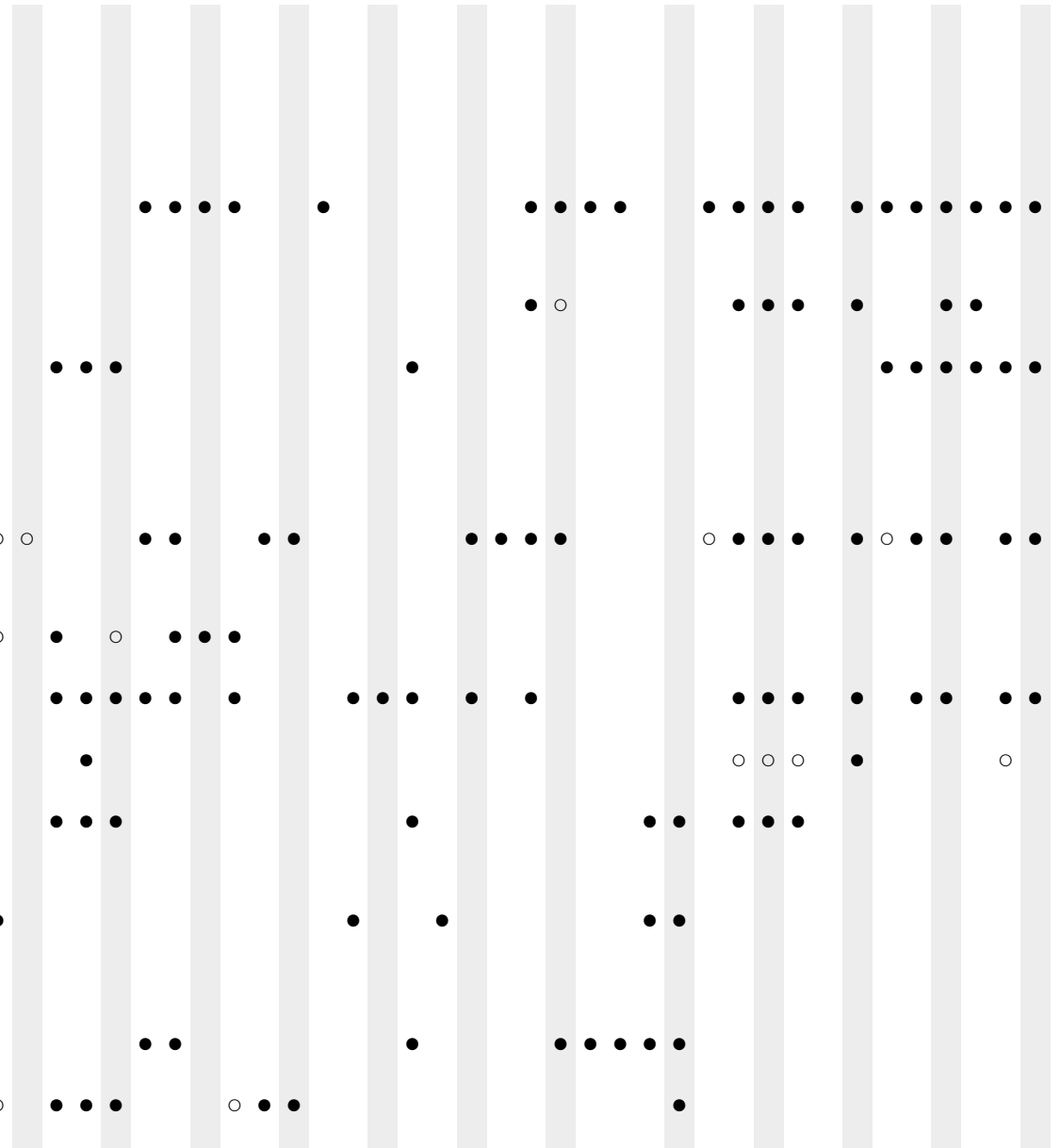
Large mammal carcasses Transect and area counts

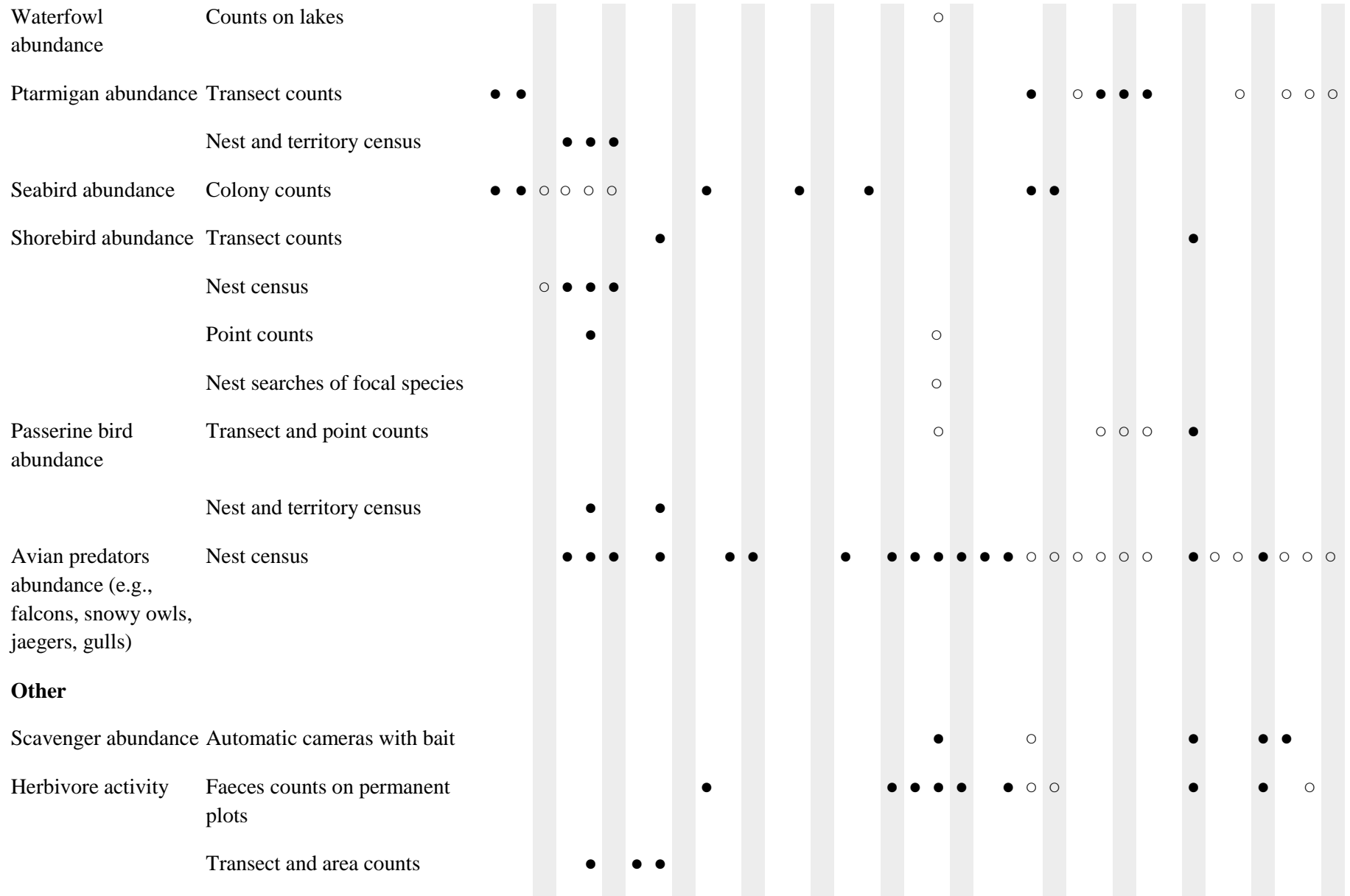
Seal rookeries Visual counts at rookeries

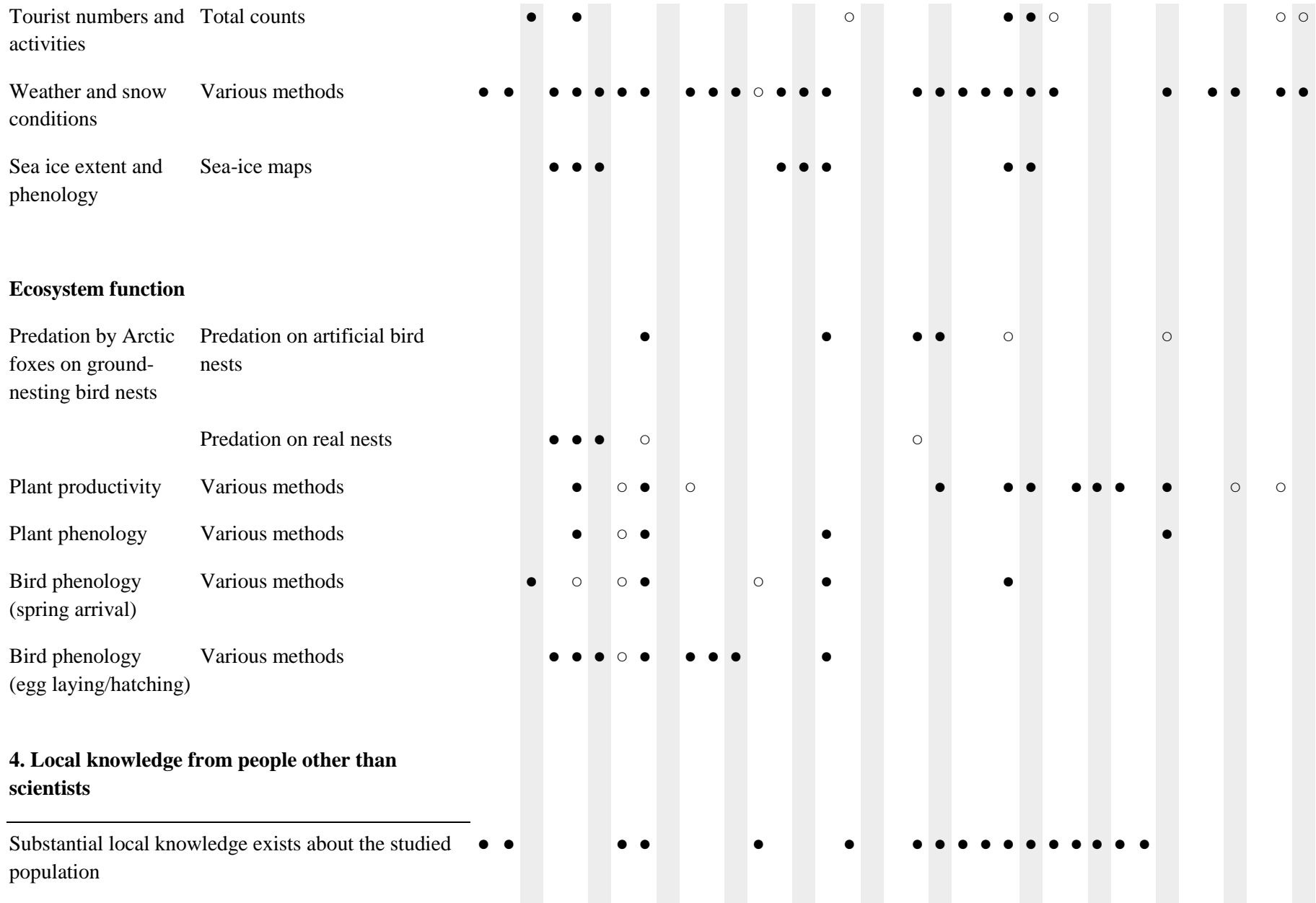
Birds

Geese abundance Aerial survey

Direct counts

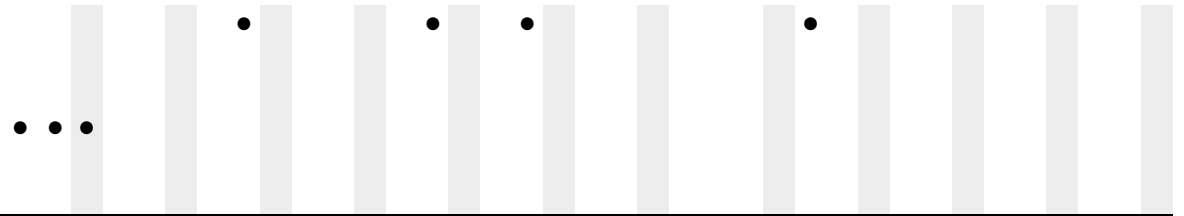






Substantial local knowledge was collected about the studied population

Local knowledge is collected repeatedly as a monitoring technique



^a Monitoring objectives are categorized as scientific when the focus is on developing an understanding of the monitored system, and management when the goal is to inform management decisions. If both objectives were followed, their importance was ranked (1 = higher importance).

References

- Herfindal I., Linnell J.D.C., Elmhagen B., Andersen R., Eide N.E., Frafjord K., Henttonen H., Kaikusalo A., Mela M., Tannerfeldt M., Dalén L., Strand O., Landa A. & Angerbjörn A. 2010. Population persistence in a landscape context: the case of endangered Arctic fox populations in Fennoscandia. *Ecography* 33, 932–941.
- Meltofte H. (ed.) 2013. *Arctic biodiversity assessment. Status and trends in Arctic biodiversity*. Akureyri: CAFF.