Title: Contrasting changes in space use induced by climate change in two Arctic marine mammal species
Authors: C.D. Hamilton, J. Vacquié-Garcia, K.M. Kovacs, R.A. Ims, J. Kohler, C. Lydersen

Supplementary material

Materials and methods

(a) Capture

Fifty-six ringed seals and 34 male white whales were caught with shore-set nets in the Svalbard Archipelago before (ringed seals=28 (1996-2003), white whales=18 (1995-2001)) and after (ringed seals=28 (2010-2016), white whales=16 (2013-2016)) a major collapse in sea-ice conditions occurred in 2006 (electronic supplementary material, tables S1, S2, figure S1). Only male white whales are considered herein due to the low number of female white whales tagged in each time period (two in both 1995-2001 and 2013-2016). Seals in 1996 were equipped with 0.5-W Satellite Linked Dive Recorders (SLDR; SDR-T6, Wildlife Computers, Redmond, USA). The rest of the ringed seals (2002-2016) and all of the white whales (1995-2016) were equipped with Satellite Relay Data Loggers (SRDLs, Sea Mammal Research Unit, University of St Andrews, St Andrews, Scotland; see [15,16,25] for more details). All animal-handling and tagging protocols were approved by the Norwegian Animal Research Authority and the Governor of Svalbard.

(b) Statistical Analysis

All data analyses were conducted using R 3.3.3 [26]. Six (or the maximum number of transmissions that day if n<6) locations were randomly selected every second day from ringed seals tagged in 2002-2016 to match the transmission frequency of seals tagged in 1996. The locations from all seals were filtered, first with the SDA filter and subsequently with the continuous-time correlated random walk (crawl) model, with a stopping model incorporated for the seals from 2002-2016 to account for the time spent hauled out [27,28] (haul-out data was not available for ringed seals tagged in 1996). One daily position was extracted from the crawl models for each seal, due to the low transmission frequency of the tags on seals in 1996.

Only time periods in which the ringed seals were close to the coast (see [15] for further details) were used in the analyses herein. White whale positions were filtered with the SDA filter [27]. Hourly locations were extracted from the SDA-filtered tracks using linear interpolation.

Ringed seal and white whale positions were compared to the locations of tidal glacier fronts in areas with Atlantic Water inflows (i.e. the west coast of Spitsbergen and Storfjorden, figure 1). Only summer and autumn data are considered in this study because these time periods are important foraging periods for both species and are times when the fjords are equally accessible to both species. Glacial meltwater plumes entrain large volumes of water as they rise to the surface, causing advection of production toward the glacier front. Lower trophic organisms in these areas also might become pushed to the surface or trapped along the bottom (below the fresh water), making these areas important for Arctic marine mammals and seabirds for foraging [8]. Glaciers in Svalbard are retreating, and thus different sets of shapefiles, from 2001-2009 and from 2015, were used for the ringed seals and white whales tagged in 1995-2003 and 2010-2016, respectively [29,30]. The proportion of time spent within 5 km of a tidal glacier front (distance <= 5 km = 1, distance > 5 km = 0) for each species was analysed using generalized additive mixed-effect models (GAMM, mgcv package [31]). Although in reality animals frequenting glacier fronts are much closer than this, five km was used to account for uncertainty in the yearly position of quickly retreating glacier fronts and the errors inherent in Argos location estimates [32]. Fifteen ringed seals and two white whales also transmitted Fastloc GPS positions. Comparisons between GPS and Argos data showed that 85% of the Argos locations from both ringed seals and white whales were within 5 km of the corresponding GPS location.

Proportion of time spent within 5 km of a glacier front was included in the GAMM models as the response variable using the logit link function and the binomial error was used to account for residual variance. Possible predictor variables included time period (i.e. before and after the collapse in sea-ice conditions), day of year, sex (ringed seals only) and mass (ringed seals only). A separate day of year smooth curve was made for each time period, by including time period as a "by" variable in the day of the year smooth term [31]. Individual ID was included as both a random effect and as a grouping factor in the temporal autocorrelation structure order one (corAR1) term. Model selection took place using p-values and model validation was conducted as recommended by [33].

Linear Models (LM) were used to test whether the subject species preferred glaciers with longer calving lengths, greater surface areas or deeper water depths in both of the study periods. The closest glacier and its associated calving length, area and water depth were identified for all locations within 5 km of a tidal glacier front. The length of the calving fronts was calculated from the glacier front shapefiles used to calculate distance in each time period (see above) and the water depth in front of the tidal glacier fronts were extracted from an updated version of the S800 bathymetry data [34]. Glacier surface area strongly influences the amount of glacial discharge at the glacier front (J.K., unpublished data). Because glacier area was highly correlated with calving length (>70%), only calving length and water depth were included as possible predictor variables in the LMs (correlation between these latter two variables was <30%). The identity link was used for the response variable in the LMs (i.e. proportion of locations in front of each tidal glacier front) and the Gaussian family was used to assess residual variance. The response variable was log-transformed to meet model assumptions. AICc was used for model selection [35] and model validation was conducted as recommended by [33].

To test if locations occurring on land, due to Argos error, were affecting the results, positions on land were corrected using their associated Argos error following a simplified particle filter adapted from [36]. For each on-land position, 50 particles were created based on the associated Argos error with each particle classified as on-land or at-sea (Argos errors based on [32,37] for animals tagged in 1995-2011 and 2012-2016, respectively). The geographic averages of the at-sea particles were used to correct each on-land location. On-land locations where the geographic average of at-sea particles occurred on land or locations that had only on-land particles were deleted. Model results did not differ based on whether locations were corrected or not, so only original (uncorrected) positions were used in the analyses herein.

To graphically illustrate the changes in space use of ringed seals and white whales shown herein, home ranges were created for areas of high use for each species that had data available for both time periods. For ringed seals, locations within St Jonsfjorden and on the northern coast of Isfjorden (encompassing Nansenbreen, Borebreen, Wahlenbergbreen and Sveabreen) were selected and for white whales, locations near Negribreen and Heuglibreen were selected (see tables S3 and S4). A utilization distribution for each area was created using kernelUD with the smoothing parameter “href”. A 75% home range was extracted from each utilization distribution (adehabitatHR package) [38].

Spatial analyses in this study are restricted to 2-dimensional versions of space use because the large developments in biotelemetry devices that have taken place since 1995 and the realities of scale in small areas make more analytically complex comparison of the two time periods impossible. The white whales tagged in 1995-2001 and the ringed seals tagged in 1996 did not transmit comparable dive data to the biotelemetry devices used in later deployments. Therefore, analyses investigating differences in diving behaviour could not be conducted across the whole time frame of this study (differences in ringed seal diving behaviour between 2002-2003 and 2010-2013 have been published [see 15]). The small spatial scale of Svalbard’s fjords, combined with Argos error, also breaks key assumptions of other spatial analyses, such as first passage time and behavioural switching correlated random walk models [39,40]. For example, a circle with a 5 km radius encompasses both tidal glacier fronts and central areas of most fjords in Svalbard and key assumptions separating travelling and foraging in animal movement models (i.e. that travelling takes place in straight lines) are broken when attempted to deal with fine spatial scales.

References

25. Gjertz I, Kovacs KM, Lydersen C, Wiig Ø. 2000 Movements and diving of adult ringed seals (*Phoca hispida*) in Svalbard. *Polar Biol*. **23,** 651-656. (doi:10.1007/s003000000143)
26. R Development Core Team. 2013 *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing. http://www.R-project.org
27. Freitas C, Lydersen C, Fedak MA, Kovacs KM. 2008 A simple new algorithm to filter marine mammal Argos locations. *Mar. Mamm. Sci.* **24,** 315-325. (doi:10.1111/j.1748-7692.2007.00180.x)
28. Johnson DS, London JM, Lea MA, Durban JW. 2008 Continuous-time correlated random walk model for animal telemetry data. *Ecology* **89,** 1208-1215. (doi:10.1890/07-1032.1)
29. König M, Kohler J, Nuth C. 2013 Glacier area outlines – Svalbard [Data set]. Norwegian Polar Institute. (doi:10.21334/npolar.2013.89f430f8)
30. Kohler J, König M, Nuth C, Villaflor G. 2018 Svalbard tidewater glacier front database [Data set]. Norwegian Polar Institute. (doi:10.21334/npolar.2018.7cd67b1a)
31. Wood SN. 2006 *Generalized Additive Models: An Introduction With R*. Boca Raton, FL: Chapman & Hall/CRC.

32. Costa DP *et al*. 2010 Accuracy of ARGOS locations of pinnipeds at-sea estimated using Fastloc GPS. *PLoS ONE* **5,** e8677. (doi:10.1371/journal.pone.0008677)

33. Zuur AF, Ieno EN, Walker NJ, Saveliev AA, Smith GM. 2009 *Mixed Effects Models And Extensions In Ecology With R*. New York, NY: Springer-Verlag.

34. Hattermann T, Isachsen PE, von Appen WJ, Albretsen J, Sundfjord A. 2016 Eddy-driven recirculation of Atlantic water in Fram Strait. *Geophys. Res. Lett.* **43,** 3406-3414. (doi:10.1002/2016GL068323)

35. Burnham KP, Anderson DR. 2002 *Model selection and multimodel inference: a practical information-theoretic approach*. New York, NY: Springer-Verlag.

36. Tremblay Y, Robinson PW, Costa DP. 2009 A parsimonious approach to modeling animal movement data. *PLoS ONE* **4,** e4711. (doi:10.1371/journal.pone.0004711)

37. Lowther AD, Lydersen C, Fedak MA, Lovell P, Kovacs KM. 2015 The Argos-CLS Kalman filter: error structures and state-space modelling relative to Fastloc GPS data. *PLoS ONE* **10,** e0124754. (doi:10.1371/journal.pone.0124754)

38. Calenge C. 2006 The package “adehabitat” for the R software: A tool for the analysis of space and habitat use by animals. *Ecol. Model.* **197,** 516-519. (doi:10.1016/j.ecolmodel.2006.03.017)

39. Fauchald P, Tveraa T. 2003 Using first-passage time in the analysis of area-restricted search and habitat selection. *Ecology* **84,** 282-288. (doi:10.1890/0012-9658(2003)084[0282:UFPTIT]2.0.CO;2)

40. Jonsen ID, Flemming JM, Myers RA. 2005 Robust state-space modeling of animal movement data. *Ecology* **86,** 2874-2880. (doi:10.1890/04-1852)

Title: Contrasting changes in space use induced by climate change in two Arctic marine mammal species
Authors: C.D. Hamilton, J. Vacquié-Garcia, K.M. Kovacs, R.A. Ims, J. Kohler, C. Lydersen

seal ID	sex	mass (kg)	tagging date	tagging latitude (°N)	tagging longitude (°E)	tracking duration (d)
8568	F	68.5	1996-07-01	78.5	12.8	5
14747	F	51	1996-07-04	78.5	12.9	119
14748	M	69.5	1996-07-05	78.5	13.1	115
14749	F	60	1996-07-06	78.5	13.1	115
14750	F	52.5	1996-07-06	78.5	13.1	109
14751	F	52	1996-07-08	78.5	13.1	73
14752	F	68.5	1996-07-10	78.5	13.1	113
14753	M	54	1996-07-23	77.8	15.7	5
F31-02	F	31	2002-07-21	78.7	20.2	62
F33-02	F	33	2002-07-21	78.7	20.2	99
F36-02	F	36	2002-07-21	78.7	20.2	101
F37-02	F	37	2002-07-20	78.7	20.2	32
F57-02	F	57	2002-07-19	78.7	20.2	101
M28-02	M	28	2002-07-20	78.7	20.2	102
M34-02	M	34	2002-07-19	78.7	20.2	32
M50-02	M	60	2002-07-19	78.7	20.2	1
M65-02	M	65	2002-07-20	78.7	20.2	101
M72-02	M	72	2002-07-21	78.7	20.2	39
F28-03	F	28	2003-07-20	78.7	20.2	102
F34-03	F	34	2003-07-19	78.7	20.2	102
F37-03	F	37	2003-07-22	78.7	20.2	98
F53-03	F	53	2003-07-21	78.7	20.2	101
F58-03	F	58	2003-07-19	78.7	20.2	103
F59-03	F	59	2003-07-20	78.7	20.2	102
F89-03	F	89	2003-07-20	78.7	20.2	100
M40-03	M	40	2003-07-22	78.7	20.2	98
M57-03	M	57	2003-07-21	78.7	20.2	79
M59-03	M	59	2003-07-24	78.7	20.2	98
F34-10	F	34	2010-08-03	79.8	21.7	24
F52-10	F	52	2010-08-03	79.8	21.7	51
F61-11	F	61	2011-07-28	78.9	12.4	94
F66-11	F	66	2011-07-30	78.9	12.4	92
F72-11	F	72	2011-08-03	78.9	12.4	88
F73-11	F	73	2011-07-22	78.9	12.4	100
F76-11	F	76	2011-07-30	78.9	12.4	72
F99-11	F	99	2011-07-29	78.9	12.4	93
M55-11	M	55	2011-07-28	78.9	12.4	94
M57-11	M	57	2011-08-03	78.9	12.4	88
M81-11	M	81	2011-07-24	78.9	12.4	98
M90-11	M	90	2011-08-03	78.9	12.4	88
M100-11	M	100	2011-07-20	78.9	12.4	102
M44-12	M	44	2012-07-29	79.8	21.7	4
F61a-12	F	61	2012-08-15	78.9	12.4	68
F61b-12	F	61	2012-08-17	78.9	12.4	74
F64-12	F	64	2012-08-18	78.9	12.4	73
M60a-12	M	60	2012-08-25	78.5	12.6	62
M60b-12	M	60	2012-08-15	78.9	12.4	76
M74-12	M	74	2012-08-25	78.5	12.6	66
M88-12	M	88	2012-08-26	78.5	12.6	65
M100-12	M	100	2012-08-25	78.5	12.6	66
M103-12	M	103	2012-08-25	78.5	12.6	66
F55-16	F	55	2016-07-25	78.5	13.1	97
F58-16	F	58	2016-07-26	78.5	13.1	96
F65-16	F	65	2016-07-26	78.5	13.1	94
M53-16	M	53	2016-07-26	78.5	13.1	96
M65-16	M	65	2016-07-26	78.5	13.1	28

Table S1. Tagging metrics for 56 ringed seals equipped with biotelemetry devices from 1996-2016 in Svalbard, Norway, including tagging date, tagging location and tracking duration. Note that the tracking duration ends either on 01 November or when the seals left the west coast of Svalbard or the Storfjorden area.

whale ID	sex	tagging date	tagging latitude (°N)	tagging longitude (°E)	tracking duration (d)
1995-1	M	1995-07-07	77.8	16.9	31
1995-2	M	1998-07-09	77.9	16.3	30
1995-3	M	1995-07-08	77.8	15.7	58
1996-1	M	1996-07-20	77.5	16.0	7
1997-1	M	1997-08-04	77.8	16.0	54
1997-2	M	1997-08-04	77.8	16.0	34
1997-3	M	1997-08-04	77.8	16.0	82
1998-7	M	1998-09-01	78.5	18.9	7
1999-3	M	1999-08-21	78.5	18.9	72
1999-4	M	1999-08-21	78.5	18.9	13
1999-5	M	1999-08-18	78.5	18.9	63
1999-6	M	1999-08-18	78.5	18.9	68
1999-7	M	1999-08-18	78.5	18.9	55
1999-8	M	1999-08-19	78.5	18.9	65
2000-2	M	2000-10-18	78.5	18.9	13
2001-1	M	2000-10-17	78.5	18.9	10
2001-2	M	2000-10-18	78.5	18.9	13
2001-3	M	2000-10-19	78.5	18.9	12
2013-1	M	2013-08-16	79.8	12.2	76
2013-2	M	2013-08-23	78.4	17.3	70
2013-3	M	2013-08-23	78.3	15.7	69
2014-1	M	2014-08-11	77.0	16.4	20
2014-2	M	2014-08-14	77.0	16.4	51
2014-3	M	2014-08-14	77.0	16.4	78
2014-4	M	2014-08-03	78.5	18.9	81
2014-5	M	2014-08-11	77.0	16.4	81
2014-8	M	2014-08-18	77.5	14.7	21
2015-5	M	2015-07-19	79.3	11.7	19
2015-8	M	2015-07-19	79.2	11.6	2
2016-1	M	2016-08-14	78.4	17.0	78
2016-2	M	2016-08-04	78.1	14.0	88
2016-3	M	2016-08-09	78.0	14.2	82
2016-4	M	2016-07-19	78.5	11.7	56
2016-5	M	2016-08-04	78.0	14.1	88

Table S2. Tagging metrics for 34 male white whales equipped with biotelemetry devices from 1995-2016 in Svalbard, Norway, including tagging date, tagging location and tracking duration. Note that the tracking duration ends either on 01 November or when the whales left the west coast of Svalbard or the Storfjorden area.

Glacier ID	Glacier name	Percentage used 1996-2003	Percentage used 2010-2016
15404	Aavatsmarkbreen	0.30	8.01
15515	Blomstrandbreen	0.45	11.84
14901	Borebreen	0.15	1.44
15412	Comfortlessbreen	3.87	NA
15512	Conwaybreen	NA	13.14
15319	Dahlbreen	0.89	1.44
14903.1	Esmarkbreen	0.15	NA
15316	Gaffelbreen	7.75	5.00
11406	Inglefieldbreen	4.32	NA
11106.1	Johansenbreen	1.34	NA
15511.1	Kongsbreen	0.15	19.03
15314.1	Konowbreen	2.53	10.34
15511.2	Kronebreen	0.15	10.13
14902	Nansenbreen	0.30	0.55
11105.1	Negribreen	25.93	NA
11502.2	Nuddbreen/Strongbreen	1.19	NA
15313.2	Osbornebreen	0.15	7.32
11101	Pedašenkobreen	1.34	NA
11503.1	Perseibreen	2.68	NA
11106.2	Petermannbreen	7.45	0.21
11103	Sonklarbreen	29.66	NA
15107.2	Søre Buchananisen	1.64	NA
14803	Sveabreen	NA	0.55
15312	Vintervegen	0.89	6.02
14805.1	Wahlenbergbreen	0.15	2.26

Table S3. Proportion of locations that were within 5 km of the different tidal glacier fronts for 56 ringed seals equipped with biotelemetry devices in Svalbard, Norway from 1996-2016. Only glaciers that had use percentages >1.00% or are labelled in figure S2 were included; an additional 28 glaciers were excluded.

Glacier ID	Glacier name	Percentage used 1995-2001	Percentage used 2010-2015
12505	Vestre Torrellbreen	0.44	2.80
12420	Hansbreen	1.82	2.32
12418.1	Paierlbreen	0.23	1.12
12412	Storbreen	0.66	3.10
12407.2	Samarinbreen East	0.71	1.98
12202.1	Vasilievbreen	0.52	1.41
12413	Hyrnebreen	0.37	1.21
12408	Chomjakovbreen	1.39	3.35
12202.3	Vasilievbreen	0.55	2.26
11503.1	Perseibreen	1.07	0.97
11412.1	Thomsonbreen	0.34	2.41
11411.2	Ingerbreen	0.52	1.83
12104.1	Hambergbreen	1.06	0.83
13213.1	Zawadzkibreen	1.75	0.06
13214.1	Nathorstbreen	1.27	0.03
12405.1	Petersbreen	0.57	1.68
12404	Körberbreen	1.24	3.20
12407.1	Samarinbreen West	0.77	1.40
12503.1	Austre Torellbreen	0.35	3.39
13708	Fridtjovbreen	0.11	2.10
12102	Markhambreen	0.49	1.64
12101.1	Crollbreen	0.34	1.13
11505.1	Jemelianovbreen	0.57	1.47
11106.2	Petermannbreen	7.50	1.85
11105.1	Negribreen	56.97	17.41
11106.1	Johansenbreen	2.42	0.52
11103	Sonklarbreen	0.64	1.90
11101	Pedasjenkobreen	0.35	1.41
11201.1	Heuglinbreen	2.82	3.02
11201.4	Hayesbreen S	1.30	0.36
11407	Arnesenbreen	0.26	1.59
11408.1	Beresnikovbreen	0.48	2.98
11206.1	Ulvebreen	0.31	1.43
13116	Recherchebreen	NA	2.93
16111.1	Raudfjordbreen	NA	1.61

Table S4. Proportion of locations that were within 5 km of the different tidal glacier fronts for 34 male white whales equipped with biotelemetry devices in Svalbard, Norway from 1995-2016. Only glaciers that had use percentages >1.00% or are labelled in figure S2 were included; an additional 81 glaciers were excluded.

Species	Model	AICc	ΔAICc	$AICc_w$
Ringed seal	**Depth**	**274.38**	**0.00**	**0.40**
	Depth*TimePeriod+FrontLength	275.58	1.20	0.22
	Depth+TimePeriod	276.52	2.14	0.14
	Depth+TimePeriod+FrontLength	276.62	2.24	0.13
	FrontLength	276.86	2.48	0.12
White whale	Depth+TimePeriod+FrontLength	623.09	0.00	0.17
	TimePeriod+FrontLength	623.37	0.28	0.15
	Depth+TimePeriod*FrontLength	623.89	0.80	0.12
	FrontLength	**624.04**	**0.94**	**0.11**
	Depth+FrontLength	624.09	0.99	0.10
	TimePeriod*FrontLength	624.29	1.19	0.09
	Depth*TimePeriod+FrontLength	624.64	1.55	0.08
	Depth*FrontLength+TimePeriod	624.95	1.86	0.07
	Depth*TimePeriod+FrontLength*TimePeriod	625.13	2.04	0.06
	Depth*FrontLength+TimePeriod*FrontLength	625.59	2.49	0.05

Table S5. AICc table showing the AICc value, difference in AICc values and AICc weight for the top five and ten linear models for the glacier characteristics analyses for 56 ringed seals and 34 white whales, respectively, equipped with biotelemetry devices from 1995-2016 in Svalbard, Norway. The AICc selected model for each species is bolded.

Species	Predictor variable	Estimate	Std. Error	t value	p value
Ringed seal	Intercept	-5.745	0.326	-17.637	<0.001
(all glaciers)	Depth	0.054	0.020	2.678	0.009
Ringed seal	Intercept	-5.583	0.335	-16.658	<0.001
(without largest glaciers)	Depth	0.035	0.023	1.565	0.122
White whale	Intercept	-6.388	0.156	-40.920	<0.001
(all glaciers)	Front length	0.0002	0.00003	5.716	<0.001
White whale	Intercept	-6.290	0.175	-35.980	<0.001
(without largest glaciers)	Front length	$2x10^{-4}$	$4x10^{-5}$	3.612	<0.001

Table S6. Results of the linear models examining the glacier characteristics for 56 ringed seals and 34 white whales equipped with biotelemetry devices from 1995-2016 in Svalbard, Norway. ”Largest glaciers” refers to Negribreen (both species) and Sonklarbreen (ringed seals only); these two glaciers had frontal lengths and depths over two times larger than the next largest glacier.

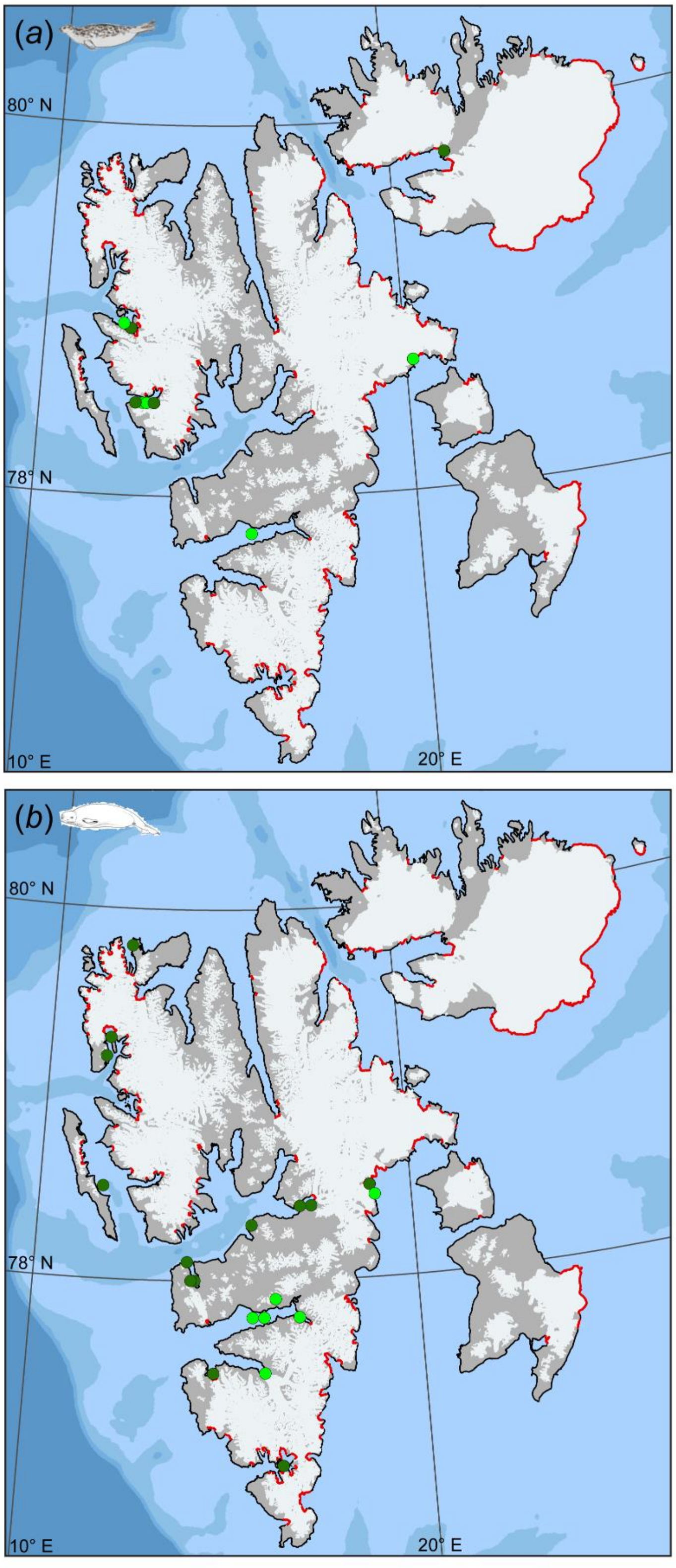

Figure S1. Tagging locations for (*a*) 56 ringed seals and (*b*) 34 white whales equipped with biotelemetry devices in 1995-2003 (light-green) and 2010-2016 (dark-green) in Svalbard, Norway. Tidal glacier fronts (red), glaciers (white) and land (grey) in 2015 are shown.

Title: Contrasting changes in space use induced by climate change in two Arctic marine mammal species
Authors: C.D. Hamilton, J. Vacquié-Garcia, K.M. Kovacs, R.A. Ims, J. Kohler, C. Lydersen

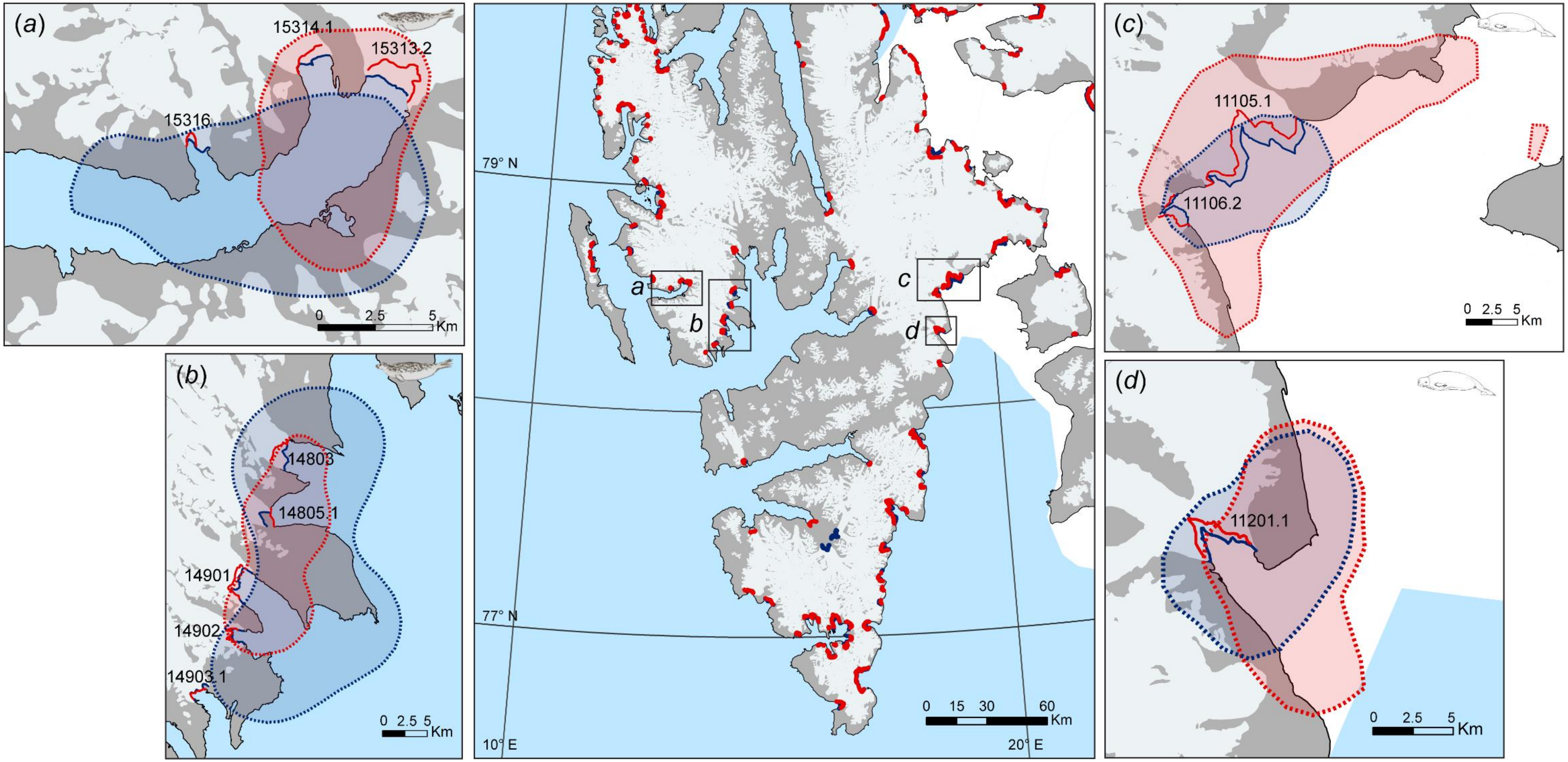

Figure S2. Changes in glacier front locations, sea-ice extent and home range size for selected areas (based on data availability in both time periods) for (*a*,*b*) 56 ringed seals and (*c*,*d*) 34 white whales equipped with biotelemetry devices from 1995-2016 in Svalbard, Norway. Tidal glacier fronts in 2010 (dark-blue solid lines) and 2015 (red solid lines), sea-ice concentration ≥ 10% in October 2003 (white), glaciers (light-grey; 2010) and land (dark-grey; 2010) are shown. Sea ice with ≥ 10% concentration was largely absent from these areas in the summer and autumn in 2010-2016. The shaded areas (with dotted outlines) indicate the 75% home range sizes of animals in these areas in 1995-2003 (dark-blue) and 2010-2016 (red). The 75% home range sizes changed from (*a*) 98 km^2 in 1996-2003 to 60 km^2 in 2010-2016, (*b*) 541 km^2 in 1996-2003 to 189 km^2 in 2010-2016, (*c*) 146 km^2 in 1995-2001 to 443 km^2 in 2013-2016 and (*d*) 114 km^2 in 1995-2001 to 132 km^2 in 2013-2016. Home ranges also became more and less concentrated around tidal glacier fronts for ringed seals and white whales, respectively, between 1995-2003 and 2010-2016. The numbers in the inset maps correspond to the glacier IDs in tables S3 and S4.