Population-specific sex and size variation in long-term foraging ecology of belugas and narwhals

Supplementary tables and figures

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Table S1. Sample information. For each individual, we include sample ID (MCE is the collection number at the Natural History Museum of Denmark, University of Copenhagen), TEAL (lab ID at the University of Trent, Canada) population, $\delta^{13}C$, $\delta^{13}C$ corrected for the Suess effect, $\delta^{15}N$ (‰), sample locality, sex, year of sampling, and size proxy for each individual (in cm, length for the total skull length and L2 for the other measure for belugas, see Supplementary Figure 1).

MCE	TEAL	Population	$\delta^{13}C$	$\delta^{13}C$ Suess	$\delta^{15}N$	Locality	Sex	year	Length	L2
571	1312	WG beluga	-15.04	-14.42	17.46	Kullorsuaq	unknown	1990	52.3	32.5
572	1313	WG beluga	-14.77	-14.16	17.22	Kullorsuaq	unknown	1990	46.6	28.2
573	1314	WG beluga	-14.52	-13.89	17.1	Kullorsuaq	unknown	1991	52.5	32.5
587	1316	WG beluga	-14.68	-14	18.44	Nuusuaaq	male	1994	NA	NA
588	1318	WG beluga	-15.14	-14.46	15.95	Nuusuaaq	male	1994	40	23
589	1319	WG beluga	-14.9	-14.22	18.07	Nuusuaaq	male	1994	61.7	41
590	1320	WG beluga	-14.6	-13.91	18.03	Nuusuaaq	male	1994	62.7	42
591	1321	WG beluga	-15.07	-14.39	18.61	Nuusuaaq	male	1994	62.2	42.2
592	1322	WG beluga	-15.22	-14.54	15.99	Nuusuaaq	female	1994	56.1	34
593	1323	WG beluga	-14.43	-13.74	17.25	Nuusuaaq	female	1994	54	34.2
594	1324	WG beluga	-14.56	-13.88	17.66	Nuusuaaq	male	1994	NA	37
595	1325	WG beluga	-14.45	-13.77	17.22	Nuusuaaq	male	1994	NA	38.4
596	1326	WG beluga	-14.91	-14.23	17.51	Nuusuaaq	male	1994	58.6	NA
599	1329	WG beluga	-14.71	-14.02	17.67	Nuusuaaq	male	1994	64.3	44.5
600	1330	WG beluga	-14.7	-14.02	16.82	Nuusuaaq	female	1994	NA	34.8
601	1331	WG beluga	-14.76	-14.07	17.77	Nuusuaaq	female	1994	NA	35.7
602	1332	WG beluga	-14.66	-13.98	16.45	Nuusuaaq	female	1994	NA	34.2
603	1333	WG beluga	-14.57	-13.88	17.02	Nuusuaaq	female	1994	NA	36
4070	1334	WG beluga	-14.59	-13.91	17.28	Nuusuaaq	female	1994	46.6	28.3
4069	1335	WG beluga	-14.32	-13.64	17.8	Nuusuaaq	male	1994	62.3	43.4
4067	1337	WG beluga	-14.84	-14.15	17.52	Nuusuaaq	male	1994	NA	35.1
4068	1338	WG beluga	-14.98	-14.29	17.12	Nuusuaaq	female	1994	46.2	29
4065	1343	WG beluga	-14.47	-13.79	17.67	Nuusuaaq	unknown	1994	62.5	40.6
4064	1344	WG beluga	-14.43	-13.75	17.17	Nuusuaaq	male	1994	60.5	39.2
4063	1345	WG beluga	-14.74	-14.06	16.33	Nuusuaaq	female	1994	NA	35.6
4071	1350	WG beluga	-14.2	-13.52	16.8	Nuusuaaq	male	1994	55.7	35.5

4072	1351	WG beluga	-15.03	-14.34	16.76	Nuusuaaq	male	1994	51	31
576	1358	WG narwhal	-14.87	-14.2	17.24	Uummannaq	unknown	1993	NA	NA
577	1359	WG narwhal	-15.83	-15.17	17.48	Uummannaq	female	1993	48.9	NA
580	1360	WG narwhal	-15.15	-14.48	17.72	Uummannaq	female	1993	57.8	NA
581	1361	WG narwhal	-15.14	-14.47	16.91	Uummannaq	female	1993	56.4	NA
582	1362	WG narwhal	-15.24	-14.57	16.69	Uummannaq	female	1993	NA	NA
583	1363	WG narwhal	-15.56	-14.9	16.77	Uummannaq	female	1993	NA	NA
584	1364	WG narwhal	-15.81	-15.14	16.38	Melville Bay	female	1993	43.7	NA
585	1365	WG narwhal	-15.43	-14.76	17.54	Melville Bay	male	1993	49.2	NA
586	1366	WG narwhal	-14.93	-14.27	17.55	Melville Bay	female	1993	58.7	NA
4000	1367	WG narwhal	-15.49	-14.64	16.4	Qaanaaq	male	2002	NA	NA
4042	1369	WG narwhal	-15.13	-14.26	16.65	Qaanaaq	male	2003	NA	NA
4043	1370	WG narwhal	-14.93	-14.05	16.62	Qaanaaq	male	2003	57.3	NA
4044	1371	WG narwhal	-15.45	-14.58	16.58	Qaanaaq	male	2003	62.9	NA
4045	1372	WG narwhal	-15.29	-14.42	17.69	Qaanaaq	female	2003	58.6	NA
613	1374	WG narwhal	-15.36	-14.48	16.32	Qaanaaq	male	2003	NA	NA
4047	1375	WG narwhal	-15.24	-14.37	16.44	Qaanaaq	female	2003	NA	NA
4048	1376	WG narwhal	-14.83	-13.95	17.14	Qaanaaq	male	2003	NA	NA
615	1377	WG narwhal	-15.86	-14.99	16.73	Qaanaaq	male	2003	61.3	NA
605	1380	WG narwhal	-15.42	-14.55	16.55	Qaanaaq	female	2003	NA	NA
607	1382	WG narwhal	-15.13	-14.26	16.69	Qaanaaq	female	2003	53.2	NA
608	1383	WG narwhal	-15.22	-14.35	16.05	Qaanaaq	female	2003	53.3	NA
609	1384	WG narwhal	-14.82	-13.95	16.9	Qaanaaq	male	2003	61	NA
610	1386	WG narwhal	-15.11	-14.24	16.82	Qaanaaq	male	2003	58.5	NA
611	1388	WG narwhal	-14.88	-14.01	16.63	Qaanaaq	female	2003	NA	NA
612	1389	WG narwhal	-14.86	-13.99	16.13	Qaanaaq	female	2003	54.2	NA
4049	1390	WG narwhal	-14.99	-14.12	16.82	Qaanaaq	male	2003	63.6	NA
4050	1392	WG narwhal	-15.34	-14.44	16.37	Qeqertarsuaq	male	2004	56.2	NA
4051	1393	WG narwhal	-15.28	-14.38	16.48	Qeqertarsuaq	male	2004	NA	NA
4052	1397	WG narwhal	-15.4	-14.5	16.54	Qeqertarsuaq	female	2004	52.8	NA
4053	1398	WG narwhal	-15.35	-14.45	16.49	Qeqertarsuaq	male	2004	60.9	NA
4054	1400	WG narwhal	-15.35	-14.45	16.26	Qeqertarsuaq	male	2004	NA	NA
4056	1402	WG narwhal	-15.32	-14.42	16.68	Qeqertarsuaq	female	2004	NA	NA
4055	1403	WG narwhal	-15.72	-14.83	16.12	Qeqertarsuaq	male	2004	NA	NA
4057	1405	WG narwhal	-14.88	-13.93	17.34	Melville Bay	male	2006	62.1	NA
4058	1406	WG narwhal	-15.17	-14.22	17.16	Melville Bay	female	2006	57.5	NA
4059	1408	WG narwhal	-15.16	-14.21	16.76	Melville Bay	female	2006	53.2	NA
4060	1409	WG narwhal	-15.12	-14.17	17.74	Melville Bay	female	2006	56.8	NA
4061	1414	WG narwhal	-15.52	-14.58	16.94	Qaanaaq	male	2006	NA	NA
4062	1419	WG narwhal	-15.13	-14.18	16.4	Qaanaaq	male	2006	56.7	NA
4033	1574	WG narwhal	-15.09	-14.42	17.18	Uummannaq	female	1993	46.8	NA
4001	1432	EG narwhal	-16.29	-15.6	16.25	Scoresbysund	male	1994	NA	NA

4002	1433	EG narwhal	-16.86	-16.18	15.8	Scoresbysund	male	1994	NA	NA
4003	1434	EG narwhal	-16.33	-15.64	16.81	Scoresbysund	male	1994	60.9	NA
4004	1435	EG narwhal	-16.86	-16.18	16.45	Scoresbysund	male	1994	57.7	NA
4005	1436	EG narwhal	-16.37	-15.68	17.24	Scoresbysund	male	1994	65	NA
4006	1437	EG narwhal	-16.7	-16.02	17.19	Scoresbysund	male	1994	56.9	NA
4007	1438	EG narwhal	-17.28	-16.59	15.64	Scoresbysund	male	1994	51.1	NA
4008	1439	EG narwhal	-16.88	-16.2	16.27	Scoresbysund	male	1994	64.4	NA
4009	1440	EG narwhal	-16.83	-16.15	16.07	Scoresbysund	female	1994	56.8	NA
4010	1441	EG narwhal	-16.84	-16.16	15.83	Scoresbysund	male	1994	52.9	NA
4011	1442	EG narwhal	-16.54	-15.86	16.33	Scoresbysund	male	1994	60.1	NA
4012	1443	EG narwhal	-16.86	-16.18	15.87	Scoresbysund	male	1994	60.8	NA
4014	1445	EG narwhal	-16.93	-16.23	15.84	Scoresbysund	female	1995	57.8	NA
4015	1446	EG narwhal	-16.67	-15.97	15.65	Scoresbysund	female	1995	52.1	NA
4016	1447	EG narwhal	-16.94	-16.24	15.56	Scoresbysund	male	1995	54	NA
4017	1448	EG narwhal	-17.12	-16.42	15.78	Scoresbysund	female	1995	50.9	NA
4018	1449	EG narwhal	-17.09	-16.39	14.91	Scoresbysund	female	1995	46.5	NA
4019	1450	EG narwhal	-16.73	-16.03	15.83	Scoresbysund	female	1995	54.1	NA
4020	1451	EG narwhal	-16.74	-16.04	15.85	Scoresbysund	female	1995	58.5	NA
4022	1452	EG narwhal	-17.23	-16.53	15.43	Scoresbysund	male	1995	52.9	NA
4023	1453	EG narwhal	-16.98	-16.28	15.91	Scoresbysund	unknown	1995	NA	NA
4021	1454	EG narwhal	-16.79	-16.09	15.77	Scoresbysund	male	1995	49.4	NA
4024	1455	EG narwhal	-16.43	-15.73	14.47	Scoresbysund	male	1995	53.6	NA
4025	1456	EG narwhal	-16.38	-15.68	15.01	Scoresbysund	female	1995	56.8	NA
4026	1457	EG narwhal	-16.77	-16.07	15	Scoresbysund	female	1995	53.3	NA
4027	1458	EG narwhal	-16.89	-16.19	14.91	Scoresbysund	female	1995	53.4	NA
4028	1459	EG narwhal	-16.6	-15.9	14.46	Scoresbysund	female	1995	54.1	NA
4029	1460	EG narwhal	-16.42	-15.72	15.11	Scoresbysund	male	1995	55.4	NA
4030	1461	EG narwhal	-16.73	-16.03	14.93	Scoresbysund	female	1995	55.6	NA
4031	1462	EG narwhal	-16.91	-16.21	14.75	Scoresbysund	male	1995	46.8	NA
4032	1463	EG narwhal	-16.93	-16.23	14.92	Scoresbysund	female	1995	52.3	NA
4034	1578	EG narwhal	-17.08	-16.11	15.83	Scoresbysund	female	2007	57.8	NA
4035	1579	EG narwhal	-17.1	-16.13	15.96	Scoresbysund	female	2007	55.3	NA
4036	1580	EG narwhal	-17.16	-16.19	15.38	Scoresbysund	female	2007	53.4	NA
4037	1581	EG narwhal	-16.89	-15.92	15.54	Scoresbysund	male	2007	NA	NA
4038	1584	EG narwhal	-16.88	-15.91	15.98	Scoresbysund	male	2007	NA	NA
4040	1585	EG narwhal	-16.72	-15.75	15.82	Scoresbysund	male	2007	NA	NA
4041	1589	EG narwhal	-17.23	-16.26	15.48	Scoresbysund	male	2007	NA	NA
4039	1591	EG narwhal	-16.92	-15.95	16.83	Scoresbysund	male	2007	NA	NA

Table S2. Mean isotopic compositions recorded for reference materials analyzed alongside the samples presented in this study. Mean values for USGS40 and USGS41a are not presented, as these are predetermined.

Standard	**N**	**$\delta^{13}C$**	**$\delta^{15}N$**
USGS40	11	±0.04	±0.17
USGS41a	7	±0.06	±0.16
SRM-1	6	-19.41 ± 0.03	+1.78 ± 0.09
SRM-2	9	-14.84 ± 0.03	+15.60 ± 0.04
SRM-14	7	-13.75 ± 0.05	+21.62 ± 0.15
SRM-17	5	-12.53 ± 0.02	+3.17 ± 0.11

Table S3. Stable isotope data summary. Sample size (n), $\delta^{13}C$ and $\delta^{15}N$ mean and SD (‰), mean SEA_C and SEA_B values ($‰^2$) in West Greenland (WG) belugas, WG narwhals, and East Greenland (EG) narwhals for all individuals, males and females.

Group	**n**	**$\delta^{13}C$ (‰)**	**$\delta^{15}N$ (‰)**	**SEA_C (‰2)**	**SEA_B ($‰^2$)**
WG belugas	27	-14.0 (0.26)	17.3 (0.66)	0.56	0.56
WG narwhals	40	-14.4 (0.31)	16.8 (0.46)	0.46	0.46
EG narwhals	39	-16.1 (0.24)	15.7 (0.67)	0.51	0.51
WG beluga males	14	-14.0 (0.29)	17.5 (0.71)	0.7	0.85
WG beluga females	9	-14.1 (0.24)	16.9 (0.55)	0.41	0.27
WG narwhals males	19	-14.4 (0.31)	16.7 (0.37)	0.37	0.37
WG narwhals females	20	-14.4 (0.32)	16.9 (0.52)	0.55	0.55
EG narwhals males	22	-16.0 (0.28)	15.9 (0.71)	0.62	0.63
EG narwhals females	16	-16.1 (0.18)	15.4 (0.51)	0.3	0.3

Figure S1. Photo of the measurement of “length 2 (L2)”, as a proxy of total (condylobasal) length measure used for belugas to increase sample size, due to many skulls being broken.

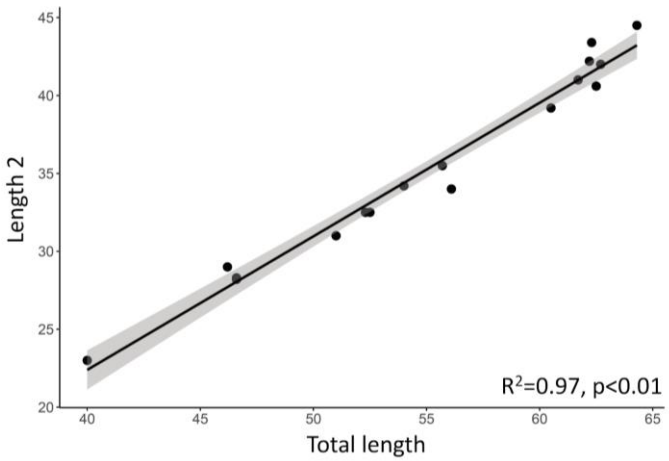

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Figure S2. Variation of length 2 (cm, see Supplementary Figure 1) according to total (condylobasal) skull length (cm) for beluga samples for which both measures could be taken (n=17). R^2=0.97 and P<0.01.The regression line and the confidence interval (grey shading) are plotted.

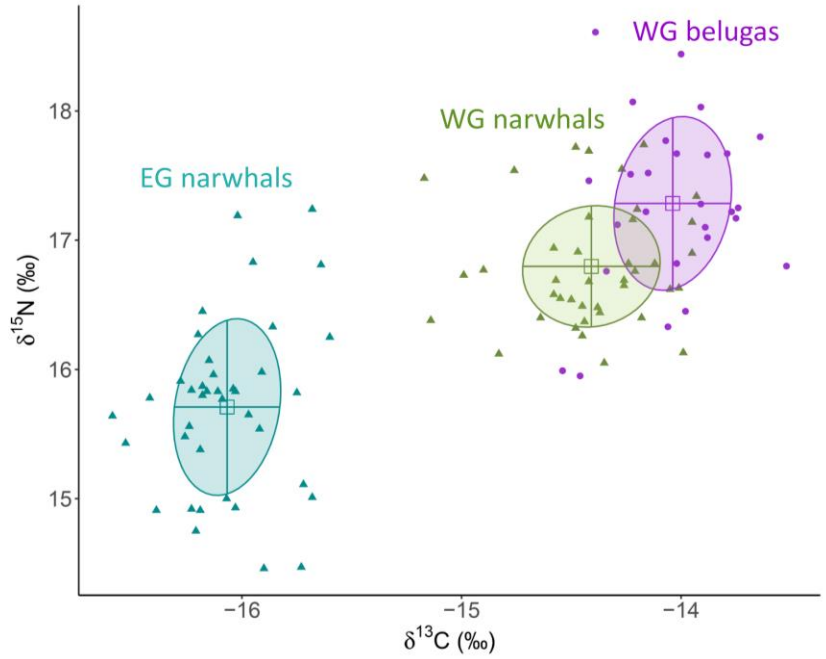

Figure S3. Bone $\delta^{13}C$ and $\delta^{15}N$ values for West Greenland (WG) belugas (n=27), WG narwhals (n=40), and East Greenland (EG) narwhals (n=39). Solid circles indicate Bayesian standard ellipse areas (SEA_B). Mean (square) and SD (error bars) are indicated.

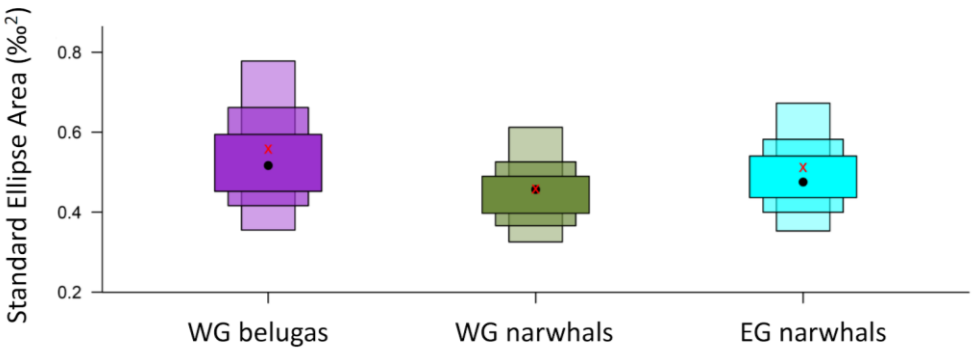

Figure S4. Size of the Standard Ellipse Areas (SEA, ‰^{2}) for West Greenland (WG) belugas (n=27), WG narwhals (n=40), and East Greenland (EG) narwhals (n=39), with the black dot indicating the mode of the size of the SEA_B, the red cross the mean for the SEA_C, and the box edges the 50, 75 and 95% credible intervals.

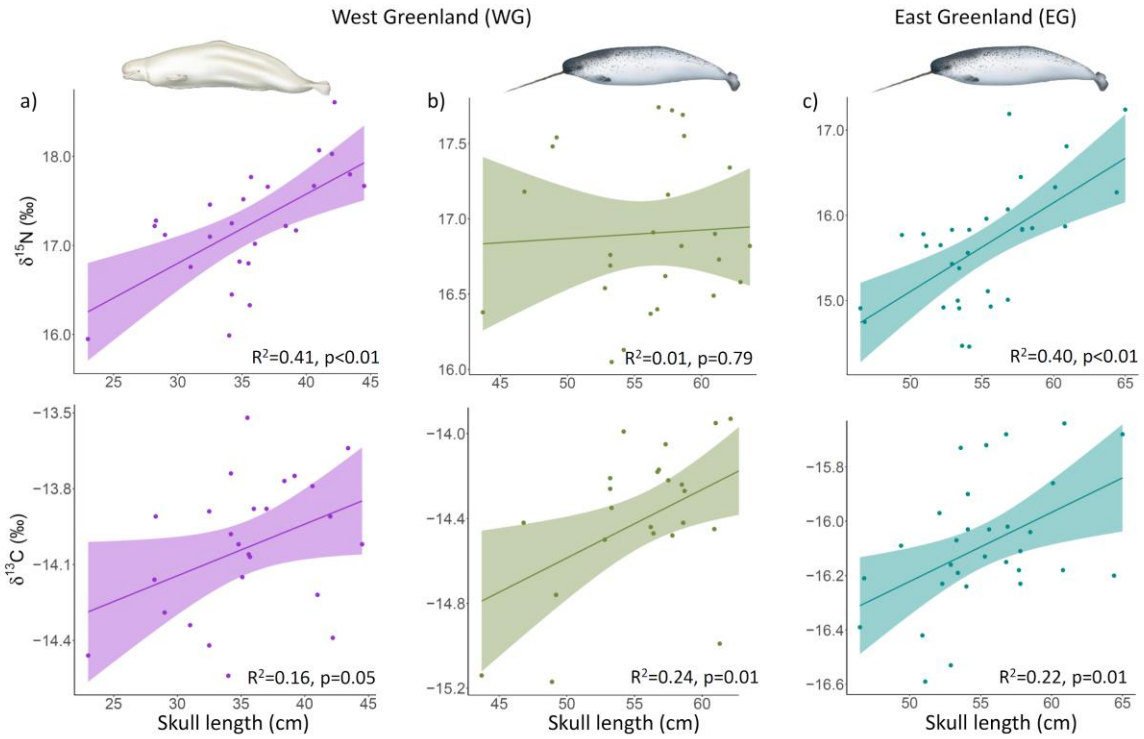

Figure S5. Variation in $\delta^{13}C$ and $\delta^{15}N$ from bone samples according to skull length (in cm) for a) WG belugas (n=25); b) WG narwhals (n=25); c) EG narwhals (n=31). Regression lines and the confidence intervals (coloured shading) are included. Whale illustrations by Uko Gorter.

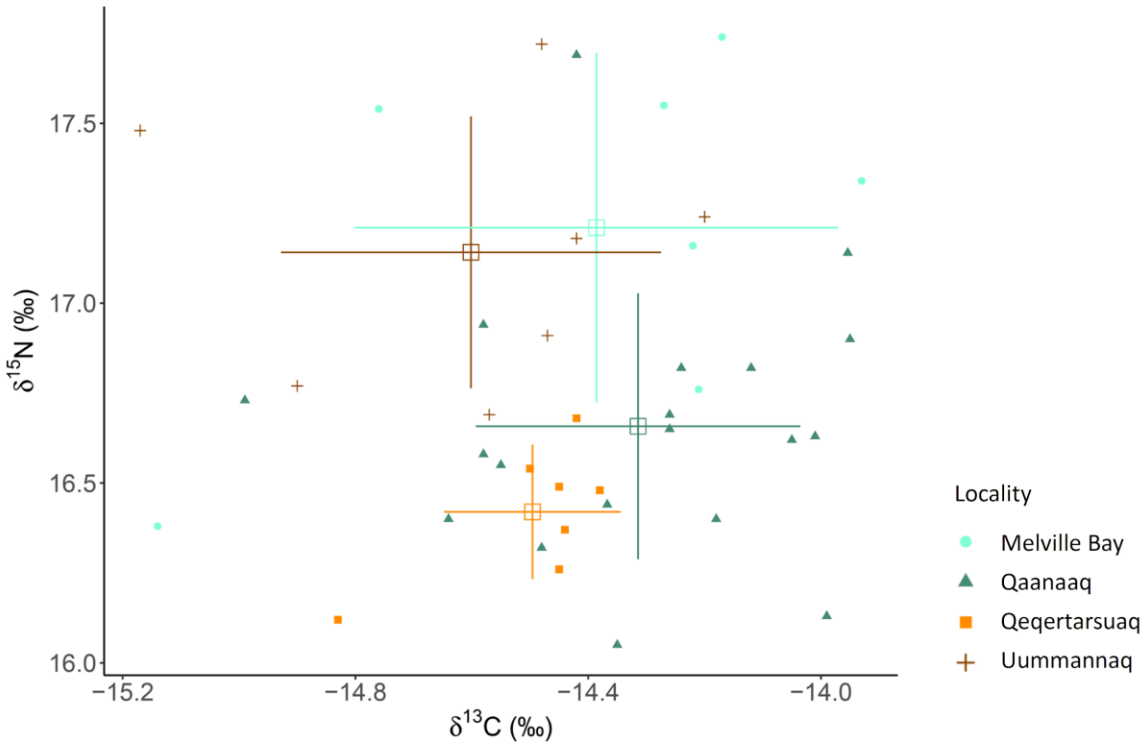

Figure S6. Bone $\delta^{13}C$ and $\delta^{15}N$ values for West Greenland (WG) narwhals from different localities. Melville Bay (n=7) and Qaanaaq (n=19) are summering localities while Qeqertarsuaq (n=7) and Uummannaq (n=7) are migratory areas. Mean (square) and SD (error bars) are also indicated.

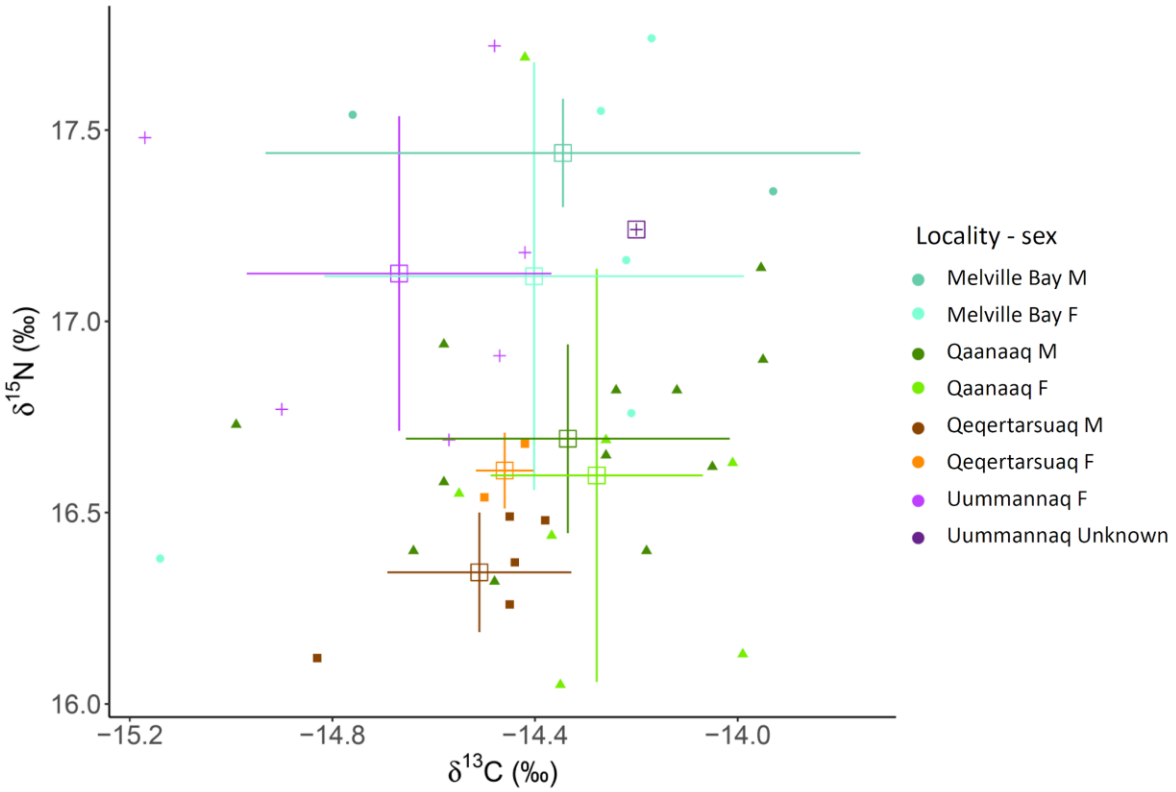

Figure S7. Bone $\delta^{13}C$ and $\delta^{15}N$ values for male and female West Greenland (WG) narwhals from different localities. Melville Bay (n_M=2, n_F=5) and Qaanaaq (n_M=10, n_F=7) are summering localities while Qeqertarsuaq (n_M=5, n_F=2) and Uummannaq (n_F=6, unknown sex=1) are migratory areas. Mean (square) and SD (error bars) are also indicated.

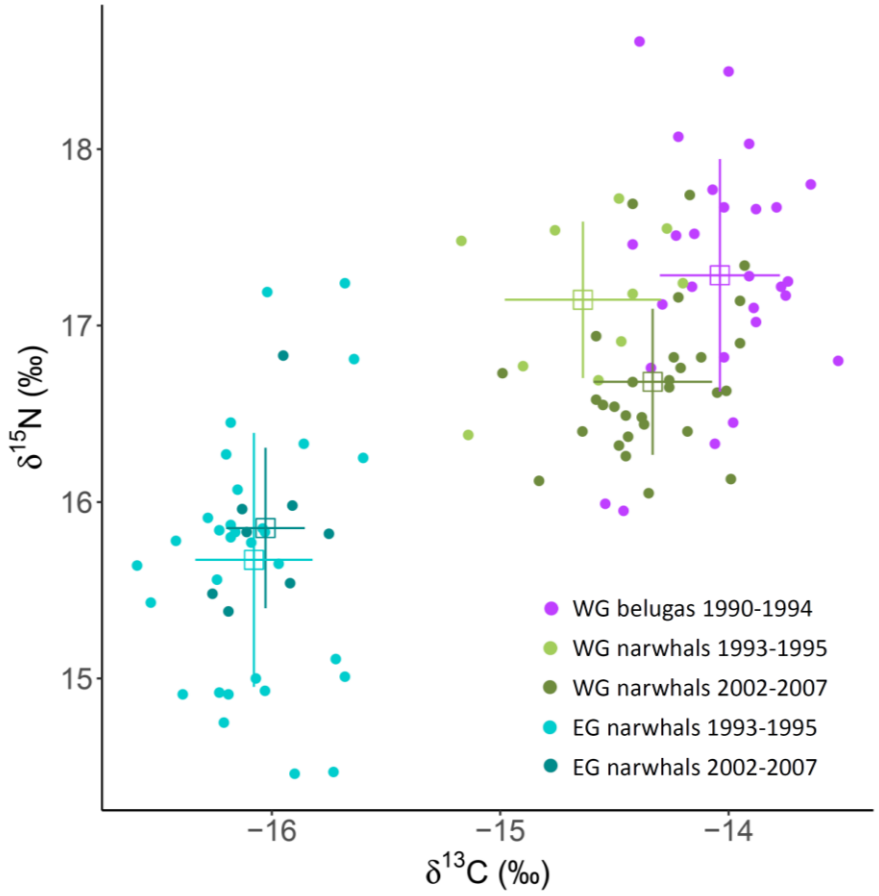

Figure S8. Bone $\delta^{13}C$ and $\delta^{15}N$ values for West Greenland (WG) belugas in 1990-1994 (n=27), WG narwhals in 1993-1995 (n=10) and 2002-2007 (n=30), and East Greenland (EG) narwhals in 1993-1995 (n=31) and 2002-2007 (n=8). Mean (square) and SD (error bars) are also indicated.