Table S1. Summary of site locations and deployment details**.** Site designations are: GC - Green Canyon MC - Mississippi Canyon, and DT - Dry Tortugas.

Site	**Deployment number**	**Longitude (W)**	**Latitude (N)**	**Depth (m)**	**Start Date**	**End Date**	**Data Duration (days)**	**Data Size (TB)**
GC	1	91°10.01’	27°33.47’	1115	15-Jul-10	11-Oct-10	88	2.77
GC	2	91°10.01’	27°33.47’	1160	08-Nov-10	02-Feb-11	86	2.70
GC	3	91°10.07’	27°33.42’	1100	23-Mar-11	08-Aug-11	138	4.34
GC	4	91°10.06’	27°33.43’	1100	23-Sep-11	17-Feb-12	118	3.71
GC	5	91°10.56’	27°33.44’	1100	28-Feb-12	12-Dec-12	289	9.08
GC	6	91°10.09’	27°33.35’	1100	12-Dec-12	10-Sep-13	271	8.52
GC	7	91°10.09’	27°33.35’	1100	13-Jan-14	29-Sep-14	254	7.99
GC	8	91°10.07’	27°33.37’	1100	19-Oct-14	10-Jun-15	234	7.34
GC	9	91°10.10’	27°33.36’	1133	07-Aug-15	23-May-16	290	9.10
GC	10	91°10.08’	27°33.37’	1129	20-Jul-16	17-May-17	301	9.46
MC	1	88°27.93’	28°50.75’	980	16-May-10	28-Aug-10	104	3.27
MC	2	88°27.91’	28°50.77’	980	07-Sep-10	19-Dec-10	103	3.24
MC	3	88°27.91’	28°50.78’	980	20-Dec-10	21-Mar-11	91	2.86
MC	4	88°27.95’	28°50.76’	980	22-Mar-11	09-Apr-11	146	4.59
MC	5	88°27.99’	28°50.80’	980	22-Sep-11	21-Feb-12	152	4.78
MC	6	88°28.04’	28°50.85’	980	29-Feb-12	11-Dec-12	288	9.05
MC	7	88°28.06’	28°50.78’	900	11-Dec-12	03-Aug-13	235	7.39
MC	9	88°28.10’	28°58.85’	800	23-Ap-14	28-Sep-14	159	5.00
MC	10	88°28.08’	28°58.73’	800	29-Sep-14	15-Jul-14	289	9.09
MC	11	88°28.08’	28°58.73’	770	07-Aug-15	11-Mar-16	217	6.82
MC	12	88°28.08’	28°58.73’	775	20-Jul-16	16-May-17	299	9.41
DT	1	84°38.25’	25°31.91’	1320	09-Aug-10	26-Oct-10	79	2.48
DT	2	84°38.25’	25°31.91’	1320	04-Mar-11	24-Jun-11	111	3.49
DT	3	84°38.26’	25°31.86’	1300	13-Jul-11	14-Nov-11	124	3.90
DT	4	84°38.26’	25°31.87’	1300	14-Dec-11	09-Jan-12	26	0.82
DT	5	84°38.04’	25°31.94’	1200	28-May-12	07-Dec-12	195	6.13
DT	6	84°38.05’	25°31.94’	1200	07-Dec-12	18-Aug-13	253	7.95
DT	7	84°38.15’	25°32.22’	1158	01-Nov-13	17-Aug-14	290	9.10
DT	8	84°37.87’	25°32.32’	1189	28-Sep-14	15-Jul-15	289	9.10
DT	9	84°37.88’	25°32.32’	1240	02-Aug-15	15-Mar-16	226	7.11
DT	10	84°37.74’	25°32.36’	1210	22-Jun-16	08-Dec-16	170	5.33
						Full Effort	**16 years**	**186 TB**

Table S2. Summary of grid-search optimization listing optimized parameter values, the minimum and maximum search range values based on published references for other populations or demographics.

Parameter		Optimized distribution sample mean	SD	Range of values searched for optimization		Reference
				Min	*Max*	
Signal characteristics (demographic-specific)						
Source level (dB_{pp})	Social group	237 ±5	2-3	229 ±5	243 ±5	*Other population*: 229 dB_{peak} re: 1 µPa (Zimmer et al. 2005), 235 dB_{rms} re: 1 µPa (Møhl et al. 2003) **equivalent to 235-244 dB_{pp}* re: 1 µPa, respectively
	Mid-size	238 ±5		230 ±5	243 ±5	
	Adult male	242 ±5		233 ±5	250 ±5	
Directivity (dB)	Social group	30.5 ±2.5	-	25 ±2.5	33 ±2.5	*Other population*: 26.7 (Zimmer et al. 2005), 27 (Møhl et al. 2003)
	Mid-size	32.5 ±2.5				
	Adult male	32.5 ±2.5				
Minimum off-axis transmission loss (dB) *(Group counting)*		34.5 ± 1.5	2-3	33 ±1.5	40 ±1.5	*Other population*: ~ 40 (Zimmer et al. 2005)
Diving behavior (site-specific):						
Water column dive altitude (m)	MC	450 ± 50	10-30	300 ±50	600 ±50	*GoMex population*: 644 (Watwood et al. 2006) **dive depth (not relative to seafloor depth)*
	GC	650 ± 50		400 ±50	700 ±50	
	DT	850 ± 50		600 ±50	900 ±50	
Water column dive fraction (%)	MC	55 ± 5	1-2	55 ±5	95 ±50	*GoMex population*: Watwood et al. (2006) did not distinguished between pelagic and benthic dives, stating benthic dives were infrequent.
	GC	55 ± 5				
	DT	95 ± 5				
Benthic dive fraction (%)	MC	45 ± 5	1-2	5 ±5	45 ±5	*GoMex population*: Bimodal dive of a 20-hour dive profile (Mate et al. 2017). *Other population*: median 0.9 – 21.9 % (Irvine et al. 2017)
	GC	55 ± 5				
	DT	5 ± 5				

Table S3. Summary of published echolocation click rates of sperm whales. Mean click rates and inter-click intervals organized by known age group and sex, site and study. For each example, the number of whales and number of clicks per dive or session are indicated. When available, uncertainty in mean values is included in parentheses.

Sex/age of whales analyzed	Num. of whales	Sample size (clicks)	μ click rate (s^{-1})	μ ICI (s)	Location
Females or immatures	Group	-	1 – 3[2]	0.33 – 1[1]	SE Caribbean (Watkins et al. 1985)
Females or immatures	9	1397 (9 sessions)	-	0.51[3]	Galapagos Islands (Weilgart & Whitehead 1988)
Females or immatures	9	1322 5-min recording sessions	-	0.5[6]	Galapagos Islands (Weilgart & Whitehead 1990)
Females	4	1032, 664, 547, 1711	1.92 (0.04[4]), 1.52 (0.08[4]), 1.83 (0.04[4]), 2.15 (0.03[4])	0.52[1], 0.66[1], 0.55[1], 0.46[1]	Azores (Goold & Jones 1995)
10 m individual	1	1804 (1 dive)	~ 1 – 4[2]	stable 0.5 (0.25 – 1[2])	Papua New Guinea (Madsen et al. 2002)
Sub-adult males	3	4647 (3 dives), 4274 (3 dives), 4807 (3 dives)	1.37 (0.24[4]), 1.32 (0.67[4]), 1.12 (0.34[4])	0.73[1], 0.76[1], 0.89[1]	Kaikoura, New Zealand (Douglas et al. 2005)
Males (presumed sub-adults)	2	18, 20	-	0.96 (0.14[5]), 0.69 (0.18[5])	Scotian Shelf, Nova Scotia (Mullins et al. 1988)
Male (smaller than a bull)	1	975	1.40 (0.04[4])	0.71[1]	Azores (Goold & Jones 1995)
Males	4	1056, 1125, 655, 775	1.07 (0.03[4]), 1.07 (0.03[4]), 1.30 (0.07[4]), 1.09 (0.03[4])	0.93[1], 0.94[1], 0.77[1], 0.91[1]	Azores (Goold & Jones 1995)
Adult male	1	5 dives	-	0.30 – 1.7[2]	Norway (Wahlberg 2002)
Adult males	4	158217 (29 dives), 128153 (25 dives), 88222 (17 dives), 61546 (12 dives)	-	0.8[6], 0.8[6], 0.4 and 0.8[6], 0.4[6]	Norway (Teloni et al. 2008)
Unknown	1	14100	-	1.0[6]	Ligurian Sea (Zimmer et al. 2005)

[1] Converted from click rate values, [2] Range, [3] Median, [4] 95% CI, [5] Standard deviation, [6] Mode

Table S4. Mean of Gaussian fit for log_{10} number of clicks per 5-min bin, selected for bins with at least one click of amplitude > 160 dB_{pp}, by demographic class and site (MC, GC, and DT). Expected number of clicks represent those expected from a single continuously clicking animal based on mean ICIs of that demographic group.

Demographic class	**Measured # clicks/5-min**			**Expected # clicks/5-min bin**			**# bins with > 160 dB**		
	MC	**GC**	**DT**	**MC**	**GC**	**DT**	**MC**	**GC**	**DT**
Social group	317	346	336	628	626	583	16199	3730	957
Mid-size	139	106	111	430	429	427	434	385	108
Adult male	111	148	120	342	396	367	153	159	60

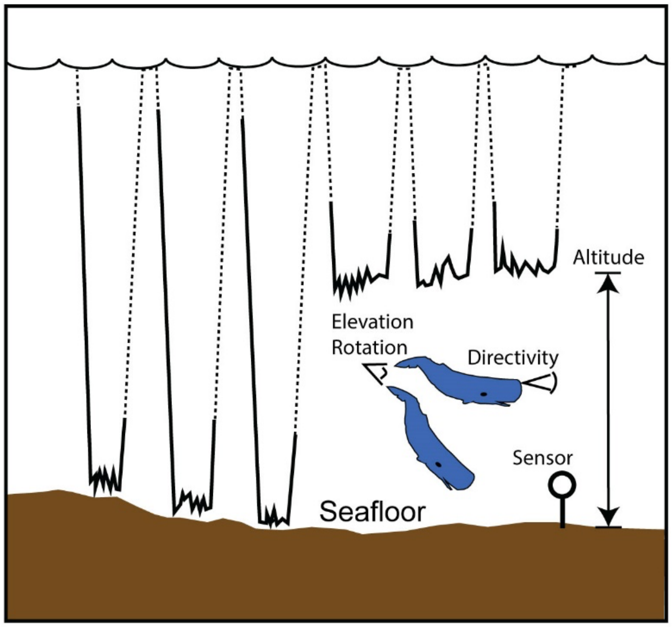

Figure S1. Sperm whales click detection model while diving (dotted lines) near the seafloor (left) and in the mid-water column (right). The bold portion of the dive track denotes the time spent clicking (following (Watwood et al. 2006)). The model considers the detection probability both for individual clicks, and for detecting at least one click when a group of animals is present.

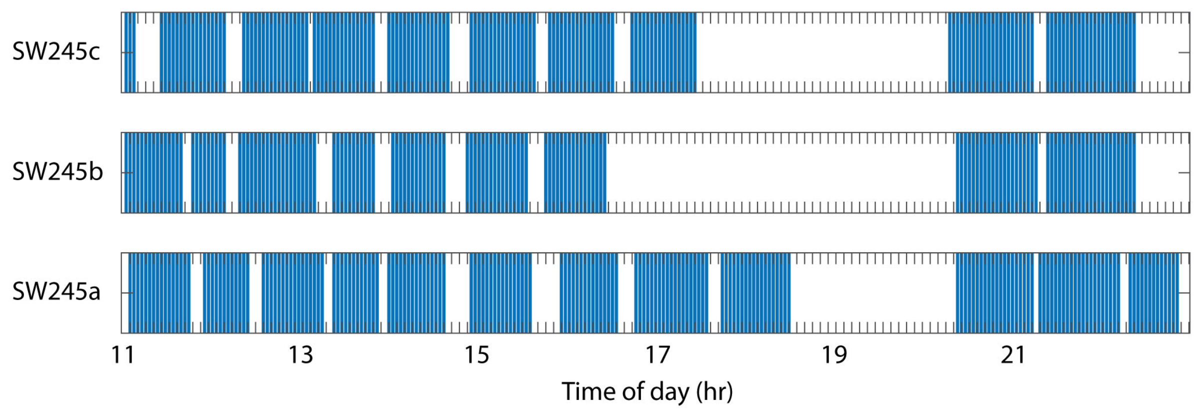

Figure S2. Echolocation sequences for three sperm whales simultaneously tagged in the northern Gulf of Mexico by (Jochens et al. 2008). Blue bars are periods of echolocation adapted from Hildebrand et al. 2012. Synchrony among pairs of whales within the group was estimated, and was on average 77% ± 4 % (with an overlap of 80% between pair SW245c-SW245b, 76% between pair SW245c-SW245a, and 71% between pair SW245b-SW245a)

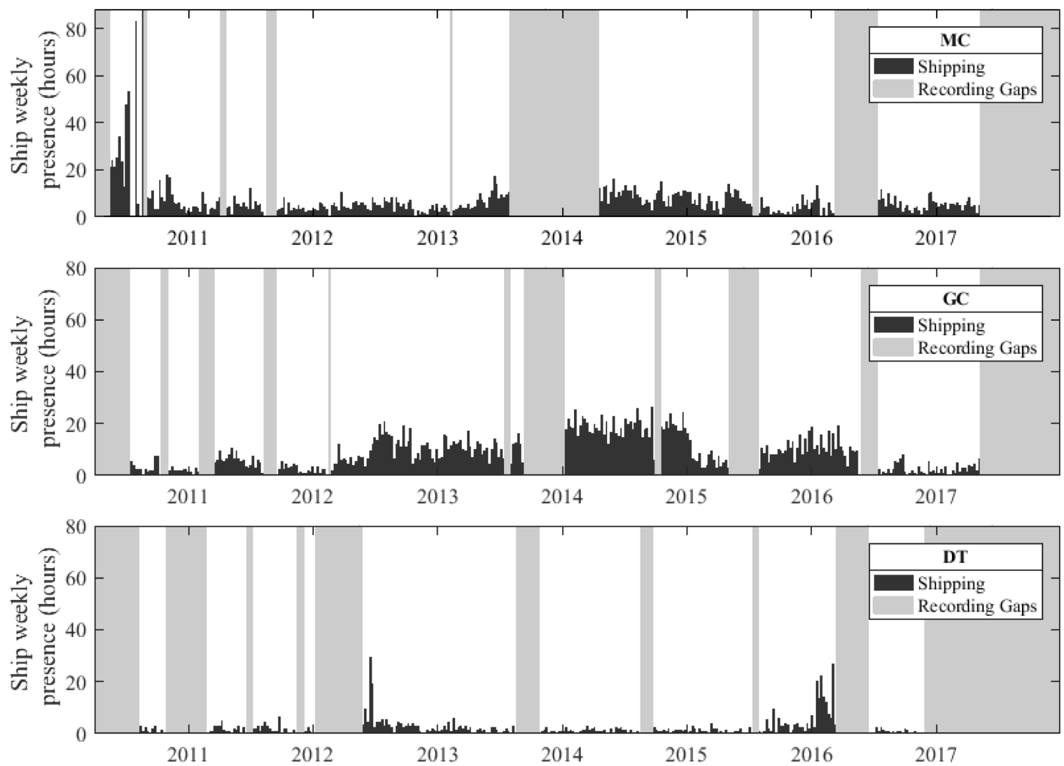

Figure S3. Presence of shipping at site MC, GC, and DT as hours per week. Periods with shipping presence were excluded from analysis of sperm whale echolocation because of the similarity of impulsive shipping noise to sperm whale clicks. Shaded areas lack recording effort.

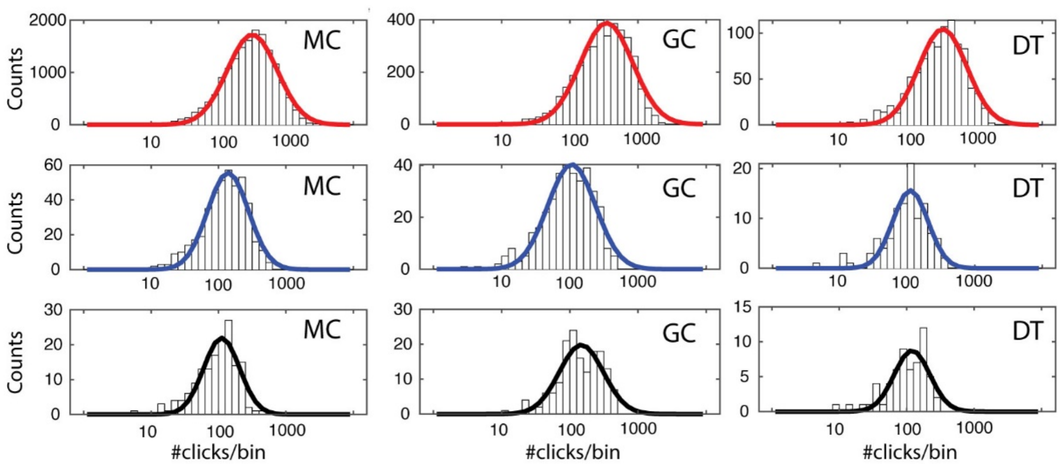

Figure S4. Histograms for the number of clicks per 5-min bin in a log scale, selected for those bins with at least one click of amplitude > 160 dB_{pp}, separated by demographic class for social group (red), mid-size animals (blue) and adult male (black) at sites MC, GC and DT. Lines give fit for normal distribution.

Text S1. Group size estimates based on overlapping click sequences with consistent inter-click intervals:

Observing the number of simultaneously received echolocation click sequences can provide insight into group size. In some cases it is possible to directly count the number of simultaneous click sequences from a single-sensor recorder (Hildebrand et al. 2015) as a proxy for group size, but with larger group sizes this approach becomes difficult. The assumption of this approach is that all animals in a group click and are detected simultaneously within the time window of analysis, so the number of clicks is a proxy for group size.

The acoustic recordings were examined for periods when groups of animals were located near the sensor based on high click received amplitudes. We selected time windows with at least one click above 160 dB_{pp} re 1 µPa, and then examined the mean number of clicks detected within a 5-min time for each of the demographic classes. To examine constraints on group size, specific time windows were selected in which high amplitude clicks were present, requiring that the group be in close proximity to the sensor, and increasing the likelihood of simultaneous detection of click trains from multiple animals. By setting a click detection threshold of 160 dB_{pp} re: 1µPa or above (exceptionally high amplitude), the effective distance to social groups for on-axis clicks was limited to approximately 3 km (4.5 km for males) from the receiver. This can be calculated on the relationship between received sound pressure level (160 dB_{pp} re: 1µPa) and source level (232 dB re: 1µPa @ 1m) minus the propagation loss (72 dB re 1 m; including geometric spreading and attenuation) for social groups. Figure displays the number of detected clicks within 5-min bins when these bins were specifically chosen to include at least one click with an amplitude exceeding 160 dB_{pp} re: 1µPa.

To establish a normal distribution, we have presented the data as $\log_{10}$ of the click counts. For social groups, the log-normal mean number of clicks from bins with amplitudes greater than 160 dB_{pp} re: 1µPa account for only 54% of what would be expected from a single continuously clicking animal (612 clicks per 5-min). In the case of males, these clicks represent 34%, and for mid-sized groups 28%, of the number of clicks that would be expected from a single animal (Table S4).

These findings imply that the group sizes of adult males and mid-size animals are similar, but that both these groups comprise smaller numbers of animals than those for social groups. Moreover, it is important to acknowledge that a more comprehensive understanding of click detectability during time windows with clicks exceeding 160 dB_{pp} re: 1µPa is necessary to directly estimate group size from these values. While this approach does not provide precise quantitative estimates of group sizes, it strengthens the expectation that adult males and mid-size groups are generally smaller groups when compared to social groups (Gaskin 1970).

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