The following supplement accompanies the article

An integrated mark-recapture and genetic approach to estimate the population size of white shark in South Africa

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Photographic capture-mark-recapture-technique

Table S1 Sampling effort of each month: column 1 = month of sampling or capture occasion, column 2 = number of sampling days at each month, column 3 = number of photographic identifications collected (excluding multiple photographs of the same shark collected on the same day), and column 4 = total number of identified sharks (n_i). The last two columns indicate, for identified sharks, how many were newly identified (u_i) and how many were sharks previously included in the database (m_i).

SAMPLING EFFORT			IDENTIFIED SHARKS		
Capture Occasions (i)	**Sampling Day**	**Photo ID**	**Captured sharks (n_i)**	**Newly Identified Sharks (u_i)**	**Monthly Recaptured Sharks (m_i)**
2009 04	17	40	28	28	0
2009 05	21	57	41	35	6
2009 06	16	87	70	58	12
2009 07	10	46	34	21	13
2010 02	5	23	18	17	1
2010 03	19	69	43	24	19
2010 04	14	65	42	22	20
2010 05	13	79	57	32	25
2010 06	8	35	28	10	18
2010 07	10	27	21	7	14
2010 08	8	34	28	12	16
2010 09	13	94	61	31	30
2010 10	14	39	32	11	21
2010 11	12	39	31	14	17
2010 12	12	37	21	4	17
2011 01	13	29	20	9	11
2011 02	11	57	36	17	19
2011 03	11	73	38	7	31
2011 04	11	49	36	3	33
2011 05	10	70	55	22	33
2011 06	9	60	51	9	42
2011 07	12	66	34	9	25
2011 08	5	12	10	3	7
2011 09	7	29	27	8	19
2011 10	10	58	39	5	34
2011 11	2	13	13	2	11
2011 12	5	17	14	6	8
TOT	**298**	**1304**	**928**	**426**	**502**

The mean estimated total length of the study animals (N = 426), based on size of first capture was 3.14 m, with a range of 1.30–5.50 m TL and a 3.20 m median (Fig. S1a). The sex ratio (males:females) was 1:1.09 (N = 313) (Fig. S1c), which was not significantly different from equality according to the exact binomial test (p = 0.20). There was also no evidence of any relationship between sex and size (Fig. S1b).

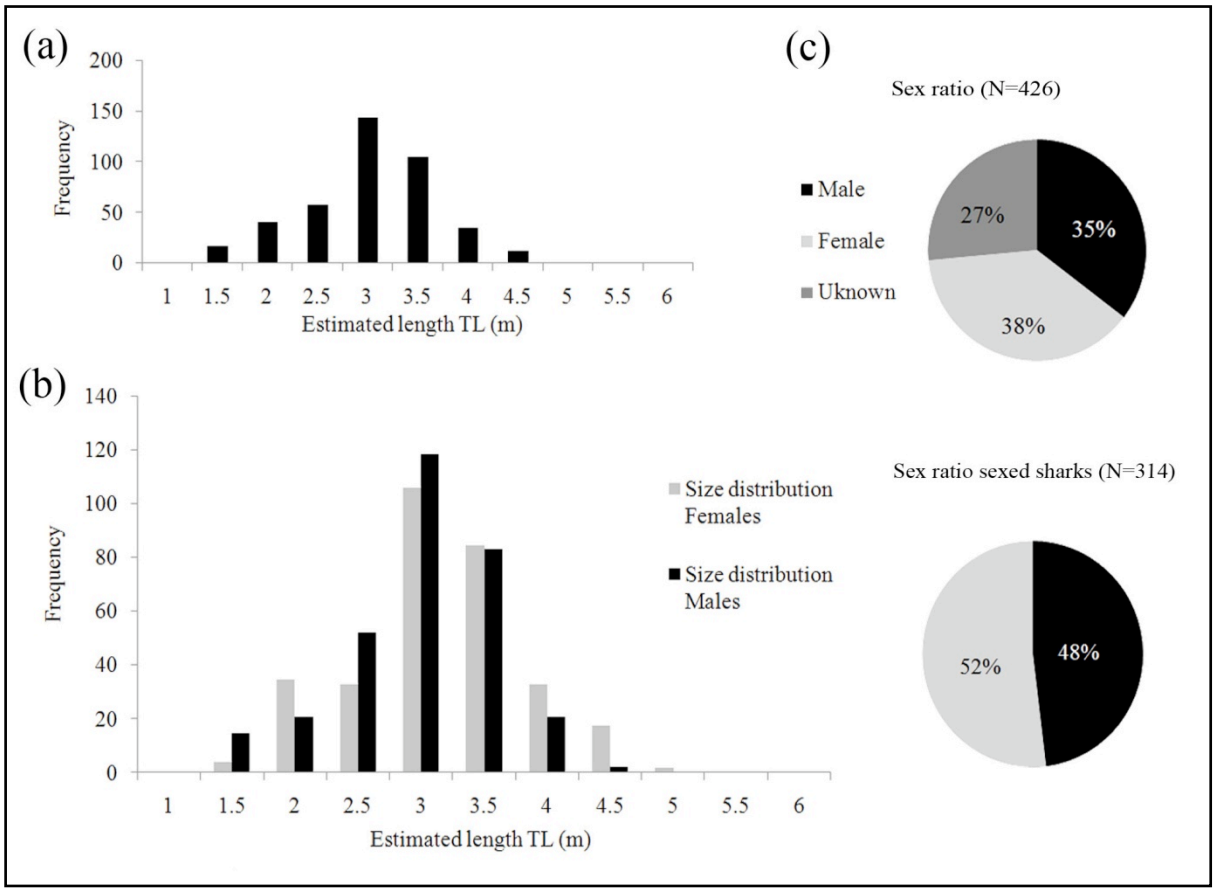

Figure S1 (a) Size distribution of 426 white sharks at Gansbaai, South Africa; (b) Length distribution per sex based on 315 of these animals that could be sexed (female: grey, male: black) and (c) sex ratio (female: grey, male: black, unknown: dark gray).

The total number of sharks identified during each season in 2010 and 2011 were normalized (based on the sampling occasions in each season). The results were compared to evaluate seasonal variation in the sharks' local abundance (Fig. S2). Seasonality was evident with the highest abundance during winter (May-July) and lowest abundance occurring during summer (November-January). Finally the counts of re-capture events during adjacent weeks indicated that white sharks, on average remain in the study area for a week, or a maximum of two weeks (Andreotti et al. unpublished data), minimizing the possibility of pseudo replications of sharks across adjacent months.

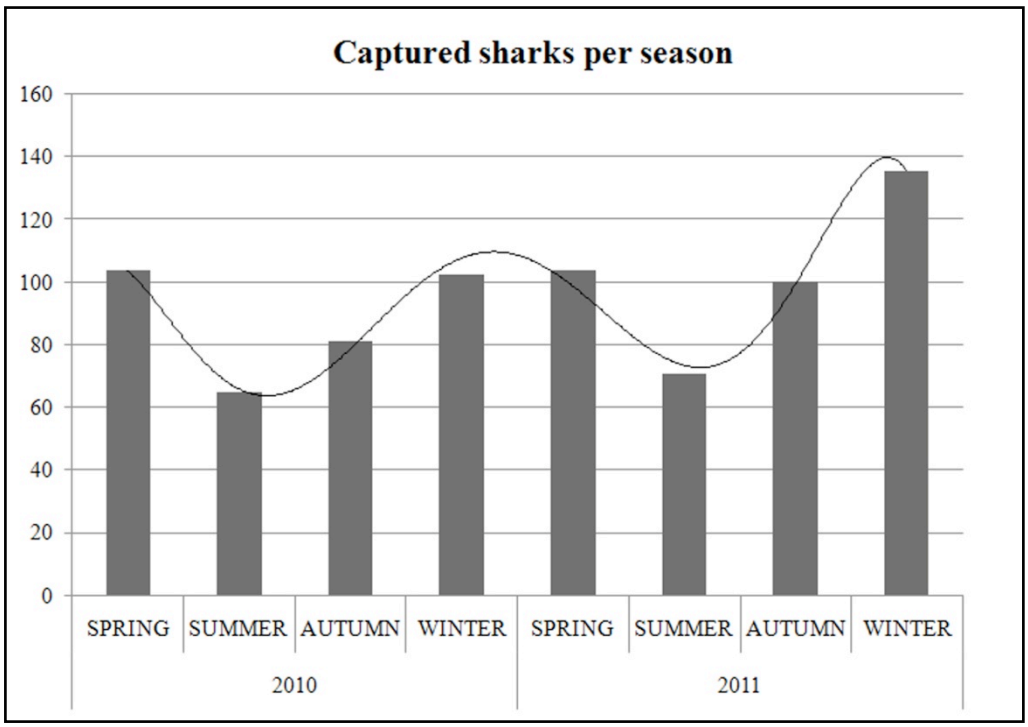

Figure S2 Seasonal occurrence of white sharks at the Dyer Island Nature Reserve (Gansbaai, South Africa). The values are normalized per sampling occasion to compare months in which the sampling effort differs due to the weather conditions.

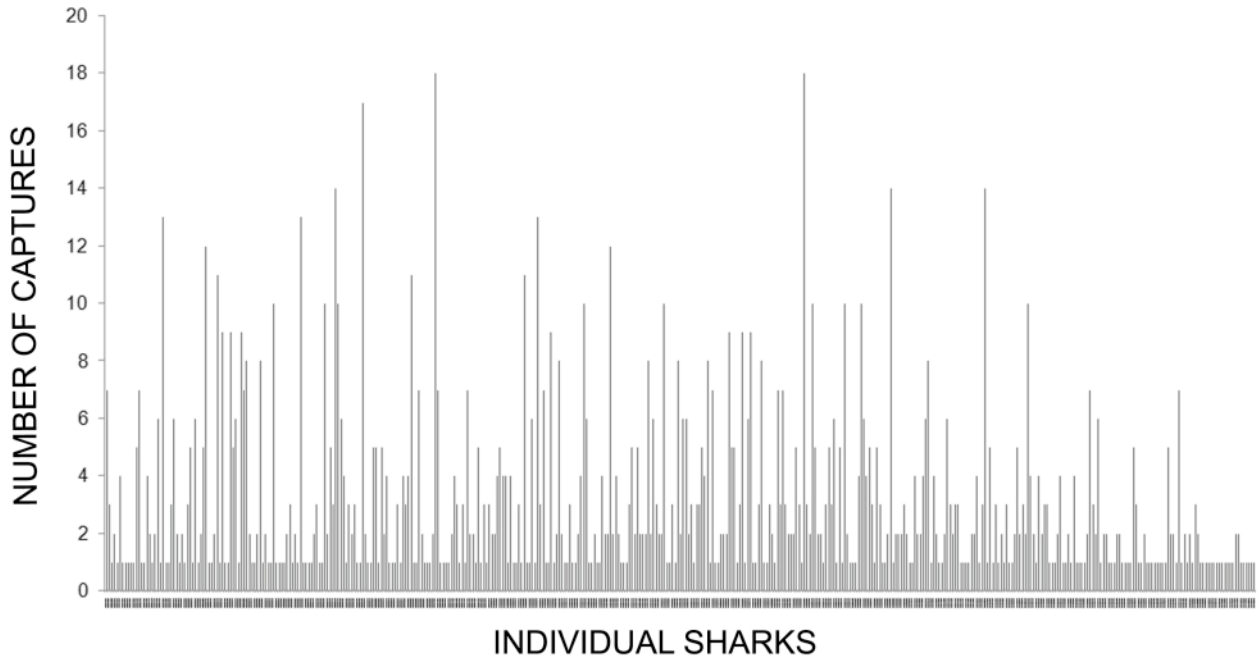

Figure S3 Captures of each individual shark (N = 426) included in the dataset. The individuals are organized by their first date of capture (left to right, from 2009 to 2011).

Results

Validation program DARWIN for white sharks photographic identifications

"Fin Trace" failed to automatically draw an accurate edge around the dorsal fin and manual optimization was needed in each instance (Fig. S4).

Figure S4 Example of photo identification for three different great white sharks (one row for each shark). Due to DARWIN's inherent prerequisite to work with fins from the left side only, some of the photographs were rotated horizontally (the true side of the fin is indicated as R = right, L = left, on the image). Procedures flow from the left: (1) image from the database; (2) image to be matched showing the line traced automatically by the software "Fin Trace"; (3) images with the line manually re-traced to allow for better comparison within "Fin Matching"; (4) examples of an image that could not be matched by the software. Row (a) is an example of a matched image (Ranked=1); Row (b) Example of a correct match found in the first 20 ranked images (Ranked=6); Row (c) example of an unmatched image (Ranked=65). The Rank assigned by the software to the correctly matched image is indicated on the photograph.

After adjusting the edge, 86% of the control pictures (e.g. photographs copied from the database) were correctly matched by DARWIN (Rank = 1). In the validation trial DARWIN correctly matched 20% of the photographs from the collection and an additional 20% could be found in the first 20 ranked images. The remaining 60% ranked lower than 20, with some matches as low as position 234 (Fig. S4). The trial conducted with photographs of the same three re-sighted individuals showed similar results (Fig. S5). The average difference (95% confidence) between first rank and the software's match is 66.34. The paired t-test rejected the null hypothesis that DARWIN can successfully match a white shark dorsal fin image in the upper range of up to 20 ranked images (t-stat=5.73, $p = 3.72 \times 10^{-8}$).

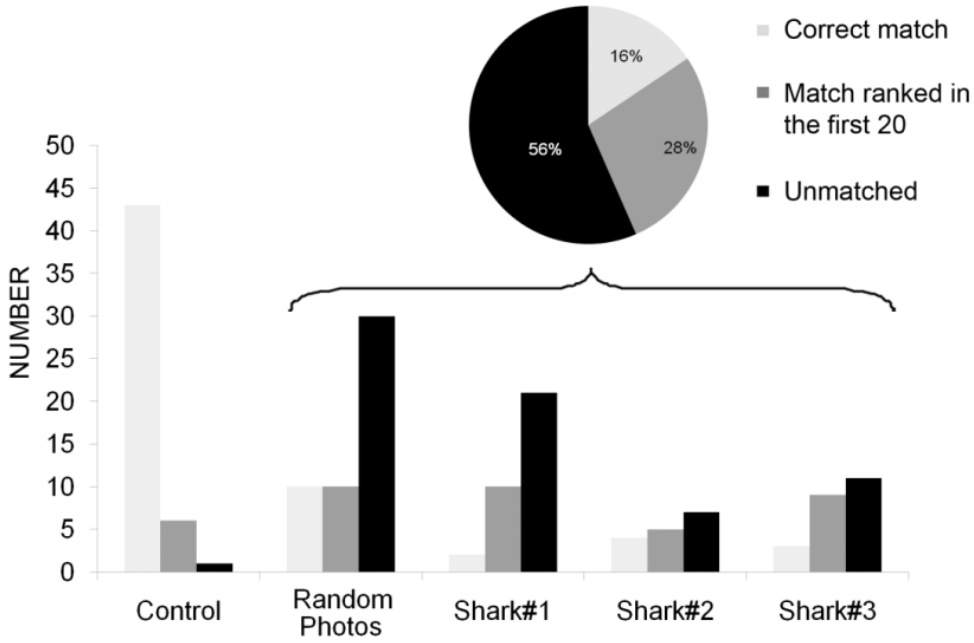

Figure S5 DARWIN results showing the number of matched images for each trial conducted. The pie chart indicates the percentage of each score.

LITERATURE CITED

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