The following supplement accompanies the article

Quantifying injury to common bottlenose dolphins from the *Deepwater Horizon* oil spill using an age-, sex- and class-structured population model

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Age-specific Baseline Mortality

Table S1. Summary of age-at-death data sources incorporated into age-specific mortality analysis.

Site	Time Period	# Males	Male Age Range (Years)	# Females	Female Age Range (Years)	Total Number	Reference
Texas	1981-1990	83	0-33	83	0-41	166	Fernandez and Hohn (1998)
Mississippi Sound	1986-2003	69	0-27	42	0-30	111	Mattson et al. (2006)
Sarasota Bay	1993-2014	51	0-44	52	0-58	103	R Wells unpublished
Indian River Lagoon	1978-1997	118	0-35	72	0-35	190	Stolen and Barlow (2003)
South Carolina	1991-2012	228	0-41	237	0-42	465	McFee unpublished, McFee et al. (2010)

Method Details

The Siler model assumes that survivorship, the probability of surviving to age x, is the product of 3 competing risks: an exponentially decreasing risk due to juvenile factors, a constant risk experienced by all age classes, and an exponentially increasing risk due to senescent risk factors (Siler 1979):

$$l(x) = e^{-a_1 \cdot (1-e^{-b_1 \cdot x})} \cdot e^{-a_2 \cdot x} \cdot e^{a_3 \cdot (1-e^{b_3 \cdot x})}$$

where a_1 , a_2, a_3, b_1, and b_3 are model parameters.

If age-at-death data are collected from a population in stable age distribution and growing at an exponential rate r, the expected proportion of dead animals in age class x will be:

$$p(x) = \frac{e^{-r \cdot x}[l(x) - l(x+1)]}{\sum_{y=0}^{M} e^{-r \cdot y}[l(y) - l(y+1)]}$$

where M is the maximum age class (60 in our case). We assume that the proportion of reported strandings in each age class is representative of the proportion of deaths in the corresponding class. The likelihood for a given distribution of observed ages is then given as:

$$L(n) = \prod_{x=0}^{M} p(x)^{n_x}$$

where n_x is the number of deaths observed at age x (Stolen & Barlow 2003). Although the age-at-death data were collected from genetically different BSE stocks, we assume that life-history characteristics are similar enough that baseline survivorship patterns do not differ significantly among stocks. Previous studies of southeast U.S. BSE stocks suggest a common basis to biology, behavior, ecology, and health for bottlenose dolphins (Wells & Scott 1999, Reynolds et al. 2000), supporting the assumption of similar survivorship. In addition, we assume no age bias in recovery of strandings; this is supported by a recent study of the BSE stock in Sarasota Bay, FL that found a similar recovery rate for young-of the-year (mean=0.39, SD=0.35) and non-young-of-year (mean=0.31, SD=0.17) dolphins (Wells et al. 2015). Finally, we assume a stable age distribution, although we allowed the various stocks to be growing/declining at different rates.

The survivorship function was estimated using the software JAGS (version 3.3.0; http://mcmc-jags.sourceforge.net/), and the rjags package (R version 3.0.3). Four MCMC chains were sampled through an adaptation phase of 200 samples followed by a burn-in period of 10,000 samples. Following burn-in, 1,000 samples were collected from the posterior distribution by sampling for an additional 10,000 samples, thinning by 10. The Gelman convergence diagnostic (Gelman & Rubin 1992), as implemented in the R coda package (version 0.18-1), was used to assess convergence. Trace and density plots were used for visual confirmation of convergence. The potential scale reduction factor (PSRF) was calculated for each marginal posterior distribution, and reported as a point estimate and upper confidence limit. In brief, PSFR indicates how much narrower the posterior distribution might become if the simulation were continued for an infinite number of iterations. When the upper limit for PSRF is close to 1, approximate convergence is indicated. A general rule of thumb is to achieve PSRF < 1.1.

Additional Results

MCMC diagnostics indicated adequate convergence. PSRF for all variables of interest (r_g for $g = 1..4$; $l_s(x)$ for $s = 1,2\ and\ x = 1..59$) was < 1.1. The highest PSRF (1.09) was calculated for $l_s(x)$ in older males (above 45 years) and is likely due to the non-normality of the distribution as survival probability approaches zero along with the limited number of strandings in this age class.

Resulting age-specific survival curves indicated higher survival rates for females as compared to males (Figure S1, Table S2-S3), particularly in the youngest and oldest age classes. When males and females were combined, annual survival for dolphins less than one year was 0.791 (95% credible interval (CI) 0.748-0.838), very similar to the previously reported survival rate of 0.811 (SD=0.064) for bottlenose dolphins in Sarasota Bay less than one year (Wells & Scott 1990).

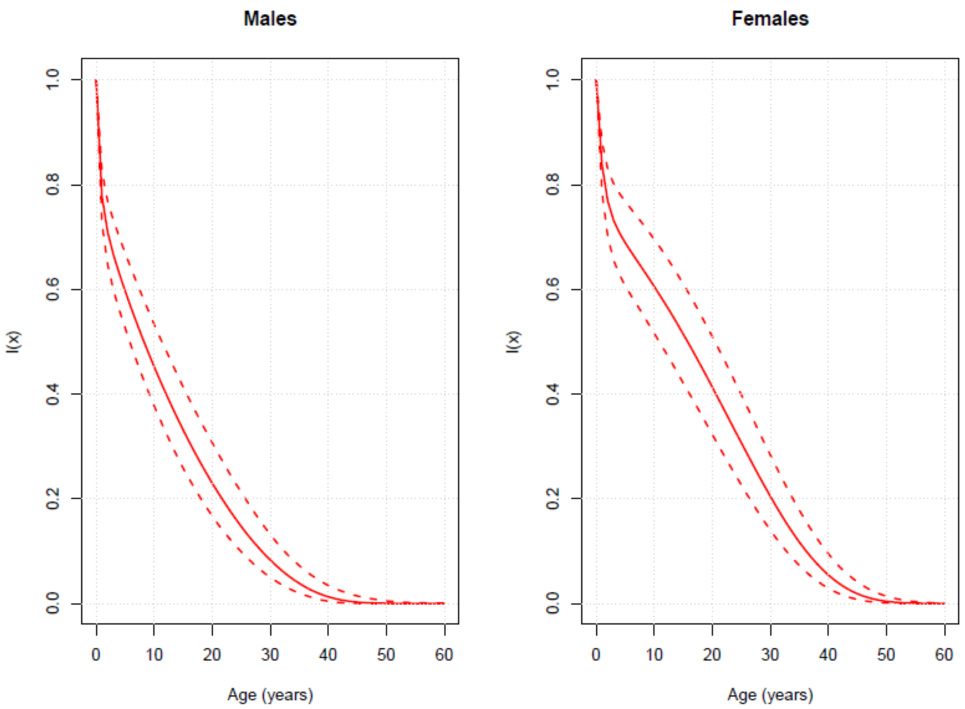

Figure S1. Cumulative survival, l(x), as a function of age for (a) male, and (b) female bottlenose dolphins. Solid line is posterior median, dashed lines represent 95% credible interval.

Table S2. Posterior median annual survival rate and 95% credible interval by sex- and age-class.

Age Range (years)	Annual Survival for Females	Annual Survival for Males
0 - 1	0.84 (0.78-0.88)	0.78 (0.72-0.82)
1 - 4	0.96 (0.90-0.98)	0.94 (0.88-0.96)
5 - 9	0.97 (0.97-0.98)	0.95 (0.93-0.96)
10 - 19	0.96 (0.95-0.98)	0.93 (0.91-0.95)
20 - 29	0.93 (0.90-0.95)	0.91 (0.87-0.93)
30 - 39	0.88 (0.82-0.92)	0.85 (0.72-0.90)
40 - 49	0.78 (0.67-0.85)	0.73 (0.35-0.86)

Table S3. Posterior median annual survival, x = 0..60 years, for females ($S_{f,x}$), and males ($S_{m,x}$).

Age (years)	$S_{f,x}$	$S_{m,x}$
0	0.8374	0.7770
1	0.9180	0.9124
2	0.9533	0.9408
3	0.9680	0.9467
4	0.9737	0.9481
5	0.9755	0.9481
6	0.9757	0.9474
7	0.9751	0.9464
8	0.9741	0.9453
9	0.9728	0.9440
10	0.9713	0.9428
11	0.9697	0.9414
12	0.9680	0.9398
13	0.9661	0.9381
14	0.9640	0.9363
15	0.9619	0.9343
16	0.9596	0.9322
17	0.9572	0.9299
18	0.9547	0.9275
19	0.9519	0.9247
20	0.9490	0.9218
21	0.9459	0.9185
22	0.9426	0.9150
23	0.9391	0.9113
24	0.9354	0.9072
25	0.9314	0.9029
26	0.9271	0.8980
27	0.9226	0.8927
28	0.9178	0.8869
29	0.9128	0.8805
30	0.9073	0.8737
31	0.9015	0.8663
32	0.8953	0.8583
33	0.8889	0.8496
34	0.8819	0.8404
35	0.8745	0.8305
36	0.8666	0.8199
37	0.8583	0.8084
38	0.8495	0.7963
39	0.8403	0.7833
40	0.8309	0.7692
41	0.8206	0.7542
42	0.8097	0.7389
43	0.7981	0.7217
44	0.7861	0.7036
45	0.7735	0.6849
46	0.7603	0.6653
47	0.7463	0.6443
48	0.7317	0.6222
49	0.7164	0.5994
50	0.7005	0.5753
51	0.6838	0.5492
52	0.6665	0.5220
53	0.6485	0.4949
54	0.6297	0.4673
55	0.6103	0.4391
56	0.5900	0.4105
57	0.5692	0.3817
58	0.5481	0.3526
59	0.5263	0.3245
60	0.0000	0.0000

Sensitivity analysis

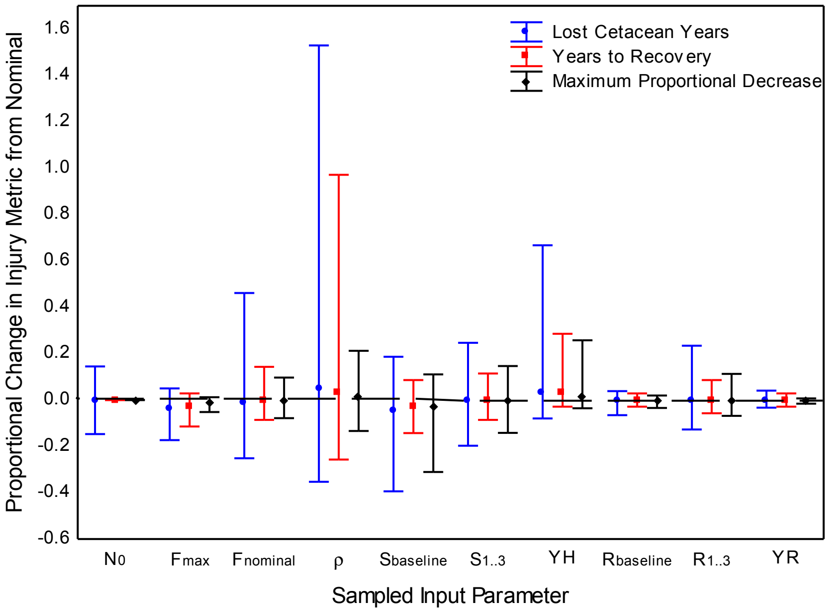

Figure S2. Proportional change in estimated injury metric related to sampling of each input variable while holding all other input variables at their nominal value. Whiskers indicate 95th percentile range and symbols represent median of 10,000 simulations for Lost Cetacean Years (blue circle), Years to Recovery (red square), and Maximum Proportional Decrease (black diamond). Horizontal dashed line indicates zero change.

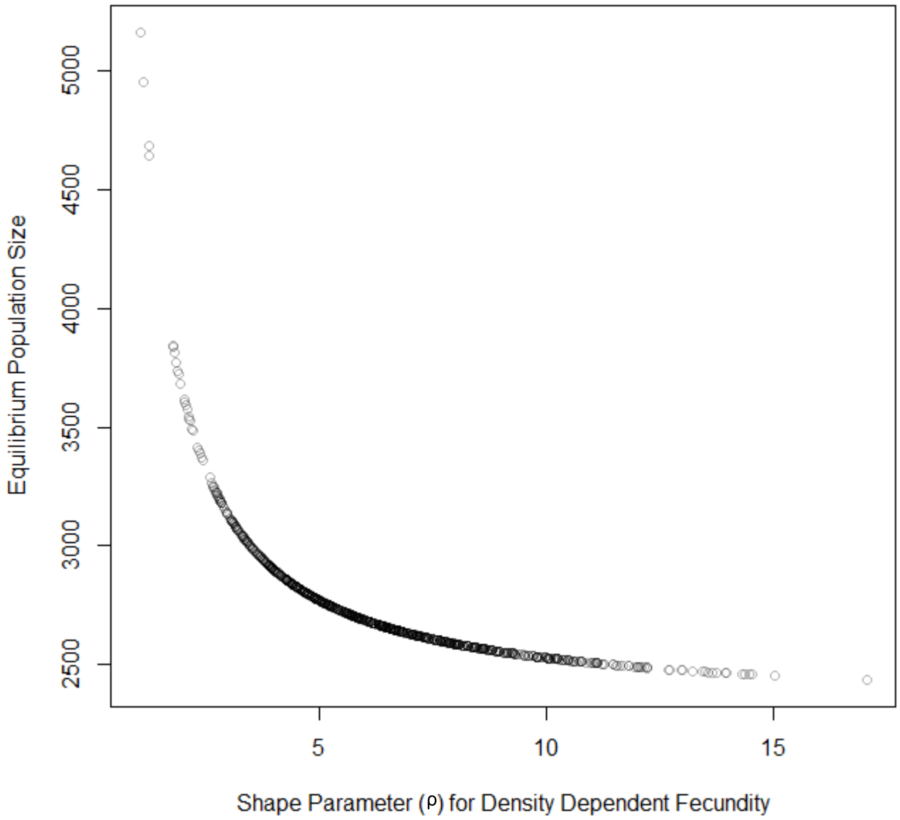

Figure S3. Change in equilibrium population size (carrying capacity) as a function of *ρ*. Hollow circles represent the results of 10,000 simulations, thinned by 10 for graphing.

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