*Supplementary Methods*

Comparative Data

*Gleiss, Potvin & Goldbogen (in review)* Physical trade-offs shape the evolution of buoyancy control in sharks. *Proceedings of the Royal Society B*

*Morphology*

We gathered data on the buoyancy of sharks from previously published works [[1-3](#_ENREF_1)] and one thesis sourced from the University of Otago, New Zealand [[4](#_ENREF_4)]. In addition, we determined the density of a single Leopard Shark (*Triakis semifasciata*) captured in Elkhorn Slough, California. For the single leopard shark, density was calculated by displacement. The shark was immersed in fully filled plastic container with a spout for overflow. As the shark was immersed, excess water equivalent to the body volume of the shark spilled into a secondary plastic container located on a laboratory balance. The volume could subsequently be calculated using the known density of water. Density of the animal tissue was then calculated from volume and mass of the body. The same procedure was repeated after removal of the liver. For the three other studies, buoyancy was determined by weighing animals with and without liver in water of known density, in order to calculate densities and tissue volumes [[1-5](#_ENREF_1)]. All sources provided the necessary parameters describe the body composition for our analysis; mass and density of the liver, the lean tissue (defined as all tissue excluding the liver) or all tissue combined. Additionally, all papers reported submerged weights and/or water density where the animal was captured. This allowed us to calculate a complete set of characters for our analysis, which were the volumes, masses and densities of liver and lean tissue, as well as the values for the whole animal (Table S1). Shark bodies do not include any gas-filled spaces used for floatation, thus the density of tissues can act as a simple proxy for buoyancy. For each species, our data-set ranged from 1 to 30 individuals. Where necessary we calculated means for the trait data derived from multiple individuals, since our comparative analysis only allows for a single tip in the phylogeny for each species. Our sources reported different length standards (e.g. fork length, total length, pre-caudal length) and one paper did not report any length measure at all; we used commonly available length-weight and length-length relationships [[6](#_ENREF_6)] for those species where either the wrong measure was available or no length was given all together. Since the major interest of our paper was concerned with the change in drag-related properties of the shark’s body, we chose pre-caudal length (PCL or also known as Standard Length, SL) as the standardized unit for comparison. This measure largely characterizes the shark’s body, without the influence of the length and shape of the caudal fin. Therefore, any changes between volume and standard length would be closely related to fineness of the body, a key parameter governing hydrodynamic drag. No data for neonate elasmobranchs was included in our data-set, since these feature larger livers following birth due to maternal provisioning, which is utilised in the weeks following parturition, before a “normal” liver volume is attained [[7](#_ENREF_7)]. We also did not include data from gravid females, due to changes in liver volume/density associated with this life-history stage [[2](#_ENREF_2), [3](#_ENREF_3)].

*Vertical Distribution*

We used a combination of literature sources to determine the broad vertical distribution of the 32 species in our data-set. Because data in the literature often primarily refer to maximum and minimum depths, rather than mean depths, Median Depths of Occurrence (MDO), has become common place in similar comparative studies [[8](#_ENREF_8), [9](#_ENREF_9)]. MDO has significant advantages over for instance minimum depths, which would result in a highly zero inflated data-sets, since half of all species in our data-set are known to commonly occur in surface waters. We used a variety of sources and selected the best evidence from those. Initially we performed a literature search for depth distributions of the species in question from electronic tagging data (Pop-Up Satellite Archival Tags); which we believe to be the most reliable source. Electronic tagging data were available for 12 of the 32 species. If more than one paper reported was found for a species, the vertical distributions of the two were combined, so that the final minimum and maximum could be derived from different studies. If such data were not available, we used data from Fishbase (www.fishbase.org), an online resource maintained by scientists curating data on the biology of fishes. Fishbase often refers to “depth range” and common “depth range”; these in a few cases showed widely different depth distributions, for instance common maximum depth for silky sharks was 500m, whereas maximum depths was considered to be 4000m – representing the deepest depths sharks have been encountered at and therefore highly unlikely mfor this epipelagic species [[9](#_ENREF_9)]. As a result, we selected “common depth distribution” when available. “Common depth distribution” and data from electronic tagging data showed good correlation in both maximum and median depths (Spearman’s ρ=0.62).

 **References**

[1] Baldridge Jr, H.D. 1970 Sinking factors and average densities of Florida sharks as functions of liver buoyancy. *Copeia*, 744-754.

[2] Bone, Q. & Roberts, B.L. 1969 The density of elasmobranchs. *J. Mar. Biol. Assoc. UK* **49**, 913-937.

[3] Corner, E., Denton, E. & Forster, G. 1969 On the buoyancy of some deep-sea sharks. *Proceedings of the Royal Society B: Biological Sciences* **171**, 415-429.

[4] Smith, M.P. 1975 The buoyancy of six New Zealand species of elasmobranch, University of Otago.

[5] Gleiss, A.C., Potvin, J., Keleher, J.J., Whitty, J.M., Morgan, D.L. & Goldbogen, J.A. 2015 Mechanical challenges to freshwater residency in sharks and rays. *The Journal of experimental biology* **218**, 1099-1110.

[6] 2010 In *FishBase 2000: concepts, design and data sources* (eds. R. Froese & D. Pauly), p. 344. ICLARM, Los Baños, Laguna, Philippines.

[7] Hussey, N.E., Wintner, S.P., Dudley, S.F.J., Cliff, G., Cocks, D.T. & Aaron MacNeil, M. 2010 Maternal investment and size-specific reproductive output in carcharhinid sharks. *Journal of Animal Ecology* **79**, 184-193. (doi:10.1111/j.1365-2656.2009.01623.x).

[8] Treberg, J.R. & Speers-Roesch, B. 2016 Does the physiology of chondrichthyan fishes constrain their distribution in the deep sea? *Journal of Experimental Biology* **219**, 615-625. (doi:10.1242/jeb.128108).

[9] Priede, I.G., Froese, R., Bailey, D.M., Bergstad, O.A., Collins, M.A., Dyb, J.E., Henriques, C., Jones, E.G. & King, N. 2006 The absence of sharks from abyssal regions of the world's oceans. *Proceedings of the Royal Society B: Biological Sciences* **273**, 1435-1441. (doi:10.1098/rspb.2005.3461).