

Shark movements and the design of protected pelagic environments within and beyond the Galapagos Marine Reserve

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The Galapagos Archipelago is one of the last outposts where large numbers of marine predators still linger in the tropical eastern Pacific, but alternatives to conserve and manage them are lacking. The Galapagos Marine Reserve (GMR) offers some protection; however, the original design did not consider large marine predators, limiting its effectiveness. We intend to alleviate this management problem by incorporating movements of top marine predators in the design of protected pelagic environments in the region. Our studies using satellite and continuous tracking at the Galapagos Islands show movements of scalloped hammerhead, Galapagos, and whale sharks at different spatial scales: insular or fine-scale (< 50 km), inter-island (50-400 km) and oceanic (> 500 km). Insular movements are associated to 'hotspots' around islands, inter-island movements appear as directional and non-directional within the archipelago, whereas oceanic ones are directional to regions away from the archipelago. This implies 1) a high degree of use of areas bordering islands and inter-island connectivity within the GMR, and 2) the likelihood of migratory corridors between islands of the Galapagos and other open water regions adjacent to the 40-mile limit of the GMR and outside the reserve. Our studies demonstrate that hotspots vary in scale, hence a large region encompassing Darwin and Wolf islands may function as a large-scale hotspot and within this region other hotspots are contained, such as those contiguous to the southeastern shores of these islands. Our findings have strong implications in the shaping of marine reserves based on movements and habitat use of top marine predators within and beyond the GMR and not on arbitrary standards.