The influence of oceanographic processes on top predator (sea turtle, seabird, marine mammal) distribution

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Oceanic top predators depend on patchy food resources that are determined by complex food-web dynamics, by local oceanographic forcing, and by the natural cycles of climate-driven variability. Because they are long-lived, top predators are well adapted to these sources of variability over evolutionary time scales. However, because of human pressures on their populations, either from direct exploitation or from habitat degradation, several species face serious conservation issues and their ability to cope with anthropogenic climate change may be compromised. Therefore, it is important to gain a detailed understanding of top predator distribution and habitat use in relation to the underlying oceanographic processes, as this knowledge will be valuable in predicting their response under potential climate change scenarios.

Our understanding of the movements and distribution of top predators in relation to environmental variability has seen significant progress in recent years thanks to advances in miniaturized electronic tag technology. Just as crucial has been the availability of high-resolution oceanographic data collected by a constellation of Earth-monitoring satellites (Palacios *et al.*, 2006), which have allowed us to analyze the animals' movements in the context of the local environmental conditions. Under the Tagging of Pacific Pelagics Program (TOPP; Block, 2005), over 2,000 electronic tags have now been deployed on over 20 species of tunas, sharks, turtles, seabirds, seals, and whales in the North Pacific Ocean (http://www.topp.org/). Examples of these studies include leatherback turtles (Fig. 1), Hawaiian albatrosses (Fig. 2), and blue whales (Fig. 3). These studies have revealed unique and persistent migration corridors and foraging destinations through dynamic oceanographic features such as currents, fronts, and eddies that were previously unknown.

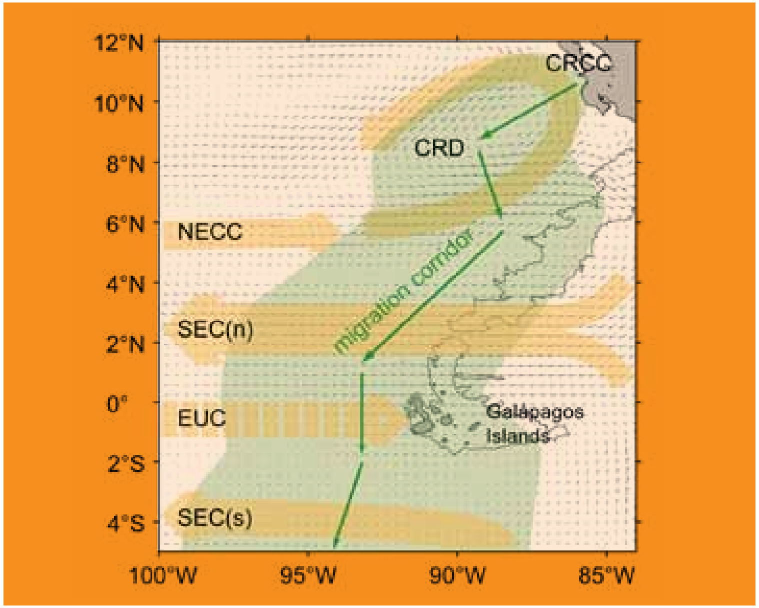

Figure 1. The migration corridor (green swath) of female eastern Pacific leatherback sea turtles, from their nesting site at at Playa Grande, Costa Rica, through the equatorial current system (yellow arrows) (from Shillinger et al., 2008).

Meta-analyses of historical databases can also yield important new insights into the global patterns of top predator distribution. In a recent study combining information in the published literature with a global sea-surface temperature database, we found that the location of all known humpback whale breeding grounds was consistently associated with a particular temperature range (21-28°C), such that the migration distance between the high-latitude foraging grounds and the low-latitude breeding grounds for all populations was dictated by the particular temperature regime in each ocean basin (Fig. 4). Because of this temperature dependence during the breeding phase of their migrations, humpback whales may be particularly susceptible to climate change, and this information will be useful in understanding the potential impact of different climate change scenarios on humpback whale populations.

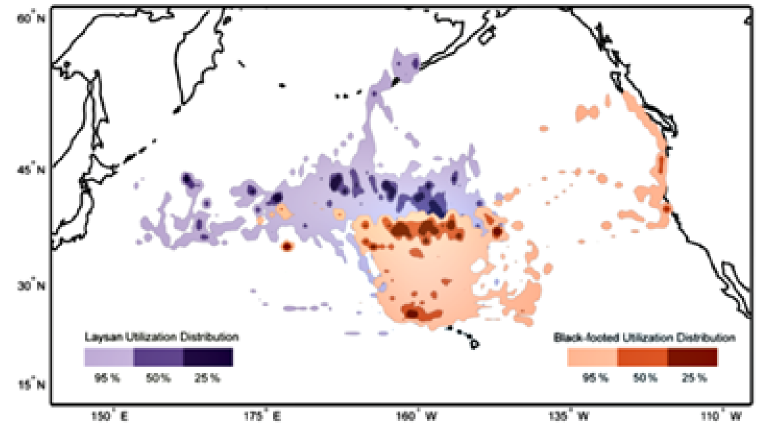

Figure 2. The different oceanic habitats of Laysan and black-footed albatrosses in the North Pacific based on data from animals tagged in Hawaii (from Kappes et al., in press).

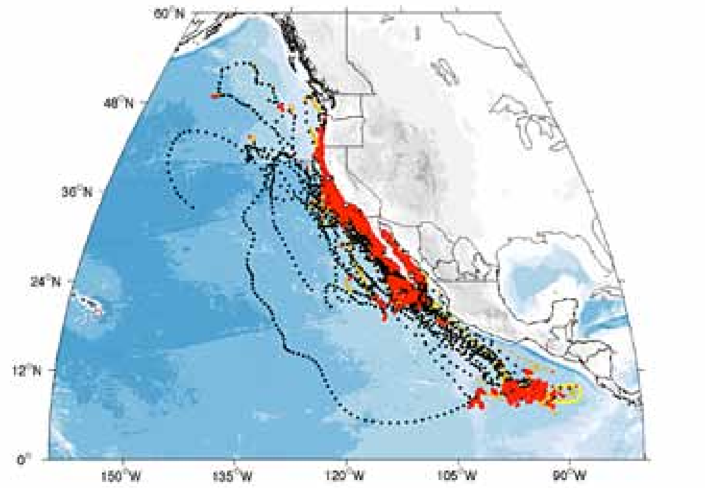

Figure 3. The migratory (black circles) and foraging (red circles) movements of eastern North Pacific blue whales from long-term satellite tracking studies (from Bailey et al., submitted).

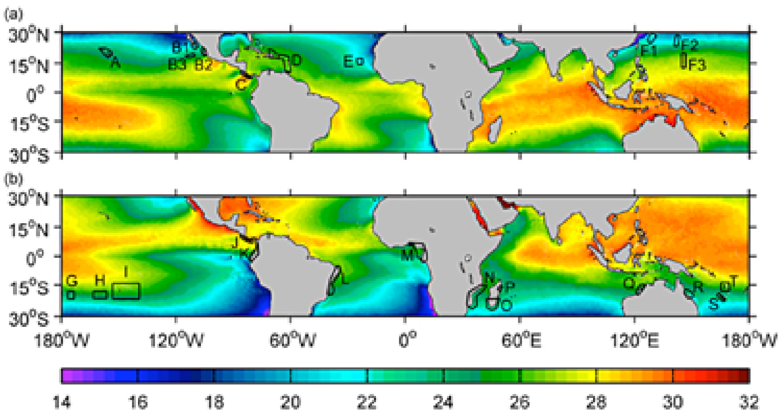

Figure 4. The worldwide distribution of all known humpback whale breeding areas (black polygons, labeled A-F and G-T) in relation to sea-surface temperature (°C) in the northern (a) and southern (b) hemisphere, respectively (from Rasmussen et al., 2007).

References

Bailey, H., B.R. Mate, D.M. Palacios, L. Irvine, and S.J. Bograd. Submitted. Behavioural estimation of blue whale movements in the Northeast Pacific from state-space model analysis of satellite tracks. Endangered Species Research.

Kappes, M.A., S.A. Shaffer, Y. Tremblay, D.G. Foley, D.M. Palacios, P.W. Robinson, S.J. Bograd, and D.P. Costa. In press. Hawaiian albatrosses track interannual variability of marine habitats in the North Pacific. Progress in Oceanography.

Palacios, D.M., S.J. Bograd, D.G. Foley, and F.B. Schwing. 2006. Oceanographic characteristics of biological hot spots in the North Pacific: A remote sensing perspective. Deep-Sea Research II 53(3-4):250-269, doi:10.1016/j.dsr2.2006.03.004.

Block, B.A. 2005. Physiological ecological in the 21st century: advancements in biologging science. Integrative and Comparative Biology 45:305-320.

Rasmussen, K., D.M. Palacios, J. Calambokidis, M. Saborio, L. Dalla-Rosa, E. Secchi, G. Steiger, J. Allen, and G. Stone. 2007. Southern Hemisphere humpback whales wintering off Central America: insights from water temperature into the longest mammalian migration. Biology Letters 3(3):302-305, doi:10.1098/rsbl.2007.0067.

Shillinger, G.L., D.M. Palacios, H. Bailey, S.J. Bograd, A.M. Swithenbank, P. Gaspar, B.P. Wallace, J.R. Spotila, F.V. Paladino, R. Piedra, S.A. Eckert, and B.A. Block. 2008. Persistent leatherback turtle migrations present opportunities for conservation. PLoS Biology 6(7), e171, doi:10.1371/journal.pbio.0060171.

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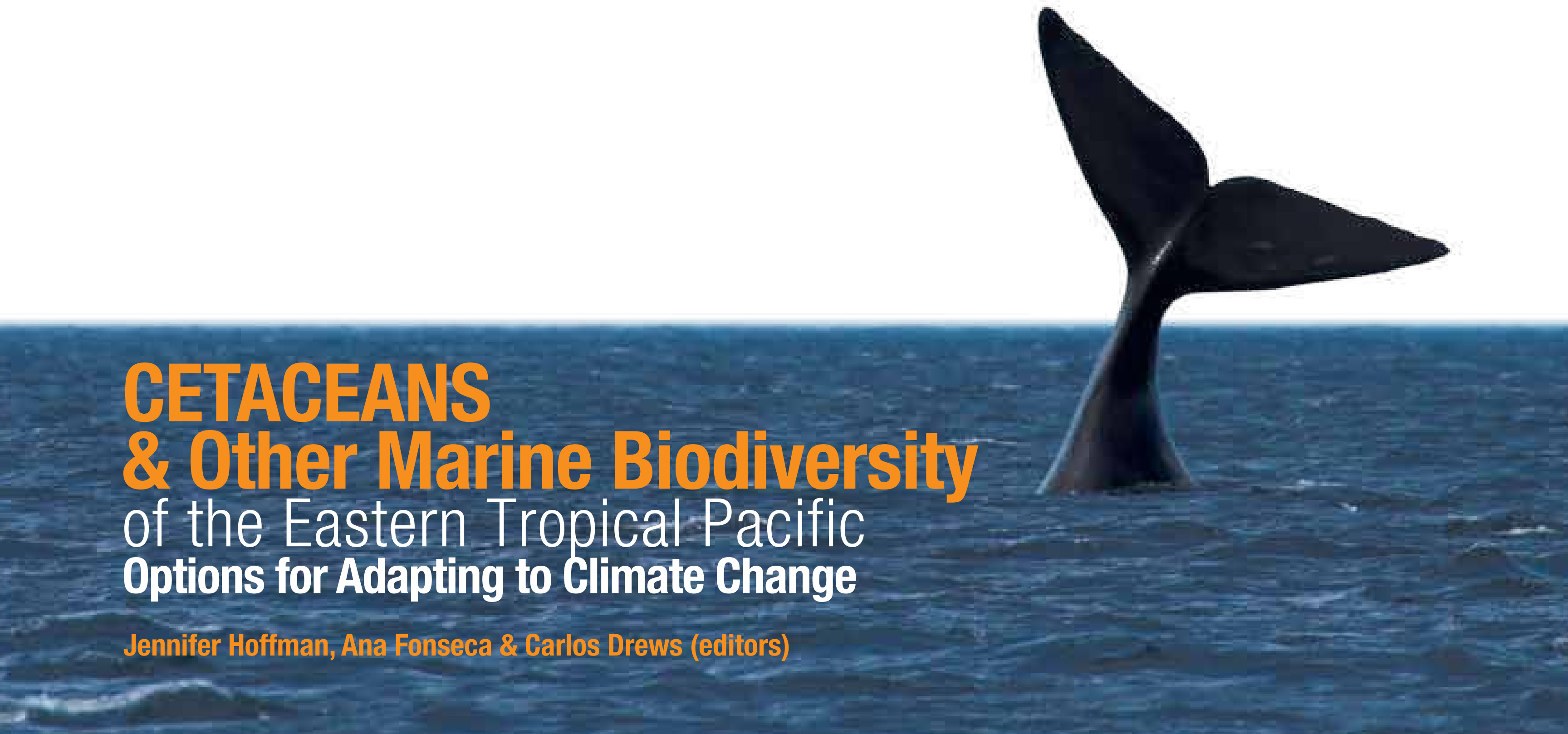

CETACEANS & Other Marine Biodiversity of the Eastern Tropical Pacific

Options for Adapting to Climate Change

Jennifer Hoffman, Ana Fonseca & Carlos Drews (editors)

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