PREDICTIVE MODELING OF MARINE MAMMAL DENSITY FROM EXISTING SURVEY DATA AND MODEL VALIDATION USING UPCOMING SURVEYS: EASTERN PACIFIC

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The Navy and other users of the marine environment need to estimate cetacean density within their operational areas in order to comply with the requirements of the Marine Mammal Protection Act, the Endangered Species Act, and the National Environmental Policy Act. The goal of our SERDP-funded research is to develop methods to predict cetacean densities within any user-defined region in the eastern Pacific Ocean using habitat variables. We developed cetacean-habitat models for the California Current Ecosystem (CCE) and in the Eastern Tropical Pacific (ETP) ecosystem. Densities for individual species or groups of related species (termed guilds) were modeled as functions of oceanographic variables and other environmental characteristics. Generalized additive and generalized linear modeling approaches were used, and the resulting models were similar in most cases. Data from NOAA research surveys from 1986-2003 were used to parameterize the models, and models were validated using data from surveys in 2005-2006.

We developed density models for 12 species or guilds in the CCE: striped dolphin (Stenella coeruleoalba), short-beaked common dolphin (Delphinus delphis), Risso’s dolphin (Grampus griseus), Pacific white-sided dolphin (Lagenorhynchus obliquidens), northern right whale dolphin (Lissodelphis borealis), Dall’s porpoise (Phocoenoides dalli), sperm whale (Physeter macrocephalus), fin whale (Balaenoptera physalus), blue whale (Balaenoptera musculus), humpback whale (Megaptera novaeangliae), small beaked whale species (Ziphius and Mesoplodon), and Baird’s beaked whale (Berardius bairdii). We developed density models for 16 species, subspecies or guilds in the ETP: offshore spotted dolphin (Stenella attenuata), striped dolphin, rough-toothed dolphins (Steno bredanensis), short-beaked common dolphin, bottlenose dolphin (Tursiops truncatus), Risso’s dolphin, eastern spinner dolphins (Stenella longirostris orientalis), whitebelly spinner dolphin (Stenella longirostris longirostris), sperm whale, Bryde’s whales (Balaenoptera edeni), blue whale, dwarf sperm whale (Kogia sima), Cuvier’s beaked whale (Ziphius cavirostris), pilot whales (Globicephala spp.), Mesoplodon beaked whales (Mesoplodon spp.), and small beaked whale (Ziphius and Mesoplodon). The density models were unique for each species, indicating that none shared exactly the same niche. Models developed for specific ecosystems (the CCE or the ETP) had greater predictive power than models that were developed from the pooled data. Some species were better modeled with remotely sensed habitat variables (surface chlorophyll and temperature), and others were better modeled with remotely sensed variables that included water column properties.