SC/66a/HIM/13

Assessing risks to endangered blue whales in the Northern Indian Ocean

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INTERNATIONAL
WHALING COMMISSION

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Background statement

The endangered blue whales in the Northern Indian Ocean (NIO) are a poorly studied subspecies of pygmy blue whale (Brownell & Donahue 1994, SMM Committee on Taxonomy 2014). They breed six months out of phase with pygmy blue whales in the Southern Indian Ocean (Mikhalev 2000), are morphologically distinct, and have a unique call (McDonald et al. 2006). Unlike other blue whale populations, the NIO population does not migrate annually to cooler waters, but remain and feed in warm tropical waters year-round (Alling et al. 1991, de Vos et al. 2012).

Their confinement to the Northern Indian Ocean makes them vulnerable to human activities. For example the primary shipping lanes overlap with important foraging areas, where commercial shipping density is in the top 0.2 % globally (Eiden & Martinsen 2010). This is double the shipping traffic off California's Santa Barbara Channel, which has been the focus of extensive action to mitigate the risk of ship-strikes for the California blue whale population (Redfern et al. 2013, Dettmer & Teufel 2014). Off Sri Lanka, overlap between the presence of blue whales and established shipping lanes has led to comparatively high levels of documented ship-strike mortality. For example, in early 2012, two blue whales were killed within a 12-day period (de Vos et al. 2013), with one discovered across the bow of a container ship in Colombo Harbor on March 20, 2012 and the second floating dead at sea on April 2, 2012 with evidence of traumatic injury likely caused by vessel strike (Olsen 2012a, b, de Vos et al. 2013). Observed ship strike mortality is likely a fraction of actual ship strikes as it is likely that most struck individuals do not strand or sink offshore without being documented (Allison et al. 1991) and we suspect that ship-strike is one of the most important causes of Sri Lankan blue whale mortality, potentially inhibiting population recovery from earlier direct exploitation (de Vos et al. In preparation). Without focused action, blue whale ship strike in this region is likely to increase due to increased economic activity in Sri Lanka following the end of secessionist hostilities (Ondaatjie 2011), the construction of a new international port closer to blue whale foraging areas (Aneez 2012), and the predicted doubling of global ship traffic in the next 10-20 years (Southall 2005).

This working paper represents an update on the research conducted by de Vos et al. to identify areas of greatest whale density in relation to shipping lanes in Sri Lankan waters and assess ship-strike risk to the blue whales using these waters.

Transferability of Cetacean-Habitat Models

Jessica Redfern, Paul Fielder, Thomas Moore, Robert Brownell, Asha de Vos and Lisa Ballance

The goal of this research is to explore the transferability of species habitat models built in data-rich regions to data-poor regions. This research is important because we need information about species distributions in data-poor regions to be able to address conservation concerns. We selected blue whales for a case study because they are known to associate closely with upwelling conditions in both temperate and tropical ecosystems. If models are not transferable for a species with well-defined habitat that is similar across a range of ecosystems, it is unlikely we can succeed for species with more complex habitat patterns.

We use data collected during 12 years of systematic cetacean and ecosystem assessment surveys conducted by NOAA Fisheries Southwest Fisheries Science Center in the California Current ecosystem (CCE) and eastern tropical Pacific (ETP). We build models using data from the CCE, ETP, and both ecosystems. We use the following predictor variables: surface temperature, surface salinity, distance to shelf, mixed layer depth, wind speed, and sea surface height. A model is built using just the six individual variables and 15 models are built adding each pairwise interaction. Generalized additive models (GAMs) are fit in the R package mgcv using a Tweedie distribution, REML, and k=4.

The models are used to predict blue whale distributions in each ecosystem. For the CCE and ETP, the models predict back on July to December averages of the years used to build the models. Predictions are evaluated using the area under the Receiver Operating Characteristic (ROC) curve. Specifically, we evaluated the ability of models built using CCE data to predict blue whale distributions in the CCE and in the ETP. Similar evaluations are done for models built using the ETP and combined data sets.

The models are also used to predict in a novel ecosystem – the northern Indian Ocean (NIO). For the NIO, predictions are made on January to March and July to September averages calculated using data from 1991 to 2010. The January to March time period captures the Northwest Monsoon, while the July to September time period captures the Southwest Monsoon. Predictions in the NIO are evaluated using the area under the ROC curve calculated for presence-only data. Both whaling records collected in the 1960's and sightings data collected in the 1990's and 2000's are used in the evaluation. We also use these data to develop MaxEnt models for the NIO. Predictions from the MaxEnt models are compared to predictions from GAMs built using CCE, ETP, and combined data. Finally, predictions for all ecosystems are compared to predictions from global environmental envelope models.

Assessing ship-strike risk to blue whales off Sri Lanka

Asha de Vos, Jessica Redfern, Robert Brownell Jr., Paul Fiedler, Thomas Moore, Lisa Ballance, Bernie Tershy and Don Croll

Predictions from a suite of models developed by Redfern et al. will be used to assess the risk of ships striking blue whales and to evaluate alternative strategies for mitigating this risk. In particular, we will identify areas of highest shipping traffic using global satellite data and explore consequences of changing shipping patterns. We will explore shifting traffic farther offshore, which would decrease overlap with known blue whale foraging grounds and enforcing speed restrictions to slow traffic within designated areas. We will also evaluate potential changes in traffic between the southern coast of Sri Lanka and Kochi, Kerala because extensive shipping was observed between these areas and this route could be impacted by changes in shipping lanes. We assume risk is proportional to the number of whales in each shipping scenario. We will expand upon this basic co-occurrence risk assessment by using a random walk model to estimate the portion of time whales are at the surface and exposed to ship-strike risk. Finally, we will estimate the economic effects of implementing the modeled ship traffic management measures off southern Sri Lanka. Specifically, we consider the scenarios where ships are required to reduce speed or reroute further offshore when transiting these areas. These analyses explicitly incorporate the increased time and, concomitantly, cost associated with vessels reaching their destination under both scenarios. This approach enables us to assess risk to the blue population in Sri Lankan waters and estimate potential costs of management actions to the shipping industry.

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