ICES CM 2014/J:11

Estimation of common dolphin (*Delphinus delphis*) biological parameters for the construction of a population dynamic model: an approximation of the mortality-at-age and the influence of by-catch.

Camilo Saavedra (1), Daniel Howell (2), Santiago Cerviño (1), Graham J. Pierce (3,4), Fiona Read (3,5), M. Begoña Santos (1).

(1) Instituto Español de Oceanografía, Centro Oceanográfico de Vigo, 36200Vigo, Pontevedra, Spain; (2) Institute of Marine Research, P.O. Box 1870 Nordnes, 5817 Bergen, Norway; (3) Oceanlab. University of Aberdeen, Main Street, Newburgh, Aberdeenshire, AB41 6AA, UK; (4) CESAM & Departamento de Biologia, Universidade de Aveiro, 3810-193 Aveiro, Portugal; (5) Instituto de Investigaciones Marinas (CSIC), Eduardo Cabello 6, 36208 Vigo, Spain. Presenter contact details: camilo.saavedra@vi.ieo.es, Phone +34 679 789 190

Summary:

The short-beaked common dolphin (*Delphinus delphis*) is the most abundant small cetacean in the north eastern Atlantic and in some regions by-catch is considered to be unsustainable. To help inform conservation measures, population models are needed to explore how the population will react under different scenarios. In order to build a population model, mortality-at-age curves derived from stranding data were constructed, using a Siler model fitted to the total observed dataset. Due to the paucity of data for the youngest age classes, a separate model was fit to a subset of the data that did not include the youngest age classes. Finally, a Heligman-Pollard model was fitted to the second subset of data as well, taking into account the proportion of by-caught dolphins in the sample. The survivorship curves for the Siler models reported that a median of 30% of the females achieve maturity when we used the total observed data set but only the 18% if we remove the youngest ages. The Heligman-Pollard model showed a more realistic shape since by-catch mortality was taken into account. The results of this model show an effective growth of 0.912 which indicate a population decline, likely due to high rates of by-catch.

Introduction:

Estimations of life-history parameters (e.g. sex ratio, age at sexual maturity, life expectancy and pregnancy rate) can be derived from the examination of stranded and by-caught individuals. Survivorship and mortality-at-age can also be calculated from the age distribution of deaths. Life tables allow the construction of a theoretical population structure with a corresponding abundance by age when a stationary age distribution is assumed (Caughley, 1996). However, possible biases arising from the use of stranding data should be taken into account and therefore, age-at-death distribution is usually modelled with parametric models such as Siler´s (Siler, 1979). One of the most important biases is related to the fact that not all carcasses arrive ashore, especially those of small and younger animals that could be more vulnerable to predation, more rapidly decomposed and/or have lower detection probability (Stolen and Barlow, 2003). In the present work, we evaluated the implications of not taking these biases into account. In addition, when developing a population model, it is important to take into account that the shape of the classic Siler model is appropriate when the mortality describes a consistent pattern unaffected by external disturbances. However, some cetacean populations are highly affected by anthropogenic pressures and by-catch mortality is believed to have a higher impact in some age groups than others (López et al., 2002). For this reason we propose a new method to derive mortality curves for cetacean populations at risk due to by-catch using the Heligman-Pollard model (Heligman and Pollard, 1980). This model can incorporate the effect of different threats and has been already used for human populations.

Materials and Methods:

We used a time series of stranded and by-caught common dolphins available since 1990 to 2013 in Galicia (Northwest Spain). The number of stranded dolphins of each age class in the sample is expected to be higher in the first age groups. However, in the data set, number of dolphins by age class increase from the oldest ages to the youngest, as is expected, but them descend again. Based on the turning point of our data we removed the ages with lower values than expected and fitted two Siler models, one for the whole age classes (S0) and the second after removing the youngest ages (S2). We also fitted a Heligman-Pollard to the subset of data that did not include the youngest age classes (HP2). This parametric model includes a component which reflects an extra mortality that is added to the natural mortality and provides a combined mortality rate. Finally, we constructed a Leslie matrix for each of the fitted models and compared the projected trends of the population.

Results and Discussion:

In the S0 model, the minimum mortality rate fell on the first age classes, with age 0 showing an unrealistic negative mortality rate. In the S2 model age classes 6, 7 and 8 showed the lowest mortality rates. The percentage of annual deaths calculated from life tables was 12% of the population in the S0 and 19% in the S2 models, respectively. Based on these results, the total mortality rate of the population could be underestimated if the lower than expected animals in the first ages is not corrected. The survivorship curves indicate that a median of 30% [28-39%] of the females achieve maturity in the S0 and only 18% [17-22%] in the S2 models, respectively. The amount of births calculated using the S0 model exceeded in 70% the number of births calculated by the S2 model. The results of the HP2 model showed a slight difference with those obtained with the S2 in the adult ages where the shape remained almost flat due to the high influence of by-catch in these age classes. The HP model has the additional advantage, since this allow us to disentangle a theoretical natural mortality for the population. By applying Leslie matrices to the models we got an effective growth of 0.926, 0.891 and 0.912 for the S0, S2 and HP2 models, respectively. The theoretical growth calculated for a population not affected by by-catch was 1.017. The HP2 model allowed a better fit to the observed by-catch mortality and allowed the estimation of a natural mortality for the population. Therefore, we propose this model as an appropriate tool for modeling the population of common dolphins in Atlantic Iberian waters and deriving mortality trajectories.

References:

Caughley, G. (1966). Mortality Patterns in Mammals. Ecology, 47(6), 906–918.

Heligman, L., and Pollard, J. H. (1980). The age pattern of mortality. Journal of the Institute of Actuaries, 107(01): 49–80.

López, A., Santos, M. B., Pierce, G. J., González, A. F., Valeiras, X., & Guerra, A. (2002). {T}rends in strandings and by-catch of marine mammals in north-west {S}pain during the 1990s. Journal of Marine Biological Associacion of the United kingdom, 82(3916): 1–9.

Siler, W. (1979). A Competing-Risk Model for Animal Mortality. Ecology, 60(4), 750–757.

Stolen, M. K. and Barlow, J. (2003). A model life table for bottlenose dolphins (*Tursiops truncatus*) from the Indian River Lagoon system, Florida, U.S.A. Marine Mammal Science, 19(4): 630–649.