Piecewise Exponential Survivor Function, Intrinsic Rate of Growth and Stable Population for Blue Whales (*Balaenoptera Musculus)*

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To motivate my students for continuous demographic models, I use the following biological models as a summary case study for my lectures in demography and life table analysis, which I give at the Department of Statistics of the Technical University of Dortmund. I am a statistician and demographer, but not a biologist.

Continuous models of population dynamics are used to estimate the intrinsic growth rate and other demographic characteristics of blue whale populations. The basis of my investigation is an article by Branch (2008), who estimated the mean annual growth rate as 4.1%, using a simple survival function. Mathematical and Statistical Background, Assumptions, Formulas and Numerical Results, Lit. Sources can be found under: https://www.researchgate.net/publication/359046019

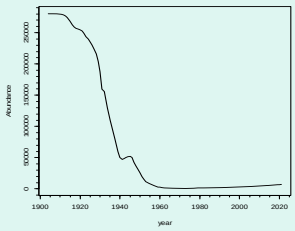

Fig 1: Abundance of blue whales

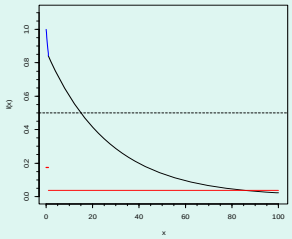

Fig 2: Life Table (2-pieces)

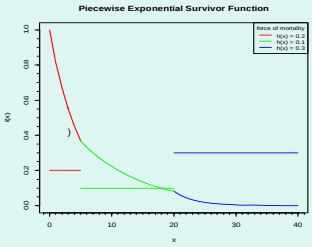

Fig 3: Life Table (3-pieces)

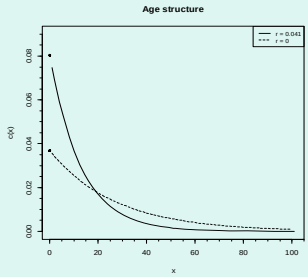

Fig. 4: Age distribution of the stable population

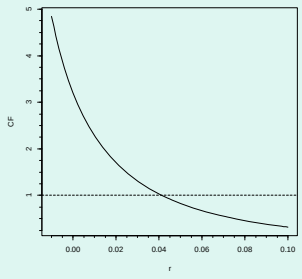

Fig. 5: Intrinsic rate of growth (annual pregnancy rate is between 1/3 and ½ from age 10)

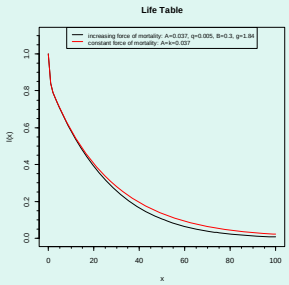

Fig. 6: Comparing with a more complex and realistic life table

Conclusions

The piecewise exponential survival function is an appropriate choice for demographic modeling of blue whale populations when little information on mortality is available, as long as one is not interested in the distribution of old age or even wants to estimate the maximum age. A major advantage of this simple function is the fact that we can derive basic formulas for important demographic parameters. Survival functions that consider continuous hazard functions produce essentially the same results. However, they require the estimation of additional parameters, which is not always practical, especially in view of the limited data information available for wild cetacean populations.