

**NONPARAMETRIC ESTIMATION OF SURVIVAL IN THE WILD:  
APPLICATIONS IN ECOLOGY AND EVOLUTION**

Gimenez, O.

*Centre d'Ecologie Fonctionnelle et Evolutive, UMR5175, 1919 Route de Mende, 34293,  
Montpellier Cédex 5, France.*

Animal survival is a demographic parameter of primary importance in population biology. Because random processes are involved, modelling, estimating and inferring variations in survival rates require the use of statistical analysis. However, studying survival is problematic in the wild since, contrary to studies in human epidemiology or machine reliability, individuals cannot be exhaustively monitored *in natura*, and the event of death is seldom observed. Because of this detectability issue, the most relevant information is based on capture-mark-recapture (CMR) experiments, which consist of collecting samples of marked individuals that are subsequently reobserved / recaptured over time.

In the last forty years, a challenging research topic in ecological statistics has been the estimation of demographic parameters, including survival, using CMR data, and when possible, to explain variation using auxiliary variables like e.g. time, age of animal or relevant external covariates like temperature or rainfall.

These explanatory factors are typically accommodated in models using a logistic regression framework, assuming linear or/and quadratic relationships. However, the biological truth is certainly more complex, and nonlinearities are more likely to be able to capture the patterns in survival variation and therefore should be considered.

The aim of this work is to make the link between CMR methods, which allow for estimating survival while coping with imperfect detection, and nonparametric methods using splines functions, for modelling in the most flexible way the relationship between survival and explanatory factors.

We illustrate our approach using two real examples. In ecology, with regard to the increasing negative human impact on environment, quantifying the effect of climate on survival may be useful in showing an influence of global warming. In evolution, assessing the form of the relationship between survival and an individual trait like body mass may be useful in proving the action of natural selection on this trait by giving an advantage / disadvantage in terms of life expectancy to its bearer.