From identification to models: reassessment of usual methods for populations monitoring. The case of bottlenose dolphin (*Tursiops truncatus*) inhabiting the English Channel.

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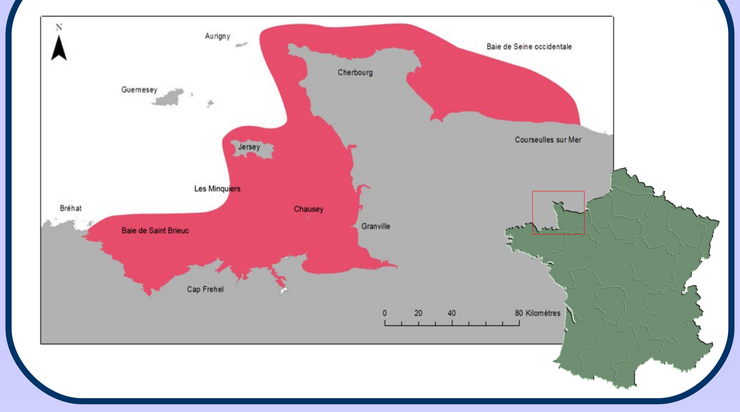
Introduction

The development of conservation and management measures needs suitable indicators that describe the study population very precisely to detect changes in this population. The Groupe d'Etude des Cétacés du Cotentin (GECC) studies the bottlenose dolphin population (*Tursiops truncatus*) inhabiting the English Channel (maps on the right) since 2007. This monitoring is mainly based on annual population size, estimated by capture-recapture (CR) method with close population models (see methods), implemented in the CAPTURE programme of the MARK software. However, this method is not adequate, principally because it requires to respect strict hypothesis, which are unrealistic when concerning marine mammals inhabiting a large geographic area. Thus, it is primordial for the GECC to reexamine its statistic tools in order to obtain reliable indexes which could rapidly identify changes in the population.

The aim of this study is to compare results from the close population models and those obtain by a recent CR method: the multievent models, implemented in the E-SURGE software. The close population models deal with data year by year whereas multievent models deal with all available data.

Study area



M1

M2

M3

M4

Methods

The capture-recapture methods are based on the photo-identification of each animal. The photo-identification is carried out through natural marks (scars, notches) present on their dorsal fin. The level of marking for each individual is matched to a scale starting from M1 to M4 (see photos on the left).

Close population models

To date, the GECC has estimated population size with models that consider the population as closed, ie there is no immigration, emigration, birth or death during a sampling period. This is a questionable hypothesis which isn't representative of dolphin's biology (mobile animals and births throughout the year). These models are based on intra-annual analyses of the population, thus they need several capture sessions in the same year. Some others assumptions were necessary to use these models, like no mark loses, correct identification of each marked animals and equal capture probability among animals.

Survival multievent models

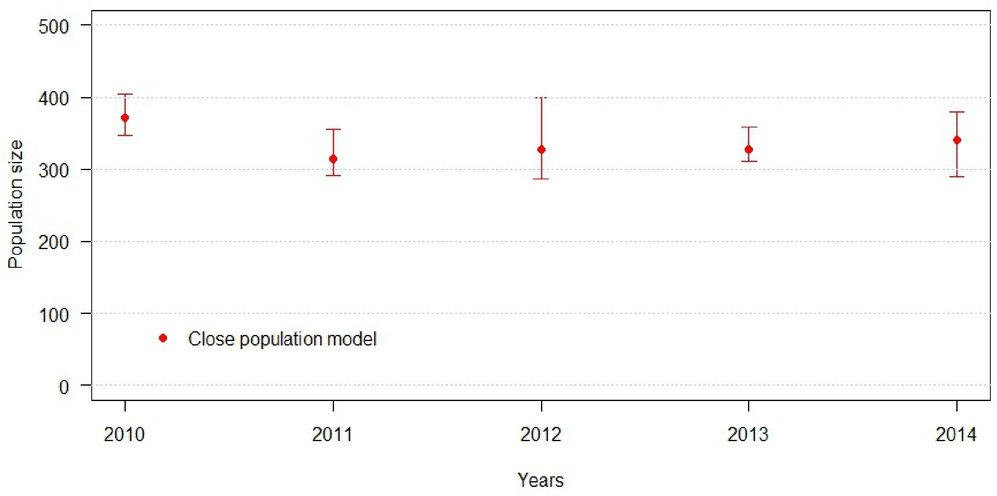
The use of survival multievent models considers the studied population as open, ie they allow migrations phenomenon and death / birth events, which is more realistic than close population. Survival multievent models run with all the available data for an inter-annual analyse, thus they only need one capture session by year. Here a capture session includes summer months (June to September) when field work is more intensive. These models estimate survival rate and capture probabilities. These two parameters are then used to calculate population size according to Cubaynes *et al.* (2010) recommendations.

Results : close population models

Capture probabilities: intra-annual variations

The close population models include intra-annual variations of the capture probabilities. This temporal variation authorizes different capture probabilities from a capture session to another.

Population size



The number of individuals in the population varies between 314 and 372. The confidence intervals seem quite large compared to those calculate with multievent models.

Survival rate: not available

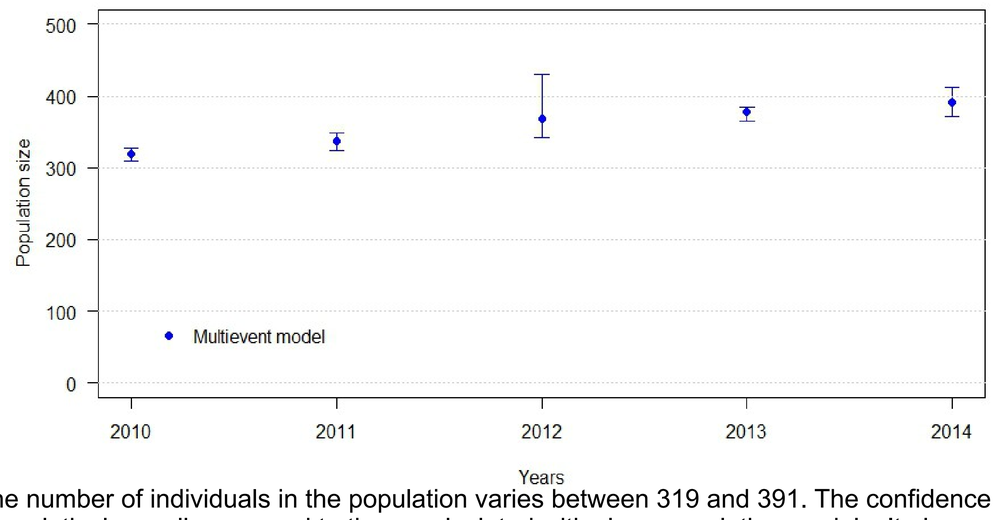
The models in this method do not evaluate the survival rate of this population.

Results : survival multievent models

Capture probabilities : inter-annual variations

A preliminary analysis of the data set highlighted capture heterogeneity, ie capture probabilities among animals are different from one year to another. This factor is considered in multievent models in order to not underestimate the population size.

Population size



The number of individuals in the population varies between 319 and 391. The confidence intervals are relatively small compared to those calculated with close population models. It also seems that the population size increases.

Survival rate : it differs according to animals marking level.

Individuals M2 and M3 : 99%
Individuals M4 : 91%

The values for M2 and M3 animals are relatively high, but in agreement with those recovered in the literature (Smith 2012 and Silva *et al.* 2009). The one obtains from M4 animals is lower.

Discussion - Conclusion

Population size: the estimations of population size are very similar between the two methods. However, the confidence intervals appear to be better for the survival multievent models, which means that the error on each estimation is reduced. Therefore, this new method provides reliable tools to identify trends in population size. Nevertheless, the estimation of population size alone is an insufficiant indicator to determine wether or not the population is "healthy". That's why we have focus on annual survival rate.

Annual survival rate: in the framework of population conservation and managment, we need to understand the population dynamic, ie the changes / variations that can be observed within the population. To highlight the dynamic of population it is not necessary to estimate the population size, but rather demographic parameter which rule and explain this dynamic. For long-lived species, like bottlenose dolphins,the survival rate is a key parameter because it has a strong influence on the population dynamic (Heppell *et al.* 2000). The survival multievent models are thus advantageous because they can calculate this major parameter.
The low survival rate of individuals M4 can be due to senescence or to transient individuals. Moreover, some M4 animals are seen outside the capture session, so they are considered as missing.

Field work: the appropriate conditions of use of the CR methods involve a homogeneous sampling of the studied area for each capture session. For the method with close population models, one capture session should last few days in order to respect the close population hypothesis (no migration, death and birth). This makes the field work very restrictive, especially because the study area is very large. One of the advantage of survival multievent models is that one session have a longer duration (4 months), which provides more time to cover all the studied area.

Perspectives: this work will continue in a PhD thesis. The aim is to develop and to adapt reliable statistical tools to the needs and possibilities of the managers. The idea is that these methods can be used autonomously by managers, and be applied to other small cetacean resident populations.
These methods involve the diversification of the demographic parameters, for example the recruitment, and also to include the spatial component in CR methods. Thus, these developments will provide a better overview of the population dynamic.

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