Productivity estimation in waterfowl using a non-invasive method

Adrien Tableau* Iain Henderson† Sébastien Reeber‡ Alain Caizergues§

02 septembre, 2021

Contents

*Office Français de la Biodiversité, France - adrien.tableau@ofb.gouv.fr - contribution in data analyses & writing
†Animal and Plant Health Agency, United Kingdom - iain.henderson@apha.gov.uk - contribution in data collection
‡Société Nationale pour la Protection de la Nature, France - sebastien.reeber@snpn.fr - contribution in data collection
§Office Français de la Biodiversité, France - alain.caizergues@ofb.gouv.fr - contribution in writing

Abstract

The response of a waterfowl population to a harvest pressure depends on its capacity to renew. The recruitment, i.e. the number of young adults reproducing for the first time, is a key indicator to describe the renewal of a population, and therefore an essential tool in population management. The productivity, i.e. the number of recruits per breeder, is even more informative because it is independent of the population size and allows a comparison over time and between species. The proportion of young adults in a waterfowl population is often estimated from game-hunting samples. However, this proportion, which is a main step in estimating productivity, is not accessible in years without harvest, or with a low harvest rate. Moreover, the age-structure in the harvest samples, commonly called hunting bag, does not necessarily reflect the underlying age-structure of the population. It is often skewed towards juveniles and can lead to an overestimation of the productivity. In waterfowl, adult males usually display brighter colours than juveniles and females. This dichromatism can be characterized and monitored from count surveys, a non-invasive method. Such information can be used to infer the proportion of young adults, and consequently the productivity. In using two populations of ruddy duck, this study develops a Bayesian method to estimate the productivity from count data. To judge the accuracy of this approach, the results are compared to productivity estimates from samples. The adult survival can be estimated from both the counting and the sampling methods and is commonly found in the literature. The consistency of the two approaches is thus discussed by comparing the survival estimates with the literature values.

1 Introduction

1.1 The use of productivity in population management.

The productivity is the number of recruits per their breeders. If one considers a species reaching the sexual maturity as early as the first year, all the population is mature just before the reproduction season. The productivity is thus the ratio of the number of young adults at the reproduction season the year n on the number of all adults at the reproduction season the year n - *1*.

productivity is more closely related to recruitment, which defined with the adult survival the population growth rate and consequently the evolution of the population size and the maximum sustainable catch rate This parameter is complex because it is composed of two sub-parameters, the reproduction success, and the youth survival.

1.2 The variability of the productivity.

A waterfowl species that is released in a favourable habitat will naturally expand (malthus). The growth of such a population is due to its productivity parameter that is higher than its adult mortality. This expansion is limited by the carrying capacity of the habitat (ref). When a waterfowl species is endemic of an ecosystem and evolves in stable environmental conditions, the population size varies around the carrying capacity because the individuals compete for space or/and food (ref). This competition commonly induces a lower reproduction success or/and a higher youth mortality (ref). The productivity then decreases because it is dampened by density-dependent effects (holt). For an endemic species evolving in stable environmental conditions, the productivity and the adult mortality are balanced, which explains the stabilization of the number of individuals.

Hunted waterfowl species can have high harvest rate. Such high harvest pressure increases adult and juvenile mortality (ref). Paradoxically, this high juvenile mortality does not induce a decrease of productivity (ref). Indeed, one expects that a population with a high adult mortality combined to a low productivity would rapidly extinct. However, hunting waterfowl has a long history, and most of these species persisted over time. The reason is that high harvest pressure stimulates the productivity because the competition for space and food is lower and the density-dependent effects affecting the productivity are dampened. The exploitation of a population thus increases adult mortality and productivity. These two parameters can reach a new equilibrium, which explains that the size of an exploited population in stable environmental conditions should reach a new equilibrium, which is lower than the size without harvest.

Productivity is thus a varying parameter that reaches its highest values when no density-dependent effects occurs. Exploring

1.3 Is the variability of the productivity huge or not? What part of the productivity gradient should we know for population management?

1.4 What is the ideal biological model to explore the gradient of the productivity?

Hunting waterfowl has a long history, and few species have observed long-term moratorium Alien species colonizing new territories and then heavily controled are a good model to overcome density-dependent effects and explore the gradient productivity. These species are often introduced during unvoluntary release events. and its presence causes some se species are often arrived because of undesired released

In Europe, a population following its maximum growth rate is a perfect study model

1.5 What are the limitations of the sampling method to estimate the productivity?

- We cannot explore the productivity when there is no harvest, however, it is crucial to explore what happens when there is no harvest in a scenario where we suggest a moratorium to let the population recover.
- Biais because hunting like any predation action is selective. Often towards the weakest individuals. So overstimation of productivity, and potentially maximum sustainable harvest rate overestimated and consequently depletion of the managed population.

1.6 Why counting data is a potential tool to estimate the productivity?

Long time series, easy access, no need of samples

1.7 What is the methodology of this study?

Nichols -> il faut compter de la façon dont on demande

idée: estimer l'age moyen de la pop grâce la vulnerabilité et le sexe ratio chez les adultes

breeding/reproduction success good but not enough because variable survival of juveniles

Introduction:

productivity often defined as Jt/At but more realistic to defined as Jt/At-1

2 Materials & methods

develop the counting method :

2 ways to check the method :

sampling method? Ok but few data as poorly harvested

realistic survival? if > 1, estimated productivity is too low to support the maximum growth rate in the range of similar species in litterature -> satisfying

blabla

3 Results

blabla

4 Discussion

blabla

Nichols -> il faut compter de la façon dont on demande

Aknowledgements

This work was partly funded by the LIFE Oxyura project (LIFE17 NAT/FR/000942) through the LIFE program. This work was carried on with the impulse of Jean-François Maillard, and Jean-Baptiste Mouronval from the Office Français de la Biodiversité, and Jean-Marc Gillier from the Société Nationale pour la Protection de la Nature. The authors aknowledge all the contributors of the data collection in the UK, especially: **names** , and in France, especially: Vincent Fontaine, Denis Lacourpaille, Jules Joly, Justin Potier, Valentin Boniface, Alexis Laroche, and Médéric Lortion, **other names**.

References