PhD-Dissertation Reviews

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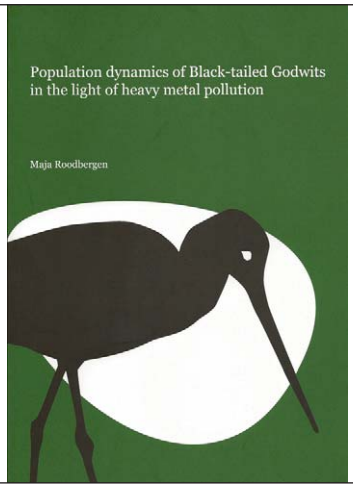
Roodbergen M. 2010. Population dynamics of Black-tailed Godwits in the light of heavy metal pollution. PhD thesis, University of Groningen, The Netherlands. ISBN 978-90-367-4584-0, paperback, 170 pp. Available at http://irs.ub.rug.nl/ppn/329616617.



Approximately 40% of the continental European population of Black-tailed Godwits *Limosa limosa limosa* breeds in The Netherlands, underlining the crucial importance of this country for the conservation of this species. However, the popula-tion is in vast decline, and there is currently only little hope that it will stop or even recover any time soon. A population declines because reproductive output does not sufficiently compensate for dying individuals. Such can be the case if either adult mortality increased, or reproductive output decreased, or both. Knowledge about these central demographic parameters in relation to a changing environment is crucial to stop the decline of the godwit in The Netherlands. The PhD thesis of Maja Roodbergen contributes greatly to our knowledge on the demographic ins and outs of Black-tailed Godwits breeding in The Netherlands. Although the set-up of the thesis is to compare two breeding sites with different levels of anthropogenic pollution, the results are widely applicable and interesting for conservation biology.

The ostensible idea of the thesis is to study the effects of heavy metal pollution on breeding meadowbirds. The major problem posed by heavy metal pollution is bioaccumulation and subsequent biomagnification upwards the food chain. This process can lead to pathologically high concentrations of heavy metal. Thus, even in areas with relatively low, but elevated levels of heavy metals, organisms with a long lifespan at the end of a long food chain, such as birds, are extremely vulnerable to heavy metal poisoning.

Two study sites are compared with respect to heavy metal concentration in soil, earthworms, godwit eggs and feathers. Soil from the polluted area contained more Copper, Mercury, Lead and Zinc than that of the non-polluted site. This translated to higher levels of those heavy metals in earthworms from the polluted site as compared to the non-polluted site. The differences between the two sites were more pronounced in the earthworms than in the soil, very likely because earthworms accumulate heavy metals over time. Concentrations of Mercury and Lead were also significantly higher in godwit eggs from the polluted site than from the clean site, as were levels of Cadmium, Chromium and Lead in feathers. These results suggest that even relatively low levels of environmental pollution can lead to considerable differences in body and reproductive tissue of meadowbirds and earthworms.

Chapter three compares timing of reproduction and reproductive success of godwits from both sites over a three-year period. The unpolluted site harboured nearly three times the density of breeding pairs than the polluted site, where god-wits started laying eggs later in the season. Overall mean reproductive output was 0.23–0.59 fledglings per breeding pair, and it declined significantly over the course of the season in all years and on both sites. This decline in reproductive suc-cess may originate, or be enhanced, through anthropogenic factors or predation. Overall, mean reproductive output was insufficient in all years and on all sites to compensate for mortality, therefore both sites can be considered to be sinks. In order to increase reproductive

success, a change in agricultural temporal schedules is proposed, specifically the delay of mowing.

By using survival analysis of godwits from both study sites, it becomes clear that mortality of adult godwits did not decline during the last 30 years. Hence, the dramatic population decrease cannot be blamed on increased adult mortality, for instance by hunting. In contrast, adult godwit survival was and still is remarkably high, with annual survival estimates between 0.85 and 0.95, which means that godwits may on average reach an age of 14 years. While adult survival was lower at the contaminated site than at the unpolluted site, survival was still high enough for pollution to be unlikely to have influenced adult survival.

In chapter five, a matrix population model is presented. Such a model can be helpful in detecting which demographic parameters are most important, and which are not. Such a model was applied to data of five meadowbird species, Black-tailed Godwit, Northern Lapwing, Eurasian Curlew, Eurasian Oystercatcher and Common Redshank. The results suggest that in order to maintain populations at their current size, conservation efforts should focus on reproduction for the conservation of breeding redshanks and curlews, on reproduction and pre-adult survival in oystercatchers and godwits, and on all demographic parameters in lapwings.

The theoretical results are supported by a considerable literature review in chapter six for all species: godwits, oyster-catcher, lapwing, curlew and redshank. Data was gathered from the so-called "grey literature", and it becomes blatantly clear that adult survival did not decline over the last few decades. Very distressingly, but probably not surprisingly, nest success and chick survival declined massively all over Europe in the last 40 years. In addition, predation rates have in-creased in all of Western Europe during recent decades.

The last chapter concludes that it is unlikely that heavy metals as they occur on the polluted study site have a strong effect on godwit population dynamics. However, most importantly, it is evident that the population decline of godwits, but likely also those of other meadowbird species breeding in Dutch meadows are caused by a reduction in reproductive success.

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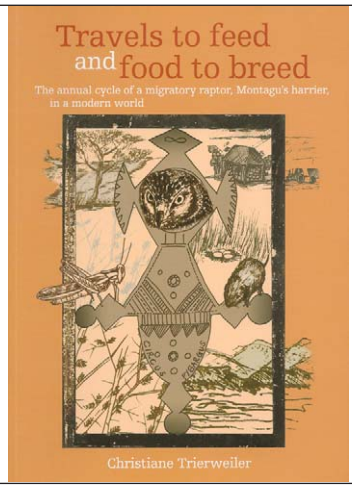
Trierweiler C. 2010. Travels to feed and food to breed: the annual cycle of a migratory raptor, Montagu's harrier, in a modern world. PhD thesis. University of Groningen, The Netherlands. ISBN 978-90-367-4540-6/ Paperback, 264 pp. Available at http://irs.ub.rug.nl/ppn/329607529.



The links between habitat, food and fitness, such as breeding success and survival, are amongst the most important for conservation biology and have immediate corollaries in terms of conservation management recommendations. A study on those aspects is always worthwhile and can lead to good applied science. It is, however, rare to attempt a combined view of all the different aspects of the annual cycle of a species of conservation concern, and most studies – certainly those within one PhD study – deal with only one of the seasons, breeding, wintering or migration. This thesis, in contrast, contemplates the year-round population ecology of a conservation-dependent, vulnerable and fascinating species, the Montagu's Harrier.

Trierweilers' thesis contains nine chapters and five boxes, which are structured in four parts: the breeding season, migration, wintering season and the final part providing a synthesis and a general discussion. Chapter 2 evaluates how population numbers and growth, as well as breeding parameters, relate to vole abundance, and which habitat hosts higher vole abundances. The chapter shows that Montagu's Harrier population size in a given year does not depend on current vole numbers, but population growth does, since higher growth was observed after years of high vole abundance. Vole abundance in a given year affected laying date and consequently clutch size, but the effect on population growth could not be explained through increased local recruitment. Vole abundance was

particularly high in fallow land, and availability of this habitat is what makes agricultural habitats attractive and suitable for breeding. Chapters 3 and 4 present results of a 4-year radio-tracking study that tackles the issue of foraging habitat selection and hunting success, a topic of enormous importance for conservation management. A total of 10 males were radio-tracked and intensively monitored visually, which is an impressive amount of work for this wide-ranging species. Home range sizes, habitat preference, habitat quality (in terms of captures per unit time), and effects on individual fitness (fledging success), were evaluated. The thesis thus links individual behaviour to parameters affecting population dynamics. All the above results are translated into habitat management recommendations for increasing food supply and thereby reproductive success and breeding numbers. These include not only the type of habitat needed, but also advise on the management of those habitats to modify vegetation structure to optimize food availability for the harriers.

Part II evaluates which migration routes are used, and the connectivity between breeding and wintering areas throughout Europe. Chapters 5 and 6 present data from 30 harriers that were fitted with satellite transmitters in five countries in northern Europe during 5 years, rendering 36 autumn tracks and 16 spring tracks. What is impressive is not just the number of tagged birds, but the logistical and coordinating effort made to assure that results are meaningful beyond one study area and applicable to the species at a wide range. Finally, Box C, which, in my opinion, would merit chapter status, provides a synthesis on the migratory system of Montagu's Harriers, combining satellite tracking data, ringing data and count data at migratory points, assessing the relative importance of all migratory pathways at the European meta-population level.

Part III provides information on a critical part of the annual cycle, the wintering season, combining data from satellite-tracked birds, remote imagery (for habitat or NDVI values) and on-site collected information, such as food abundance and harrier behaviour and diet. Analyses of combined sources allowed determining that regional movements during winter are driven by seasonal habitat changes which have consequences for grasshopper abundances. However, data from birds monitored over several years also show that the species is relatively faithful to wintering areas, which suggests either that food abundance was relatively stable in the years of study, or that there are individual constraints to tracking changes in food supply. It remains to be investigated whether different strategies or conditions during winter have any carry-over effects on fitness, as Trierweiler herself says, but I think the foundations laid in this work will make this future task much easier and meaningful.

The final part, the synthesis, makes a good job of summarizing existing information and presenting a general discussion of population processes for the species. Additionally, Box E – again, deserving chapter status – presents results of a population model that evaluates the output of different scenarios. These results show that, at the present moment, nest protection or conservation actions in the breeding quarters are more urgent and with a higher likelihood of producing results than conservation actions in the wintering quarters to assure population sustainability. Such a conclusion is particularly relevant when thinking about the need to prioritize conservation actions in the light of the current economic crisis.

A major highlight of this thesis, therefore, is that it combines different approaches and geographical scales, from long-term monitoring of breeding populations, in-depth observational studies of individual behaviour, extensive fieldwork around the globe for fixing satellite tags and monitoring wintering areas, and combining empirical with modelling data. Even considering the financial and logistical support from the Dutch Montagu's Harrier Foundation, and the 'horde' of volunteers that are duly acknowledged in each chapter, it seems extraordinary that so much good-quality work has been achieved in the course of a PhD project, and that so many relevant conclusions have been extracted from this work.

It is a prime example of science-for-conservation, as it provides both the science in which to base conservation actions, and proves that those have a noticeable effect on the target species. For example, fallow field margins have been a success for conservation of this species in The Netherlands, having a direct and noticeable effect on population numbers.

I think this work represents a landmark in the understanding of the population ecology and conservation biology of Montagu's Harrier, but moreover it relates not only to the model species, but to the conservation of farmland biodiversity at large. It is timely, relevant and full of information. Furthermore, it is very well written and beautifully presented, which makes this a thoroughly enjoyable piece of work.

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