The “annual life-cycle approach” in volunteer studies of migratory waders

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Volunteer researchers restricted by time and small budgets can contribute to the big issues in wader science and/or conservation. They can fill gaps in wader knowledge anywhere along the major wader flyways and by doing this can contribute to the big issues in wader science.

Foundation WIWO, an initiative-supporting organisation of volunteers, may serve as a model for the initiation, organisation and funding of relatively small-scale projects anywhere – from the Taimyr Peninsula in Russia to Cape Town, South Africa. The “annual life-cycle approach” is a conceptual framework within which many themes and topics give inspiration for projects. Several of the big issues in migratory wader science are related to the geographical and temporal characteristics of the annual life cycle. An increase in the knowledge of key factors in the annual life cycle of waders is essential for understanding their evolutionary ecology and for developing successful conservation strategies.

INTRODUCTION

Migrant waders are characterised by their itinerant life cycle, being constantly on the move between breeding areas, stopover and moulting sites and wintering haunts (Fig. 1). All factors that influence fitness components, such as survival of waders throughout their annual life cycle and their reproductive success during the breeding season in particular, will eventually, across seasons, determine demographic rates and consequently population size. Therefore, conservation and site management can only be effective if this fundamental knowledge of population size, survival, reproductive success and life cycles of waders is available. As population size and population stability usually determine conservation and management priorities, this implies that for every species the key sites have to be mapped and monitored, and the key factors in population regulation throughout the annual life cycle have to be determined. In this framework, *all information from all seasons is relevant* and their worth can only be evaluated afterwards.

Throughout their annual life cycle, migrant waders have to make individual choices, each with specific fitness consequences. These may, for example, include choosing one mate or another, whether to breed early or late, whether to moult or to suspend moult, whether to forage or to look for predators, whether to leave or to stay and so on. The study of these choices and their relation to fitness, whether carried out on snow-covered Taimyr tundra, intertidal flats in the Wadden Sea or in a shrinking lake in Africa, forms the heart of the annual life cycle approach. The evolution of individual migration strategies is one of the big issues in wader science and has been a popular subject of theoretical studies using, for example, optimization models (Alerstam & Lindström 1991) or dynamic programming (Clark & Butler 1999). These models urgently need real birds and original field data, or in other words, they are waiting like polished showroom cars to be driven in the real world. In this paper I show that even volunteer researchers, restricted by time and small budgets, can contribute to the big issues in wader science and/or conservation. The working method of Foundation WIWO may serve as a model.

FOUNDATION WIWO: AN INITIATIVE-SUPPORTING ORGANISATION OF VOLUNTEERS

The Foundation Working Group on International Wader and Waterfowl Research (WIWO) was established in 1983, in order to create an accessible intermediary between financing organisations and governmental bodies on the one hand, and volunteer ornithologists interested in studying waterbirds on the other. Starting with the first Netherlands Ornithological Mauritania Expedition (Altenburg *et al.* 1982), over 80 projects have been carried out under WIWO’s umbrella (WIWO 2002). From the very start, the essence of WIWO has been its function as an intermediary: WIWO merely provides people willing to initiate waterbird studies abroad with assistance and guidance in logistic matters and with application for funds. The foundation’s role as an initiative-supporting rather than an initiative-developing organisation bears upon the level of detail with which plans for the future can be specified. Which research issues are taken up and explored will primarily depend on the interest and availability of time and technical resources of the volunteers involved.

Foundation WIWO aims to (1) stimulate, initiate and execute scientific research on waders and other waterbirds and their haunts for the benefit of nature conservation and (2) to make this information widely available through publications. These goals allow a great variety of worldwide research activities on any species of waterbird. However, practical considerations have led WIWO to focus on migratory waterbirds in areas along the eastern coasts of the Atlantic Ocean. The focus on waders reflects the present personal interests of people most involved with WIWO activities, while the geographic focus arose from the connections between the

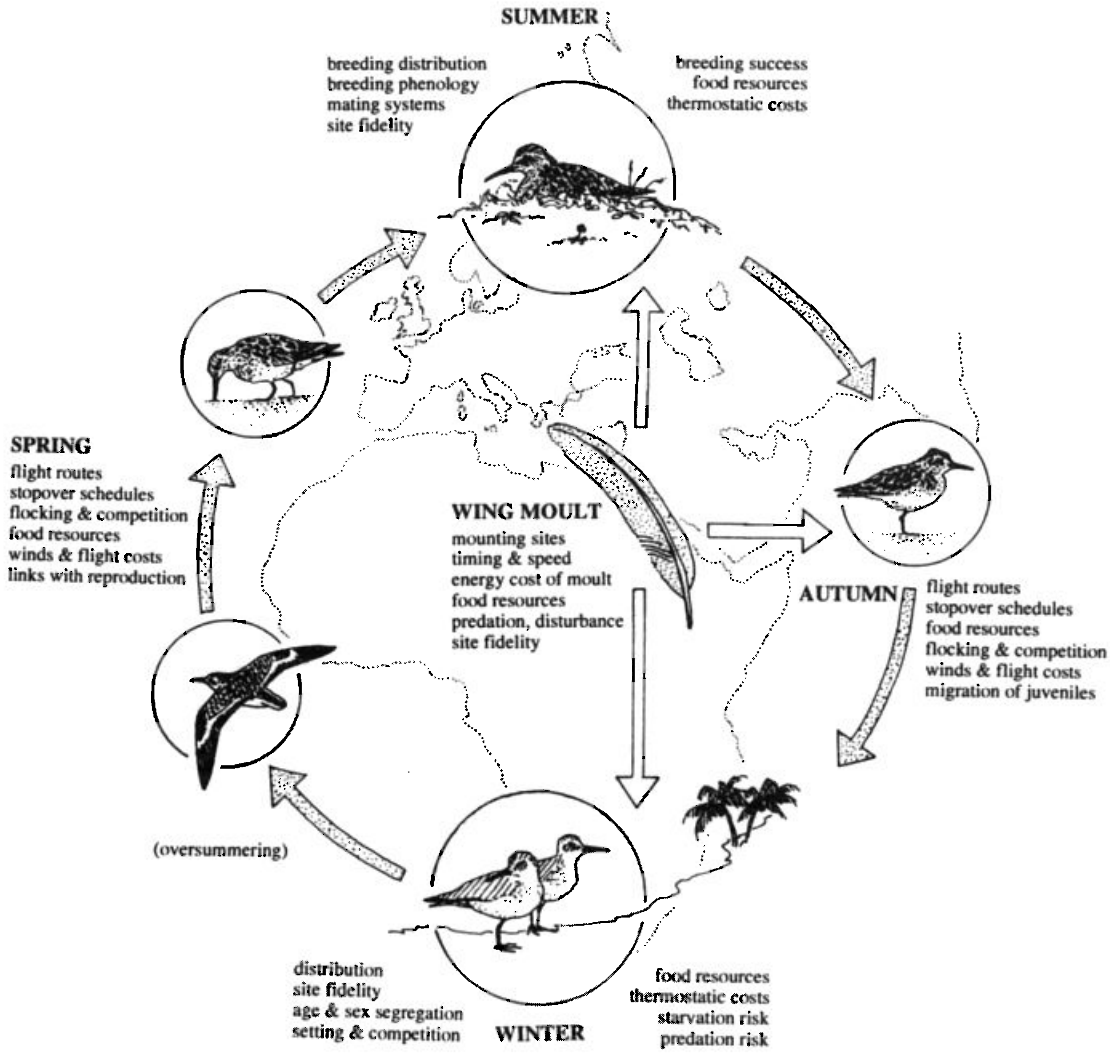

Fig. 1. Schematic representation of the annual life cycle of an imaginary migratory wader species, and the issues that need to be studied for a comprehensive understanding of its ecology and conservation. The annual life-cycle is divided into four seasonal stages plus a fifth stage (wing moult) with a variable timing. For each stage, a short list of the main topics is given, reflecting its geographical and time setting, and the major resources and constraints involved. Circled diagrams represent sites used, and grey arrows denote migratory flights. Although the scheme is set against the background of the Palaearctic–African migration system, the placement of migration arrows and staging sites have no precise geographical meaning.

areas studied and the Dutch Wadden Sea. More recently, activities have expanded both geographically (especially in the Mediterranean, Black Sea region, Middle East and Central Asia) and in the choice of subjects (e.g. breeding bird censuses of wetlands and studies of other non-passerines). The range of WIWO's activities can thus be described as *"studies on waterbirds worldwide, with special attention to migratory species in wetlands in the Afro-Palaearctic migration system"*.

WIWO-projects fall into three categories.

(1) ***Long-term studies and repeated surveys*** at specific localities that generate continuity in contacts with counterpart organisations. This leads to an increase in local support, interest and experience in waterbird and wetland studies (i.e. in "expert capacity"). Ultimately, this may lead to more conservation awareness and action.

(2) ***Annual life cycle studies***: following one species year-round identifies gaps in knowledge and gives insight into flyway connections, such as within the East Atlantic and Mediterranean Flyways and bottlenecks.

(3) ***Distribution-oriented studies***: establishing the international importance of wetlands with waterbird surveys contributes significantly to the identification of Important Bird Areas. A review of WIWO activities is presented in Forward Plan 1999–2003 (WIWO 1998, WIWO 2002), which include lists of over 70 published reports and of publications in various journals. It also includes a brief overview of the current state of knowledge of waders in the East Atlantic and Mediterranean Flyways, complemented with a discussion of regional research priorities in the Arctic, Mediterranean, Africa and Middle East.

THE ANNUAL LIFE CYCLE

A short list of research topics, which all can be studied by volunteer scientists during relatively short projects at representative sites for the species during a particular part of the annual cycle (Fig. 1), is given below. Most factors mentioned below are linked with the fitness of individual birds and consequently with demographic rates and population size.

Spring

Topics include flight routes, stopover schedules, flocking behaviour, competition, food resources, flight costs, departure conditions and migration strategy linked with reproduction.

The spring migration of arctic waders from wintering grounds to breeding grounds has been studied in considerable detail. For several species of coastal waders (particularly Red Knot *Calidris canutus*, Bar-tailed Godwit *Limosa lapponica* and Whimbrel *Numenius phaeopus*), the main staging areas and the distances that are covered in single flights are now well established (Ens *et al.* 1990). Considerable progress has also been made in describing the feeding conditions and constraints allowing the birds to make these flights. Even for these species, however, some uncertainty remains as to whether they use one extra stopover between the Wadden Sea and the breeding grounds. If they do, the stopover sites (quite possibly in the eastern White Sea) need to be identified and the feeding conditions there studied in order to obtain a complete picture of the spring migration. This is particularly important because of the possibility that conditions in the last stopover site influence breeding success through the size of energy stores upon arrival on the breeding grounds. Just how important this mechanism is for waders still needs to be established.

Summer

Several aspects of breeding ecology have been studied in detail, such as breeding distribution, phenology, mating systems, site fidelity, reproductive success, food resources and thermostatic costs. The least-known aspect is that of resources and constraints. Food choice and food availability have been studied in relatively few species at this time of the year, and this is also true of the constraints that the arctic climate may impose on the birds' reproductive effort. Of particular interest is the timing of and condition at arrival on the breeding grounds in relation to the local onset of spring and the fitness consequences thereof.

Autumn

Compared to spring migration, the return southwards in autumn is a poorly explored part of the annual life cycle. Although the general timing and routes are relatively clear, only in a few species do we know which staging areas are used successively and what distances are covered in single flights. Although autumn migration might not be as critical in the annual cycle as spring migration (because the pressure to reach the breeding grounds on time is absent), it is possible that this is not the case since the resources for autumn migrants generally decrease with time, and because autumn migration is often closely linked with moult. Furthermore, birds may have to compete for wintering resources. For juveniles, however, it is certain that the southward migration is a critical test. They lack experience and have to perform their first long flight along routes where the location of suitable stopover sites is probably unknown to them, at least on a detailed scale. Moreover they also have to compete for resources with more experienced adults. Other relevant topics are stopover schedules, flocking and antipredator behaviour, departure conditions, flight-costs and age- and gender-dependent differential migration.

Winter

With the exception of inland waders, the wintering phase is perhaps the best known in the annual life cycle of many waders. Distribution and numbers are relatively well known, while studies on food availability and feeding ecology have been carried out in a variety of areas ranging from NW Europe to South Africa (Kalejta 1992). A gap still exists in the tropical parts of coastal Africa, but this is now in the process of being filled with studies in Guinea-Bissau, Guinée Conakry and Gabon (see references in WIWO 1998, 2002). A considerable amount of work has also been done on the implications of climatic differences between wintering areas at different latitudes (Piersma *et al.* 1992). However, relatively little is known yet about predation pressure in different wintering areas, despite the fact that this might be a factor of importance in shaping migration strategies (see Butler *et al.*, this volume). Other topics requiring attention are site fidelity, age and gender segregation, competition during settling, predation and starvation risk.

Moult

There are several indications that flight-feather moult is a sensitive phase in the annual cycle of waterbirds. It interferes with migration directly because flight is impaired. The fact that moult rarely overlaps more than partly in time with premigratory fattening, suggests that it is also a costly process in terms of energy expenditure. Thirdly, many waders moult in large concentrations in very specific areas before spreading out to winter in a larger number of sites. Many waterfowl species even undertake long "moult migrations", the direction of which may be quite different from that of the movement between breeding and wintering areas. This indicates that moult poses special demands on the areas where the birds stay, either with respect to food or safety and disturbance (Smit & Piersma 1989). Identification of the most important moulting sites and the resources that make them suitable therefore deserves attention.

POPULATION REGULATION

Although the number of population models for wader species is slowly increasing, they are mainly limited to temperate, short-distance migrants (such as Eurasian Oystercatcher *Haematopus ostralegus*, Atkinson *et al.* 2002). Also, they usually apply to a specific area and not to complete flyway populations. To my knowledge, no population models are yet available for long-distance migrants like Curlew Sandpiper *Calidris ferruginea* and White-rumped Sandpiper *C. fuscicollis*. Density-dependence is likely to occur in many wetlands along the flyway but quantitative data on fitness components determining demographic rates are difficult to obtain. Breeding success is difficult to measure due to high latitudes of breeding and mainly available only as indices from catches at wintering or staging sites (Blomqvist *et al.* 2002). Survival estimates are scarce to nonexistent as many wintering sites are in remote areas. For a good number of species, population size is reasonably well known but population trend data are scarce and difficult to obtain. In view of recent evidence that populations of many intercontinental migrants are in decline (Zöckler *et al.*, this volume), a big issue might be how population regulation depends on migration distance. Myers (1981) showed that there are considerable cross-seasonal interactions between migration distance and social systems. This suggests that there may be a large influence of migration distance on population regulation. One reason for this may be that competitive interactions between different age-classes and sexes are highly site and time dependent. The intensity of these interactions is likely to depend on food availability during migration and on the wintering grounds. This kind of information from anywhere along the flyway is relevant, particularly from those coastal sites that support large numbers of the focal species. Studies at inland wetlands are also needed in order to gather data on inland waders. Volunteer researchers can contribute to these issues by collecting data on food resources and differential utilization by different sexes and age-classes at different periods during the annual cycle anywhere along the flyway.

AREA OF OCCUPANCY

IUCN criteria are now widely used for setting conservation priorities globally and regionally (Gärdenfors *et al.* 2001). These are based on population size, the reduction of population size, size and change of geographic range or quantitative analysis of extinction risk. Huge and continuing contributions have been made to our knowledge of population sizes and trends in shorebirds by regular waterbird counts worldwide. Information on global distribution of a selection of mainly temperate species has recently been compiled for the forthcoming *Atlas of Wader Populations in Africa and Western Eurasia*. However, I do not know of any studies that are aimed to measure the area of occupancy of waders during the non-breeding season, which is the period when they are most concentrated and thus most vulnerable. While most waders are relatively evenly spread during the breeding season, there seem to be huge between-species differences in the areas of occupancy during migration, moult and winter. Some coastal waders are highly concentrated in only a few wetlands during part or the whole of the non-breeding season (e.g. Hudsonian Godwit *Limosa haemastica* and Red Knot), while many inland waders are dispersed over huge areas during migration and winter (e.g. Common Sandpiper *Actitis hypoleucos* and Wood Sandpiper *Tringa glareola*). This information is also important for establishing local densities and linking them with the dynamics of flyway populations. Census work by volunteer researchers in wetlands, which yet have to be counted or have been counted infrequently, can still make a significant contribution to the knowledge of global wader distribution.

CONCLUSIONS

Volunteer researchers can fill gaps in wader knowledge anywhere along the major wader flyways and by doing this can contribute to the big issues in wader science. Several of these, such as the evolution of social systems, population regulation and structural and physiological plasticity, are related to the geographical and temporal characteristics of the annual life cycle. Increasing our knowledge of key factors in the annual life cycle of waders is essential for understanding their evolutionary ecology and will contribute to the development of successful conservation strategies. Learning how migrants optimise their annual cycles, life histories and migration routes remains a challenging agenda (Ricklefs 2002). Progress in most of these fields of research still depends heavily on basic field work carried out by volunteer researchers, such as monitoring numbers, breeding success, and survival through census work and ringing studies throughout the wader flyways.

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REFERENCES

Alerstam, T. & Å. Lindstrom 1990. *Optimal bird migration: the relative importance of time, energy and safety.* In: Bird migration: Physiology and Ecophysiology (Gwinner, E. Ed.) Berlin, Springer. pp. 331–351.

Altenburg, W., Engelmoer, M, Mes, R. & T. Piersma 1982. *Wintering waders at the Banc d'Arguin, Mauritania.* Communication 6, Wadden Sea Working Group, Leiden.

Atkinson, P.W., Clark, N.A., Bell, M.C., Dare, P.J., Clark J.A. & P.L. Ireland 2003. Changes in commercially fished shellfish stocks and shorebird populations in the Wash, England. *Biol. Cons.* (in press).

Blomqvist, S., Holmgren, N., Åkesson, S., Hedenström, A. & J. Pettersson 2002. Indirect effects of lemming cycles on sandpiper dynamics: 50 years of counts from southern Sweden. *Oecologia* 133: 146–158.

Clark, C.W. & R.W. Butler 1999. Fitness components of avian migration: A dynamic model of Western Sandpiper migration. *Evol. Ecol. Res.* 1: 443–457.

Ens, B.J., Piersma, T., Wolff, W.J. & L. Zwarts 1990. Homeward Bound: problems waders face when migrating from the Banc d'Arguin, Mauritania, to their northern breeding grounds in spring. *Ardea* 78: 1–16.

Gärdenfors, U., Hilton-Taylor, C., Mace, G.M. & J.P. Rodríges 2001. The application of IUCN Red List criteria at regional levels. *Biol. Cons.* 15: 1202–1206.

Houston, A.I. & McNamara, J.M. 1999. *Models of adaptive behaviour: an approach based on state.* Cambridge, Cambridge University Press.

Kalejta, B. 1992. Time budgets and predatory impacts of waders at the Berg River estuary, South Africa. *Ardea* 80: 327–342.

Myers, J.P. 1981. Cross-seasonal interactions in the evolution of sandpiper social system. *Behav. Ecol. & Sociobiol.* 8: 195–202.

Piersma, T, Drent, R. & P. Wiersma 1991. Temperate versus tropical wintering in the world's most northernmost breeder, the Knot: metabolic scope and resource levels restrict supspecific options. *Acta XX Congr. Internat. Ornithol.* (Christchurch), p. 761–772.

Ricklefs, R. E. 2002. Birds of two worlds: temperate-tropical migration systems. *Trends Ecol. Evol.* 17: 302–303.

Smit, C.J. & T. Piersma 1989. *Numbers, midwinter distribution, and migration of wader populations using the East Atlantic flyway.* In: Flyways and reserve networks for waterbirds (Boyd, H. & J.-Y. Pirot, Eds.). IWRB Special Publ. 9, Slimbridge, pp. 24–63.

Weber, T.P. 2001. Long-distance migrants as a model system of structural and physiological plasticity. *Evol. Ecol. Res.* 3: 255–271.

WIWO 1999. *Between Taimyr and Table Mountain: Forward Plan* 1999–2003. WIWO, Zeist.

WIWO 2002. www.wiwo.org