Summary

In migrants, the annual cycle consists of four different seasons, notably breeding, autumn migration, wintering and spring migration. During different seasons, survival and reproduction of individuals are influenced, which is potentially reflected in population trends. Understanding the population trends of migratory animal species represents a challenge, because effects operate at widely separated places. Studying the annual cycle of long-distance migratory bird species is especially difficult since breeding and wintering areas can be located on different continents and autumn and spring migrations occur over thousands of kilometres. For a basic understanding of population dynamics and the development of effective conservation strategies, however, studies of the whole annual cycle are crucial: long-distance migratory bird species generally declined steeper in numbers during the last decades than short-distance and non-migratory bird species. Likely causes for the declines are consequently not only to be found in the breeding areas, but also along migration routes and on the wintering grounds.

The combination of sophisticated technology and traditional fieldwork enables biologists nowadays to study the whole annual cycle of long-distance migrants. This thesis is a study on the annual cycle of Montagu’s harrier *Circus pygargus*, a medium-sized, slender-winged raptor that was originally a steppe bird. Montagu’s harriers migrate annually between European breeding and African wintering areas south of the Sahara. It can therefore be used as model species for long-distance migratory raptors. Most of the natural breeding habitats in Europe are now cultivated or highly degraded, and harrier populations are since the last century most often breeding in farmland habitats. Because Montagu’s harriers build their nests on the ground, breeding in farmland is hazardous. During the harvest, nests are often destroyed and even incubating females may be killed. In addition, intensification of agriculture leads to decreasing food availability. Although Montagu’s harrier is not categorised as globally threatened, the species is included in several European national “Red Lists”, being in need of special conservation actions.

This thesis comprises parts on (1) processes during the breeding season, (2) processes during migrations and (3) processes during the wintering season. In the last part (4), a complete picture of the annual cycle of Montagu’s harriers is created.

In part 1, it is shown that NW-European farmland is attractive to Montagu’s harriers when high numbers of small mammal prey, mostly voles, are available. Vole abundance positively influenced population growth rate and clutch size. High vole abundance alone, however, does not warrant nestling survival, which is also depending on nest protection from agricultural practices and forthcoming predation, and may depend on the abundance of alternative prey such as farmland birds, and weather conditions during the early nestling phase. To reveal how the harriers use the modern farmed landscape, we deployed miniature radio transmitters on birds in two Dutch farmland areas and tracked them by car using hand-held antennas. Results from these telemetry data showed that high habitat diversity was generally favoured within the home ranges, with lucerne, fallow habitats and cereals being
most preferred habitats within the home ranges. For hunting, specifically intensive grasslands and natural grasslands were preferred. Birds with a high proportion of lucerne and fallow habitat types in a 1.6 km radius around their nest site had relatively small home ranges and a relatively high breeding success, possibly because of energy and time savings of shorter hunting trips. Strategies to conserve breeding populations in intensive farmland should aim at offering more of these habitat types. Offering profitable hunting habitats can be realised by agri-environmental schemes (e.g. fallow field margins), being favourable hunting habitats themselves and potentially functioning as a year-round source habitat for potential prey animals colonising the surrounding landscape. Not only vegetation type but also vegetation management determines Montagu’s harriers’ hunting success. Mowing of grassy vegetation reduces cover for prey animals and makes them more readily available during several days. Phased and partial mowing, e.g. in the context of agri-environmental schemes, can thus be regarded as a tool to increase food availability for harriers during the breeding season each time on the short term. Besides, mowing can create heterogeneous habitats (foraging habitats and cover) for other farmland birds. Montagu’s harrier, being on top of the food web, can function as a flagship and indicator species for the conservation of the underlying farmland small mammal and bird communities.

In part 2, the life of Montagu’s harriers during autumn- and spring migrations is investigated. Satellite transmitters were deployed on the birds as a backpack. Signals sent by these transmitters are received by satellites; localisations of the birds are sent to the researchers via the internet. These telemetry data show that north-west and northeast European Montagu’s harriers used three important migratory pathways to their West-African wintering areas: either via Spain, Italy or Greece. Whereas migrants via Spain and Italy returned via similar routes to the breeding areas, migrants via Greece mostly returned in a loop via Italy. Combining insights from satellite tracking and recent migration counts, it is suggested that another important pathway must be located between the Caspian and Black Sea via Israel into West- or East-African wintering areas. Migratory connectivity between breeding and wintering populations is significant: the geographical locations of the different breeding areas are a mirror image of the locations of different wintering areas, and most individuals stick in subsequent years to certain migration routes, wintering- and breeding areas.

In part 3, we use satellite telemetry to provide insights into processes in West-African wintering areas. It was previously thought that Montagu’s harriers were nomadic during the winter, following outbursts of high food abundance such as migratory locust swarms. During this study, they were bound to a small number of winter home ranges that they visited in subsequent years. Fieldwork revealed that during the study period - years without migratory locust plagues -, Montagu’s harriers needed to rely on non-migratory grasshoppers and alternative prey such as birds, small mammals and reptiles. Movements between the harriers’ home ranges were correlated with a southward shift in vegetation greenness during the wintering (the Sahelian dry) season. The harriers followed a “green belt” of optimal vegetation greenness, which is apparently linked to grasshopper food availability. The use of
chemical insecticides against crop-damaging grasshoppers may confront Montagu’s harriers and other grasshopper-consumers in West-Africa with poisoned food sources. The increasingly widespread use of biological insecticides that are not harmful to birds opens potential future perspectives for the conservation of grasshopper-consuming (migratory) birds.

In part 4, we conclude from the presented data that the two most important components in Montagu’s harriers’ annual cycle can be summarised as “travels to feed” and “food to breed”. Annual routines are characterised by movements on different scale levels (“travels to feed”): from small scale hunting trips (breeding areas) over medium scale movements between winter home ranges to large scale intercontinental during autumn and spring migrations. All movements are between areas abounding with different types of prey at different times of the year. Most important preys (“food to breed”) are small mammals in the European farmland breeding habitats, directly influencing reproduction and population change. In the West-African natural and farmland wintering habitats, large insects play an important role, possibly influencing survival and reproductive success via effects on adult body condition and migration phenology, carrying over to the breeding season. In both breeding and wintering areas, modern landscapes are dominated by human influences. Agricultural intensification results in decreased food availability both in summer and winter as well as in nest destruction during the breeding season, the latter currently having the largest negative effect on population change within the annual cycle. Agricultural intensification can consequently be seen as the main threat to Montagu’s harriers at this time. Effective conservation actions targeting this problem in the European breeding areas are nest protection and improvement of food availability by farmland extensification (e.g. agri-environmental schemes). Problems in the wintering areas are more difficult to tackle. Intensification of agriculture in West-Africa is a result of the growing human population. Montagu’s harrier conservation strategies can make use of the fact that harriers often concentrate in small areas and are site-faithful. Effective conservation actions may thus be targeted at these areas. In general, a motivation to strive for sustainable use of Sahelian farmland ecosystems is not only the benefit for biodiversity but also for human food security.

The aspect in the annual cycle of Montagu’s harrier that is still least well understood are the processes during migration itself. Annual mortality is highest during migrations. Possible reasons are energetic bottlenecks during the crossings of barriers, e.g. the desert or the sea, but also illegal hunting. Suitability of stopover sites may be a prerequisite for successful migration. In future research, the relationship of ecological conditions during stopover and wintering with Montagu’s harriers’ fitness components will be investigated. The focus will be especially on a stopover site in eastern Morocco that was identified by satellite telemetry, being used in autumn and spring before respectively after the crossing of the Sahara desert.