The annual cycle of German adult Ospreys (*Pandion haliaetus*) – studies in the breeding and wintering areas as well as during migration since 1995, using satellite telemetry

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Key findings

A) Female ospreys have an unusually early departure compared with the males
B) Male ospreys exhibit diverse migratory strategies (short- and long-distance)
C) Regardless of the sex and migration strategy, the overall distance the birds cover over the course of a year is approximately the same.

Abstract

German ospreys (*Pandion haliaetus*) were thought to migrate to sub-Saharan Africa. Most of the many ring recoveries, however, were from juvenile birds, and adults were never satellite-tracked. During 1995 – 2011, we marked 28 adult ospreys in northeast Germany with satellite tags that worked for up to 8 years. Three males wintered in Iberia, while the other birds wintered in West Africa. The migratory paths followed by the ospreys while in Europe, especially in autumn, seemed much straighter and more directional than the migratory paths followed in Africa. This pattern related to the wind conditions, whereby individuals drifted with the winds as they crossed the Sahara, then compensated as they approached their winter destination, leading to a more diffuse migratory path. Consequently, individuals were fairly consistent in the routes used in Europe over the years, but not in the routes taken in Africa. Males started their autumn migration at the very end of the breeding season when the young left, whereas females typically commenced migration much earlier, long before the young became independent. When breeding failed, females left the breeding sites as early as late June. In contrast, the timing of the onset of spring migration varied little between the sexes. While males exhibited little variation in their arrival time at the breeding grounds, female arrival times were more variable. The difference between the sexes in the variance in arrival dates may be due to the pressure on males to arrive at breeding places early to find and defend a high-quality breeding territory.

Materials and Methods

Satellite transmitters (platform transmitter terminals, PTTs) were deployed on 28 adult ospreys between 1995 and 2011 in northeastern Germany (25 in Mecklenburg-Vorpommern and 3 in Brandenburg). A harness was used to fix the PTT near the center of lift to minimize the effect of the PTT on the bird's behavior. Individuals were tracked for up to 8 years. Ospreys were trapped using the so-called dho-gaza method, which is the most successful method for trapping live adult sea eagles (*Haliaeetus albicilla*). The eyries of most birds were on medium-voltage pylons, and some were in trees. At a few nests, different ospreys were caught over the years, but the same individuals usually used a given nest each year. Many of the ospreys had already been ringed as nestlings, mostly by Dietrich Roepke; thus, information about their age (the oldest caught male was 18 years old), the distance of the location from their place of birth, and so on, was available. One bird was caught on three separate occasions and carried three different PTTs because two of them did not work. In a few cases, the PTTs were removed when the birds were caught the second time, and in one case, in Portugal, the bird was injured and therefore released after its recovery without a PTT.
We cleaned up the movement data for each individual using the general purpose filters available in the R package *move,* whereby we removed duplicate entries for the same individual with the same timestamp and positions, and an average speed higher than 35 m-s. After filtering the data, we divided it into stationary versus movement periods.

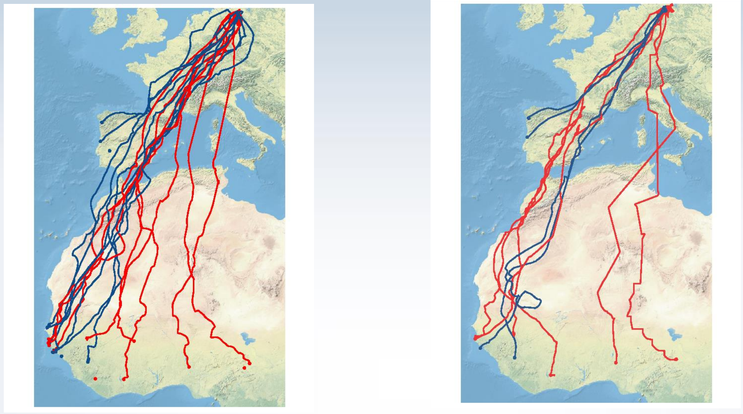
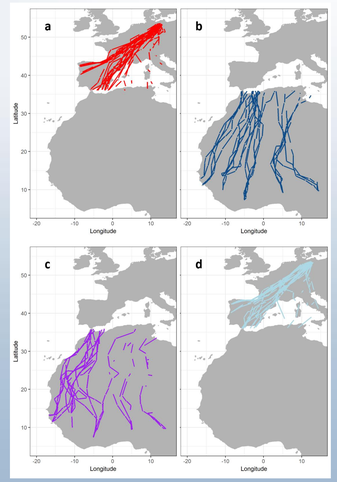


Figure 1. Autumn (left) and spring (right) migration routes of female (red) and male (blue) ospreys. Points indicate non-breeding sites. Individuals with only non-breeding sites had insufficient data on their exact migration routes.

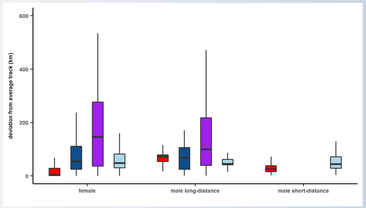


To investigate diurnal and annual movements, we evaluated several aspects: 1) accumulated distances ospreys traveled during the breeding and non-breeding season, 2) accumulated distances ospreys traveled over the annual cycle, 3) mean distances of hourly movements, and 4) mean distances per hour over the course of the day for both the breeding and non-breeding season. To investigate aspects 1 and 2, we only included ospreys with data for a full breeding or non-breeding season or a complete annual cycle, whereas for aspects 3 and 4, we included individuals with incomplete data for the entire annual cycle.

Figure 2. Overview of the daily distances covered by all individuals that were tracked continuously for more than 1 year in a) Europe in autumn, b) Africa in autumn, c) Africa in spring, and d) Europe in spring.

Results.

We obtained data for 8 individuals with ARGOS data totaling 13 bird-years and GPS data of 17 individuals totaling 33 bird-years (one individual was tracked for 8 consecutive years). In this paper, we focus only on the first year a bird was tracked. For fine-scale analyses on migration progression and home range sizes, we focused on the more accurate and frequently recorded GPS data of the transmitters used since 2006.
The ospreys migrated over a broad front southward to their non-breeding grounds, which were located mainly throughout western sub-Saharan Africa, but three males spent the non-breeding season on the Iberian Peninsula (Figure 1). Most of the birds spent the non-breeding season at the coast of Senegambia and Guinea-Bissau, but some migrated as far east as Lake Lagdo in northern Cameroon (Figure 1).
Over the whole annual cycle, the short-distance males accumulated 13,897 to 17,315 km, long-distance males accumulated 16,295 km, and females accumulated 14,304 to 19,426 (mean 16,386) km.



Deviations (in km) of the average track for each individual divided by females; males that migrated to sub-Saharan Africa; and males that stayed in Europe, migrating to the Iberian Peninsula. Colors correspond with Figure 1: red is the autumn migration in Europe; dark blue, the autumn migration in Africa; purple, the spring migration in Africa; and light blue, spring migration in Europe.

Discussion.

The migratory behavior of ospreys from Germany is highly repeatable between years in regard to the use of breeding and nonbreeding sites and the timing of spring migration, but individuals possess the navigational capacity to migrate in various ways between these areas, allowing for drift at major barriers such as the Sahara Desert.
Routes were mainly repeatable within individuals on the European continent, suggesting that ospreys might use familiar landmarks, navigating toward particular goal areas. Interestingly, females showed smaller deviations from the average individual tracks in autumn than males. This is likely because females make prolonged stops during autumn migration at sites that are visited each year. In contrast, males usually migrate more progressively and faster because they leave the breeding grounds much later than females after the young have fledged. Consequently, autumn migration timing was not repeatable. This lack of repeatability may also be due to individuals leaving the breeding grounds on different dates each year depending on the duration of the breeding season. Spring migration, however, was somewhat repeatable, especially in males. The crossing of the Sahara Desert, in particular, occurred at different places each year. This pattern seems to relate mainly to the wind conditions, with individuals drifting more over the desert, after which they compensate to arrive at either their nonbreeding or breeding site.
Individuals timed their spring migration similarly, despite the stronger wind drift they experienced, especially while crossing the Sahara Desert. Because ospreys are known to use both soaring and more active flight strategies, one might have expected them to compensate more in areas with unfavorable winds, a strategy common to migrating raptors that use flapping flight. Instead, ospreys seemed to minimize the energy spent crossing barriers by allowing for drift and only compensating again when nearing the goal areas.