



## SYMPOSIUM 'REINTRODUCING MIGRATORY BIRDS'

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### Why do birds fly in formation? Ongoing research with the Northern Bald Ibis

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Migratory birds comprise more than 80% of avian diversity in temperate regions of the world. How birds can perform such endurance flights is still poorly understood. We examined energy expenditure and physiological changes in Northern Bald Ibis (*Geronticus eremita*) during natural flights using birds trained to follow an ultra-light aircraft. This so-called human-led migration (HLM) were also used to study the mechanism and function of avian formation flight.

Bairlein et al. (2015) found that instantaneous energy expenditure decreased with flight duration, and that the birds appeared to balance aerobic and anaerobic metabolism, using fat, carbohydrate and protein as fuel. This made flight both economic and tolerable. Portugal et al. (2014) showed that Northern bald ibises flying in a V flock position themselves in aerodynamically optimum positions, in that they agree with theoretical aerodynamic predictions. Furthermore, we demonstrate that birds show wingtip path coherence when flying in V-positions, flapping spatially in phase and thus enabling upwash capture to be maximized throughout the entire flap cycle. However, as the leading bird in a formation cannot profit from this up-wash, a social dilemma arises around the question of who is going to fly in front? Voelkl et al. (2015) investigate how this dilemma is solved and could show that the amount of time a bird is leading a formation is strongly correlated with the time it can itself profit from flying in the wake of another bird. These results suggest that Northern bald ibis cooperate by directly taking turns in leading a formation.

All these findings allowed to optimize the human-led migration as a method for conservation and for basic research. Meanwhile human-led daily flight-stages of up to 360 km and 8 hours duration are possible. These flights largely resemble the migration flights of wild, migrating Northern Bald Ibises.

As a kind of a by-product of our whole-population bio-logging, we found evidence that tagging of the Northern bald ibises caused an eye-disease and aerodynamic disadvantages with obvious negative fitness effects for the bird. Further research is urgently needed to minimize fitness impairing effects in this fast-growing field of bio-logging.