Ecology and energetics of Eurasian wigeon (*Anas penelope*) in the Schleswig-Holstein Wadden Sea

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Summary

Eurasian wigeon (*Anas penelope* L. 1758) have to deal with an energetic bottleneck for two reasons: they feed poorly digestible food and are also the smallest of all 24 grazing bird species.

This study aims to investigate the key ecological factors of Wigeon wintering in the Schleswig-Holstein Wadden Sea (SHW), the area along the North Sea coast of Germany, and to calculate their energy budget. The study was carried out from 1990 to 1996.

SHW forms the northern border of wigeon winter distribution in northwest Europe. From the 1960s to the 1990s peak numbers increased from 50,000 to 140,000. This was mainly due to an increase of winter wheat and winter rape, as the crop area almost tripled during this period. Wigeon spent about 15.5 million bird days in SHW, 2.2 to 9.2 million of which were spent feeding on winter grains.

The proportions of wigeons in winter are 50 % adult males, 36 % adult females and 7 % immature males and females. The proportion of adult males is highest on islands, salt marshes and in large flocks.

Activity budgets over winter have been established for 50 whole day and 15 whole night observations, and the observation of flights during dusk. Wigeon spend 15.4 hours a day feeding (minimum 14.3 hours a day in September, maximum 17.0 hours a day in April). This is more than any other bird. There is no relationship with the phases of the moon.

As an adaption to their nocturnal activity, wigeon have developed their twilight vision. Their eyes reflect incident light, which causes a red shimmering. This has not been discovered in other *anseriformes* so far. The choroidal pigment epithelium is clearly less pigmented in wigeon than in the brent goose (*Branta bernicla bernicla*) for example.

Wigeon often fly off when disturbed, 1.53/h by day and 0.35/h by night. 85% of the disturbances are caused by birds, 15% by humans. Great black-backed gulls (*Larus marinus*) caused the greatest number of the observed disturbances, peregrines (*Falco peregrinus*) the longest lasting ones. The number of great black-backed gulls was positively correlated with the number of disturbances of wigeon in different areas. Based on 650 hours of observation, these gulls and falcons are the main predators of wigeon, causing an estimated winter mortality of 9.6 %.

Unlike other ducks, wigeon feed almost invariably on land, where they are greatly exposed to predators. This is reflected in their behaviour; feeding flocks stay close to bodies of water to which they can flee (average 20 metres), the flock size is larger by day (250 vs. 100 individuals at night) and all flocks are characterized by collective nervousness (harmless waders caused 20 % of the disturbances).

During the daytime, wigeon mainly feed on the banks of the stretches of water they flee to Vegetation and food intake is thus significantly reduced, and this is reflected in a decline in droppings of more than 50 %.

Energy intake has been calculated using activity budgets, dropping frequency, and energy content of food (21.2 kJ/g organic matter for all food plants) and droppings, and the specific digestibility

(salt grass 21 %, sweet grass: 37 %, winter wheat 45 %, winter rape 74 %). The mean energy intake is 630 kJ/d, slightly higher in midwinter.

Energy expenditure for wintering wigeon is composed of basal metabolic rate, thermoregulation, heating and processing food and the costs of activities. The basal metabolic rates and thermostatic costs of 10 wigeon have been measured under laboratory conditions (3.5 W in males; 2.8 W in females).

Heated taxidermic mounts (HTM) have been used to determine thermostatic costs outdoors. The effects of temperature, wind and global radiation were calculated with a regression model. Temperature is the key climatic factor for wigeon. During winter, wind increases thermostatic costs by 10 %, whereas global radiation lowers it by 3 %.

The energetic costs of activities were measured for 3 individuals with heart rate telemetry under semi-natural conditions. Multiples of basal (BMR) and resting metabolic rates (RMR) for ten activities, excluding flying, were measured for the first time in herbivorous *anseriformes*.

Similarly parallel HTM measures indicated that locomotion-generated heat counts for 90 % of thermostatic costs among free living wigeon that are active for 19 to 22 hours a day in winter.

Accumulation or depletion of depot fat is not significant since the body mass of free living wigeon does not change in winter, as measured among 333 hunted birds.

Energy intake and energy expenditure corresponds well, although identified with different methods. The mean metabolic rate of free living wigeon from September to April is 2.2 times their BMR.

By day, wigeon mainly feed on pastures on the banks of bodies of water, which are thus subject to heavy grazing activity. The energy balance there is 9 kJ/h. By night they feed on inland pastures (32 kJ/h), winter wheat (51 kJ/h) or winter rape (205 kJ/h). The increase of the wigeon population in SHW is explained by the increase in cultivation of winter grains in the area.

Energy deficiencies occur when feeding areas are completely snow-covered and the birds cannot access their food. Their body reserves meet this situation for 4 - 6 days. Freezing of bodies of water (which are used to escape to) without snow is less serious. This only blocks escape waters and feeding areas by day, when wigeon gain 15 % of their daily energy intake.

The energetic cost of a single disturbance is 0.45 kJ, calculated for a day equivalent to 1.3 % of daily energy intake.

Due to their small body size, with relatively high heat losses, wigeon spend many more hours feeding than geese do. The evolutionary advantage of being small is better maneuverability in flight. Ground feeding wigeon are highly exposed to and at risk of being captured by avian predators. The advantage of being small comes at the high cost of an extremely long feeding time, which is limited only by what is temporally possible.