

SUSTAINABLE COMPENSATION MEASURES FOR WETLAND RESTORATION

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Abstract: Climate change will affect wetlands significantly in their spatial extent, distribution and function. Therefore restoration measures in wetlands must be able to cope with future climate extremes. To obtain a sustainable system of compensation measures for affected wetlands a “3-columns-model” of rewetting measures was developed for a water work in the state of Hesse (Germany). This paper presents the survey results of amphibians and water/marsh birds after rewetting the nature reserves “Mairied”, “Gänsweid” and “Tiefes Ried”. For wetland restoration of IBA and NATURA 2000 areas, influenced by ground water exploitation, flexible water rights for water works depending on climate conditions are crucial to be prepared for climate change. In the future more planning of technical solutions must be considered for sustainable functioning compensation measures.

Keywords: Restoration of water dynamics, amphibian (*Hyla arborea*), water/marsh birds, compensation measures, climate extremes.

Introduction

The implementation of the NATURA 2000 network has become a new challenge for the planning of sustainable compensation measures in wetlands for climate change will affect wetlands significantly in their spatial extent, distribution and function (Dawson et al. 2003). Therefore restoration measures in wetlands must be able to cope with future climate extremes to be of long-term function. Not only because of ecological reasons but also due to the legal obligation, according to the EU Habitats Directive, that NATURA 2000 habitats and species must be kept in a favourable conservation status for a foreseeable future (European Commission 2005). Furthermore the compensation regulation of the State of Hesse (Germany) requires a continuous ecological function of compensation measures for at least 30 years.

In an ecohydrological casestudy the environmental impact of the ground water exploitation of the water work “Inheiden” on the protection areas in the Horloff river floodplain in Hesse, Germany, is investigated since 1997. The water work provided up to 18 Mio. m³ a⁻¹ drinking water for the southern parts of Hesse and the city of Frankfurt. The Horloff floodplain is characterized by intensive agriculture and settlements on the one hand and extended fen wetlands and nature conservation areas (IBA, NATURA 2000, nature reserves) on the other. So an environment impact assessment (EIA) was conducted for the water work, for the water-right ran out in 2004. The hydrological investigations showed, that the derivation of surface water from the Horloff river alone would be insufficient to flood the affected fens in the nature reserves in the required period and depth of inundation. For that reason a realignment of the pumping of the water work was necessary to raise the ground water level of the floodplain significantly. Thus the pumping must be reduced from 18 Mio. m³ a⁻¹ to 16,5 Mio. m³ a⁻¹ in normal and wet climate periods and down to 9,5 Mio. m³ a⁻¹ in dry climate periods to match the legal obligations. To obtain a sustainable system of compensation measures, that is able to mitigate the impacts of future climate change on the affected wetlands, a “3-columns-model” of rewetting measures was developed.

First column: Limitation of ground water table decrease in the protected areas by pumping reduction in dry climate periods. Critical water levels and minimum flooding areas for wetlands and species are defined and derived from monitoring-data and literature.

Second column: Increasing of natural flooding of the protection areas by derivation of water from the Horloff river by river bank modifications and/or reactivation of old irrigation weirs.

Third column: Artificial flooding of the wetlands with ground water in case of long-term draught by using a pipeline from the water work.

This paper presents the survey results of amphibians and water/marsh birds after rewetting the nature reserves “Mairied”, “Gänsweid” and “Tiefes Ried” by a realignment of the ground water pumping in 2000.

Materials and methods

For the assessment of the effectiveness of the compensation measures wetland/marsh birds, amphibians, vegetation, inundation areas and ground water table are surveyed in the nature reserves “Mairied”, “Gänsweid” and “Tiefes Ried”. Special attention is given to selected critical endangered amphibians and water/marsh birds of the annexes of the EU Habitat Directive.

Amphibians

Survey of Tree Frog (*Hyla arborea*) and Green Toad (*Bufo viridis*) is conducted by estimation of number of calling males with six one-hour counts in the breeding period from April to June at best weather conditions before mid-night.

Water/marsh birds

Survey of 16 target species of water/marsh birds by a total sum of 12 survey visits of three nature reserves from March to October. For the monitoring of breeding birds eight visits are conducted. Migrating birds are detected by four surveys in spring and fall. A broadcast tape is played to elicit calls from mostly night active rails (i.e. *Rallus aquaticus*, *Crex crex*).

The three columns system was started in 2000. To date column 1 and 3 are implemented, column 2 is about to start in 2008. The realignment of the pumping in combination with wet climate conditions led to a significant rising of the ground water table in the vicinity of the water work compared to the last decades (Fig. 1). Although the historical ground water level was never reached again, the nature reserves are continuously flooded since 2000. Before the inundation there was no open water in the nature reserves for at least 3 years (1995 – 1998).

Results and discussion

The survey of the Tree Frog population showed a strong increase after the first flooding (Fig. 2). Starting from zero in 1998, the number of calling males grew fast to a maximum of about 325 in 2000. The population remained on a high level until 2003. After that time the population sank continuously to a total sum of less than 100 calling males. The reason for that finding is, that in permanent ponds the number of predators is increasing with time. In temporary ponds a higher survival probability than in

permanent ponds can occur due to a lesser number of tadpole predators like water birds, fish, dragon fly larvae, newts and others (Vos & Stumpel 1995).

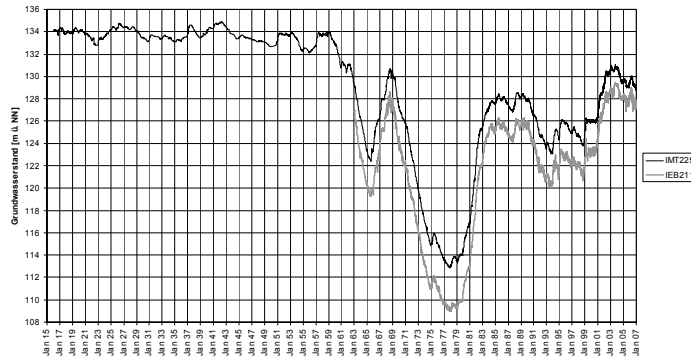


Figure 1. Ground water level of borehole IMT 225 in the Horloff floodplain 1915 – 2007. Active pumping of well IEB 211 started in 1963. Lowest ground water level in the 70ies during an extreme dry climate period.

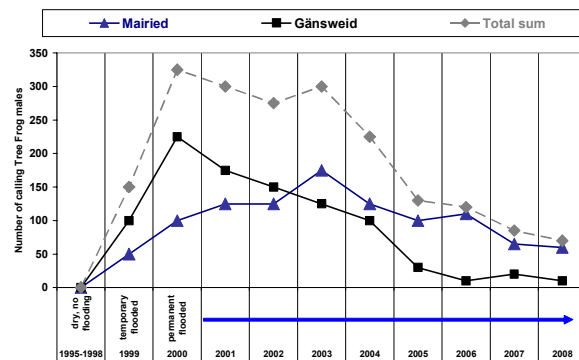


Figure 2. Number of calling Tree Frog males in the nature reserves Mairied and Gänsweid 1998 – 2008. From 1995 - 1998 the nature reserves were dried out, from 2000 on permanent flooding occurred. The arrow indicates permanent flooding.

The systematic monitoring of the water birds was started in the nature reserves in 2003. The observations showed an increase of the number of breeding pairs of the target species over the years (Fig. 3). In 2003 a total of 27 breeding pairs were surveyed. After a little decline in 2004 the number of breeding pairs rose up to 72 breeding pairs in 2007. Although a high number of breeding pairs was counted, the reproduction success was comparatively low in 2007. We think the reason for that is a dry and hot climate period from March to May 2007. The water levels sank quickly and shallow water areas of the ponds dried out. As a consequence we observed an increasing intraspecific competition of the water birds. There is also evidence that a rising number of predators (racoon, fox, wild boar) caused the losses.

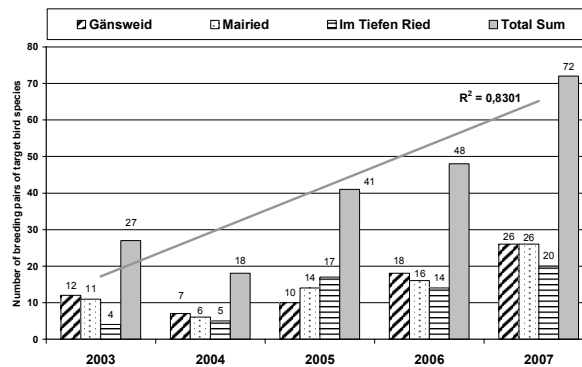


Figure 3. Number of breeding pairs of target species (water birds) in the nature reserves Gänsweid, Mairied and Im Tiefen Ried 2003 – 2007. Regression with data from the total sum of breeding pairs.

The survey of amphibians and water birds showed, that the implementation of column 1 has been very effective for the restoration of the wetlands already. Nevertheless column 2 (Increasing of natural flooding by derivation of water from the Horloff river) is necessary to optimize the compensation measures in order to keep the water levels high in spring time as long as possible. In case Horloff river water can not be used to flood the nature reserves, because of low run off rates in extreme dry climate periods, a water pipeline from the water work to the nature reserves was constructed in 2006. So far the column 3 was not used, but according to the climate models for the state of Hesse, the possibility of dry climate periods will increase in the future.

Conclusions

For wetland restoration of IBA and NATURA 2000 areas, influenced by ground water exploitation, flexible water rights for water works depending on climate conditions are crucial to be prepared for climate change. In the future more technical solutions must be considered for sustainable functioning compensation measures in order to permit species survival in changing protected sites and to maintain the connectivity and permeability of the landscapes and to win time for the adaption of species.

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