

WATERFOWL AND MACROZOOBENTHOS OF THE STANING RESERVOIR (RIVER ENNS, AUSTRIA)

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ABSTRACT

The waterfowl population of the Reservoir Staning (River Enns, Austria) was counted monthly from 1984 - 1990. The daily food demand of the diving waterfowl (Tufted Duck, Goldeneye, Pochard and Coot) was compared to the standing crop of macroinvertebrates. The benthos assemblage was sampled at three sites in water depths of 1m, 2m and 3m in 1984 and 1985. Average biomass ranged between 8-36 g/m² dry weight. The biomass was calculated for the total bottom area beneath less than 3 metres of water. Assuming that diving waterfowl feed mainly in this area the calculated food-demand of the diving waterfowl was always lower than 0.5% of the average standing crop.

INTRODUCTION

In many cases reservoirs have become important areas for waterfowl. Sufficient food supply may be a decisive reason. In many studies the availability and amount of prey has been assumed to be the main factor determining the distribution and density of waterfowl (Galhoff, 1987; Hargeby *et al.*, 1994; Staicer *et al.*, 1994; Suter, 1994). Some authors discuss good correlations between the densities of waterfowl and macrozoobenthos but the published data concerning the degree of utilizations vary from a few percent to nearly 100 percent (Table 1). We have tried to investigate the question of whether the amount of available food in an impoundment seems to have any effect on the abundance and species composition of diving waterfowl and if there is a measurable effect of feeding pressure on the macrozoobenthos as some authors state (Szijj, 1965; Nilsson, 1969; Willi, 1970; Newton, 1972; Thompson, 1973; Reichhoff and Reichhoff-Riehm, 1982; Ponyi, 1994).

Table 1: Published consumption rate on Zoobenthos by waterfowl in percent

%	Author	Study site
10 - 15	Unterer Inn - Reservoir	Reichholf & Reichholf-Riehm 1982
> 90	Klingnauer - Reservoir	Willi 1970
100*	Lake Bodensee	Sziji 1965
70	Coastal Waters	Nilsson 1969
50	Loch Leven	Allison and Newton 1972
25	Mississippi	Thompson 1973
1.1 - 7.1	Kernnaden	Gaihoff 1987

*Concerning Zebra mussels (*Dreissena polymorpha*)

Generally, zoobenthos is known to be very abundant in reservoirs (Flak, 1978; Polzer, 1985; Russev, 1985; Krzyzamek and Kasza, 1986; Kohmann, 1982). The probable cause of these rich zoobenthic communities may be the low velocity of the waterflow, resulting in high sedimentation rates and the deposition of organic matter (Herzig, 1987).

METHODS

Our data are based on monthly counts of waterfowl, from 1984 to 1990 and 1993 on the reservoir near Staning on the River Enns. The common diving depth of waterfowl extends up to three metres or more. In 1984 and 1985 macro-invertebrates (larger than 0,5 mm) were sampled at three sites at different depths (1 m, 2 m, and 3 m) using an Ekman grab. Five samples were taken per site and date and sieved with a net (500 Fm opening). Samples were preserved with formalin and examined in the laboratory. Geometric mean, upper- and lower 95% confidence limits of numbers were calculated after a log (x+1) transformation and the dry weight of the zoobenthos was determined (24 hours, 90EC).

The amount of food available for diving waterfowl (Tufted Duck, Goldeneye, Pochard and Coot) was estimated in kJ using the energy contents of the invertebrates given in the literature (Table 2). Extrapolations are based on mean values of the average benthos biomass for the depth zone 0 to 3 m (0.6 km³). The consumption rate was calculated using the daily energy demand of the diving waterfowl (Table 3). In cases where the conversion factors varied in the literature an average

value was adopted. The mean energy demand of diving waterfowl was calculated and corresponds to 45.5 g invertebrate biomass in dry weight per day.

Table 2: Energy contents of the most common groups of invertebrates

	kJ/g	Author
Chironomids	18.3	Galhoff 1987
Oligochaetes	20.9	Galhoff 1987
Pisidia	20.5	Suter 1982

Table 3: Daily energy demand (kJ/24) of diving waterfowl

	kJ/24h	Authors	Used
<i>Aythya fuligula</i>	911.2	Nilsson 1969	854
	796.3	Suter 1982	
<i>Aythya ferina</i>	1003.2	Nilsson 1969	908
	836.4	Galhoff 1987	
	883.4	Suter 1982	
<i>Bucephala clangula</i>	961.4	Nilsson 1969	961
<i>Fulica atra</i>	690.7	Hurter 1970	691
Diving Waterfowl			853

STUDY AREA

The study site is an impoundment on the River Enns (48°47'N 14°28'E), upstream of its confluence with the Danube River (Table 4). The reservoir has a length of 10 km behind a dam which was constructed in 1946. The hydrological regime of the River Enns is affected by a cascade of 15 reservoirs but the study site follows a section of 6 km which is not impounded and is free flowing. The catchment is dominated by limestone. The upstream end of the impoundment, a small section with higher velocities and islands is followed by a larger open surface area with two small islands and a water depth mostly less than 3 metres. Further downstream follows a less wide section with a larger island, snag wood and a large expanse of shallow water followed again by large open water areas, steep banks and deep water. The last part of the reservoir is in a narrow ravine with a stretch of deep water.

Table 4: Enns Reservoir Staining

Hydrological and morphological data		
Above Sea Level	m	283
Volume	m ³	13*106
Length	km	10
Depth max	m	16
average	m	5.8
Area	km ²	2
Area Water depth 0-3 m	km ²	0.6
Area of islands	ha	12
Discharge		
MQ (1966-81)	m ³	202
NQ (1970)	m ³	26.3
HQ (1975)	m ³	2560
Theoretical renewal rate		
MQ	hours	17.9
HO	hours	1.4

The monthly average discharge ranges between 100 and 400 m³/s. The main discharge occurs between April and June, the time of snowmelt. The biological oxygen demand (BOD₅) and total phosphorus concentrations (PTot.) are in the range of mesotrophic systems (BOD₅ 1983-1993: 0.4-3.3 mg/l; PTot. 1983.1993: 50-340 ppb).

RESULTS

Waterfowl

Of the most frequently observed species (Table 5), Mallard, Coot, Tufted Duck, Mute Swan and Black-headed Gull are abundant throughout the year, Pochard, Great Crested Grebe, Little Grebe and Teal are all fairly frequent and Heron and Moorhen are sometimes abundant whereas Goldeneye occurs only during winter. Common Gull, Cormorant and Goosander are highly variable in their occurrence.

Table 5: Frequency of occurrence (FO) of the observed species on the Staning Reservoir in % (FO > 5%, 1984-1990 and 1993); monthly counts (n=91)

Species	FO
Mallard, <i>Anas platyrhynchos</i>	100%
Coot, <i>Fulica atra</i>	98.9%
Tufted Duck, <i>Aythya fuligula</i>	98.9%
Mute Swan, <i>Cygnus olor</i>	97.8%
Black headed Gull, <i>Larus ridibundus</i>	96.7%
Pochard, <i>Aythya ferina</i>	86.8%
Great Crested Grebe, <i>Podiceps cristatus</i>	81.3%
Little Grebe, <i>Tachybaptus ruficollis</i>	70.3%
Teal, <i>Anas crecca</i>	59.3%
Heron, <i>Ardea cinerea</i>	48.4%
Goldeneye, <i>Bucephala clangula</i>	47.3%
Moorhen, <i>Gallinula chloropus</i>	39.6%
Common Gull, <i>Larus canus</i>	23.1%
Cormorant, <i>Phalacrocorax carbo</i>	20.9%
Goosander, <i>Mergus merganser</i>	15.4%
Black throated Diver, <i>Gavia arctica</i>	12.1%
Garganey, <i>Anas querquedula</i>	9.9%
Gadwall, <i>Anas strepera</i>	9.9%
Eider, <i>Somateria mollissima</i>	7.7%
Black Tern, <i>Chlidonias niger</i>	6.6%
Herring Gull, <i>Larus cachinans</i>	6.6%
Smew, <i>Mergus albellus</i>	6.6%
Red crested Pochard, <i>Netta rufina</i>	5.5%
Wigeon, <i>Anas penelope</i>	5.5%

Birds gather in groups of 300 to more than 3000, equivalent to 150 to 1500 ind/km⁵. The highest numbers are observed in autumn and winter, the lowest in summer. Seasonality differs among the most common species: Coot, Great Crested Grebe, Mallard and Little Grebe peak in autumn, Black-headed Gull, Tufted Duck, Goldeneye, Pochard and Cormorant in winter. The Mute Swan is the only species with a peak of abundance in summer.

The waterfowl population is dominated by diving ducks throughout the entire year (Figure 1) while dabbling ducks and Coot are sub-dominant.

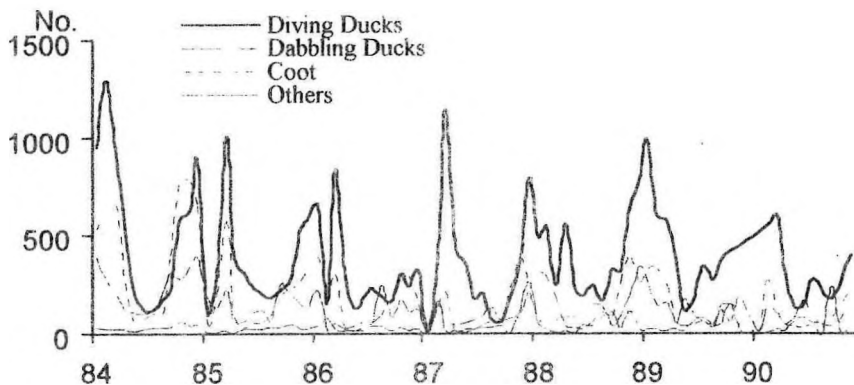


Figure 1: Number of diving ducks, dabbling ducks, coot and other species on the Staning Reservoir in 1984 -1990 (monthly counts, $n = 83$).

Zoobenthos

The macrozoobenthos community of the reservoir is dominated by *oligochaetes* (50 - 95% of numbers) and *chironomids* (10 - 25% of numbers). These groups constitute more than 90% of the community at each sample site and date. Rather common small mussels such as the *Pisidia* occur in most samples but always in low numbers. They are most abundant at around 2 m depth of water.

The highest densities of total benthos were found in August with more than 200,000 ind/m² and lowest in winter with 8,000 - 10,000 ind/m². Biomasses are higher in February in areas with water depths around 1 m because of the occurrence of very large *Oligochaetes*. The sampling sites with water depths of 2 and 3 m had higher biomasses during spring and autumn.

In areas with a water depth of up to 3 metres (about 40% of the impoundment) mean benthic biomass was in the range of 8 - 36 g/m² dry weight (1m: 4 - 39 g/m²; 2m: 15 - 64 g/m²; 3m: 3 - 29 g/m²). 3 to 80 kg DW of benthic biomass is needed to satisfy the daily energy demand of diving waterfowl.

Table 6: Daily Food demand (DEM, kg) of diving waterfowl (WF, monthly count), standing crop (SC, kg) of the area less than 3 metres (0.6 km^2) and theoretical feeding pressure (FP, % of SC)

	WF	DEM	SC	FP
1984 08	417	19.0	19440	0.1
09	829	37.7	19800	0.2
10	1343	61.1	21000	0.3
11	1721	78.3	21480	0.4
12	1615	73.5	17460	0.4
1985 01	55	2.5	4860	0.05
02	1412	64.2	12240	0.5
03	1446	65.8	16020	0.4
04	576	26.2	13860	0.2
05	340	15.5	14700	0.1
06	242	11.0	13800	0.08
07	308	14.0	16440	0.08
08	282	12.9	14640	0.09
09	519	23.6	9600	0.2
10	493	22.4	10080	0.2

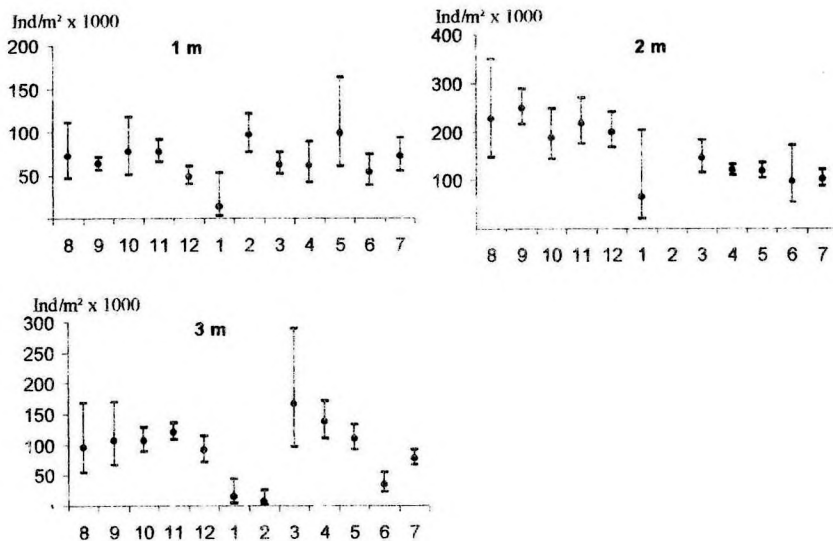


Figure 2: Density of macroinvertebrates below water depths of 1 m, 2 m and 3 m on the Staning Reservoir; August 1984 - July 1995, geometric means, lower- and upper 95% confidence limits

The feeding pressure of diving waterfowl on the benthos is thus surprisingly low when the whole of the bottom area below less than 3 metres of water is taken into account (Table 6). The daily pressure is less than 0.5 percent of the total benthic biomass.

DISCUSSION

The proportion of the benthos removed by waterfowl is actually even smaller, than calculated above, since benthic production is not taken into account in comparing the standing crop and the daily food demand of the diving waterfowl. It can therefore be concluded that there is no food limitation for the waterfowl. On the other hand, the majority of the zoobenthic population may be flushed away in flood conditions. Abnormal high floods in summer reduce the densities of diving ducks in autumn and winter (Figure 3), although zoobenthic standing crops in autumn are not significantly different before and after floods in summer.

Zoobenthos is not a limiting parameter as a food source for waterfowl on this reservoir.

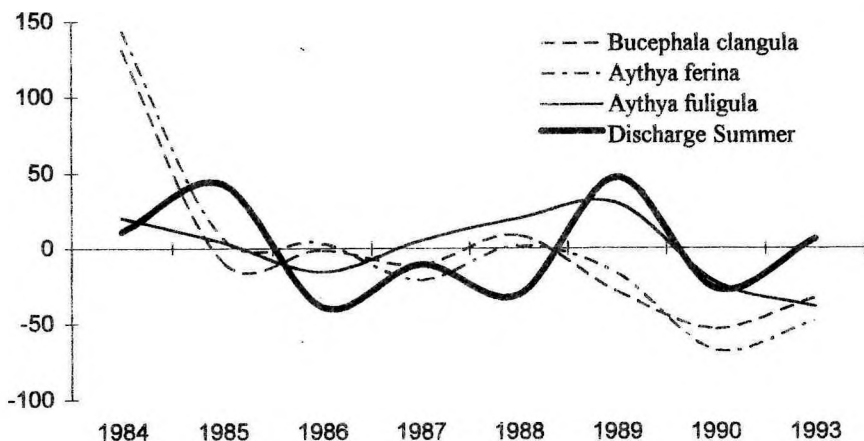


Figure 3: Deviation of summer discharge (June - August) and the yearly totals of diving ducks (October-March) from the long term mean (in percent).

This is contrary to the conclusions of other authors (Szijj, 1965; Willi, 1970; Reichholf and Reichholf-Riehm, 1982; Ponyi, 1994). However, the standing crop may only approximately reflect the available food. The sampling method used (Ekmann-grab) collects the benthic assemblage up to a depth of 10 cm within the sediment. Diving waterfowl feed mainly on the surface of the sediment. Additionally, selective feeding can also reduce the range of potential food. Tufted Duck feed mainly on molluscs (Mlikovsky and Buric, 1983) while Pochard and Goldeneye are less selective in feeding (Blömel and Krause, 1990; Bauer and Glutz von Blotzheim, 1980). Furthermore, it is the productivity of the macrozoobenthos (the biomass produced per unit time) which actually determines the available resources. Another important factor might be the possible competition for benthic food resources between waterfowl and fish species. Fish appear to exploit the aquatic invertebrate food supply more efficiently than waterfowl (Giles, 1994).

The results of this investigation thus only permit the conclusion that a whole year the daily food demand of the diving waterfowl was less than 0.5 % of the standing crop of benthos. While the rich faunal community of the reservoir may be attractive to waterfowl, the density and distribution of birds are most probably influenced by other variables, such as impoundment morphometry, shoreline structures or human disturbance.

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