Four decades of waterfowl counts at pre-alpine Lake Constance

H.-G. Bauer, Max Planck Research Centre for Ornithology, Vogelwarte Radolfzell, Schlossallee 2, D-78315 Radolfzell. E-mail: bauer@vowa.ornithol.mpg.de W. Fiedler, Max Planck Research Centre for Ornithology, Vogelwarte Radolfzell, Schlossallee 2, D-78315 Radolfzell. H. Stark, Ornithologische Arbeitsgemeinschaft Bodensee (OAB), Landgasse 2, D-78479 Reichenau.

1. Introduction

Lake Constance, a pre-alpine lake of 571 km^2 bordering on Austria, Germany and Switzerland, is one of the most important breeding, staging and wintering sites for waterfowl in Central Europe (Fig. 1). Coordinated counts were initiated as early as 1951, but since 1962 counts of all waterbirds at the lake take place once monthly from September through April (coordinated by the international Ornithological working group OAB). The present paper summarizes some of the results obtained so far.

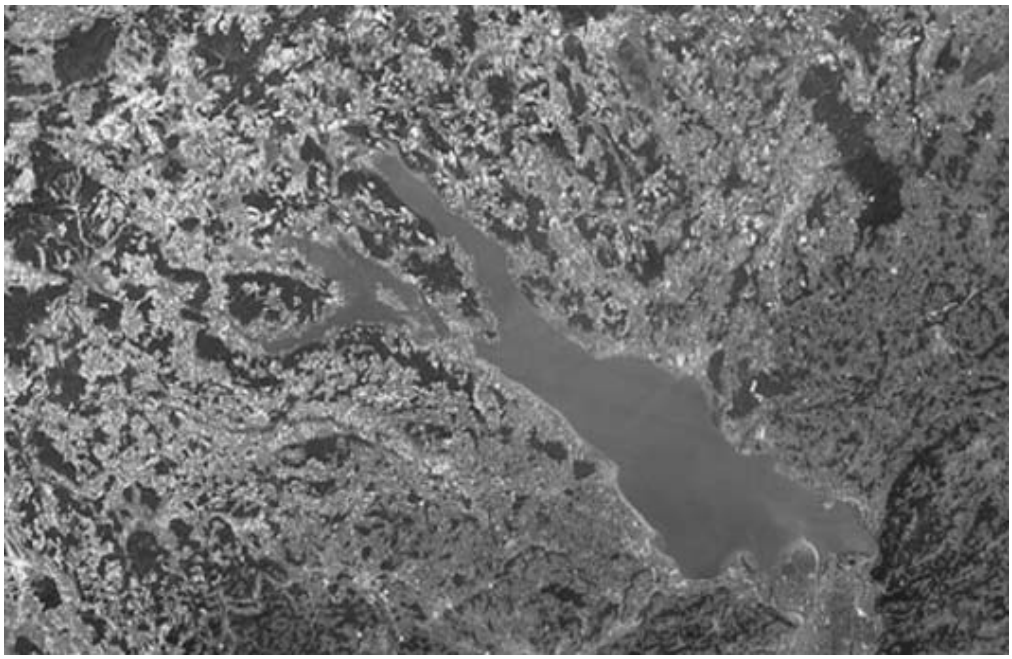

Fig. 1. Lake Constance lies at 400 m asl and features two clearly different ecological entities: a shallow, nutrient-rich western part (Untersee) covering 71.5 km^2, and a large, rather deep (max depth 254 m) eastern part (Obersee) covering 500 km^2 which is poorer in nutrients. The lake's water regime is largely dependent on the alpine system of the river Rhine that enters the lake at the Austrian-Swiss border..

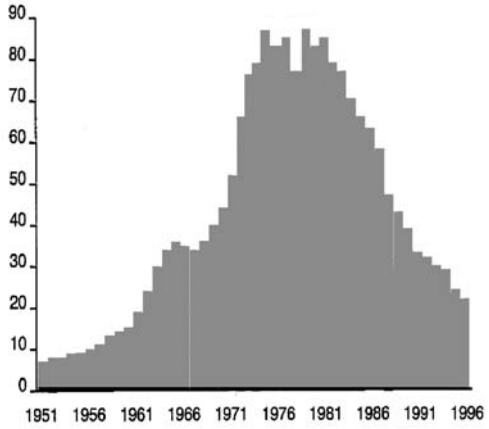

Fig. 2. Development of phosphorus concentrations (total amount of P) from 1951-96 at Lake Constance. The diagram shows that nutrient content in the lake increased dramatically in the 1970s to cause a considerable impact on lake ecology, especially on submerged macrophytes such as stoneworts (Characeae). From the 1980s onwards, nutrient levels in the lake were reduced markedly, allowing Characeae to recover.

2. Material and Methods

Volunteers carry out the counts from given points in 96 fixed segments around the lake. The counting always takes place on the Sunday closest to the 15th of the month from September to April. The database available now comprises some 25 000 "segment counts". Analysis took place using standard software. Limnological data were made available by the Limnological Institutes of Langenargen and the University of Constance. Data on lake morphology were taken from the Geographical Information System BUGIS of the University of Hohenheim; other sources for the data analysis are described in Stark *et al.* (1999).

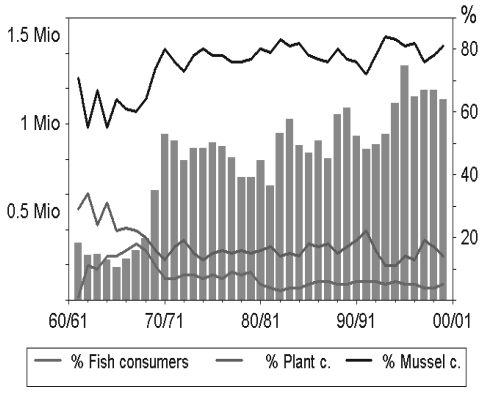

Fig. 3. Winter totals (September-March) of all wintering waterbirds 1961/62 through 1998/99.

3. Results

Lake Constance's international importance may be assessed from two factors:

a. The maximum number of waterbirds recorded per month, annual numbers ranging to some 250 000 birds in October, and over 200 000 from November to January.
b. The 'winter totals' (*i.e.* all waterbirds counted from September to April), over a million birds in recent years (maximum: 1.3 m in 1995/96; see Fig. 3).

The dominant species are Pochard *Aythya ferina*, Tufted Duck *A. fuligula* and Coot *Fulica atra*, which comprised some 60% of all birds in winter in the 1960s, and up to 80% at present. Fig. 4 shows that Coot was the most dominant 'diving' species in the early years, but that Tufted Duck has become the most numerous since the 1980s.

The dramatic, fourfold increase in numbers of wintering waterfowl can be explained by two effects from the 1960s: the invasion of the lake by the zebra mussel *Dreissena polymorpha* and the massive degree of eutrophication (mainly by phos-

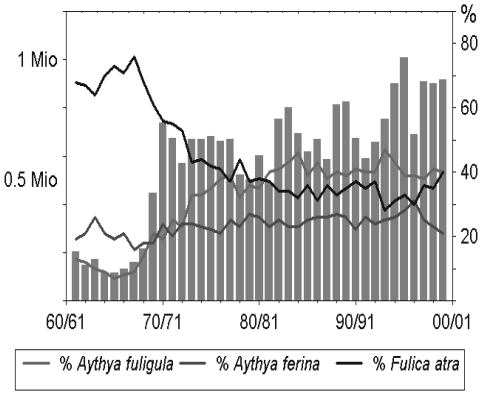

Fig. 4. Population dynamics of Tufted Duck *Aythya fuligula*, Pochard *A. ferina* and Coot *Fulica atra* in relation to the winter totals of all waterbirds consuming zebra mussels Dreissena polymorpha 1961/62 - 1998/99.

phorus, see Fig. 2). Mussel exploiters profited most from these changes in lake ecology, but fish eaters such as Great Crested Grebe *Podiceps cristatus* also increased considerably. The correlations between white fish (*Cyprinid spp*) catches and Great Crested Grebe numbers is highly significant (Bauer *et al.* 2000). One of the few species adversely hit by eutrophication was Red-crested Pochard *Netta rufina* due to its dependence on submerged macrophytes (*Chara spp*) in oligotrophic conditions. Intensive water purification measures since the 1970s, reflected in a decrease of phosphorus (Fig. 2), have led to the re-emergence of large *Chara* banks, and Red-crested Pochard numbers have reached an all-time high in the last few years (over 20 000 individuals in Oct 99), winter totals reaching 40 000 individuals (Fig. 5).

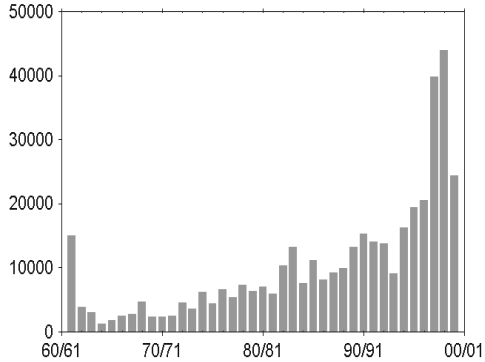

Fig. 5. Winter totals of Red-crested Pochard Netta rufina at Lake Constance from 1961/62 - 1999/2000.

4. Discussion

Four decades of waterbird counts by volunteers at a large and internationally important site offer unique opportunities for analyses. This papers sums up some of the results of a first preliminary analysis. It is shown that waterbird numbers reflect some of the dramatic ecological changes that took place at the lake during the last 40 years, but that the latest change, re-oligotrophication, has still to act on mussel consumers. Our intention is that a closer inspection of the data and a more elaborate use of limnological parameters will make fuller use of this enormous dataset (suggestions are very welcome). In a joint project with both Limnological Institutes at the lake, the importance of waterbirds in this lake ecosystem will be more intensively studied in future (Bauer & Stark 1999). Furthermore, the waterfowl counts at Lake Constance will continue unabated.

Acknowledgements. We are extremely grateful to the hundreds of volunteers and to the six coordinators who contributed to this unique data collection over these four decades.

References

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