

EFFECTS OF FISH UPON SUBMERGED VEGETATION

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The result of a study (BEST, 1980) carried out between 1976 and 1979 indicated that about 25 percent of the total surface area of Lake Maarsseveen I was occupied by a dense growth of submerged macrophytes. Lake Maarsseveen I is an oligo-mesotrophic lake, artificial created as a result of dredging for sand in 1960. The lake is 70 ha in surface area and its depth increases rapidly to a maximum of about 30 metres. Historically the submerged vegetation present was dominated by charophytes. Representatives of this group were absent only at sites with a dense cover of *Elodea* sp. (BEST, 1980). Recently a marked decrease in submerged macrophyte biomass was observed. Of particular interest was the fact that large beds of *Chara* had disappeared.

In the summer of 1984, experiments were conducted to study the impact of fish feeding upon chironomid larvae. Cages of wire netting (2 x 2 m, 30 cm height, 2.5 cm mesh width) were placed on the lake bottom at a depth of 2.5 m to exclude most predatory fish from chironomid larvae. Divers inspected these cages weekly. After one week, young sprouts of *Chara* were observed in the cages. Within three weeks, a dense *Chara* growth had developed, while outside the cages, *Chara* was entirely absent. After the three week period, the cages were removed, and the bottom was again exposed to fish. One week later, the *Chara* growth had completely disappeared, and the sample sites were indistinguishable from the surrounding area. This phenomenon was also observed at a depth of 0.5 m, where *Potamogeton pusillus* and *Elodea nutalli*, occurred more frequently after enclosure periods of several weeks.

For Lake Vechten, a decline in density of the submerged vegetation during recent years was described by BEST (1982). Lake Vechten is created by sand digging in 1941. This lake has a surface area of 4.7 ha and maximum depth of 11 m. The lake is eutrophic. The same species of cyprinid fish occur in Lake Vechten as are found in Lake Maarsseveen. The vegetation in Lake Vechten principally consists of *Ceratophyllum demersum* and *Potamogeton natans*. Charophytes are found only incidentally (BEST, 1982). She attributed the decrease in density of submerged macrophytes in Lake Vechten to diminished irradiance resulting from the trees surrounding the lake and enhanced eutrophication. No experiments to support these explanations were done however. From our observations, it may be concluded that the benthic way of feeding by fish as bream, carp and roach are at least partly responsible for the disappearance of some submerged plants.

During the first years of development of Lake Maarsseveen I, the fish population was small. As a result, the submerged macrophyte community grew apparently unaffected. Later, however, the fish population increased, and the macrophyte populations were increasingly affected. Moreover, as carp and bream populations age, the older forms tend toward more active benthic feeding and burrowing deeper in the sediment for food (BACKIEL and ZAWISZA, 1968; IVLEV, 1961). With increasing densities of fish, especially young fish, competition for zooplankton would tend to an increased consumption of bottom organisms. This phenomenon has been described by LAMMENS (1982) for the bream in Lake Tjeukemeer. Such increased utilization of benthic food sources is probably responsible for the recent decline of the *Chara* stands in Lake Maarsseveen I. The fish population of Lake Vechten is controlled by the stocking of fish by an angling association. The fish density in this lake, therefore, is maintained at a higher level of population density. Further, Lake Vechten is some twenty years older than Lake Maarsseveen. This combination will make it hard to

survive for most species of submerged aquatic plants. Further evidence in support of this overgrazing thesis is to be found in Lake Tjeukemeer. This eutrophic lake has a surface area of 20,000 ha and a mean depth of 1.5 m. It has a very high biomass of bream (GOLDSPINK, 1978), which are dependent upon the benthos for food. In this lake, submerged macrophyte vegetation is entirely absent.

It would appear that the burrowing and digging activity of cyprinid fish is an important mechanism by which some species of submerged macrophyte vegetation are reduced or eliminated in the lakes mentioned.

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