Abstract

In this thesis, the phosphorus cycle in new and reestablished lakes is investigated. Phosphorus (P) often constitute the growth limiting factor in lakes and therefore is crucial for the water quality and trophic structure. Lakes naturally receives P from the surroundings, however anthropogenic activities have led to nutrient enrichment and a general eutrophication of lakes. In addition, many lakes and wetlands have disappeared due to drainage and conversion into agricultural land, which further impoverishes these ecosystems and the associated biodiversity. Over the last few decades, lakes have been reestablished and new formed, where there have never previously been lakes.
The aim of this thesis is to elucidate the P-cycle in the new lakes, find out if deviations are exhibited in relation to natural lakes and which measures could lead to the best possible water quality and ecological state in future lakes. The influence of the catchment on the water quality of 90 new lakes were elucidated from determination of the land use and P-concentration of the lake water (MS 1). The average P-concentration of the new lakes were higher compared to other Danish lakes, which could be due to that many of the new lakes are established in order to retain nutrients. This is also reflected by the on average larger catchments with higher proportions of agriculture. Furthermore, it was found that the P-concentration of new lakes could be predicted from estimated external P-loadings modelled from catchment characteristics using tools of varying complexity (MS 1). The most suitable tools depended on the size of the catchment and even simple approaches based on empirical coefficients, only depending on land use, soil composition and annual runoff, were able to provide relatively precise predictions of the P-concentration.
Many new lakes are established on former fertilized arable land, which is expected to contain considerable P-contents, some of which may be released as it is flooded. During the inundation of the new Lake Rønnebæk a short period with P-release was observed. Within 60 days 85% of the observed P-release was released followed by limited exchange between soil and water (MS 3). The P-release of 31 new lakes was found to be significantly lower in comparison to 31 natural lakes (MS 2). For the same lakes, the sediment density was found to be higher and the organic content lower in the new lakes, especially for those with the topsoil excavated during establishment. Both the P-release and the importance of this internal loading was highest in the most recently established lakes (MS 1 and MS 2). The P-release of both new and natural lakes was found to depend on the concentration and ratio between P and iron (Fe) in the sediment. The lower P-release from the new lakes could be explained by a generally higher Fe:P-ratio, controlling the P-release under oxic conditions, as well as lower sediment P-concentrations (MS 2). The sediment characteristics of the lakes where the topsoil was not removed, reached levels resembling the

average levels of natural lakes within 20-30 years from establishment. This was not the case in new lakes with the topsoil excavated, which may be due to the lower nutrient levels in these lakes (MS 2). The release of P following establishment of new lakes can be expected to negatively impact the ecological status of the new lake and may threaten downstream ecosystems. In studies at Lake Rønnebæk it was found that simple soil pretreatments efficiently decreased the P-release after inundation and constituted cost-effective alternatives to topsoil removal (MS 3). Both addition of an Fe-product, in order to increase the P-binding capacity of the sediment surface, and burial of the topsoil, by sand-capping and depth-plowing, completely prevented the release of P.