Lärjeåns garden

Development of waterpurification marsh for sewage treatment

(Summery and conclusions)

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Conclusionen

- The primary purpose with the water purification marshes (WPM) is to prevent that high rates of inorganic nutrients are transported quickly to lakes and seas. Instead they should be locally incorporated in new biomass and by consumers and breaking down organisms with minimal loss remain in the biological food chain.
- Through nutrient chains activity in the different levees (ponds) gives opportunity for different ecosystems and always space for new production.
- Since production is highest in early successions management efforts in a WPM should favor the maintenance of organisms in the early succession like bacteria, phyto- and zooplankton that appear during the first growing season, thereby preventing mature or climax stages (higher plants) to develop, which reduce light and heat in the shallow water.
- Necessary condition for high productivity is continuously access of nutrient rich water with nitrogen and phosphorous in right relation.
- The diversity of fast growing plankton and attached algae give the possibility of primary productivity all over the year due to light, temperature and grazers.

The waterpurification marsh in Lärjeåns Gardens

In 2006 two WPM were compared, the new constructed in Lärjeåns gardens (Fig.1 and 3) and one in Bergums farm, constructed in 1995 both in the municipal of Göteborg (Fig.2).

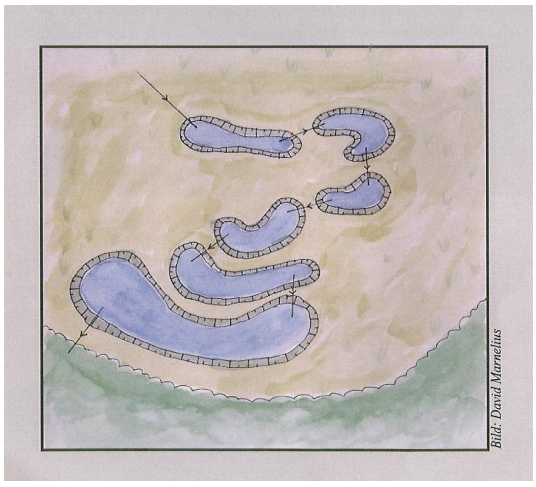


Figure 2. Drawing of the water purification marsh in Lärjeåns gardens. Illustration David Marnelius 2006

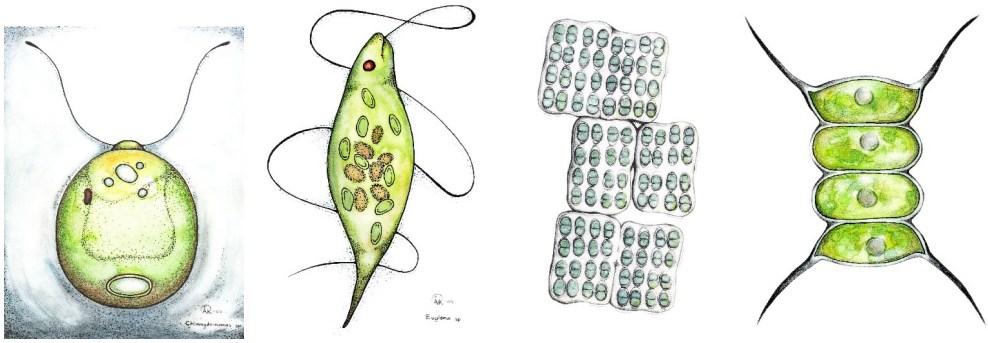
Figure 2. Bergums waterpurification marsh constructed 1995. Photo Olof Pehrsson 2007

Figure 3. Newly constructed water purification march 2006 and after one year 2007. Photo Gunilla Magnusson

Water samples were taken to measure chlorophyll content and to examine the composition of plankton. Oxygen and conductivity were measured at the same time. The examination of the plankton composition was repeated in Lärjeåns gardens in 2007 and nutrient contents were measured.

Primary production was analyzed by photosynthetic measurements as oxygen production and consumption once a month in the summer of 2007.
In Bergum both measurements of chlorophyll, oxygen and plankton show that the quantity of plankton has decreased during the summer. This decrease of growth is probably caused by the competition of the duckweed *Lemna minor* that covered the ponds during most of the summer and thereby decreased the light available to the plankton. In pond 2-4 numerous tadpoles lived resulting in clear water with few plankton organisms and little chlorophyll. The ponds 1-4 in Bergum were dominated by Cyanophyta, Merismopedia sp. This is probably caused by the warm weather, which benefits the bloom of cyanobacteria and that Merismopedia sp. may be very good at photosynthesising at low solar radiation compared with other plankton.

The species first found in the WPM in Lärjeåns gardens are opportunistic or pioneer species i.e. species which can quickly colonize new areas, they are first in place after major changes in the environment. The plankton first found in Lärjeåns trädgårdar was the Chrysococcus sp. (Chrysophyta), which occurred in a large quantity. Trachelomonas sp. (Euglenophyta) and Oscillatoriales (Cyanophyta) occurred in a relative large quantity during the first two measurements. The Chlamydomonas sp. (Clorophyta) on the other hand, may be a slower colonizer as the species had their largest quantity at the last measurement. The quantity of Chlamydomonas sp. had increased both in Bergum and Lärjeåns gardens in the beginning of August which can be due to some environmental circumstances, for example the weather, benefiting this species (Fig. 4).



Greenalgae, Clamydomonas sp. Euglena sp. Bluegreen algae, Merismopedia sp. Greenalgae, Scenedesmus.sp

Figure 4. The most common speices in the water purificarion march. Illustration Åsa Rehndell 2007

Both the amount of species and individuals are higher in each levee in Bergum than in Lärjeåns gardens during 2006 with increasing amount of species further down the system. On the other hand usually there were higher numbers of individuals in the first ponds. During 2007 the dominating species were the same in Lärjeåns gardens as in 2006 but the amount of species and individuals increased. as expected in this kind of community.

Oxygen fluxes were carried out using 24 cm long Plexiglass cores i.d. 8 cm placed in the air next to the ponds giving incident light once a month from May to October 2007 (Fig 5). Water with the whole plankton community including bacteria, microalgae and microfauna was incubated for one hour in light and one cylinder was darkened to count for the community respiration. In spite of visible bubbles in the ponds total photosynthetic rates were not very high.

The oxygen content in the ponds during the summer varied from 0 to 21,6 mg l^{-1},

Figure 5. Expiremental upset for Measurement of photosyntheses

with lower values in the first pond. The photosynthetic measurements show that the community consist of both autotrophic (oxygen producing organisms, plants) and heterotrophic (oxygen consuming organisms, bacteria and animals) giving low values of net oxygen production. The oxygen produced by the photosynthesizing organisms is quickly consumed by oxygen demanding organisms, an indication of a community in balance. Low photosynthetic rate and rather low oxygen content in the first pond with few plankton but much bacteria show that the bacteria play a big role in transformation of the organic nutrients in the sewage to inorganic forms being available to plant material.

Nutrient content and N/P-ratio

To confirm that water originates from sewage an adequate parameter to calculate is the ratio between nitrogen and phosphor, the N/P ratio. Since nutritional biological material from human emanate from food that consist of living organisms have a rather constant N/

P ratio (about 7) rest products from households coincide with the same N/P ratio. Different parts of sewage water have different N/P-ratios table 1.
Although the year 2007 was wet and cold the second and third pond was nearly always empty or only little water was left in the bottom. The ponds were sealed both in the bottom and between the ponds excluding any possibilities for leakage. The fact that there is only waste water in the first and second pond and groundwater in the fifth there are no possibilities to count the difference between pond one and five as uptake of nutrients.

Content in sewage (Naturvårdsverket)	g / person / day		
	N	P	N/P
Urine	11	1,0	11
Faeces	1,5	0,5	3,0
BDT	1,0	0,6	1,7
Urine + faeces	12,5	1,5	8,3
Urine +BDT	12,0	1,6	10,4
Total	13,5	2,1	6,4
Concentrations of nutrients in inlet and outlet water	mg/l	mg/l	
Lärjeåns gardens in	28,1	5,5	5,1
Lärjeåns gardens out	7,3	1,9	4,0
Bergum in	76,4	12,4	6,2
Bergum out	8,6	1,3	6,6
Ryaverket in (www.gryaab.se/ 2006)	23,3	3,8	6,1
Ryaverket out	10,0	0,5	20

Table 1. Outlet per person and day (Naturvårdsverket) and comparisons with mean value of inlet and outlet from water purification marshes and sewage treatment plant.

Other methods of sewage treatment
In Sweden the most common cleaning method for sewage water from household without connection to sewage treatment plants is different kinds of infiltration and filters. Another treatment in progress in Sweden is small sewage treatment plants. In comparison with other methods the WPM show best result in nutrient reduction. The efficiency of nutrient reduction, BOD_7 (Biological oxygen demand) and bacteria are showed in table 2.

Reduction method	Reduction %			
	Tot-P	Tot-N	BOD_7	Bacteria
Only three compartment tanks	5-10	10-15	10-20	25
Filterbed	10-40	25-50	90-99	95-99
Infiltration	25-80	20-40	90-95	99
Mini sewage treatment plant	70-90	20-50	80-95	60
Bergums WPM	91	90	96	84

Table 2. Efficiency of nutrient and bacteria reduction in different methods

In conclusion the four different cleaning methods are good in reducing BOD_7-reduction. Due to nutrients reduction the different filter methods have low efficiency both regarding nitrogen (N) and phosphor (P). In this case the mini sewage treatment plants are better. Regarding bacteria reduction both WPM and the mini sewage treatment plant are lower but in test the WPM managed bathing quality.