# Biodiversity in wet sedimentation ponds constructed for road runoff

# Biodiversitet i rensebasseng som mottar avrenningsvann fra veg

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## Preface

This master thesis is written in collaboration with the Norwegian Public Roads Administration and their project NORWAT. The thesis which is 60 credits, is part of a MSc degree in Biology, Plant physiology at the Institute of Plant and Environmental Science at the Norwegian University of Life Science.

I wish to thank my supervisors John Brittain and Sondre Meland for exceptional help during my master thesis, and the Norwegian Public Roads Administration for financial funding.

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*Helene Thygesen*

## Abstract

An increase in road traffic has increased the number of wet sedimentation ponds (WSP) being constructed. At a time when the numbers of ponds is declining all over Europe, these WSPs could be a potential habitats for pond living organisms. Previous research has found elevated concentrations of several metals and PAHs in WSPs, but also a biodiversity that is similar to natural ponds. Near threatened species and Amphibians were some of the organisms that were found in these polluted WSPs.

Twelve wet sedimentation ponds located in Oslo, Akershus and Østfold counties were investigated in this thesis. In addition to sampling organisms, water quality samples were taken during the four surveys from April to October 2012. The main objective was to document biodiversity, and determine what factors affected the biodiversity the most. Water quality, average annual daily traffic (AADT), vegetation, closeness to other ponds/water bodies and size of the WSP were included as factors that could affect biodiversity.

Many of the studied WSPs had high concentrations of metals and PAHs. 115 taxa were found, and five of them were classified as near threatened (NT) on the Norwegian Red List, while one species was classified as vulnerable (VU). This indicates that many organisms can live in the studied WSPs. AADT, water quality and size of basin were the environmental parameters affecting biodiversity the most. However the correlation between Shannon Diversity and water quality was not statistically significant and only slightly positive which indicates that water quality did not have a major effect on biodiversity. AADT is largest in Skullerud, Taraldrud north, crossing, south and in Vassum, although the three Taraldrud WSPs were the cleanest WSPs and Vassum was exceptionally rich in taxa. This explains why AADT is positively correlated with biodiversity.

## Sammendrag

En økning i traffikk har ført til en økning av antall rensebasseng som blir bygget. Naturlige dammer er i nedgang over hele Europa, og da kan disse rensebassengene fungere som habitat for vannlevende organismer. Forskning har funnet høye konsentratsjoner av flere metaller og PAHer i rensebasseng, men også en biodiversitet i rensebassengene som er tilsvarende til naturlige dammer.

Tolv rensebasseng i Oslo, Akershus og Østfold kommune ble undersøkt i denne oppgaven. I tillegg til å fange vannlevende organismer, ble vannprøver tatt for å undersøke vannkvaliteten. Dette ble gjort fire ganger, iløpet av april til oktober. Hovedhypotesen var å dokumentere biodiversiteten, og å bestemme hvilke faktorere som påvirket denne. Vannkvalitet, Årsdøgnstrafikk (ÅDT), vegetasjon, nærhet til nærmeste dam/vann og størrelse på rensebasseng ble inkludert som faktorer som kunne påvirke biodiversiteten.

Mange av rensebassengene hadde høye konsentrasjoner av mange metaller og PAHer, men 115 taksa ble funnet og fem av dem var klassifisert som nær truet ( NT) på den norske rødlisten, en art var klassifisert som sårbar. Dette indikerer at organismer kan leve i rensebasseng. ÅDT, vannkvalitet og størrelse på dammen var de miljøparametrene som påvirket biodiversitet mest, men korrelasjon mellom diversitet og vannkvalitet var ikke statistisk signifikant, og bare litt positive, noe som indikerer at vannkvalitet ikke påvirker biodiversitet. ÅDT er størst i Skullerud, Taraldrud nord, krysset, sør og i Vassum. De tre Taraldrud rensebassengene er renest med tanke på vannkvalitet i hele undersøkelsen, og Vassum er eksepsjonelt rik på taksa, derfor er ÅDT positivt korrelert med biodiversitet.

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# 1. Introduction

Road pollution has been an increasing concern over the last 10-20 years, correlated with increased traffic. The European Water Framework Directive (WFD) was incorporated in Norwegian law in 2007, and states that within 2021 all water bodies should have an acceptable ecological and chemical quality (EC 2006). NORWAT (Nordic Road Water) is an ongoing project to research how the Norwegian Roads Administration (NPRA) can build and maintain roads in Norway in an environmentally safe way that water will not be harmed in an unexceptional way. To try to mitigate the effects of road pollution and meet the demands in the WFD, wet sedimentation ponds (WSP) and similar constructions have been, and are being constructed alongside heavily trafficated highways to treat road runoff. During the last 10-15 years there has been an increase in the number of new WSPs (Casey et al. 2007).

For several decades there has been a trend of decline in natural ponds. In northern Europe there has been a 40 - 90% decline in ponds, caused by anthropogenic changes such as industrial and agricultural development  (Boothby 2003; Hull 1997; Zacharias & Zamparas 2010). With the increase in numbers of WSPs, questions have been raised if such ponds have the potential to be suitable habitats for birds, amphibians and insects, and consequently contribute to the maintenance of biodiversity (Le Viol et al. 2009).

It seems many organisms observed in WSPs can use it as habitat, including amphibians (Le Viol et al. 2009). Amphibians was observed in several of the WSPs surveyed in this thesis. But WSPs could potentially act as traps of biodiversity because of high concentrations of pollutants, which MacCarthy & Lathrop (2011) found to be the case for amphibians. This master thesis support the statement found by Karouna- Renier et al (2001) and Le Viol et al (2009) that wet sedimentation ponds can most likely support wildlife, macro invertebrates and amphibians. McCarthy & Lathrop (2011) advocated that road engineers should consider WSPs not only for their function of retaining pollutants but also for their potential roles in biodiversity, both negative and potentially positive in human-dominated landscapes.

This thesis studies evenness, taxa richness, water quality parameters and the effect of road runoff to look at biodiversity. Evenness are how close two or more species are in numbers and in this thesis it was done by comparing taxa numbers and total insect numbers.

### 1.2 Hypothesis

There is little knowledge about WSPs and there are uncertainty surrounding weather they are suitable habitats for water living organisms (Le Viol et al. 2009; Scher & Thiery 2005). The main goals for this thesis were to look at biodiversity and then look at factors influencing biodiversity. My hypothesis is thereafter:

- Document biodiversity in WSPs, is it a high enough factor to be considered in construction of WSPs?
- Does water quality affect biodiversity?
- Does higher or lower AADT affect biodiversity
- Does vegetation growing in the basin or on the edges of the WSPs affect biodiversity?
- Does the size of the WSPs affect biodiversity?
- Does close proximity to other ponds/water bodies affect the biodiversity?

## 2. Theory

### 2.1 Road runoff

Road runoff contains pollutants from traffic, from the road itself and from maintenance of roads. There is a lot of research on what kind of pollutants that originate from road pollution (Amundsen 2010; Brown & Peake 2006; Goetz & Zilberman 2000; Lindgren 1996; Mayer et al. 2008; Sternbeck et al. 2002).

Runoff from roads has different patterns than other pollution sources. During seasons or periods with heavy rain or snowmelt a "first flush" will occur. This is a phenomenon where pollutants rapidly increase  and then decrease during the rainfall or rapid snowmelt. Road runoff varies both in volume and in the concentration of different pollutants.

Variation in runoff from roads are mostly dependent on the size of the runoff area, variation in weather, annual average daily traffic (AADT), driving speed, proportion of heavy vehicles and numbers of vehicles with studded tires during the winter season. Road pollution comes from impervious surfaces and are washed into nature by rain or snowmelt episodes (Hvitved-Jacobsen et al. 2010). Moving vehicles pollute with degraded products from tires and brake pad wear, corrosion products from the vehicle bodies, and from fuel combustion engines. Contaminants from asphalt wear and road salt used as a de-icing agent also contribute to pollution (Hvitved-Jacobsen et al. 2010).

Runoff from tunnels is different and will only occur when they are washed. In these instances there will rapidly be an extreme increase in pollutants. Tunnel wash runoff is usually more polluted because accumulation will occur between every wash, whereas the road runoff is regularly exposed to precipitation, wind, sunlight and temperature differences (Hvitved-Jacobsen et al. 2010). Tunnels in Norway are washed from two to twelve times a year, depending on traffic density and the tunnel size (NPRA 2010). Some tunnels have WSPs that the water from the tunnel wash will go through before it flows out to a receiving water.

### 2.1.1 Pollutants

The pollution from roads mainly consists of natrium chloride (NaCl), heavy metals and polycyclic aromatic hydrocarbons (PAH) (Brown & Peake 2006; Bækken & Haugen 2006; Lindgren 1996). Salinization is an emerging concern for aquatic habitats, especially in Norway and other countries in northern latitudes which use salt to prevent road icing during the cold months of the year (Dobbs et al. 2012). Other factors influencing the pollution is amount of precipitation and speed limit (Bækken & Haugen 2006).

Asphalt contains mostly stone fractions, and some bitumen. Bitumen contains trace quantities of metals, and chromium (Cr), nickel (Ni), iron (Fe), calcium (Ca), magnesium (Mg) and vanadium (V), however most metals would come from the stone fractions according to Lindgren (1996). According to Hvitved-Jacobsen et al (2010) the most common heavy metals originated from automobile traffic are, copper (Cu), lead (Pb), zinc (Zn) and cadmium (Cd), and sometimes Ni and Cr as well. PAH comes from combustion engines (Hvitved-Jacobsen et al. 2010), while Zn, Cu and Pb come from road debris. Pyrene can come from street dust, (Brown & Peake 2006), while brake dust particles are Cu, Zn and antimony (Sb). Fe, Cu, Pb and Zn are ubiquitous in brake linings and are common pollutants from brake wear. Cu is found to be most ample in brake wear (Sternbeck et al. 2002; Thorpe, A & Harrison, R. M 2008) . Debris from tire wear could be aluminum (Al), calium (K), Ca, Cu, Fe, cobalt (Co) and Zn according to Thorpe and Harrison (2008). Barium (Ba), Cu, Pb, Sb and possibly Cd and Zn are sources from combustion, although this was found to be an insignificant source according to (Sternbeck et al. 2002).

Studies have found that elevated levels of metals affect benthic macro invertebrates (Beasley & Kneale 2002; Du et al. 2012; Timmerman 1991). Heavy metals, particularly lead (Pb), copper (Cu) and Zink (Zn) accumulate in benthic macro invertebrates even at low concentrations (Karouna-Renier & Sparling 2001). Pollutant accumulation can occur through the food chain, and can have lethal effects on organisms receiving concentrations of pollutants at high doses (Karouna-Renier & Sparling 2001). Beasley and Kneale (2002) found that numbers and diversity of benthic macro invertebrates declined when the catchment area was exposed to more traffic. Gallagher *et al* (2011) found that the top sediment layer of sedimentation ponds could give rise to toxic effects on the benthic fauna which utilize this area, and that this was the case in 96% of the ponds he examined.

## 2.2 Best management practices

Road runoff is an important source of pollution, and in the WFD and in NORWAT the NPRA is trying to mitigate the pollution from roads. Mitigation of road runoff can be done in several ways. There are many constructions and best management practices (BMPs) made to mitigate road runoff and a description of the most common ones are given in the next paragraph (Hvitved-Jacobsen et al. 2010).

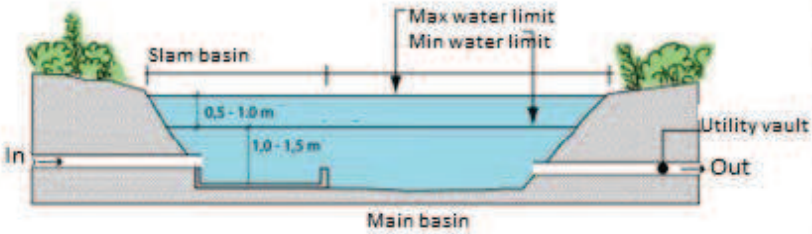
WSPs have a permanent pool of water and lake like appearance. Extended detention basins are another mitigation construction, which normally do not have a permanent water pool between events (Hvitved-Jacobsen et al. 2010). Constructed wetlands have much vegetation and some water, while infiltration trenches have filter fabric and stones on top, which filter the runoff from roads. Infiltration basins are basins which filter the road runoff to underlying soil (Hvitved-Jacobsen et al. 2010). Sand filters are used to remove particulate matter from road runoff, where a biofilm attached to the filter increase the removal of pollutants. Water quality inlets is a collective term for many devices that imitate elements of nature. Swales which are vegetated channels for storm water episodes and normally have shallower water levels (Hvitved-Jacobsen et al. 2010).

### 2.2.1 Wet sedimentation ponds

Wet sedimentation ponds are designed with a permanent volume of water and room for additional volume for temporary storage. WSP temporarily store road runoff from rainstorms or snow melt to avoid peak runoffs that would eventually drain into the groundwater or a recipient lake or river downstream. This function is called hydraulic control (Hvitved-Jacobsen et al. 2010). WSPs are obstacles that stop polluted runoff from roads spilling into nearby water. They also prevent spill from accidents with exceptional contamination coming into groundwater or a recipient lake or river downstream (Scher & Thiery 2005). WSP are designed to look like a small lake, and has the characteristics of a lake, whereas they can have recreational values in an urban environment. A few years after construction the WSP will get the appearance of a natural pond, although this depends on the substrate and degree of filling. Water coming into the WSP should have a sufficient retention time to allow for sedimentation of particle bound pollutants to ensure water has a higher quality running out than coming into the WSP. WSP also remove some of the soluble pollutants, by production processes, including growth of macrophytes (Hvitved-Jacobsen et al. 2010).

WSPs are mostly built with two separate basins, either entirely or partially separated. The first basin is a slam basin, where the largest particles settle (heavy metals). This first basin have to be emptied  more often than the main basin, because of the size of the particles that settle here and the small size of basin (Åstebøl et al. 2010). Smaller particles will settle in the second chamber where they will have a longer retention time, Figure 1.

a)




b)


**Figure 1). Conceptual illustration of a wet sedimentation pond. a) Show the lower water volume and the basins permanent water volume, the top volume is made for storage of water. b) Show a wet sedimentation pond from above, modified according to (Sundby 1995b; Åstebøl et al. 2010).**

## 2.3 Biodiversity

Biodiversity means something more than just species numbers, it entails all the types of different organisms present and the interaction between them. It is an important dimension of a biological system (Maclaurin & Sterelny 2008; Smith & Wilson 1996). It is challenging to measure biodiversity, and it is difficult to measure biodiversity with numbers (Purvis & Hector 2000). Factors affecting biodiversity are competition and predation, whether species have an active or passive dispersal, and abiotic and biotic factors (Brønmark & Hansson 2005).

Factors affecting macro invertebrate distribution and abundance were hypothesizes by Weatherhead & James (2001) (Figure 2). This was done for the littoral zone of a lake, and can be transferred to apply for WSPs as well, taking into consideration that the basin is smaller, and the fact that wave action will not have much effect in small basins. They hypothesized that bottom substrate and macrophyte abundance were the main factors affecting macro invertebrates, and their research supports this. Weatherhead and James (2001) final results were that substrate and macrophyte biomass together with detritus were the main factors controlling abundance and distribution of macro invertebrates. WSPs with less macrophytes and detritus will most likely have less species due to lack of food and places to hide from predators (Jeffries 2003). In addition to water quality, factors controlling the distribution of benthic macro invertebrates include stability of water depth, substrate, and dissolved oxygen (Hellawell 1986). Hellawell (1986) revealed that macro invertebrates together with algae were the most used organisms in evaluating water quality.

Water quality affects whether or not macro invertebrates can live in WSPs (Beasley & Kneale 2002). Species/taxa richness is the amount of total taxa or species numbers and are related to pond size. Spencer et al (1999) found more species in larger ponds than in smaller. Species richness of Triturus larvae are strongly affected by presence of fish, but this does not apply for adult Triturus, which can live in ponds with fish present (Le Viol et al. 2012).

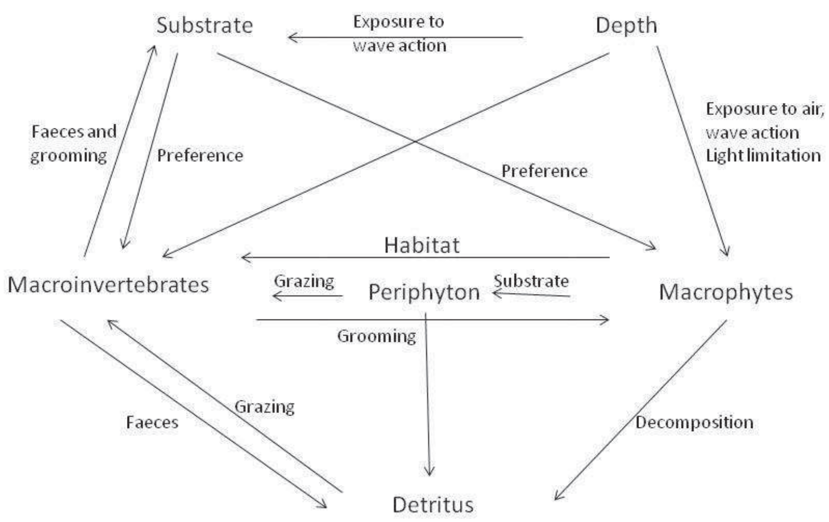



**Figure 2. Hypothetical physical and biological interactions in the littoral zone of a lake, modified according to: (Weatherhead & James 2001).**

## 2.4 Organisms in wet sedimentation ponds

Organisms found in water have very differing sensitivity to pollution, making them ideal as pollution indicators. Indicator species can be defined when a species environmental requirements have been determined (Hellawell 1986). There are also considerable knowledge on benthic macro invertebrates and how they are affected by pollution (Hellawell 1986). A good indicator should be easily sampled and identified, as well as having a wide distribution (Hellawell 1986). Many macro invertebrates are sedentary which will help to find the exact location of the pollution. Many of them have long life histories which will be necessary for periodic sampling and examination of temporal changes (Hellawell 1986). Macro invertebrates are used in numerous pollution indices and are the best documented and understood group when it comes to pollution in freshwater, according to Hellawell (1986).

There are many aquatic organisms in the world, and the life cycle of most of them are complex. A few patterns for aquatic insects are the same: most aquatic insect do not spend their whole life cycle in water, an adult stages are sometimes terrestrial. The adult stages and the aquatic stages normally have very differing morphology. Some beetles and Heteroptera can live their whole life in water (Brønmark & Hansson 2005). The main part of aquatic insects live their life in or on the sediment surface or on the macrophytes in the littoral zone. These insects are referred to as benthic. A few exceptions are Chaoborus and water surface insects, such as water strider and whirligig beetles, which live on the surface or in open water. The upcoming facts about different organisms in WSPs are gathered from the book The biology of lakes and ponds and Insects and their diverse world (Brønmark & Hansson 2005; Sundby 1995a).

**Ephemeroptera**

Ephemeroptera have three life stages; egg stage, which can be deposited in, or on the water surface, nymph stage which is in water and lasts from one to three years, sub imago and adult. As a fully grown nymph it crawl or swim to the surface and molts to a sub imago. It then flies off and molts to the final adult stage on some nearby vegetation. This takes approximately one day, as an adult they do not feed and after reproduction they are dead within days. As nymphs they feed on algae and detritus and are predated by fish. 45 species are known in Norway.

### Odonata

Zygoptera and Anisoptera are the two suborders of Odonata and have life cycles ranging from one to five years. Eggs are deposited on the water surface or in the littoral zone. The nymph stage is in water and the adult stage is terrestrial. While larval Zygoptera can swim and crawl, the Anisoptera larva is less active. Fish are an important predator to Odonata, but in fishless ecosystems Odonata are the predator of other water insects, such as tadpoles and fish larvae. 44 species are known in Norway.

### Trichoptera

The Trichoptera have four life stages; egg, larva, pupae and adult. Some larvae are case bearing, and some are free living larvae, the larva stage is in water. The cases are built from various materials, such as stones, organic material or snail shells. The larvae breathe in water with gills on the sides of its body. Trichoptera are a common part of fish diets and 195 species are known in Norway.

### Heteroptera

Aquatic Heteroptera have an egg, nymph and an adult stage during their life cycle. They only leave the water to disperse to other habitats. They do not breathe in water, and have to surface to get air. The nymphs have quite similar morphology to the adults. Heteroptera are eaten by other water bugs, fish and cannibalism may occur. Heteroptera can be predators or eat algae and detritus. There are 30 known species in Norway

### Beetle

Most species of beetles have both the adult and larva stage in water, while the adult stage is terrestrial only on short dispersal flights. Depending on the species the beetles can be predators eating tadpoles, other insects or fish, or could be feeding on algae and detritus. Both Dytiscidae and Hydrophilidae larva and adults have to surface to get air, while the Gyrinidae larva has gills for breathing. There are 126 known species of Dytiscidae, eleven of Gyrinidae and 69 known species of Hydrophilidae in Norway.

**Amphibians**

Most amphibians live in water during their larval stage, and then metamorphosis and are able to be terrestrial as an adult and spend the winters on land. Eggs are always deposited in/ on water. There are five knows amphibians species in Norway (Dolmen 1996).

**Oligochaeta**

All species have their  life cycle in water, with the exception of one, which is semi aquatic. Oligochaeta can feed on algae and microorganisms or be predators. Some species like substrate to be stones and gravel, while others are more associated with mud and sand. There are 50 species of Oligochaeta in Norway (Sloreid & Bremnes 1996).

**Chironomidae**

Most of the species in Norway have larva in freshwater, while some larva live in moist soil and a few in salt water. Chironomidae can be found almost everywhere from small puddle to arctic streams. Many of the Chironomidae larvae are adapted to develop in low temperatures and have short seasons. They feed on algae, microorganisms and can be predators, and have very dense populations. There are 500 species of Chironomidae in Norway.

**Gastropoda**

Snails are omnivore common in the littoral zone. Some species are most common in smaller water bodies and one species live in rivers. Snails are sensitive for acidic water, and disappear if the water gets too acidic. There are 27 known species of Gastropoda in Norway (Økland & Økland 1996).

**Cladocera**

Cladocera are found in all water, including puddles and groundwater. Most of the species are herbivore but a few can be predators. The herbivore living in the pelagic zone filter water for food, while the littoral living Cladocera eat algae and detritus. Some species are active during winter, but most lay eggs which hatch next season. Cladocera is sensitive to both acidic and alkaline water, with a few exceptions. There are 84 known species of Cladocera in Norway.

## 3. Materials and methods


Figure 3. Location of the six wet sedimentation ponds located in Oslo and Akershus county. Red dots mark wet sedimentation ponds. From the north: SKU- Skullerud, TAN- Taraldrud north, TAK- Taraldrud crossing, TAS- Taraldrud south, NOS- Nostvedt, VAS- Vassum .


Figure 4. Location of the 6 wet sedimentation ponds in Østfold county. From the top: SAS- Sastad, FIU- Fiulstad, IDR- Idrettsveien, KAB- Karlshusbunn, NOR- Nordby, ENE- Enebakk.

| WSP (short) | Construction year | Size (m²) | AADT (annual average daily traffic) | Ponds within 1km radius of the WSP | GPS coordinate (EUREF89, zone:32V) |
|---|---|---|---|---|---|
| **Skullerud (SKU)** | 1998/1999 | Slam pool 68, and depth of 1.5 m. Main pool is 910 , with a depth of 0,8m | 66500 (2011, NPRA) | 980 m to pond on the left side of E6, | East: 0602567.42 North: 6637507.70 |
| **Taraldrud north (TAN)** | 2004 | 780 | 42900 (2011, NPRA) | 450 m to lake Snipetjern, 780 m to pond, 960 m to elgrudstjernet. | East: 603187.58 North: 6631640.69 |
| **Taraldrud crossing (TAK)** | 2004 | 1400 | 42200 (2011, NPRA) | 120 m to pond,450 m to pond, 560 m to pond. 590 m to lake snipetjern. 350 m to pond. 475 m to lake Assuren. | East: 0603289.70 North: 663194.25 |
| Taraldrud south (TAS) | 2004 | 474 | 42200 (2011, NPRA) | 130 m to small river leading to lake Assuren, 270 m to lake Assuren. 765 m to pond in the industry area. 650 m to lake Grytetjernet. | East: 0603293.71 North: 6628790.66 |
| Nostvedt (NOS) | 2009 | Mud/slam pool 40, main pool:340 | 35500 (2011, NPRA) | 15 m to small river leading to Snipetjernet which is 720 m away. 993 m to a pond in the industrial area. | East: 0602919.97 North: 6627375.73 |
| **Vassum (VAS)** | 2000 | Slam pool 68, mainpool:363 | 41000 (2011, NPRA) | 30m to Årungselva, 875 m to lake Årungen. 890 m to pond (froensvei). 750 m to pond (grøterud), 670 m to pond. | East: 0603187.58 Nord: 6631640.69 |
| **Fiulstad (FIU)** | 2004 | 150 | 33575 (2012, NPRA) | 400 m to pond across E6 (såstad). 330 m to lake Vansjø. 913 m to pond (gipsundskogen). | East: 0598147.41 North: 6585797.87 |
| **Sastad (SAS)** | 2004 | Slam pool 48, mainpool: 80 | 33575 (2012, NPRA) | 92 m to lake Vansjø. 415 to Fiulstad WSP. 744 m to pond across E6 (såstad). | zone: 32V East: 0598023.12 North: 6586193.63 |
| **Idrettsveien (IDR)** | 2004/2005 | road slam pool: 19, industrial slam pool:173, wetland: 745 | 22735 (2012, NPRA) | 720m to Karlshusbunn WSP, 690m to lake Vansjø.913 m to pond, Ringstad. | zone: 32V East: 606269.04 North: 65811250.95 |
| **Karlshusbunn (KAB)** | 2004/2005? | road slam pool:87. Agriculture slam pool:100 wetland/mainpool:165 | 22735 (2012, NPRA) | 720m to closest WSP.960 m to Nordy WSP. 240 m to lake Vansjø. | East: 607037.98 North: 6580950.22 |
| **Nordy (NOR)** | 2004/2005 | Road slam pool: 89. Agricultural slam pool:143 Wetland/mainpool: 389 | 22735 (2012, NPRA) | 600 m,650 m and 660 m to 3 ponds in a cluster. 890 m to pond. 880 m to the lake Vansjø. 800m to pond across E6. 890 m to pond across E6. 960 m to the nearest WSP. | East: 0607946.5 North: 6580874.41 |
| **Enebakk (ENE)** | 2004/2005 | Slam pool 132 | 23837 (2012, NPRA) | 1km to pond farm Hauger, 900 m to two ponds at farm Borge. 722 m to pond Sandbakken, across E6. 587 m to pond across E6, near Åkebergrød. | East: 0609718.54 North: 6579377.82 |

**Table 1. Additional information about the wet sedimentation ponds (Kartverket ; NPRA 2011; Winter- Larsen 2010).**

## 3.1 Site description

The WSPs investigated are located along the major highway, E6, outside the City of Oslo, in Oslo, Akershus and Østfold county. Twelve WSPs were included and collection of organisms and water samples were executed on four occasions, in April, June, August and October 2012. An additional collection in June was made in Vassum WSP right after a tunnel wash.

### 3.1.1 Skullerud

Skullerud WSP was built simultaneously with rebuilding  E6 into a four lane highway, and is placed directly underneath the E6, in Oslo county (Figure 3). The WSP was built to protect biological diversity and recreational values of the river Ljanselva from polluted runoff from E6. The pond is divided into a closed pre- slam basin, and an open main basin (Figure 5) (Åstebøl 2004). The effects of the Skullerud WSP is in line with the best international experiences with cleaning effects of WSPs (Åstebøl 2004).


**Figure 5). a) Skullerud wet sedimentation pond. b) Vassum wet sedimentation pond, picture taken in August 2012. Photo: Helene Thygesen.**

### 3.1.2 Taraldrud north

This WSP is located on the west side of the four lane highway, E6, nearby the border of Akershus and Oslo county (Figure 3). It was built when the E6 was extended from Assurtjern, to Oslo city border (Winter- Larsen 2010). It consists of a small slam basin and a larger main basin without complete separation (Figure 6). This WSP was built to protect a stream, Snipetjernbekken, which drain into the Lake, Gjersjøen (Winter- Larsen 2010).


**Figure 6). Picture of Taraldrud north wet sedimentation pond, a) from April 2012. b) from August 2012. Photo: Helene Thygesen.**

### 3.1.3 Taraldrud crossing

This WSP was built at the same time and has the same construction as Taraldrud north, with coherent slam basin and a larger main basin with shared water surface (Figure 7). Emissions from the WSP are led into a small stream, Snipetjernbekken, which eventually discharge into the lake, Gjersjøen (Figure 3) (Winter- Larsen 2010).


**Figure 7). Picture of Taraldrud crossing wet sedimentation pond. a) from April 2012. b) from August 2012. Photo: Helene Thygesen**

### 3.1.4 Taraldrud south

Taraldrud south has a small slam basin which is not fully casted, but the main basin is (Figure 8). It discharges into a small stream, Assurbekken, which flows into the lake, Gjersjøen (Figure 3). (Winter- Larsen 2010). The substrate of the small slam basin consists of small stones.


**Figure 8). Picture of Taraldrud south wet sedimentation pond. a) from April 2012. b) from August 2012. Photo: Helene Thygesen**

### 3.1.5 Nostvedt

Driving in a southern direction, this WSP is located on the left side of the E6 just before the Nostvedt tunnel (Figure 3). The slam basin is fully casted and is connected with the main basin through pipes. Water will run from the slam basin into the main basin when the water level exceeds a certain level. In the main basin there are several thresholds, which divides the basin into smaller areas where the pollutants will have more time to sediment (Figure 9) (Winter- Larsen 2010). In the main basin the substrate consists of small stones.


**Figure 9). Picture of Nostvedt wet sedimentation pond, a) taken in April, from the outlet. b) taken in August, from the inlet. Photo: Helene Thygesen**

### 3.1.6 Vassum

Vassum WSP is located between the three tunnels, Vassum, Nordby and Smihagan (Figure 3). It receives tunnel wash water from these three tunnels, in addition to road runoff from the E6 (Meland et al. 2010). It is constructed in two parts, a concrete slam basin and a main basin of variable depth. When the water level is high, the two basins have a shared water surface. It purifies discharges running into the river, Årungselva (Winter- Larsen 2010). Vassum WSP was washed two times during this survey; a "full" wash of the entire tunnel, road and technical installation on 18-19 of June and a "half" wash on 18-19 August. The difference between a full and half wash is that in a half wash the roof of the tunnel is not washed (Grefsrud 2013; NPRA 2010).

### 3.1.7 Fiulstad

This WSP was built to protect the lake Vannsjø (Figure 4). The two basins have a shared surface when the water level is high, but when the water level is low the two basins are divided by a threshold of small stones held in place by netting (Figure 10). It has a normal water depth of 1m, although during summer months it is usually substantially lower. The bottom of the WSP consists of small stones (Winter- Larsen 2010).

**Figure 10). Picture of Fiulstad wet sedimentation pond, a) taken in April 2012. b) taken in August 2012. Photo: Helene Thygesen.**

### 3.1.8 Sastad

Sastad is built in the same way as Fiulstad WSP, and protects the lake Vannsjø (Figure 4) (Winter- Larsen 2010). The bottom of the basin is filled with small stones.

### 3.1.9 Idrettsveien

Idrettsveien has two small slam basins with a wetland filter that drains both basins. These basins are fully casted, and one is getting runoff from an industrial area the other accepts road runoff. It is built to protect Starengbekken and Storefjord (Figure 4) (NPRA 2005; Vegdirektoratet ; Winter- Larsen 2010).

### 3.1.10 Karlshusbunn

Karlshusbunn has two small slam basins with pipes leading water to a wetland filter. The basin which receives road runoff has been casted and has a cover on the bottom and the substrate consists of small stones. The other basin receives agriculture runoff (Figure 4). They both drain into a shared wetland filter. The basins are placed within a few meters of the E6 (Figure 11) (Winter- Larsen 2010).


**Figure 11). Picture of Karlshusbunn wet sedimentation pond, a) the left slam basin receiving road runoff. b) the right slam basin receiving agricultural runoff. Both pictures were taken in August 2012. Photo: Helene Thygesen**

### 3.1.11 Nordby

Nordby has two slam basins, one that is fully casted and receives road runoff and one which receives runoff from agriculture. These two basins drain into the same wetland filter. It is located in the middle of agricultural fields when driving in a southern direction (Figure 4) (Winter- Larsen 2010).

### 3.1.12 Enebakk

This WSP consists of a small slam basin , with a drainage to a wetland filter. There is also a small stream which discharges out into the wetland (Winter- Larsen 2010). The slam basin is casted and has a cover on the bottom. It is located in an agricultural area (Figure 4) (Winter- Larsen 2010).

For more information and location of the WSPs, see Table 1.

## 3.2 Water quality

Water samples were taken close to the inlet in all WSPs. Five bottles were used; one 125 ml acid washed polyethylene (PE)- bottle for analysis of heavy metals Al, Sb, arsenic (As), Ba, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, manganese (Mn), mercury (Hg), molybdenum (Mo), Ni, phosphorus (P), K, silicon (Si), silver (Ag), sodium (Na), strontium (Sr) and Zn. Two 125 ml PE- bottles were used, one for anions, chloride (Cl), nitrate ($NO_3$) and sulfate ($SO_4$), and one for total organic carbon (TOC). Two 1L glass bottles were used one for oil analysis (hydrocarbon) and one for polycyclic aromatic hydrocarbons (16 PAH). The analyses were undertaken by ALS Laboratory Group, Skøyen, Oslo.

With a small handheld Extech Exstick 11 DO600 probe, oxygen was measured by the inlet of each WSP. Another handheld probe Extech Exstick EC500 was used to measure conductivity, pH and temperature, at the same site. These two handheld probes were used in the two first surveys and in the tunnel wash survey. During the last two surveys a multi-parameter water quality-probe YSI 6600 V2-4 was used, to measure all parameters.

## 3.3 Sampling methods

Organisms were sampled using traps and a kick net with 30x30 opening and mesh size of 0.45 mm. Sampling of organisms were executed at three sites within each WSP. Where there were small stones on the bottom, kick sampling with five sweeps were used. If the bottom material was not covered in stones, 5 sweeps were taken through the water at approximately 50 cm depth. The net was then inverted into a sampling tray, and the organisms poured in plastic bags for preservation in 70% ethanol. Sampling was done once close to the inlet and twice, on either side of the main basin/wetland, three times in total in each WSP. Two traps were put into the main basin at approximately the same place as the samples were taken. They were left in place a different number of days, depending on the time of year. Organism data were normalized before statistical tests were done. The number of species and individuals found in the trap were divided by the number of days the traps had been in the pond, and used in the statistics as number of individuals per day.

Traps were made of empty soda bottles 1.5 L, cut in two where the bottleneck starts to form the spout. The bottleneck was turned around placing the spout inside the bottle. Transparent tape was used to attach the two parts (Figure 12). A string was attached to the bottle, to make it easier to handle.

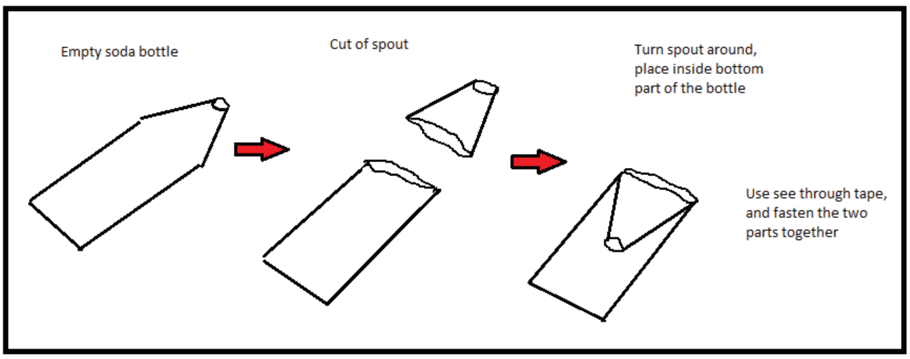



**Figure 12. Illustration of trap made of empty plastic soda bottles.**

**Shannon Diversity index**

Shannon Diversity Index is a quantitative index of species diversity developed by Claude Shannon in 1948 (Spellerberg & Fedor 2003). The values of which this index is made depends on species evenness and richness of the species. The formula for Shannon Diversity Index is (Molles 1999):

$$H' = -\sum_{i=1}^{R} p_i \ln p_i$$

## 3.4 Taxonomy

Organism samples were sorted in the laboratory, and Trichoptera, Ephemeroptera, Coleoptera, Plecoptera and Heteroptera were if possible identified to species level. Odonata was identified to family level. Other benthic macro invertebrates collected were recorded, and identified to family, or species level if possible. Literature used for taxonomy was: Larvae of the British Emphemeroptera (Elliot et al. 1988), Adult and nymphs of British Stoneflies (Plecoptera) (Hynes 1993), Aquatic insects of North Europe, taxonomic handbook, volume 1 (Nilsson 1996) and Aquatic insects of North Europe, taxonomic handbook, volume 2 (Nilsson 1997).

Identification of Dytiscidae taxonomy was verified by Ole Wiggo Røstad, Ephemeroptera and Plecoptera were verified by John Brittain. Trond Bremnes verified Trichoptera and checked random samples of Heteroptera and Odonata.

## 3.5 Statistics

### 3.5.1 Univariate statistics

The free statistical program R, version 2.14.1 for windows 7, was used for one way- anova to test for differences in Shannon Diversity Index between the different WSPs, and difference in taxa numbers between the different WSPs. An anova to test for differences between water quality (sample scores) and the different WSPs was also executed. The data was tested with the Shapiro test to see if they were normally distributed. If the data was not normally distributed the data was log transformed (logx+1). Variance were done with the Bartlet test, before an anova was done.

Correlation was examined to look at relationships. Pearson's product- moment correlation test was used when data was normally distributed and $p<0,05$ was used as a threshold for statistical significance. Spearman rank correlation coefficient was used when the data was not normally distributed (Dytham 2011).

### 3.5.2 Multivariate statistics

Canoco (CANOnical Community Ordination) version 5.0 (ter Braak & Šmilauer 2012) was used to perform multivariate statistics. Dimension reduction (ordination) and regression analysis is emphasized in this program, The integrated combination of the two called canonical ordination, or normally called constrained ordination. The general idea of ordination analysis is to assist scientists within the field of community ecology to detect patterns and structure in their data. Constrained ordination is a technique relating multiple variables to explanatory variables (ter Braak & Šmilauer 2012).

Multivariate statistics are useful to help see a pattern in a dataset, but on a more overall view. It can also be used to test hypothesis. Ordination was done with principal components analysis (PCA). A theoretical variable was constructed to best fit the data according to a linear or unimodal model. If the data best fit is a linear model, PCA and redundancy analysis, RDA are chosen. If the data are unimodal, detrended correspondence analysis (DCA) and canonical or constrained correspondence (CCA) are chosen. PCA and RDA was chosen for all the data sets in this thesis, because they were linear models. In PCA it is only possible to have one dataset. PCA was used to look at the variation within this dataset, which explain maximum variation. Significance cannot be tested with PCA (Lepš & Šmilauer 2003).

RDA is a linear method of canonical ordination, used to explain the response data with the explanatory variables. RDA two was used to compare taxa data to water chemistry. In RDA forward selection was used to automatically choose which parameters were most important (ter Braak & Šmilauer 2012).

Reading an ordination diagram, samples are represented by symbols, and species represented by arrows. Environmental variables are also represented by arrows. The length of the arrows is important, and the longer the arrow the more variation is caused by this species, or variable. Arrows pointing in opposite direction of each other is negatively correlated, while arrows pointing in approximately the same direction is positively correlated and most likely interfere with each other. Also if the angle between arrows is almost a right angle the two arrows have a low correlation and the tighter the angle, the more correlated they are. Also arrows or symbols close to the first and second axis is positively correlated with the one it is closest to. The first and second axis are not correlated (Lepš & Šmilauer 2003).

When statistical tests in Canoco were done the data set was divided into four; April, June, August and October. This was done to avoid repeated measurements, since the four field surveys cannot be said to be completely independent of each other. Parameters compared with insects and water quality in statistical tests were: "size of pond", found by measuring the different ponds in a digital map (Kartverket)."Vegetation in pond" and "Vegetation around pond", they say something about the amount of vegetation in the pond, and around the edges of the pond. "Little", "some" and "much" are used with 1(33%) ,2 (66%) and 3(100%) in statistical test, and refers to the amount of vegetation in, or around the pond (Appendix 5). AADT is annual average daily traffic and gives an estimate of how many vehicles that drive on the road on a daily basis. It does not discriminate between heavy or light vehicles. "Number of ponds/water bodies within 1 km" is also used as a parameter, and "the closest pond in meter" is another, where a digital map was used to count pond/water bodies and to measure the length from the WSP to the closest pond (Kartverket).

Sample score 1 and 2 come from PCA done on water quality and organism data, and are used in statistics instead of all the water quality parameters analyzed, or all the taxa found respectively. When PCA is run with water quality you get case scores in this thesis called sample scores Sample scores are averages of the response variables (water quality) scores, and are given in standard deviation units (ter Braak & Šmilauer 2012). Sample scores are used instead of all the water quality parameters or organisms analyzed, to make the presentation of the results shorter and more comprehensible. Sample score 1 is values from the first axis of the canoco plot, and sample score 2 is values from the second axis of canoco plots.

The WSPs surveyed got shortened names such as VAS= Vassum. WSP names with "left" or "right" after the name show which slam basin it is. Right is the right slam basin, and left is the left basin. Shortened names with "M" behind means wetland/ main basin.

With data under the detection limits, 1/2 limit of detection (LOD) was used. However parameters with 15% or more values under the detection limit were excluded from further analysis (EPA 2000). All data was log transformed (logx+1), before statistical tests were undertaken, either in Excel, or in CANOCO, with the exception of vegetation and pH. Forward selection displays all environmental variables, it begins with the environmental variable that has the highest share of variation in the response (ter Braak & Šmilauer 2012). All the effects are pre- tested and both statistics level and significance level are shown. The parameters statistically significant ($p<0.05$) were shown in the final plot. The p- value is mutually dependent and can change when choosing parameters. Significance was tested with

Monte Carlo test when RDA was analyzed. Monte carlo test combined with RDA enables the use of null hypothesis (ter Braak & Šmilauer 2012).

# 4. Results and discussion

## 4.1 Water quality

### 4.1.1 General water quality

There were 55 water quality parameters analyzed in this survey and some metals and PAHs analyzed in this survey were quite high (Table 2-4, Appendix 1-4). Klif in cooperation with Aquateam has made environmental standards and classification of environmental pollutants that can be used in water, sediment and biota. These are used to compare the concentrations analyzed in this survey with what Klif have found to be environmental quality standards (EQS) (Klif 2012). Maximum limit and yearly average are also shown in Table 5, together with the average concentration for each WSP (Klif 2012). Environmental Quality Criteria for Lakes and Watercourses made by Swedish EPA (SWEPA) has also been used to compare water quality parameter analyzed in this survey. Canadian environmental quality guidelines (CCME) and data from StormTac has also been used to compare water quality parameters analyzed in this survey (CCME 2007; StormTac 2012)

### 4.1.2 Inorganic pollutants

The oxygen concentrations in the WSP were quite high. All ponds except Idrettsveien left was oxygen rich (>7 mg/L). Idrettsveien left was moderately oxygen rich. Oxygen was high from April to October in most WSPs, but this does not have to coincide with the WSPs being a healthy ecosystems since the high oxygen concentration could be caused by plant assimilation (SWEPA 2000).Idrettsveien left had little vegetation, a concrete pool and a red color from iron precipitates which might explain the low level of oxygen and give an explanation as to why it was the only basin with low oxygen concentrations (SWEPA 2000). There were a lot of vegetation in many of the WSPs surveyed and this could be the reason the amount of oxygen in the WSPs differed in concentration (Appendix 7). Oxygen concentrations during winter will most likely be different. Oxygen deficiency will be expected in the cold months when the ponds are covered with ice and most vegetation decomposes. Oxygen depletion will be a limiting factor for fauna that remain in the WSPs during winter, as Hellawell (1986) coincide with.

As for pH most of the WSPs had a neutral pH (>6.8pH). Nordby right and Enebakk were weakly acidic (6.2-6.5 pH), and Idrettsveien right and Idrettsveien left were moderately acidic (5.6-6.2 pH) (SWEPA 2000). That Idrettsveien right and Idrettsveien left were most acidic could have something to do with the WSPs lying in the middle of agricultural fields, although some of the other WSPs were also surrounded of agricultural fields without being acidic. Atmospheric deposition can also make water acidic, but this is most likely not the case here, because most of the WSPs were located quite close, and if it had been due to atmospheric deposition more WSPs would have been acidic (Driscoll et al. 2001). The pH in Idrettsveien right and Idrettsveien left can be explained by sulfur dioxide, nitrogen oxides and ammonia, that are common from acidic deposition but could possibly come from road runoff and agriculture (Driscoll et al. 2001).

Taraldrud north had a very low TOC (≤4 mg/L), while Skullerud, Taraldrud south, Nostvedt and Idrettsveien right had a low TOC (4-8 mg/L). A moderate to high concentration of TOC was found in; Taraldrud crossing, Fiulstad, Sastad, Karlshusbunn right, Karlshusbunn left, Nordby right, Nordby left and Enebakk (8-12 mg/L) (SWEPA 2000). High concentration of TOC was found in Vassum and Idrettsveien left (12-16 mg/L), and these basins were also the ones that were most turbid, which increases the TOC concentrations. The rest of the WSPs were less turbid.

Conductivity was quite high in most WSPs and this could be due to concentrations of K and Mg, when the concentration of these metals are high, conductivity will increase (Kazi et al. 2009). Na and Cl will also increase conductivity and these metals in addition to K, Mg, Na and Cl had high concentrations, and are most likely the reason the conductivity was high (SWEPA 2000).

### 4.1.3. Metals

Concentrations of As were low compared to concentrations measured by SWEPA (0.4-5 µg/L) or very low (≤0.4 µg/L) in all WSPs except Taraldrud north, where the concentration compared with SWEPA was moderately high (5-15 µg/L ). The natural pristine concentration was 0.2 µg/L As, which most of the WSPs exceeded (SWEPA 2000). For As only the WSP Taraldrud north was above the maximum limit. The rest of the WSP were under the yearly average used in SWEPA (2000). For Cr, Taraldrud north had very low concentrations compared to concentrations measured by SWEPA (≤0.3 µg/L),while Sastad had moderately high concentrations of Cr (5-15 µg/L). The rest of the WSPs had low concentrations of Cr

(0.3-5 μg/L). The natural pristine concentration was 0.05 μg/L Cr, and all the WSPs were under both the maximum limit and the yearly average for Cr, but over the natural pristine concentration (SWEPA 2000). All WSPs except Taraldrud north had low concentration of Ni compared to SWEPA (0.7-15 μg/L), while Taraldrud north had very low concentration (≤0.7 μg/L Ni). The natural pristine concentration was 0.2 μg/L Ni, which all WSPs exceeded (SWEPA 2000). Ba was moderately high in some WSPs, Mo and $SO_4$ were low compared to concentrations from CCME (2007). Mn for all WSPs were low, except for Fiulstad, Sastad and Idrettsveien left which had concentrations ranging from 308-460 μg/L Mn. CCME had 200 μg/L Mn as agricultural water quality guidelines for irrigation. The three WSPs with most Mn in them were the three with orange water most likely due to iron precipitates. Mn is often leached from laterite ores, and this could be one possibility in this case.

For Hg, the natural pristine concentration measured by SWEPA was 0.001 μg/L, and the different WSPs was 0.00μg/L except for Fiulstad, Sastad, Idrettsveien left, Karlshusbunn left, Nordby right, Nordby left and Enebakk which had concentrations ≥0.01 (SWEPA 2000). With these concentrations the classification of Hg was good, according to classification standards made by klif (SFT 2007). Fe was high in some WSPs such as, Idrettsveien left, Fiulstad and Nordby right, which coincide with Mn for Idrettsveien left and Fiulstad, and the color of the water (orange), which indicated iron precipitation (CCME 2007). Sb concentrations were low compared with CCMEs agricultural water quality guidelines (CCME 2007). Sb can come from brake dust particles (Thorpe, A & Harrison, R. M 2008).

Cu concentrations for Nostvedt, Vassum, Fiulstad, Sastad, Karlshusbunn left, Nordby right and Enebakk were over 7.8 μg/L Cu, a high concentration compared to the natural pristine concentration found in Sweden of 0.3 μg/L Cu, by SWEPA (2000). Skullerud, Taraldrud crossing, Taraldrud south, Idrettsveien right, Idrettsveien left, Karlshusbunn right and Nordby left had moderate to high concentrations, and Taraldrud north had low concentrations of Cu. The natural pristine concentration was 11 μg/L for Zn, the highest measured concentrations in this survey was 355.3 μg/L in Vassum, which is a high concentrations compared with the natural pristine concentration. Zn was under the maximum limit and yearly average in only two WSP; Taraldrud crossing and Taraldrud north. The rest of the WSPs were above both maximum limit and yearly average (SWEPA 2000). Both Zn and Cu concentrations coincide with concentrations from a master thesis about heavy metals in benthic invertebrates, where the same WSPs are used as in my thesis. Cu was in some measurements higher in Damsgårds thesis; Accumulation of heavy metals in benthic invertebrates and frogs from sedimentation ponds receiving runoff from a four lane motorway (E6), but variation from year to year and from different seasons are normal (Damsgård 2011). Also in the PhD Ecotoxicological effects of highway and tunnel wash water runoff by Meland (2010) there were found high concentrations of Cu and Zn.

Cd concentrations for all WSPs were moderately high (0.1-0.3 µg/L) or low compared to concentrations from SWEPA (0.01-0.1 µg/L) (2000). The natural pristine concentration was 0.005 µg/L Cd, which most WSPs exceeded (SWEPA). Taraldrud north, Taraldrud south and Nostvedt had very low concentrations of Cd (≤0.01 µg/L). Most of the WSPs had moderately (≤0.2 µg/L) to low concentrations (0.2-1 µg/L) of Pb, while Nordby right had high concentrations (3-15 µg/L Pb) and Karlshusbunn left had very high concentrations (>15µg/L Pb). Taraldrud north had very low concentrations compared to concentrations in SWEPA (≤0.2 µg/L Pb). The natural pristine concentration was 0.05 µg/L Pb, which all WSPs exceeded (SWEPA 2000). Damsgårds thesis (2011) and the PhD by Meland (2010) had approximately the same concentrations of Cd and Pb.

Ba, Cu, Pb, Sb and possibly Cd and Zn are sources from combustion, though an insignificant source according to Sternbeck et al (2002), while Zn can also originate from tire wear (Thorpe, A & Harrison, R. M 2008). Fe, Cu, Pb and Zn are ubiquitous in brake linings and are common pollutants from brake wear, and Cu is found to be most ample in brake wear (Sternbeck et al. 2002; Thorpe, A & Harrison, R. M 2008). Cd could be a pollutant coming from combustion according to Sternbeck et al (2002). Some of the pollution in these WSPs can possibly come from nonpoint diffuse sources brought there by wind and precipitation (Hvitved-Jacobsen et al. 2010).

A difference in the WSPs with two slam pools were obvious (Idrettsveien left, Idrettsveien right, Karlshusbunn left, Karlshusbunn right, Nordby left, Nordby right). Idrettsveien right receives runoff from an industrial area. By looking at the water quality in the left and right basin there was a clear difference. Na and Cl which most likely come from salt from road runoff were much higher in the one basin which received road runoff (Idrettsveien left, Karlshusbunn left, Nordby left). Sodiumchloride (NaCl) is the most common de-icing agent used in Norway. For several months at a time during winter it is used to prevent and remove ice from the road (Amundsen et al. 2010), Na and Cl were quite high in most WSPs, but a clear difference between the ponds receiving runoff from roads and the ones receiving runoff from agriculture could be seen. Cl was higher than the long term exposure and short term exposure in all WSPs found in the Canadian Water Quality Guidelines for the Protection of Aquatic Life, and the WSPs which receives runoff from road were always higher in concentration of Cl, than the ones that received runoff from agriculture (CCME 2007; Le Viol et al. 2012). Some species are very affected by salinity, such as Gastropoda (Le Viol et al. 2009). Although aquatic macro invertebrates are quite salt tolerant, unless the salt content reaches values that can give osmotic stress (Mayer et al. 2008). There was a great deal of salt in the WSPs surveyed but apparently not enough to cause osmotic stress, because it was found so many organisms living there.

K and Mg were quite high for most WSPs (SWEPA 2000). K had high concentrations in most WSPs and when comparing with Vassum WSPs during a tunnel wash from Melands thesis (2010), some of the WSPs were even above this level. Mg can come from brake dust, and along with Ca, Al, Fe and K it can originate from road wear and concrete inside tunnels (Hildermann et al. 1991; Thorpe, A. & Harrison, R. M. 2008).

Al was quite high in Nostvedt, Fiulstad, Sastad, Idrettsveien left, Karlshusbunn left, Nordby right and Enebakk, while the rest of the WSPs had low or intermediate concentrations. Co and Ca were not high compared with CCMEs agricultural water quality guidelines, but some were high compared to concentrations from tunnel wash in Melands thesis (CCME 2007; Meland 2010). The natural pristine concentration for Co were 0.03 μg/L, all averages for all WSPs exceeded this concentration (SWEPA 2000). Debris from tire wear and road dust could contain Al, K, Ca, Cu, Fe, Co and Zn (Hildermann et al. 1991; Thorpe, A. & Harrison, R. M. 2008), which fits with the high concentrations of the water quality parameters found in this survey.

Si had intermediate or low concentrations in these WSPs; Skullerud, Taraldrud north Taraldrud crossing, Taraldrud south and Nostvedt. The rest of the WSPs had high concentration of Si (Klif 2012). Si can come from asphalt wear (Lindgren 1996), and was higher in the WSPs lying in Østfold county.

$NO_3$ was quite high in several of the WSPs. $NO_3$ compared to concentrations set by the Canadian Water Quality Guidelines (3.0 L/$NO_3$) for long term exposure were quite high for most of the WSPs researched (CCME 2007). The WSPs with concentrations of nitrate over 9 mg/L was; Fiulstad, Sastad, Karlshusbunn right, Nordby right and Enebakk. Both KABH and NORH were only receiving agricultural runoff and had high nitrogen concentration, high nitrogen could come from agriculture (Di & Cameron 2002). Most of the WSPs lie in agricultural landscapes, and surely will get some nitrogen from agriculture, but the rest of the WSPs with lower concentrations of $NO_3$ are ponds that were not located in agricultural areas. This can also be seen for P in some WSPs, in the ponds which receives agricultural runoff (Karlshusbunn right, Nordby right). P had quite high concentrations for almost all WSPs compared to the trigger ranges made by Canadian Water Quality Guidelines and also EPAs EQS (2007; EPA 2000). Vassum, Sastad, Fiulstad and Nordby right was highest with concentrations of 150 µg/L P and over, which is an extremely high concentration. P was higher than the ones which receives road runoff (Karlshusbunn left, Nordby left) (Goetz & Zilberman 2000). The high concentrations were most likely caused by leaching from agriculture because the WSPs with two slam basins were always highest in the one receiving agricultural runoff (Jensen et al. 1999)

### 4.1.4 Organic pollutants

There were low concentrations of Naphthalene, Acenaphthylene, Acenaphthene, Benzo(a)antracen, Fluorene, Anthracene, Fluoranthene and Phenanthrene. Benzo(a)anthracene had maximum limit of 0.02 µg/L, and yearly average of 0.01 µg/L. All WSPs averages were 0,01, which mean a low concentration. Dibenzo(ah)anthracene had maximum limit of 0.02 µg/L, and yearly average of 0.00 µg/L. All averages of the WSPs were 0,01, which is just under the maximum limit and above the yearly average (Klif 2012). Pyrene had high concentration in all WSPs. Benzo(ghi)perylene and Indeno(123)pyrene also had high concentrations. Naphthalene, Acenaphthylene, Acenaphthene, Fluorene and Phenanthrene, Anthracene, Fluoranthene and Pyrene had only yearly average available from Klif, and Anthracene and Fluoranthene were under this value, Pyrene can come from street dust (Brown & Peake 2006), and was equal or over the yearly average value of 0.02 µg/L (Klif 2012). PAH can also come from combustion engines, when incomplete combustion happens (Guo et al. 2003). Benzo(ghi)perylene and Indeno(123)pyrene can come from asphalt wear according to Brandt and De Groot (2001). Many PAHs were excluded from statistical analysis due to LOD. A complete list of water quality parameters are shown in appendix 1-6.

Hydrocarbons measured in this study were quite low compared to StormTac data (StormTac 2012). The WSPs with highest concentrations were Vassum, Nostvedt and Idrettsveien right, but they were all lower than the concentrations StormTac found for ten different highways ranging from 0.77-1.4 mg/L oil (StormTac 2012). Hydrocarbons can come from leakages from cars, oil spills and also from petroleum (Wang et al. 2012).

The water quality parameters found in this thesis fit with what is common to find in waters which receives road runoff (Damsgård 2011; Meland 2010), and show that WSPs in this thesis are polluted environments, with many elevated concentrations of metals, and with some elevated PAH.

**Table 2. Water quality parameter concentrations shown as average and standard deviation for each wet sedimentation ponds in all four surveys. nd= not detected.**

| WSP | Statistics | Cl mg/L | Sulfate (SO4)mg/L | Ca mg/L | Fe mg/L | K mg/L | Mg mg/L | Na mg/L | Al µg/L | As µg/L | Ba µg/L | Cd µg/L | Co µg/L | Cr µg/L | Cu µg/L | Mn µg/L | Mo µg/L | Ni µg/L | P µg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SKU | average | 75.78 | 17.69 | 24.49 | 0.36 | 2.22 | 4.70 | 45.63 | 301.95 | 0.26 | 20.09 | 0.02 | 0.23 | 2.02 | 8.15 | 24.38 | 1.91 | 1.08 | 19.81 |
| | SD | 65.05 | 8.24 | 11.29 | 0.27 | 1.08 | 2.78 | 36.33 | 296.94 | 0.07 | 10.18 | 0.01 | 0.16 | 1.09 | 4.08 | 10.61 | 0.98 | 0.27 | 10.67 |
| TAN | average | 122.40 | 4.88 | 15.80 | 0.30 | 2.34 | 1.89 | 73.25 | 67.65 | 12.69 | 15.95 | 0.00 | 0.10 | 0.22 | 2.74 | 19.05 | 0.91 | 0.50 | 18.50 |
| | SD | 92.67 | 1.48 | 3.14 | 0.13 | 0.61 | 0.70 | 49.36 | 75.41 | 21.54 | 7.97 | 0.00 | 0.05 | 0.16 | 0.84 | 7.30 | 0.31 | 0.16 | 7.49 |
| TAK | average | 208.75 | 32.88 | 38.85 | 0.60 | 3.66 | 4.43 | 125.48 | 353.48 | 0.29 | 35.65 | 0.03 | 0.25 | 0.63 | 6.42 | 34.23 | 2.46 | 2.28 | 15.71 |
| | SD | 100.28 | 6.83 | 9.69 | 0.66 | 0.86 | 1.19 | 42.26 | 501.04 | 0.10 | 9.80 | 0.02 | 0.24 | 0.63 | 3.19 | 33.03 | 0.88 | 1.17 | 11.07 |
| TAS | average | 291.78 | 3.37 | 8.32 | 0.49 | 2.89 | 1.75 | 174.85 | 136.33 | 0.20 | 17.85 | 0.00 | 0.15 | 0.44 | 4.17 | 15.30 | 0.82 | 0.75 | 21.30 |
| | SD | 200.20 | 1.50 | 2.67 | 0.26 | 0.94 | 0.88 | 112.82 | 156.39 | 0.05 | 7.18 | 0.00 | 0.10 | 0.35 | 1.48 | 6.36 | 0.17 | 0.21 | 9.56 |
| NOS | average | 160.70 | 11.23 | 18.28 | 1.11 | 2.79 | 2.68 | 97.00 | 919.25 | 0.30 | 27.05 | 0.01 | 0.55 | 1.91 | 12.00 | 55.63 | 1.74 | 1.91 | 31.65 |
| | SD | 128.66 | 1.82 | 3.11 | 0.88 | 0.73 | 0.75 | 75.40 | 676.73 | 0.04 | 6.76 | 0.01 | 0.33 | 1.16 | 1.64 | 16.90 | 0.54 | 0.85 | 12.31 |
| VAS | average | 558.52 | 27.04 | 38.14 | 1.64 | 6.97 | 6.51 | 344.86 | 518.40 | 0.40 | 50.90 | 0.03 | 2.04 | 2.13 | 17.98 | 165.42 | 8.73 | 5.53 | 159.54 |
| | SD | 770.53 | 12.48 | 10.71 | 1.03 | 3.90 | 3.46 | 462.16 | 371.67 | 0.20 | 35.77 | 0.03 | 1.36 | 1.31 | 6.57 | 131.26 | 4.81 | 4.06 | 128.93 |
| FIU | average | 249.75 | 37.33 | 44.58 | 5.24 | 5.60 | 6.83 | 144.50 | 1191.00 | 1.12 | 72.18 | 0.11 | 2.11 | 2.05 | 9.70 | 460.25 | 0.99 | 8.49 | 42.05 |
| | SD | 65.51 | 6.41 | 6.09 | 3.98 | 0.48 | 0.84 | 29.34 | 1056.72 | 0.73 | 5.94 | 0.02 | 1.00 | 1.90 | 4.47 | 163.36 | 0.29 | 1.95 | 30.83 |
| SAS | average | 357.00 | 39.50 | 52.13 | 2.60 | 9.61 | 70.25 | 202.00 | 1412.00 | 1.16 | 69.98 | 0.15 | 1.41 | 5.14 | 11.05 | 383.25 | 1.84 | 8.40 | 134.40 |
| | SD | 148.07 | 5.25 | 12.04 | 3.01 | 0.99 | 102.05 | 77.33 | 1511.21 | 0.88 | 9.46 | 0.12 | 1.76 | 4.98 | 6.01 | 426.70 | 0.71 | 3.87 | 149.45 |
| IDRH | average | 33.26 | 13.03 | 19.35 | 1.40 | 3.59 | 3.22 | 23.35 | 366.75 | 0.31 | 32.30 | 0.09 | 0.48 | 1.08 | 6.97 | 64.45 | 1.71 | 2.58 | 23.54 |
| | SD | 19.23 | 0.99 | 1.37 | 0.28 | 0.50 | 0.15 | 1.74 | 182.22 | 0.06 | 2.69 | 0.02 | 0.10 | 0.42 | 1.45 | 12.19 | 0.28 | 0.28 | 13.01 |
| IDRV | average | 298.50 | 24.08 | 40.25 | 10.93 | 5.53 | 6.05 | 166.00 | 1213.75 | 0.81 | 63.65 | 0.06 | 1.40 | 2.29 | 5.95 | 307.75 | 0.99 | 3.78 | 44.95 |
| | SD | 101.93 | 0.99 | 9.04 | 5.48 | 0.37 | 1.41 | 43.53 | 1379.28 | 0.51 | 12.90 | 0.03 | 0.75 | 1.78 | 5.34 | 95.05 | 0.39 | 1.73 | 39.07 |
| KABH | average | 81.53 | 16.71 | 24.83 | 1.65 | 6.44 | 4.68 | 46.08 | 445.75 | 0.34 | 37.70 | 0.05 | 0.35 | 0.81 | 3.82 | 81.45 | 0.62 | 1.81 | 24.33 |
| | SD | 33.00 | 7.36 | 4.75 | 0.74 | 0.83 | 0.80 | 20.60 | 144.44 | 0.03 | 2.62 | 0.01 | 0.06 | 0.13 | 0.77 | 32.90 | 0.30 | 0.25 | 7.79 |
| KABV | average | 296.25 | 31.73 | 28.58 | 0.95 | 4.69 | 4.67 | 179.98 | 1008.50 | 0.38 | 47.60 | 0.05 | 0.58 | 1.87 | 9.94 | 34.78 | 1.90 | 3.23 | 39.85 |
| | SD | 156.58 | 14.48 | 9.45 | 0.77 | 1.16 | 1.58 | 72.81 | 692.91 | 0.16 | 17.53 | 0.01 | 0.26 | 0.98 | 3.00 | 14.66 | 0.69 | 1.01 | 22.65 |
| NORH | average | 48.90 | 16.95 | 20.00 | 5.17 | 7.06 | 8.02 | 27.61 | 2737.50 | 1.44 | 53.20 | 0.13 | 2.75 | 3.21 | 10.74 | 286.32 | 0.58 | 4.63 | 487.00 |
| | SD | 31.43 | 4.69 | 3.84 | 5.98 | 1.41 | 1.48 | 16.61 | 2459.64 | 1.18 | 25.38 | 0.13 | 3.82 | 2.74 | 7.17 | 435.41 | 0.10 | 3.13 | 523.45 |
| NORV | average | 167.40 | 45.28 | 39.70 | 0.70 | 6.27 | 7.85 | 102.55 | 578.75 | 0.27 | 32.35 | 0.04 | 0.33 | 1.08 | 7.51 | 25.65 | 1.66 | 2.61 | 20.20 |
| | SD | 77.47 | 9.07 | 2.85 | 0.41 | 0.83 | 0.71 | 38.59 | 410.88 | 0.11 | 2.58 | 0.01 | 0.13 | 0.46 | 2.51 | 7.15 | 0.58 | 0.57 | 6.95 |
| ENE | average | 190.58 | 20.60 | 21.23 | 1.74 | 5.73 | 6.90 | 115.63 | 1440.25 | 0.59 | 37.90 | 0.05 | 0.75 | 1.93 | 9.83 | 40.38 | 1.81 | 3.93 | 63.35 |
| | SD | 63.25 | 3.51 | 2.11 | 0.85 | 0.83 | 0.89 | 32.82 | 877.58 | 0.16 | 1.84 | 0.01 | 0.31 | 1.14 | 2.51 | 15.18 | 0.55 | 1.27 | 22.12 |

**Table 3. Water quality parameter concentrations shown as average and standard deviation for each wet sedimentation ponds in all four surveys. nd= not detected.**

| WSP | Statistics | Pb µg/L | Si mg/L | Sr µg/L | Zn µg/L | Sb µg/L | TOC mg/L | Temp. | Oxygen mg/L | pH | conductivity µs/m | Naphtalene µg/L | Acenafthylene µg/l | Acenaphthene µg/L | Fluorene µg/L | Phenanthrene µg/L | Anthracene µg/L | Fluoranthene µg/L | Pyrene µg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SKU | average | 0.58 | 1.86 | 81.70 | 24.18 | 0.75 | 6.04 | 11.26 | 9.14 | 7.32 | 234.35 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 |
| | SD | 0.43 | 1.09 | 38.84 | 13.17 | 0.38 | 0.77 | 3.75 | 1.59 | 0.87 | 183.24 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| TAN | average | 0.14 | 0.46 | 56.15 | 5.48 | 0.78 | 3.97 | 13.15 | 8.99 | 7.31 | 524.25 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 |
| | SD | 0.10 | 0.43 | 13.99 | 2.82 | 0.19 | 1.09 | 4.01 | 1.84 | 0.97 | 353.88 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| TAK | average | 0.54 | 1.69 | 113.03 | 8.94 | 0.54 | 9.58 | 12.62 | 9.91 | 7.36 | 678.55 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 |
| | SD | 0.71 | 2.27 | 29.58 | 8.34 | 0.19 | 2.89 | 3.75 | 1.48 | 0.76 | 438.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| TAS | average | 0.28 | 0.33 | 50.35 | 11.38 | 0.82 | 5.24 | 14.10 | 8.35 | 7.21 | 583.40 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 |
| | SD | 0.19 | 0.26 | 21.93 | 5.45 | 0.25 | 1.21 | 3.53 | 1.18 | 1.06 | 498.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NOS | average | 0.90 | 2.63 | 63.85 | 57.75 | 1.59 | 5.90 | 14.83 | 9.31 | 7.66 | 439.35 | 0.05 | 0.01 | 0.01 | 0.01 | 0.03 | 0.01 | 0.02 | 0.03 |
| | SD | 0.58 | 1.47 | 19.93 | 28.16 | 0.32 | 1.68 | 3.05 | 1.18 | 0.87 | 437.48 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 |
| VAS | average | 1.41 | 3.79 | 174.62 | 355.32 | 2.81 | 15.19 | 13.45 | 9.05 | 7.87 | 573.20 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.04 |
| | SD | 0.57 | 1.23 | 92.32 | 472.65 | 1.84 | 12.69 | 2.74 | 3.52 | 0.50 | 308.18 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.02 |
| FIU | average | 1.75 | 7.84 | 184.50 | 31.78 | 0.43 | 8.78 | 9.30 | 9.72 | 7.53 | 707.58 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.02 |
| | SD | 1.37 | 1.64 | 22.29 | 12.74 | 0.17 | 2.07 | 2.62 | 1.72 | 1.55 | 455.83 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| SAS | average | 1.78 | 8.05 | 239.50 | 33.75 | 0.60 | 9.83 | 9.57 | 9.54 | 6.86 | 1134.40 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 |
| | SD | 1.93 | 1.46 | 54.26 | 25.43 | 0.18 | 2.72 | 2.36 | 2.94 | 0.76 | 722.63 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| IDRH | average | 0.79 | 5.72 | 79.60 | 88.90 | 0.73 | 7.64 | 11.01 | 8.05 | 6.38 | 273.00 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 |
| | SD | 0.22 | 0.95 | 6.30 | 18.08 | 0.09 | 1.40 | 2.37 | 0.77 | 0.95 | 30.08 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| IDRV | average | 2.23 | 7.27 | 154.75 | 41.10 | 0.31 | 15.13 | 10.35 | 6.49 | 6.18 | 873.98 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 |
| | SD | 2.93 | 1.06 | 36.44 | 27.70 | 0.21 | 3.89 | 2.52 | 1.28 | 1.14 | 498.49 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| KABH | average | 0.43 | 5.46 | 136.50 | 26.38 | 0.25 | 9.57 | 11.37 | 11.18 | 6.98 | 425.50 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 |
| | SD | 0.06 | 0.82 | 10.87 | 22.16 | 0.04 | 1.98 | 3.59 | 1.95 | 0.84 | 112.82 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| KABV | average | 16.68 | 3.89 | 108.83 | 27.50 | 0.84 | 11.83 | 14.18 | 11.61 | 7.38 | 873.35 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 |
| | SD | 27.21 | 2.53 | 36.14 | 21.32 | 0.21 | 3.95 | 4.38 | 1.33 | 1.02 | 575.41 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NORH | average | 4.69 | 6.73 | 152.25 | 25.86 | 0.28 | 11.04 | 12.26 | 11.56 | 6.80 | 332.10 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 |
| | SD | 4.15 | 2.94 | 27.64 | 26.83 | 0.06 | 1.23 | 4.03 | 3.44 | 0.64 | 110.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NORV | average | 0.80 | 6.11 | 138.00 | 20.30 | 0.48 | 9.95 | 10.99 | 11.63 | 6.98 | 607.33 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 |
| | SD | 0.42 | 1.00 | 6.48 | 3.46 | 0.12 | 2.91 | 2.95 | 1.14 | 0.73 | 333.32 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ENE | average | 2.15 | 6.56 | 122.50 | 87.15 | 0.80 | 11.81 | 11.20 | 10.23 | 6.81 | 615.05 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 |
| | SD | 0.65 | 1.58 | 10.69 | 18.53 | 0.10 | 4.00 | 2.96 | 0.97 | 0.75 | 356.88 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**Table 4. Water quality parameter concentrations shown as average and standard deviation for each wet sedimentation ponds in all four surveys. nd= not detected.**

| WSP | Statistics | Benso(a)anhtracene^ µg/L | Chrysen^ µg/L | Benzo(b)fluoranthene^ µg/L | Benzo(k)fluoranthene^ µg/L | Benzo(a)pyrene^ µg/L | Dibenzo(ah)anthracene^ µg/L | Benzo(ghi)perylene µg/L | Indeno(123cd)pyrene^ µg/L | Sum PAH-16 µg/l | Sum PAH carcinogene^ µg/L | Fraksjon >C10-C12 µg/L | Fraksjon >C12-C16 µg/L | Fraksjon >C16-C35 µg/L | Fraksjon >C12-C35 µg/L | Fraksjon >C35-C40 µg/L | Sum >C10-C40 µg/L | Hg µg/L | Nitrat (NO3)mg /L | Ag µg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SKU | average | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 102.00 | 102.63 | 20.00 | 122.25 | 0.00 | 1.16 | 0.08 |
| | SD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | n.d. | n.d. | 0.00 | 0.00 | 108.10 | 107.60 | 22.65 | 130.94 | 0.00 | 1.19 | 0.10 |
| TAN | average | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | 25.00 | 0.00 | 0.29 | 0.08 |
| | SD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | n.d. | n.d. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.16 | 0.10 |
| TAK | average | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 21.25 | 23.13 | 5.00 | 32.50 | 0.00 | 1.71 | 0.08 |
| | SD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | n.d. | n.d. | 0.00 | 0.00 | 10.83 | 9.74 | 0.00 | 7.50 | 0.00 | 1.65 | 0.10 |
| TAS | average | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 62.75 | 64.00 | 8.75 | 120.50 | 0.00 | 0.14 | 0.08 |
| | SD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | n.d. | n.d. | 0.00 | 0.00 | 54.97 | 53.88 | 6.50 | 48.50 | 0.00 | 0.00 | 0.10 |
| NOS | average | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.06 | n.d. | 2.50 | 3.30 | 191.25 | 192.75 | 94.75 | 101.25 | 0.00 | 2.00 | 0.08 |
| | SD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | n.d. | 0.00 | 1.39 | 147.37 | 147.83 | 109.41 | 100.96 | 0.00 | 1.11 | 0.10 |
| VAS | average | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.19 | 0.01 | 3.60 | 13.44 | 535.00 | 546.80 | 108.80 | 659.20 | 0.00 | 1.92 | 0.07 |
| | SD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.20 | 19.52 | 320.88 | 326.04 | 70.02 | 388.45 | 0.00 | 1.98 | 0.09 |
| FIU | average | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | 25.00 | 0.01 | 9.12 | 0.11 |
| | SD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | n.d. | n.d. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 7.95 | 0.09 |
| SAS | average | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 22.25 | 24.13 | 6.50 | 55.00 | 0.02 | 23.93 | 0.08 |
| | SD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | n.d. | n.d. | 0.00 | 0.00 | 12.56 | 11.47 | 2.60 | 0.00 | 0.01 | 10.42 | 0.10 |
| IDRH | average | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 5.30 | 285.75 | 289.75 | 26.00 | 121.18 | 0.00 | 6.02 | 0.08 |
| | SD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | n.d. | n.d. | 0.00 | 2.81 | 281.17 | 278.45 | 20.51 | 76.97 | 0.00 | 1.49 | 0.10 |
| IDRV | average | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 76.75 | 78.00 | 19.50 | 175.00 | 0.01 | 2.07 | 0.11 |
| | SD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | n.d. | n.d. | 0.00 | 0.00 | 92.03 | 91.19 | 21.79 | 122.00 | 0.01 | 1.38 | 0.10 |
| KABH | average | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | 25.00 | 0.00 | 19.28 | 0.08 |
| | SD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | n.d. | n.d. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.63 | 0.10 |
| KABV | average | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 32.25 | 34.13 | 7.75 | 62.50 | 0.01 | 4.52 | 0.08 |
| | SD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | n.d. | n.d. | 0.00 | 0.00 | 29.88 | 28.80 | 4.76 | 37.50 | 0.00 | 0.96 | 0.10 |
| NORH | average | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | 25.00 | 0.02 | 26.03 | 0.11 |
| | SD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | n.d. | n.d. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 12.25 | 0.09 |
| NORV | average | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 42.25 | 44.13 | 5.00 | 84.50 | 0.01 | 6.01 | 0.08 |
| | SD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | n.d. | n.d. | 0.00 | 0.00 | 47.20 | 46.12 | 0.00 | 59.50 | 0.00 | 2.61 | 0.10 |
| ENE | average | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 55.25 | 56.50 | 13.00 | 87.67 | 0.01 | 12.35 | 0.08 |
| | SD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | n.d. | n.d. | 0.00 | 0.00 | 43.55 | 42.39 | 10.22 | 51.03 | 0.01 | 4.97 | 0.10 |

**Table 5. Klifs Environmental Quality Standards (EQS), and averages of the different water quality parameters for each wet sedimentation ponds. Max limit and yearly average are found in Klifs EQS for freshwater (Klif 2012).**

| WSP, average | As µg/L | Cr µg/L | Cu µg/L | Zn µg/L | Naphtalene µg/L | Acenaphfthylen µg/L | Acenaphftene µg/L | Fluorene µg/L | Phenanthrene µg/L | Anthracene µg/L | Fluoranthene µg/L | Pyrene µg/L | Benzo(a) antgracene^ µg/L | Dibenzo(ah) anthracene^ µg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SKU | 0.26 | 2.0 | 8.2 | 24 | 0.050 | 0.0050 | 0.0050 | 0.010 | 0.015 | 0.010 | 0.015 | 0.030 | 0.0050 | 0.0050 |
| TAN | 13 | 0.22 | 2.7 | 5.5 | 0.050 | 0.0050 | 0.0050 | 0.010 | 0.015 | 0.010 | 0.015 | 0.030 | 0.0050 | 0.0050 |
| TAK | 0.29 | 0.63 | 6.4 | 8.9 | 0.050 | 0.0050 | 0.0050 | 0.010 | 0.015 | 0.010 | 0.015 | 0.030 | 0.0050 | 0.0050 |
| TAS | 0.20 | 0.44 | 4.2 | 11 | 0.050 | 0.0050 | 0.0050 | 0.010 | 0.015 | 0.010 | 0.015 | 0.030 | 0.0050 | 0.0050 |
| NOS | 0.30 | 1.9 | 12 | 58 | 0.050 | 0.0050 | 0.0050 | 0.010 | 0.026 | 0.011 | 0.015 | 0.030 | 0.0050 | 0.0050 |
| VAS | 0.40 | 2.1 | 18 | 355 | 0.050 | 0.0050 | 0.0050 | 0.010 | 0.020 | 0.010 | 0.022 | 0.041 | 0.0050 | 0.0050 |
| FIU | 1.1 | 2.0 | 9.7 | 32 | 0.050 | 0.0050 | 0.0050 | 0.010 | 0.015 | 0.010 | 0.015 | 0.024 | 0.0050 | 0.0050 |
| SAS | 1.2 | 5.1 | 11 | 34 | 0.050 | 0.0050 | 0.0050 | 0.010 | 0.015 | 0.010 | 0.015 | 0.030 | 0.0050 | 0.0050 |
| IDRH | 0.31 | 1.1 | 7.0 | 89 | 0.050 | 0.0050 | 0.0050 | 0.010 | 0.015 | 0.010 | 0.015 | 0.030 | 0.0050 | 0.0050 |
| IDRV | 0.81 | 2.3 | 5.9 | 41 | 0.050 | 0.0050 | 0.0050 | 0.010 | 0.015 | 0.010 | 0.015 | 0.030 | 0.0050 | 0.0050 |
| KABH | 0.34 | 0.81 | 3.8 | 26 | 0.050 | 0.0050 | 0.0050 | 0.010 | 0.015 | 0.010 | 0.015 | 0.030 | 0.0050 | 0.0050 |
| KABV | 0.38 | 1.9 | 9.9 | 28 | 0.050 | 0.0050 | 0.0050 | 0.010 | 0.015 | 0.010 | 0.015 | 0.030 | 0.0050 | 0.0050 |
| NORH | 1.4 | 3.2 | 11 | 26 | 0.050 | 0.0050 | 0.0050 | 0.010 | 0.015 | 0.010 | 0.015 | 0.030 | 0.0050 | 0.0050 |
| NORV | 0.27 | 1.1 | 7.5 | 20 | 0.050 | 0.0050 | 0.0050 | 0.010 | 0.015 | 0.010 | 0.015 | 0.030 | 0.0050 | 0.0050 |
| ENE | 0.59 | 1.9 | 9.8 | 87 | 0.050 | 0.0050 | 0.0050 | 0.010 | 0.015 | 0.010 | 0.015 | 0.030 | 0.0050 | 0.0050 |
| average, all WSPs | 1.4 | 1.8 | 8.5 | 56 | 0.050 | 0.0050 | 0.0050 | 0.010 | 0.016 | 0.010 | 0.015 | 0.030 | 0.0050 | 0.0050 |
| **max limit µg/L** | **8.5** | **3.4** | **7.8** | **11** | **130** | **3.3** | **5.8** | **5.0** | **5.1** | | | | **0.018** | **0.018** |
| **yearly average** | **4.8** | **3.4** | **7.8** | **11** | **2.0** | **1.3** | **3.8** | **2.5** | **1.3** | **0.10** | **0.12** | **0.023** | **0.012** | **0.0020** |

### 4.1.5 General trends in water quality

PCA for water quality April, show that the WSPs with highest concentrations were Nordby, Vassum, Taraldrud north, Skullerud and Fiulstad (Figure 13). The most important metals according to Canoco when count was limited to the ten most important metals were; Sr, Ba, Cd, Ni, Si, Fe, Co, Al, Cr and Pb. The percentage explanation for the first and second axis were 42% and 18% respectively. The first axis was correlated with most of the metals analyzed, together with conductivity and oxygen, while the second axis was mostly correlated with Sb, Na, Cl and Ca. In this case the second axis can be thought of as a salt gradient.

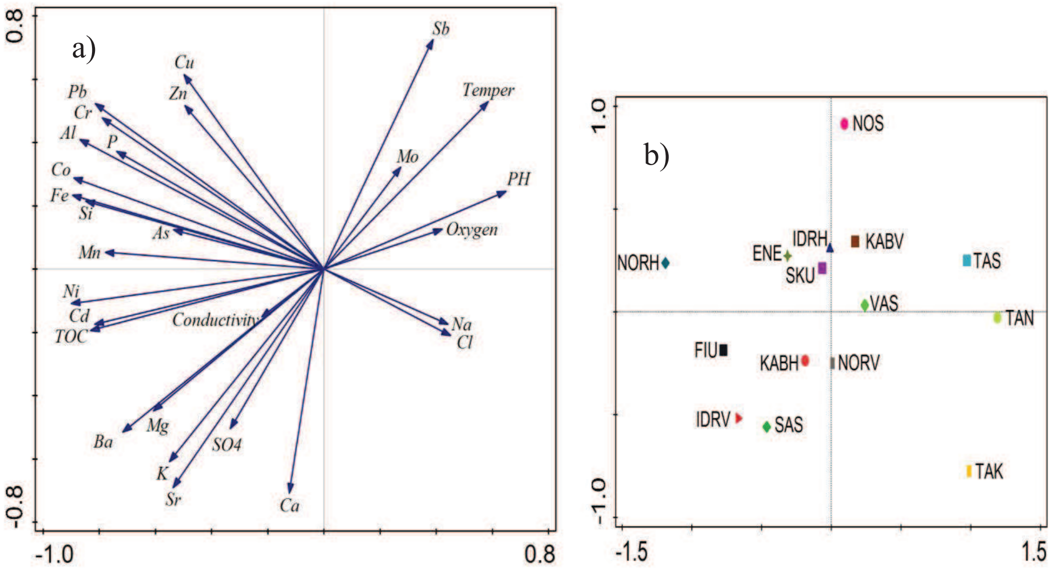



**Figure 13). PCA for water quality from April 2012. a) show water quality parameters. b) show the respective wet sedimentation ponds.**

PCA water quality for June 2012 show approximately the same trend as in figure 13 (Figure 14). The ten most important metals according to Canoco when count was limited to the ten most important metals were: Zn, Pb, Cr, Co, Al, Ni, Ba, Mg, Sr and Ca. The first axis were mostly correlated with most of the metals and TOC, while the second axis were correlated with Sb, pH, oxygen and conductivity. The first axis explained 39% of the variation while the second axis explained 19%. There has been a slight change from April, and the second axis was no longer correlated with salinity, as was seen in the month of April (Figure 13).

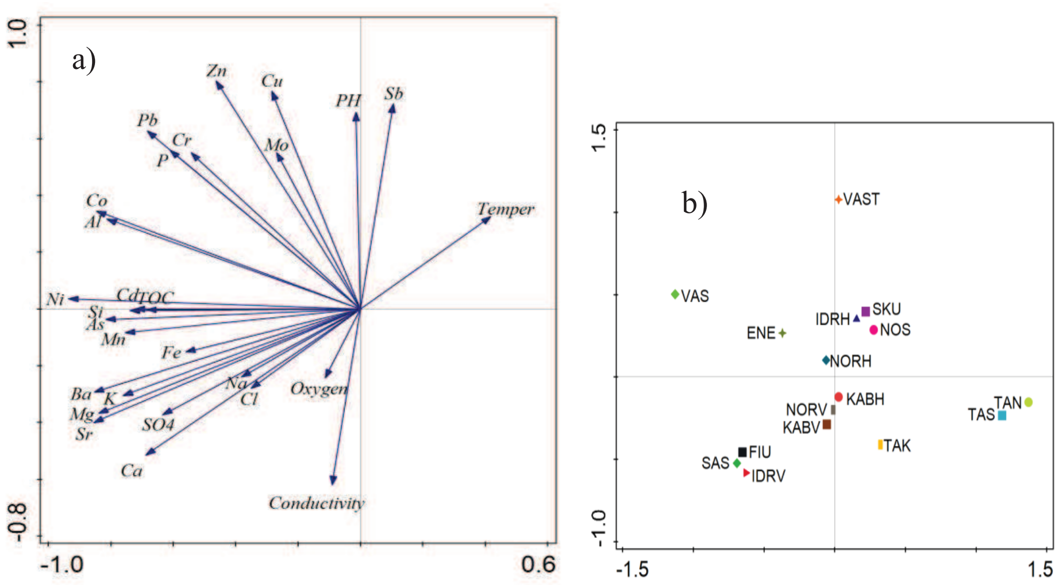



**Figure 14). PCA of water quality for June 2012. a) show water quality parameters. b) show the respective wet sedimentation ponds.**

PCA of water quality from August 2012 (Figure 15), show the most important metals in PCA water quality. According to Canoco when count was limited to the ten most important metals these metals were most important: Sb, Mo, Cu, Co, Pb, Ni, Cd, K, Ba and Sr. The first axis was correlated with the metals analyzed in this survey, while the second axis was correlated with Sb, pH, oxygen and As. The first axis explains 53% of the variation while the second axis explains 13%. It can be seen that the metals are gathering more around the first axis, than in the preceding months.

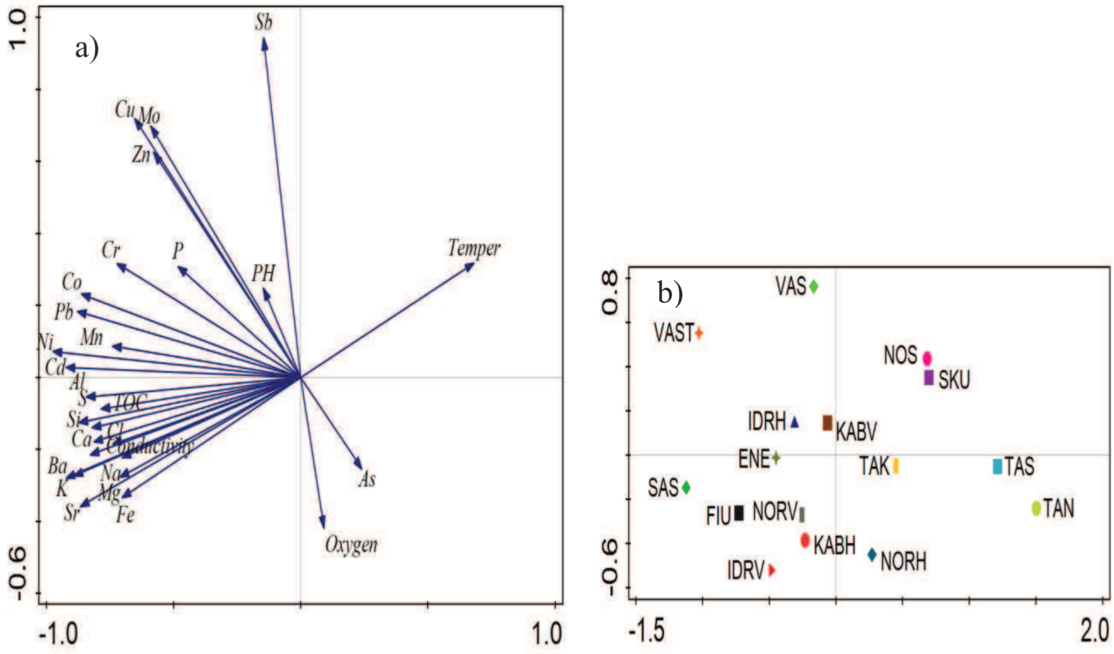



**Figure 15). PCA of water quality from August 2012. a) show water quality parameters. b) show the respective wet sedimentation ponds.**

Looking at PCA water quality for October 2012 most metals were strongly correlated with the first axis, which explained 62% of the variation and the second axis explained 11% (Figure 16). There was a trend that the water quality parameters oxygen, temperature and TOC were correlated with the second axis, while pH, Sb, temperature, oxygen, TOC and metals were correlated with the first axis. Conductivity seems to be more correlated with the first axis. The ten most important metals in PCA water quality October were Si, Cd, Mg, Ni, Ba, Al, Co, Fe, Cr and Cu.

The trend show that the metals were more and more correlated with the first axis during this survey, from April- October. This trend was very clear in August and October. It can also be seen that the WSPs were not changing that much, and TAN, TAS and TAK looks like the WSPs with less water quality parameters for all four surveys.

The most important metals for WSPs in Canoco were quite similar for all four field surveys, Ni, Co and Ba were found to be in the top ten most important metals in all four surveys. Of these three only Co had a really high concentration compared to SWEPA (SWEPA 2000). In Canoco the interaction between the metals were interfering with which one is going to be the most important metal in the dataset, that is why the metals Canoco rates as most important do not always coincide with the real concentration measured.

PCA done on water quality parameters showed that Taraldrud crossing, Taraldrud south and Taraldrud north had the lowest concentrations of water quality parameters of the WSPs. The WSPs with the highest concentrations of water quality parameters in them were Skullerud, Karlshusbunn right, Idrettsveien right, Nordby, Sastad and Fiulstad WSPs.

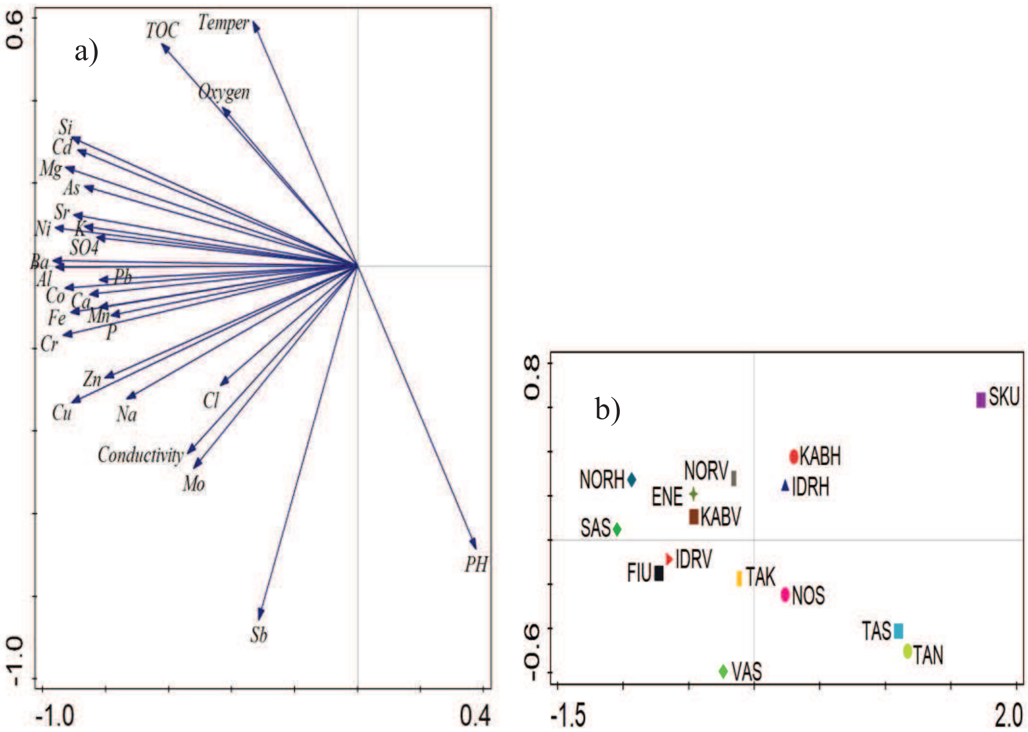



**Figure 16). PCA of water quality from October 2012. a) show water quality parameters. b) Show the respective wet sedimentation ponds.**

Sample scores obtained from the four PCA (April, June, August and October) (Figure 17) on water quality parameters show increasing sample scores and it should be stressed that it means a general decrease in the concentration of several metals such as the ones along the first PCA axis (Figure 13-16). Sample score 1 was mostly correlated with most of the metal parameters analyzed in this survey (Table 1-4). Based on the sample scores there were an apparent trend that the metal concentration in Nordby right, Vassum and Skullerud fluctuate more compared to the other WSPs. This might be due to pollution incidents or heavy rain events that they have a higher fluctuation in their sample scores and subsequently higher concentrations of water quality parameters levels. The WSP with the lowest levels of water quality parameters were Nostvedt, Taraldrud crossing, Skullerud, Taraldrud south and Taraldrud north, which coincides with most of the ponds found to have lower concentrations of water quality parameters in PCA. Skullerud was among the WSPs with smallest concentrations of water quality parameters even though AADT were largest here, this might be due to the large size of the WSP, and the dilution effect of water quality parameters in larger compared to smaller WSPs. Many of the ponds have a rather stable share of water quality parameters across the season (April- October). Ponds in Østfold county seems to have higher concentrations of water quality parameters than the ones in Oslo, and Akershus county, with exception of Vassum.

The WSPs with less water quality concentrations for sample score 2 were Enebakk, Idrettsveien right, Nostvedt and Skullerud (Figure 18). Vassum and Nostvedt had the largest variation of water quality parameters in this survey, which can be due to pollution incidents or heavy rain events. These sample scores were correlated with other water quality parameters than the first axis, such as, oxygen, Sb, pH and more (Table 1-4). Vassum is the fifth pond with least concentrations of water quality parameters, but the fluctuation in the concentrations were high. The WSPs with highest concentrations of water quality parameters were; Idrettsveien left, Sastad, Taraldrud crossing, Fiulstad and Nordby left, which coincide with water quality PCA (Figure 13-16).

The WSPs with highest concentrations of water quality parameters from both sample score 1 and 2 were Idrettsveien left and Sastad. It was expected that Vassum was fluctuating more than the others in both sample score 1 and 2, because it receives runoff from tunnels when washed, which can happen several times a year (NPRA 2010).

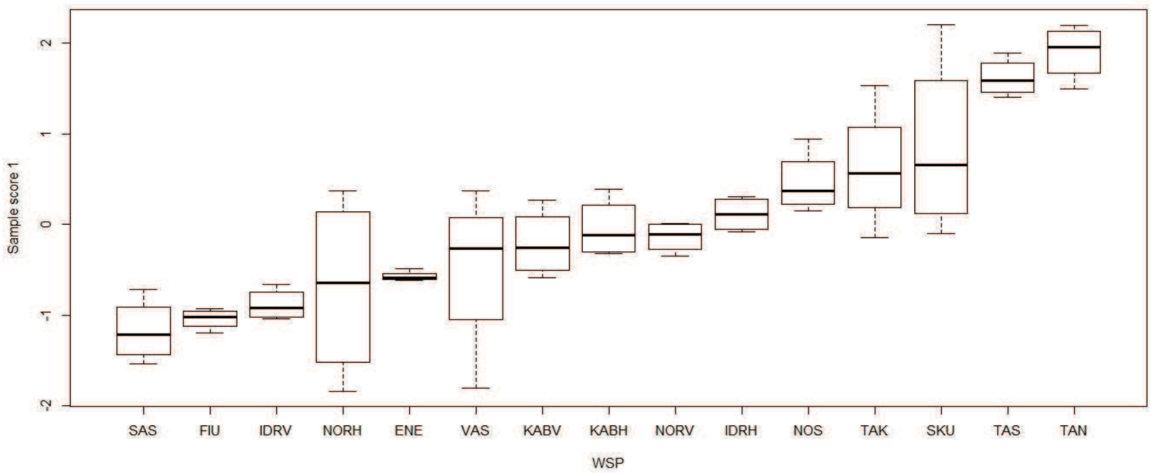



**Figure 17. Show sample score 1 from PCA water quality parameters. The higher the sample score, the lower is the concentrations of water quality parameters found in the wet sedimentation ponds. The top value of the box plot is maximum value, and the bottom is minimum value, the line in the middle of each box plot is the mean value.**

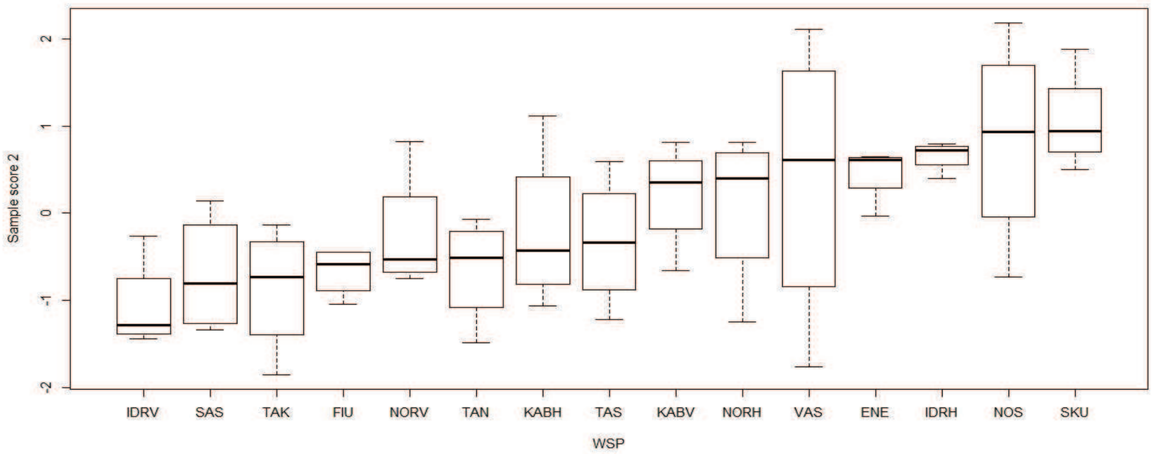



**Figure 18. Show sample score 2 from water quality parameters. The higher the sample score, the lower is the concentrations of various water quality parameters found in the wet sedimentation pond. The top value of the box plot is maximum value, and the bottom is minimum value, the line in the middle of each box plot is the mean value.**

Correlation on sample scores (Table 6) show correlation between sample score 1 and 2 from the first and second axis from water quality PCA. There was also done correlation between the different sample scores from the first axis, and between the different sample scores from the second axis. The numbers in bold were the outputs from the correlation that were statistically significant, and with a positive correlation. The samples that indicates a significant positive association were: sample score 1 from June and April, Sample score 2 from June and April. Sample score 1 from April and August had a significant positive correlation, sample score 1 from August and June also had a statistically significant positive correlation. Sample score 2 from August and April, sample score 2 from August and June had a statistically significant positive correlation. Sample score 1 for October and sample score 1 from April, June and August. Sample score 2 from October had a statistically significant positive correlation with sample score 1 from April.

There was mostly correlation between sample scores from the first axis, except sample score 2 for October that correlates with sample score 1 April. That sample scores from axis one was mostly correlated show that the amount of water quality parameters were quite stable, and that most of the water quality parameters were associated with the first axis.

**Table 6. Correlation (r) between sample score 1 and 2 from water quality parameters for all four surveys (April-October). Bold numbers have a significant positive correlation. p= significance.**

| | PCA 1 April | PCA 2 April | PCA 1 June | PCA 2 June | PCA 1 August | PCA 2 August | PCA 1 October | PCA 2 October |
|---|---|---|---|---|---|---|---|---|
| PCA 1 April | r=0.000 p=1 | r=0.000 p=1 | **r=0.68 p=0.005** | r=0.016 p=0.96 | **r=0.68 p=0.005** | r=0.32 p=0.24 | **r=0.63 p=0.011** | **r=-0.51 p=0.051** |
| PCA2 April | r=0.000 p=1 | r=0.000 p=1 | r=0.25 p=0.370 | **r=0.68 p=0.005** | r=0.37 p=0.17 | **r=0.50 p=0.058** | r=0.30 p=0.27 | r=0.025 p=0.92 |
| PCA 1 June | **r=0.68 p=0.005** | r=0.25 p=0.370 | r=0.000 p=1 | r=-0.001 p=0.97 | **r=0.87 p=0.000** | r=-0.13 p=0.64 | **r=0.72 p=0.002** | r=-0.13 p=0.64 |
| PCA 2 June | r=0.016 p=0.96 | **r=0.68 p=0.005** | r=-0.001 p=0.97 | r=0.000 p=1 | r=0.28 p=0.34 | **r=0.69 p=0.004** | r=0.37 p=0.18 | r=0.15 p=0.60 |
| PCA 1 August | **r=0.68 p=0.005** | r=0.37 p=0.17 | **r=0.87 p=0.000** | r=0.28 p=0.34 | r=0.000 p=1 | r=0.17 p=0.55 | **r=0.79 p=0.001** | r=-0.31 p=0.27 |
| PCA 2 August | r=0.32 p=0.24 | **r=0.50 p=0.058** | r=-0.13 p=0.64 | **r=0.69 p=0.004** | r=0.17 p=0.55 | r=0.000 p=1 | r=0.30 p=0.28 | r=-0.23 p=0.40 |
| PCA 1 October | **r=0.63 p=0.011** | r=0.30 p=0.27 | **r=0.72 p=0.002** | r=0.37 p=0.18 | **r=0.79 p=0.001** | r=0.30 p=0.28 | r=0.000 p=1 | r=-0.000 p=1 |
| PCA 2 October | **r=-0.51 p=0.051** | r=0.025 p=0.92 | r=-0.13 p=0.64 | r=0.15 p=0.60 | r=-0.31 p=0.27 | r=-0.23 p=0.40 | r=-0.000 p=1 | r=0.000 p=1 |

## 4.2 Biodiversity

Total taxa found in the twelve WSPs surveyed were 115. There were seven taxa found in all WSP investigated. Hydracarina, Hirudinea, *Notonecta reuteri,* Chironomidae, Chaoboridae*,* *Caenis horaria* and Coenagrionidae. There were 32 taxa that were present in 2 or more of the WSP.

### 4.2.1 Norwegian Red List

*Brychius elevatus larvae, Hygrotus confluens, Ilybius guttiger, Ilybius quadriguttatus and Triturus vulgaris,* found in this survey were near threatened (NT), and on the Norwegian Red List (Artsdatabanken 2011). *Plateumaris braccata* was the only species found which was vulnerable (VU) according to the Norwegian Red List (Artsdatabanken 2011) (Appendix 6-17).

In a report from NINA looking at macro invertebrates in a newly developed pond system in Trøgstad county they found 116 taxa when the ponds were a few years old. When the ponds were newly developed they found 52 taxa (Hov & Walseng 2003). This is numbers from a collection of ponds and can be compared to our numbers found in this thesis. Of the WSPs included in this thesis the WSPs constructed last was in 2005, meaning all WSPs in this thesis were eight years, or more, and should have had time to increase species numbers.

Species found in the WSPs researched in this survey were NT and VU on the Norwegian Red List, which indicates that these WSPs were suitable habitats for macro invertebrates and amphibians and that they were important ecosystems in a time when natural ponds are short. Le Viol et al (2009) found that there was a higher abundance of small and medium sized macro invertebrates in WSPs, which had short lives with more generations per year and had a passive dispersion. Higher nutrient concentration and a larger productivity in WSPs  is why Le Viol et al (2009) thought there were more short- lived invertebrates. Le Viol et al (2009) found that the family composition did not differ from ponds in the wider landscape compared to WSPs, and that that WSPs contribute to the maintenance of the biodiversity, as also Scher et al (2005)  proposed, and this surveys taxa numbers agrees with.

There were found amphibians in the WSP surveyed in this thesis. Amphibians utilize wetlands for breeding and larva stage, changes in the environment will affect this in a negative way. Understanding of how urbanization affects breeding of amphibians is good knowledge when building WSPs or when changing wetlands already there (Rubbo & Kiesecker 2005). Rubbo et al (2005) found that amphibians were positively correlated with the amount of forest habitat surrounding the pond they breed in. Ponds with fish, had fewer amphibians in it, and ponds in a more urbanized habitat will have less amphibians (Rubbo & Kiesecker 2005). Skullerud WSP did not have Newts but did have frogs, this was also the only WSP surveyed which had fish in it. Le Viol et al (2009) found more amphibians than expected in highway storm water ponds. Skullerud WSP had tadpoles from frogs or toads , along with Vassum, Fiulstad, Nordby and Enebakk. Newt both adults and larvae were found in Taraldrud north, Nostvedt, Sastad, Idrettsveien, Karlshusbunn and Nordby. This show that amphibians can handle a great deal of pollution when they live in some of the most polluted WSPs found in this survey.

### 4.2.2 Taxa richness

Number of taxa in the different WSPs show that Vassum and Nordby were very taxa  rich compared with the other WSPs (Figure 19), both Taraldrud north and Karlshusbunn were also quite taxa rich compared to the other WSPs. Nostvedt and Fiulstad had least taxa of the WSPs surveyed. This could be due to the human made appearance of the WSPs and low water level during the warmest months. It could also be due to poor sampling when water level is low and vegetation are at its largest. Nordby is the WSP with the most natural look, compared with some of the other WSPs it had a quite stabile water level. There were a lot of vegetation around and in the pool, this is positive for benthic macro invertebrates for hiding and spawning (Le Viol et al. 2012), and could be why there are so many taxa in this WSP. Vassum WSP receives tunnel wash runoff in addition to road runoff, but was still rich in taxa compared to the other WSPs, an extra sampling of Vassum WSP after the tunnel wash was included (VAST), and could be the reason why Vassum is shown to be among the most taxa rich in this survey. Vassum is known to be very species rich, at least concerning Dytiscidae species. Research done by Røstad in Vassum WSP has discovered 30 species of Dytiscidae collected from 2002 until 2007 (Røstad 2013). Compared to eleven species found in Trøgstad county, this number of species in Vassum was high (Hov & Walseng 2003). Dytiscidae do not breathe in water, they are dependent on surfacing to get air,  this could be the reason why there are so many species of Dytiscidae in this WSP, which receives tunnel wash runoff on a regular basis. It could also have something to do with interaction among organisms, or patterns of dispersal for beetles in this area. Vassum has three natural ponds within one kilometer, in addition to the river, Årungelva and  lake Årungen, which can possibly explain the high numbers of Dytiscidae, because they can easily spread.

Research done by NIVA of 17 lakes in western Norway found from 16-38 different taxa in these lakes, which were research to see if they needed liming or not (Åtland et al. 2001). Compared to these lakes the taxa number in this thesis show a biodiversity that is important to take care of. WSPs in Trøgstad county compared to WSPs in this thesis were a little bit lower in this thesis or quite equal, since more taxa were decided to species in the survey in Trøgstad county (Hov & Walseng 2003). Ponds other than natural ones, such as WSPs, golf ponds and safety ponds (for water supply, firefighting) have increased over the years (Karouna-Renier & Sparling 2001). Ponds are extremely rich in species (Davies et al. 2008). But it has been difficult to find natural ponds to compare the biodiversity with, because small ponds have been little studied, both in terms of their ecological role and their community (Williams et al. 2004).

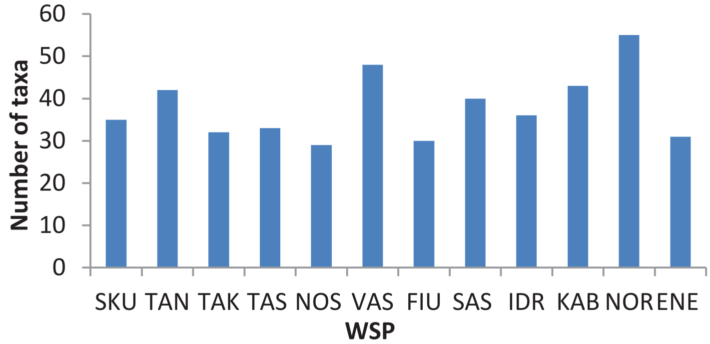



**Figure 19. Number of taxa found in the different wet sedimentation ponds in all four field surveys (April, June, August and October), including the tunnel wash in June in Vassum.**

Percentage of Odonata, Trichoptera, Ephemeroptera, Coleoptera, Heteroptera, Amphibians, Oligochaeta, Chironomidae, Gastropoda, Cladocera, and Other which is the group where the rest of the taxa were gathered are shown (Figure 20). The group "other" include: Copepoda, *Nemurella pictetii*, *Nemoura cinerea*, *Phoxinus phoxinus*, Hirudinea, Collembola, Chaoboridae, Tabanidae, Culicidae larvae, *Sialis lutaria*, Hydracarina, Pyralidae larvae, *Asellus aquaticus* and Tipulidae. In the group Gastropoda, Planorbidae and Sphaerida were included. In most of the WSPs Cladocera was the largest group, in Sastad, Idrettsveien, Karlshusbunn, Nordby and Enebakk other groups had bigger percentages. In Sastad WSP mollusks was the largest group followed by Cladocera and other. Idrettsveien also had mollusks and other as the largest groups with Ephemeroptera as the third largest. Karlshusbunn had high percentage of other and Chironomidae, with Ephemeroptera as the third largest. Nordby had mollusks and Cladocera as largest groups and Ephemeroptera as the third largest group. It is normal to find many individuals of a few species as in this thesis, and fewer individuals of the rest of the species according to Hellawell (1986). The WSPs in Akershus and Oslo county had most Cladocera, this could have a connection with these WSPs having less concentrations of water quality parameters.

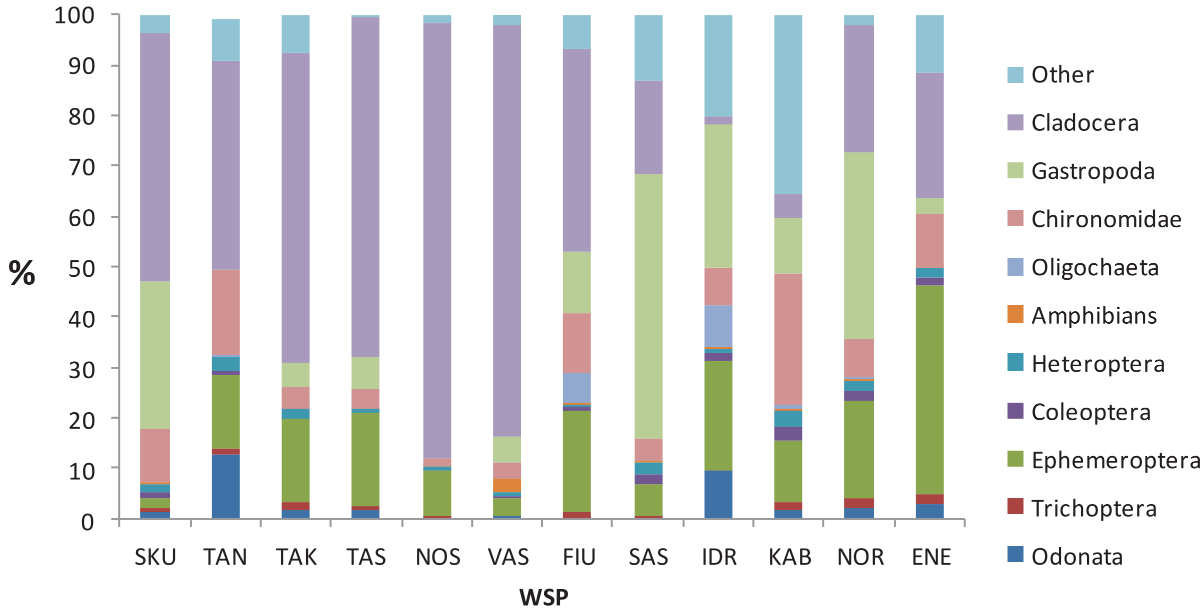



Figure 20. Percentage of the main groups for each wet sedimentation pond in this thesis.

The most taxa rich of the WSP with two slam basins which receives runoff and agricultural runoff, was Nordby and the wetland/ main basin in Nordby (NORM) (Figure 21). The wetlands/main basins (IDRM, KABM, NORM) were a bit more taxa rich for all WSPs, compared to the slam basins. The appearance of the wetlands/ main basins were very similar to natural ponds with a lot of vegetation in the summer months. Nordby wetland/main basin was very similar to a natural pond, and had a high water level through the whole season, Idrettsveien wetland/main basin and Karlshusbunn wetland/main basin had a low water level in the warmest months during this survey. In all the WSPs with two slam basins, the wetland was always the most taxa rich. It is not surprising because the runoff had already had time to sediment in the slam basins, which makes the water in the wetland cleaner than the first runoff in slam basins. The biodiversity that exists in these WSPs compared to 17 lakes in western Norway researched by NIVA are comparable or even bigger than these natural lakes (Åtland et al. 2001).

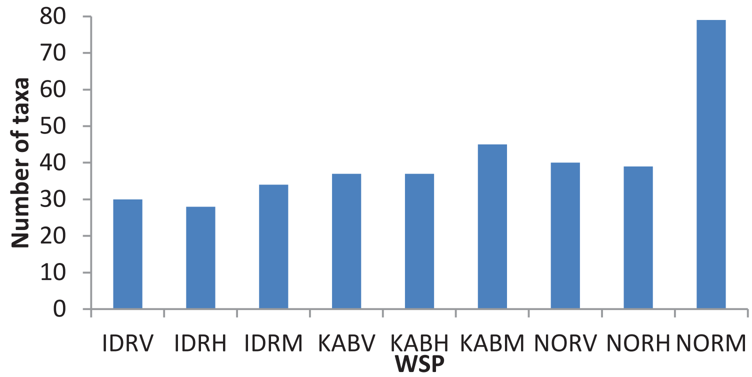



**Figure 21. Number of taxa in Idrettsveien, Karlshusbunn and Nordby. V= left slam basin, H= right slam basin, M= wetland/ main basin.**

Organisms that were collected in the different months of the field survey in  April, June, August and October in all WSP are shown in Figure 22 a-x, in Vassum an extra survey after a tunnel wash was included (VAST). The main trends were that most WSPs had most total organism numbers in August, with exception of Nostvedt, Idrettsveien and Nordby which has most total organisms in October. This could be due to episodes of pollution, sampling method or other things affecting the organisms in the WSPs. Most WSPs also had most numbers of taxa in the month of June, except Skullerud which had most taxa in October, and Taraldrud crossing , Nostvedt, Fiulstad which had most taxa in August, and Sastad which had most taxa in April. It seems there were more taxa in the beginning of summer (June) and more of the individuals in August, for most WSPs. This might be due to eggs of the different organisms that had not hatched in June when the sampling was done, but had hatched within August and the next sampling. One reason that numbers of taxa could be higher in June could be that August is in the middle of dispersal flights for taxa that disperse, but not for the organisms just hatched. There are more of the organisms hatched than the adult organisms that disperse in the month of August (Åtland et al. 2001). Another reason why some WSPs differ in trends could be bad sampling methods in months of excessive vegetation, or episodic events out of control in this thesis.

Vassum WSP in April show a quite large increase  in organism numbers in August, despite a tunnel wash episode days ahead of the third survey (Figure 22i and j). There were no drop in taxa numbers after the tunnel wash in August. Taxa numbers stayed quite the same after an increase from April until June. There was a small decrease in taxa after the tunnel wash episode, but not as large as for total organisms number. Vassum had 46 of 115 taxa found in this survey. On the contrary WSPs receiving tunnel wash runoff in addition to "normal" road runoff could be a large trap for amphibians, and could be for macro invertebrates too, it depends on the macro invertebrates way of life (Le Viol et al. 2012). It could be seen that the number of taxa in Vassum WSP after the tunnel wash event did go down, but not as far as the total organism number. The total insect number went drastically down, to April and October level. An observation made a couple of days before the tunnel wash showed a WSP full of tadpoles, and a few days after the tunnel wash in June all the tadpoles were dead. This observation let us know that the amphibians were very vulnerable to tunnel wash runoff, and we should take precautions not to damage the tadpoles as they only live in this pond for a couple of months before they are developed and find other habitats to live in (Brønmark & Hansson 2005; Busterud 2012). Tunnel wash  could be postponed to late summer when most amphibians has left the pond.

Compared with number of taxa in lakes in western Norway Vassum are very taxa rich, with 46 taxa compared with 16-38 in the natural lakes in the survey from NIVA (Johansen & Thygesen 2012; Åtland et al. 2001). A bigger decrease in total organism numbers than in taxa number, could be caused by the type of pollution in tunnels, and the sudden pollution. If there are taxa that has large organisms numbers and do not tolerate the pollution all of these will disappear, and the rest of the taxa that has fewer individuals could be more pollution tolerant, and will give a large drop in organisms total number and not in taxa number.

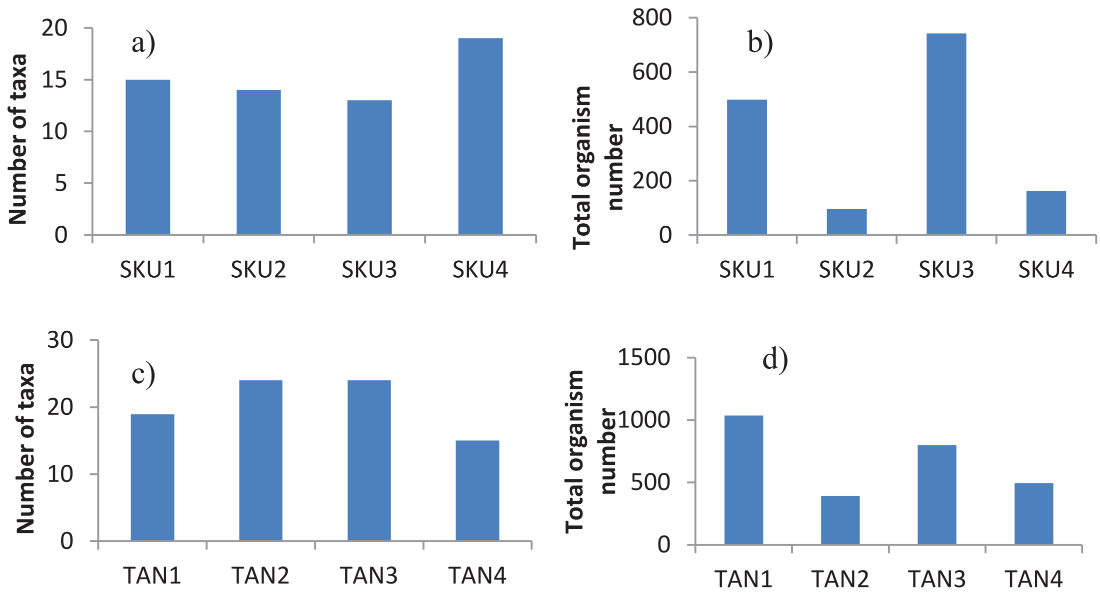



**Figure 22.) Number of taxa and total insect numbers for all wet sedimentation ponds surveyed. Numbers after the wet sedimentation ponds name are 1=April, 2=June, 3=August, 4=October. 9 i) and j) The axis has different scales.**

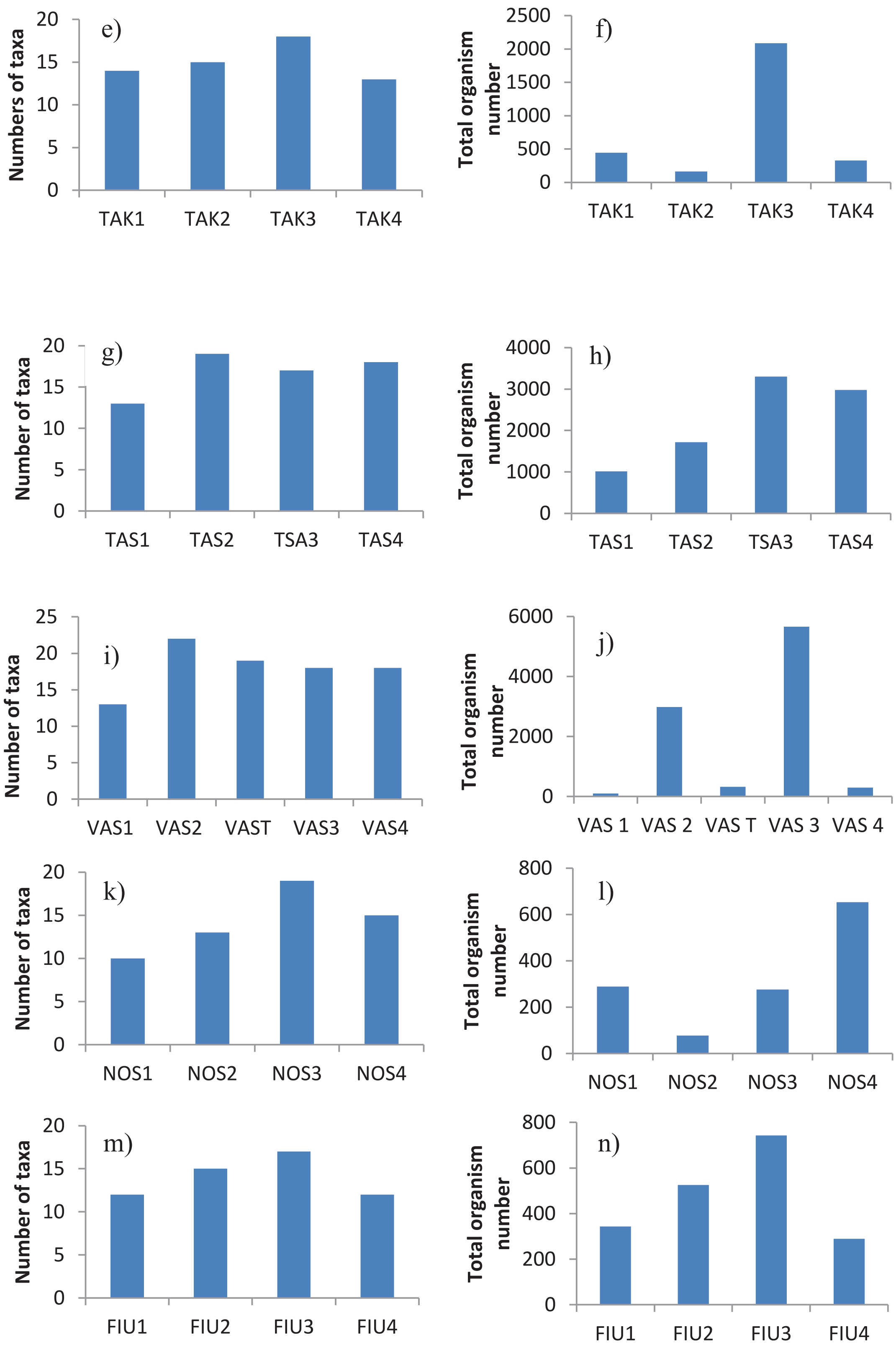



**Figure 22. ) Number of taxa and total insect numbers for all wet sedimentation ponds surveyed. Numbers after the wet sedimentation ponds name are 1=April, 2=June, 3=August, 4=October. 9 i) and j) VAST= tunnel wash event. The axis has different scales.**

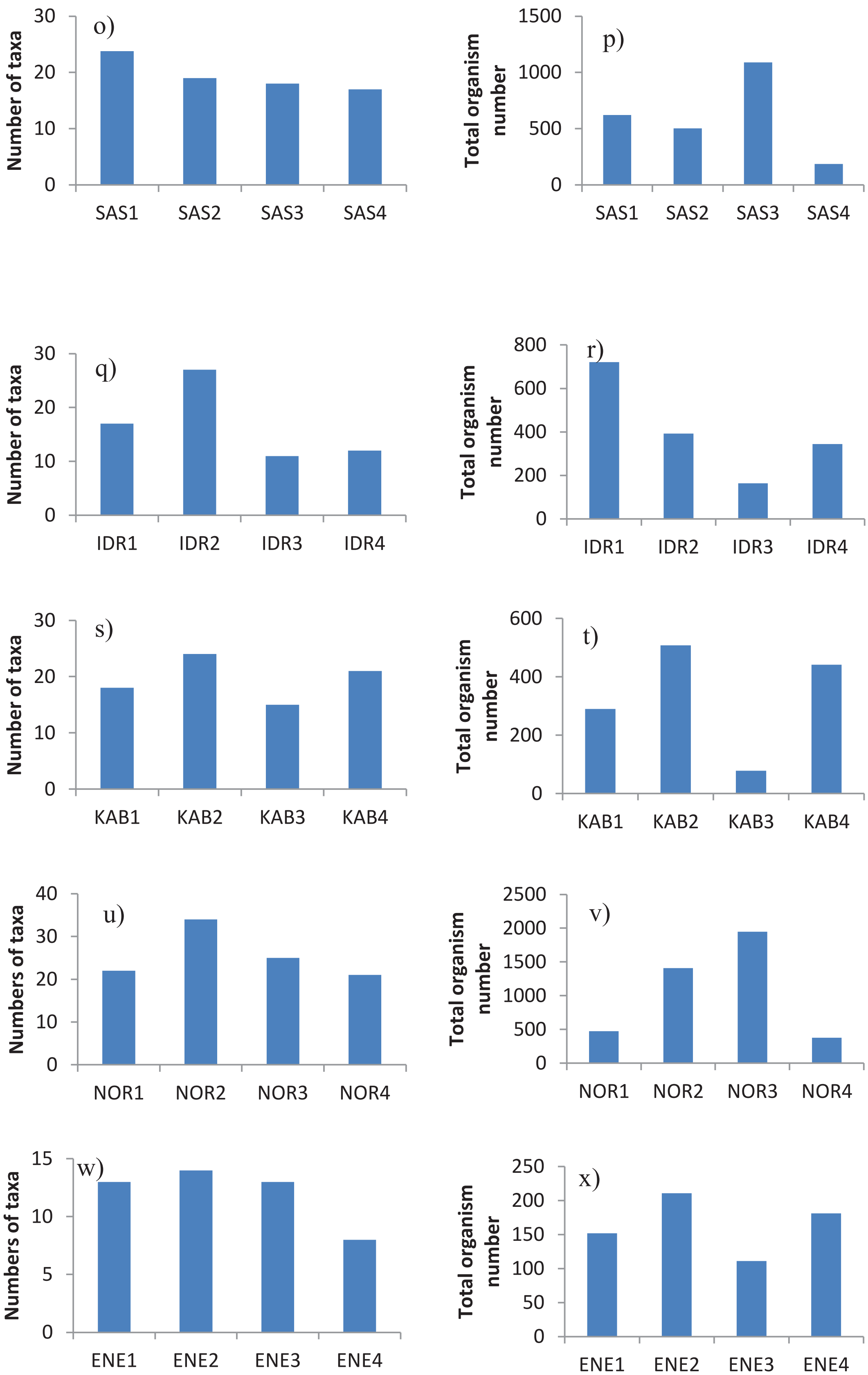



**Figure 22) Number of taxa and total insect numbers for all wet sedimentation ponds surveyed. Numbers after the wet sedimentation ponds name are 1=April, 2=June, 3=August, 4=October. 9 i) and j) The axis has different scales.**

There were found statistically significant differences between WSPs with an anova (p=0.00307). Idrettsveien and Nostvedt, Idrettsveien and Fiulstad and Enebakk and Idrettsveien had statistically significant differences. This could be affected by the fact that Idrettsveien was the most taxa rich WSP compared to the rest of the WSPs, and there were such a large difference from Nostvedt, Fiulstad and Enebakk.

### 4.2.3 Shannon Wiener Index

Shannon Wiener Index was very low (≤ 1.48) and low (1.48-2.22) for most of the WSPs in this survey (SWEPA 2000). The WSPs with the highest Shannon Wiener diversity were Vassum, Idrettsveien and Taraldrud south. The WSP with the lowest diversity were Skullerud. Shannon diversity index for all four field surveys, and for the respective WSP showed no significant difference (p=0.456) between the different WSPs. The biodiversity in the different WSP did not differ much, but from the box plot it could be seen that some of the WSPs have more variation in their biodiversity than others. Taraldrud south, Idrettsveien left and Taraldrud crossing had a large variation in biodiversity. This might be due to events not researched in this thesis, such as spill events, because they lie in the same geographical area, and they are quite similar in water chemistry parameters. Vassum tunnel wash was not included in Shannon diversity index this could be why Vassum has high taxa found in Figure 19, and a low Shannon diversity. This could also be a result of the sampling method, or other factors out of my control. Shannon Diversity Index is high if there are many species found in this survey, and several of them were dominant. Shannon diversity were low if there were few species, and only one or more were very dominant compared with the rest (SWEPA 2000). Vassum has a very low Shannon diversity index and a high amount of taxa, this might be due to the high numbers of species, where few were dominant, or when Shannon diversity index were low and many of the species found were dominant. When sampling organisms only a small number of species will be numerous, the bulk will be represented by a few or even single individuals of each species, this will give a low Shannon diversity index (Hellawell 1986). Quantitative sampling of benthic macro invertebrates are difficult since high numbers of samples are needed to get a precise estimate of the population abundance (Hellawell 1986).

### 4.2.4 Variation in taxa

PCA done on taxa show which taxa were most important in our dataset, it measures variation. The first axis explains 39% and the second axis explains 16% of the variation in PCA taxa from April (Figure 23). Most taxa were gathered around the first axis and the rest along the second axis. One taxa standing out was Oligochaeta, from PCA in April. This means

Oligochaeta had different living standards than the other taxa in this survey. According to the PCA the abundance of Oligochaeta seems to be a pollution tolerant group and these findings is coherent with the elevated concentrations of metals measured in the very same WSPs, which were the WSPs with highest concentrations of water quality parameters. Eijsackers (2010) found that Oligochaeta can tolerate high concentrations of pollution, and are often the first taxa to inhabit polluted areas, in accordance with the results of this master thesis. Other taxa that stand out are the ones correlated with the second axis, which are three Dytiscidae, two other beetles and one Hemiptera which all have to surface to get air (Sundby 1995a). Therefore they will not be as affected as organisms that breathe in water through gills, if the water they live in have high concentrations of water quality parameters. This is why these taxa are spread from the other ones in the Canoco plot, because they are pollution tolerant.

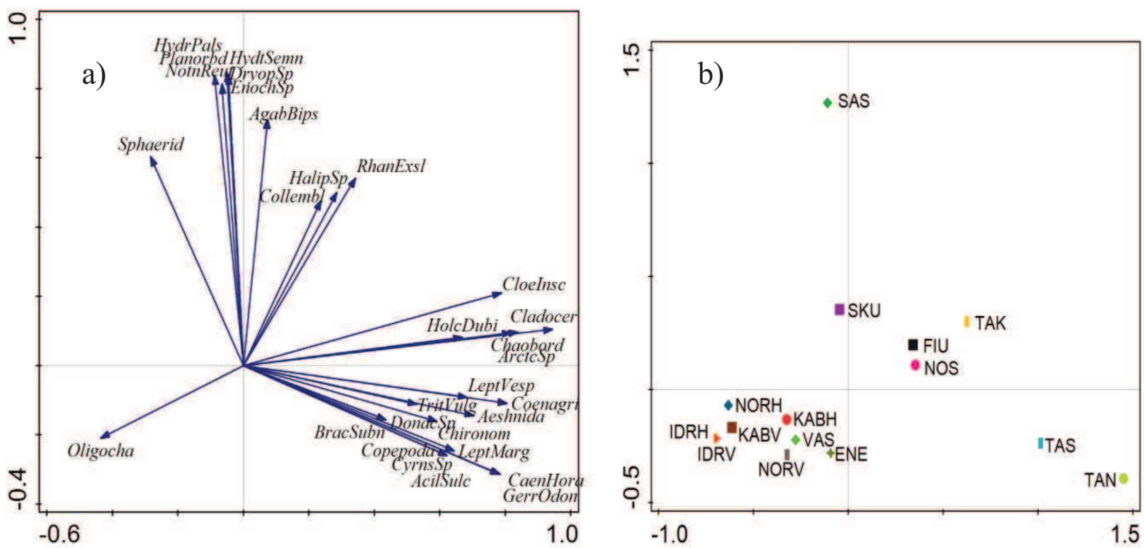



**Figure 23. PCA taxa, in April 2012, a) illustrates the 30 most important taxa species. b) show which pond the taxa were associated with.**

PCA on taxa from June 2012 (Figure 24), the first axis was explained by 34% and the second axis was explained by 14%. Species has begun to spread a bit more compared to April (Figure 23). The species has spread more evenly in the plot. It might be because the summer was approaching and the water was warming up, and more insects had become active. There were no longer any taxa that stands out as much as in April. The trend in this plot is the same as the preceding month, that the most pollution tolerant species were correlated with the second axis.

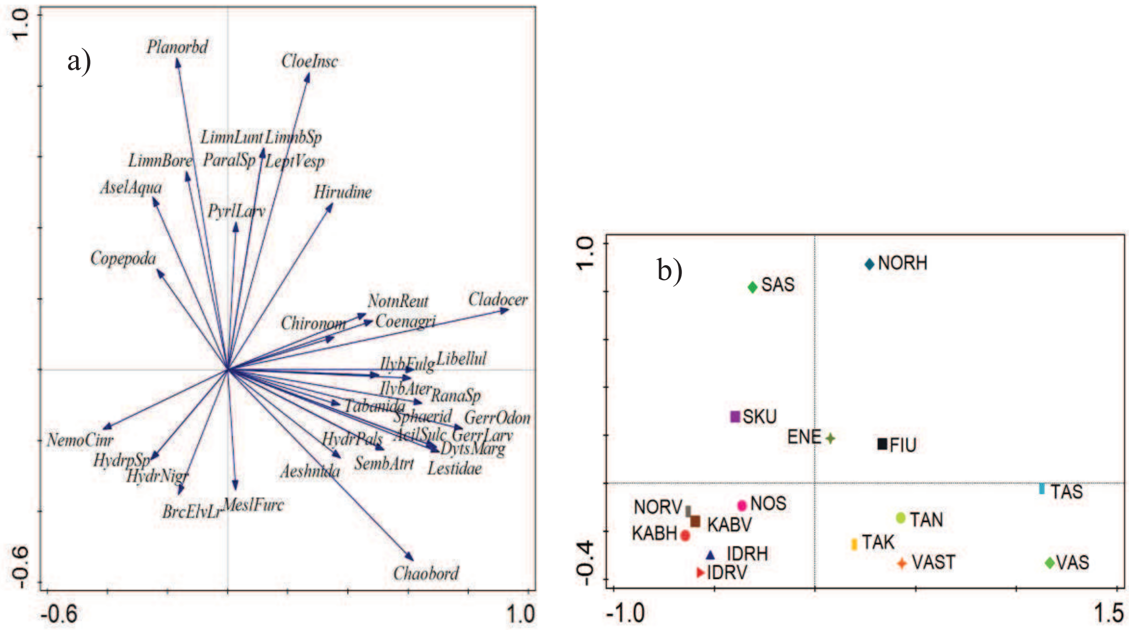



**Figure 24. PCA taxa, June 2012. a) show the 30 most important taxa. b) show the wet sedimentation ponds the taxa were associated with.**

In PCA on taxa from August 2012 (Figure 25), this figure had a strong first axis which explained 37%, and a weaker second axis which explained 18% of the variation. This was very similar to preceding month, June ( Figure 24). Arctocorisa Sp was the taxa that was most separated from the rest of the taxa. Arctocorisa Sp could be a pollution tolerant species, as Oligochaeta. Arctocorisa Sp spend most of their lives on the surface of the water and eat other insects, it does not breathe in water and that could be why it can handle to live in (or at) polluted environments, and why it is positively correlated with high concentrations of many water quality parameters (Brønmark & Hansson 2005). Some of the taxa that correlated with the second axis were Oligochaeta and *Asellus aquatica*, which are both very pollution resistant (Eijsackers 2010; Maltby 1991).

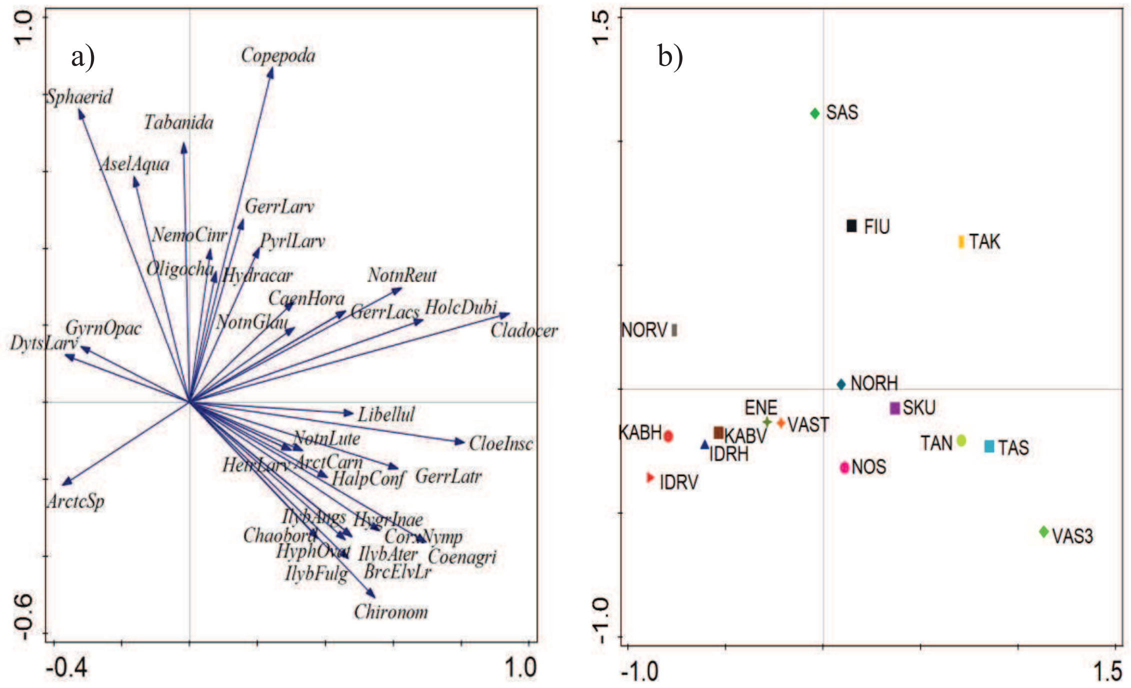



**Figure 25. PCA on taxa from August 2012. a) show the 30 most important taxa. b) show wet sedimentation ponds the taxa were associated with.**

PCA on taxa from October 2012 (Figure 26), show that the first axis explains a great deal of the variation, 42%, and the second axis explains 11% of the variation. The plot has begun to look more like the one from April (Figure 23). The WSPs correlated least with organism taxa were Nordby left and Enebakk, meaning these were the WSP with the least taxa in them at this time of year. When we compare PCA in April, and PCA in October. it can be seen that the WSPs associated with the first axis in most figures were Taraldrud north, Taraldrud crossing and Taraldrud south. These WSPs were also the ones with low concentrations of water quality parameters. *Nemoura cinera* was only shown in Canoco plot in the month of August. *Leptophlebia vespertina* was correlated with the first axis in canoco plot, showing that the species is not pollution tolerant. *L. vespertina*, Coenagerion sp and- *Nemoura cinera* show a strong relationship to specific microhabitats, related to the proportion of emergent macrophytes and coarse particulate organic matter (CPOM) (Feld & Hering 2007). This could be why N. cinerea only was found in August, when the vegetation was at a maximum.

The trend in all PCA taxa plot were that pollution sensitive species correlated with the first axis, while the second axis were correlated with pollution tolerant species, such as *Asellus aquaticus* and Oligochaetae. Taraldrud north and Taraldrud south were the WSPs richest in species, when taken into account that the PCA plot only showed the 30 most important species of this survey. The WSPs that correlated with less taxa compared to all the WSPs in this survey were Idrettsveien, Karlshusbunn and Nordby, taken into consideration that PCA species only showed the 30 most important species. Nordby was shown to be very taxa rich in Figure 21, and the reason why it does not show this in canoco plot is because in PCA on taxa only Nordby left and Nordby right were included, not Nordby wetland/ main basin, which was included in Figure 21.

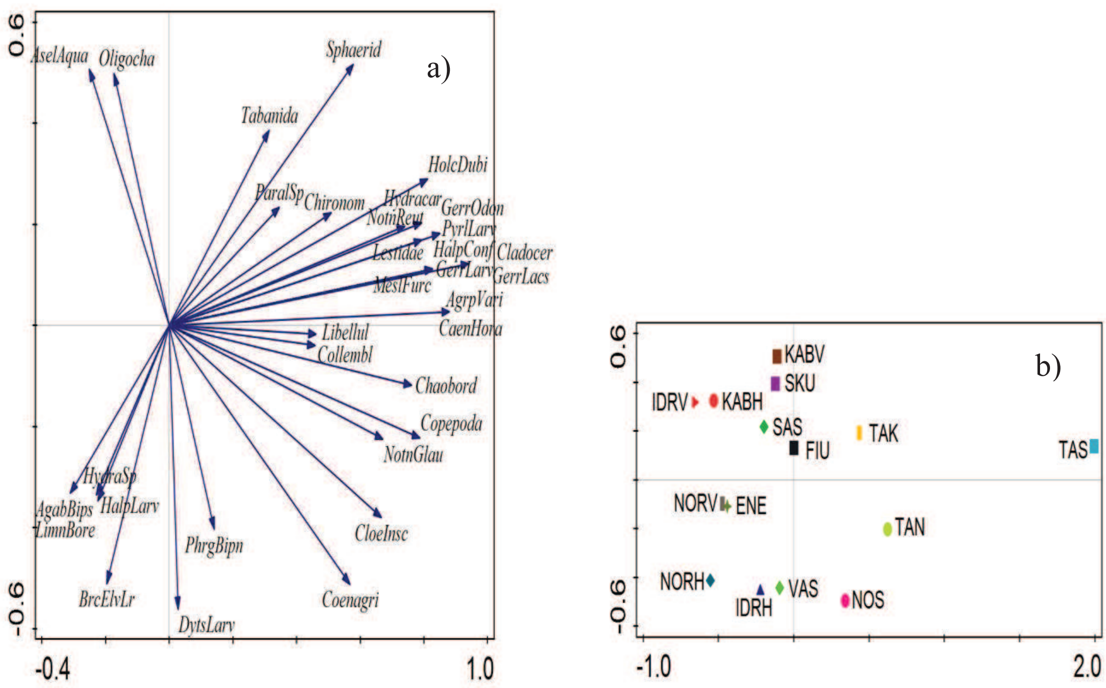



**Figure 26. PCA of taxa, October 2012. a) show the 30 most important macro invertebrate, b) Show the wet sedimentation ponds the taxa were associated with.**

Correlation of taxa numbers from PCA (Table 7) were done and the ones with a significant positive correlation were: Sample score 1 from August and April, Sample score 2 from August and June, sample score 1 from October were positively correlated with sample score 1 from April, June and August. These results show that the taxa numbers were quite stable as Figure 22 confirm. There were most sample scores from the first axis that were correlated with the first axis of other months, except August that had sample score 2 associated with sample score 2 from June. This show that sample score 2 was most different compared to the sample score 1. This show that it is important to survey data in different time of the year, preferably during the whole wear, when the idea with the survey is to look at biodiversity.

**Table 7. Correlation (r) between sample score 1 and 2 from taxa data, for all four surveys (April-October). Bold numbers have a significant positive correlation. p= significance.**

| | PCA 1 April | PCA 2 April | PCA 1 June | PCA 2 June | PCA 1 August | PCA 2 August | PCA 1 October | PCA 2 October |
|---|---|---|---|---|---|---|---|---|
| PCA 1 April | r=0.000 p=1 | r=0.000 p=1 | r=0.25 p= 0.37 | r=-0.410 p=0.13 | **r=0.52 p= 0.046** | r=-0.34 p=0.21 | **r=0.73 p=0.003** | r=0.014 p=0.96 |
| PCA 2 April | r=0.000 p=1 | r=0.000 p=1 | r=0.043 p= 0.88 | r=0.15 p=0.59 | r=0.069 p=0.81 | r=-0.43 p=0.11 | r=-0.25 p=0.38 | r=-0.37 p=0.17 |
| PCA 1 June | r=0.25 p= 0.37 | r=0.043 p= 0.88 | r=0.000 p=1 | r=0.20 o=0.466 | r= 0.87 p= <0.000 | r=-0.079 p= 0.782 | **r=0.61 p=0.018** | r=-0.43 p=0.11 |
| PCA 2 June | r=-0.410 p=0.13 | r=0.15 p=0.59 | r=0.20 o=0.466 | r=0.000 p=1 | r=0.18 p=0.52 | **r=0.59 p=0.022** | r=0.004 p= 0.995 | r=0.018 p=0.95 |
| PCA 1 August | **r=0.52 p= 0.046** | r=0.069 p=0.81 | r= 0.87 p= <0.000 | r=0.18 p=0.52 | r=0.000 p=1 | r=-0.068 p=0.81 | **r=0.81 p=0.000** | r=-0.25 p=0.38 |
| PCA 2 August | r=-0.34 p=0.21 | r=-0.43 p=0.11 | r=-0.079 p= 0.782 | **r=0.59 p=0.022** | r=-0.068 p=0.81 | r=0.000 p=1 | r=-0.079 p=0.783 | r=0.31 p=0.26 |
| PCA 1 October | **r=0.73 p=0.003** | r=-0.25 p=0.38 | **r=0.61 p=0.018** | r=0.004 p= 0.995 | **r=0.81 p=0.000** | r=-0.079 p=0.783 | r=0.000 p=1 | r=-0.15 p=0.59 |
| PCA 2 October | r=0.014 p=0.96 | r=-0.37 p=0.17 | r=-0.43 p=0.11 | r=0.018 p=0.95 | r=-0.25 p=0.38 | r=0.31 p=0.26 | r=-0.15 p=0.59 | r=0.000 p=1 |

### 4.2.5 Sampling method

Net samples contained 52 taxa, net and trap together contained 45 taxa, and trap alone contained 18 taxa (Figure 27). Different taxa were easier to catch in a net and others were easier to catch with a trap. Benthic macro invertebrates were easier caught with a trap, this also applied for fast swimming beetles, which were difficult to catch in a net. Surface living species were mostly caught with a net, simply because some insects live their whole life on the surface, and do not swim to the bottom where the traps were placed (Sundby 1995a). How many macro inverebrates caught, also depended on the season, there would be more macro invertebrates active and spawning during the summer than in April and October. Other factors affecting the sampling could be vegetation. In some WSPs the vegetation almost covered the whole wetland/ main basin during the warmest months, and made sampling hard (Figure 8b). It can be smart to include more sampling methods when looking at biodiversity, to ensure that the largest amount  of taxa and numbers of species are caught.

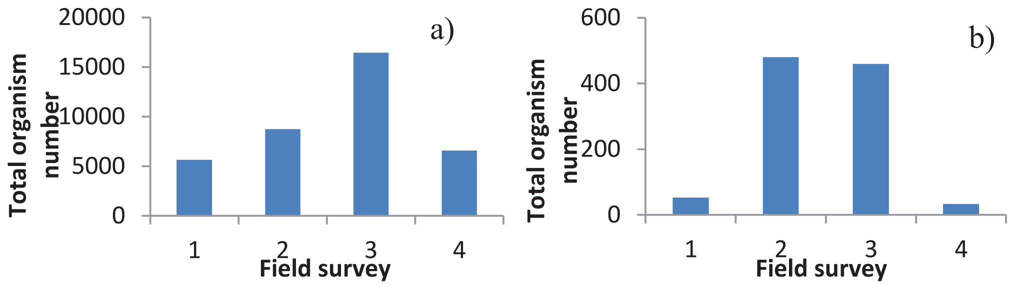



Figure 27. Total insect number in a) net. b) trap during, the four field surveys. 1=April, 2=June, 3= August, 4= October. The axis has different scales.

The correlation between Shannon- Wiener index and sample score axis 1 and 2 were 0.18 (p=0.17) and 0.21 (p=0.1), respectively, from Pearson's product moment (Figure 28). This was not statistically significant and only slightly positive, sample score 1 and sample score 2 were not correlated with Shannon Diversity Index. This might indicate that the diversity did not get much affected by the concentrations of water quality parameters, diversity were not very dependent on concentrations of water quality parameters. Other variables could be more important, maybe the physical features of the pond or other factors not examined in this survey.

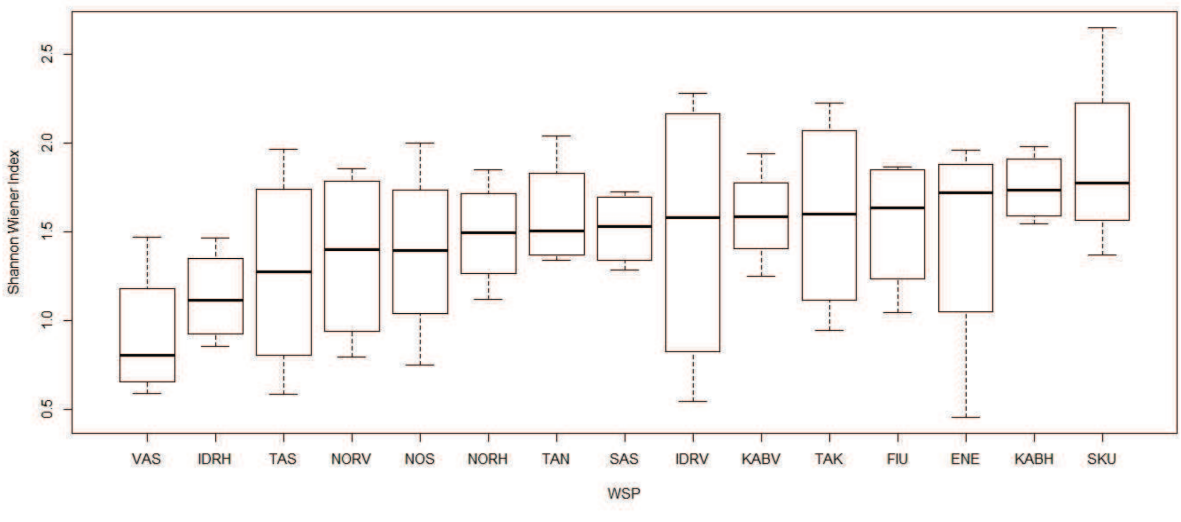



Figure 28. Shannon Wiener Index correlated with sample score 1 and 2 for all four field surveys, April, June, August and October, for the respective wet sedimentation ponds.

## 4.3 Environmental parameters

Explanatory variables that were statistically significant from RDA were samplescore 1 (p=0.004), size (p=0.028) and AADT (p=0.046) (Figure 29). Sample score 1 explain 25% of the variation while the second axis explains 12%. Sample scores were increasing with the arrow, and indicates reduced concentrations of water quality parameters. RDA done without forward selection on data from April, showed that size, sample score 1 and AADT were the ones with most impact on the species. With smaller arrows, indicating less impact on species were vegetation in pond, distance to closest pond/waterbody, and sample score 2. Only the six most important parameters were mentioned here. RDA with forward selection gives a good description compared to RDA without forward selection. AADT and sample score 1 was significant and affected biodiversity the most with forward selection.

Pond size matter only for Odonata, was the result (Oertli et al. 2002) got when he surveyed 80 ponds in Switzerland. Coleoptera did not increase with increasing size of the pond, also amphibian did not increase when ponds were larger (Oertli et al. 2002). Agabus bipustulatus was found more often in smaller ponds than in larger (Oertli et al. 2002). The biogeographically principal that ponds that are bigger support more biodiversity was only true for Odonata, not for Amphibians and Coleoptera according to Oertli et al (2002). In this thesis size of basin only affected biodiversity in the month of April.

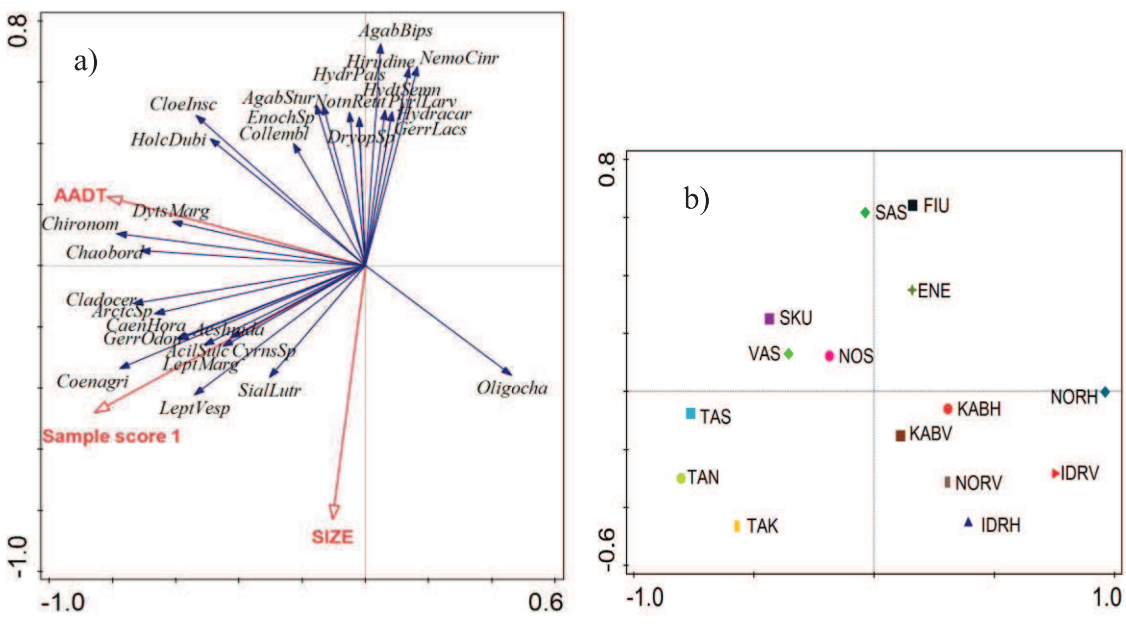



Figure 29). RDA with forward selection, sample scores, AADT, size and species, April 2012. a) Statistically significant environmental parameters and taxa. b) The respective wet sedimentation ponds.

RDA for June show that none of the parameters were statistically significant (Figure 30). The first axis in the plot explains 24% of the variation, while the second axis explains 12%. The four parameters AADT, Sample score 1 and "closest pond" were shown because they were the most important because of the length of their arrow. The longer the arrow, the more important the parameter, but not statistical significant in this case. Sample score 1 increased in the direction of the arrow, which indicates a reduced amount of water quality parameters.

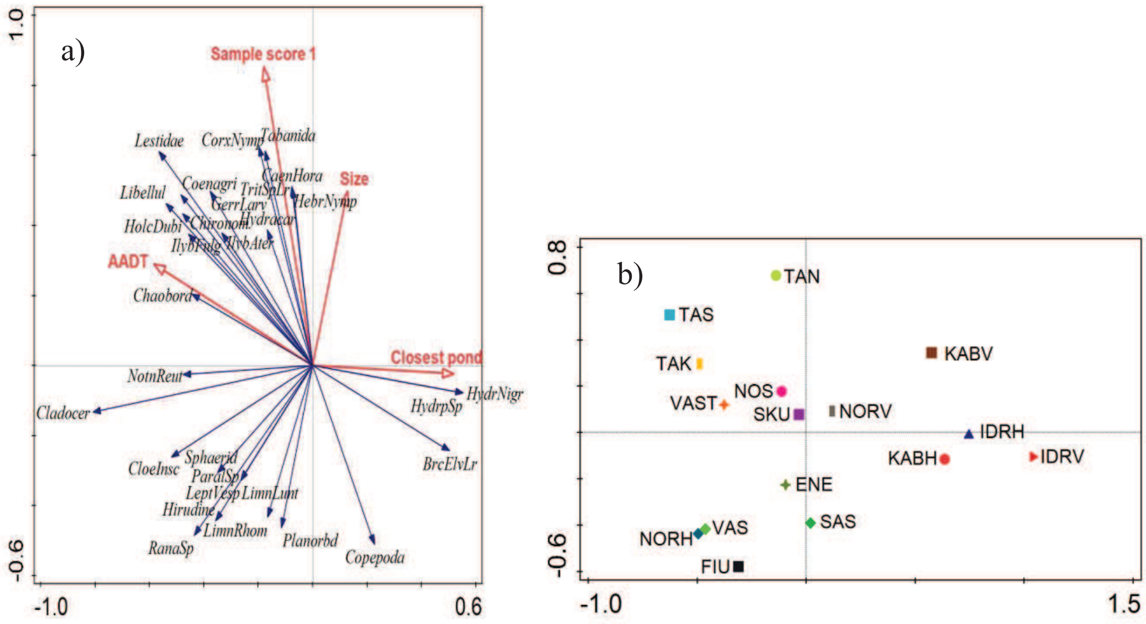



**Figure 30). RDA with forward selection, sample score 1, AADT, size," closest pond" and species, June 2012. a) Statistically significant environmental parameters and taxa. b) The respective wet sedimentation ponds.**

AADT ($p=0.002$)and sample score 1($p=0.008$) were statistically significant (Figure 31). The first axis explains 24%, and the second axis explains 11%. Sample score 1 increased in the direction of the arrow, which indicates a reduced amount of water quality parameters. RDA done with and without forward selection show that the same parameters are significant. AADT and sample score 1 were the most impact parameters because of the length of the arrows. When not done forward selection more parameters are statistically significant; closest pond, sample score 2, size and vegetation in pond. AADT were correlated with the first axis, which means; more traffic equals more species. The reason why AADT was correlated with organisms could be that the WSPs with low concentrations of water quality parameters were the ones with highest AADT. With forward selection there were some environmental parameters that were excluded but can still explain variation, but it could not bring something extra instead of one already chosen.

Scher &Thiery (2005) found dragonflies to be positively correlated with hydrophytes richness, in this thesis vegetation in and around the basins researched were not statistically significant when forward selection was done, and was not the factor affecting biodiversity the most, but could have some impact although other environmental parameters were more important. Size, percent of emergent macrophytes and percent of unmanaged near- shore vegetation was not significant associated with number of species found in the WSPs researched in McCarthy & Lathrops article (2011). This is consistent with result in this master thesis

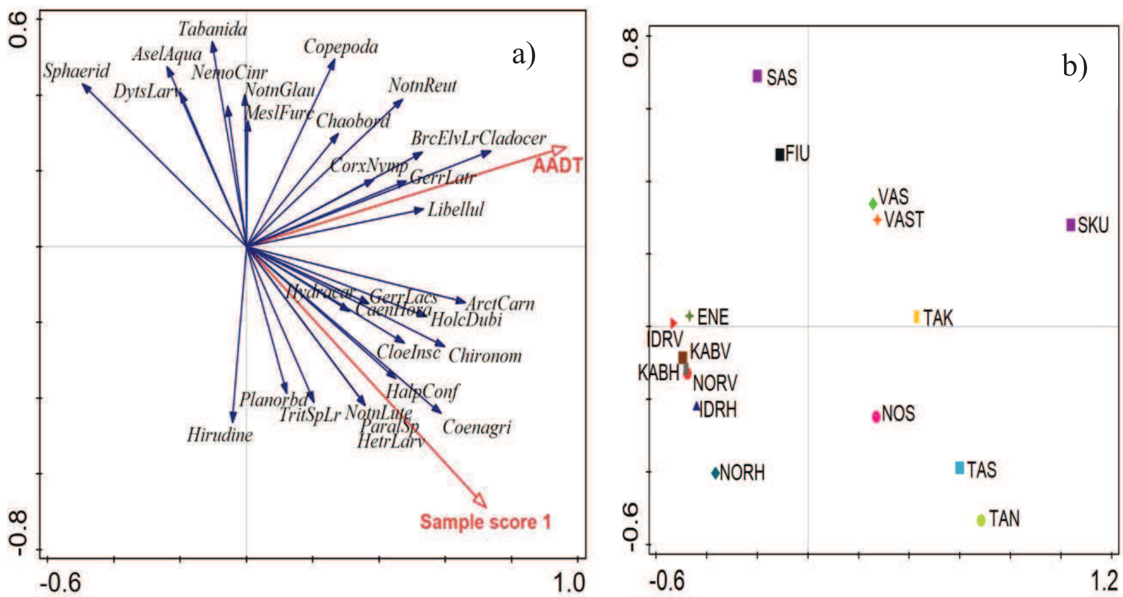



**Figure 31). RDA with forward selection, August 2012. a) Sample scores 1, AADT and species. a) Statistically significant environmental parameters and taxa. b) The respective wet sedimentation ponds.**

In RDA for October the first axis explains 28% of the variation, and the second explains 7% of the variation (Figure 32). Parameters which were statistical significant were sample score 1 ($p= 0.004$) and sample score 2 ($p= 0.026$). Sample score 1 and 2 were statistically significant and explain much of the variation in the data set. Sample score 1 increased in the direction of the arrow, which indicates a reduced concentration of water quality parameters. Samples score 1 was the one parameter that was significant in three of the months surveyed, the fourth survey did not have any statistically significant parameters. AADT was significant in two of the surveys, and size and sample score 2 were significant in one survey.

When RDA was run in Canoco, the test could be unreliable because of the large numbers of environmental variables that were included (8), compared to the number of cases (15). Also forward selection could exclude environmental parameters, but considering there were done RDA without forward selection and the two answers were compared, the Canoco plots given here will show the best answer possibly.

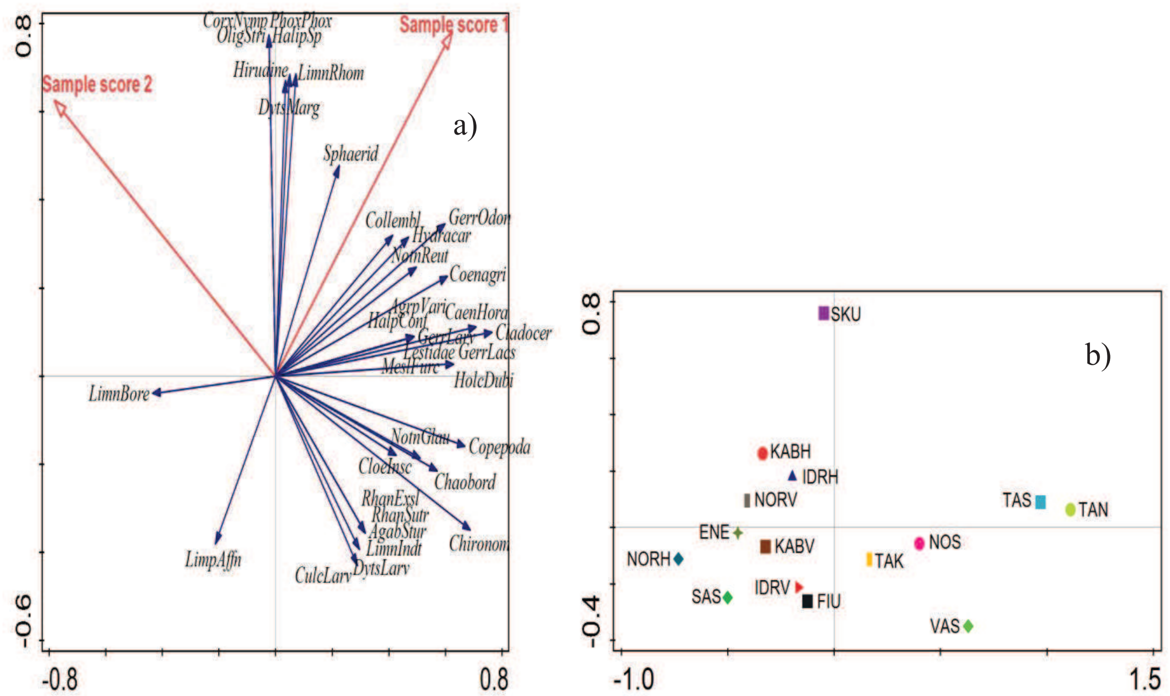



**Figure 32). RDA with forward selection, October 2012 samples score 1 and 2. a) Show sample scores and insects species. b) Show the respective wet sedimentation ponds.**

A summary of PCA for species and RDA are shown, explanatory variable 1 and 2 and the parameters significant (Table 8).

**Table 8. Explanatory variables for PCA species and RDA, and statistically significant parameters for all the four field surveys in April- October.**

| Month | Statistical test | Explanatory variable 1 % | Explanatory variable 2 % | Statistically significant parameter |
|---|---|---|---|---|
| April | PCA, species | 39 | 16 | |
| | RDA | 25 | 12 | sample score1, size, AADT |
| June | PCA, species | 34 | 14 | |
| | RDA | 24 | 12 | none |
| August | PCA, species | 37 | 18 | |
| | RDA | 24 | 11 | sample score 1, AADT |
| October | PCA, species | 42 | 11 | |
| | RDA | 28 | 6.9 | sample score 1, samplescore 2 |

Of all environmental parameters AADT and sample score 1 affected taxa the most, but there were possibly other environmental factors affecting more than the ones included in this thesis. McCarthy and Lathrop (2011) found that water chemistry measured did not affect species, and found that conductance, pH and temperature did not affect species distribution either

(McCarthy & Lathrop 2011). WSPs researched in MacCarthy & Lathrops (2011) study was sinks for two species not found in this master thesis, this might mean WSPs could be sinks for other species too, due to the elevated levels of water quality parameters, and do have an impact on organisms living there. Weatherhead & James (2001) hypothetical physical and biological interactions show that the six most important environmental factors are depth, macrophytes, detritus, macro invertebrates and substrate (Figure 2). Many of these were not researched in this thesis, but can still have an effect, and not to forget the gathered effect of several environmental parameters can be more important than just one.

Dragonfly richness  are higher in ponds with natural bottoms than the ones that was casted or had a membrane cover on the bottom (Scher & Thiery 2005). In the different WSPs surveyed in this thesis, the bottom material was not the same for all WSPs. Some WSPs had small stones covering the bottom, others had covers or natural bottoms. Stone bottoms will attract different species than a natural and a covered bottom. In Weatherhead & James (2001) model, substrate was one of the six most important parameters affecting biodiversity (Figure 2).

Research around the topic of how concentrations of water quality parameters affect biodiversity are ambiguous. Casey et al (2008) found that concentrations of metals in WSPs were low, and wildlife around and in WSPs would not be affected. Le Viol et al (2009) found that biodiversity in WSPs were equally good or better compared to ponds in the wider landscape, a higher abundance of short lived, small benthic macro invertebrates was the only difference. Le Viol et al (2009) found that human altered landscapes such as WSPs could have some biodiversity, at least a "common" biodiversity, but with less rare species. Le Viol et al (2012) also found almost as many amphibian species in highway ponds as in ponds in a wider landscape, but most of the species was more abundant in the ponds in a wider landscape, than in the highway ponds. On the other hand some found concentrations of water quality parameters did affect the biodiversity (Beasley & Kneale 2002; Du et al. 2012; Timmerman 1991). Altered landscapes such as WSPs can potentially act as refugees and corridors in urban areas, and are important for organisms which are dependent on small water bodies to survive (Brand & Snodgrass 2010).

## 5. Conclusions

Biodiversity in the wet sedimentation ponds surveyed is good compared to other studies, considering the high concentrations of many pollutants and that the Shannon Diversity indices were low. Near threatened and vulnerable species were found in these WSPs and this indicates that WSPs can house valuable biodiversity. Parameters affecting the biodiversity most was AADT, but this was most likely because the WSPs with lower concentrations of water quality parameters happened to have highest AADT. Water quality had the most impact on biodiversity after AADT. However, Vassum which receives tunnel wash runoff, had high biodiversity compared to the rest of the WSPs in this thesis. Shannon diversity and water quality were not correlated, indicating that this aspect of biodiversity was little affected by water quality. The study showed somewhat ambiguous conclusions, but although water quality parameters do affect biodiversity, it is not known to what extent. The size of pond affected biodiversity in the month of April, but was not statistically significant in later months. Vegetation in and around the basins was not the environmental parameter that affected biodiversity in most ponds, neither was proximity to other ponds/water bodies. There may be factors not considered in this study that affect biodiversity, but most likely it is a combination of many factors, such as water quality, vegetation, size and substrate.

Wet sedimentation ponds (WSPs) should be considered for their ability to function in conserving biodiversity in addition to their main reason, to prevent road runoff reaching streams and lakes. Action should be taken to conserve the species that manage to live in these environments, even though the WSPs are constructed to treat road runoff and not as habitats for insects and amphibians. In a human dominated landscape it is necessary to have refugia to ensure connectivity and dispersal between natural areas (Le Viol et al. 2012; Rosenzweig 2003), or else roads, parks and industrial areas will act as distribution barriers, and negatively affect biodiversity (McKinney 2006).

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# Appendix I-XVII

## Appendix 1. Water quality concentrations analyzed for all wet sedimentation ponds.

| Canoco code | Klorid (Cl-) | Sulfat (SO4 | Ca mg/l | Fe mg/l | K mg/l | Mg mg/l | Na mg/l | Al µg/l | As µg/l | Ba µg/l | Cd µg/l | Co µg/l | Cr µg/l | Cu µg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sku1i | 172.000 | 25.600 | 37.300 | 0.791 | 3.680 | 8.710 | 98.900 | 813.000 | 0.325 | 34.500 | 0.023 | 0.409 | 3.160 | 10.900 |
| sku2i | 96.700 | 23.300 | 28.500 | 0.332 | 2.460 | 5.360 | 57.100 | 170.000 | 0.337 | 24.200 | 0.026 | 0.375 | 2.390 | 10.200 |
| sku3i | 30.800 | 17.500 | 25.800 | 0.075 | 2.070 | 3.720 | 23.600 | 78.800 | 0.197 | 13.800 | 0.011 | 0.059 | 2.300 | 10.400 |
| sku4i | 3.610 | 4.370 | 6.370 | 0.222 | 0.652 | 1.020 | 2.920 | 146.000 | 0.192 | 7.840 | 0.009 | 0.093 | 0.229 | 1.100 |
| tan1i | 246.000 | 6.500 | 20.500 | 0.111 | 3.080 | 2.910 | 137.000 | 26.000 | 0.305 | 29.200 | 0.001 | 0.059 | 0.106 | 2.170 |
| tan2i | 176.000 | 5.690 | 16.800 | 0.303 | 2.740 | 2.160 | 104.000 | 16.600 | 0.283 | 8.190 | 0.001 | 0.093 | 0.134 | 3.390 |
| tan3i | 49.600 | 2.540 | 13.200 | 0.306 | 1.540 | 1.330 | 37.600 | 30.000 | 50.000 | 11.900 | 0.001 | 0.062 | 0.146 | 1.680 |
| tan4i | 18.000 | 4.770 | 12.700 | 0.489 | 1.990 | 1.160 | 14.400 | 198.000 | 0.174 | 14.500 | 0.011 | 0.181 | 0.497 | 3.700 |
| tak1i | 306.000 | 25.200 | 49.700 | 0.034 | 3.830 | 5.640 | 156.000 | 27.700 | 0.276 | 44.000 | 0.019 | 0.056 | 0.083 | 2.930 |
| tak2i | 312.000 | 35.800 | 46.700 | 0.266 | 4.670 | 5.530 | 178.000 | 61.200 | 0.207 | 42.700 | 0.033 | 0.162 | 0.304 | 5.970 |
| tak3i | 110.000 | 27.900 | 26.200 | 0.383 | 2.280 | 2.880 | 82.800 | 105.000 | 0.227 | 19.400 | 0.012 | 0.105 | 0.416 | 5.170 |
| tak4i | 107.000 | 42.600 | 32.800 | 1.730 | 3.840 | 3.660 | 85.100 | 1220.000 | 0.459 | 36.500 | 0.068 | 0.661 | 1.700 | 11.600 |
| tas1i | 503.000 | 5.530 | 11.100 | 0.187 | 3.790 | 2.700 | 294.000 | 86.200 | 0.258 | 26.800 | 0.009 | 0.100 | 0.240 | 3.520 |
| tas2i | 478.000 | 4.010 | 10.800 | 0.281 | 3.860 | 2.560 | 279.000 | 27.100 | 0.150 | 22.800 | 0.001 | 0.087 | 0.163 | 3.890 |
| tas3i | 125.000 | 1.770 | 6.280 | 0.680 | 1.940 | 0.959 | 84.900 | 28.000 | 0.261 | 9.300 | 0.003 | 0.077 | 0.309 | 2.650 |
| tas4i | 61.100 | 2.180 | 5.080 | 0.799 | 1.970 | 0.798 | 41.500 | 404.000 | 0.150 | 12.500 | 0.006 | 0.316 | 1.040 | 6.620 |
| nøs1i | 268.000 | 9.620 | 15.000 | 1.390 | 3.060 | 3.250 | 162.000 | 1380.000 | 0.310 | 28.700 | 0.015 | 0.816 | 1.790 | 14.700 |
| nøs2i | 309.000 | 11.200 | 23.400 | 0.296 | 3.850 | 3.490 | 182.000 | 311.000 | 0.318 | 36.200 | 0.010 | 0.346 | 1.200 | 10.800 |
| nøs3i | 37.400 | 9.890 | 17.500 | 0.333 | 2.010 | 1.620 | 26.400 | 206.000 | 0.233 | 17.300 | 0.005 | 0.119 | 0.804 | 10.600 |
| nøs4i | 28.400 | 14.200 | 17.200 | 2.440 | 2.230 | 2.340 | 17.600 | 1780.000 | 0.331 | 26.000 | 0.019 | 0.923 | 3.830 | 11.900 |
| vas1i | 295.000 | 39.500 | 50.800 | 0.431 | 4.890 | 6.620 | 196.000 | 293.000 | 0.100 | 33.200 | 0.010 | 0.493 | 0.828 | 7.680 |
| vas2i | 2090.000 | 12.800 | 36.900 | 1.580 | 13.800 | 12.800 | 1260.000 | 508.000 | 0.500 | 121.000 | 0.027 | 3.590 | 1.040 | 18.200 |
| vas3i | 221.000 | 30.300 | 41.400 | 2.540 | 8.730 | 5.750 | 180.000 | 180.000 | 0.692 | 39.900 | 0.085 | 3.760 | 1.420 | 28.400 |
| vas4i | 34.600 | 40.600 | 42.900 | 3.050 | 4.270 | 5.060 | 32.200 | 1230.000 | 0.335 | 40.000 | 0.029 | 1.140 | 3.290 | 18.600 |
| vasTi | 152.000 | 12.009 | 18.700 | 0.612 | 3.140 | 2.330 | 56.100 | 381.000 | 0.361 | 20.400 | 0.019 | 1.210 | 4.090 | 17.000 |
| Fiu1i | 341.000 | 28.300 | 39.900 | 5.320 | 4.970 | 5.990 | 187.000 | 643.000 | 0.790 | 76.800 | 0.125 | 1.710 | 0.955 | 8.500 |
| fiu2i | 276.000 | 44.500 | 53.500 | 1.820 | 6.190 | 8.040 | 149.000 | 294.000 | 0.592 | 70.300 | 0.098 | 1.620 | 0.828 | 5.500 |
| fiu3i | 216.000 | 42.100 | 46.800 | 2.100 | 5.900 | 7.170 | 137.000 | 837.000 | 0.710 | 63.300 | 0.071 | 1.280 | 1.080 | 7.580 |
| fiu4i | 166.000 | 34.400 | 38.100 | 11.700 | 5.320 | 6.120 | 105.000 | 2990.000 | 2.380 | 78.300 | 0.132 | 3.820 | 5.330 | 17.200 |
| sås1i | 341.000 | 31.300 | 41.200 | 0.535 | 8.380 | 10.100 | 187.000 | 623.000 | 0.338 | 61.900 | 0.095 | 0.340 | 0.583 | 4.850 |
| sås2i | 548.000 | 45.400 | 69.500 | 0.616 | 11.000 | 13.200 | 290.000 | 199.000 | 0.660 | 71.600 | 0.086 | 0.338 | 0.860 | 6.460 |
| sås3i | 403.000 | 39.000 | 57.200 | 1.480 | 9.060 | 247.000 | 247.000 | 826.000 | 1.020 | 61.600 | 0.069 | 0.519 | 12.800 | 12.800 |
| sås4i | 136.000 | 42.300 | 40.600 | 7.770 | 9.990 | 10.700 | 84.000 | 4000.000 | 2.620 | 84.800 | 0.367 | 4.450 | 6.330 | 20.100 |
| idr1Vi | 392.000 | 23.000 | 42.800 | 5.970 | 5.490 | 6.660 | 208.000 | 463.000 | 0.250 | 66.900 | 0.069 | 0.977 | 1.010 | 2.860 |
| idr1Hi | 46.600 | 11.900 | 18.400 | 1.010 | 3.030 | 3.320 | 21.900 | 287.000 | 0.250 | 29.100 | 0.060 | 0.423 | 0.590 | 4.580 |
| idr2Vi | 394.000 | 23.200 | 53.000 | 16.300 | 6.110 | 8.010 | 205.000 | 311.000 | 0.887 | 83.000 | 0.020 | 1.220 | 1.400 | 1.790 |
| idr2Hi | 43.800 | 12.600 | 18.900 | 1.260 | 3.320 | 3.010 | 23.300 | 186.000 | 0.328 | 31.300 | 0.114 | 0.555 | 0.933 | 7.030 |
| idr3Vi | 258.000 | 25.300 | 37.100 | 4.960 | 5.470 | 5.260 | 148.000 | 481.000 | 0.522 | 48.800 | 0.037 | 0.752 | 1.380 | 4.030 |
| idr3Hi | 42.600 | 14.600 | 21.700 | 1.640 | 4.380 | 3.390 | 26.200 | 324.000 | 0.264 | 36.500 | 0.099 | 0.332 | 1.070 | 8.180 |
| idr4Vi | 150.000 | 24.800 | 28.100 | 16.500 | 5.060 | 4.280 | 103.000 | 3600.000 | 1.600 | 55.900 | 0.111 | 2.670 | 5.360 | 15.100 |
| idr4Hi | 0.050 | 13.000 | 18.400 | 1.700 | 3.630 | 3.140 | 22.000 | 670.000 | 0.405 | 32.300 | 0.076 | 0.594 | 1.740 | 8.080 |
| kab1Vi | 333.000 | 14.700 | 19.900 | 0.502 | 3.410 | 3.090 | 192.000 | 592.000 | 0.337 | 34.600 | 0.039 | 0.386 | 0.895 | 6.400 |
| kab1Hi | 59.700 | 9.850 | 19.900 | 0.876 | 5.480 | 3.730 | 31.100 | 612.000 | 0.310 | 33.400 | 0.043 | 0.313 | 0.659 | 2.540 |
| kab2Vi | 528.000 | 32.800 | 41.900 | 0.190 | 6.570 | 6.480 | 288.000 | 345.000 | 0.150 | 77.800 | 0.044 | 0.412 | 0.936 | 7.560 |
| kab2Hi | 108.000 | 13.400 | 25.900 | 2.710 | 6.370 | 4.920 | 56.600 | 234.000 | 0.338 | 40.000 | 0.059 | 0.391 | 0.708 | 3.990 |
| kab3Vi | 221.000 | 25.200 | 19.400 | 0.907 | 4.340 | 3.110 | 153.000 | 947.000 | 0.587 | 39.400 | 0.048 | 0.494 | 2.500 | 13.200 |
| kab3Hi | 119.000 | 29.100 | 32.100 | 1.970 | 6.140 | 5.850 | 74.300 | 398.000 | 0.319 | 39.600 | 0.042 | 0.280 | 0.983 | 4.590 |
| kab4Vi | 103.000 | 54.200 | 33.100 | 2.210 | 4.420 | 6.000 | 86.900 | 2150.000 | 0.444 | 38.600 | 0.058 | 1.020 | 3.140 | 12.600 |
| kab4hi | 39.400 | 14.500 | 21.400 | 1.050 | 7.750 | 4.220 | 22.300 | 539.000 | 0.383 | 37.800 | 0.064 | 0.429 | 0.891 | 4.170 |
| nor1Vi | 267.000 | 32.600 | 35.700 | 0.499 | 5.850 | 6.730 | 150.000 | 364.000 | 0.150 | 36.600 | 0.042 | 0.298 | 0.666 | 4.930 |
| nor1Hi | 10.500 | 10.600 | 16.000 | 3.800 | 5.000 | 8.900 | 6.330 | 4580.000 | 1.340 | 69.700 | 0.085 | 1.080 | 3.710 | 13.300 |
| nor2Vi | 201.000 | 41.600 | 42.400 | 0.379 | 5.660 | 8.150 | 116.000 | 326.000 | 0.212 | 32.200 | 0.038 | 0.218 | 0.740 | 6.180 |
| nor2Hi | 93.500 | 14.500 | 17.900 | 0.744 | 7.070 | 5.570 | 49.700 | 477.000 | 0.384 | 29.500 | 0.068 | 0.439 | 1.060 | 5.120 |
| nor3Vi | 146.000 | 50.200 | 42.400 | 0.520 | 5.870 | 8.680 | 101.000 | 335.000 | 0.292 | 30.500 | 0.025 | 0.249 | 1.070 | 7.340 |
| nor3Hi | 61.100 | 20.100 | 19.900 | 0.816 | 7.160 | 8.190 | 36.200 | 153.000 | 0.650 | 27.500 | 0.011 | 0.137 | 0.581 | 3.250 |
| nor4Vi | 55.600 | 56.700 | 38.300 | 1.400 | 7.690 | 7.830 | 43.200 | 1290.000 | 0.437 | 30.100 | 0.037 | 0.550 | 1.830 | 11.600 |
| nor4Hi | 30.500 | 22.600 | 26.200 | 15.300 | 8.990 | 9.410 | 18.200 | 5740.000 | 3.390 | 86.100 | 0.347 | 9.350 | 7.480 | 21.300 |
| ene1i | 242.000 | 15.500 | 18.800 | 1.420 | 4.610 | 5.460 | 139.000 | 1180.000 | 0.377 | 35.700 | 0.045 | 0.657 | 1.220 | 6.670 |
| ene2i | 246.000 | 23.600 | 22.900 | 0.753 | 6.000 | 7.450 | 142.000 | 631.000 | 0.616 | 37.400 | 0.055 | 0.644 | 1.370 | 9.510 |
| ene3i | 185.000 | 24.100 | 23.700 | 1.700 | 5.410 | 7.770 | 121.000 | 1030.000 | 0.528 | 37.700 | 0.042 | 0.426 | 1.230 | 9.450 |
| ene4i | 89.300 | 19.200 | 19.500 | 3.080 | 6.880 | 6.900 | 60.500 | 2920.000 | 0.820 | 40.800 | 0.070 | 1.270 | 3.910 | 13.700 |

## Appendix 2. Water quality concentrations analyzed for all wet sedimentation ponds.

| Canoco code | Mn µg/l | Mo µg/l | Ni µg/l | P µg/l | Pb µg/l | Si mg/l | Sr µg/l | Zn µg/l | Sb µg/l | TOC mg/l | Temp | Oxyg mg/L | pH | cond µs/m |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sku1 | 28.40 | 2.58 | 1.30 | 23.60 | 1.05 | 3.47 | 127.00 | 36.80 | 1.04 | 4.88 | 5.80 | 10.20 | 8.59 | 82.40 |
| sku2 | 39.90 | 2.48 | 1.40 | 35.60 | 0.97 | 0.41 | 97.50 | 34.50 | 0.92 | 7.04 | 12.40 | 9.98 | 6.17 | 514.00 |
| sku3 | 15.50 | 2.36 | 0.83 | 9.92 | 0.13 | 1.94 | 81.70 | 21.80 | 0.92 | 6.25 | 16.22 | 6.40 | 7.07 | 282.00 |
| sku4 | 13.70 | 0.22 | 0.80 | 10.10 | 0.16 | 1.61 | 20.60 | 3.63 | 0.10 | 5.99 | 10.61 | 9.99 | 7.43 | 59.00 |
| tan1 | 14.40 | 1.01 | 0.42 | 9.61 | 0.09 | 0.44 | 75.70 | 6.19 | 0.78 | 2.98 | 8.30 | 10.10 | 7.92 | 95.00 |
| tan2 | 13.40 | 1.34 | 0.52 | 12.80 | 0.10 | 0.07 | 62.70 | 3.53 | 1.00 | 4.97 | 15.30 | 11.42 | 6.06 | 750.00 |
| tan3 | 16.90 | 0.51 | 0.32 | 27.60 | 0.06 | 0.17 | 46.00 | 2.44 | 0.48 | 5.14 | 18.53 | 6.97 | 6.72 | 276.00 |
| tan4 | 31.50 | 0.77 | 0.74 | 24.00 | 0.32 | 1.17 | 40.20 | 9.75 | 0.84 | 2.78 | 10.48 | 7.46 | 8.53 | 976.00 |
| tak1 | 3.12 | 1.17 | 1.02 | 4.35 | 0.05 | 0.05 | 143.00 | 2.24 | 0.31 | 5.00 | 7.80 | 11.60 | 8.34 | 122.20 |
| tak2 | 31.40 | 2.55 | 2.29 | 10.40 | 0.12 | 0.38 | 141.00 | 5.94 | 0.47 | 9.22 | 14.90 | 10.70 | 6.20 | 1350.00 |
| tak3 | 13.70 | 2.47 | 1.65 | 14.20 | 0.20 | 0.71 | 75.70 | 4.38 | 0.55 | 11.80 | 17.40 | 7.61 | 7.36 | 602.00 |
| tak4 | 88.70 | 3.66 | 4.14 | 33.90 | 1.77 | 5.60 | 92.40 | 23.20 | 0.83 | 12.30 | 10.38 | 9.72 | 7.53 | 640.00 |
| tas1 | 11.00 | 0.88 | 0.62 | 18.40 | 0.24 | 0.13 | 75.40 | 12.70 | 1.10 | 3.35 | 11.50 | 10.30 | 8.04 | 155.60 |
| tas2 | 13.20 | 1.04 | 0.78 | 11.10 | 0.11 | 0.13 | 68.30 | 8.04 | 0.87 | 6.39 | 16.00 | 7.89 | 5.40 | 1420.00 |
| tas3 | 10.80 | 0.58 | 0.52 | 18.70 | 0.17 | 0.31 | 33.80 | 5.18 | 0.41 | 6.21 | 18.88 | 7.12 | 7.78 | 498.00 |
| tas4 | 26.20 | 0.76 | 1.07 | 37.00 | 0.60 | 0.76 | 23.90 | 19.60 | 0.92 | 5.00 | 10.02 | 8.09 | 7.62 | 260.00 |
| Nos1 | 66.30 | 1.50 | 1.74 | 41.70 | 1.28 | 3.75 | 64.60 | 93.70 | 1.94 | 5.68 | 13.50 | 10.75 | 8.33 | 103.40 |
| Nos2 | 50.20 | 2.54 | 1.30 | 25.40 | 0.45 | 0.76 | 96.10 | 25.90 | 1.86 | 7.38 | 16.30 | 8.70 | 6.23 | 1191.00 |
| Nos3 | 30.80 | 1.83 | 1.26 | 14.60 | 0.22 | 1.67 | 48.60 | 35.00 | 1.17 | 7.31 | 18.83 | 7.70 | 8.41 | 257.00 |
| Nos4 | 75.20 | 1.07 | 3.35 | 44.90 | 1.63 | 4.35 | 46.10 | 76.40 | 1.40 | 3.23 | 10.68 | 10.07 | 7.65 | 206.00 |
| vas1 | 48.70 | 5.38 | 1.59 | 18.20 | 0.45 | 4.27 | 174.00 | 35.40 | 1.38 | 4.25 | 10.40 | 10.35 | 8.55 | 133.00 |
| vas2 | 160.00 | 17.50 | 12.60 | 128.00 | 1.85 | 2.32 | 345.00 | 79.20 | 6.35 | 30.50 | 16.80 | 14.40 | 7.27 | 656.00 |
| vas3 | 417.00 | 10.10 | 7.50 | 392.00 | 1.23 | 5.44 | 154.00 | 1290.00 | 1.49 | 30.90 | 15.74 | 6.25 | 7.41 | 1062.00 |
| vas4 | 121.00 | 6.54 | 2.92 | 186.00 | 2.12 | 4.51 | 132.00 | 125.00 | 2.77 | 3.94 | 10.09 | 9.98 | 7.78 | 392.00 |
| vasT | 80.40 | 4.15 | 3.04 | 73.50 | 1.38 | 2.39 | 68.10 | 247.00 | 2.08 | 6.35 | 14.20 | 4.26 | 8.35 | 623.00 |
| Fiu1 | 360.00 | 0.75 | 6.85 | 35.80 | 1.26 | 6.09 | 167.00 | 43.20 | 0.49 | 5.65 | 5.80 | 10.10 | 7.20 | 137.30 |
| Fiu2 | 376.00 | 0.66 | 7.94 | 15.10 | 0.51 | 6.82 | 217.00 | 23.20 | 0.18 | 8.15 | 8.30 | 11.78 | 5.40 | 1234.00 |
| Flu3 | 362.00 | 1.18 | 7.37 | 23.40 | 1.17 | 8.04 | 193.00 | 15.50 | 0.40 | 10.70 | 12.99 | 7.01 | 9.74 | 1067.00 |
| Flu4 | 743.00 | 1.35 | 11.80 | 93.90 | 4.08 | 10.40 | 161.00 | 45.20 | 0.67 | 10.60 | 10.09 | 9.98 | 7.78 | 392.00 |
| Sas1 | 103.00 | 0.78 | 4.63 | 45.60 | 0.39 | 7.26 | 226.00 | 27.50 | 0.45 | 6.02 | 6.10 | 10.37 | 7.59 | 139.60 |
| Sas2 | 118.00 | 2.11 | 6.29 | 40.30 | 0.35 | 6.50 | 310.00 | 13.80 | 0.39 | 9.18 | 8.80 | 12.66 | 5.60 | 1812.00 |
| Sas3 | 192.00 | 2.75 | 7.88 | 58.70 | 1.31 | 8.05 | 261.00 | 16.80 | 0.80 | 13.60 | 12.29 | 4.70 | 7.04 | 1836.00 |
| Sas4 | 1120.00 | 1.74 | 14.80 | 393.00 | 5.06 | 10.40 | 161.00 | 76.90 | 0.75 | 10.50 | 11.09 | 10.43 | 7.22 | 750.00 |
| Idr1V | 266.00 | 0.63 | 2.74 | 17.10 | 0.50 | 6.35 | 163.00 | 43.50 | 0.25 | 10.40 | 6.20 | 6.40 | 6.55 | 141.90 |
| Idr2V | 453.00 | 0.73 | 2.83 | 31.10 | 0.58 | 6.80 | 207.00 | 15.40 | 0.09 | 13.00 | 11.20 | 4.55 | 4.34 | 1420.00 |
| Idr3V | 193.00 | 0.99 | 2.76 | 19.60 | 0.56 | 6.86 | 143.00 | 20.10 | 0.24 | 16.30 | 12.98 | 6.90 | 6.36 | 1234.00 |
| Idr4V | 319.00 | 1.62 | 6.77 | 112.00 | 7.30 | 9.07 | 106.00 | 85.40 | 0.66 | 20.80 | 11.02 | 8.11 | 7.46 | 700.00 |
| Idr1H | 53.70 | 1.40 | 2.17 | 9.47 | 0.50 | 4.99 | 74.00 | 90.20 | 0.81 | 5.24 | 7.20 | 8.78 | 7.14 | 250.00 |
| Idr2H | 76.50 | 1.48 | 2.58 | 15.50 | 0.67 | 4.60 | 79.50 | 92.10 | 0.81 | 8.73 | 11.70 | 8.60 | 4.76 | 266.00 |
| Idr3H | 76.70 | 1.92 | 2.63 | 43.80 | 0.95 | 6.89 | 89.90 | 112.00 | 0.60 | 8.30 | 13.72 | 6.81 | 6.70 | 324.00 |
| Idr4H | 50.90 | 2.05 | 2.95 | 25.40 | 1.05 | 6.40 | 75.00 | 61.30 | 0.68 | 8.29 | 11.40 | 8.01 | 6.91 | 252.00 |
| kab1V | 47.10 | 1.01 | 1.88 | 24.70 | 0.97 | 2.96 | 76.60 | 19.40 | 1.13 | 5.03 | 8.50 | 10.47 | 8.07 | 122.40 |
| kab2V | 20.00 | 1.47 | 2.87 | 11.80 | 0.29 | 1.40 | 168.00 | 9.10 | 0.58 | 13.60 | 17.20 | 12.25 | 5.88 | 1717.00 |
| kab3V | 20.40 | 2.35 | 3.48 | 68.60 | 1.65 | 3.09 | 82.70 | 17.70 | 0.94 | 13.90 | 19.50 | 13.47 | 8.53 | 976.00 |
| kab4V | 51.60 | 2.75 | 4.67 | 54.30 | 63.80 | 8.12 | 108.00 | 63.80 | 0.70 | 14.80 | 11.52 | 10.24 | 7.05 | 678.00 |
| kab1H | 44.40 | 0.30 | 1.44 | 20.20 | 0.51 | 4.82 | 121.00 | 12.50 | 0.21 | 8.74 | 6.30 | 10.65 | 7.12 | 328.00 |
| kab2H | 128.00 | 0.59 | 1.75 | 35.30 | 0.46 | 5.05 | 132.00 | 15.70 | 0.22 | 6.82 | 16.40 | 14.50 | 5.58 | 495.00 |
| kab3H | 96.00 | 1.11 | 2.11 | 14.50 | 0.33 | 6.86 | 149.00 | 64.70 | 0.29 | 10.60 | 11.91 | 9.86 | 7.79 | 574.00 |
| kab4h | 57.40 | 0.50 | 1.95 | 27.30 | 0.43 | 5.09 | 144.00 | 12.60 | 0.29 | 12.10 | 10.86 | 9.70 | 7.41 | 305.00 |
| nor1V | 34.90 | 0.79 | 1.96 | 18.40 | 0.51 | 4.47 | 128.00 | 22.60 | 0.67 | 5.57 | 6.30 | 11.10 | 7.82 | 112.30 |
| nor2V | 23.10 | 1.75 | 2.33 | 12.50 | 0.49 | 6.47 | 138.00 | 19.00 | 0.36 | 9.41 | 14.20 | 13.58 | 5.85 | 962.00 |
| nor3V | 15.60 | 2.43 | 2.65 | 18.40 | 0.66 | 6.35 | 146.00 | 15.30 | 0.43 | 11.30 | 12.55 | 11.16 | 7.37 | 856.00 |
| nor4V | 29.00 | 1.68 | 3.51 | 31.50 | 1.52 | 7.16 | 140.00 | 24.30 | 0.46 | 13.50 | 10.92 | 10.69 | 6.86 | 499.00 |
| nor1H | 46.90 | 0.74 | 4.08 | 337.00 | 8.25 | 9.09 | 166.00 | 12.00 | 0.28 | 9.34 | 6.30 | 9.08 | 6.92 | 164.40 |
| nor2H | 48.40 | 0.50 | 2.55 | 119.00 | 0.72 | 2.77 | 116.00 | 15.40 | 0.23 | 12.40 | 15.40 | 17.50 | 5.73 | 447.00 |
| nor3H | 9.96 | 0.61 | 1.99 | 112.00 | 0.40 | 5.07 | 138.00 | 4.23 | 0.22 | 10.40 | 16.48 | 9.76 | 7.22 | 412.00 |
| nor4H | 1040.00 | 0.48 | 9.89 | 1380.00 | 9.39 | 9.98 | 189.00 | 71.80 | 0.37 | 12.00 | 10.87 | 9.89 | 7.33 | 305.00 |
| ene1 | 44.20 | 0.95 | 2.66 | 60.00 | 1.48 | 5.58 | 104.00 | 75.10 | 0.96 | 7.51 | 6.30 | 10.97 | 7.48 | 95.20 |
| ene2 | 31.90 | 2.23 | 3.59 | 52.20 | 2.33 | 4.79 | 129.00 | 65.00 | 0.78 | 9.24 | 13.00 | 11.10 | 5.54 | 982.00 |
| ene3 | 22.40 | 2.35 | 3.43 | 41.30 | 1.66 | 6.89 | 129.00 | 95.50 | 0.76 | 12.50 | 13.96 | 8.65 | 7.19 | 907.00 |
| ene4 | 63.00 | 1.70 | 6.04 | 99.90 | 3.14 | 8.97 | 128.00 | 113.00 | 0.68 | 18.00 | 11.54 | 10.19 | 7.03 | 476.00 |

## Appendix 3.Water quality concentrations analyzed for all wet sedimentation ponds.

| Canoco code | Naftalen µg/l | Acenaftylen µg/l | Acenaften µg/l | Fluoren µg/l | Fenantren µg/l | Antracen µg/l | Fluoranten µg/l | Pyren µg/l | Benso(a)antracen^ µg/l | Krysen^ µg/l | Benso(b)fluoranten^ µg/l | Benso(k)fluoranten^ µg/l | Benso(a)pyren^ µg/l | Dibenso(ah)antracen^ µg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sku1 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| sku2 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| sku3 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| sku4 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| tan1 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| tan2 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| tan3 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| tan4 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| tak1 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| tak2 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| tak3 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| tak4 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| tas1 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| tas2 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| tas3 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| tas4 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Nos1 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Nos2 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Nos3 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Nos4 | 0.05 | 0.01 | 0.01 | 0.01 | 0.06 | 0.02 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| vas1 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| vas2 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| vas3 | 0.05 | 0.01 | 0.01 | 0.01 | 0.04 | 0.01 | 0.05 | 0.09 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| vas4 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| vasT | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Fiu1 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Fiu2 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Flu3 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Flu4 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Sas1 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Sas2 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Sas3 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Sas4 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Idr1V | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Idr2V | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Idr3V | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Idr4V | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Idr1H | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Idr2H | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Idr3H | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Idr4H | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| kab1V | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| kab2V | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| kab3V | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| kab4V | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| kab1H | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| kab2H | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| kab3H | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| kab4h | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| nor1V | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| nor2V | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| nor3V | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| nor4V | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| nor1H | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| nor2H | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| nor3H | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| nor4H | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| ene1 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| ene2 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| ene3 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| ene4 | 0.05 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

### Appendix 4. Water quality concentrations analyzed for all wet sedimentation ponds.

| Canoco code | Benso(ghi)perylen µg/l | Indeno(123cd)pyren^ µg/l | Sum PAH-16 µg/l | Sum PAH carcinogene^ µg/l | Fraksjon >C10-C12 µg/l | Fraksjon >C12-C16µg/l | Fraksjon >C16-C35 µg/l | on >C12-C35 | Fraksjon >C35-C40 µg/l | >C10-C40 µg/l | Hg µg/l | Nitrat (NO3)mg/l | Ag µg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sku1 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 286.00 | 286.00 | 59.00 | 346.00 | 0.00 | 3.14 | 0.03 |
| sku2 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 36.00 | 36.00 | 5.00 | 36.00 | 0.00 | 0.14 | 0.03 |
| sku3 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 71.00 | 71.00 | 11.00 | 82.00 | 0.00 | 1.04 | 0.03 |
| sku4 | 0.01 | 0.01 | n.d | n.d | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | 25.00 | 0.00 | 0.34 | 0.25 |
| tan1 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.00 | 0.52 | 0.03 |
| tan2 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.00 | 0.14 | 0.03 |
| tan3 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.00 | 0.14 | 0.03 |
| tan4 | 0.01 | 0.01 | n.d | n.d | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | 25.00 | 0.00 | 0.36 | 0.25 |
| tak1 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.00 | 0.72 | 0.03 |
| tak2 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.00 | 1.55 | 0.03 |
| tak3 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 40.00 | 40.00 | 5.00 | 40.00 | 0.00 | 0.14 | 0.03 |
| tak4 | 0.01 | 0.01 | n.d | n.d | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | 25.00 | 0.01 | 4.44 | 0.25 |
| tas1 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.00 | 0.14 | 0.03 |
| tas2 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.00 | 0.14 | 0.03 |
| tas3 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 72.00 | 72.00 | 5.00 | 72.00 | 0.00 | 0.14 | 0.03 |
| tas4 | 0.01 | 0.01 | n.d | n.d | 2.50 | 2.50 | 149.00 | 149.00 | 20.00 | 169.00 | 0.00 | 0.14 | 0.25 |
| Nos1 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 414.00 | 414.00 | 96.00 | 15.00 | 0.00 | 3.58 | 0.03 |
| Nos2 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 49.00 | 49.00 | 5.00 | 49.00 | 0.00 | 0.61 | 0.03 |
| Nos3 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 68.00 | 68.00 | 5.00 | 68.00 | 0.00 | 2.40 | 0.03 |
| Nos4 | 0.01 | 0.01 | 0.06 | n.d | 2.50 | 5.70 | 234.00 | 240.00 | 273.00 | 273.00 | 0.00 | 1.41 | 0.25 |
| vas1 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 161.00 | 161.00 | 28.00 | 191.00 | 0.00 | 5.10 | 0.03 |
| vas2 | 0.01 | 0.01 | n.d. | n.d. | 8.00 | 52.30 | 617.00 | 669.00 | 136.00 | 813.00 | 0.00 | 0.14 | 0.03 |
| vas3 | 0.01 | 0.01 | 0.19 | 0.01 | 2.50 | 7.40 | 970.00 | 977.00 | 147.00 | n.d. | 0.00 | 0.14 | 0.03 |
| vas4 | 0.01 | 0.01 | n.d | n.d | 2.50 | 2.50 | 173.00 | 173.00 | 28.00 | 207.00 | 0.00 | 3.34 | 0.25 |
| vasT | 0.01 | 0.01 | n,d. | n,d. | 2.50 | 2.50 | 754.00 | 754.00 | 205.00 | 961.00 | 0.00 | 0.87 | 0.03 |
| Fiu1 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.01 | 5.94 | 0.15 |
| Fiu2 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.00 | 3.69 | 0.03 |
| Flu3 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.02 | 4.04 | 0.03 |
| Flu4 | 0.01 | 0.01 | n.d | n.d | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | 25.00 | 0.03 | 22.80 | 0.25 |
| Sas1 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.01 | 29.20 | 0.03 |
| Sas2 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.01 | 15.00 | 0.03 |
| Sas3 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.01 | 13.10 | 0.03 |
| Sas4 | 0.01 | 0.01 | n.d | n.d | 2.50 | 2.50 | 44.00 | 44.00 | 11.00 | 55.00 | 0.04 | 38.40 | 0.25 |
| Idr1V | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.00 | 3.83 | 00.3/2 |
| Idr2V | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.00 | 0.14 | 0.03 |
| Idr3V | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 42.00 | 42.00 | 11.00 | 53.00 | 0.01 | 2.77 | 0.05 |
| Idr4V | 0.01 | 0.01 | n.d | n.d | 2.50 | 2.50 | 235.00 | 235.00 | 57.00 | 297.00 | 0.03 | 1.55 | 0.25 |
| Idr1H | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 7.80 | 93.00 | 101.00 | 6.00 | 114.00 | 0.00 | 7.13 | 0.03 |
| Idr2H | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 8.40 | 93.00 | 101.00 | 5.00 | 111.00 | 0.00 | 3.88 | 0.03 |
| Idr3H | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 768.00 | 768.00 | 47.00 | 21.70 | 0.00 | 5.41 | 0.03 |
| Idr4H | 0.01 | 0.01 | n.d | n.d | 2.50 | 2.50 | 189.00 | 189.00 | 46.00 | 238.00 | 0.00 | 7.67 | 0.25 |
| kab1V | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 84.00 | 84.00 | 16.00 | 100.00 | 0.00 | 5.42 | 0.03 |
| kab2V | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.00 | 4.44 | 0.03 |
| kab3V | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.01 | 2.98 | 0.03 |
| kab4V | 0.01 | 0.01 | n.d | n.d | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | 25.00 | 0.01 | 5.25 | 0.25 |
| kab1H | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.01 | 19.30 | 0.03 |
| kab2H | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.00 | 15.70 | 0.03 |
| kab3H | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.00 | 12.20 | 0.03 |
| kab4h | 0.01 | 0.01 | n.d | n.d | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | 25.00 | 0.01 | 29.90 | 0.25 |
| nor1V | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 124.00 | 124.00 | 5.00 | 144.00 | 0.00 | 6.75 | 0.03 |
| nor2V | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.00 | 4.15 | 0.03 |
| nor3V | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.01 | 3.22 | 0.03 |
| nor4V | 0.01 | 0.01 | n.d | n.d | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | 25.00 | 0.01 | 9.93 | 0.25 |
| nor1H | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.05 | 38.60 | 0.15 |
| nor2H | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.00 | 16.30 | 0.03 |
| nor3H | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.01 | 11.50 | 0.03 |
| nor4H | 0.01 | 0.01 | n.d | n.d | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | 25.00 | 0.04 | 37.70 | 0.25 |
| ene1 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 119.00 | 119.00 | 30.00 | 150.00 | 0.01 | 9.63 | 0.03 |
| ene2 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 72.00 | 72.00 | 12.00 | 88.00 | 0.01 | 14.20 | 0.03 |
| ene3 | 0.01 | 0.01 | n.d. | n.d. | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | n.d. | 0.00 | 6.17 | 0.03 |
| ene4 | 0.01 | 0.01 | n.d | n.d | 2.50 | 2.50 | 15.00 | 17.50 | 5.00 | 25.00 | 0.02 | 19.40 | 0.25 |

Appendix 5. Vegetation index for all wet sedimentation ponds surveyed. x=no data

| **Month** | **April** | | **June** | | **August** | | **October** | |
|---|---|---|---|---|---|---|---|---|
| *WSP* | around pond | in pond | around pond | in pond | around pond | in pond | around pond | in pond |
| SKU1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 |
| TAN1 | 2 | 1 | 2 | 1 | 2 | 2 | 2 | 2 |
| TAK1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 |
| TAS1 | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 2 |
| NØS1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| VAS1 | 1 | 1 | 2 | 1 | 3 | 2 | 3 | 2 |
| VAST | x | x | 2 | 2 | 2 | 2 | x | x |
| FIU1 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| SÅS1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 |
| IDR1Vi | 1 | 2 | 1 | 2 | 2 | 2 | 1 | 2 |
| IDR1Hi | 2 | 2 | 1 | 2 | 2 | 2 | 3 | 2 |
| KAB1Vi | 2 | 1 | 3 | 1 | 1 | 1 | 2 | 1 |
| KAB1Hi | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 3 |
| NOR1Vi | 2 | 1 | 1 | 2 | 3 | 2 | 2 | 2 |
| NOR1Hi | 3 | 2 | 3 | 2 | 1 | 2 | 3 | 2 |
| ENE1 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 1 |

## Appendix 6. Taxa in all wet sedimentation ponds in all the four surveys in this study.

| | Lype phaeopa | Cyrnus sp | Holocentropus dubius | Chironomidae | Plectrocnemia conspersa | Oligotricha striata | Agrypnia varia | Phryganea bipuncta ta | Semblis atrata | Brachycentrus subnilius | Micrasema gelidum | Chaetopteryx sp | Colpotaulius incisus | Limephilus affinis | Limnephilus borealis | Limnephilus lunatus | Limnephilus rhombicus | Nemotaulius punctatolineatus | Limnephilidae indet |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sku1i | | | | 6 | | | | | | | | | | | | | | | |
| sku1m1 | | | | | | | | | | | | | | | | | | | |
| sku1m2 | | | 1 | 71 | | | | | | | | | | | | | 2 | | |
| sku1f1 | | | | | | | | | | | | | | | | | | | |
| sku1f2 | | | | | | | | | | | | | | | | | | | |
| sku2i | | | | 5 | | | | | | | | | | | | | | | |
| sku2m1 | | | 2 | 13 | | | | | | | | | | | | | | | |
| sku2m2 | | | 1 | 17 | | | | | | | | | | | | | | | |
| sku2f1 | | | | | | | | | | | | | | | | | | | |
| sku2f2 | | | | | | | | | | | | | | | | | | | |
| sku3i | | | | | | | | | | | | | | | | | | | |
| sku3m1 | | | | 24 | | | | | | | | | | | | | | | |
| sku3m2 | | | | 6 | | | | | | | | | | | | | | | |
| sku3f1 | | | | | | | | | | | | | | | | | | | |
| sku3f2 | | | | 2 | | | | | | | | | | | | | | | |
| sku4i | | | | 2 | | | | | | | | | | | | | 3 | | |
| sku4m1 | | | | | | | | | | | | | | | | | | | |
| sku4m2 | | | 1 | 3 | | | | | | | | | | | | | | | |
| sku4f1 | | | | | | 1 | | | | | | | | | | | | | |
| sku4f2 | | | | | | | | | | | | | | | | | | | |
| tan1i | | | | | | | | | | | | | | | | | | | |
| tan1m1 | | 1 | | 93 | | | | | | | | | | | | | | | |
| tan1m2 | | | 2 | 70 | | | | | | | | | | | | | | | |
| tan1f1 | | | | 4 | | | | | | | | | | | | | | | |
| tan1f2 | | | | | | | | | | | | | | | | | | | |
| tan2i | | | | 65 | | | | | | | | | | | | | | | |
| tan2m1 | | | 1 | 43 | | | | | | | | | | | | | | | |
| tan2m2 | | | | 37 | | | | | | | | | | | | | | | |
| tan2f1 | | | | | | | | | | | | | | | | | | | |
| tan2f2 | | | | | | | | | | | | | | | | | | | |
| tan3i | | | | 29 | | | | | | | | | | | | | | | |
| tan3m1 | | | 1 | 15 | | | | | | | | | | | | | | | |
| tan3m2 | | | 3 | 22 | | | | | | | | | | | | | | | |
| tan3f1 | | | | | | | | | | | | | | | | | | | |
| tan3f2 | | | | | | | | | | | | | | | | | | | |
| tan4i | | | | 20 | | | | | | | | | | | | | | | |
| tan4m1 | | | 25 | 19 | | | | | | | | | | | | | | | |
| tan4m2 | | | 4 | 29 | | | | | | | | | | | | | | | |
| tan4f1 | | | 1 | | | | | | | | | | | | | | | | |
| tak1i | | | | 7 | | | | | | | | | | | | | | | |
| tak1m1 | | | | 16 | | | | | | | | | | | | | | | |
| tak1m2 | | | | 13 | | | | | | | | | | | | | | | |
| tak1f1 | | | | | | | | | | | | | | | | | 1 | | |
| tak1f2 | | | | | | | | | | | | | | | | | | | |
| tak2i | | | | 3 | | | | | | | | | | | | | | | |
| tak2m1 | | | | 13 | | | | | | | | | | | | | | | |
| tak2m2 | | | 2 | 9 | | | | | | | | | | | | | | | |
| tak2f1 | | | | | | | | | | | | | | | | | | | |
| tak2f2 | | | | | | | 1 | | | | | | | | | | | | |
| tak3i | | | 2 | | | | | | | | | | | | | | | | |
| tak3m1 | | | 5 | 31 | | | | | | | | | | | | | | | |
| tak3m2 | | | 4 | 18 | | | | | | | | | | | | | | | |
| tak3f1 | | | 3 | 3 | | | | | | | | | | | | | | | |
| tak3f2 | | | | | | | | | | | | | | | | | | | |
| tak4i | | | | 4 | | | | | | | | | | | | | | | |
| tak4m1 | | | 2 | | | | | | | | | | | | | | | | |
| tak4m2 | | | 18 | 7 | | | | | | | | | | | | | | | |
| tak4f1 | | | | | | | | | | | | | | | | | | | |
| tak4f2 | | | | | | | | | | | | | | | | | | | |
| tas1i | | | | 45 | | | | | | | | | | | | | | | |
| tas1m1 | | | | 57 | | | | | | | | | | | | | | | |
| tas1m2 | | | 7 | 43 | | | | | | 1 | | | | | | | | | |
| tas1f1 | | | | 2 | | | | | | | | | | | | | | | |
| tas1f2 | | | | 1 | | | | | | | | | | | | | | | |
| tas2i | | | | 49 | | | | | | | | | | | | | | | |
| tas2m1 | | | 4 | 62 | | | | | | | | | | | | | | | |
| tas2m2 | | | | 23 | | | | | | | | | | | | | | | |
| tas2f1 | | | | 5 | | | | | | | | | | | | | | | |
| tas2f2 | | | | 9 | | | | | | | | | | | | | | | |
| tas3i | | | 1 | 12 | | | | | | | | | | | | | | | |
| tas3m1 | | | 18 | 4 | | | | | | | | | | | | | | | |
| tas3m2 | | | 11 | 10 | | | | | | | | | | | | | | | |
| tas3f1 | | | | | | | | | | | | | | | | | | | |
| tas3f2 | | | | | | | | | | | | | | | | | | | |
| tas4i | | | 2 | 14 | 1 | | | | | | | | 1 | | | | | | |
| tas4m1 | | | 6 | 10 | | | | | | | | | 1 | | | | | | |
| tas4m2 | | | 15 | 12 | 2 | | | | | | | | | | | | | | |
| tas4f1 | | | | | | | | | | | | | | | | | | | |
| tas4f2 | | | 1 | | | | | | | | | | | | | | | | |
| nøs1i | | | | 5 | | | | | | | | | | | | | | | |
| nøs1m1 | | | | 11 | | | | | | | | | | | | | | | |
| nøs1m2 | | | | 42 | | | | | | | | | | | | | | | |
| nøs1f1 | | | | | | | | | | | | | | | | | | | |
| nøs1f2 | | | | | | | | | | | | | | | | | | | |
| nøs2i | | | | 6 | | | | | | | | | | | | | | | |
| nøs2m1 | | | | 15 | | | | | | | | | | | | | | | |
| nøs2m2 | | | | 2 | | | | | | | | | | | | | | | |
| nøs2f1 | | | | | | | | | | | | | | | | | | | |
| nøs2f2 | | | 4 | | | | | | | | | | | | | | | | |
| nøs3i | | | 1 | 7 | | | | | | | | | | | | | | | |
| nøs3m1 | | | | 3 | | | | 1 | | | | | | | | | | | |
| nøs3m2 | | | | 15 | | | | | | | | | | | | | | | |
| nøs3f1 | | | | | | | | 2 | | | | | | | | | | | |
| nøs3f2 | | | | | | | | | | | | | | | | | | | |
| nøs4i | | | | 2 | | | | | | | | | | | | | | | |
| nøs4m1 | | | | 4 | | | | | | | | | | | | | | | |
| nøs4m2 | | | | 6 | | | | | | | | | | | | | 1 | | |
| nøs4f1 | | | | | | | | 3 | | | | | | | | | | | |
| nøs4f2 | | | | | | | | | | | | | | | | | | | |
| vas1i | | | | 9 | | | | | | | | | | | | | | | |
| vas1m1 | | | | 43 | | | | | | | | | | | | | | | |
| vas1m2 | | | | 32 | | | | | | | | | | | | | | | |
| vas1f1 | | | | | | | | | | | | | | | | | | | |
| vas1f2 | | | | | | | | | | | | | | | | | | | |
| vas2i | | | | 29 | | | | | 1 | | | | | | | | | | |
| vas2m1 | | | | 5 | | | | | | | | | | | | | | | |
| vas2m2 | | | | 6 | | | | | | | | | | | | | | | |
| vas2f1 | | | | | | | | | | | | | | | | | | | |
| vas2f2 | | | | | | | | | | | | | | | | | | | |
| vas3i | | | 1 | 65 | | | | | | | | | | | | | | | |
| vas3m1 | | | | 60 | | | | | | | | | | | | | | | |
| vas3m2 | | | | 40 | | | | | | | | | | | | | | | |
| vas3f1 | | | | 1 | | | | | | | | | | | | | | | |
| vas3f2 | | | | 9 | | | | | | | | | | | | | | | |
| vas4i | | | | 79 | | | | | | | | | | | | | | | 1 |
| vas4m1 | | | | 17 | | | | | | | | | | | | | | | 1 |
| vas4m2 | | | | 40 | | | | | | | | | | | | | | | |
| vas4f1 | | | | | | | | | | | | | | | | | | | |
| vas4f2 | | | | | | | | | | | | | | | | | | | |

## Appendix 7. Taxa in all wet sedimentation ponds in all the four surveys in this study.

| | *Lype phaeopa* | *Cyrnus sp* | *Holocentropus dubius* | *Chironomidae* | *Plectrocnemia conspersa* | *Oligotricha striata* | *Agrypnia varia* | *Phryganea bipunctata* | *Semblis atrata* | *Brachycentrus subnilius* | *Micrasema gelidum* | *Chaetopteryx sp* | *Colpotaulius incisus* | *Limephilus affinis* | *Limnephilus borealis* | *Limnephilus lunatus* | *Limnephilus rhombicus* | *Nemotaulius punctatolineatus* | *Limnephilidae indet* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| vasTi | | | | 21 | | | | | | | | | | | | | | | |
| vasTm1 | | | | 12 | | | | | | | | | | | | | | | |
| vasTm2 | | | | 14 | | | | | | | | | | | | | | | |
| vasTf1 | | | | | | | | | | | | | | | | | | | |
| vasTf2 | | | | 25 | | | | | | | | | | | | | | | |
| Fiu1i | | | | 13 | | | | | | | | | | | | | | | |
| Fiu1m1 | | | 1 | 18 | | | | | | | | | | | | | | | |
| fiu1m2 | | | 3 | | | | | | | | | | | | | | | | |
| fiu1f1 | | | | | | | | | | | | | | | | | | | |
| fiu1f2 | | | | | | | | | | | | | | | | | | | |
| fiu2i | | | | 8 | | | | | | | | | | | | | | | |
| fiu2m1 | | | | 8 | | | | | | | | | | | | | | | |
| fiu2m2 | | | 1 | 56 | | | | | | | | | | | | | 1 | | |
| fiu2f1 | | | | | | | | | | | | | | | | | | | |
| fiu2f2 | | | | | | | | | | | | | | | | | | | |
| fiu3i | | | | | | | | | | | | | | | | | | | |
| fiu3m1 | | | | | | | | | | | | | | | | | | | |
| fiu3m2 | | | | | | | | | | | | | | | | | | | |
| fiu3f1 | | | | 3 | | | | | | | | | | | | | | | |
| fiu3f2 | | | 1 | | | | | | | | | | | | | | | | |
| fiu4i | | | | 48 | | | | | | | | | | 3 | | | | | |
| fiu4m1 | | | | | | | | | | | | | | | | | | | |
| fiu4m2 | | | 8 | 7 | | | | | | | | | | | | | | | |
| fiu4f1 | | | | | | | | | | | | | | | | | | | |
| fiu4f2 | | | | | | | | | | | | | | | | | | | |
| sås1i | | | 1 | 6 | | | | | | | | | | | | | | | |
| sås1m1 | | | | 1 | | | | | | | | | | | | | | | |
| sås1m2 | | | | 7 | | | | | | | | | | | | | | | |
| sås1f1 | | | | | | | | | | | | | | | | | | | |
| sås1f2 | | | | | | | | | | | | | | | | | | | |
| sås2i | | | | 29 | | | | | | | | | | | | | | | |
| sås2m1 | | | | 40 | | | | | | | | | | | | | | | |
| sås2m2 | | | | 8 | | | | | | | | | | | 1 | | | | |
| sås2f1 | | | | | | | | | | | | | | | | | | | |
| sås2f2 | | | | | | | | | | | | | | | | | | | |
| sås3i | | | | | | | | | | | | | | | | | | | |
| sås3m1 | | | | | | | | | | | | | | | | | | | |
| sås3m2 | | | 2 | | | | | | | | | | | | | | | | |
| sås3f1 | | | | | | | | | | | | | | | | | | | |
| sås3f2 | | | | | | | | | | | | | | | | | | | |
| sås4i | | | | 1 | | | | | | | | | | 2 | | | | | |
| sås4m1 | | | | 4 | | | | | | | | | | | | | | 1 | |
| sås4m2 | | | 2 | 4 | | | | | | | | | | | | | | | |
| sås4f1 | | | | | | | | | | | | | | | | | | | |
| sås4f2 | | | | | | | | | | | | | | | | | | | |
| idr1Vi | | | | 33 | | | | | | | | | | | | | | | |
| idr1Hi | | | | 6 | | | | | | | | | | | | | | | |
| idr1m1 | | | | 11 | | | | | | | | | | | | | | | |
| idr1m2 | 1 | | | 2 | | | | | | | 1 | | | | | | | | |
| idr1f1 | | | | | | | | | | | | | | | | | | | |
| idr2Vi | | | | 6 | | | | | | | | | | | | | | | |
| idr2Hi | | | | 6 | | | | | | | | | | | | | | | |
| idr2m1 | | | | 7 | | | | | | | | | | | | | | | |
| idr2m2 | | | | 4 | | | | | | | | | | | | | | | |
| idr2f1 | | | | | | | | | | | | | | | | | | | |
| idr2f2 | | | | | | | | | | | | | | | | | | | |
| idr3Vi | | | | 8 | | | | | | | | | | | | | | | |
| idr3Hi | | | | 2 | | | | | | | | | | | | | | | |
| idr3m1 | | | | 2 | | | | | | | | | | | | | | | |
| idr3m2 | | | | | | | | | | | | | | | | | | | |
| idr3f1 | | | | | | | | | | | | | | | | | | | |
| idr3f2 | | | | | | | | | | | | | | | | | | | |
| idr4Vi | | | | 32 | | | | | | | | | | | | | | | |
| idr4Hi | | | | | | | | | | | | | | | | | | | |
| idr4m1 | | | | 4 | | | | | | | | | | | | | | | |
| idr4m2 | | | | 5 | | | | | | | | | | | | | | | |
| idr4f1 | | | | | | | | | | | | | | | | | | | |
| idr4f2 | | | | | | | | | | | | | | | | | | | |
| kab1Vi | | | | 19 | | | | | | | | | | | | | | | |
| kab1Hi | | | | 37 | | | | | | | | | | | | 1 | 1 | | |
| kab1m1 | | | | 11 | | | | | | | | | | | | 1 | | | |
| kab1m2 | | | | 9 | | | | | | | | | | | | | 4 | | |
| kab1f1 | | | | | | | | | | | | | | | | | | | |
| kab1f2 | | | | | | | | | | | | | | | | | | | |
| kab2Vi | | | | 110 | | | | | | | | | | | | | | | |
| kab2Hi | | | | 9 | | | | | | | | | | | | | | | |
| kab2m1 | | | 1 | 38 | | | | | | | | | | | | | | | |
| kab2m2 | | | 2 | 15 | 1 | | | | | | | | | | | | | | |
| kab2f1 | | | | | | | | | | | | | | | | | | | |
| kab2f2 | | | | 20 | | | | | | | | | | | | | | | |
| kab3Vi | | | | 6 | | | | | | | | | | | | | | | |
| kab3Hi | | | | 11 | | | | | | | | | | | | | | | |
| kab4Vi | | | 1 | 24 | | | | | | | | | | | | | | | |
| kab4hi | | | 2 | 9 | | | | | | | | | | | | | | | |
| kab4m1 | | | 5 | 15 | | | | | | | | | | | | | | | |
| kab4m2 | | | 1 | 6 | | | | | | | | | | | | | | | |
| kab4f1 | | | | 1 | | | | | | | | | | | | | | | |
| nor1Vi | | | | 6 | | | | | | | | | | | | | | | |
| nor1Hi | | | | | | | | | | | | | | | | | | | |
| nor1m1 | | | 2 | 9 | | | | | | | | | | | | | 2 | | |
| nor1m2 | | | 3 | 3 | | | | | | | | | | | | | | | |
| nor1f1 | | | | 1 | | | | | | | | | | | | | | | |
| nor1f2 | | | | | | | | | | | | | | | | | | | |
| nor2Vi | | | | 112 | | | | | | | | | | | | | | | |
| nor2Hi | | | | 21 | | | | | | | | | | | | 3 | | | |
| nor2m1 | | | | 16 | | | | | | | | | | | | | | | |
| nor2m2 | | | 2 | 31 | | | | | | | | | | | | | | | |
| nor2f1 | | | | | | | | | | | | | | | | | | | |
| nor2f2 | | | | | | | | | | | | | | | | | | | |
| nor3Vi | | | | 26 | | | | | | | | | | | | | | | |
| nor3Hi | | | | 15 | | | | | | | | | | | | | | | |
| nor3m1 | | | | 16 | | | | | | | | | | | | | | | |
| nor3m2 | | | | 34 | | | | | | | | | | | | | | | |
| nor3f1 | | | | 12 | | | | | | | | | | 1 | | | | | |
| nor3f2 | | | | | | | | | | | | | | | | | | | |
| nor4Vi | | | | 7 | | | | | | | | | | | 7 | | | | |
| nor4Hi | | | | | | | | | | | | | | | 19 | | | | |
| nor4m1 | | | | 3 | | | | | | | | | | | 12 | | | | |
| nor4m2 | | | | 3 | | | | | | | | | | | 28 | | | | |
| nor4f1 | | | | | | | | | | | | | | | | | | | |
| nor4f2 | | | | 2 | | | | | | | | | | | 1 | | | | |
| ene1i | | | 1 | 32 | | | | | | | | | | | | | | | |
| ene1m1 | | | | 15 | | | | | | | | 2 | | | | | | | |
| ene1m2 | | | | 7 | | | | | | | | | | | | | 2 | | |
| ene1f1 | | | | | | | | | | | | | | | | | | | |
| ene2i | | | 1 | 4 | | | | | | | | | | | | | | | |
| ene3i | | | | 6 | | | | | | | | | | | | | | | |
| ene4i | | | | 5 | | | | | | | | | | | | | | | |
| ene4m1 | | | | 1 | | | | | | | | | | | | | | | |
| ene4m2 | | | | 4 | | | | | | | | | | | | | | | |

## Appendix 8. Taxa in all wet sedimentation ponds in all the four surveys in this study.

| | *Limnehilus sp* | *Brychius elevates larvae* | *Haliplus sp* | *Haliplus confinis* | *Haliplidae larvae* | *Noterus clavicornis* | *Hygrotus confluens* | *Hygrotus inaequalis* | *Hyphydrus ovatus* | *Hydroporus nigrita* | *Hydroporus palustris* | *Hydroporus planus* | *Hydroporus sp* | *Scarodytes halensis* | *Platambus maculatus* | *Agabus palodosus* | *Agabus guttatus* | *Agabus bipustulatus* | *Agabus sturmii* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sku1i | | | | | | | | | | | | | | | | | | | |
| sku1m1 | | | | | | | | | | | | | | | | | | | |
| sku1m2 | | | | | | | 1 | | | | | | | | | | | | |
| sku1f1 | | | | | | | | | | | | | | | | | | | |
| sku1f2 | | | | | | | | | | | | | | | | | | | |
| sku2i | | | | | | | | | | | | | | | | | | | |
| sku2m1 | | | | | | | | | | | | | | | | | | | |
| sku2m2 | | | | | | | | | | | | | | | | | | | |
| sku2f1 | | | | | | | | | | | | | | | | | | | |
| sku2f2 | | | | | | | | | | | | | | | | | | | |
| sku3i | | | | | | | | | | | | | | | | | | | |
| sku3m1 | | 2 | | | | | | | | | | | | | | | | | |
| sku3m2 | | | | | | | | | | | | | | | | | | | |
| sku3f1 | | | | | | | | | | | | | | | | | | | |
| sku3f2 | | | | | | | | | | | | | | | | | | | |
| sku4i | | | | | | | | | | | | | | | | | | | |
| sku4m1 | | | | | | | | | | | | | | | | | | | |
| sku4m2 | | | 4 | | | | | | | | | | | | | | | | |
| sku4f1 | | | | | | | | | | | | | | | | | | | |
| sku4f2 | | | | | | | | | | | | | | | | | | | |
| tan1i | | | | | | | | | | | | | | | | | | | |
| tan1m1 | | | | | | | | | | | | | | | | | | | |
| tan1m2 | | | | | | | | | | | | | | | | | | | |
| tan1f1 | | | | | | | | | | | | | | | | | | | |
| tan1f2 | | | | | | | | | | | | | | | | | | | |
| tan2i | | | | | | | | | | | | | | | | | | | |
| tan2m1 | | | | | | | | | | | | | | | | | | | |
| tan2m2 | | | | | | | | | | | | | | | | | | | |
| tan2f1 | | | | | | | | | | | | | | | | | | | |
| tan2f2 | | | | | | | | | | | | | | | | | | | |
| tan3i | | | | | | | | | | | | | | | | | | | |
| tan3m1 | | | | 1 | | | | | | | | | | | | | | | |
| tan3m2 | | | | | | | | | | | | | | | | | | | |
| tan3f1 | | | | | | | | | | | | | | | | | | | |
| tan3f2 | | | | | | | | | | | | | | | | | | | |
| tan4i | | | | | | | | | | | | | | | | | | | |
| tan4m1 | | | | | | | | | | | | | | | | | | | |
| tan4m2 | | | | | | | | | | | | | | | | | | | |
| tan4f1 | | | | | | | | | | | | | | | | | | | |
| tak1i | | | | | | | | | | | | | | | | | | | |
| tak1m1 | | | | | | | | | | | | | | | | | | | |
| tak1m2 | | | | | | | | | | | | | | | | | | | |
| tak1f1 | | | | | | | | | | | | | | | | | | | |
| tak1f2 | | | | | | | | | | | | | | | | | | | |
| tak2i | | | | | | | | | | | | | | | | | | | |
| tak2m1 | | | | | | | | | | | | | | | | | | | |
| tak2m2 | | | | | | | | | | | | | | | | | | | |
| tak2f1 | | | | | | | | | | | | | | | | | | | |
| tak2f2 | | | | | | | | | | | | | | | | | | | |
| tak3i | | | | | | | | | | | | | | | | | | | |
| tak3m1 | | | | | | | | | | | | | | | | | | | |
| tak3m2 | | | | | | | | | | | | | | | | | | | |
| tak3f1 | | | | | | | | | | | | | | | | | | | |
| tak3f2 | | | | | | | | | | | | | | | | | | | |
| tak4i | | | | | | | | | | | | | | | | | | | |
| tak4m1 | | | | | | | | | | | | | | | | | | | |
| tak4m2 | | | | | | | | | | | | | | | | | | | |
| tak4f1 | | | | | | | | | | | | | | | | | | | |
| tak4f2 | | | | | | | | | | | | | | | | | | | |
| tas1i | | | | | | | | | | | | | | | | | | | |
| tas1m1 | | | | | | | | | | | | | | | | | | | |
| tas1m2 | | | 1 | | | | | | | | | | | | | | | | |
| tas1f1 | | | | | | | | | | | | | | | | | | | |
| tas1f2 | | | | | | | | | | | | | | | | | | | |
| tas2i | | | | 3 | | | | | | | | | | | | | | | |
| tas2m1 | | | | | | | | | | | | | | | | | | | |
| tas2m2 | | | | | | | | | | | | | | | | | | | |
| tas2f1 | | | | | | | | | | | | | | | | | | | |
| tas2f2 | | | | | | | | | | | | | | | | | | | |
| tas3i | | | | 7 | | | | | | | | | | | | | | | |
| tas3m1 | | | | 1 | | | | | | | | | | | | | | | |
| tas3m2 | | | | | | | | | | | | | | | | | | | |
| tas3f1 | | | | | | | | | | | | | | | | | | | |
| tas3f2 | | | | | | | | | | | | | | | | | | | |
| tas4i | | | 1 | | | | | | | | | | | | | | | | |
| tas4m1 | | | | | | | | | | | | | | | | | | | |
| tas4m2 | | | | | | | | | | | | | | | | | | | |
| tas4f1 | | | | | | | | | | | | | | | | | | | |
| tas4f2 | | | | | | | | | | | | | | | | | | | |
| nøs1i | | | | | | | | | | | | | | | | | | | |
| nøs1m1 | | | | | | | | | | | | | | | | | | | |
| nøs1m2 | | | | | | | | | | | | | | | | | | | |
| nøs1f1 | | | | | | | | | | | | | | | | | | | |
| nøs1f2 | | | | | | | | | | | | | | | | | | | |
| nøs2i | | | | | | | | | | | | | | | | | | | |
| nøs2m1 | | | | | | | | | | | | | | | | | | | |
| nøs2m2 | | | | | | | | | | | | | | | | | | | |
| nøs2f1 | | | | | | | | | | | | | | | | | | | |
| nøs2f2 | | | | | | | | | | | | | | | | | | | |
| nøs3i | | 1 | | | | | | | | | | | | | | | | | |
| nøs3m1 | | | | | | | | | | | | | | | | | | | |
| nøs3m2 | | | | | | | | | | | | | | | | | | | |
| nøs3f1 | | | | | | | | | | | | | | | | | | | |
| nøs3f2 | | | | | | | | | | | | | | | | | | | |
| nøs4i | | | | | | | | | | | | | | | | | | | |
| nøs4m1 | | | | | | | | | | | | | | | | | | | |
| nøs4m2 | | | | | | | | | | | | | | | | | | | |
| nøs4f1 | | | | | | | | | | | | | | | | | | | |
| nøs4f2 | | | | | | | | | | | | | | | | | | | |
| vas1i | | | | | | | | | | | | | | | | | | | |
| vas1m1 | | | | | | | | | | | | | | | | | | | |
| vas1m2 | | 1 | | | 1 | | | | | | | | | | | | | | |
| vas1f1 | | | | | | | | | | | | | | | | | | | 3 |
| vas1f2 | | | | | | | | | | | | | | | | | | | |
| vas2i | | | | | | | | | | | | | | | | | | | |
| vas2m1 | | | | | | | | | | | | | | | | | | | |
| vas2m2 | | 2 | | | | | | | | | 1 | | | | | | | | |
| vas2f1 | | | | | | | | | | | | | | | | | | | |
| vas2f2 | | | | | | | | | | | | | | | | | | | |
| vas3i | | | | | | | | | | | | | | | | | | | |
| vas3m1 | | 2 | | | | | | | | | | | | | | | | | |
| vas3m2 | | | | | | | | 1 | | | | | | | | | | | |
| vas3f1 | | | | | | | | | 1 | | | | | | | | | | |
| vas3f2 | | | | | | | | | | | | | | | | | | | |
| vas4i | | | | | | | | | | | | | | | | | | | |
| vas4m1 | | | | | 3 | | | | | | | | | | | | | | |
| vas4m2 | | 1 | | | | | | | | | | | | | | | | | 1 |
| vas4f1 | | | | | 1 | | | | | | | | | | | | | | 2 |
| vas4f2 | | | | | | | | | | | | | | | | | | | |

## Appendix 9. Taxa in all wet sedimentation ponds in all the four surveys in this study.

| | Limnehilus sp | Brychius elevates larvae | Haliplus sp | Haliplus confinis | Haliplidae larvae | Noterus clavicornis | Hygrotus confluens | Hygrotus inaequalis | Hyphydrus ovatus | Hydroporus nigrita | Hydroporus palustris | Hydroporus planus | Hydroporus sp | Scarodytes halensis | Platambus maculatus | Agabus palodosus | Agabus guttatus | Agabus bipustulatus | Agabus sturmii |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| vasTi | | | | | | | | | | | | | | | | | | | |
| vasTm1 | | | | 1 | | | | | | | | | | | | | | | |
| vasTm2 | | | | | | | | | | | | | | | | | | | |
| vasTf1 | | | | | | | | | | | | 1 | | | | | | | |
| vasTf2 | | | | | | | | | | | | | | | | | | | |
| Fiu1i | | | | | | | | | | | | | | | | | | | |
| Fiu1m1 | | | | | | | | | | | | | | | | | | | |
| fiu1m2 | | | | | | | | | | | | | | | | | | | |
| fiu1f1 | | | | | | | | | | | | | | | | | | | |
| fiu1f2 | | | | | | | | | | | | | | | | | | 1 | 1 |
| fiu2i | | | | | | | | | | | | | | | | | | | |
| fiu2m1 | | | | | | | | | | | | | | | | | | | |
| fiu2m2 | | | | | | | | | | | | | | | | | | | |
| fiu2f1 | | | | | | | | | | | | | | | | | | | |
| fiu2f2 | | | | | | | | | | | | | | | | | | | |
| fiu3i | | | | | | | | | | | | | | | | | | | |
| fiu3m1 | | | | | | | | | | | | | | | | | | | |
| fiu3m2 | | | | | | | | | | | | | | | | | | | |
| fiu3f1 | | | | | | | | | | | | | | | | | | | |
| fiu3f2 | | | | | | | | | | | | | | | | | | | |
| fiu4i | | | | | | | | | | | | | | | | | | | |
| fiu4m1 | | | | | | | | | | | | | | | | | | | |
| fiu4m2 | | | | | | | | | | | | | | | | | | | |
| fiu4f1 | | | | | | | | | | | | | | | | | | | |
| fiu4f2 | | | | | | | | | | | | | | | | | | | |
| sâs1i | | | | | | | | | | | | | | | | | | | |
| sâs1m1 | | | | | | | | | | | | | | | | | | | |
| sâs1m2 | | | 1 | | | | | | | | 8 | | | | | | | | |
| sâs1f1 | | | | | | | | | | | | | | | | | | 1 | 1 |
| sâs1f2 | | | | | | | | | | | | | | | | | | | |
| sâs2i | | | | | | | | | | | | | | | | | | | |
| sâs2m1 | | | | 2 | | | | | | | | | | | | | | | |
| sâs2m2 | | | | | | | | | | | | | | | | | | | |
| sâs2f1 | | | | | | | | | | | | | | | | | | | |
| sâs2f2 | | | | | | | | | | | | | | | | | | | |
| sâs3i | | | | | | | | | | | | | | | | | | | |
| sâs3m1 | | | | | | | | | | | | | | | | | | | |
| sâs3m2 | | | | | | | | | | | | | | | | | | | |
| sâs3f1 | | | | | | | | | | | | | | | | | | | |
| sâs3f2 | | | | | | | | | | | | | | | | | | | |
| sâs4i | | | | | | | | | | | | | | | | | | | |
| sâs4m1 | | | | | | | | | | | | | | | | | | | |
| sâs4m2 | | | | | | | | | | | | | | | | | | | |
| sâs4f1 | | | | | | | | | | | | | | | | | | | |
| sâs4f2 | | | | | | | | | | | | | | | | | | | |
| idr1Vi | | | | | | | | | | | | | | | | | | | |
| idr1Hi | | | | | | | | | | | | | | | | | | | |
| idr1m1 | | | | | | | | | | | | | | | | | | | |
| idr1m2 | | | | | | | | | | | | | | | | | | | |
| idr1f1 | | | | | | | | | | | | | | | | | | | |
| idr2Vi | | 12 | | 1 | | | | | | 1 | | | 1 | | | | | | |
| idr2Hi | | | | | | | | | | | | | | | | | | | |
| idr2m1 | | 2 | | | | | | | | | | | | | | | | | |
| idr2m2 | | 1 | | | | | | | | | | | | | | | | | |
| idr2f1 | | | | | | | | | | | | | | | | | | | |
| idr2f2 | | | | | | | | | | | | | | | | | | | |
| idr3Vi | | | | | | | | | | | | | | | | | | | |
| idr3Hi | | | | | | | | | | | | | | | | | | | |
| idr3m1 | | | | | | | | | | | | | | | | | | | |
| idr3m2 | | | | | | | | | | | | | | | | | | | |
| idr3f1 | | | | | | | | | | | | | | | | | | | |
| idr3f2 | | | | | | | | | | | | | | | | | | | |
| idr4Vi | | | | | | | | | | | | | | | | | | | |
| idr4Hi | | | | | | | | | | | | | | | | | | | |
| idr4m1 | | | | | | | | | | | | | | | | | | | |
| idr4m2 | | | | | | | | | | | | | | | | | | | |
| idr4f1 | | | | | | | | | | | | | | | | | | | |
| idr4f2 | | | | | | | | | | | | | | | | | | | |
| kab1Vi | | | | | | | | | | | | | | | | | | | |
| kab1Hi | | | | | | | | | | | | | | | | | | | |
| kab1m1 | | | | | | | | | | | | | | | | | | | |
| kab1m2 | | | | | | | | | | | | | | | | | | | |
| kab1f1 | | | | | | | | | | | | | | | | | | | 1 |
| kab1f2 | | | | | | | | | | | | | | | | 1 | | | |
| kab2Vi | | | | | | | | | | | | | | | | | | | |
| kab2Hi | | 1 | | | | | | | | | | | | | | | | | |
| kab2m1 | | | | | | | | | | | | | | | | | | | |
| kab2m2 | | | | | | | | | | | | | | | | | | | |
| kab2f1 | | | | | | | | | | | | | | | | | | | |
| kab2f2 | | | | | | | | | | | | | | | | | | | 1 |
| kab3Vi | | | | | | | | | | | | | | 1 | | | | | |
| kab3Hi | | | | | | | | | | | | | | | | | | | |
| kab4Vi | | | | | | | | | | | | | | | | | | | |
| kab4hi | | | | | 1 | | | | | | | | | 5 | | | | | |
| kab4m1 | | | | | | | | | | | | | | | | | | | |
| kab4m2 | | | | | | | | | | | | | | | | | | | |
| kab4f1 | | | | | | | | | | | | | | | | | | | |
| nor1Vi | | | | | | | | | | | | | | | | | | | |
| nor1Hi | | | | | | | | | | | | | | | | | | | |
| nor1m1 | | | | | | | | | | | | | | | | | | | 1 |
| nor1m2 | | | | | | | | | | | | | | | | | | | |
| nor1f1 | | | | | | | | | | | 1 | | | | | | | | 3 |
| nor1f2 | | | | | | | | | | | | | | | | | | | 7 |
| nor2Vi | | 1 | | | | | | | | | | | | | | | | | |
| nor2Hi | | | | | | | | | | | | | | | | | | | |
| nor2m1 | | 1 | | | | | | | | | | | | | | | | | |
| nor2m2 | | 14 | | | | | | | | | | | | | | | | | |
| nor2f1 | | | | | | | | | 1 | | | | | | | | | | 3 |
| nor2f2 | | | | | | | | | | | | | | | | | | | |
| nor3Vi | | | | | | | | | | | | | | | | | | | |
| nor3Hi | | | | | | | | | | | | | | | | | | | |
| nor3m1 | | | | | 1 | | | | | | | | | | | | | | |
| nor3m2 | 1 | | | | | | | | | | | | | | | | | | |
| nor3f1 | | | | | | | | | | | | | | | | | | | |
| nor3f2 | | | | | | | | | | | | | | | | | | | |
| nor4Vi | | | | | | | | | | | | | | | | | | | |
| nor4Hi | | 1 | | | 1 | | | | | | | | | | | | | 2 | |
| nor4m1 | | | | | | | | | | | | | | | | | | | |
| nor4m2 | | | | | | | | | | | | | | | | | | | |
| nor4f1 | | | | | | | | | | | | | | | | | | | |
| nor4f2 | | | | | | | | | | | | | | | | | | | |
| ene1i | | | | | | | | | | | | | | | | | | | |
| ene1m1 | | | | | | | | | | | | | | | | | 1 | | |
| ene1m2 | | | | | | | | | | | | | | | | | 1 | | |
| ene1f1 | | | | | | | | | | | | | | | | | | | |
| ene2i | | 1 | | | | 1 | | | | | | | | | | | | | |
| ene3i | | | | | | | | | | | | | | | | | | | |
| ene4i | 1 | | | | | | | | | | | | | | | | | | |
| ene4m1 | | | | | | | | | | | | | | | 3 | | | | |
| ene4m2 | 6 | | | | | | | | | | | | | | | | | | |

## Appendix 10.Taxa in all wet sedimentation ponds in all the four surveys in this study.

| | *Ilybius angustior* | *Ilybius ater* | *Ilybius fuliginosus* | *Ilybius guttiger* | *Ilybius quadriguttatus* | *Rhantus grapii* | *Rhantus suturalis* | *Rhantus exsoletus* | *Colymbetes paykulli* | *Hydaticus seminiger* | *Acilius sulcatus* | *Dysticus lapponicus* | *Dysticus marginalis* | *Dytiscidae larvae* | *Gyrinus sp larvae* | *Gyrinus opacus* | *Laccophilus sp* | *Hydrobius fuscipes larvae* | *Enochrus sp* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sku1i | | | | | | | | | | | | | | | 2 | | | | 1 |
| sku1m1 | | | | | | | | | | | | | | | | | | | |
| sku1m2 | | | | | | | | | | | | | | | | | | | |
| sku1f1 | | | | | | | | | | | | 1 | 8 | | | | | | |
| sku1f2 | | | | | | | | | | | | | 2 | | | | | | |
| sku2i | | | | | | | | | | | | | | | | | | | |
| sku2m1 | | | | | | | | | | | | | | 2 | | | | | |
| sku2m2 | | | | | | | | | | | | | | | | | | | |
| sku2f1 | | | | | | | | | | | | | | | | | | | |
| sku2f2 | | | | | | | | | | | | | | | | | | | |
| sku3i | | | | | | | | | | | | | | | | | | | |
| sku3m1 | | | | | | | | | | | | | | 1 | | | | | |
| sku3m2 | | | | | | | | | | | | | | | | | | | |
| sku3f1 | | | | | | | | | | | | | | | | | | | |
| sku3f2 | | | | | | | | | | | | | | | | | | | |
| sku4i | | | | | | | | | | | | | | | | | | | |
| sku4m1 | | | | | | | | | | | | | | | | | | | |
| sku4m2 | | | | | | | | | | | | | | | | | | | |
| sku4f1 | | | | | | | | | | | | | 1 | | | | | | |
| sku4f2 | | | | | | | | | | | | | | | | | | | |
| tan1i | | | | | | | | | | | | | | | | | | | |
| tan1m1 | | | | | | | | | | | | | | | | | | | |
| tan1m2 | | | | | | | | | | | | | | | | | | | |
| tan1f1 | | | | | | | | | | | 2 | | 3 | | | | | | |
| tan1f2 | | | | | | | | 1 | | | 2 | | 9 | | | | | | |
| tan2i | | | | | | | | | | | | | | | | | | | |
| tan2m1 | | | | | | | | | | | | | | | | | | | |
| tan2m2 | | | | | | | | | | | | | | 1 | | | | | |
| tan2f1 | | | | | | | | | | | | | 2 | | | | | | |
| tan2f2 | | | | | | | | | | | | | | | | | | | |
| tan3i | | | | | | | | | | | | | | | | | | | |
| tan3m1 | | | | | | | | | | | | | | | | | | | |
| tan3m2 | | | | | | | | | | | | | | | | | | | |
| tan3f1 | | | | | | | | | | | | | | | | | | | |
| tan3f2 | | | | | | | | | | | | | | | | | | | |
| tan4i | | | | | | | | | | | | | | | | | | | |
| tan4m1 | | | | | | | | | | | | | | 1 | | | | | |
| tan4m2 | | | | | | | | | | | | | | | | | | | |
| tan4f1 | | | | | | | | | | | | | | | | | | | |
| tak1i | | | | | | | | | | | | | | | | | | | |
| tak1m1 | | | | | | | | | | | | | | | | | | | |
| tak1m2 | | | | | | | | | | | | | | | | | | | |
| tak1f1 | | | | | | | | | | | | | | | | | | | |
| tak1f2 | | | | | | | | | | | | | | | | | | | |
| tak2i | | | | | | | | | | | | | | | | | | | |
| tak2m1 | | | | | | | | | | | | | | | | | | | |
| tak2m2 | | | | | | | | | | | | | | 1 | | | | | |
| tak2f1 | | | | | | | | | | | | | | | | | | | |
| tak2f2 | | | | | | | | | | | | | | | | | | | |
| tak3i | | | | | | | | | | | | | | | | | | | |
| tak3m1 | | | | | | | | | | | | | | | | | | | |
| tak3m2 | | | | | | | | | | | | | | | | | | | |
| tak3f1 | | | | | | | | | | | | | | | | | | | |
| tak3f2 | | | | | | | | | | | | | | | | | | | |
| tak4i | | | | | | | | | | | | | | | | | | | |
| tak4m1 | | | | | | | | | | | | | | | | | | | |
| tak4m2 | | | | | | | | | | | | | | | | | | | |
| tak4f1 | | | | | | | | | | | | | | | | | | | |
| tak4f2 | | | | | | | | | | | | | | | | | | | |
| tas1i | | | | | | | | | | | | | | | | | | | |
| tas1m1 | | | | | | | | | | | | | | | | | | | |
| tas1m2 | | | | | | | | | | | | | | | | | | | |
| tas1f1 | | | | | | | | | | | | | 1 | | | | | | |
| tas1f2 | | | | | | | | | | | | | | | | | | | |
| tas2i | | | | | | | | | | | | | | 3 | | | | | |
| tas2m1 | | | | | | | | | | | | | | | | | | | |
| tas2m2 | | | | | | | | | | | | | | | | | | | |
| tas2f1 | | 1 | 1 | | | | | | | | | | | | | | | | |
| tas2f2 | | | | | | | | | | | | | 1 | | | | | | |
| tas3i | | | | | | | | | | | | | | | | | | | |
| tas3m1 | | | | | | | | | | | | | | | | | | | |
| tas3m2 | | | | | | | | | | | | | | | | | | | |
| tas3f1 | | | | | | | | | | | | | | | | | | | |
| tas3f2 | | | | | | | | | | | | | | | | | | | |
| tas4i | | | | | | | | | | | | | | | | | | | |
| tas4m1 | | | | | | | | | | | | | | | | | | | |
| tas4m2 | | | | | | | | | | | | | | | | | | | |
| tas4f1 | | | | | | | | | | | | | | | | | | | |
| tas4f2 | | | | | | | | | | | | | | | | | | | |
| nøs1i | | | | | | | | | | | | | | | | | | | |
| nøs1m1 | | | | | | | | | | | | | | | | | | | |
| nøs1m2 | | | | | | | | | | | | | | | | | | | |
| nøs1f1 | | | | | | | | | | | | | | | | | | | |
| nøs1f2 | | | | | | | | | | | | | 2 | | | | | | |
| nøs2i | | | | | | | | | | | | | | | | | | | |
| nøs2m1 | | | | | | | | | | | | | | 6 | | | | | |
| nøs2m2 | | | | | | | | | | | | | | | | | | | |
| nøs2f1 | | | | | | | | | | | | | | | | | | | |
| nøs2f2 | | | | | | | | | | | | | | | | | | | |
| nøs3i | | | | | | | | | | | | | | | | | | | |
| nøs3m1 | | | | | | | | | | | | | | | | | | | |
| nøs3m2 | | | | | | | | | | | | | | | | | | | |
| nøs3f1 | | | 1 | | | | | | | | | | | | | | | | |
| nøs3f2 | | | | | | | | | | | | | | | | | | | |
| nøs4i | | | | | | | | | | | | | | | | | | | |
| nøs4m1 | | | | | | | | | | | | | | 4 | | | | | |
| nøs4m2 | | | | | | | | | | | | | | | | | | | |
| nøs4f1 | | | | | | | | | | | | | | | | | | | |
| nøs4f2 | | | | | | | | | | | | | | | | | | | |
| vas1i | | | | | | | | | | | | | | | | | | | |
| vas1m1 | | | | | | | | | | | | | | | | | | | |
| vas1m2 | | | | | | | | | | | | | | | | | | | |
| vas1f1 | | | | | | | | | | | | | 3 | | | | | | |
| vas1f2 | | | | | | | | | 1 | | | | 7 | | | | | | |
| vas2i | | | | | | | | | | | | | | 1 | | | | | |
| vas2m1 | | | | | | | | | | | | | | | | | | | |
| vas2m2 | | | | | | | | | | | | | | 1 | | | | | |
| vas2f1 | | | | | | | | | | | | | | | | | | | |
| vas2f2 | | | | | | | | 1 | | | 1 | | 3 | | | | | | |
| vas3i | | | | | | | | | | | | | | | | | | | |
| vas3m1 | | 1 | | | | | | | | | | | | | | | | | |
| vas3m2 | | | | | | | | | | | | | | 1 | | | | | |
| vas3f1 | 1 | | 1 | | | | | | | | | | | | | | | | |
| vas3f2 | | | 2 | | | | | | | | | | | | | | | | |
| vas4i | | | | | | | | | | | | | | 18 | | | | | |
| vas4m1 | | | | | | | | | | | | | | 1 | | | | | |
| vas4m2 | | | | | | | | | | | | | | 12 | | | | | |
| vas4f1 | | | | | | | | 1 | | | | | | | | | | | |
| vas4f2 | | | | | | | 1 | | | | | | 1 | | | | | | |

## Appendix 11. Taxa in all wet sedimentation ponds in all the four surveys in this study.

| | *Ilybius angustior* | *Ilybius ater* | *Ilybius fuliginosus* | *Ilybius guttiger* | *Ilybius quadriguttatus* | *Rhantus grapii* | *Rhantus suturalis* | *Rhantus exsoletus* | *Colymbetes paykulli* | *Hydaticus seminiger* | *Acilius sulcatus* | *Dysticus lapponicus* | *Dysticus marginalis* | *Dytiscidae larvae* | *Gyrinus sp larvae* | *Gyrinus opacus* | *Laccophilus sp* | *Hydrobius fuscipes larvae* | *Enochrus sp* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| vasTi | | | | | | | | | | | | | | | | | | | |
| vasTm1 | | | | | | | | | | | | | | 3 | | | | | |
| vasTm2 | | | | | | | | | | | | | | 4 | | | | | |
| vasTf1 | | | | | | | | | | | | | | 11 | | | | | |
| vasTf2 | | | | | | | | | | | | | | | | | | | |
| Fiu1i | | | | | | | | | | | | | | | | | | | |
| Fiu1m1 | | | | | | | | | | | | | | | | | | | |
| fiu1m2 | | | | | | | | | | | | | | | | | | | |
| fiu1f1 | | | | | | | | | | | | | | | | | | | |
| fiu1f2 | | | | | | | | | | | | | | | | | | | |
| fiu2i | | | | | | | | | | | | | | | | | | | |
| fiu2m1 | | | | | | | | | | | | | | | | | | | |
| fiu2m2 | | | | | | | | | | | | | | | | | | | |
| fiu2f1 | | | | | | | | | | | | | | 1 | | | | | |
| fiu2f2 | | | | | | | | | | | | | | | | | | | |
| fiu3i | | | | | | | | | | | | | | 1 | | | | | |
| fiu3m1 | | | | | | | | | | | | | | 1 | | | | | |
| fiu3m2 | | | | | | | | | | | | | | 2 | | | | | |
| fiu3f1 | | | | | | | | | | | | | | | | | | | |
| fiu3f2 | | | | | | | | | | | | | | | | | | | |
| fiu4i | | | | | | | | | | | | | | 2 | | | | | |
| fiu4m1 | | | | | | | | | | | | | | | | | | | |
| fiu4m2 | | | | | | | | | | | | | | | | | | | |
| fiu4f1 | | | | | | | | | | | | | | | | | | | |
| fiu4f2 | | | | | | | | | | | | | | | | | | | |
| sås1i | | | | | | | | | | | | | | | | | | | 1 |
| sås1m1 | | | | | | | | | | | | | | | | | | | |
| sås1m2 | | | | | | | | | | | | | | | | | | | |
| sås1f1 | | | | | | | | 1 | | 1 | | | 1 | | | | | | |
| sås1f2 | | | | | | | | | | | | | 1 | | | | | | 3 |
| sås2i | | | | | | | | | | | | | | | | | | | |
| sås2m1 | | | | | | | | | | | | | | 7 | | | | | |
| sås2m2 | | | | | | | | | | | | | | 5 | | | | | |
| sås2f1 | | | | | | | | | | | | | | | | | | | |
| sås2f2 | | | | | | | | | | | | | | 2 | | | | | |
| sås3i | | | | | | | | | | | | | | | | | | | |
| sås3m1 | | | | | | | | | | | | | | 1 | | | | | |
| sås3m2 | | | | | | | | | | | | | | | | | | | |
| sås3f1 | | | | | | | | | | | | | | | | | | | |
| sås3f2 | | | | | | | | | | | | | | | | | | | |
| sås4i | | | | | | | | | | | | | | 3 | | | | | |
| sås4m1 | | | | | | | | | | | | | | | | | | | |
| sås4m2 | | | | | | | | | | | | | | | | | | | |
| sås4f1 | | | | | | | | | | | | | | | | | | | |
| sås4f2 | | | | | | | | | | | | | | | | | | | |
| idr1Vi | | | | | | | | | | | | | | | | | | | |
| idr1Hi | | | | | | | | | | | | | | | | | | | |
| idr1m1 | | | | | | | | | | | | | | | | | 3 | | |
| idr1m2 | | | | | | | | | | | | | | | | | | | |
| idr1f1 | | | | | | | | | | | | | 1 | | | | | | |
| idr2Vi | | | | | | | | | | | | | | 4 | | | | | |
| idr2Hi | | | | | | | | | | | | | | 3 | | | | | |
| idr2m1 | | | | | | | | | | | | | | 1 | | | | | |
| idr2m2 | | | | | | | | | | | | | | | | | | | |
| idr2f1 | | | | | | | | | | | | | | | | | | | |
| idr2f2 | | 2 | | | | | | | | 1 | | | | | | | | | |
| idr3Vi | | | | | | | | | | | | | | 1 | | | | | |
| idr3Hi | | | | | | | | | | | | | | | | | | | |
| idr3m1 | | | | | | | | | | | | | | | | | | | |
| idr3m2 | | | | | | | | | | | | | | | | | | | |
| idr3f1 | | | | | | | | | | | | | | | | | | | |
| idr3f2 | | | | | | | | | | 1 | | | | | | | | | |
| idr4Vi | | | | | | | | | | | | | | | | | | | |
| idr4Hi | | | | | | | | | | | | | | 2 | | | | | |
| idr4m1 | | | | | | | | | | | | | | | | | | | |
| idr4m2 | | | | | | | | | | | | | | | | | | | |
| idr4f1 | | | | | | | | | | | | | | | | | | | |
| idr4f2 | | | | | | | | | | | | | | | | | | | |
| kab1Vi | | | | | | | | | | | | | | | | | | | |
| kab1Hi | | | | | | | | | | | | | | | | | | | |
| kab1m1 | | | | | | | | | | | | | | | | | | | |
| kab1m2 | | | | | | | | | | | | | | | | | | | |
| kab1f1 | | | | | 1 | | | | | | | | | | | | | | |
| kab1f2 | | | | | | | | | | | | | | | | | | | |
| kab2Vi | | | | | | | | | | | | | | 3 | | | | | |
| kab2Hi | | | | | | | | | | | | | | | | | | | |
| kab2m1 | | | | | | | | | | | | | | 2 | | | | | |
| kab2m2 | | | | 1 | | | | | | | | | | | | | | | |
| kab2f1 | | | | | | | | | | | | | | | | | | | |
| kab2f2 | | | | | | | | | | 3 | | | | 1 | | | | | |
| kab3Vi | | | | | | | | | | | | | | | | | | | |
| kab3Hi | | | | | | | | | | | | | | 6 | | | | | |
| kab4Vi | | | | | | | | | | | | | | | | | | | |
| kab4hi | | | | | | | | | | | | | | 2 | | | | | |
| kab4m1 | | | | | | | | | | | | | | | | | | | |
| kab4m2 | | | | | | | | | | | | | | 6 | | | | | |
| kab4f1 | | | | | | | | | | | | | | | | | | | |
| nor1Vi | | | | | | | | | | | | | | | | | | | |
| nor1Hi | | | | | | | | | | | | | | | | | | | |
| nor1m1 | | | | | | | | | | | | | | | | | | | |
| nor1m2 | | | | | | | | | | | | | | | | | | | |
| nor1f1 | | | 2 | | | 1 | | | | | | | | | | | | | |
| nor1f2 | | | | | | | | | | | | | 1 | | | | | | |
| nor2Vi | | | | | | | | | | | | | | 3 | | | | | |
| nor2Hi | | | | | | | | | | | | | | 9 | | | | | |
| nor2m1 | | | | | | | | | | | | | | 5 | | | | | |
| nor2m2 | | | | | | | | | | | | | | 4 | | | | | |
| nor2f1 | | 1 | 6 | | | | | | | | | | | 1 | | | | | |
| nor2f2 | | | 1 | | | | | | | | | | | 1 | | | | | |
| nor3Vi | | | | | | | | | | | | | | 5 | | 1 | | | |
| nor3Hi | | | | | | | | | | | | | | 1 | | | | | |
| nor3m1 | | | | | | | | | | | | | | | | | | | |
| nor3m2 | | | | | | | | | | | | | | | | 1 | | | |
| nor3f1 | | | | | | | | | | | | | | | | | | | |
| nor3f2 | | | 1 | | | | | | | | | | | | | | | | |
| nor4Vi | | | | | | | | | | | | | | 1 | | | | | |
| nor4Hi | | | | | | | | | | | | | | 1 | | | | | |
| nor4m1 | | | | | | | | | | | | | | | | | | | |
| nor4m2 | | | | | | | 2 | | | | | | | | | | | | |
| nor4f1 | | | | | | | | | | | | | | | | | | | |
| nor4f2 | | | | | | | | | | | | | | | | | | | |
| ene1i | | | | | | | | | | | | | | | | | | | |
| ene1m1 | | | | | | | | | | | | | | | | | | | |
| ene1m2 | | | | | | | | | | | | | | | | | | | |
| ene1f1 | | | | | | | | | | | | | | | | | | | |
| ene2i | | | | | | | | 1 | | | | | | | | | | 1 | |
| ene3i | | | | | | | | | | | | | | 1 | | | | | |
| ene4i | | | | | | | | | | | | | | | | | | | |
| ene4m1 | | | | | | | | | | | | | | | | | | | |
| ene4m2 | | | | | | | | | | | | | | | | | | | |

## Appendix 12. Taxa in all wet sedimentation ponds in all the four surveys in this study.

| | *Coelostoma orbiculare larvae* | *Hydraena sp* | *Limnebius sp* | *Elodes marginata* | *Dryops sp* | *Hydraenidae* | *Donacia sp* | *Plateumaris braccata* | *Bagous sp* | *Centroptilum luteolum* | *Cloeon inscriptum* | *Caenis horaria* | *Leptophlebia marginata* | *Leptophlebia vespertina* | *Paraleptoplebia sp.* | *Baetis rhodani* | *Lestidae* | *Aeshnidae* | *Libellulidae* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sku1i | | | | | | | | | | | | | | | | | | | |
| sku1m1 | | | | | | | | | | | | | | | | | | | |
| sku1m2 | | | | | | | | | | | 3 | | | | | | | | |
| sku1f1 | | | | | | | | | | | | | | | | | | | |
| sku1f2 | | | | | | | | | | | | | | | | | | | |
| sku2i | | | | | | | | | | | | | | | | | | | |
| sku2m1 | | | | | | | | | | | 1 | | | | | | | | |
| sku2m2 | | | | | | | | | | | | 1 | | | | | | | |
| sku2f1 | | | | | | | | | | | | | | | | | | | |
| sku2f2 | | | | | | | | | | | | | | | | | | | |
| sku3i | | | | | | | | | | | | | | | | | | | |
| sku3m1 | | | | | | | | | | | 12 | | | | | | | | |
| sku3m2 | | | | | | | | | | | 3 | | | | | | | | 2 |
| sku3f1 | | | | | | | | | | | 1 | | | | | | | | |
| sku3f2 | | | | | | | | | | | 1 | | | | | | | | |
| sku4i | | | | | | | | | | | | | | | | | | | |
| sku4m1 | | | | | | | | | | | | | | | | | | | |
| sku4m2 | | | | | | | | | | | 9 | | | | | | | | |
| sku4f1 | | | | | | | | | | | | | | | | | | | |
| sku4f2 | | | | | | | | | | | | | | | | | | | |
| tan1i | | | | | | | | | | | | | | | | | | | |
| tan1m1 | | | | | | | | | | | 18 | 2 | | 21 | | | | | |
| tan1m2 | | | | | | | | | | | 44 | | 5 | 11 | | | | | |
| tan1f1 | | | | | | | | | | | | 1 | | | | | | | |
| tan1f2 | | | | | | | | | | | | 1 | | | | | | 4 | |
| tan2i | | | | | | | | | | | | | | | | | 1 | | |
| tan2m1 | | | | | | | | | | | 2 | 3 | | | | | 17 | 2 | 7 |
| tan2m2 | | | | | | | | | | | | 8 | | | | | 5 | | 2 |
| tan2f1 | | | | | | | | | | | | | | | | | | | |
| tan2f2 | | | | | | | | | | | | | | | | | | | |
| tan3i | | | | | | | | | | | 3 | | | | | | | | |
| tan3m1 | | | | | | | | | | | 29 | | | | | | | | 1 |
| tan3m2 | | | | | | | | | | | 29 | | | | 1 | | 1 | | 2 |
| tan3f1 | | | | | | | | | | | | | | | | | | | |
| tan3f2 | | | | | | | | | | | 1 | | | | | | | | 1 |
| tan4i | | | | | | | | | | | 119 | | | | 1 | | | | |
| tan4m1 | | | | | | | | | | | 40 | 1 | | | 5 | | | | 1 |
| tan4m2 | | | | | | | | | | | 30 | | | | | | | | |
| tan4f1 | | | | | | | | | | | 2 | | | | 5 | | | | |
| tak1i | | | | | | | | | | | 2 | | | | | | | | |
| tak1m1 | | | | | | | | | | | 6 | | | 11 | | | | | |
| tak1m2 | | | | | | | | | | | 5 | | | 2 | | | | | |
| tak1f1 | | | | | | | | | | | | | 1 | | | | | | |
| tak1f2 | | | | | | | | | | | | | | | | | | 1 | |
| tak2i | | | | | | | | | | | | | | | | | 1 | | |
| tak2m1 | | | | | | | | | | | | | | | | | 10 | | |
| tak2m2 | | | | | | | | | | | 3 | | | | | | 3 | | 2 |
| tak2f1 | | | | | | | | | | | 1 | | | | | | | | |
| tak2f2 | | | | | | | | | | | | | | | | | | | |
| tak3i | | | | | | | | | | | 11 | 2 | | | | | | | |
| tak3m1 | | | | | | | | | | | 136 | | | | | | | | |
| tak3m2 | | | | | | | | | | | 111 | | | | | | | | 3 |
| tak3f1 | | | | | | | | | | | 11 | | | | | | | | |
| tak3f2 | | | | | | | | | | | 11 | | | | | | | | |
| tak4i | | | | | | | | | | | 10 | | | | | | | | |
| tak4m1 | | | | | | | | | | | 106 | | | | | | | | |
| tak4m2 | | | | | | | | | | | 67 | | | | 1 | | | | |
| tak4f1 | | | | | | | | | | | 3 | | | | | | | | |
| tak4f2 | | | | | | | | | | | 3 | | | | | | | | |
| tas1i | | | | | | | 1 | | | | 12 | 1 | | | | | | | |
| tas1m1 | | | | | | | | | | | 4 | | | | | | | | |
| tas1m2 | | | | | | | | | | | 65 | | | | | | | | |
| tas1f1 | | | | | | | | | | | 14 | | | | | | | | |
| tas1f2 | | | | | | | | | | | 12 | | | | | | | | |
| tas2i | | | | | | | | | | | 2 | | | | | | 12 | | 6 |
| tas2m1 | | | | | | | | | | | 9 | | | | | | 18 | | 5 |
| tas2m2 | | | | | | | | | | | 9 | | | | | | 9 | | 2 |
| tas2f1 | | | | | | | | | | | 2 | | | | | | | | |
| tas2f2 | | | | | | | | | | | 3 | | | | | | | | |
| tas3i | | | | | | | | | | | 192 | 1 | | | | | | | 2 |
| tas3m1 | | | | | | | | | | | 179 | | | | | | | | 4 |
| tas3m2 | | | | | | | | | | | 94 | | | | | | | | 1 |
| tas3f1 | | | | | | | | | | | 1 | | | | | | | | |
| tas3f2 | | | | | | | | | | | 25 | | | | | | | | 1 |
| tas4i | | | | | | | | | | | 715 | 1 | | | 4 | | | | |
| tas4m1 | | | | | | | | | | | 111 | | | | | | | | 1 |
| tas4m2 | | | | | | | | | | | 196 | | | | 6 | | | | 2 |
| tas4f1 | | | | | | | | | | | 3 | | | | | | | | |
| tas4f2 | | | | | | | | | | | | | | | | | | | |
| nøs1i | | | | | | | | | | | 5 | | | | | | | | |
| nøs1m1 | | | | | | | | | | | 6 | | | | | | | | |
| nøs1m2 | | | | | | | | | | | 32 | | | | | | | | |
| nøs1f1 | | | | | | | | | | | 3 | | | | | | | 1 | |
| nøs1f2 | | | | | | | | | | | 1 | | | | | | | 1 | |
| nøs2i | | | | | | | | | | | | | | | | | 1 | | |
| nøs2m1 | | | | | | | | | | | 2 | | | | | | | | |
| nøs2m2 | | | | | | | | | | | 2 | | | | | | | | |
| nøs2f1 | | | | | | | | | | | 2 | | | | | | | 3 | |
| nøs2f2 | | | | | | | | | | | | | | | | | | | |
| nøs3i | | | | | | | | | | | 57 | | | | | | | | |
| nøs3m1 | | | | | | | | | | | 63 | | | 2 | | | | | |
| nøs3m2 | | | | | | | | | | | 61 | | | | | | | | |
| nøs3f1 | | | | | | | | | | | | | | | | | | | 1 |
| nøs3f2 | | | | | | | | | | | 2 | | | | | | | | |
| nøs4i | | | | | | | | | | | 30 | | | | | | | | |
| nøs4m1 | | | | | | | | | | | 369 | | | | | | | | |
| nøs4m2 | | | | | | | | | | | 119 | | | | | | | | |
| nøs4f1 | | | | | | | | | | | 1 | | | | | | | | |
| nøs4f2 | | | | | | | | | | | 7 | | | | | | | | |
| vas1i | | | | | | | | | | | | | | | | | | | |
| vas1m1 | | | | 1 | | | | | | | 1 | | | | | | | | |
| vas1m2 | | | | | | | | | | | 3 | | | | | | | | |
| vas1f1 | | | | | | | | | | | | | | | | | | | |
| vas1f2 | | | | | | | | | | | | | | | | | | | |
| vas2i | | | | | | | | | | | | | | | | | | | |
| vas2m1 | | | | | | | | | | | | | | | | | 3 | | |
| vas2m2 | | | | | | 2 | | | | | | | | | | | 1 | 2 | |
| vas2f1 | | | | | | | | | | | | | | | | | | | |
| vas2f2 | | | | | | | | | | | | | | | | | | | |
| vas3i | | | | | | | | | | | 4 | | | | | | | | |
| vas3m1 | | | | | | | | | | | 352 | | | | | | | | 1 |
| vas3m2 | | | | | | | | | | | 129 | | | | | | | | 1 |
| vas3f1 | | | | | | | | | | | 4 | | | | | | | | |
| vas3f2 | | | | | | | | | | | 3 | | | | | | | | |
| vas4i | | | | | | | | | | | 5 | | | | | | | | |
| vas4m1 | | | | | | | | | | | 26 | | | | | | | | |
| vas4m2 | | | | | | | | | | | 41 | | | | | | | | |
| vas4f1 | | | | | | | | | | | | | | | | | | | |
| vas4f2 | | | | | | | | | | | | | | | | | | | |

## Appendix 13. Taxa in all wet sedimentation ponds in all the four surveys in this study.

| | *Coelostoma orbiculare larvae* | *Hydraena sp* | *Limnebius sp* | *Elodes marginata* | *Dryops sp* | *Hydraenidae* | *Donacia sp* | *Plateumaris braccata* | *Bagous sp* | *Centroptilum luteolum* | *Cloeon inscriptum* | *Caenis horaria* | *Leptophlebia marginata* | *Leptophlebia vespertina* | *Paraleptophlebia sp.* | *Baetis rhodani* | *Lestidae* | *Aeshnidae* | *Libellulidae* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| vasTi | | | | | | 1 | | | | | 1 | | | | | | | | |
| vasTm1 | | | | | | | | | | | | | | | | | 2 | | 1 |
| vasTm2 | | | | | | | | | | | | | | | | | 1 | | 2 |
| vasTf1 | | | | | | | | | | | | | | | | | | | 7 |
| vasTf2 | | | | | | | | | | | | | | | | | | | |
| Fiu1i | | | | | | | | | | | 27 | | | | | | | | |
| Fiu1m1 | | | | | | | | | | | 120 | | | | | | | | |
| fiu1m2 | | | | | | | | | | | 45 | | | | | | | | |
| fiu1f1 | | | | | | | | | | | | | | | | | | | |
| fiu1f2 | | | | | | | | | | | | | | | | | | | |
| fiu2i | | | | | | | | | | | | | | | | | | | |
| fiu2m1 | | | | | | | | | | | 3 | | | | | | | | 1 |
| fiu2m2 | | | | | | | | | | | 11 | | | | | | | | |
| fiu2f1 | | | | | | | | | | | | | | | | | | | |
| fiu2f2 | | | | | | | | | | | | | | | | | | | 1 |
| fiu3i | | | | | | | | | | | 27 | | | | | | | | |
| fiu3m1 | | | | | | | | | | | 11 | | | | | | | | |
| fiu3m2 | | | | | | | | | | | 4 | | | | | | 1 | | 1 |
| fiu3f1 | | | | | | | | | | | | | | | | | | | |
| fiu3f2 | | | | | | | | | | | | | | | | | | | |
| fiu4i | | | | | | | | | | | 68 | | | | | | | | |
| fiu4m1 | | | | | | | | | | | 11 | | | | | | | | |
| fiu4m2 | | | | | | | | | | | 70 | | | | | | | | |
| fiu4f1 | | | | | | | | | | | 3 | | | | | | | | |
| fiu4f2 | | | | | | | | | | | 3 | | | | | | | | |
| sås1i | | | | | | | | | | | | | | | | | | | |
| sås1m1 | | | | | 3 | | | | | | 7 | | | | | | | | |
| sås1m2 | | | | | 2 | | | | | | 16 | | | | | | | | |
| sås1f1 | | | | | | | | | | | 1 | | | | | | | | |
| sås1f2 | | | | | | | | | | | | | | | | | | | |
| sås2i | | | | | | 2 | | | | | 5 | | | | | | | | |
| sås2m1 | | | | | | | | | | | 35 | | | | | | 1 | | |
| sås2m2 | | | | | | | | | | | 5 | | | | | | | | |
| sås2f1 | | | | | | | | | | | | | | | | | | | |
| sås2f2 | | | | | | | | | | | | | | | | | | | |
| sås3i | | | | | | | | | | | | | | | | | | | 1 |
| sås3m1 | | | | | | | | | | | 3 | | | | | | | | |
| sås3m2 | | | | | | | | | | | 2 | | | | | | | | |
| sås3f1 | | | | | | | | | | | | | | | | | | | |
| sås3f2 | | | | | | | | | | | | | | | | | | | |
| sås4i | | | | | | | | | | | 1 | | | | | | | | |
| sås4m1 | | | | | | | | | | | 34 | | | | | | | | 1 |
| sås4m2 | | | | | | | | | | | 41 | | | | | | | | |
| sås4f1 | | | | | | | | | | | | | | | | | | | |
| sås4f2 | | | | | | | | | | | 2 | | | | | | | | |
| idr1Vi | | | | | | | | | | | | | | | | | | | |
| idr1Hi | | | | | | | | | | | | | | | | | | | |
| idr1m1 | 1 | | | | | | | | | | 75 | | | | | | | | |
| idr1m2 | 1 | | | | | | | | | | 55 | | | | | | | | |
| idr1f1 | | | | | | | | | | | 6 | | | | | | | | |
| idr2Vi | | | | | | 4 | | | | | | | | | | | | | |
| idr2Hi | | | | | | | | | | | | | | | | | | | |
| idr2m1 | | | | | | | | | | | 43 | | | | | | | | 1 |
| idr2m2 | | | | | | | | | | | 9 | | | | | | | | |
| idr2f1 | | | | | | | | | | | 10 | | | | | | | | |
| idr2f2 | | | | | | | | | | | 5 | | | | | | | | 1 |
| idr3Vi | | | | | | | | | | | | | | | | | | | |
| idr3Hi | | | | | | | | | | | 27 | | | | | | | | |
| idr3m1 | | | | | | | | | | | 4 | | | | | | | | |
| idr3m2 | | | | | | | | | | | 2 | | | | | | | | 1 |
| idr3f1 | | | | | | | | | | | | | | | | | | | |
| idr3f2 | | | | | | | | | | | | | | | | | | | |
| idr4Vi | | | | | | | | | | | 1 | | | | | | | | |
| idr4Hi | | | | | | | | | | | 58 | | | | | | | | 4 |
| idr4m1 | | | | | | | | | | | 15 | | | | | | | | |
| idr4m2 | | | | | | | | | | | 21 | | | | | | | | |
| idr4f1 | | | | | | | | | | | 5 | | | | | | | | |
| idr4f2 | | | | | | | | | | | 6 | | | | | | | | |
| kab1Vi | | | | | | | | | | 5 | | | | | | | | | |
| kab1Hi | | | | | | | | | | | | | | | 2 | | | | |
| kab1m1 | | | | | | | | | | | | | | | | | | | 1 |
| kab1m2 | 1 | | | | | | | 1 | | | | | | | 15 | | | | |
| kab1f1 | | | | | | | | | | 1 | | | | | | | | | |
| kab1f2 | | | | | | | | | | | | | | | | | | | |
| kab2Vi | | | | | | | | | | | 3 | | | | | | | | 2 |
| kab2Hi | | | | | | | | | | | | | | | | | | | |
| kab2m1 | | | | | | | | | | | | | | | 1 | | | | |
| kab2m2 | | | | | | | | | | | | | 1 | | | | | | |
| kab2f1 | | | | | | | | | | | | | | | | | | | |
| kab2f2 | | | | | | | | | | | | | | | | | | | |
| kab3Vi | | | | | | | | | | | 3 | | | | | | | | 1 |
| kab3Hi | | | | | | | | | | | 4 | | | | | | | | |
| kab4Vi | | | | | | | | | | | 65 | | | | 8 | | | | 2 |
| kab4hi | | | | | | | | | | | 46 | | | | | | | | |
| kab4m1 | | | | | | | | | | | 6 | | | | | | | | |
| kab4m2 | | | | | | | | | | | 4 | | | | | | | | 1 |
| kab4f1 | | | | | | | | | | | | | | | | | | | |
| nor1Vi | | | | | | | | | | | 3 | | | | | | | | |
| nor1Hi | | | | | | | | | | | 3 | | | | | | | | |
| nor1m1 | | | | | | | | | | | 32 | | | | | | | | |
| nor1m2 | | | | | | | 1 | | | | 35 | | | | | | | | |
| nor1f1 | | | | | | | | | | | 9 | | | | | | | | |
| nor1f2 | | | | | | | | | | | 2 | | | | | | | | |
| nor2Vi | | | | | | | | | | | 1 | | | | | | | | |
| nor2Hi | | | 1 | | | | | | | | 123 | | | 2 | 2 | | | | 3 |
| nor2m1 | | | | | | | | | | | 98 | | | | | | 1 | | 1 |
| nor2m2 | | | | | | | | | | | 118 | | | | | | | | 1 |
| nor2f1 | | | | | | | | | | | | | | | | | | | |
| nor2f2 | | | | | | | | | | | 1 | | | | | | | | |
| nor3Vi | | | | | | | | | | | 5 | | | | | | 1 | | 1 |
| nor3Hi | | | | | | | | | | | 64 | | | | | | | | |
| nor3m1 | | | | | | | | | | | 49 | | | | | | | | |
| nor3m2 | | | | | | | | | | | 22 | | | | | | | | |
| nor3f1 | | | | | | | | | | | 18 | | | | | | | | |
| nor3f2 | | | | | | | | | | | 13 | | | | | | | | |
| nor4Vi | | | | | | | | | | | 110 | | | | | | | | |
| nor4Hi | | 1 | | | | | | | | | 70 | | | | | | | | |
| nor4m1 | | | | | | | | | 1 | | 16 | | | | | | | | |
| nor4m2 | | | | | | | | | | | 16 | | | | | | | | |
| nor4f1 | | | | | | | | | | | 1 | | | | | | | | |
| nor4f2 | | | | | | | | | | | 3 | | | | | | | | |
| ene1i | | | | | | | | | | | 36 | | | | | | | | |
| ene1m1 | | | | | | | | | | | | | | | | 4 | | | |
| ene1m2 | | | | | | | | | | | | | | | | 10 | | | |
| ene1f1 | | | | | | | | | | | | | | | | | | | |
| ene2i | | | | | | | | | | | 24 | | | | | | | | 2 |
| ene3i | | | | | | | | | | | 63 | | | | | | | | 7 |
| ene4i | | | | | | | | | | | 132 | | | | 1 | | | | 10 |
| ene4m1 | | | | | | | | | | | 5 | | | | | | | | |
| ene4m2 | | | | | | | | | | | 11 | | | | | | | | |

## Appendix 14. Taxa in all wet sedimentation ponds in all the four surveys in this study.

| | Coenagrionidae | Mesolvellia furcata | Hebrus ruficeps | Gerris lateralis | Gerris lacustris | Gerris odontogaster | Gerridae larvae | Nepa cinerea | Notonecta glauca | Notonecta lutea | Notonecta reuteri | Notonecta sp nymph | Corixidae nymph | Artocorisa carinata | Arctocorisa germari | Arctocorisa sp | Hebridae nymph | Heteroptera larvae | Copepoda |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sku1i | | | | | | | | | 1 | | | | | | | | | | |
| sku1m1 | | | | | | | | | | | | | | | | | | | |
| sku1m2 | 7 | | | | | | | | | | | | | | | | | | |
| sku1f1 | | | | | | | | | | | | | | | | | | | |
| sku1f2 | | | | | | | | | | | | | | | | | | | |
| sku2i | | | | | | | | | | | | | | | | | | | |
| sku2m1 | 2 | | | | | | | | | | | | 1 | | | | | | |
| sku2m2 | | | | | 1 | | | | | | | 1 | | | | | | | |
| sku2f1 | | | | | | | | | | | | | | | | | | | |
| sku2f2 | | | | | | | | | | | | | | | | | | | |
| sku3i | | | | | | | | | | | | | | | | | | | 6 |
| sku3m1 | 1 | | | 2 | | 1 | | | | | | | 5 | 1 | | | | | 3 |
| sku3m2 | 4 | | | | | 1 | | | | | | | | | | | | | |
| sku3f1 | | | | | | | | | | | | | | | | | | | 1 |
| sku3f2 | | | | | | | | | | | | | | | | | | | 11 |
| sku4i | | | | | | | | | | | | | | | | | | | |
| sku4m1 | 2 | | | | | 1 | | | | | | | 2 | | | 6 | | | |
| sku4m2 | 1 | | | | | 1 | | | | | 1 | | | | | | | | |
| sku4f1 | | | | | | | | | | | | | | | | | | | |
| sku4f2 | | | | | | | | | | | | | | | | | | | |
| tan1i | | | | | | | | | | | | | | | | | | | 90 |
| tan1m1 | 19 | | | | | 1 | | | | | | | | | | 3 | | | |
| tan1m2 | 43 | | | | | 1 | | | | | | | | | | 2 | | | |
| tan1f1 | | | | | | | | | | | | | | | | | | | |
| tan1f2 | | | | | | | | | | | | | | | | | | | |
| tan2i | | | | | | | 1 | | | | 3 | | | | | | | | |
| tan2m1 | 5 | | | | | 3 | 11 | | 1 | | 3 | 1 | | | | | 1 | | |
| tan2m2 | 13 | | | | | | 2 | | | | 7 | | 8 | | | | 1 | | |
| tan2f1 | | | | | | | | | | | | | | | | | | | |
| tan2f2 | 1 | | | | | | | | | | 2 | | | | | | | | |
| tan3i | | | | | | | | | | | 1 | | 1 | | | | | 1 | 4 |
| tan3m1 | 78 | | | | | | 2 | | | | | | 2 | 1 | | | | | |
| tan3m2 | 52 | | | 6 | | 2 | 3 | | | | | | | | | | | | |
| tan3f1 | | | | | | | | | 1 | 2 | | | | | | | | | |
| tan3f2 | | | | | | | | | | | | | | | | | | | |
| tan4i | 2 | | | | | | | | | | | | | | | | | | 45 |
| tan4m1 | 58 | | | | | | | | | | | | | | | | | | |
| tan4m2 | 14 | | | | | 1 | | | | | 1 | | | | | | | | |
| tan4f1 | 4 | | | | | | | | | | | | | | | | | | 3 |
| tak1i | 1 | | | | | | | | | | | | | | | 1 | | | |
| tak1m1 | 6 | | | | | | | | | | | | | | | | | | |
| tak1m2 | 7 | | | | | | | | | | | | | | | | | | |
| tak1f1 | | | | | | | | | | | | | | | | | | | |
| tak1f2 | | | | | | | | | | | | | | | | | | | |
| tak2i | 1 | | | | | | | | 22 | | | | | | | | | | |
| tak2m1 | 5 | | | | | | 1 | | 6 | | 14 | | | | | | | | |
| tak2m2 | | | | | | | | | 6 | | | | | | | | | | |
| tak2f1 | 2 | | | | | | | | | | | | | | | | | | |
| tak2f2 | | | | | | | | | | | | | | | | | | | |
| tak3i | 3 | | | | | | 1 | | | | | | | | | | | | 10 |
| tak3m1 | 6 | 1 | | | 2 | | 4 | | | | | | | | | | | | |
| tak3m2 | 4 | | | | | 1 | 1 | | | | 1 | | | | | | | | 157 |
| tak3f1 | | | | | | | | | | | | | | | | | | | |
| tak3f2 | | | | | | | | | | | | | | | | | | | 3 |
| tak4i | | | | | | | | | | | | | | | | | | | |
| tak4m1 | 2 | | | | | | | | | | | | | | | | | | |
| tak4m2 | 1 | | | | | 1 | | | | | | | | | | | | | |
| tak4f1 | | | | | | | | | | | | | | | | | | | |
| tak4f2 | | | | | | | | | | | | | | | | | | | 5 |
| tas1i | 1 | | | | | | | | | | | | | | | 1 | | | |
| tas1m1 | 4 | | | | | 1 | | | | | | | | | | | | | |
| tas1m2 | 12 | | | | | | | | | | | | | | | | | | |
| tas1f1 | 2 | | | | | | | | | | | | | | | | | | |
| tas1f2 | 1 | | | | | | | | | | | | | | | | | | |
| tas2i | 3 | | | | | 1 | 9 | | | | 5 | | 1 | | | | | | |
| tas2m1 | 7 | | | | | 1 | 7 | | | | 2 | | | | | | | | |
| tas2m2 | 3 | | | | | 1 | 2 | | | | 3 | | | | | | | | |
| tas2f1 | | | | | | | 2 | | | | | | | | | | | | |
| tas2f2 | | | | | | | 3 | | | | | | | | | | | | |
| tas3i | 3 | | | | | 1 | | | 1 | | 1 | | | | | | | | |
| tas3m1 | 16 | | | | 1 | 2 | | | | | 1 | | | | | | | | |
| tas3m2 | 5 | | | | | 1 | | | | | | | | | | | | | |
| tas3f1 | | | | | | | | | | | | | | | | | | | |
| tas3f2 | | | | | | | | | | | | | | | | | | | |
| tas4i | 13 | | | | | | | | | | | | | | | 12 | | | |
| tas4m1 | 10 | | | | | | | | | | | | | | | | | | |
| tas4m2 | 20 | | | | | 1 | | | 1 | | | | | | | 1 | | | |
| tas4f1 | | | | | | | | | | | | | | | | | | | |
| tas4f2 | 1 | | | | | | | | | | | | | | | | | | |
| nøs1i | | | | | | | | | | | | | | | | 1 | | | |
| nøs1m1 | | | | | | | | | 1 | | | | | | | | | | |
| nøs1m2 | | | | | | | | | | | | | | | | | | | |
| nøs1f1 | | | | | | | | | | | | | | | | | | | |
| nøs1f2 | | | | | | | | | | | | | | | | | | | |
| nøs2i | 1 | | | | | | | | | | 2 | | | | | | | | |
| nøs2m1 | | | | | | | | | | | 15 | | | | | | | | |
| nøs2m2 | 1 | | | | | | | | | | 1 | | | | | | | | |
| nøs2f1 | | | | | | | | | | | | | | | | | | | |
| nøs2f2 | | | | | | | | | | | | | | | | | | | |
| nøs3i | | | | | | | 1 | | | | | | | | | | | | |
| nøs3m1 | 1 | | | | | | | | | | | | | | | | | | 1 |
| nøs3m2 | 3 | | | | | | | | | | 1 | | | | | | | | |
| nøs3f1 | | | | | | | | | | | | | | | | | | | |
| nøs3f2 | | | | | | | | | | | | | | | | | | | 3 |
| nøs4i | | | | | | | | | 2 | | | | | | | 6 | | | 12 |
| nøs4m1 | 1 | | | | | | | | | | | | | | | | | | 35 |
| nøs4m2 | 4 | | | | | 1 | | | 5 | | | | | | | | | | 2 |
| nøs4f1 | | | | | | | | | 1 | | | | | | | | | | |
| nøs4f2 | | | | | | | | | | | | | | | | | | | 2 |
| vas1i | | | | | | | | | | | | | | | | | | | |
| vas1m1 | | | | | | | | | | | | | | | | | | | |
| vas1m2 | | | | | | | | | | | | | | | | | | | |
| vas1f1 | | | | | | | | | | | 2 | | | | | | | | |
| vas1f2 | | | | | | | | | | | | | | | | | | | |
| vas2i | | | | | | 1 | | | 1 | | | | | | | | | | |
| vas2m1 | | | | | | 1 | 3 | | | | 17 | | | | | | | | |
| vas2m2 | 1 | | | | | 2 | 8 | | | | 11 | 1 | | | | | | | |
| vas2f1 | | | | | | | | | | | | 1 | | | | | | | |
| vas2f2 | | | | | | | | | | | | | | | | | | | |
| vas3i | | | | | | | | | | | | | | | | | | | |
| vas3m1 | 11 | | | 6 | | 1 | | | 4 | | 2 | | 3 | | | | | | |
| vas3m2 | 33 | | | 3 | | 5 | | | | | | | 25 | | | | | | |
| vas3f1 | | | | | | | | | 3 | | | | | | | | | | |
| vas3f2 | | | | | | | | | | | | | 4 | | | | | | |
| vas4i | | | | | | | | | 4 | | | | | | | | | | 1 |
| vas4m1 | 2 | | | | | | | | 1 | | | | | | | 2 | | | |
| vas4m2 | 3 | | | | | | | | | | | | | | | | | | |
| vas4f1 | | | | | | | | | 1 | | | | | | | | | | |
| vas4f2 | 1 | | | | | | | | | | | | | | | | | | |

## Appendix 15. Taxa in all wet sedimentation ponds in all the four surveys in this study.

| | Coenagrionidae | Mesolvellia furcata | Hebrus ruficeps | Gerris lateralis | Gerris lacustris | Gerris odontogaster | Gerridae larvae | Nepa cinerea | Notonecta glauca | Notonecta lutea | Notonecta reuteri | Notonecta sp nymph | Corixidae nymph | Artocorisa carinata | Arctocorisa germari | Arctocorisa sp | Hebridae nymph | Heteroptera larvae | Copepoda |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| vasTi | | 2 | | | | | | | | | | | | | | | | | |
| vasTm1 | | | | | | 2 | 1 | | | | | | | | | | | | |
| vasTm2 | | | | | | | | | | | 2 | | | | | | | | |
| vasTf1 | | | | | | | | | | | | | | | | | | | |
| vasTf2 | | | | | | | | | | | | | | | | | | | |
| Fiu1i | | | | | 2 | | | | | | | | | | | | | | |
| Fiu1m1 | | | | | | | | | | | | | | | | | | | |
| fiu1m2 | | | | | 1 | | | | | | | | | | | | | | |
| fiu1f1 | | | | | | | | | | | | | | | | | | | |
| fiu1f2 | | | | | | | | | | | | | | | | | | | |
| fiu2i | | | | | | | | | | | | | | | | | | | |
| fiu2m1 | | | | | | | | | | | | | | | | | | | |
| fiu2m2 | | | | | | 1 | | | | | | | | | | | | | 8 |
| fiu2f1 | | | | | | | | | | | | | | | | | | | 2 |
| fiu2f2 | | | | | | | | | | | 1 | | | | | | | | |
| fiu3i | | | | 3 | | | | | 2 | | 1 | | | | | | | | |
| fiu3m1 | | | | | | | | | | | | | 1 | | | | | | 25 |
| fiu3m2 | | | | | | | | | | | | | | | | | | | 19 |
| fiu3f1 | | 1 | | | | | | | | | | | | | | | | | 5 |
| fiu3f2 | | | | | | | | | | | | | | | | | | | |
| fiu4i | | | | | | | | | 1 | | | | | | | | | | 16 |
| fiu4m1 | | | | | | | | | | | | | | | | | | | |
| fiu4m2 | | | | | | | | | | | | | | | | | | | 10 |
| fiu4f1 | | | | | | | | | | | | | | | | | | | |
| fiu4f2 | | | | | | | | | | | | | | | | | | | 1 |
| sås1i | | | | | | | | | | | | | | | | | | | |
| sås1m1 | | | | | | | | | | | | | | | | | | | |
| sås1m2 | | | | | | | | | | | | | | | | 1 | | | |
| sås1f1 | | | | | | | | | | | 3 | | | | | | | | |
| sås1f2 | | | | | | | | | | | 15 | | | | | | | | |
| sås2i | | | | | | | | | | | | | | | | | | | |
| sås2m1 | | | | | | 1 | | | 2 | | 18 | | | | | | | | 3 |
| sås2m2 | | | | | | | 1 | | | | 4 | | | | | | | | 4 |
| sås2f1 | | | | | | | | | | | | | | | | | | | 4 |
| sås2f2 | | | | | | | | | | | | | | | | | | | 1 |
| sås3i | | | | | | 2 | | | | | 3 | | | | | | | | 70 |
| sås3m1 | | | | | | 2 | 1 | | | | | | | | | | | | 10 |
| sås3m2 | | | | | | 1 | 2 | | 2 | | | | | | | | | | 82 |
| sås3f1 | | | | | | | | | | | | | | | | | | | 1 |
| sås3f2 | | | | | | | | | | | | | | | | | | | 2 |
| sås4i | | | | | | | | | 2 | | | | | | | | | | 4 |
| sås4m1 | | | | | | | | | | | | | | | | | | | 5 |
| sås4m2 | | | | | | 1 | | | | | 1 | | | | | | | | 1 |
| sås4f1 | | | | | | | | | | | | | | | | | | | 11 |
| sås4f2 | | | | | | | | 1 | | | | | | | | | | | 1 |
| idr1Vi | | | | | | | | | | | | | | | | | | | |
| idr1Hi | | | | | | | | | | | | | | | | | | | 225 |
| idr1m1 | | | | | | | | | | | | | | | | | | | |
| idr1m2 | | | | | | | | | | | | | | | | | | | |
| idr1f1 | | | | | | | | | | | | | | | | | | | |
| idr2Vi | | 1 | | | | 1 | | | 2 | | | | | | | | | | |
| idr2Hi | 2 | | | | | | | | | | 2 | 1 | | | | | | | 3 |
| idr2m1 | 1 | | | | | 1 | | | | | | | | | | | | | 7 |
| idr2m2 | | | | | | | | | | | | | | | | | | | |
| idr2f1 | | | | | | | | | | | | | | | | | | | |
| idr2f2 | | | | | | | | | | | | | | | | | | | |
| idr3Vi | | | | | | | | | | | | | | | | 6 | | | |
| idr3Hi | 24 | | | | | | | | | | | | | | | | | | |
| idr3m1 | | | | | | | | | | | | | | | | | | | |
| idr3m2 | | | | | | | | | | | | | | | | | | | |
| idr3f1 | | | | | | | | | | | | | | | | | | | |
| idr3f2 | | | | | | | | | | | | | | | | | | | |
| idr4Vi | | | | | | | | | | | | | | | | 1 | | | |
| idr4Hi | 119 | | | | | | | | | | | | | | | | | | 4 |
| idr4m1 | | | | | | | | | | | | | | | | | | | |
| idr4m2 | | | | | | | | | | | | | | | | | | | |
| idr4f1 | | | | | | | | | | | | | | | | | | | |
| idr4f2 | | | | | | | | | | | | | | | | | | | |
| kab1Vi | 1 | | 1 | | | | | | | | | | | | | | | | |
| kab1Hi | | | | | | | | | | | | | | | | | | | |
| kab1m1 | | | | | | | | | | | | | | | | | | | |
| kab1m2 | | | | | | | | | | | | | | | | | | | |
| kab1f1 | | | | | | | | | | | | | | | | | | | |
| kab1f2 | | | | | | | | | | | | | | | | | | | |
| kab2Vi | | | | | | | 4 | | 1 | | | 8 | | | | | | | |
| kab2Hi | | | | | | | | | | | 14 | | | | | | | | 7 |
| kab2m1 | | | | | | | | | | | | | | | | | | | 187 |
| kab2m2 | | | | | | | | | | | | | | | | | | | 7 |
| kab2f1 | | | | | | | | | | | | | | | | | | | |
| kab2f2 | | | | | | | | | | | | | | | | | | | |
| kab3Vi | 2 | | | | | | | | | | | | 2 | | | | | | |
| kab3Hi | | | | | | 8 | | | 1 | | | | | | | | | | |
| kab4Vi | 1 | | | | | | | | | | | | | | | 1 | | | |
| kab4hi | | | | | | | | | | | | | | | | | | | |
| kab4m1 | 6 | | | | | | | | | | | | | | | | | | |
| kab4m2 | 5 | | | | | | | | | | | | | | | | | | 3 |
| kab4f1 | | | | | | | | | | | | | | | | | | | |
| nor1Vi | | | | | | | | | | | | | | | | | | | |
| nor1Hi | | | | | | | | | | | | | | | | | | | |
| nor1m1 | 3 | | | | | | | | 1 | | | | | | | | | | |
| nor1m2 | 7 | | | | | | | | | | | | | | | | | | |
| nor1f1 | 1 | | | | | | | 2 | | | 12 | | | | | | | | |
| nor1f2 | 1 | | | | | | | | 2 | | 4 | | | | | | | | |
| nor2Vi | | | | | | | | | | | 1 | | | | | | | | |
| nor2Hi | 11 | | | | | | | | | | 8 | | | | | | | | |
| nor2m1 | 12 | 1 | | | | 2 | 1 | | 1 | | 11 | | | | | | | | |
| nor2m2 | 1 | | | | | | 1 | | | | 13 | | | | 1 | | | | |
| nor2f1 | | | | | | | | | | | | | | | | | | | |
| nor2f2 | | | | | | | | | | | 1 | | | | | | | | 10 |
| nor3Vi | | | | | | 3 | 4 | | 2 | | | | | | | | | | 11 |
| nor3Hi | 2 | | | | | 1 | | | | | | | 1 | | | | | | |
| nor3m1 | 6 | | | | | | 3 | | | | | | | | | 10 | | | |
| nor3m2 | 2 | | | | | | | | | | | | | | | | | | |
| nor3f1 | | | | | | | | | 1 | | | | | | | | | | |
| nor3f2 | 1 | | | | | 1 | | | | | | | | | | | | | 1 |
| nor4Vi | 1 | | | | | | | | 3 | | 1 | | | | | | | | |
| nor4Hi | 7 | | | | | | | | | | | | | | | 1 | | | |
| nor4m1 | 14 | | | | | | | | | | | | | | | | | | |
| nor4m2 | 4 | | | | | | 1 | | 3 | | | | | | | | | | |
| nor4f1 | | | | | | | | | | | | | | | | | | | |
| nor4f2 | | | | | | | | | | | | | | | | | | | |
| ene1i | | | | | | | | | | | | | | | | | | | |
| ene1m1 | | | | | | | | | | | | | | | | | | | |
| ene1m2 | | | | | | | | | | | | | | | | | | | |
| ene1f1 | | | | | | | | | | | | | | | | | | | |
| ene2i | | | | | | 1 | | | | | 5 | | | | | | | | |
| ene3i | | 2 | | | | 3 | 1 | | | | | | | | | | | | |
| ene4i | | | | | | | | | | | | | | | | | | | |
| ene4m1 | | | | | | | | | | | | | | | | | | | |
| ene4m2 | | | | 1 | | | | | | | | | | | | | | | |

## Appendix 16. Taxa in all wet sedimentation ponds in all the four surveys in this study.

| | *Cladocera* | *Triturus sp larvae* | *Triturus vulgaris* | *Rana sp* | *Planorbidae* | *Sphaeridae* | *Nemurella pictetii* | *Nemoura cinerea* | *Phoxinus phoxinus* | *Hirudinea* | *Collembola* | *Chaoboridae* | *Tabanidae* | *Culicidae larvae* | *Sialis lutaria* | *Hydracarina* | *Pyralidae larvae* | *Oligochaeta* | *Asellus aquaticus* | *Tipulidae* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sku1i | | | | | 308 | | | | | | | | | | | | | | 1 | |
| sku1m1 | | | | | | | | | | | | | | | | | | | | |
| sku1m2 | | | | | | | | | | | | | | | | | | | | |
| sku1f1 | | | | | | | | | | 1 | | | | | | | | | | |
| sku1f2 | 75 | | | | | | | | 7 | | | | | | | | | | | |
| sku2i | 4 | | | | 13 | | | | | | | | | | | | | | | |
| sku2m1 | 2 | | | | 11 | | | | | | | | | | | | | | | |
| sku2m2 | 9 | | | | | | | | | | | | | | | 1 | | | | |
| sku2f1 | | | | 2 | | | | | | | | | | | | | | | | |
| sku2f2 | 1 | | | | | | | | 6 | | | | | | | | | | | |
| sku3i | 345 | | | | | | | | | | | | | | | | | | | |
| sku3m1 | 228 | | | | 4 | | | | | | | | | | | | | | | |
| sku3m2 | | | | | | | | | | | | | | | | | | | | |
| sku3f1 | | | | | | | | | | | | | | | | | | | | |
| sku3f2 | 75 | | | | | | | | | | | | | | | | | | | |
| sku4i | | | | | 3 | 101 | | | | 1 | | | | | | | | | | |
| sku4m1 | | | | | | | | | | | | | | | | | | | | |
| sku4m2 | 4 | | | | | | | | | | 2 | | | | | 1 | | | | |
| sku4f1 | | | | | | | | | 7 | | | | | | | | | | | |
| sku4f2 | | | | | | | | | 4 | | | | | | | | | | | |
| tan1i | 150 | | | | | | | | | | | 4 | | | | | | | | |
| tan1m1 | 75 | | | | | | | | | | | | | | | | | | | |
| tan1m2 | 300 | | | | | | | | | | 1 | 46 | | | | | | | | |
| tan1f1 | | | 6 | | | | | | | | | | | | | | | | | |
| tan1f2 | | | | | | | | | | | | | | | | | | | | |
| tan2i | | | | | | | | | | | | 4 | 14 | | | | | | | |
| tan2m1 | | 1 | | | | | | | | | | | | | | 1 | 2 | | | |
| tan2m2 | 109 | | | | | | | | | | 2 | | | | | | | | | |
| tan2f1 | | | | | | | | | | | | | | | | | | | | |
| tan2f2 | | | | | | | | | | | | | | | | | | | | |
| tan3i | 112 | 6 | | | 65 | | | | | | | | | | | | | | | |
| tan3m1 | 158 | | | | | | | | | | | | | | | 1 | | | | |
| tan3m2 | 152 | | | | | | | | | | | | | | | | 1 | 10 | | |
| tan3f1 | | | | | | | | | | | | | | | | | | | | |
| tan3f2 | | | | | | | | | | | | | | | | | | | | |
| tan4i | 50 | 1 | | | | | | | | | | | | | | | | | 1 | |
| tan4m1 | 10 | | | | | | | | | | | | | | | | | | | |
| tan4m2 | | | | | | | | | | | | | | | | | | | | |
| tan4f1 | | | | | | 1 | | | | | | 1 | | | | | | | | |
| tak1i | 150 | | | | 6 | 36 | | | | | 1 | 11 | | | | | | | | |
| tak1m1 | 150 | | | | | 3 | | | | | 1 | | | | | | | | | |
| tak1m2 | | | | | | 7 | | | | | | | | | 1 | | | | | |
| tak1f1 | | | | | | | | | | | | | | | | | | | | |
| tak1f2 | | | | | | 1 | | | | | | | | | | | | | | |
| tak2i | 15 | | | | | 7 | | | | | | 4 | | | | 1 | | | | |
| tak2m1 | | | | | | 11 | | | | | | 6 | | | | | | | | |
| tak2m2 | | | | | | 7 | | | | | | 7 | | | | | | | | |
| tak2f1 | | | | | | | | | | | | | | | | | | | | |
| tak2f2 | | | | | | | | | | | | | | | | | | | | |
| tak3i | 1070 | | | | 2 | 35 | | | | | | | | | | 1 | | | | |
| tak3m1 | 192 | | | | | | | | | | | | | | | 5 | | 1 | | |
| tak3m2 | 225 | | | | | 7 | | | | | | | | | | | | | | |
| tak3f1 | | | | | | 1 | | | | | | | | | | | | | | |
| tak3f2 | 1 | | | | | 1 | | | | | 1 | | | | | | | | | |
| tak4i | 15 | | | | | 9 | | | | | | | | | | | | | | |
| tak4m1 | 21 | | | | | 1 | | | | | | 11 | | | | | | | | |
| tak4m2 | 16 | | | | | 15 | | | | | 1 | 5 | 1 | | | | 1 | | | |
| tak4f1 | | | | | | 2 | | | | | | | | | | | | | | |
| tak4f2 | | | | | | 2 | | | | | | | | | | | | | | |
| tas1i | 105 | | | | | | | | | | | 11 | | | | | | | | |
| tas1m1 | 450 | | | | | | | | | | | 4 | | | | | | | | |
| tas1m2 | 150 | | | | | | | | | | | 3 | | | | | | | | |
| tas1f1 | | | | | | | | | | | | | | | | | | | | |
| tas1f2 | | | | | | | | | | | | 1 | | | | | | | | |
| tas2i | 120 | | | | | 150 | | | | | | | | | | | | | | |
| tas2m1 | 150 | | | | | 180 | | | | | | 9 | 2 | | | | | | | |
| tas2m2 | 600 | | | | | 210 | | | | | | 6 | | | | | | | | |
| tas2f1 | | | | | | | | | | | | | | | | | | | | |
| tas2f2 | | | | | | | | | | | | | | | | | | | | |
| tas3i | 800 | | | | | | | | | | | | | | | 1 | | | | |
| tas3m1 | 600 | | | | | | | | | 1 | | | | | | | | | | |
| tas3m2 | 1290 | | | | | | | | | | | 1 | | | | 1 | | | | |
| tas3f1 | | | | | | | | | | | | | | | | | | | | |
| tas3f2 | 4 | | | | | 3 | | | | | 2 | | | | | | | | | |
| tas4i | 900 | | | | | | | | | | | 2 | | | | | | | | |
| tas4m1 | 850 | | | | 1 | | | | | | | 1 | | | | | | | | |
| tas4m2 | 50 | | | | | | | | | 1 | 1 | | | | | | | | | |
| tas4f1 | 4 | | | | | | | | | | | | | | | | | | | |
| tas4f2 | 4 | | | | | | | | | | | | | | | | | | | |
| nøs1i | 75 | | | | | | | | | | 49 | | | | | | | | | |
| nøs1m1 | 30 | | | | 3 | | | | | | 8 | | | | | | | | | |
| nøs1m2 | | | | | 1 | | | | | | 4 | | | | | | | | | |
| nøs1f1 | | | 8 | | | | | | | | | | | | | | | | | |
| nøs1f2 | | | | | | | | | | | | | | | | | | | | |
| nøs2i | 2 | | | | | | | | | | 1 | | | | | 1 | | | | |
| nøs2m1 | | | | | | | | | | | 3 | 3 | | | | | | | | |
| nøs2m2 | | | | | | | | | | | | 2 | | | | | | | | |
| nøs2f1 | | | | | | 1 | | | | | | 1 | | | | | | | | |
| nøs2f2 | | | | | | | | | | | | | | | | | | | | |
| nøs3i | 10 | | | | | 1 | | | | | | 11 | | | | 2 | | | | |
| nøs3m1 | 5 | | | | 3 | | | | | 1 | | 5 | | | | | | | | |
| nøs3m2 | 6 | 1 | | | | 1 | | | | | | 1 | | | | | | | | |
| nøs3f1 | | 1 | | | | | | | | | | | | | | 1 | | | | |
| nøs3f2 | | | | | | | | | | | | | | | | | | | | |
| nøs4i | | | | | 2 | | | | | | | 2 | | | | | | | | |
| nøs4m1 | 10 | | | | | | | | | | | 12 | | | | | | | | |
| nøs4m2 | 2 | | | | | | | | | | 1 | 6 | | | | | | | | |
| nøs4f1 | | | | | | | | | | | | | | | | | | | | |
| nøs4f2 | | | | | | | | | | 1 | | | | | | | | | | |
| vas1i | | | | | | | | | | | 1 | | | | | | | | | |
| vas1m1 | | | | | | | | | | | 1 | | | | | | | | | |
| vas1m2 | | | | | 1 | 1 | | | | | | 7 | | | | | | | | |
| vas1f1 | | | | | | | | | | | | | | | | | | | | |
| vas1f2 | | | | | | | | | | | | | | | | | | | | |
| vas2i | 2 | | | | | | | | | | | 5 | | | | | | | | |
| vas2m1 | 906 | | | | | 800 | | | | 1 | | 1 | | | | | | | | |
| vas2m2 | 927 | | | | | 10 | | | | | | 15 | | | | | | | | |
| vas2f1 | | | | 31 | | | | | | | | | | | | | | | | |
| vas2f2 | | | | 400 | | | | | | | | | | | | | | | | |
| vas3i | | | | | | | | | | | | | | | | | | | | |
| vas3m1 | 1000 | | | | | 1 | | | | | | 88 | | | | | | | | |
| vas3m2 | 3600 | | | | | 1 | | | | | | 127 | | | | | | | | |
| vas3f1 | | | | | | | | | | | | | | | | | | | | |
| vas3f2 | 158 | | | | | | | | | | | 6 | | | | | | | | |
| vas4i | 3 | | | | | | | | | | 1 | | | 30 | | | | | | |
| vas4m1 | | | | | | | | | | | | | | | | | | | | |
| vas4m2 | | | | | | | | | | | | 2 | | | | | | | | |
| vas4f1 | | | | | | | | | | | | | | | | | | | | |
| vas4f2 | | | | | | | | | | | | | | | | | | | | |

## Appendix 17. Taxa in all wet sedimentation ponds in all the four surveys in this study.

| | *Cladocera* | *Triturus sp larvae* | *Triturus vulgaris* | *Rana sp* | *Planorbidae* | *Sphaeridae* | *Nemurella pictetii* | *Nemoura cinerea* | *Phoxinus phoxinus* | *Hirudinea* | *Collembola* | *Chaoboridae* | *Tabanidae* | *Culicidae larvae* | *Sialis lutaria* | *Hydracarina* | *Pyralidae larvae* | *Oligochaeta* | *Asellus aquaticus* | *Tipulidae* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| vasTi | 3 | | | 4 | | | | | | | 2 | | | | | | | | | |
| vasTm1 | 60 | | | | | 2 | | | | | | 39 | | | | | | 1 | | |
| vasTm2 | | | | 2 | | | | | | | | 39 | | | | 1 | | | | |
| vasTf1 | | | | | | | | | | | | | | | | | | | | |
| vasTf2 | | | | | | 47 | | | | | 8 | 3 | | | | | | | | |
| Fiu1i | 3 | | | | | 18 | | 1 | | 2 | | 9 | | | | 1 | | | | |
| Fiu1m1 | 30 | | | | | 29 | | | | 1 | 1 | | | | | 1 | | | | |
| fiu1m2 | 3 | | | | | | | 3 | | 2 | | | | | | | | | | |
| fiu1f1 | | | | | | | | | | | | 1 | | | | | | | | |
| fiu1f2 | | | | | | 3 | | | | | | 3 | | | | | | | | |
| fiu2i | 2 | | | | | 13 | | | | | | | | | | | | 9 | | |
| fiu2m1 | 301 | | | | | 6 | | | | | | | | | | | | | | |
| fiu2m2 | | | | 2 | | 24 | | | | | | 5 | | | | | | 52 | | |
| fiu2f1 | | | | 2 | 2 | 1 | | | | | | 3 | | | | | | | | |
| fiu2f2 | | | | | | | | | | | | | | | | | | | | |
| fiu3i | 150 | | | | | 18 | | | | | | | | | | | | 16 | | |
| fiu3m1 | 150 | | | | | 21 | | 1 | | | | | | | | | | 11 | | |
| fiu3m2 | 130 | | | | | 90 | | | | | | | | | | | | 5 | | |
| fiu3f1 | 11 | | | | | 11 | | | | | | 2 | | | | | | 1 | | |
| fiu3f2 | 17 | | | | | | | | | | | | | | | | | | | |
| fiu4i | | | | | | 1 | | | | | | 3 | | 2 | | | | 20 | 1 | |
| fiu4m1 | | | | | | 1 | | | | | | | | | | | | | | |
| fiu4m2 | | | | | | 2 | | | | | | 3 | | | | | | 3 | | |
| fiu4f1 | | | | | | | | | | | | | | | | | | | | |
| fiu4f2 | | | | | | 1 | | | | | | 1 | | | | | | | | |
| sås1i | 4 | | | | | 16 | | 5 | | 1 | 7 | 5 | | | | | | | | |
| sås1m1 | | | | | 122 | 107 | | | | | 4 | | | | | | 1 | | 2 | |
| sås1m2 | 5 | | | | 195 | 49 | | | | | 1 | | | | | | | | 3 | |
| sås1f1 | | | | | | 4 | | | | | | | | | | | | | | |
| sås1f2 | | | 2 | | | 6 | | | | | | | | | | | | | | |
| sås2i | | | | | 198 | 20 | | | | | 2 | | | | | 1 | 3 | 1 | 2 | |
| sås2m1 | 1 | | | | 8 | 19 | | | | | | | | | | | | | 2 | |
| sås2m2 | | | | | 37 | 20 | | | | | | | | | | | | | 6 | |
| sås2f1 | | | | | | 2 | | | | | | | | | | | | | | |
| sås2f2 | | | | | | | | | | | | | | | | | | | | |
| sås3i | 40 | 1 | | | | 79 | | | | | | | 1 | | | | | 1 | 11 | |
| sås3m1 | 309 | | | | | 99 | | | | | | | | | | | | | 9 | |
| sås3m2 | 81 | | | | 3 | 246 | | | | | | | 1 | | | | 1 | | 2 | |
| sås3f1 | 1 | | | | | 7 | | | | | | | | | | 1 | | | | |
| sås3f2 | | | | | 3 | 7 | | | | | | | | | | | | | | |
| sås4i | | | | | 2 | | | | | | | | 1 | | | | | | 35 | |
| sås4m1 | | | | | | 2 | | | | | | | | | | | | | 5 | |
| sås4m2 | | | | | 1 | | | | | | | | 1 | | | | | | 2 | |
| sås4f1 | | | | | | | | | | 1 | | | | | | | | | | |
| sås4f2 | | | | | | 12 | | | | | | | | | | | | | 1 | |
| idr1Vi | | | | | 1 | 15 | | | | | | | | | | | | 21 | | |
| idr1Hi | 9 | | | | | 105 | | | | | | | | | | | | 3 | | |
| idr1m1 | | | | | | 63 | | 33 | | | 6 | 2 | | | | | | | | 1 |
| idr1m2 | | | | | | 16 | | 5 | | | 12 | | | | | | | 3 | | |
| idr1f1 | | | 3 | | | 2 | | | | | | | | | | | | | | |
| idr2Vi | | | | | 1 | 10 | | | | | 1 | 6 | | | | | | 1 | | |
| idr2Hi | | | | | | 50 | | | | | | 1 | | | | | | 30 | | |
| idr2m1 | 7 | | | | | 85 | | 3 | | | 1 | | | | | | | 10 | | |
| idr2m2 | | | | | | 22 | | | | | 1 | | | | | | 1 | 4 | | 1 |
| idr2f1 | 1 | | | | | 4 | | | | | | | | | | | | | | |
| idr2f2 | 7 | | | | | | | | | | | | | | | | | | | |
| idr3Vi | | | | | | 1 | | | | | 1 | | | | | | | 3 | | |
| idr3Hi | | | | | 1 | 40 | | | | | 3 | | | | | | | | | |
| idr3m1 | | | | | | 9 | | | | | 1 | | | | | | | 4 | | |
| idr3m2 | | | | | | 11 | | | | | | | | | | | | | | |
| idr3f1 | | | | | | 4 | | | | | | | | | | | | 2 | | |
| idr3f2 | | | | | | 4 | | | | | 1 | | | | | | | 1 | | |
| idr4Vi | | | | | | | | | | | 1 | | | | | | | 45 | | |
| idr4Hi | | | | | | 3 | | | | 1 | 1 | | | | | | | | | |
| idr4m1 | | | | | | 2 | | | | | | | | 1 | | | | 6 | | |
| idr4m2 | | | | | | 2 | | | | | | | | | | | | 2 | | |
| idr4f1 | | | | | | 1 | | | | | | | | | | | | 2 | | |
| idr4f2 | | | | | | | | | | | | | | | | | | | | |
| kab1Vi | | | | | 1 | 15 | | | | | | | | | | | | | | |
| kab1Hi | 11 | | | | | 6 | | 4 | | | 1 | | | | | | | | 17 | |
| kab1m1 | 4 | | | | | 33 | | 2 | | | 1 | | | | | | | | 7 | |
| kab1m2 | 1 | | | | | 36 | | 4 | | | 7 | | | | | | | | 7 | |
| kab1f1 | 6 | | | | | | | | | | | | | | | | | | | |
| kab1f2 | 12 | | | | | | | | | | | | | | | | | | 1 | |
| kab2Vi | | | | | | 1 | | | | | | | | | | 1 | | 1 | | |
| kab2Hi | | | | | | 4 | | 1 | | | 2 | | | | | | | | | |
| kab2m1 | | | | | | 6 | | | | 1 | | | | | | | | | 37 | |
| kab2m2 | | | | | | 4 | | | | | | | | | | | | 1 | 2 | |
| kab2f1 | | | | | | 1 | | | | | 1 | | | | | | | | | |
| kab2f2 | | | | | | 1 | | | | | | | | | | | | | 1 | |
| kab3Vi | 5 | | | | | 11 | | | | | | | | | | 1 | | | 2 | |
| kab3Hi | | | | | 1 | 11 | | | | | | | | | | | | 1 | 1 | |
| kab4Vi | 22 | | | | | 4 | | | | | | | | | | | | 4 | 62 | |
| kab4hi | | | | | | 1 | | 1 | | 2 | | | 1 | | | | | 3 | 36 | |
| kab4m1 | | | | | | 4 | | | | 1 | 1 | | | | | | 1 | 1 | 17 | |
| kab4m2 | | | | | | 6 | | | | 1 | 4 | | | | | | 1 | | 39 | |
| kab4f1 | | 1 | | | | 2 | | | | | | | | | | | | | | |
| nor1Vi | 5 | | | | | 1 | | | | 1 | | | | | | | | | 1 | |
| nor1Hi | | | | | 3 | 4 | | | | | | | | | | | | | | |
| nor1m1 | 2 | | | | 63 | 78 | | | | | | | | | | | 1 | | | |
| nor1m2 | | | | | 45 | 95 | | | | 2 | 6 | | | | | | | | | |
| nor1f1 | 1 | | | | 1 | 1 | | | | | | | | | | | | | | |
| nor1f2 | | | 1 | | 1 | | | | | | | | | | | | | | | |
| nor2Vi | | | | | 2 | 4 | | 1 | | | | 2 | | | | | | 4 | 2 | 11 |
| nor2Hi | 240 | | | 6 | 54 | 6 | | | | 3 | 1 | | | | | | | | | |
| nor2m1 | 15 | | | 1 | 21 | 23 | | | | | 1 | | | | | | | | | |
| nor2m2 | 290 | | | | 11 | 21 | | | | | | | | | | 1 | | | | |
| nor2f1 | 8 | | | 2 | | | | | | | | | | | | | | | | |
| nor2f2 | 10 | | | 2 | 1 | | | | | | | | | | | | | | 1 | |
| nor3Vi | | 1 | | | | 155 | | | | | | | | | | 1 | | | | |
| nor3Hi | 165 | 1 | | | 260 | 39 | | | | 2 | | | | | | | | | | |
| nor3m1 | 180 | | | | 461 | 35 | | | | | | | | | | | 1 | | | |
| nor3m2 | | | | | 159 | 10 | | | | 1 | 2 | | | | | | 1 | | | |
| nor3f1 | 75 | | | | 2 | | | | | | | | | | | | | | | |
| nor3f2 | 60 | | | | | | | | | | | | | | | | | | | |
| nor4Vi | | | | | 1 | | | | | | | | | | | | | | 8 | |
| nor4Hi | | | | | | | | | | | | | | | | | | | | |
| nor4m1 | 7 | | | | 1 | 3 | | | | | | | | | | | 2 | | | |
| nor4m2 | | | | | | | | | | | | 1 | | | | | 3 | | | |
| nor4f1 | | | | | 2 | 1 | | | | | | | | | | | | | | |
| nor4f2 | | | | | 3 | | | | | | | | | | | | 1 | | | |
| ene1i | 3 | | | | | | | | | | | | | | | | 2 | | | |
| ene1m1 | | | | | | | 7 | 9 | | | | | | | | | | | | |
| ene1m2 | | | | | | | 5 | 9 | | | 2 | | | | | | | | | |
| ene1f1 | | | | | | | | | | 4 | | | | | | | | | | |
| ene2i | 160 | | | | | 7 | | | | | | | | | | 1 | 2 | | | |
| ene3i | 11 | | | 1 | 5 | 9 | | | | 1 | | | | | | 1 | | | | |
| ene4i | | | | | | | | | | | | | | | | | | | | |
| ene4m1 | | | | | | | | | | | | | | | | | | | | |
| ene4m2 | | | | | | | | | | | 1 | | | | | | | | | |