Carl Holmquist, Ida Sekizovic, Josefina Almén, Lourdes Martínez García and Sofia Magnusson

Habitat mapping - Höje å
Group one

Background

Höje å or Höje river is located in Skåne, Sweden (*figure 1)*. It is *ca.* 40 km long and according to the latest information from the "Höjeåprojektet" research (2017), it has an unsatisfactory ecological status, but the aim of the project is to reach a good ecological status by 2027.
The project in *Höje å* started in 1990 and it is considered the first project that aimed to conserve the water in wetlands in Skåne, Sweden. The purpose of this research is to increase the quality of the water, decrease the eutrophication and promote the protection of species in that area (Höje å vattenråd, 2017).

The main environmental impacts that can be found along the river are: nutrient pollution, chemical pollution and altered habitats due to morphological changes. The anthropogenic impacts in *Höje å* are: urban wastewater, agriculture, urban runoff and atmospheric deposition (Vatteninformationssystem Sverige, 2016).

Methods

Firstly, *Höje å* was divided into seven different sections and this report investigates the first area which belongs to a nature reserve (*figure 1).* To have a better understanding of the physical impacts in *Höje å,* a habitat mapping was performed with GIS along *ca.* 2 km of the right and left side of the river (*figure 2).* Habitat mapping is also a good tool to provide protection measures for nature reserves.
For the field mapping, the river was divided in 9 different sections, 4 on the left side (L) and 5 on the right side (R) depending on whenever the vegetation changed on the map. The habitat, biological values and threats to the river were quantified according to five protocols: A: Water habitat, B: Surroundings and environment, C: Tributaries and ditches, D: Barriers for fish migration and E: Road passages.

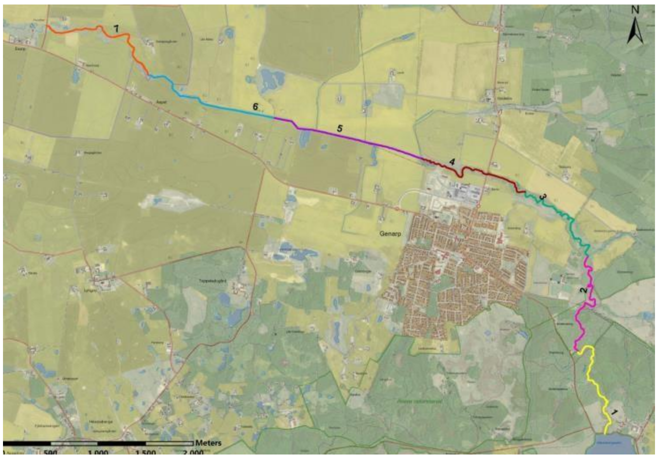

Figure 1. Höje å river divided into seven sections. This report investigates the yellow line (number 1 in the map) closest to the lake, Häckebergasjön.

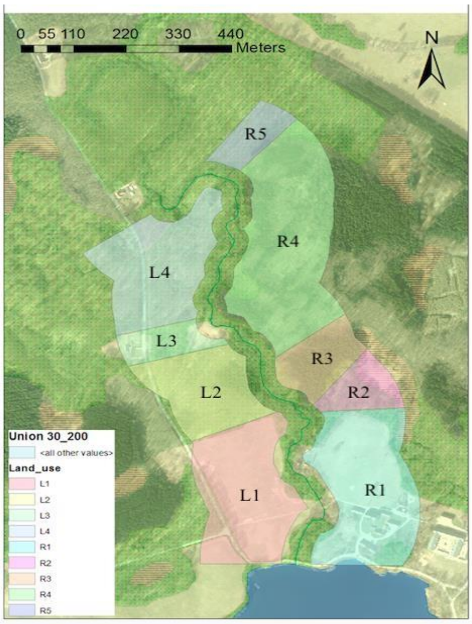

Figure 2. The different sections divided along the river by color.

Carl Holmquist, Ida Sekizovic, Josefina Almén, Lourdes Martínez García and Sofia Magnusson

Results & Discussion

Along the *ca.* 2 km of the first part of the river, the main substrate is clay, see *figure 3*. Cobbles are mostly found in the first section of the river.

The result of just having mainly clay in most of the sections of the area is that there are not many nursery habitats or resting spots (rock beds) for different invertebrates or vertebrates. As *Höje å* is a meandering river one could assume the opposite. Also, with the presence of clay, the secchi depth is lower in most of the sections in the river that might influence in the presence or absence of vegetation in *Höje å*.

High levels of shading in section three can be explained with the presence of mature forest. Whilst, at section one the high level of shading is not recognizable on the map but at site the ambient was full of trees.

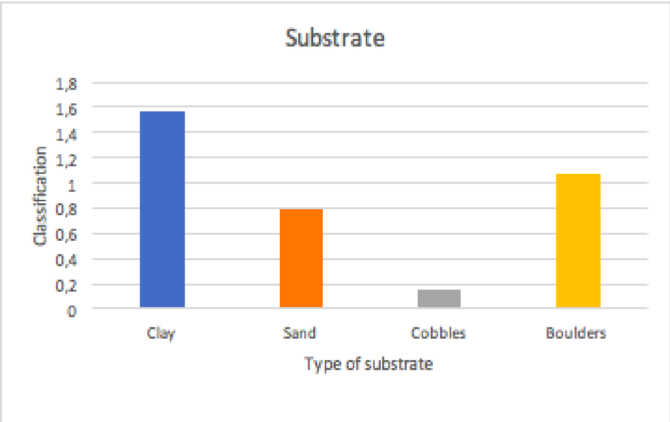

Figure 3. Differences in the substrates among the surroundings of the river according to protocol A, where 3 is >50% and 0 is missing.

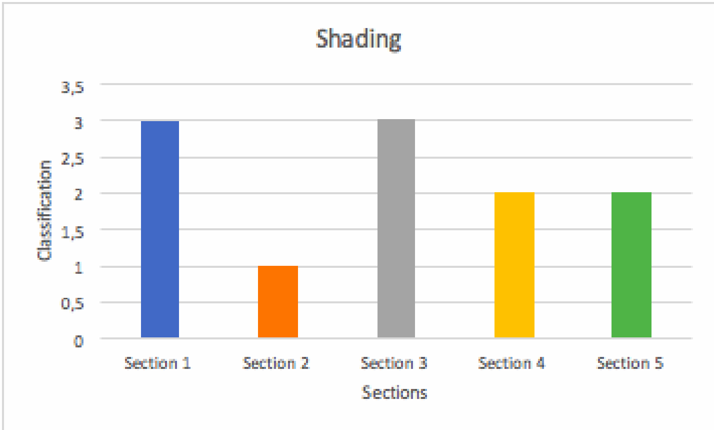

Figure 4. Differences between shading according to protocol A, where 3 is good and 0 is absent.

Figures 5 and 6 indicate that the surrounding and ambient area consists mainly of deciduous and young forest, illustrated in *figure 7*, whereas coniferous forest is presented in a low percentage. The presence of mixed forest in section one (L1), two (R2), three (R3) and four (R4), *see figure 8*, might suggest that the diversity surrounding the stream is higher due to a combination of niches. Forests provide beneficial effects, one of them being the presence of dead wood that was observed in field.

The data collected with the protocols show that this area of the river does not provide optimum nutrient sedimentation. However, a few wetlands were found at the end of the section where also the water had a slower flow, *see figure 7*.

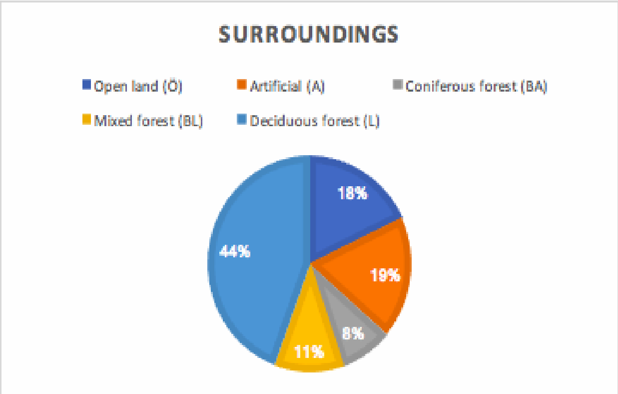

Figure 5. The percentage of different types of land use in the surrounding along the river according to protocol B.

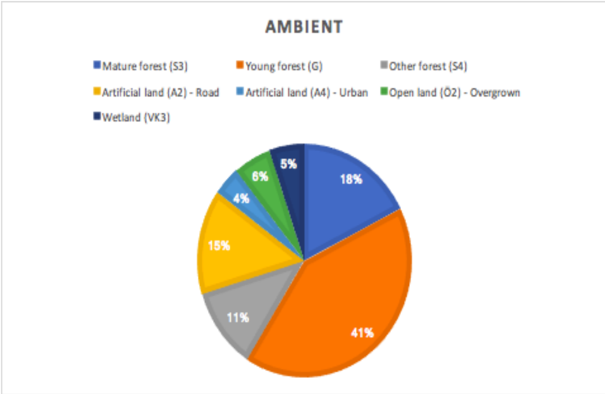

Figure 6. The percentage of different types of land use in the ambient along the river according to protocol B.

Figure 7. Largest width of the river located in section two (L2) to four (R4). Also indicating that the surroundings at this part is young forest.

Figure 8: Picture showing the surroundings in section two (R2) were one can clearly see that it is a mixed forest.

Along the river the water flow changes several times. At the inflow of water from the lake the flowing rate is rapid due to the drop height of the constructed culvert, *see figure 10*. Further on, the flow slows down and the river starts to meander through the landscape, see *figure 9*.

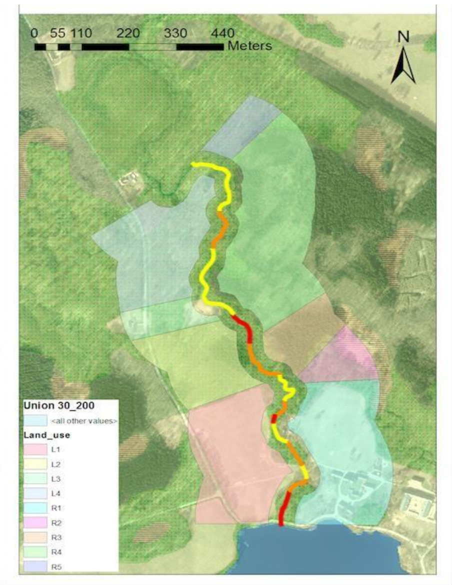

Figure 9. The flow throughout the river is represented by slow flow (yellow), flow (orange) and rapid flow (red).

Figure 10. Beginning of the river and the first road pass in section one (L1).

At the beginning of the river (section one), a barrier with four culverts has been constructed and is right underneath the road (*figure 10)*. The river is connected to the lake through this barrier and upon closer inspection *(figure 11)*, the drop height was approximately 2m which might cause difficulties for the fishes to cross.

Further along the river (still section one) there was another constructed barrier to enable passage. This barrier had two culverts with a low drop height, high depth and large diameter allowing fish to cross easily *(figure 12)*.

Figure 11. A close up of the culvert in section one.

Figure 12. Picture showing the second road passing in section one (L1).

In the sections one, two (L2), three and four there were natural barriers (fallen trees or dead wood), across the stream. These barriers make it harder for fish to cross due to the shallow water level; however, some species may be able to cross them.

To improve the trout crossing, fallen trees or dead wood consider to be total blockage, see *figure 13,* should be removed or put aside in the river, and stones should be placed to create more spawning areas, nursery habitats and available resting spots.
There were locations throughout the river with dead wood that did not cross the entire stream which can improve the rehabilitation and restoration of the river since dead wood is considered as good habitats for nursery areas, resting spots, etc.

Figure 13. Pictures showing two out of the four natural barriers in section two and three.

Conclusion

After the habitat mapping along *ca.* 2 km of *Höje å*, it can be suggested that some improvements can be done. Natural barriers that cause total blockage for fish passage should be taken away and some stones and pebbles should be artificially placed along the river to provide nursery habitats, spawning areas and resting spots.

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Habitat Mapping of Höje å, Scania Sweden

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2018-05-04

I. Introduction

During this excursion, the target of the inspection was the Höje river, which is a river located in Scania in the southern part of Sweden. Höje river is made up of water flowing from the lake called Häckebergasjön and ends in Öresund just outside Lomma. Our goal is, for a part of the river, to conduct a habitat mapping in order to classify certain characteristics of the river and the surrounding environment.

II. Methods

The habitat mapping was conducted using different protocols. Four protocols were used to assess section 2 of the river: water biotrope, surroundings/ambient environment, tributaries/ditches, and barriers to migration. The data was then transferred to excel in order to assess it in more detail. The surroundings of the stream were divided into eight different sections (Figure 1).

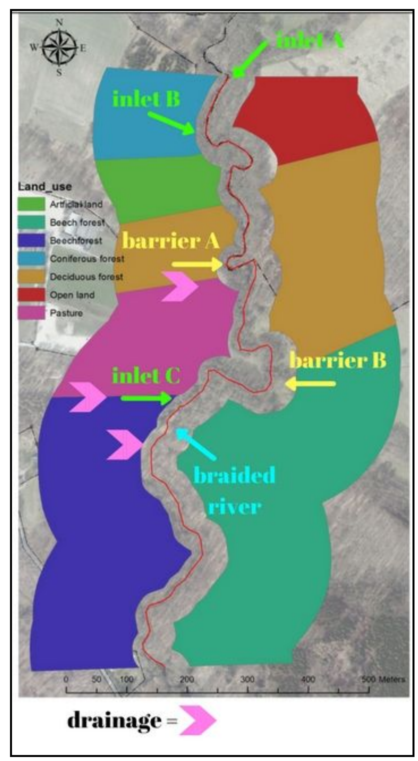

Figure 1. The locations of inlets, barriers to migration, drainage pipes, and braided river beds along the river section.

III. Observations

Three inlets/tributaries were observed along the river using protocol C. Inlet A was a 2 meter wide stretch leading in from the north into the river toward the lake. According to aerial maps, it is quite a long river that extends further north than we observed. Inlet B was a much smaller inlet that looked like it frequently dries up when the water levels are low. We hypothesize that inlet C is used for water draining due to its straight nature and its location near a pasture and buildings. It was also located near two drainage pipes. Two barriers to migration were also recorded in Protocol D. Both barriers were deemed passable by roach and trout without any injury. Barrier A consisted of dead wood logs. Barrier B consisted of large boulders and dead wood. The pink arrows in Figure 1 represent the drainage areas in the form of pipes. Three pipes were found along the river, with water flowing inward. We suspect the red and brown section on the right side did not have any drainage pipes because a majority of that coastline was an edge. A braided section of the stream was also present. This section was not a barrier to migration and possibly served as a spawning and nesting site for fish.

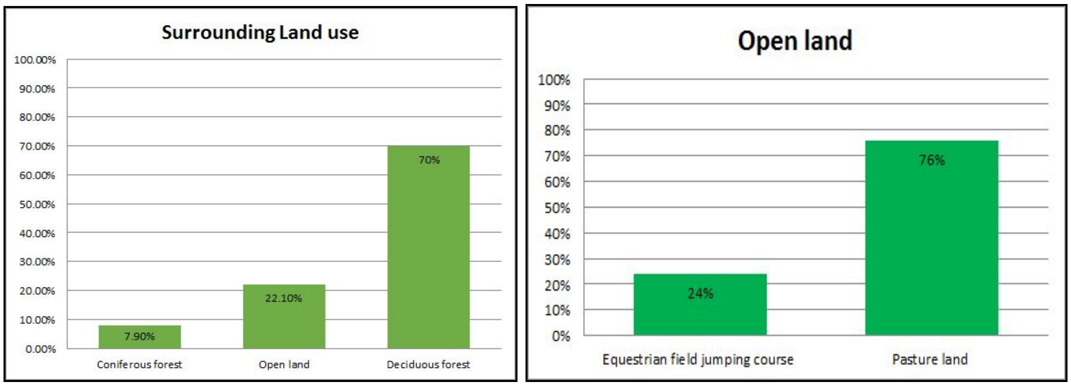

Figure 2. Surrounding land use observed 30-200 meters from the bank of the river (left). The open land was predominantly pasture land, with the rest of the land comprised of horseback riding fields (right).

A large section of this river had buffers either in the form of steep edges or flooding zones. Additionally, the course of the river changed throughout the stretch, with parts that were straight and parts that were turning and meandering. A majority of the land use surrounding the river was deciduous forests with some parts comprised of open land (Figure 2).

About 25% of the river had more than 50% shading. The other 75% of the river had between 5-50% shading. Most of the shading was downstream north of barrier A (Figure 1). The overall flow of our river stretch was gentle, with estimations between 0,1 m/s and 1 m/s. The flow was faster upstream (south) than it was downstream (north), possibly due to the straighter nature of the stream in the south. Our most notable observations were the locations of spawning sites for fish and the presence of dead wood.

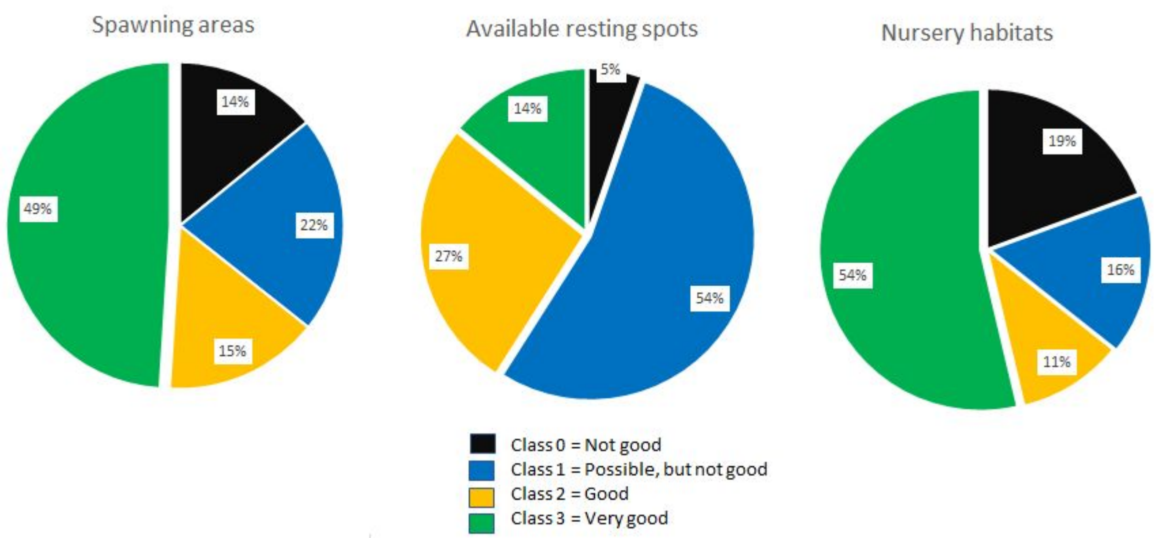

Figure 3. Available resting spots, spawning areas, and nursery habitats for fish along the river. The data is arranged by class according to protocol A.

Figure 4. An example of a spawning site (left) and a nursing habitat (right) photographed by the authors during the excursion. Both pictures were taken in the beech forest blue zone (Figure 1).

Only the section of the river by the green artificial land stretch (see Figure 1) had a lack of submersed vegetation. Small amounts of whole leafed submersed vegetation, moss, and periphyton were present upstream (lower half of the map in Figure 1). Most vegetation downstream (upper half of the map in Figure 1) was growing on the banks of the rivers in the form of grass and weeds.

Figure 5. Images taken in the downstream (left) and the upstream parts of the river (right). The image on the left shows a lack of vegetation growing in the water as most of it was growing on the bank.

Because our river stretch had forests surrounding it, dead wood floated in many parts of the river. There were no stretches of our river that had no dead wood and there were no stretches that had an excess of dead wood (=>25 logs/100m). Figure 4 shows that about half the river stretch had <6 logs/100m and half the stretch had between 6-25 logs/100m.

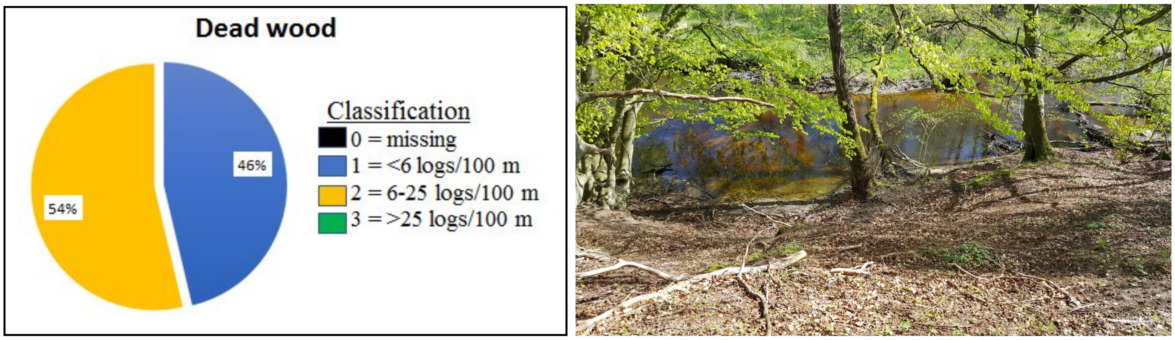

Figure 6. The percentage of the river that had a dead wood classification of 1 or 2 (left). An example of dead wood in the river in a photograph taken by one of the authors (right).

IV. Discussion

Threats: Pipes & Human interference

During our walk along the river, we saw a few pipes leaking water into the Höje å. We do not know the source of the water leaking through these pipes, perhaps it is water coming from nearby agricultural fields or maybe it is sewage water. If either of these cases are true, these pipes would prove to be a major source of nutrient intake to Höje å. Parts of the river stretch that we studied are located within the Häckeberga nature reserve, meaning there are very few buildings or other human interferences, except for the cultivation of the nature reserve. There was a good amount of dead wood along the whole stretch indicating that there is a high biodiversity. However, if too much dead wood appears in the same spot, it may create a barrier to fish (Figure 6).

Buffer zone

Based of our observations, the stretch had quite a lot of surrounding areas which can be used to hold a lot of water and therefore prevent floods. These buffer zones consisted of wet soil with low growing plants and deciduous trees such as beech. The tall trees could use their roots to keep the soil in place, preventing soil erosion (Figure 7). In some places outside the buffer zone, there were coniferous forests. We believe they were artificially planted because pine trees are normally outcompeted by leaf trees in the Scanian climate.

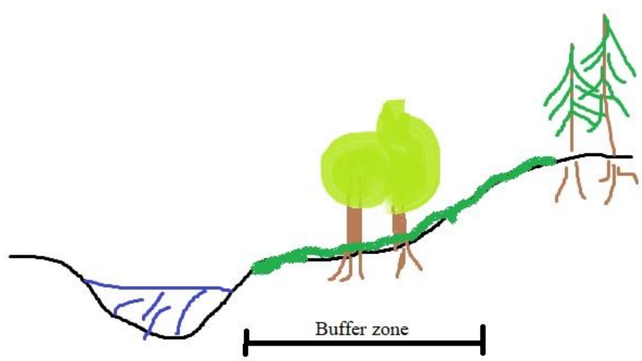

Figure 7. An artist's portrayal of the buffer zone surrounding the river. The trees closer to the river are beech trees and the forest outside the buffer zone was mostly deciduous and young.

Sources of error/difficulties

We had some problems getting close to the stream in the downstream sections because of the muddy ground. This complicated our estimations of different factors related to protocol A. To get around this problem, we could either do the observation at another dryer time of the year or be equipped with better boots. Also, since this was our first time doing a habitat mapping, there might be a big difference between our accuracy in the first sections of the river compared to the later sections when we were more experienced.

V. Conclusion

After completing our excursion and analyzing all the data we collected, we were able to use parts of all four protocols to classify the lake by its different sections. Our most detailed observations involved measures of the length, width, and depth of the different sections which helped us analyze the data for the presence of vegetation, dead wood, and fish habitats. Our section of the river seemed to have a healthy amount of resting, spawning, and nursery sites for fish. Additionally, the ample shading and slow flow provide a great habitat for the fish. The buffer zones were large enough to protect the surrounding area from flooding. They also provided a great place for grasses and weeds to flourish.

Habitat mapping and stream restoration

Group 3 - Genarp

Water Management BIOR66, Spring 2018
Maja Anehagen, Magnus Mårdberg, Sofie Nilén, Sofie Sunesson, Klara Streppel

1. Introduction

Water is essential for humans. Streams and rivers are among our most valued natural resources. For a long time streams have been used for watering fields and for transportation. Factors that can alter these aquatic systems' well-being and health are industries, households and especially agriculture. Scania has the most fertile soil in Sweden and it is no surprise that almost 50% of the total area is being used for agriculture (SCB, 2004). Streams and rivers are being affected in many ways by land use such as farmlands and Höje å is no exception.

Höje å is approximately 35 kilometers long with its source in Häckebergasjön and flows through the southeast of Lund before it continues to its outlet in Lomma. Compared to other streams Höje å is a quite small and narrow stream and is therefore sensitive to inputs of different kinds. The river basin consists mostly of farmland including the site studied at Genarp which is surrounded by cropland (Höje å Vattenråd, 2018).

Höje å is managed under one of the country's most active water councils. Restoration projects began already in 1992. The aim has been to improve the water quality, increase biodiversity and reduce eutrophication (Höje å Vattenråd, 2018)

2. Method

The first step was to point out the areas of interest on a map in ArcGis. The land use of the surrounding areas was also noted. A total length of 1.5 km along Höje å was studied, with the starting point on the banks of a farm and the end point in the forested area upstream. For the actual fieldwork the Field Manual, Habitat Mapping - Watercourse, Appendix 1 was used as an aid to map habitats, potential threats and restoration in the river and from the surrounding area.

3. Results

The results were obtained using 5 different field protocols that evaluated water biotope, surrounding and ambient environment, tributaries & ditches, barriers to migration and road passages.

3.1 Surrounding environment

The following is a map of the complete studied area with the habitat changes marked with a new letter (Figure 1). In total we noted 8 habitat changes.

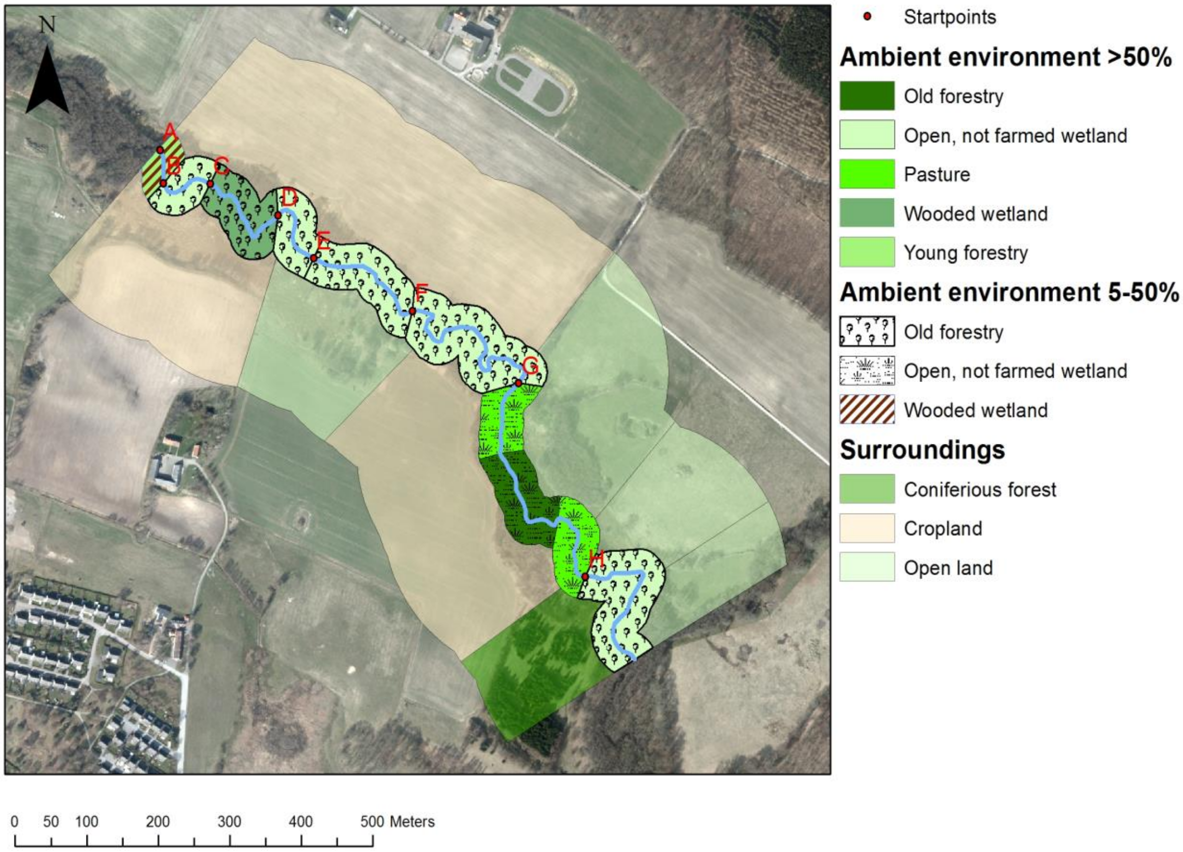

Figure 1: Map showing the vegetation surrounding of the studied stretch with points marking the starting points of environmental changes.

The ambient environment is located in a small valley and therefore prevents the surroundings from flooding. This is important as the surrounding of the stream is dominated by cropland as well as open land with some smaller parts covered with coniferous trees or, with less occurrence, deciduous trees.

Table 1: Vegetation/Shading in and over the river, 0=missing, 1= <5%, 2=5-50%, 3= >50%

Area	A	B	C	D	E	F	G	H
Rooted emerged vegetation	0	0	0	0	0	1	2	0
Submersed vegetation	0	0	0	0	0	1	1	0
Other periphyton	0	0	0	0	2	2	0	0
Shading	3	1	2	2	2	2	1	2

The underwater vegetation was scarce, we could only observe three species: periphyton, submerged and rooted vegetation. These were only found further upstream starting at point E (Table 1). The ambient environment of the river followed the same pattern except for when the landscape changed from wooded wetlands with many trees to open wetlands between G and H (Figure 1). The observed dominant tree species were *Prunus padus* and *Alnus glutinosa,* and changed to grass and reed in the open wetlands.

3.2 Water biotope: Substrate

From our observations, shown in figure 2, the substrate consisted mostly of sand and some patches of clay, gravel and cobbles.

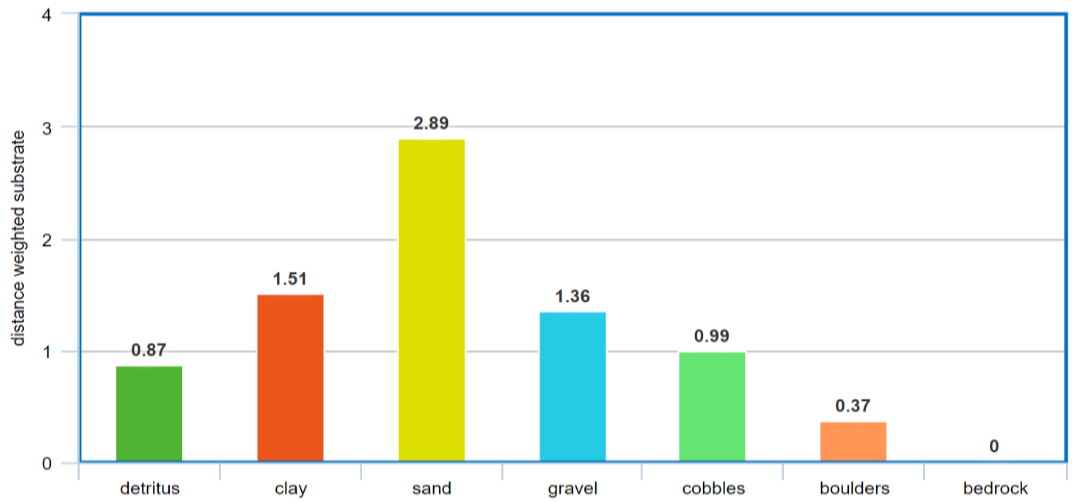

Figure 2: The ~~distance~~ length weighted substrates of the studied stretch.

3.3 Water biotope: flow rate

The flow rate increases from 0.6 m/s at point A to 0.9 m/s at point D. Then it decreases to 0.6 m/s at point E, followed by an increase to 0.8 m/s at point G and again a decrease to 0.6 m/s at point H.

3.4 Water biotope: fish environment

Table 2 shows that there are several resting spots for the trout all over the stretch, as well as some spawning areas and nursery habitats between C and H. Barriers for migration were not detected.

Table 2: Observed trout environments in Höje å. 0=absent, 1= possible, 2=fairly good, 3= very good

Trout environment in area:	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
Spawning areas	0	0	1	3	1	3	0	0
Nursery habitat	0	0	0	3	0	3	0	3
Available resting spots	2	2	3	3	3	3	3	3

3.5 Tributaries

There were many tributaries flowing into the river. However, most were concentrated in the areas that are surrounded by cropland. The water level along the tributaries was between 10-30 centimeters and slow flowing.

3.6. Further river conditions

The deadwood coverage was low throughout the whole stretch of the stream (Table 3). There was constant meandering and occasional pools and riffles as well as braided river beds (Table 3). Only one confluence was spotted in the last section (Table 3). However, the source is unknown. The width varied between 3 m and 10 m and the depth was between 0.2 m and 1 m. No road passages were included in this stretch.

Table 3: Observed characteristics of the river. 0=missing, 1= <5%, 2=5-50%, 3= >50% coverage

	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**
Dead wood	2	1	2	1	2	2	1	1
Max width (m)	6	10	5	4	4	5	3	7
Min width (m)	3	4	3	2	2	3	2	3
Pools	yes	no	no	yes	yes	yes	no	no
Riffle	no	yes	yes	yes	yes	no	yes	no
Braided river bed	no	no	no	no	yes	yes	no	no
Confluences	no	no	no	no	no	no	no	yes

4. Discussion

This part of the report discusses the results as well as potential issues that are worth to protect or should be restored.

The vegetation surrounding the river could be improved. Since the buffer zone of 30 meter mostly consist of open/wooded wetlands, see figure 1, the patches should be more diverse but according to our observations the aquatic species followed the same pattern along the river. The tree species were the same except when there was no shading and an open landscape. The shading from trees would probably be beneficial for biodiversity and prevent algae in the stream since light is an important factor for algal growth (Cloern, 1999).

Observations of the substrate resulted in a lot of sand which is not the most efficient if you want a diverse habitat and species. Risk of erosion may increase as well. A solution to this could be to add boulders along the banks that decrease the risk of erosion, or planting more vegetation. The lack of deadwood in the stream suggests that some human interference has occurred since natural stream tends to have a much higher percentage of deadwood. If the deadwood is not removed the potential to create natural habitats is higher.

The overall conditions of the stream seemed well preserved and undisturbed. There were no barriers to migration, neither natural nor manmade and no road passages.

The flow levels are considered very well for this part of the stream as it is surrounded by agricultural land which means that the area is not usually shaded, leading to growth of macrophytes that slow down the water. However as was shown in table 1, there was a substantial amount of shading and little water vegetation.

The trout benefits from faster flows if they also have available resting spots which they do in this part of the river. The fast flowing water is favorable to the general stream conditions as it oxygenates the water. The trout also benefit from faster flows since the water flushes away the fine detritus that can cover their eggs and the higher oxygen levels lead to healthy fish.

The higher concentration of tributaries near the croplands suggest that they have an agricultural source such as irrigation. However the tributaries did not look man made, except for three occasions where pipes were spotted.

Considering that Höje å is surrounded by agricultural land on which fertilizer is used it is somewhat surprising that there were no algal blooms. However, Höje å is classified as having high levels eutrophication due to nutrient loading as well as an unsatisfactory ecological status according to reports by the County Administrative Board of Scania (2013). This suggests that measures have been taken to decrease the flow of nutrients from the fields to the river at this particular site.

5. Conclusion

This site has a considerable recreational value, offering the possibilities for fishing and enabling a rich bird life in the surrounding. From our observations, there is currently no need to restore the river but for a more trustworthy result, water samples and more frequent visits are needed. Höje å vattenvård (2018) also noticed an improvement of water quality and biodiversity after the conducted restoration there. We just noticed that between G and H, where the landscape was very open, also much vegetation as well as less spawning and nursery habitats were present in the river. Therefore, an improvement could be made in this area. Otherwise Höje å is a beautiful site that needs improved availability for the public.

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Habitat Mapping of River Höje

Emelie Karlsson, Elin Persson, Camilla Bernhardsson, Rike Weber

Habitat mapping is used for a wide variety of actions in order to protect environment and biodiversity e.g. for environmental impact assessments, risk assessments, or as a base for action plans. For this report a habitat mapping of 1,3 kilometres of the river Höje next to Genarp was performed. The river has a total length of 35 kilometres and flows from the Häckeberga lake to Øresund. Water biotope, suitable habitats for trouts (*Salmo trutta*), the surrounding and ambient environment as well as ditches, road passages and barriers to migration were mapped and the results are shown and discussed below.

Results

The substrate of the researched area of Höje å mainly consisted of sand (0.02 to 2 mm) and sand was most often classified as number 3 on the four-point scale, which is equivalent to more than 50% of the underlying. The substrate also consisted of a mix of gravel (2-20 mm), cobbles (20-200 mm), and occasionally larger boulders (>200 mm). Coarse detritus such as leaves, branches, logs etc. were also found. Fine detritus (more or less decomposed organic materials, including inorganic material finer than clay) were most often classified as missing (0) or less than 5% (1). See Figure 1.

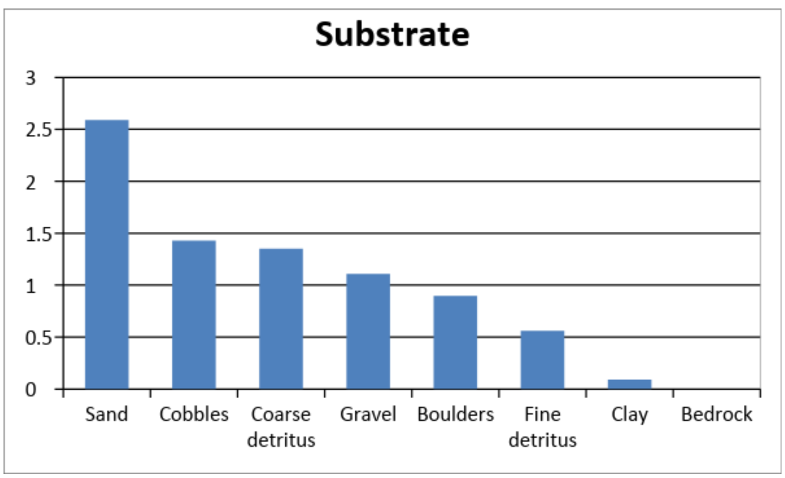

Figure 1. The composition of substrate material, with the means of the four-point scale from the stretches, where 0=missing, 1=<5%, 2=5-50%, 3=>50%.

Trouts can live in salt water and reproduce in freshwater but they can also spend their whole life in freshwater; in big lakes to small streams. The migrating population spends from half of a year up to six years in the sea or lake before they start migrating. The migration occurs in summer or fall but sometimes already in spring or winter and is usually done upstream. The spawning is occurring august to december in flowing water with a bottom substrate consisting of gravel (Artdatabanken, 2012).

In the part of Höje å that we were investigating 14 %, in average, of the stream had an environment that could work as spawning areas (fig 1a). These 14 % belong to the category “class 2” which consists of areas that we regarded as fairly good for spawning. There were areas we considered to be very good or good, but these areas were very scarce compared to the big amount of sand so in average more than half of the stream (57 %) had no spawning areas and 29 % had no obvious one.

Other elements that are important to the trouts are ones that contribute to availability of protection against the current, places with leeward where they can rest. Examples of this type of element is boulders. In average 14 % of our part of the stream were fairly good as resting spots (class 2) (fig 2b). We had some areas that were rich in boulders, but the dominant substrate the whole stream through consisted of sand only which lead to that the other 86 % in average consisted of areas that were possible resting spots.

Good habitats for nursing consists of the same elements as areas for resting. This lead to that we got the same results of amount of nursing habitats as the amount of resting spots (fig 2c).

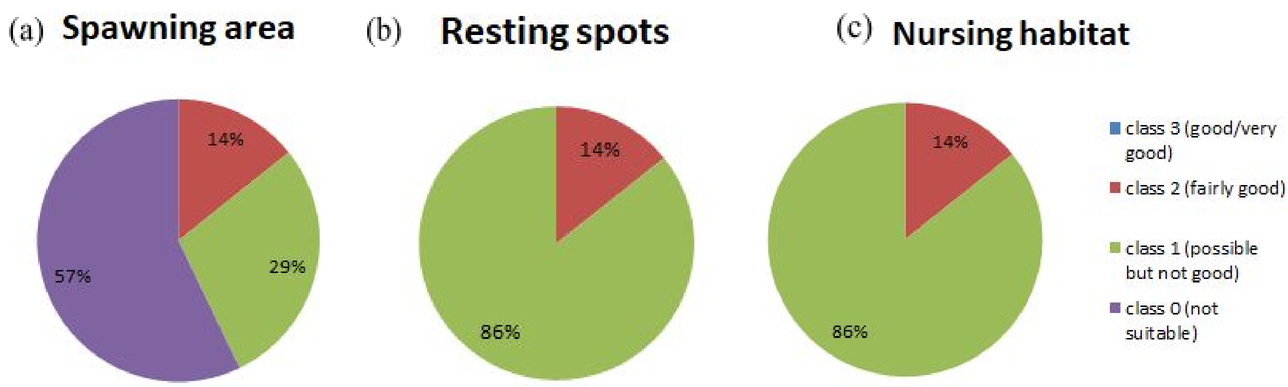

Figure 2. Suitable trout habitat based on sediment substrates. Class 0: absent/not suitable; class 1: possible but not good; class 2: fairly good; class 3: good/very good. (a) spawning area (b) resting spots and (c) nursing habitats.

This stretch of river Höje is mostly surrounded by agricultural land, however there is also some urban areas and a smaller area with deciduous forest. There are several ditches and drainage pipes that lead away the water from the surrounding fields, and are entering the stream of Höje å from both sides (see figure 3). The first ditch encountered downstream is the longest and the widest, and flows between two major fields. The rest of the ditches in this stretch are small and shallow, they come from the sides of the fields and from wetter areas by the stream. The fields has an impact on the ditches and subsequently on Höje å as well. The drainage pipes enters the stream just at the shoreline.

Due to deadwood, there are some natural barriers in the stream. Smaller logs and branches has got stuck in the stream in several places and built up barriers. On two of these places the content has created a barrier that fish are not able to pass when it is low water. When the water is high the barrier is under the surface and is possible to pass.

There is a public road crossing the stream over a bridge. The water can run freely underneath and animals in the water can pass under the road as they want from one side to the other. For the animals on land it is harder due to no land passages.

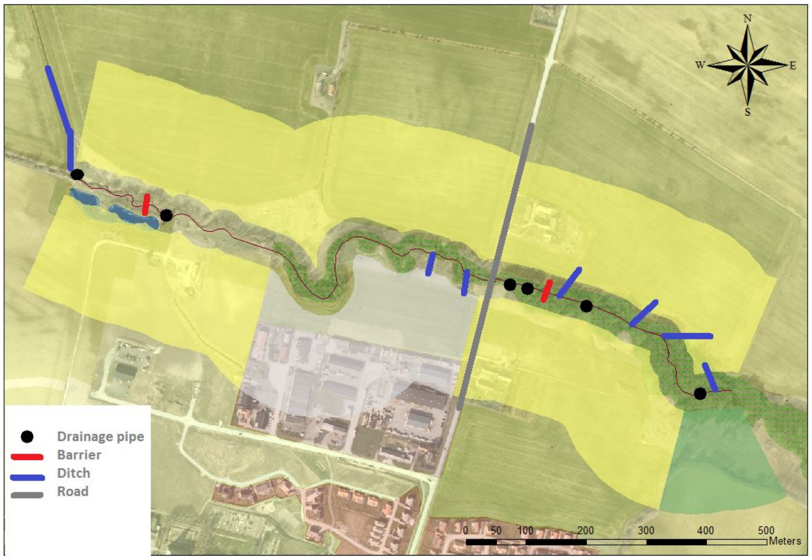

Figure 3. Stretch of Höje å surrounded by agricultural land - yellow, urban area - grey, and forest - green, in the area from 30-200 m. Drainage pipes - black dots, barriers - red lines, ditches - blue lines, and roads over the stream - grey lines, is shown.

As shown in figure 4, the current of the stream is divided into categories as following: slow flowing (<0.2 m/s), gently flowing, flowing and rapid flowing (>0.7 m/s). In each stretch these flows were estimated on a scale from 0 to 3. The graph in figure 4. shows the average of the flow categories for the whole stretch. On average for the whole stretch "flowing" was the most common predominating category, whereas "gently flowing" was the least common.

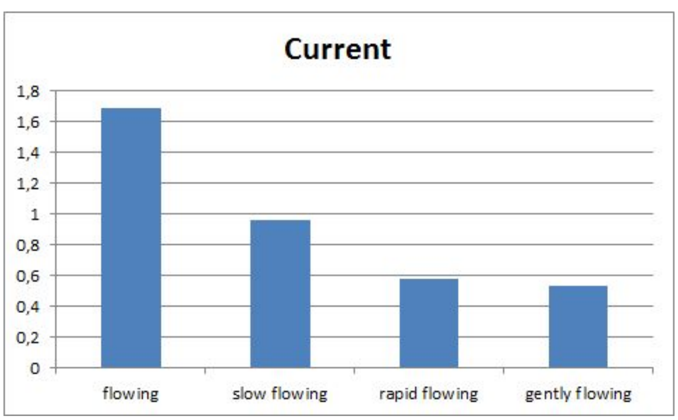

Figure 4. A bar chart of the average current flows, in the entire researched area of the river.

When a stream is surrounded by trees and shrubs, logs can fall in the water and become a habitat for water organisms. The amount of deadwood are varying along the stretch. From places where there are no logs, both downstream, with a length of 64 m, and upstream, with a length of 277 m, to where there are up to 25 logs/100 m, in the middle of the stretch, with a length of 599 m. Between them are stretches where there are up to 6 logs/100 m, with a total length of 447 m. See figure 5.

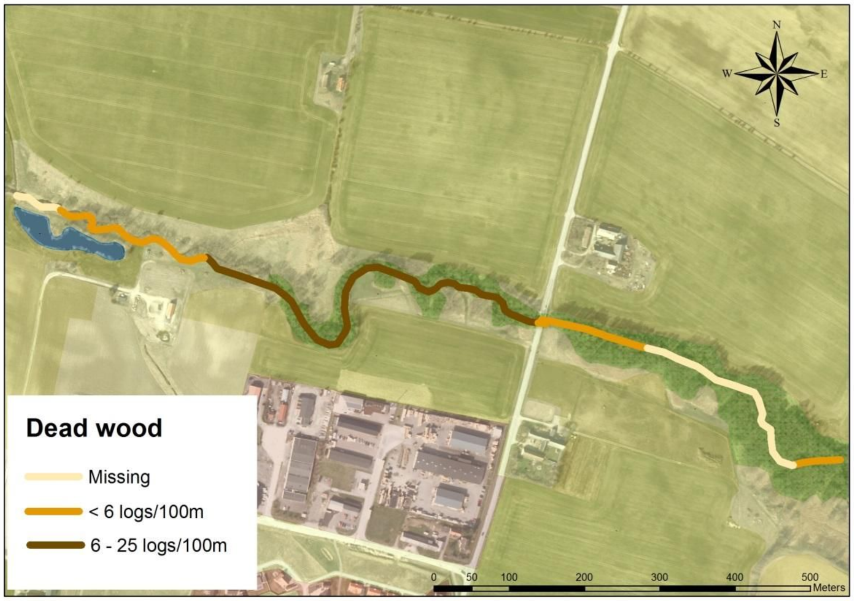

Figure 5. Map with the amount of dead wood in the water along the stretch of Höje å. Beige - missing, orange - <6 logs/100 m, brown - 6-25 logs/100 m.

Shading is measured in percentage of cover over the stream. Around the stream on both sides grows trees and shrubs in all sizes which prevents some of the light from the sun to reach to water. The shading varies along the stretch from 5% - >50% due to the surrounding vegetation. The middle part of the stream, with a length of 755 m, is the stretch which have the most cover, >50%. Upstream, with a length of 340 m, and downstream, with a length of 292 m, there is less cover, 5%-50%. See figure 6.

Figure 6. Percentage of shading over the stream. Grey - 5% - 50% shading, black - >50% shading.

Discussion

As shown in Figure 2, this part of the river Höje offers a poor habitat for trouts. This results from a heavily sand based sediment with only a small amount of boulders and cobbles needed for the trout to rest, nurse or spawn (fig. 2). An increase in sediment diversity consisting of larger stones and gravel would increase the quality of trout habitat and subsequently species diversity in general. The flowing current interrupted by few barriers, dead wood, as well as varying shading along the river provides a diverse habitat suggesting a substantial species diversity.

The surrounding/ambient environment is predominantly agricultural land with many ditches and pipes leading from the surrounding into the river, suggesting a considerable amount of nutrients entering the river (fig. 3). However, very little water vegetation and algaes were observed contradicting this suggestion. Since the nutrient levels was not measured, no final conclusion can be drawn.

Concluding, this part of the river Höje had a similar water biotope with mostly sand as a substrate, almost no vegetation, a steady current and numerous ditches and pipes leading into the river.

References

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Habitat mapping

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7 May 2018

1 Introduction

Habitat mapping is a standardized method of assessing an area's physical impact and naturalness. It can help quantify habitats, determine biological values, and discover threats towards the area. This is an important tool that can aid decisions makers on protection measures, assessments, and action plans. The method involves the use of remote sensing, field mapping, data compiling and GIS.

For this project, we used the described method of habitat mapping on an area called Höje å, a river located in Scania in southern Sweden. The river is about 40 kilometers long and has a catchment area of 316 km². The area we surveyed is in the northwest of Genarp and it extends towards the beginning of the Gödelövsbäcken river. The area surrounding the river, including the section we analyzed, is mainly composed of agriculture lands. Figure 1 displays the 1.5 kilometer span that we assessed on May 2, 2018.

Figure 1: Map of the stream and its surroundings. V is for wetland, Å is for cropland and Ö is for open land/ pasture. The stream is divided into three colors: green, magenta, and blue, and these indicate the changes of the rivers features observed during field surveying. These features include: flow, vegetation, sediments, trout habitats, and the potential shading while surveying the river.

2 Method

The methodology is divided into three parts. The first, was to create a map of the part of the stream to be analyzed using remote sensing data to determine key biotopes and land use cover of the area.

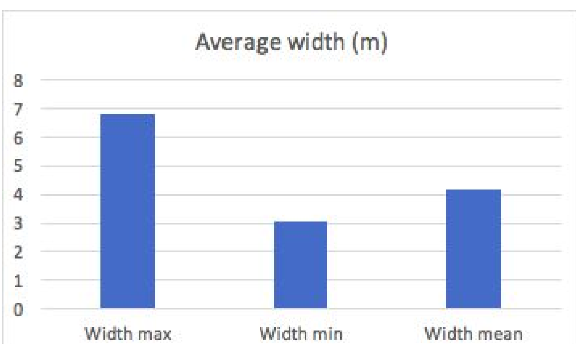
Second, the field surveying was carried out by following a field manual for habitat mapping of watercourses (see report from the County Administrative Board of Jönköping, Meddelande 2002:55) that was provided to us. The survey protocol consists in a total of five parts (A-E) and the main focus for our conducted study was on Protocol A (the biotope within streams), Protocol B (ambient habitats and the close surroundings of the stream) and Protocol C (inflowing tributaries and ditches). Lastly, we entered our collected data into customised GIS databases to analyze and visualize our results.

3 Results

3.1 Water biotope

In our groups section of Höje å river, the vegetation in the water was low, about 5-10% of the stream was covered in vegetation. Most of the vegetation was located in the blue color part (3rd section upstream) of the stream displayed in Figure 1. The most prominent vegetation observed were rooted emersed vegetation, such as reed, and submersed vegetation, which consisted mostly of finger leafed species.

The average width and the average water depth of the stream section can be seen below in Figure 2 and 3. The mean of the width and the mean of the water depth was estimated to 4.2 meters and 0.7 meters respectively.



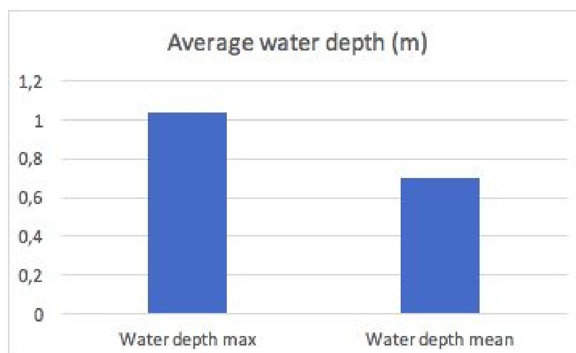
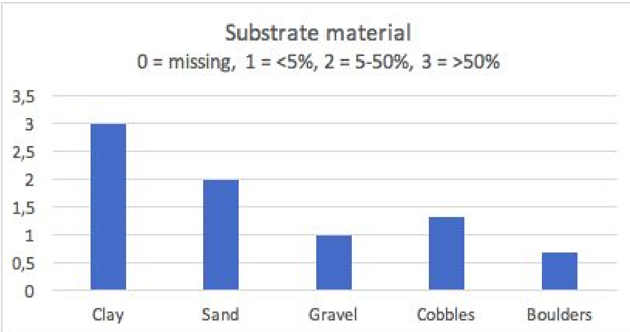


Figure 2 and 3: The average width of the stream (l) and the average depth in the stream (r) in meters.

The identified substrate material in the river can be seen in Figure 4, which shows that the bottom of the river consists mainly of clay and sand. The occurrence of trout habitats in the river, such as spawning areas, nursery habitats and available resting spots can be seen in Figure 5. In general the trout habitats were present, however not very abundant, particularly for the spawning areas.



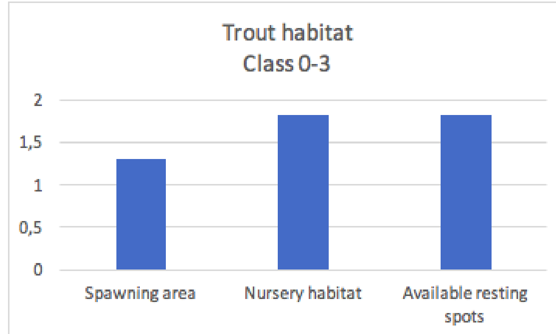


Figure 4 and 5: The mean presence of different substrate material (l). Classified according to covered percentage. The occurrence of different Trout habitats with the classification from 0 to 3 (r). Classification according to Table 1 in appendix.

The actual shading of the river and the existence of dead wood in the stream can be seen in Figure 6. The shading varied significantly along the 1.5 kilometer stretch of the stream, and when classified the results suggest that the stream is somewhere between less good and moderate for this factor. The amount of deadwood was between absent and low according to the classification throughout the river.

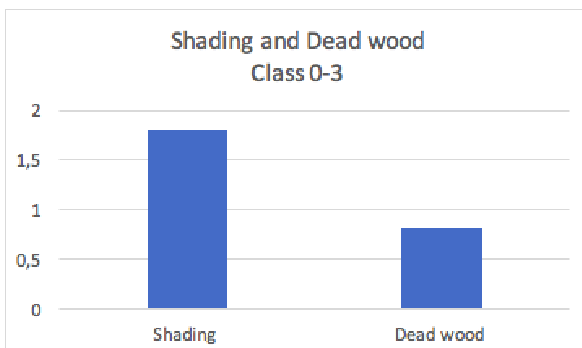
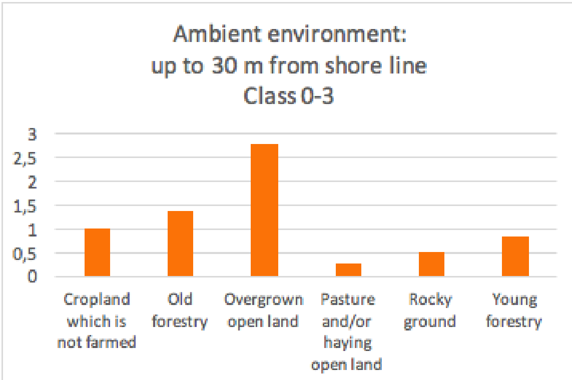


Figure 6: The occurrence of shading and dead wood. Classification for shading: 0=absent, 1=less good (<5%), 2=moderate (5-50%), 3=good (>50%). Classification for dead wood: 0=absence, 1=low occurrence (>6 logs/100m), 2=moderate occurrence (6-25 logs/100m), 3=high occurrence (>25 logs/100m).

3.2 Surroundings and ambient environment

The biotopes for the surroundings (30-200m) and ambient environments (0-30m) to the watercourse were observed. Most of the ambient environment was overgrown open land, which consisted more than 50%, and can be seen in Figure 7. The surroundings consist mostly of cropland, while the other types of land use were almost nonexistent; portrayed in Figure 8. The existence of buffer zones, flooding zone and shrubs around the stream is displayed in Figure 9, where all categories in this figure can be improved.



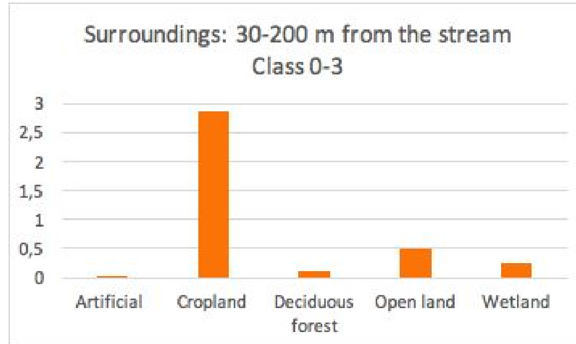


Figure 7 and 8: Different surroundings from 30m up to 200 m from the stream (l). Classification according to Table 2 in appendix. Different ambients up to 30 meters from the shore line (r). Classification according to Table 3 in appendix.

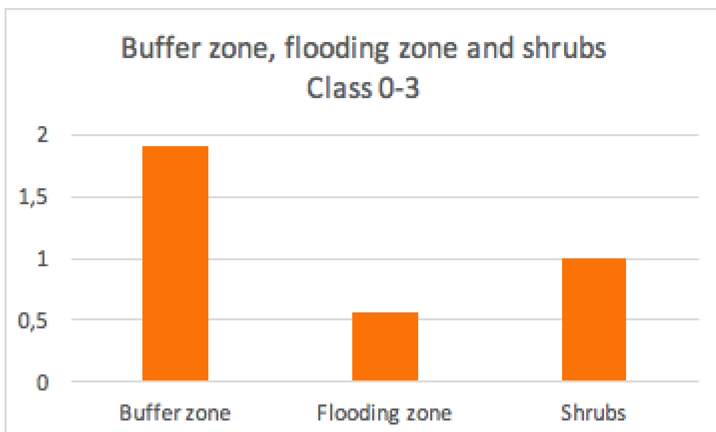


Figure 9: The occurrence of buffer zone, flooding zone and shrubs. Classification according to Table 4 in appendix.

3.3 Pipes, ditches and tributaries

The inflowing pipes, ditches and tributaries into the main river of Höje å were noted during the field studies. In total, nine pipes were identified along the investigated section of the stream and these pipes were mainly under drain pipes from the surrounding croplands. At the location of section 2 and 7 in Figure 1, man-made tributaries were flowing into the stream. In section 2, the tributary originates as a drained water stream for agriculture land. In section 7, the tributary was coming from a wetland and the inflow to Höje å was controlled by a water gate at the outlet of the wetland. If the water gate will break there is a risk that huge amount of water will enter Höje å. Along the river no ditches were identified.

4 Conclusion

From the results of our habitat mapping in Höje å river, we can conclude that the water vegetation is low due to the sediments mainly filled with clay and sand. The surroundings of the area we investigated was mainly filled with croplands and the ambient environment consists of overgrown open land that has a lack of shading near the stream. Additional planting of trees and shrubs would be recommended. Our section of the river was mainly straight, with the mean depth of the river around 0.7 meters, while the mean width of the river was estimated to be around 4.2 meters. While a straight river is not ideal, there could exist the possibility of slightly increasing the meandering of the river, which would in turn decrease the water flow and allow for more sedimentation. This would be particularly beneficial when the stream water levels are high.

No fishes were observed during the survey, but we were able to determine potential spawning habitats and nursery habitats, however the addition of gravel and cobblestones would improve the chances of having more fish in the stream. The river has a low debris amount, which only consisted of a few deadwood. The river did consist of shrubs, buffer zones and flooding zones but it could be improved due to its low volume in some parts of the stream and risk of flooding. Although in general the ditch was pretty steep all along. Along the river, there were nine pipes and two tributaries identified near the croplands. Overall the area was heavily developed through agriculture and its naturalness is low. While our investigation was only done with limited time, and we were not physically in the river, we believe the area has great potential for more restorative actions that would help turn the river from Unsatisfactory (as evaluated in 2017) to a Good ecological status.

5 Appendix

Table 1: Classification for Trout habitat.

	Class 0	Class 1	Class 2	Class 3
Spawning area	No spawning areas	No obvious spawning areas, but suitable flow conditions	Fairly good, but not optimal spawning areas	Good/very good spawning areas
Nursery habitat	Not suitable	Possible, but not good	Fairly good	Good/very good nursery habitats
Resting spots	Absent (too shallow)	Possible for solitary large trout	Fairly good	Good/very good conditions for large trout

Table 2: Type of land use in the surrounding is noted according to following codes.

Type	Definition
1 =	the specified land use makes up <5% (several types can be noted)
2 =	the specified land use makes up 5-50% (several types can be noted)
3=	the specified land use makes up >50%
Deciduous forest	The forest is dominated (> 69% of the surface) by deciduous trees.
Cropland	Cropland, including land that has been farmed until recently.
Open land	Open land in agricultural landscape. Normally comprises of moorland, meadow or pasture.
Wetland	Wetland, open or wooded. Wetlands consisting of marshes or swamp forest. Wooded or open. Wetlands, which consist of bogs. Wooded or open.
Artificial	Unspecified artificial land use.

Table 3: For each stretch land use in the ambient environment is noted and, when appropriate, land use in the protection zone as described below. Type of forest (coniferous forest (BA), mixed (BL) or deciduous (L)) is also noted. For wetlands with forestry, "category of forestry" (S3, S, G, R, S4 or K) is also noted.

Type	**Definition**
Old forestry	(= final felling forest) The age of trees is on average≥ 60 years. Tree diameter, on average≥30 cm, tree height on average> 25 m. Specify dominant tree species. Note if the forest is mixed.
Young forestry	(= intermediate cutting forest). The age of trees is up to 60 years, tree diameter on average> 10 cm but <30 cm. Specify dominant tree species. Note if the forest is mixed.
Open land	Pasture and/or haying. Overgrown open land.
Cropland	Cropland which is farmed.
Rocky ground	The area consist of rocky ground, blocks, rubbles, etc.

Table 4: Classification of different zones next to the stream.

Buffer zone	Average width of the zone is specified in a four-point scale where: 0=<3m, 1=3-10 m, 2=11-30 m and 3=>30 m. If there is a clear change in the buffer zone appearance, specify a new stretch.
Flooding zone	Occurrence of a flooding zone is noted according to a three-point scale where: 0=absent or insignificant (<3 m), 1= small (3-10 m), 2=moderate (11-30 m), 3=large (> 30 m).
Shrubs	Occurrence of a lower canopy layer (shrubs) (bushes, trees with width<5cm) along the watercourse is noted according to a four-point scale where: 0=absent or minimal, 1=sparse (<5%), 2=moderate (5-50%), 3=abundant>50%).

Habitat mapping and stream restoration of Höje stream

Introduction

Habitat mapping of watercourses is a vital tool when assessing land use and its effects as it is a standardized method which investigates the synergy of an aggegrate of factors. In this small study, habitat mapping was used to investigate a 1.5 kilometer long segment of Höje stream, just north of Genarp, Skåne, and explore possible restoration methods. Höje stream has a water source further north in Skåne in Häckebergasjön and stretches 35 km in total to Lomma bay. It runs through an area which is heavily dominated by agriculture, which led the land owners to straighten a vast majority of sections in the early 1900s'. This has had an effect on the nutrition values, shading, and biodiversity in the stream, all leading this assessment to conclude that restoration measures would help slow these consequences and provide a better habitat for all organisms in the stream.

Method

This study followed a three step procedure: remote sensing, field mapping and data digitization. Maps were downloaded from Lantmäteriet and Ortophotos maps were used in conjunction with the SWEREF99 TM coordinate system. These were treated and analyzed in ArcMap 10.0. This program allowed for the predetermined water stretch to be divided into sections based on the predominant type of land usage in the surrounding zones (30-200m). These were later double checked on site. In the field, data was collected following the protocol *Biotopkartering - vattendrag Länsstyrelsen i Jönköping Meddelande 2002:55 Apendix 1,* provided by the Lund University Water Management course advisors. The five following categories were assessed: water habitat, surroundings and ambient environment, tributories and ditches, barriers to fish migration, and road passages. For an easier overview, the 1,5km long stretch was divided into 6 individual segments, based on shading and substrate appearance (fig 1). As equipment was not provided on site, measurements were heavily approximated. The stream data was then compiled and digitized in ArcMap 10.0.

Results

The analyzed stretch of Höje stream in this project was relatively homogenous throughout the entire length. There was a number of smaller barriers, such as fallen trees and collection of debris, in the stream (blue dots in fig. 1). These did not fully hinder water flow in the stream and only slightly caused a slowing. Additionally, there were also a number under drains leading water from the agricultural fields into the stream (red dots in fig. 1). These were relatively small (20-40 cm in diameter) and showed minimal water flow volume during the observation periods.

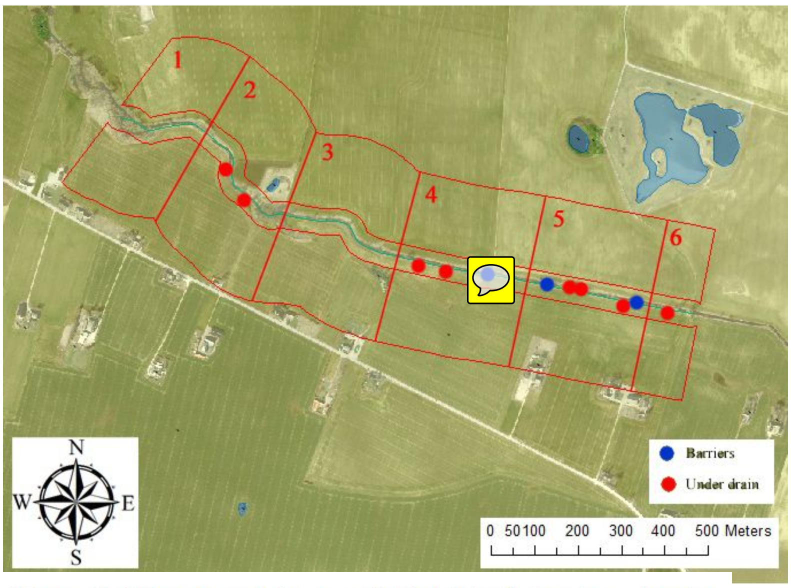


Figure 1: Map over study area divided into 6 stretches, showing barriers and under drains.

The proportion of the stream that was shaded by surrounding vegetation was also sufficiently similar along the entire stretch (fig. 2) with slight deviations as exceptions. The shading was measured using a 0-3 scale were 0= non-existent, 1= <5%, 2= 5-50% and 3= >50%. In one segment of the stretch (segment 5) the shading was determined to be a category 3, which means more than 50%. However, the mean of shading across the entire study area was determined to be 2.17, which falls into category 2.

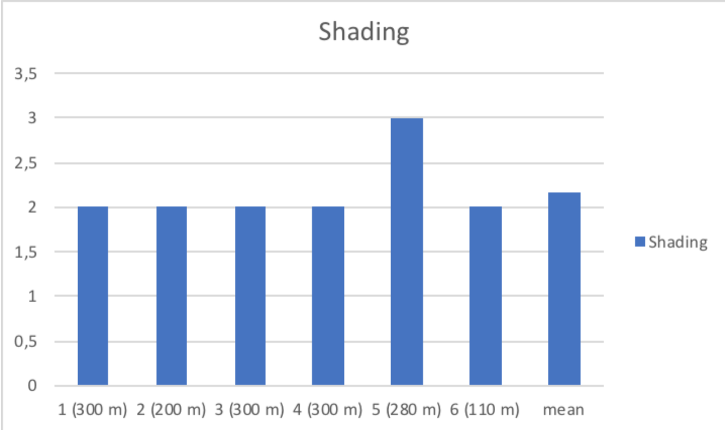


Figure 2: The proportion of the stream that was shaded (were 0=non-existent, 1= <5%, 2=5-50% and 3= >50%) for the segments of the stream as well as the mean (2.17) of the entire stretch.

The types of substrate that were found in the analyzed area were clay, sand and coarse detritus. These varied in proportion so that the dominant substrate in segments 1-3 was sand and the dominant substrate in segments 4-6 was clay (fig. 3). These were measured in a similar way as the shading with a 0-3 scale and the mean of the entire study showed that there was 5-50% clay, 5-50% sand and 5-50% coarse detritus.

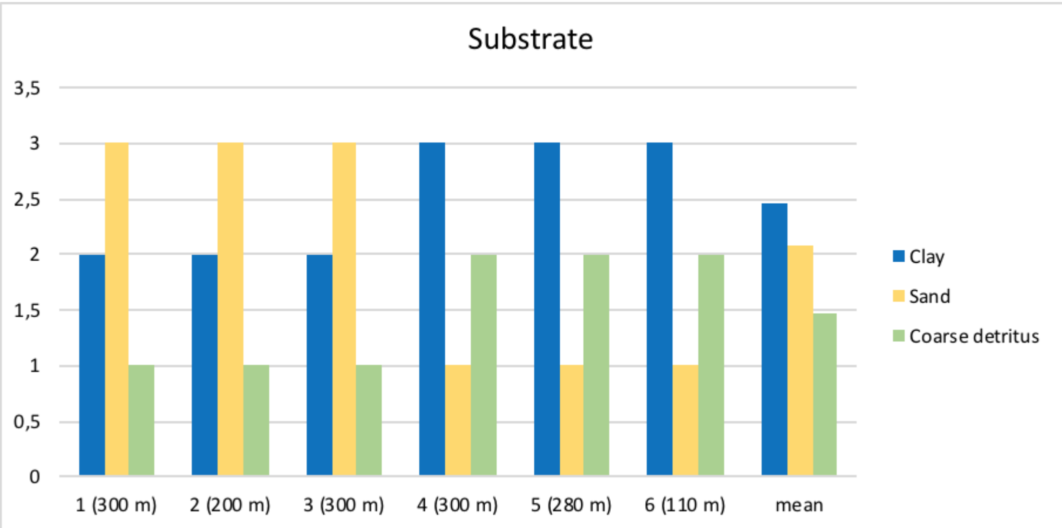


Figure 3: The proportion of the substrate at the bottom of the stream (0 = non -existent, 1= <5%, 2= 5-50% and 3= >50%) as well as the mean (clay = 2.46, sand = 2.07 and coarse detritus = 1.46) for the substrates of the entire stretch.

The types of vegetations in the study area was also quite similar throughout the entire area (Figure 4). The percentage of total coverage was determined by using a 0-3 scale were 0=non-existent, 1= <5%, 2= 5-50% and 3= >50%. The total coverage was measured to be category 2, 5-50%, in all the segments besides segment 6, which was categorized as a 1, <5%. (Figure 4). The dominating vegetation type in all of the segments were rooted emersed vegetation and on some segments there was also submersed (whole leafed) vegetation (fig. 4).

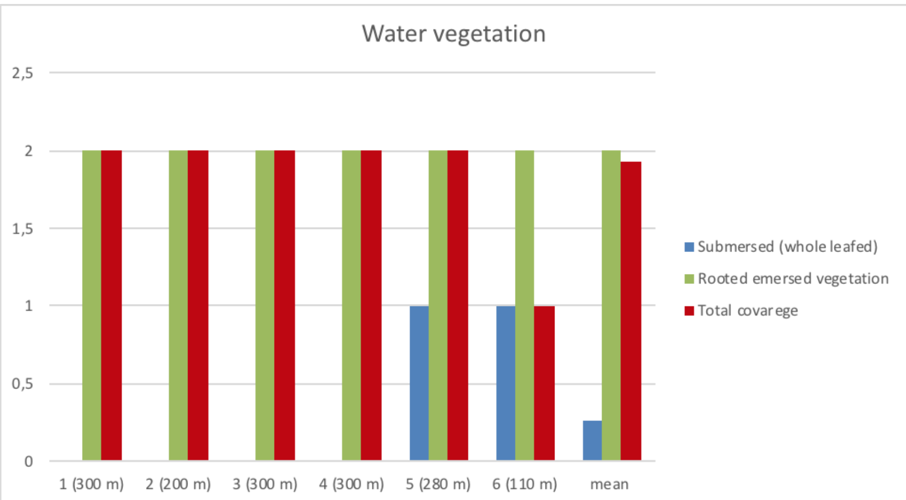


Figure 4: The proportion of the water vegetation in the stretches in the stream (were 0=non-existent, 1= <5%, 2= 5-50% and 3= >50%) as well as the mean for the entire study area (submersed whole leafed = 0.26, rooted emersed vegetation = 2 and total coverage = 1.96).

The mean width and depth of the six segments are presented in figure 5. The mean width is relatively consistent throughout the stream with values ranging between 4-5m. The total mean width of the entire study area was 4.38m and the total mean depth was 1.5m (fig 5). The mean depth in the six segments ranged from 1-2 m.

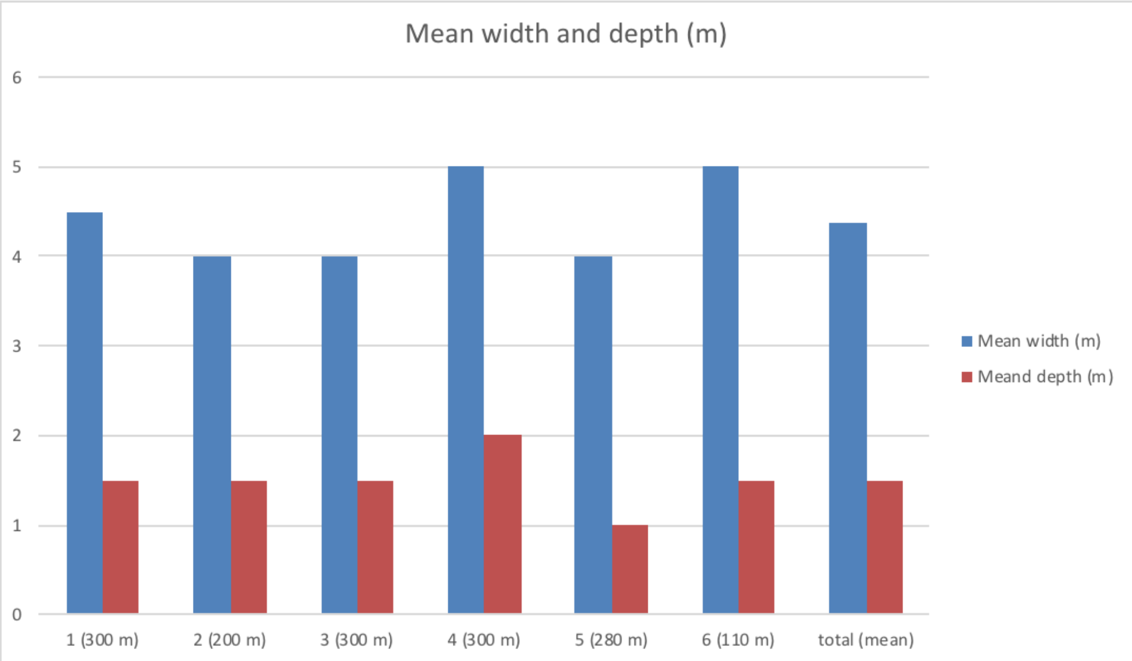


Figure 5: Mean width (meters) and depth (meters) in each segment (1-6) of the stream as well as the mean of the entire stream. The total mean width depth of the study area was 4,38 meters and 1,5 meters respectively.

The study area surroundings were dominated by agricultural fields. Close to the stream there were buffer zones of varying size and appearance. The size of the buffer zones was measured using a 0-2 scale were 0 = < 3m, 1= 3-10m and 2= 11-30m. The size of buffer zones containing trees are presented in figure 6. The majority (50 %) of these buffer zones was smaller than 3m and a third was between 11-30m. The buffer zones classified as "artificial" are presented in figure 7. The same scale to measure was used. The majority (83%) of the artificial buffer zones were less than 3m wide (fig. 7).

Figure 6 (left): Percentage of forestry buffer zones of different sizes (were 0= <3 m, 1=3-10 m and 2=11-30 m) in the entire stream. The land use for the whole stretch is described as S4, "Other forest". It often occurs close to watercourses. Figure 7 (right): Percentage of artificial buffer zones of different sizes (were 0= <3 m, 1=3-10 m and 2=11-30 m), in the entire stream. The land use for the whole stretch is described as Ö1, "Pasture and/or haying".

The flow rate in this part of Höje stream is quite consistent with some areas, in segment 3 and 4, with more rapid flowing water (>0.7 m/s) (fig. 8). There were also some areas in segment 4 with some slow flowing water (<0.2 m/s). The majority of the stream, however, was considered "gently flowing" with an average of 0.4 m/s.

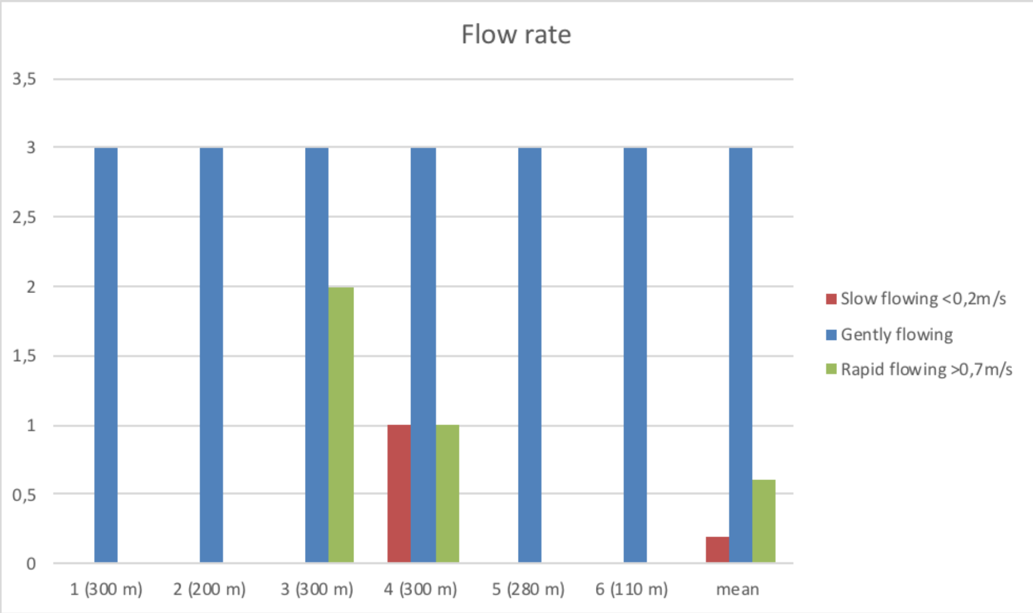


Figure 8: Flow rate of the stretches 1-6 (were 0 = missing, 1 = <5%, 2 = 5-50% and 3 = >50%) as well as the mean flow rate for the entire stream.

Discussion

Höje stream showed relatively few changes along this small analyzed course. The sediment did not change drastically, mind for a few sections where clay and sand proportions were inversely related. This is most likely due to the fact that the surrounding walls of the stream did not change much either, nor did the areas >30m out from the stream as they were all agriculture. The width of the river rarely changed and the parts that exhibited varying width were those mainly of regions where it was clearly not straightened in the early 1900's. These areas also appeared to have more dynamic flow rates within the sections and higher amounts of biodiversity in terms of the vegetation. This leads the study to conclude that areas with higher amounts of meandering provide for more opportunities for life to flourish. If some parts of the straightened sections were to be recut to be meandering, such as with corner pillars or stones, then it is believed that biodiversity in those areas would also increase in terms of plant life. Then hopefully ensuing, amphibia and vertebrate animal life would move its way into this section of the stream as well and increase the biodiversity. Another reason as to why the biodiversity is lower in this section of the stream is also possibly due to the presence of the under drains. These potentially can be leaking extraneous nutrients into the stream, causing eutrophication and leading to lower biodiversity overall. However, proper measuring tools to assess this hypothesis were not utilized and further testing is recommended.

Conclusion

Höjeå is long stream stretching across a vast part of Skåne, adding beauty to the landscape along its way. However, it is clear that the surrounding agriculture has taken its toll on the status of the stream. The straightening of the waterbody in the 1900's and potential addition of nutrients have affected large sections of the stream and it is recommended that portions of the meandering be restored and a proper nutrient assessment to be executed.

Habitat mapping at Höje å

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2018-05-07

Introduction

Höje å is a river located in the west part of Scania. It has a basin of approximately 315 km2 and is mostly surrounded by farmland (62%), the rest consists of open land, forest and smaller villages (Höje å vattenråd, 2018). The area that is investigated in this report is composed of a section of approximately 1500 meter and is located in Esarp. The intense farming on cropland that encompass Höje å has put a lot of pressure on the river concerning nutrient runoff (phosphorus and nitrogen). During the last 150 years the river have not only been exposed to the pressure from nutrients but also from drainage enterprises that has deepened the river and straightened it out, changing the natural watercourse in a large extent (Lantmäteriet, 2017). In this way the natural purification ability of the river has decreased. Lately, restoration project has been carried out in order to decrease the amount of nutrient into Höje å (Sege å Vattenråd, Höje å Vattenråd, Kävlinge å Vattenråd, 2018). The projects include created smaller open wetlands and a swamp forest. The entire river of Höje å is protected with “strandskydd” which for instance protects the shore and the area around the river from being built upon. This area is also protected and classified as “värdefulla vatten” which is a part of the national Environmental quality goals to protect water habitats in Sweden.

The purpose of this project is to investigate and map the habitats in a specific section of Höje å and its surroundings. The surrounding area is of high interest concerning its potential impact on the river, regarding the physicals influence.

Method

The project started out with a map investigation of the area, trying to classify the different habitats along the intended watercourse. Further on the areas was investigated in field to establish a updated and more accurate map as well as filling out protocols of habitat mapping A to E. These protocols concerns different parameters in the environment that affects the habitats around the river as well as the river itself. Parameters that were being looked upon were for example: land use 0-30 meters from the river as well as 30-200 meters, currents, river depth, shading over the river, buffer zones, drainage pipes from farmland, substrate in the river and water vegetation. In order to fill the protocols correctly, a field manual were used: *Habitat Mapping - Watercourses*. Maps were made in ArcGIS concerning the division into different habitats (stretches) along the water course as well as a map showing the current in the river and how it changes. A graph was made using mean values of some parameters along the entire section, where the impact was corrected by weighting the parameters influence depending on the stretch length.

Results

The land use in the ambient environment (0-30 meters from shoreline) is dominated mainly by grazed open land, and in some cases, overgrown open land, forest and swamp forest (figure 1). In some areas there is patches of open wetlands in the pasture. The surroundings is highly dominated by cropland as noted before. The ambient area therefore acts as a buffer zone for the water before it enters Höje å. It is quite common with inflowing small streams consisting of pipes draining the crop land. In the majority of the cases, the pastured area in vicinity to the river acts as a flood plain, where the water from the pipes empties before entering the river (figure 2). These flood plains has the capacity of buffering the nutrients in the water, protecting the stream from the otherwise strong influence of the cropland. In some of the ditches' floodplains, the lack of vegetation and exposed soil indicated a risk for erosion. The stream was mostly slow or gently flowing and in some areas more rapid (figure 3).

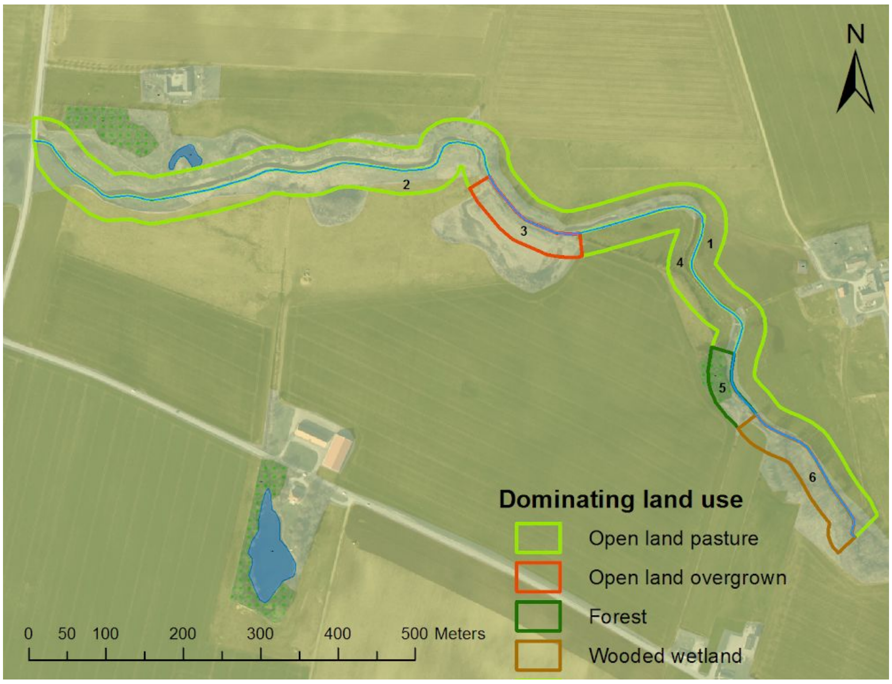
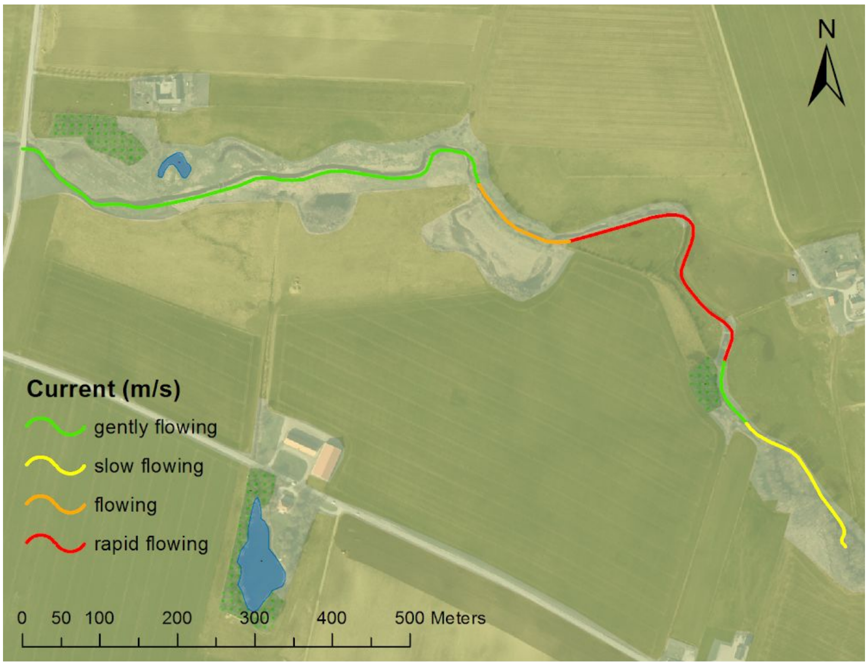


Figure 1. Investigated stretches (0-30 meter from shore line) along the watercourse Höje å. The west part of the investigated section having the coordinates 55°37'13.9"N 13°19'49.7"E (DMS).

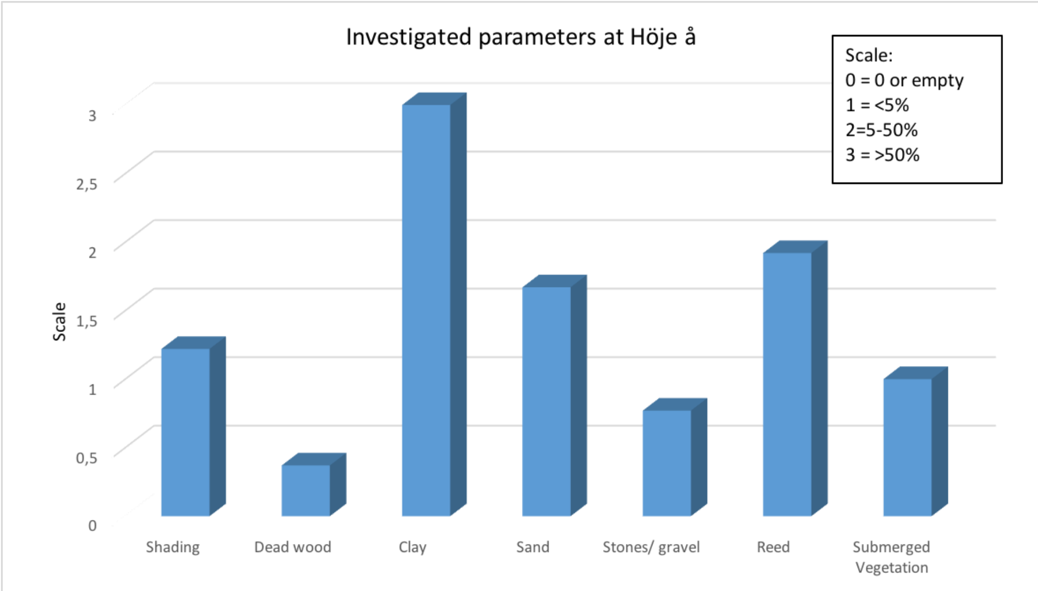
Figure 2. Example of drainage pipes (left) and flood plain (right) in vicinity to Höje å.



Figur 3. Mean current divided into slow flowing - Yellow (<0,2 m/s), gently flow - green, flowing - orange, rapid flow - red (>0,7 m/s) on a stretch at Höje å.

The vegetation in the watercourse consisted mostly of rooted emersed vegetation (phragmites), floating-leaved plants such as Water lily (Nymphaeaceae) and some submersed vegetation (whole leafed and fingered leafed). The coverage was typically less than 5-10 %. Some different frogs were also observed, one was identified as a the edible frog (Pelophylax kl. esculentus) and also one that was not possible to identify that were breeding in a reedy part of the river. One individual of Western yellow wagtail (Motacilla flava) was also observed. Many different arthropods was found such as Lycosidae, Tipulidae and Megaloptera. Several individuals of horse-leech (Haemopis sanguisuga) was observed in the floodplain you can see in figure 2.

No fish barriers or road passages was observed, only small wooden bridges without any structural elements in the water body.



Figur 4. Different parameters (shading, dead wood, clay, sand, stone/ gravel and submerged vegetation) that were investigates at Höje, with a mean value of those over the total researched area.

Generally, the shading of the investigated part of Höje å is spare; the lack of trees usually results in less than 5% shading (figure 4). There was also a lack of dead wood and bigger sediments such as stone and gravel. The substrate in the river was mainly mud with elements of sand and very small local patches of sandy gravel. It was quite common with screes where the riverbank was steep, exposing the shoreline to erosion.

Discussion

All the species we observed is categorised as least-concern species according to IUCN (International Union of Conservation of Nature), suggesting that there is no protection value in preserving the different species observed. However, the area seemed very rich because of the combination of pasture, water and wetlands which persay could have a preservation value. Also, in the first stretch there is an area with prehistoric usage and settlement continuity with a development of a farming landscape during the 18th and 19th century. This has resulted in the area being one of national interest, and is therefore protected according to MB 3 kap 6 § (Länsstyrelsen Skåne, 2008).

There were some aspects that could be improve in the area. A good but drastic improvement would be to re-meander the river over the "river plain" again, but that would probably conflict with other interests such as agriculture. Some smaller improvements could instead be to build two step ditches in the river to increase the biodiversity but still not intervene with the agriculture. Two step ditches together with some larger wetlands next to the river would most likely raise the biodiversity drastically and purify more nutrients from the farmlands. Since there were indications of erosion on the riverbank an action to prevent this could be to plant trees and bushes along the riverbank in order to stop the erosion and create shade for the river habitat. The shade for the river is good since it decrease the amount of phytoplankton in the water and lower the temperature of the water. Due to the large number of drainage pipes we observed and the intensively cultivated surroundings it could be assumed that the water from the pipes is a source of nutrients in to the river. Notable is that almost all the drainage pipes (except for one) poured out onto floodplains, were a large amount of nutrients could sediment. In this way the amount of nutrients the river receives is probably decreased compared to if the drainage pipes poured out directly into the river.

Conclusion

Our evaluation is that since the stream is ditched, straightened and adapted to agriculture, the level of achievable biodiversity is limited as the water habitat is very homogeneous and unsuitable for many organisms. However, the ambient habitat around the stream consisting of pasture can somehow protect the river from the agricultural pressure and provide a habitat for many species.

References

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