Master Thesis

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Spruce Forests and Peat Wetlands in Lake Bolmen's Catchment Both Leak and Degrade Coloured Dissolved Organic Carbon

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Yours gratefully,
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I sincerely appreciate the cooperation with:

Abstract

Lake browning in the northern hemisphere is endangering crucial ecosystem services. Darker water decreases fish and primary production as well as touristic and recreational values. It furthermore requires intensive treatment to receive safe drinking water. Brownification is connected to iron and coloured dissolved organic carbon (DOC). In Sweden, spruce plantations leak DOC, possibly depending in their DOC release rate on tree age. Whereas wetlands are known to purify water and might contribute to the degradation of DOC. This thesis aims to investigate how different land use types and other parameters affect water colour. Ditches flowing through old spruce forests, young spruce forests, and peat wetlands in the Lake Bolmen catchment, southwestern Sweden, were sampled at in- and outlet. Highly significantly positive relationships between DOC, iron and absorbance were found. The relationship was strongest between DOC and absorbance ($R^2 = 0.88$; $p < 0.001$) and weakest between DOC and iron ($R^2 = 0.54$; $p < 0.001$). High variability led to no significant differences in the release of DOC and iron between the three land use types. However, older forests tended to increase DOC and iron loading compared to younger forests. This study suggests that not only spruce forests in general are affecting the brownification, but that several different factors like age and underlying soil type might play a critical role.

Keywords: Brownification, land use, DOC, iron, water colour

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1. Introduction

1.1 Background

Lakes and rivers in the northern hemisphere are getting browner (Monteith et al., 2007; Kritzberg et al., 2020). This brownification has several negative effects on ecosystem services, as it decreases fish and primary production as well as touristic and recreational values (Brothers et al., 2014; Kritzberg, 2017). Furthermore, brown water requires cost and risk intensive drinking water treatment (Richardson et al., 2007). It is generally assumed that coloured dissolved organic carbon (DOC) and iron are causing the brown colour (Weyenmeyer et al., 2014; Lei et al., 2020). An investigation on 58000 boreal water samples revealed a strong association between DOC concentrations and absorbance at 420 nm (R^2 = 0.85, $p < 0.0001$; Weyenmeyer et al., 2014). Furthermore, DOC and iron seem to be dependent on each other as they form complexes that absorb light and cause brown colour (Canfield et al., 1984; Kritzberg et al., 2012; Lei et al., 2020). Since boreal water bodies are getting browner, it is important to gain more knowledge about the causes for the increase of DOC and iron, to counteract the loss of ecosystem services.

The potential major drivers behind brownification all provide DOC or promote and accelerate the terrestrial export of DOC and iron into water bodies. These drivers can be summarized (1) climate change, (2) reduced acid deposition and (3) shifts in land use:

(1) Climate change is prolonging the growing season, which leads to a higher supply of organic matters from the land into the water (Finstad et al., 2016). Furthermore, higher precipitation caused by climate change affects brownification through more runoff from land to water. (Laudon et al., 2011; Weyhenmeyer et al., 2014). Climate change also increases the hydrological connection between land and water by rising surface water levels (Laudon et al., 2011; Weyhenmeyer et al., 2014).

(2) Acid deposition affects the mobility and solubility of DOC and iron (Björnerås et al., 2017; Meyer-Jacobs et al., 2019). Decreased atmospheric sulphur emissions by industries leads to a recovery from acidification in the soil caused by high industrial emissions in the 70ies and 80ies (Monteith et al. 2007; Ekstrom et al. 2011). Rising pH levels in wetlands are associated with a higher release of DOC (Grybos et al., 2009).

(3) Since the 1950s a pronounced change in land-use from agriculture and natural forests to large-scale forestry with spruce plantations has occurred in the northern hemisphere (Lindbladh et al., 2014; Kritzberg, 2017; Corman et al., 2018; Škerlep et al., 2019). Furthermore, large scale wetland draining and ditching for forestry took place in Sweden (Jacks, 2019). Today, caused by plantation forestry, the most common tree in southern Sweden is the Norwegian spruce *Picea abies* (Nilsson 1990; Lindbladh et al., 2014). The Norwegian spruce is assumed to be the primary influencing factor of

increased brownification by providing large amounts of DOC and increased leaching of organic matter by clear cutting for wood harvest (Škerlep et al., 2019). There are differences in the release of carbon dioxide (CO_2) depending on the age of the forest (Naturvårdsverket, 2020). Younger forests up to the age of about 30 years are releasing more CO_2 than they take up, while forests older than 30 years take up more CO_2 than they release. However, whether this pattern persists in the leakage of DOC to water bodies is not yet known.

Protecting remaining wetlands or rewetting old drained wetlands are often proposed as possible solutions to counteract the effects of climate and land use change. For understanding brownification, it is important to examine the role of wetlands regarding the leakage or removal DOC and iron. Wetlands are commonly known to have a high potential to purify water. There is no general definition of a wetland, but according to Löfröth (1991) it is an area that is wet most part of the year with a minimum of 50 % hydrophilic plant coverage. Wetlands provide a richness of crucial ecosystem services like carbon storage, biodiversity and water purification (Millennium Ecosystem Assessment, 2005; Mitsch and Gosselink, 2007). In them, several physical, chemical and biological processes take place that remove organic material, DOC, reduce brown colour, nutrients and therefore act as a buffer zone between land and water (Hammer and Bastian, 1989; Sundaravadivel and Vigneswaran, 2001; Mitsch and Gosselink, 2007; Chileshe, 2020). The potential of wetlands to degrade coloured DOC needs further investigation and may help to remedy increasing brownification in the northern hemisphere.

The water purification potential of wetlands is complex and influenced by several different factors like its size, vegetation, climate, and retention time (Knight et al., 1987; Varma et al., 2021). But the most important factor influencing a wetland's ability to reduce organic matter seems to be its underlying soil type. Soil characteristics like salinity, pH, redox and carbon storage potential influence the types of vegetation and physical-chemical actions taking place in the wetland (Dordio et al., 2008). The effects of wetland location on peatland have previously been discussed (Freeman et al., 2002; Tranvik & Jansson, 2002). While Freeman et al. (2002) argue that peatland carbon is increasingly released due to higher peat decomposition rates caused by temperature increase. Tranvik and Jansson (2002) postulate that precipitation as well as wetland cover of the catchment shows a positive correlation with organic matter release. The impact of wetlands located on peatlands on the release of organic matter to adjacent water bodies therefore needs more investigation to understand the mechanisms behind increasing brownification.

1.2 Aim

This thesis aims to understand how changes in land use effect water colour. Particularly, whether the removal or leakage of DOC and iron differs between the following types: (1) spruce forests under 30 years old, (2) spruce forests older than 30 years and (3) wetlands on peatland.

1.3 Research Questions

(1) Is there an association between DOC, iron and absorbance?

(2) Is there a difference in DOC and iron removal between wetlands located on peatland and spruce forests of different ages?

2. Methods

2.1 Research Design

This investigation took place in the catchment of lake Bolmen in southwest Sweden. We identified 15 water course sections (sites) flowing through 3 different types of land use: (1) spruce forests > 30 years (older forests), (2) spruce forests < 30 years (younger forests) and (3) wetlands on peat (wetlands). For each type of land use, we identified 5 suitable sites. Figure 2.1 shows examples of the sampling sites for spruce forests and wetlands located on peat. At all sites, we collected water samples at the inflow and outflow for the analyses of DOC, iron, and absorbance. We measured flow, water course profile, pH, conductivity, oxygen level and temperature as well as recorded types of bottom and shoreline substrate. The surrounding was surveyed in the field at both inflow and outflow according to vegetation type next the water (groundcover, bushes, trees) and vegetation in the water (emergent, submerged, floating). All data collected was documented in a field protocol.

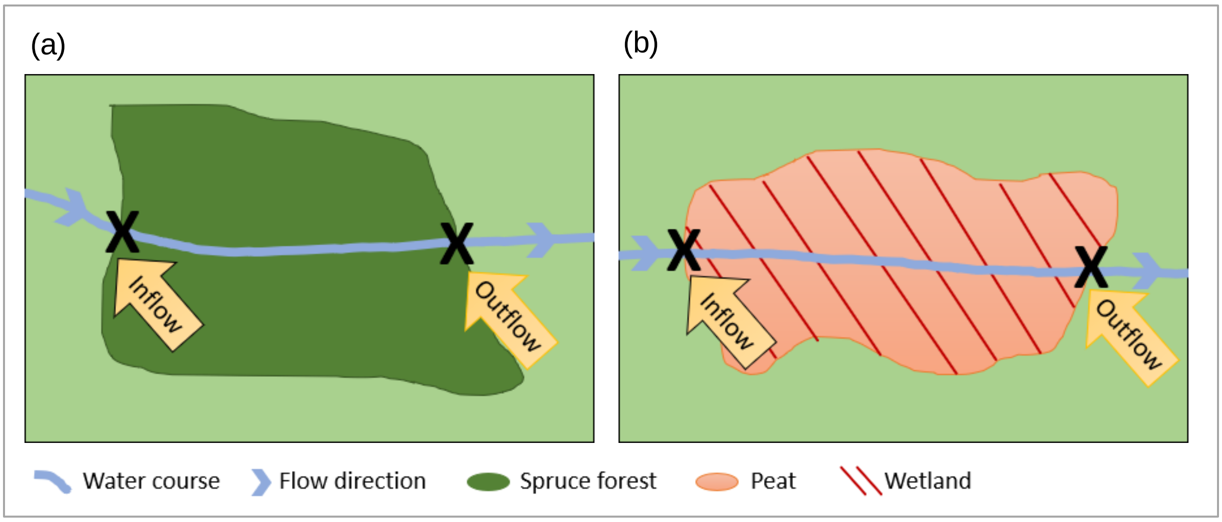

Figure 2.1: Example of sampling sites for (a) spruce forest and (b) wetland on peat.

2.2 Study catchment

Lake Bolmen in south-west Sweden has a surface area of 184 km^2, which makes it the largest lake in southern Sweden. Through the 82 km long Bolmen Water Tunnel its water is transported to Scania in southern Sweden, where it is the major source of raw water for potable water (Swedish water and wastewater Association, 2020). Since colour measurements of Lake Bolmen started in 1980, the brownification has increased steadily, which endangers several ecosystem services (Kritzberg et al., 2020). Lake Bolmen's catchment area consists mainly of spruce forests and wetlands. Most natural wetlands in its catchment are located on peatland. Figure 2.2 shows the sampling sites for spruce forests older than 30 years, spruce forests younger than 30 years and wetlands located on peat. The coordinates of the sampling sites as well as site characteristics are summarized in Appendix A.

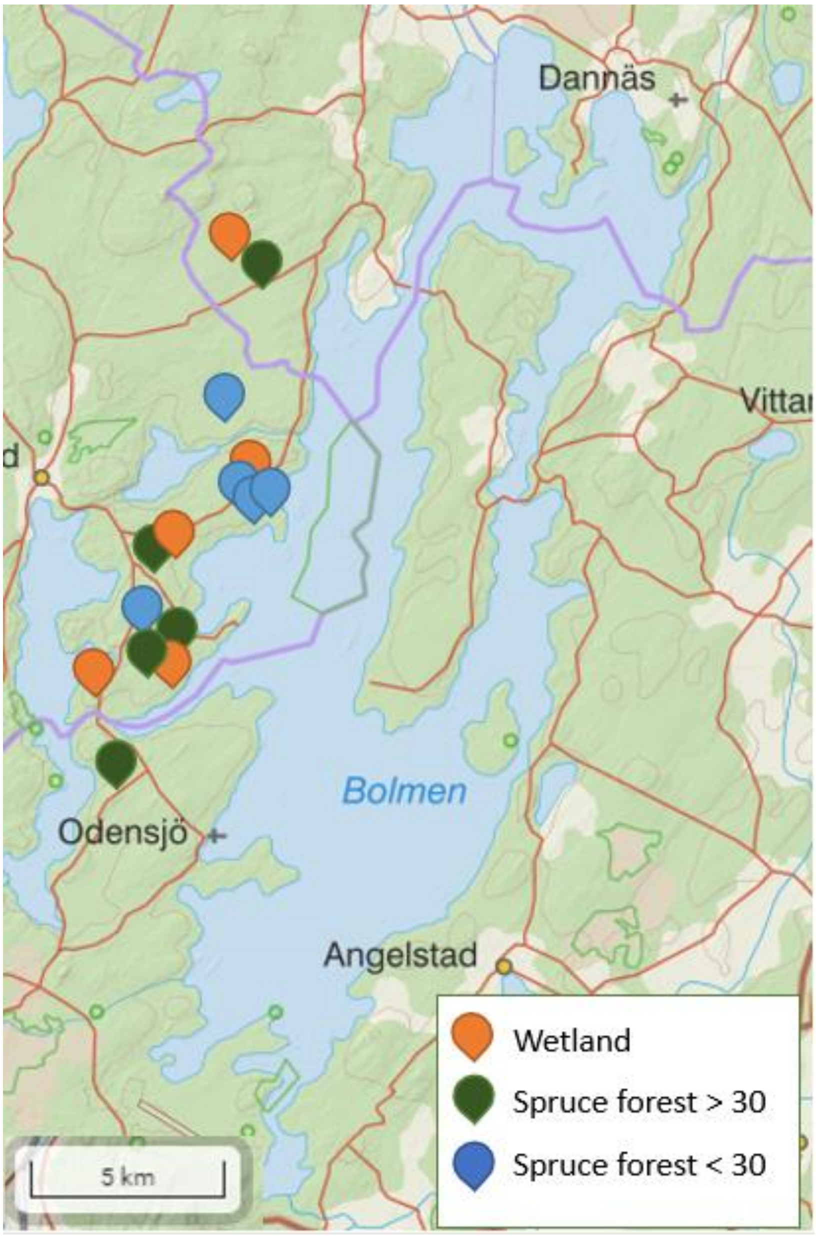

Figure 2.2: Overview of sampling sites. Source of the map: landmateriet.se

2.3 Sampling Procedure

The sampling took place in early spring 2021 between April and May. Sampling date, time, locality name, coordinates, type of land use and inflow/outflow was documented in the field protocol for environmental evaluation. A 50 ml plastic container for later laboratory analysis of DOC and absorbance was filled in a vegetation free zone in the middle of the stream without touching the ground. For the iron sampling a 50 ml measuring cylinder was filled in a vegetation free zone in the middle of the stream and emptied into a 50 ml glass container, in which 1 ml 50 % nitric acid had been added previously for preservation. Both water samples were immediately stored in a cooling bag with ice packs. Later storage took place in a 4 °C cold fridge at the Sydvatten Research Station at Lake Bolmen. The sample transport to the laboratory was undertaken in a cooling bag with ice packs. The samples were stored at 4 °C at the laboratory until analysis. Measurements for pH, temperature and conductivity were performed in the field with a HANNA (HI-9811) multimeter in stream water extracted in a 1 L plastic bag. The oxygen level was measured with an oxygen meter in the stream. The depth of the stream was measured with a folding rule about 10 cm from both edges as well as in the middle at three different spots. For later calculation of velocity an orange was used for flow measurements. The time the orange needed for a defined distance was noted. The flow measurement was repeated three times at each sampling site. The shoreline and dominant bottom substrate of the stream was recorded as stones, gavel, sand, mud, clay, peat, or detritus. The vegetation next to the water was described in species and percentages of groundcover, bushes, and trees. The vegetation in the water was described by type and percentage of emergent, submerged, and floating coverage.

2.4 Laboratory Analysis

Water samples were analysed in the in the Rydberg Laboratory for Applied Sciences at Halmstad University within one week of sampling according to standard methods. Following the literature (Weyhenmeyer at al., 2014), the samples were filtered with a 0.45 µm syringe filter before analysis. The analysis of dissolved organic carbon and iron is more stable and less easily influenceable of for instance algae or other particles. The iron analysis was performed twice on the Atomic Absorption Spectrometer, SpectraAA-100 (Varian/Victoria/Australia) according to SS028152. The instrument was calibrated with 0, 0.5, 1, 1, 2 and 5 mg/L. The DOC analysis was conducted on a total organic carbon analyser, TOC-L (SHIMADZU /Tokyo/Japan) according to SS-EN1484. Following the literature (Weyhenmeyer at al., 2014), for water colour determination the absorbance was measured in a 5 cm cuvette at 420 nm with a UV spectrophotometer, UV-1800 (SHIMADZU /Tokyo/Japan).

2.5 Data Analysis

Collected data were tabulated in excel. Mean values for iron, flow time, flow distance as well as channel depth and width were calculated. The flow speed in m/s was calculated by dividing mean flow distance by mean flow time. The channel area was calculated with the help of width and depth measurements. Calculation of the flow in m^3/s was calculated according to equation 1.

Equation 1: Flow $$F\left(\frac{m^3}{s}\right) = \frac{v\left(\frac{m}{s}\right) \times A(cm^3)}{1000}$$

DOC and iron loading were calculated by multiplying the concentration in mg/L by flow in m^3/s. In case of two inflows the weighted mean was calculated for DOC and iron concentrations before determining the loading. Furthermore, change and percentage change of DOC/iron concentration and loading between inflow and outflow were calculated. Change and percentage change in absorbance between inflow and outflow were calculated.

2.5 Statistical Analysis

The statistical analysis was performed on IBM SPSS Statistics 26. A Kolmogorov-Smirnov Test revealed that the variables DOC concentration, iron concentration and absorbance follow a normal distribution ($p = 0.107$; $p = 0.200$; $p = 0.200$ respectively). To answer question one, linear regressions were performed to see if there are any associations between absorbance and both DOC and iron concentrations. To find association between DOC and iron concentrations, a Pearson correlation was performed. A Kolmogorov-Smirnov Test revealed that the variables DOC loading and iron loading did not follow a normal distribution ($p < 0.001$; $p = 0.004$ respectively). To answer question 2, Kruskall-Wallis tests were performed to compare older forests, younger forests, and wetlands for respectively DOC and iron concentrations.

3 Results

3.1 Characteristics of Sampling Sites

The median temperature at the sampling sites was between 7 and 10 °C (Fig. 3.1 (a)). The mean pH varied between 3.8 and 4.0 (Fig. 3.1 (b)). Conductivity measurements revealed a median of 60 to 80. The median oxygen level at the sampling sites ranged between 105 and 115 % (Fig. 3.1 (c)).

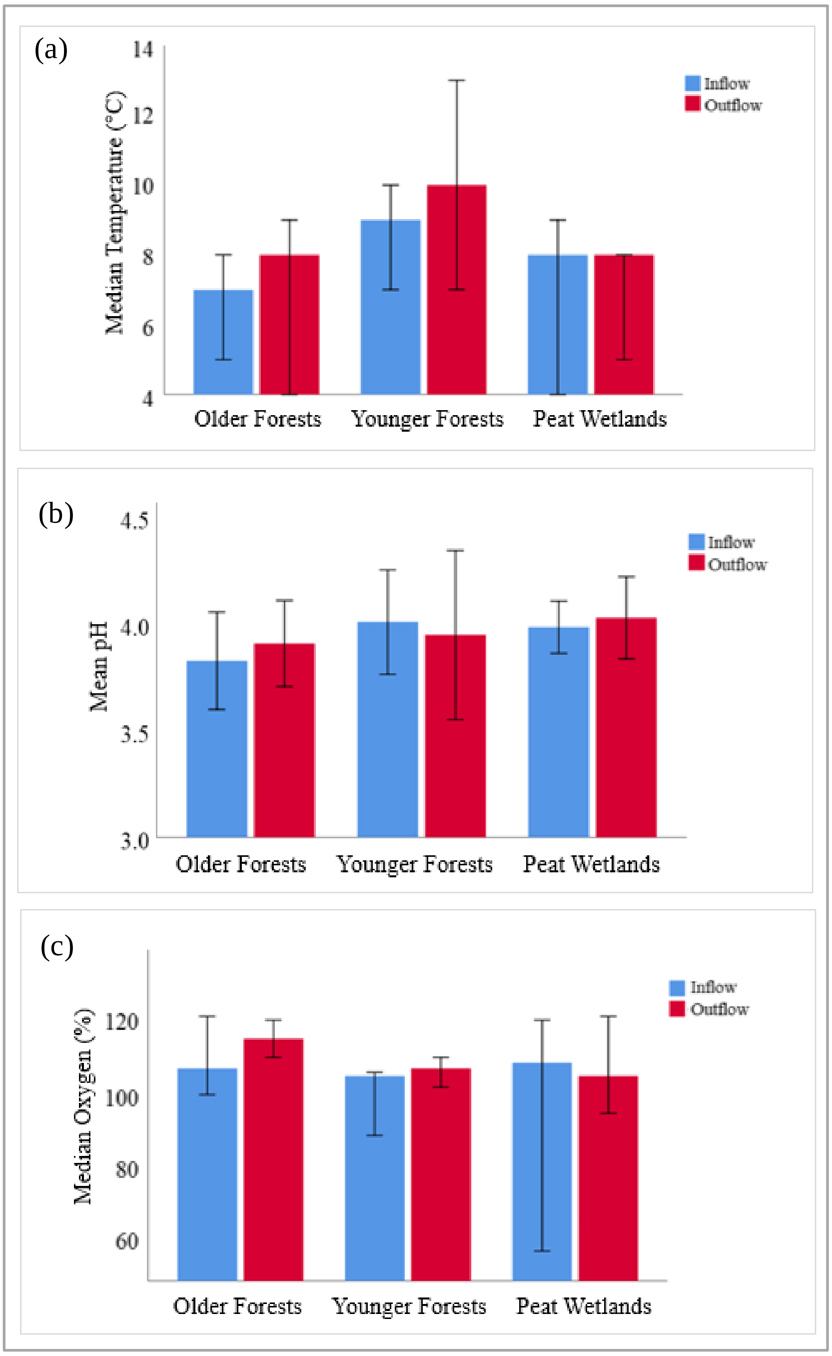

Figure 3.1: Sampling site characteristics at the different land use types regarding to inflow and outflow. (a) presents median temperature, (b) presents mean pH and (c) presents median oxygen levels.

3.2 Associations between DOC, Iron and Absorbance

The absorbance was significantly dependent on DOC concentrations (Fig, 3.2 (a); Linear regression, $R^2 = 0.88$; $F = 203$; $p < 0.001$). The absorbance was significantly dependent on iron concentrations (Fig. 3.2 (b); Linear regression, $R^2 = 0.54$; $F = 33$; $p < 0.001$). There was a strong correlation between DOC and iron concentrations (Fig. 3.2 (c); Pearson correlation, $R^2 = 0.72$; $p < 0.001$).

Mean DOC concentration for all sampling sites at inflow and outflow (± standard deviation) were 21.10 ± 5.96 mg/L For iron, mean concentrations (± standard deviation) were 1.26 ± 0.49 mg/L for iron. Mean values for absorbance (± standard deviation) at 420 nm were 0.667 ± 0.191. Table 3.2 summarizes the mean values for DOC, iron and absorbance.

Table 3.2: Mean values for DOC, iron and absorbance for inflow and outflow of all 15 sites (N = 30).

Variable	Mean	± Standard Deviation
DOC (mg/L)	25.10	± 5.96
Iron (mg/L)	1.26	± 0.49
Absorbance (420 nm)	0.667	± 0.191

3.3 Variations Between Older Forests, Younger Forests and Peat Wetlands

To determine the differences between DOC and iron release of spruce forests of different ages and wetlands on peat, the changes in both DOC and iron load were compared between the three types of land use. There was no statistically significant difference in the change of DOC loading between the three groups: older forests, younger forests and peat wetlands (Fig. 3.3.1 (a); Kruskal-Wallis test, $p = 0.185$). Neither was there a statistically significant difference in the change of iron loading between the three groups (Fig. 3.3.1 (b); Kruskal-Wallis test, $p = 0.403$). However, young forests and wetlands tended to release more DOC than they took up, whereas older forests tended to take up more DOC than they released. Within the older forests, median values of changes in DOC load were 0.141 (0.43) g/s and 0.014 (0.03) g/s for change in iron load. For the forests < 30 years median values of changes in DOC loads were -0.075 (4.72) g/s and -0.003 (0.20) g/s for changes in iron concentration. For the wetlands, median values of changes in DOC loads were 0.239 (1.96) g/s and 0.015 (0.30) g/s for changes in iron concentration.

Among the three land use types the mean DOC concentrations were between 22.77 and 26.91 mg/L (Fig. 3.3.2 (a)). Mean iron values ranged between 1.13 and 1.46 mg/L (Fig. 3.3.2 (b)). The mean absorbance at 420 nm varied between 0.65 and 0.69 (Fig 3.3.2 (c)).

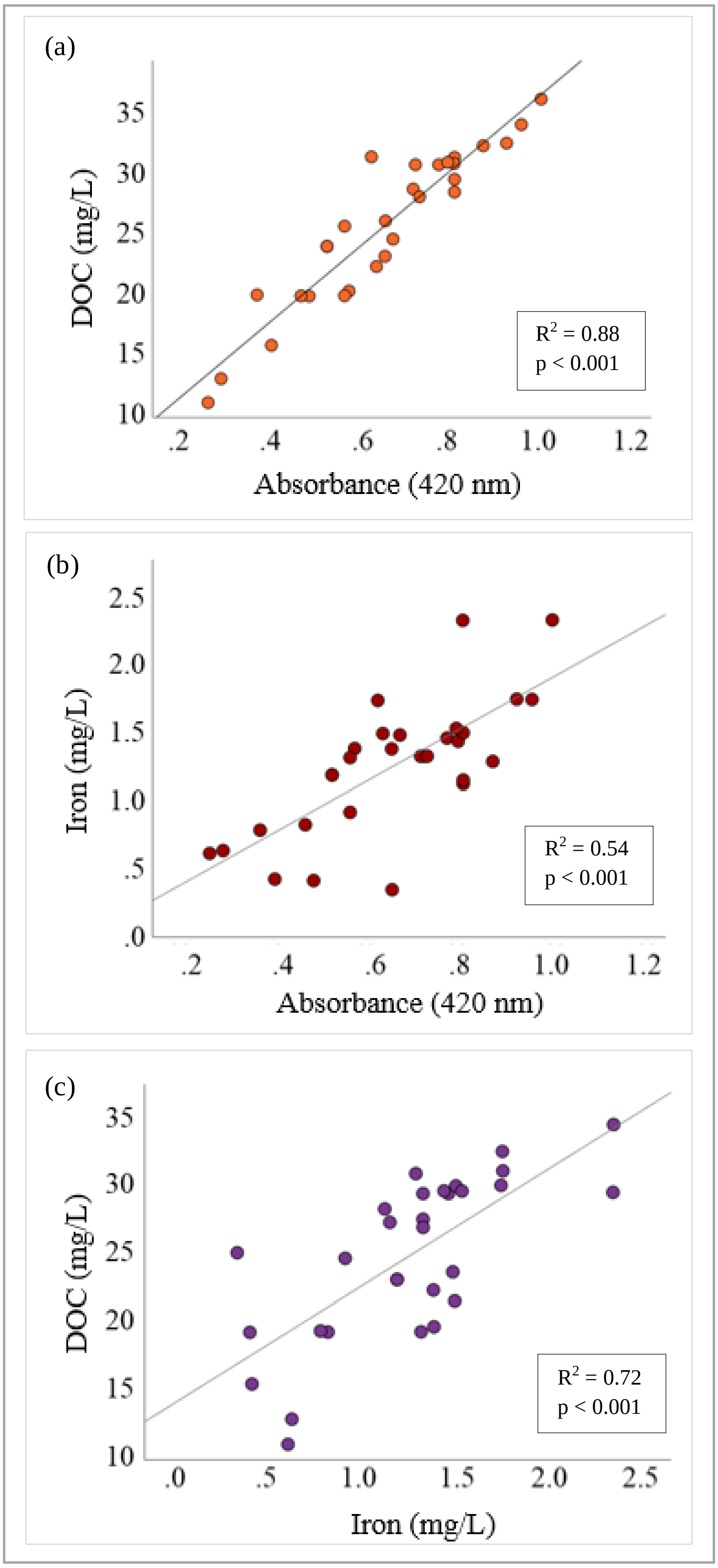

Figure 3.2: Associations between (a) DOC concentrations and absorbance, (b) iron concentrations and absorbance and (c) DOC concentrations and iron concentrations.

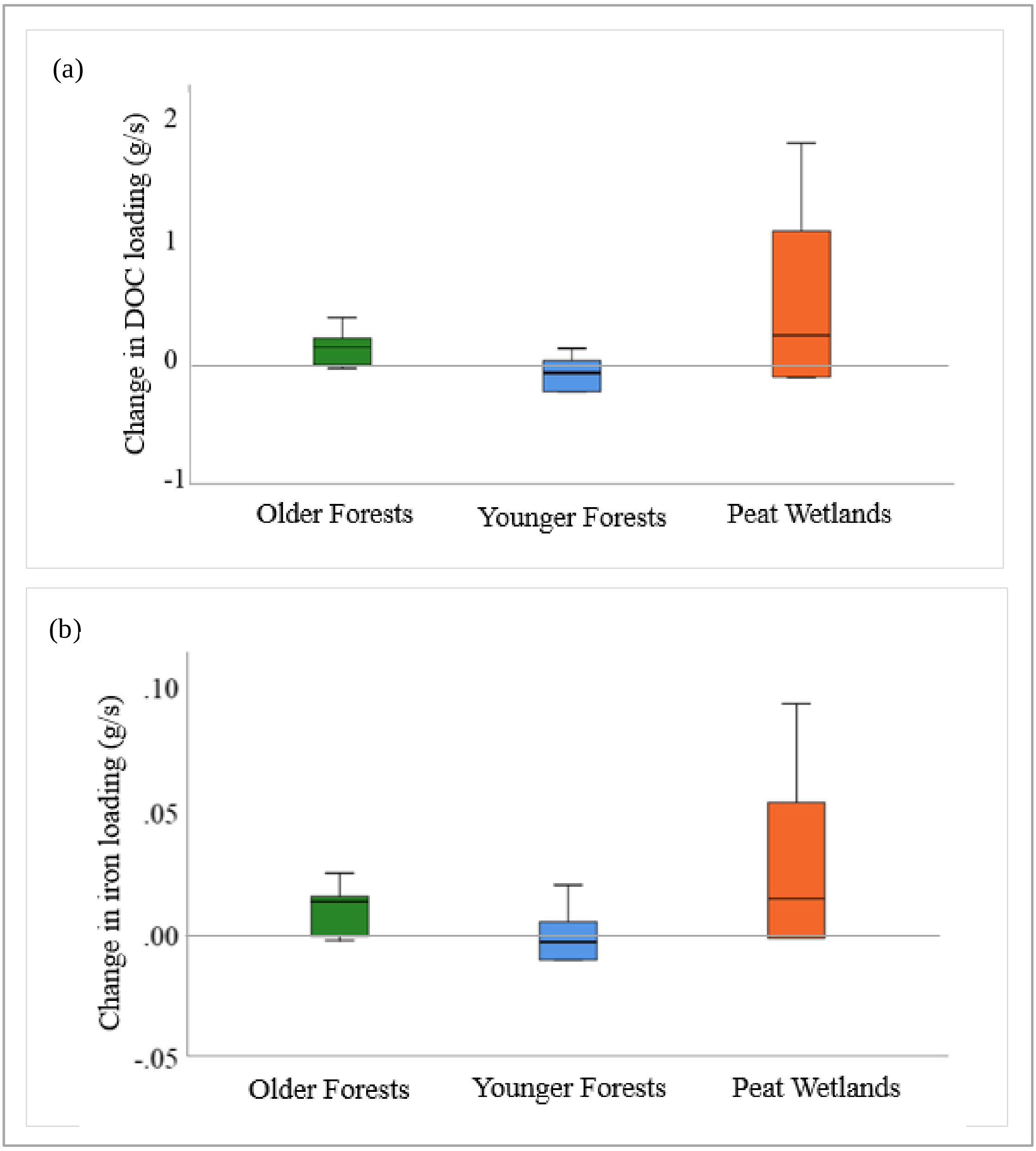

Figure 3.3.1: Median changes in (a) DOC loading and (b) iron loading according to type of land use.

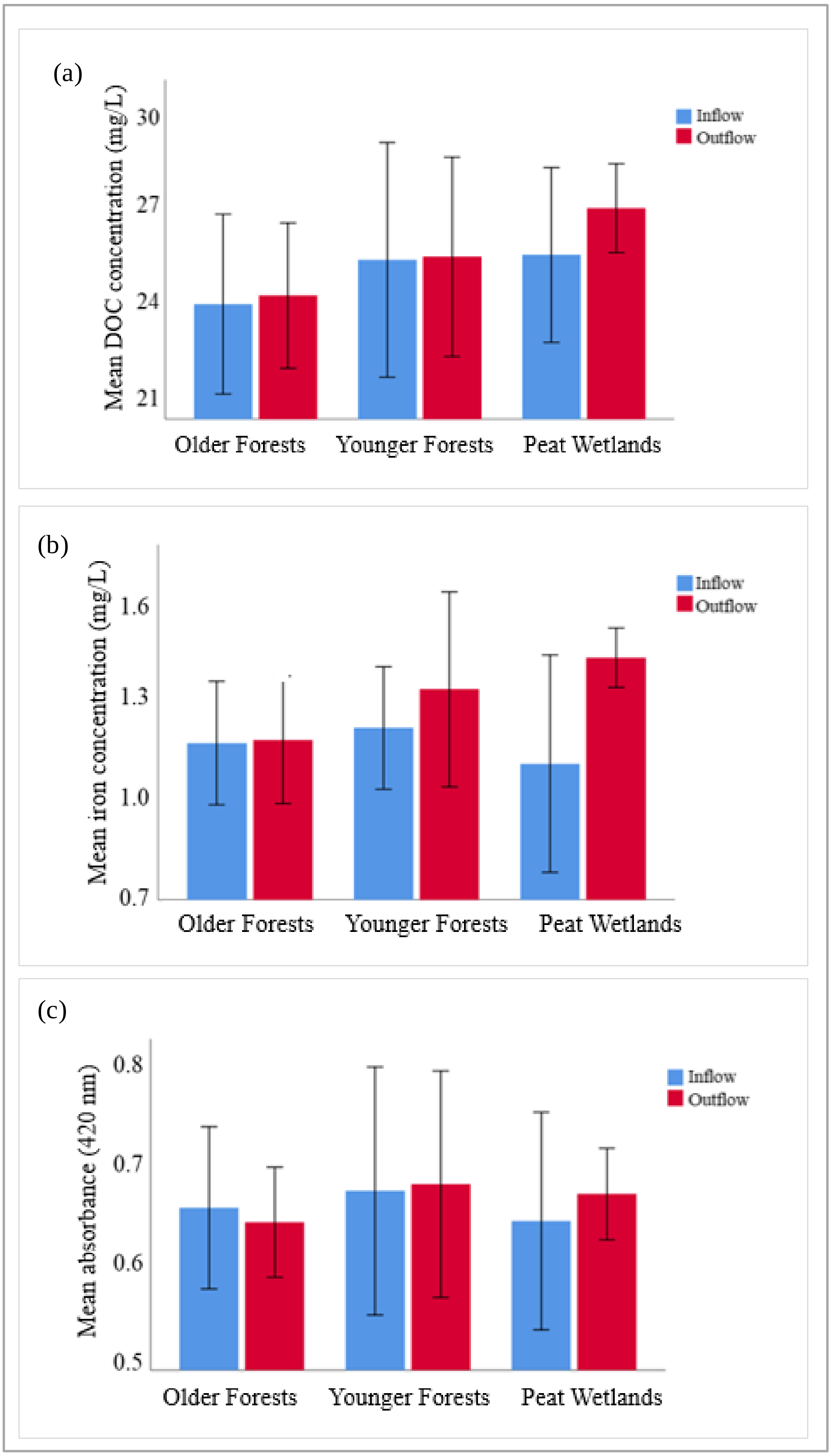

Figure 3.3.2: Sampling site characteristics at the different land use types according to inflow and outflow for (a) DOC concentrations, (b) iron concentrations and (c) absorbance.

4. Discussion

We found highly significant associations between the variables DOC, iron and absorbance. There were no significant differences in the release of DOC and iron between older forests, younger forests and wetlands. However, both older forests and peat wetlands tended to increase DOC and iron concentrations when compared to younger forests.

The present results showed a slightly stronger positive association between DOC concentration and absorbance ($R^2 = 0.88$; $p < 0.001$) than the results than the results of 58000 boreal water samples reported by Weyhenmeyer et al. 2014 ($R^2 = 0.85$; $p < 0.0001$). Thus, the outcome regarding DOC concentrations, iron concentration and absorbance of this present investigation was as expected. It shows that water bodies in lake Bolmen's catchment follow the general reported trend and confirms the correctness of our study.

The present results show that older forests, younger forests and peat wetlands release iron and both release and degrade DOC. Regarding the forests, we found that older forests tend to release more DOC and iron compared to younger forests. Further investigations are required to find significant associations. Overall, DOC and iron concentrations and DOC and iron loading may prove to be higher from peat wetlands than from forests given more data. The high variability of both DOC and iron loading among wetlands might be caused by different types of vegetation in the area of the wetland. The main tree type was the Norwegian spruce, but the age varied. Furthermore, one wetland was covered with grass and bushes. This possibly influenced the outcomes. The results reveal that there are potential differences between older forests, younger forests and wetlands which need to be further investigated in the future.

The limitations of this present investigation include having only 5 sampling sites for each land use type. A larger number of sites would give more reliable results. Furthermore, the sampling took place within the same season. Replications in time would enable an estimation of seasonal variation. It is possible that outcomes have been influenced by different weather conditions, since there were two weeks between the sampling of different sites. Regarding the wetlands, there were different types of vegetation in the surrounding area, which might affect the release of organic matter. Since one wetland had no flow at the inflow this water body only released matter and it is important to point out that this could have caused a potential error. Certain limitations of this study should be addressed in future research. Main strength of this project is the conducting of a field study with sampling and environmental evaluation. Furthermore, all laboratory analyses were implemented by us with high-tech and reliable instruments. The strong associations between DOC, iron and absorbance shows that we conducted reliable results that follow previously published patterns (Weyhenmeyer at al., 2014). The results give a valuable insight into the conditions of water bodies running through older forests, younger forests and wetlands on peat in the catchment of lake Bolmen.

In this investigation we gained valuable knowledge about the detection of suitable sampling sites and the procedure of the field work, which can be implemented as a fundament for further research addressing the issue of lake Bolmen's brownification. Especially future investigations within the project “LONA - Where should wetlands be located to best secure southern Sweden future water quality for drinking water supply, tourism and fishing?” can benefit from this present study.

The present study represents a first attempt to address the influence of different ages of forests on brownification. For higher reliability it is necessary to include more sampling sites for each type of land use. To further increase the reliability, the measurements should be replicated over a larger time span, preferably a whole year to determine seasonal variations. Another suggestion for future improvement would be including more types of land use and even differing between different types of vegetation in the area of wetlands on peat.

5. Conclusion

We found strong associations between DOC, iron and absorbance. Even though no significant difference in the DOC and iron release was detected between the investigated land use types, older forests tended to increase DOC and iron concentrations when compared to younger forests. This study revealed that not only spruce forests in general are affecting the brownification of waterbodies, but that many other factors may affect the release of uptake of DOC, such as vegetation identity and age, underlying soil type and seasonality. It is important to further investigate this topic to make forestry more sustainable in the future and decelerate further brownification in freshwater bodies.

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Appendix

Appendix A: Overview of Sampling Sites

Site	Locality	Sample No	Coordinates	Date, Time	Inflow/ Outflow	Channel area cm^2	Flow m^3/s	Temp °C	pH	Cond	Oxygen %	Abs420	Abs410	DOC mg/L	DOC loading	Iron mg/L	Iron loading
Spruce > 30 1	Sävsås/Fällan	4	N6312833 E415083	21/4/16 10:38	Inflow	1623,33	0,0531	5	3,3	60	121	0,782	0,909	29,68	1,577	1,464	0,078
Spruce > 30 1	Sävsås/Fällan	3	N6312805 E414851	21/4/16 09:35	Outflow	2445,56	0,0097	4	3,8	80	120	0,73	0,909	29,68	0,287	1,330	0,013
Spruce > 30 2	Järanäs	6	N6308448 E414963	21/4/16 13:15	Inflow	1164,44	0,0149	8	3,7	70	107	0,409	0,478	15,61	0,232	0,427	0,006
Spruce > 30 2	Järanäs	7	N6308437 E415019	21/4/16 13:37	Outflow	1031,11	0,0109	8	3,6	60	115	0,493	0,578	19,44	0,211	0,416	0,005
Spruce > 30 3	Järanäs	10	N6308492 E414628	21/4/16 15:15	Inflow	3931,11	0,0715	8	3,4	60	107	0,881	1,023	31,16	2,227	1,292	0,092
Spruce > 30 3	Järanäs	11	N6308619 E415081	21/4/16 15:40	Outflow	2625,56	0,0508	8	3,4	60	120	0,806	0,931	29,88	1,518	1,441	0,073
Spruce > 30 4	Röshult	16	N6304751 E413222	21/4/20 11:10	Inflow	2791,11	0,0231	7	4,4	70	119	0,582	0,677	19,84	0,458	1,387	0,032
Spruce > 30 4	Röshult	17	N6304751 E413216	21/4/20 11:50	Outflow	2233,33	0,0596	9	4,5	60	110	0,572	0,664	19,48	1,16	1,320	0,079
Spruce > 30 5	Ugglebo	25	N6316453 E415501	21/4/21 12:40	Inflow	3337,78	0,0152	6	4,3	60	100	0,662	0,769	22,55	0,344	1,384	0,021
Spruce > 30 5	Ugglebo	26	N6318750 E415972	21/4/21 13:15	Outflow	2172,22	0,046	8	4,2	60	115	0,643	0,747	21,75	1,001	1,497	0,069
Spruce < 30 1	Tiraholm	14	N6312649 E416954	21/4/19 13:30	Inflow	1797,78	0,0209	8	4,1	70	105	0,533	0,625	23,32	0,487	1,193	0,025
Spruce < 30 1	Tiraholm	15	N6312203 E417378	21/4/18 15:00	Outflow	2616,67	0,0145	10	4	70	110	0,572	0,673	24,89	0,362	0,919	0,013
Spruce < 30 2	Järanäs	22	N6309543 E414546	21/4/20 17:00	Inflow	3394,44	0,03	10	3,9	70	105	0,297	0,345	13,01	0,39	0,638	0,019
Spruce < 30 2	Järanäs	21	N6309514 E414640	21/4/20 16:30	Outflow	5386,67	0,0379	10	3,8	70	100	0,268	0,314	11,15	0,422	0,617	0,023
Spruce < 30 3	Fällan	28	N6312268 E415566	21/5/08 11:20	Inflow	828,61	0,0129	7	3,5	70	89	0,817	0,949	30,25	0,389	1,503	0,019
Spruce < 30 3	Fällan	27	N6312180 E415594	21/5/08 10:50	Outflow	703,89	0,0106	11	4,1	320	102	0,816	0,946	29,77	0,314	2,332	0,025
Spruce < 30 4	Sörbo	29	N6312262 E415791	21/5/09 11:20	Inflow	1531,11	0,0306	7	3,3	60	106	0,966	1,122	32,8	1,004	1,748	0,054
Spruce < 30 4	Sörbo	30	N6312194 E415771	21/5/09 11:30	Outflow	1271,67	0,0246	7	2,5	60	107	0,933	1,084	31,36	0,772	1,751	0,043
Spruce < 30 5	Hulan	32	N6314998 E415435	21/5/09 13:20	Inflow	6483,06	0,2559	9	4,8	50	105	0,817	0,947	28,54	7,304	1,128	0,289
Spruce < 30 5	Hulan	31	N6314928 E415405	21/5/09 13:00	Outflow	2820	0,0984	8	4,6	50	108	0,817	0,947	27,55	2,71	1,155	0,114
Wetland 1	Sävsås/Fällan	2	N6312802 E414936	21/4/16 09:35	Inflow	2445,56	0,0097	4	3,8	80	120	0,725	0,845	27,78	0,268	1,330	0,013
Wetland 1	Sävsås/Fällan	1	N6312805 E414851	21/4/16 09:00	Outflow	3703,33	0,0517	5	4,4	110	101	0,739	0,849	27,18	1,405	1,330	0,069
Wetland 2	Järanäs	8	N6308437 E415019	21/4/16 13:37	Inflow	1031,11	0,0109	8	3,6	60	115	0,493	0,578	19,44	0,211	0,416	0,005
Wetland 2	Järanäs	9	N6308300 E415387	21/4/16 14:30	Inflow	1117,78	0,005	7	4	50	101	0,453	0,532	19,48	0,097	1,311	0,007
Wetland 2	Järanäs	5	N6308650 E415171	21/4/16 11:30	Outflow	2143,33	0,0637	6	3,4	60	121	0,802	0,932	29,86	1,901	1,535	0,098
Wetland 3	Tiraholm	12	N6312945 E416932	21/4/18 13:30	Inflow	2957,78	0,0306	9	4,4	110	120	0,377	0,448	19,54	0,598	0,789	0,024
Wetland 3	Tiraholm	13	N6312649 E416954	21/4/19 13:30	Outflow	1797,78	0,0209	8	4,1	70	105	0,533	0,625	23,32	0,487	1,193	0,025
Wetland 4	Almesjö	20	N630705 E4141095	21/5/08 13:39	Inflow	4545	0,101	9	4,1	60	100	1,01	1,127	34,79	3,514	2,335	0,236
Wetland 4	Almesjö	18	N6307025 E413561	21/5/08 13:55	Outflow	1263,56	0,0197	8	3,8	60	95	0,632	0,927	30,29	0,596	1,741	0,034
Wetland 5	Ugglebo	23	N6318267 E414835	21/4/21 10:30	Inflow	1303,33	0	8	3,8	110	58	0,663	0,78	25,3	0	0,349	0
Wetland 5	Ugglebo	24	N6318552 E415470	21/4/21 12:20	Outflow	3501,11	0,0371	8	4,4	60	110	0,68	0,79	23,88	0,885	1,489	0,055

Temp = Temperature; Cond = Conductivity; Abs420 = Absorbance at 420 nm; Abs410 = Absorbance at 410 nm; DOC loading = DOC loading in g/s; Iron loading = Iron loading in g/s

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