The Eutrophication of the Baltic Sea: An Assessment of a Remediation Strategy Encompassing Wetlands, Algae, and Biogas

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Lund University Master's Thesis
Spring 2009

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Abstract: Eutrophication is the most serious environmental threat to the Baltic Sea (HELCOM 2009), and consumer behaviour is ultimately at the root of this problem. In order to facilitate a proper supply, landowners change their landscapes. These changes are what stimulate the nutrient enrichment in the Baltic Sea. This is a sustainability assessment of the "Wetlands, Algae, and Biogas-A Southern Baltic Sea Eutrophication Counteract Project" (WAB) in Trelleborg Commune. This assessment will critically analyze the plans for this site and ultimately determine whether or not the WAB project is on a path to sustainability. This analysis will investigate the spatial and temporal relationships between the environment, society, and the economy and attempt to discern how sustainable WAB can be. The assessment makes use of a Driver, Pressure, State, Impact, Response (DPSIR) schematic and three conceptual models to provide a depiction of the nature-society relationships that occur. Ultimately, the results determine that the WAB project is certainly on a sustainable trajectory but it could be further along.

Key Words: Eutrophication, The Baltic Sea, Wetland, Algae, Biogas, Trelleborg

Acknowledgements: I would like to thank my family and friends, Matilda Graden, Ann Åkerman, Gvantsa, Roseann, Elise, Hitesh, F. Byx, and SGT. Hotman,. Most of all, I would like to thank Göran Ewald for his care, generosity, and friendship.

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1. Introduction

Eutrophication is the most serious environmental threat to the Baltic Sea (HELCOM 2009), and consumer behaviour is ultimately at the root of this problem. A pressure for cheap food has increased the need for more agricultural land and intensified agricultural practices. In order to facilitate a proper supply, landowners change their landscapes. These changes are what stimulate the nutrient enrichment in the Baltic Sea.

What follows is a sustainability assessment of the "Wetlands, Algae, and Biogas-A Southern Baltic Sea Eutrophication Counteract Project" (WAB) in Trelleborg Commune. The project was designed to counteract the eutrophication of the Baltic Sea. This assessment will critically analyze the plans for this site and ultimately determine whether or not the WAB project is on a path to sustainability. This analysis will investigate the spatial and temporal relationships between the environment, society, and the economy and attempt to discern how sustainable WAB can be.

The assessment will begin with a general overview of its focus and objectives followed by a vivid depiction of the setting surrounding the WAB Project. The WAB project will then be placed into the context of the bigger picture and will be investigated in light of this spatial and temporal scope. A Driver, Pressure, State, Impact, Response (DPSIR) schematic and three conceptual models will be used to provide a depiction of the nature-society relationships that occur in the setting. A discussion will then commence in light of the results from the DPSIR schematic and conceptual models.

2. Theoretical Background, Objectives and Scope

The purpose of this assessment is to determine whether or not the WAB project is on a sustainable trajectory. Its objective is to focus attention on and to ensure that the fundamental interactions between nature and society move along more sustainable trajectories; the aggregate of which result in a form of sustainable development (Kates et al., 2001). According to Kates et al., (2001) this would entail meeting fundamental human needs in such a way that one does not compromise the life-support systems of the environment for current and future generations and places equal value in developing the environment, economy, and society (Kates et al., 2001). This assessment will maintain a local to regional focus.

According to Kates et al., (2001) there are three pathways or trajectories that sustainability science should follow. The first trajectory relates to the dialogue within the scientific community that must take place and paying attention to key questions, appropriate methodologies, and institutional needs. Secondly, the science within this dialogue must be connected to a political agenda that focuses on sustainable development. The third trajectory encompasses the fact that the research itself must concentrate on the characteristics of nature-society interactions, on one's ability to guide those interactions along sustainable trajectories, and on ways to promote and facilitate the social learning and knowledge that will be necessary to navigate this transition to sustainable development (Kates et al., 2001). Following these pathways will enable the current form of development to evolve towards a direction that is sustainable; or along a more sustainable trajectory (Kates et al., 2001). With that in mind, it is apparent that if the WAB project is to be considered sustainable, then it must move forward along these pathways. This assessment will keep in mind the first two trajectories but will concentrate on the third trajectory given its importance and particular relevance to the WAB project.

This concept is one which emphasizes the role of society in maintaining a form of development that is dependant on the interactions between nature and society (Kates, 2001). With that in mind, this research aims to provide what Kates refers to as an evaluation of a local to global integrated nature-society system in a short and long term perspective with the hope of determining which actions should or should not be taken in an attempt to make society sustainable (Kates, 2001).

Touched on above was a spatial and temporal component that will remain central throughout this assessment. Euliss et al., (2008); Wiggering et al., (2003); Ness, (2008); and Schanz, (2003) all make reference to the importance of exploring a project both spatially and temporally. Maintaining both spatial and temporal scales fixed on elements imperative to a system is thus critical in a sustainability assessment, and hence their inclusion in this assessment.

In consideration of the sustainability assessment standards presented by Barry Ness in his 2008 Doctoral Dissertation in which he investigated the sustainability of the Swedish sugar sector, it is an objective of this assessment to provide an account that addresses some of the important concepts raised therein. In order for a sustainability assessment to be effective it should exhibit a certain major characteristics. This assessment should hold a realistic credibility; be salient and/or relevant to the system in question; maintain a flexibility that incorporates a wide breadth of social, economic, and environmental aspects while spanning spatial and temporal scales; and it should consider the views of a variety of stakeholders (Ness, 2008).

According to Ness et al., (2006) there are three important aspects of sustainable development to consider:

- What is to be sustained: nature, life-support (i.e. agriculture, water), community, economy
- What is to be developed: people, society, economy, nature
- Intergenerational component: specific sustainability goals must express the time horizon for which the goals are to be achieved.

This Assessment will later show how the WAB aims to satisfy these three aspectual considerations but will also draw attention to what may be lacking from it.

The above mentioned aspects combine to create what may be considered as an itinerary for sustainable development. The assessment that follows will examine the WAB project in light of this itinerary and ultimately decide if it is on a path to sustainable development, how far along this path it might be, and where it could be in light of an amended strategy.

3. The Setting

The Baltic Sea

The HELCOM Baltic Sea Action Plan has identified eutrophication as one of the single greatest threats to the Baltic Sea and subsequently one of four main issues that must be dealt with in order to improve the health of this important body of water (HELCOM, 2009). This action plan has set strategic goals for its member states, objectives which, when obtained, will classify this area of water as maintaining a good ecological/ environmental status (HELCOM, 2009). What follows are the aggregate inputs of nitrogen and phosphorus from each of the HELCOM member states (Table 1) and the overall objective that would have to be attained in order for the Baltic Sea to be classified as having a good ecological/ environmental status. This section will more specifically examine Sweden's role in facilitating this objective, investigate their reduction targets and take a look at what the Swedish government is doing to reach these targets.

HELCOM Country	Nitrogen (tonnes)	Phosphorus (tonnes)
Denmark	17 210	16
Estonia	900	220
Finland	1200	150
Germany	5 620	240
Latvia	2 560	300
Lithuania	11 750	880
Poland	62 400	8760
Russia	6 970	2 500
Sweden	**20 780**	**290**
Transboundary common pool	3 780	1 660

Table 1. HELCOM member countries. and their subsequent Nitrogen and Phosphorus reduction targets as per the Baltic Sea Action Plan (HELCOM, 2007).

According to the HELCOM Baltic Sea Action Plan, the maximum allowable total amount of nitrogen (N) and phosphorus (P) that each member state is allowed to emit into the Baltic while still maintaining 'good status' is 600 000 tonnes (t) of N and 21 000 t P (HELCOM, 2005). The 1997-2003 annual average amounted to 36 000 t P and 737000 t N, therefore calling for reductions of 15000 t P and 137000 t N respectively (HELCOM, 2005). The HELCOM member countries and their individual contributed release of N and P into the Baltic Sea can be summarized in the table below.

In General

The type (waterborne or airborne) of amount of total N and P released into the Baltic Sea by all HELCOM member states in 2000 can be summarized in the table below (Table 2). The waterborne and airborne amounts were calculated simply as a percentage of the total amount. All amounts are from HELCOM (2005) and are expressed in tonnes (t).

Table 2. The type (waterborne or airborne) of amount of total N and P released into the Baltic Sea by all HELCOM member states in 2000 (HELCOM, 2005).

Type Amount	Nitrogen	Phosphorus
Total	1 009 700 t	34 500 t
Waterborne	75% of total	95-99% (97%) of total
Airborne	25% of total	1-5% (3%) of total

The source amount (agriculture and forestry, natural, and point source) of total N and P released into the Baltic Sea by all HELCOM member states in 2000 can be summarized in the table below (Table 3). Again, the agriculture and forestry, natural, and point source amounts were calculated simply as a percentage of either the waterborne amount (in the case of N) or the total amount (in the case of P as it is mostly land-based and particle-bound). All amounts are from HELCOM (2005) and are expressed in tonnes (t).

Table 3. The source amount (agriculture and forestry, natural, and point source) of total N and P released into the Baltic Sea by all HELCOM member states in 2000. The amounts were calculated as a percentage of the type amount found in Table 2 above (HELCOM, 2005).

Source Amount	Nitrogen	Phosphorus
Agriculture and Forestry	60% of Waterborne = 454 365 t	50% of Total = 16 733 t
Natural	28% of Waterborne = 212037 t	25% of Total = 8366 t
Point Source	12% of Waterborne = 90 873 t	15% of Total= 5020 t

Sweden

According to HELCOM, the Swedish annual reduction target, in order to be considered as having good ecological status, is set at 290 t P and 20780 t N (HELCOM, 2007). Sweden is responsible for 6% of the airborne deposition of nitrogen enters the Baltic and 21% of the waterborne inputs of N (HELCOM, 2005). In order to gauge the total amount of N that Sweden emits into the Baltic Sea, one can simply aggregate the 6% of the total atmospheric deposition of N (252 425 t) which equals 15 146 t N, and the 21% of the total waterborne inputs of N (757 275 t) which equals 159 028 t N. Therefore, Sweden is responsible for emitting approximately 174 174 t N into the Baltic.

Sweden is also responsible for 14% of the waterborne inputs of P into the Baltic or, in this case: 14% of 33 465; equaling 4685 t P (HELCOM, 2005). The impact and amount resulting from airborne deposition of P that enters the Baltic from Sweden is rather difficult to justify and not of much significance to this study either, so it will be left out.

Skåne, the Landscape, and Eutrophication

With a catchment of approximately 5740 hectares and a length of about 30 km the Tullstorpsån is the longest river in Trelleborg commune (Carlsson, 2009). This catchment is located in the Trelleborg Commune on the southern most shore of Sweden. Roughly 85% of the land within the catchment is arable, and as a result of the demand placed on agriculture and consequent intensified forms of farming, the majority of the waterways within this area, including the Tullstorpsån, have been straightened (Figure 1) to make way for even more farming (Carlsson, 2009). This creates a problem for water bodies downstream in that they have a tendency to fall victim to eutrophication in the presence of enough nutrients. In order to remedy this situation, the Trelleborg Commune has decided to implement the WAB project. As part of their remediation strategy, the Tullstorpsån is planned to be re-meandered (Figure 2) and a series of 49 wetlands will be constructed within the catchment.

Figure 1. The Tullstorpsån River. It has been straightened and is unable to retainwater; note how step the banks are. There is a minute Riparian Zone between it and the surrounding agricultural land. (Photo: Author, 2009).

The Tullstorpsån

In Sweden, 75 % of the N and 95% of the P that enters the Baltic does so via rivers (HELCOM, 2007). The Tullstorpsån River is responsible for an annual release of 250 t N and 4 t P into the Baltic Sea (Naturvårdsingenjörerna, 2008). Since the effects of eutrophication are a significant threat to the Baltic Sea drainage basin, Sweden, and more specifically the Trelleborg Commune, has decided to do their part in lowering the amount of nutrients its landowners release into the Baltic Sea.

The WAB

As a response to the eutrophication, the Trelleborg Commune has implemented the WAB project. The objectives of the project are summarized as follows:

- Resolve this nutrient problem
- Control flooding
- Create a healthier ecological status within the catchment
- Promotes an attractive nature and biodiversity
- Facilitate the management of the Tullstorpsån for some of the local landowners (Carlsson, 2009).

Figure 2. Rendering of a re-meandered Tullstorpsån River. (Carlsson personal communication, 2009).

The idea therein is to create a closed loop cycle that will have nutrients moving from the croplands as nutrient runoff, through the system, and back to the croplands via fertilizer once again (Project Proposal, 2009). This closed loop - Kretslopp in Swedish, literally means “circulation” in English (Ordbok, 1942). The nutrient reduction aim of the WAB project is to reduce 80 tonnes of nitrogen per year and reduce the phosphorus by 2.1 tonnes per year (Naturvårdsingenjörerna, 2008).

For clarity purposes, the WAB project can be divided into three compartments: wetlands/ Tullstorpsån; second, algae/ biogas; and third, agriculture. These compartments were designed specifically on their own but were merged together once it was evident that their individual objectives could be aligned and that they could benefit economically and mechanically from one another. When combined, these compartments form the Kretsloppet (Figure 3) (Björk, Carlsson, and Gradin interviews, 2009).

A main determinant in the removal of nutrients in this system, or in any wet environment, is the slow movement of water (Åkerman, personal communication, 2009). By having it settle within these wetlands and meanderings for some time the plants and micro organisms should have the ability to filter out many of the nutrients before they reach the Baltic Sea and stimulate eutrophication (Project Proposal, 2009). It is intended that the macrophytes and algae from these wetlands, but more-so that of the Baltic, be harvested and used in the production of biogas at the Jordberga biogas plant that is designed to produce 330 Gwh of energy per year (Bjork interview, 2009). This should also be an effective way of removing any stored nutrients from the system. The digestive residues resulting from the production of biogas will then be put back into the system in the form of agricultural fertilizers (Björk and Carlsson interviews, 2009; Project Proposal, 2009). It is now possible to notice that a cycle has been formed, starting with the fertilization of agricultural cropland and ending with it; all-the-while removing nutrients from the Baltic. Trelleborg will use the biogas for transportation fuel, heating of houses in urban areas, production of electric power, and in the ferries that sail the Baltic Sea (Björk interview, 2009).

The Kretsloppet

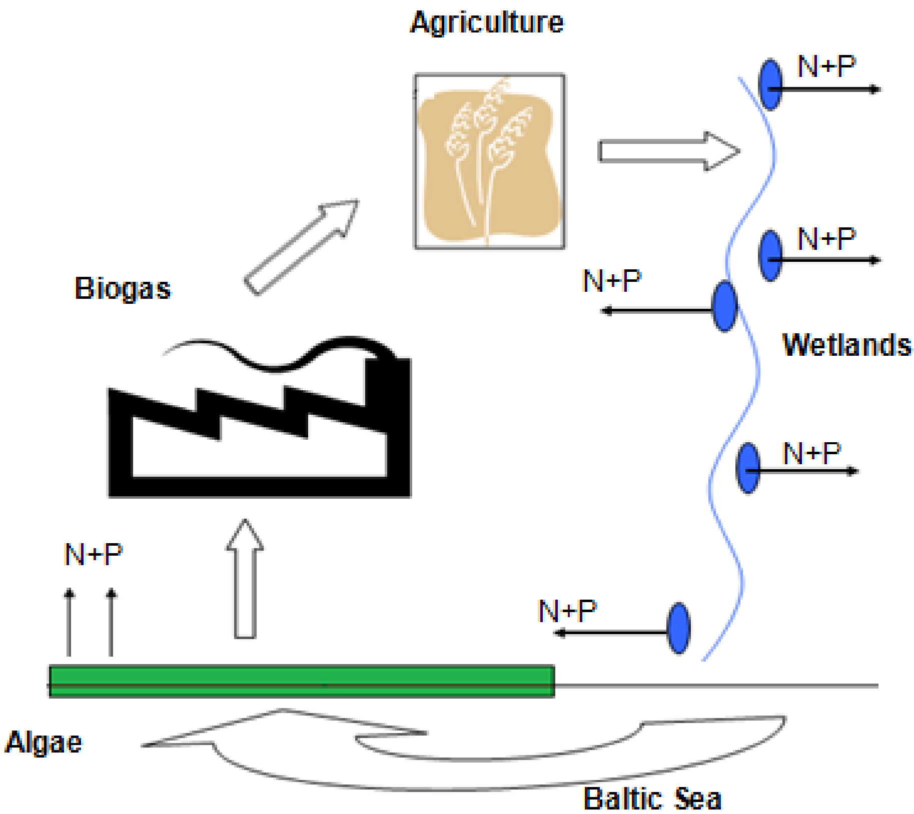

Figure 3. A depiction of the Kretsloppet. The cycle begins with nutrient runoff/drainage, either heading into the Tullstorpsån directly, or being filtered through wetlands prior to depending on what type of land management is being practiced at that specific location. The water then meanders downstream but now moving at a much slower rate than before, allowing for its detainment for a duration of time to provide vegetation and other nutrient removal strategies along the Tullstorpsån with the chance to remove some of the nutrients. This diagram shows the removal of nitrogen and phosphorus. The now 'nutrient-reduced' water flows out into the Baltic Sea as per usual. Algae and seaweed is harvested along the shore and directly from the Baltic Sea, along with the nutrients stored inside this organic matter. The biomass is then brought inland where it is processed and turned into biogas. The residual nutrient discharges from biogas production are treated and the proper material placed back on the agricultural lands as fertilizer (Modified from Gradin personal communication, 2009).

As was mentioned above, the Tullstorpsån is planned to be re-meandered and a series of 49 wetlands will be constructed within the catchment (Figure 4).

Map of the Tullstorpsån Watershed

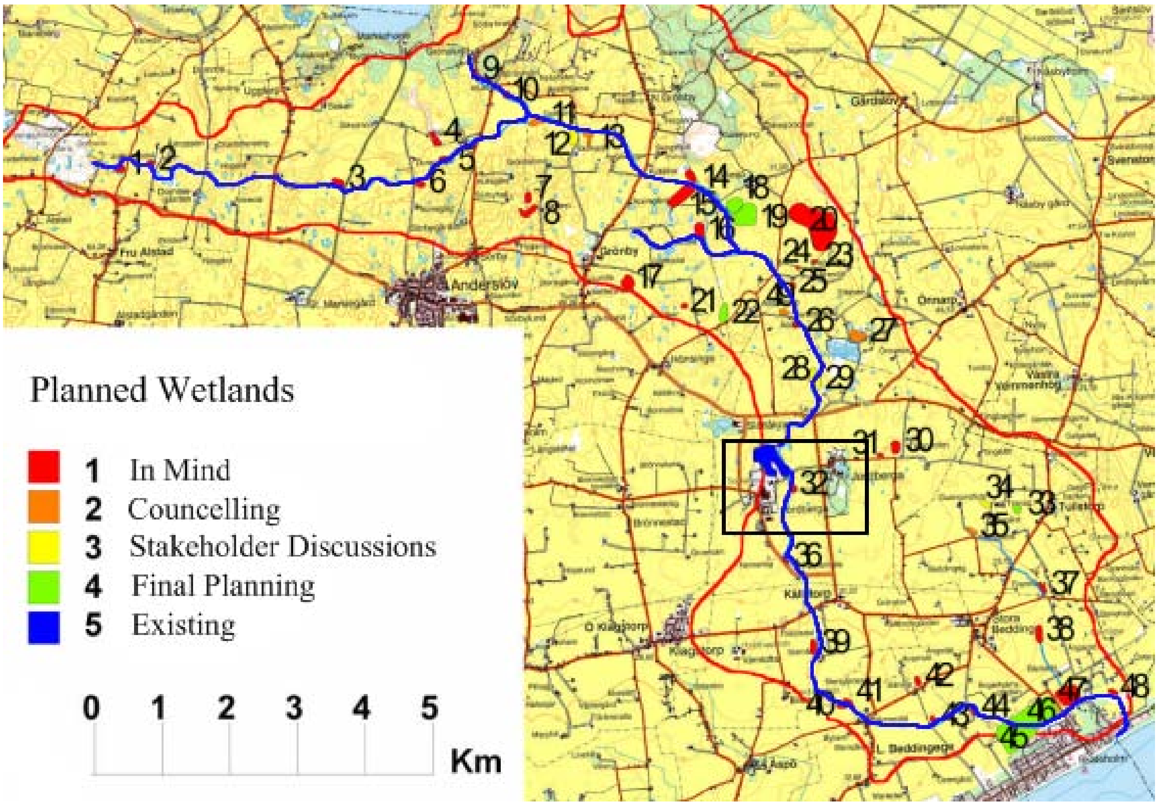

Figure 4. A map of the Tullstorpsån watershed. The river itself is shown by the heavy blue line. The location of the Jordberga Biogas plant is disclosed within the black box. The 49 wetlands are shown along with their individual stages of development to the left (Carlsson, 2009).

The WAB project might also apply a number of other "possible" management strategies within the catchment. A list of some of these management strategies and their associated significance is summarized in the table below (Table 4).

Table 4. A list of some possible management strategies and their associated significance (Carlsson, 2009).

Possible Management Strategy	Purpose
Raise river bed, lower river banks: reduce slope gradient.	Increase contact between water and vegetation, decrease water flow, provide time for vegetation to remove nutrients, reduce sediment transfer.
Sediment traps: a deeper river bed or pool formation	Allow particles to settle; if cleaned periodically, will reduce level of P transfer; can be recycled as

	fertilizer.
Protection zones or Riparian buffer zones: 5-20m strip of permanent vegetation	Captures sediment and stores nutrients that amount from agricultural runoff before reaching river.
Greppa Näringen, Focus on the Nutrients: Information, Training and advice for landowners	Reduce nutrient losses from farmland

Greppa Näringen

The wetland compartment of the WAB project is considered unique by its organizers because it is run by and for landowners and their collaborated initiatives on the basis of their willingness to create a sustainable solution to the problems with "their" river (Carlsson, 2009). Subsequent to this fact, having the knowledge and know-how to implement proper land management is a obviously a high priority for the landowners in the watershed. Thus, it is a goal for consulting firms like Naturvårdsingenjörerna to disseminate information and discuss possible water management strategies with the landowners (Carlsson, 2009). One such component that landowners have been working with is a project called Greppa Näringen, termed ‘Focus On Nutrients’ in English (Gradin interview, 2009). Greppa Näringen is essentially a campaign to provide individually tailored training and advice for the landowners (Greppa Näringen Brochure, 2009). As is stated by the Greppa Naringen Broschure, (2009) there are four main objectives of the Greppa Näringen project:

- Reduce nitrate losses from cropland
- Reduce ammonia emissions from manure
- Reduce phosphorus losses from cropland
- Avoid the spread of pesticides into surface and groundwater

In order to fulfill these objectives, the project strives to increase nutrient management efficiency on the farms by enhancing the awareness and knowledge of all landowners who wish to take part (Greppa Näringen Brochure, 2009).

It is quite apparent to notice the importance of Greppa Näringen to the agriculture and wetland compartments. Consequently, this may actually be one of the most effective ways of making a noticeable difference in reducing the amount of nutrients that are released into a system (Åkerman, personal communication, 2009). In consideration of the fact that Greppa Näringen directly attacks the problem as well as influences its ‘symptoms,’ it is unfortunate that Greppa Näringen is not engrained more in depth within the WAB project.

4. A Place in Context

It is useful to place the WAB project into a context of the bigger picture, but in order to do so, it is important to show where this project fits in terms of different spatial scales. At a local level, it is clear that a large portion of the success of the project is dependent on private interest. Accordingly, there is a significant amount of interest/willingness among the landowners to work with the Tullstorpsån to remedy many of the noted problems (Carlsson, 2009). At a municipal level, The Trelleborg Commune has recently acknowledged that the preservation of its landscape and the roles that the environment and its watercourses play roles in contributing to a good living environment that cannot be ignored (Carlsson, 2009). At a national level, the

Tullstorpsån is viewed as being nutritionally congested and this is known to have implications for the Baltic Sea downstream in terms of water quality; so something must be done (Carlsson, 2009). It is thought that the restoration of Tullstorpsån watershed will; among other things, substantially reduce nutrient and sediment transport to the Baltic Sea. If one recalls the figures presented above and considers some proposed projections based on the efficiency of the 49 wetlands to remove nutrients from the Tullstorpsån watershed, it is possible to provide an idea of where this wetland compartment of the project fits into these spatial scales; from a local level up to an international one.

As was formerly mentioned, the majority of the N and P that enters the Baltic does so via rivers and the Tullstorpsån is responsible for an annual release of 250 t N and 4 t P into the Baltic Sea (Naturvårdsingenjörerna, 2008). According to Naturvårdsingenjörerna, it is estimated that the N removal for the 49 wetlands amounts to 26 213 kg (26. 2 t N) per year; an aggregate of the estimated removal per individual wetland (Naturvårdsingenjörerna, 2008). In order to put this amount into the context of the entire Tullstorpsån watershed, we can apply the estimated N removal of the wetlands (26. 2 t) to the annual N release by the Tullstorpsån (250 t). According to this calculation, the 49 wetlands would remove approximately 10.5% of the N that that flows through them; the rest flowing downstream and into the Baltic. On a grander scale, if we apply this same N removal estimation of 26. 2t to the Swedish N reduction target of 20 780 t, the reduction amount would represent 0.001 % of the proposed needed reductions.

A cost structure was provided for wetlands based upon the cost of removing an amount of N per hectare given the parameters of each individual wetland. The total cost of the wetlands was a calculation based on cost projections provided by Naturvårdsingenjörerna. Both the estimated N removal per kilogram per year, and the estimated removal cost per N kg/yr were different for each of the 49 wetlands. Therefore, in this case, the cost for the estimated N removal per hectare, per wetland was calculated for each individual wetland and then aggregated. Thus, the cost of removing the estimated 26.2 t N from the Tullstorpsån was approximately 1 112 700 Swedish Kroner. The total cost for the construction of the 49 wetlands will amount to 22 375 000 Swedish Kroner (Naturvårdsingenjörerna, 2008). The wetlands range in price from 25 000 kr to 2 000 000 kr (Naturvårdsingenjörerna, 2008).

According to the Case Study Trelleborg 2008, the amount of land used for agriculture in the Trelleborg municipality amounts to approximately 86% of the entire landscape. The amount that will be used for these wetlands is only 2%. Seemingly, the agenda for constructing wetlands in Skåne is quite limited and this is an important fact to consider. If one reflects upon the N removal estimation of the 49 wetlands and its N removal capacities, which are fairly high for wetlands in general (Åkerman, Allström, 2009) it is quite apparent that the wetlands will not make enough of a contribution on their own to effect the Swedish N reduction targets. Further this is not even to consider P removal given the fact that it plays a significant role in counteracting the eutrophication of the Baltic. On its own, this compartment the WAB project holds a very limited role in terms of spatial scales; effective in influencing any reduction targets at a local level but not-so regionally, nationally, or internationally. Nonetheless, the optimism of Sten Björk, lead Swedish politician involved in the WAB project, has uncovered an intriguing aspect of the future success for this project. It should be noted that another aim for this project is to exhibit, at a national and international level, that the Trelleborg Commune, with its very extensive agricultural practices, will act as a model for sustainable development via this WAB enterprise (Björk interview, 2009). Thus, in Björk's mind, a requirement for success would be the involvement of others, at all spatial levels, to form partnerships and work together to ensure that many projects like this one are implemented all around the Baltic drainage area forming a giant mechanism that will one day counteract the eutrophication in the Baltic Sea (Björk, Gradin interviews, 2009).

The purpose of showing where this compartment stands in the bigger picture is to imply that at a local level, this project might have an effect on the surrounding environment, but on a regional, national or international level, this project is too small to make any sort of empirical difference. By investigating this project this way, on these spatial scales it is possible to see the importance of what Björk was conveying in saying that more development is needed. This form of development; however, does not necessarily have to come completely from more projects, as Björk's commentary seemingly alludes to. What might yield a more effective outcome, could be an expansion or the same kind of development Björk calls for, but only this time, from within. By focusing more attention towards the real problem (nutrient use and losses from farmland), as well as on the point-source symptoms (nutrient concentrations in the streams) and the expansion of other projects like the WAB, the Trelleborg Commune would be more effective in not only achieving their goal, but sustaining it in the future.

Since it is important to place this project contextually, locating this project temporally is equally important as locating it spatially as was done above. It is at this point where this project will be introduced temporally but this aspect shall be covered more in depth later on in the discussion section. To explore this notion, it is useful for a moment to keep in mind the spatial location of the WAB project. If one considers important aspects that govern the success of the project, aspects such as macrophyte species, intake and storage efficiency, growth rates, climatic preference, or potential for biogas production; one will notice that if these elements are not temporally sound then any spatial soundness could collapse over time. These are the aspects that will ultimately discern whether or not this project will work spatially at five, ten, fifty, or one hundred years down the road. By looking at this project temporally, it is possible to see that in the future, focusing on symptoms is only effective for some time. By focusing equally on the problems, the WAB project stands more of a chance at being sound both spatially and temporally.

Research Questions

In an attempt to adhere to the itinerary discussed earlier and in light of what was just presented, this study will answer three main questions in an attempt to discern whether or not the WAB project is on a sustainable trajectory; and if so, how far along it is. The three questions are as follows:

- What are the implications of carrying the WAB project through?
- What does the WAB project mean for the Trelleborg Commune?
- What will the WAB project imply for sustainable development in general?

Limitations

There are some theoretical and empirical limitations to this assessment that should be acknowledged before the WAB project is examined any further.

In terms of theoretical limitations, this assessment will not delve too heavily into the debate concerning the sustainability of biogas production. It will regard biogas from a carbon neutral standpoint and assumes that the Jordberga biogas plant of the Trelleborg Commune will generate biogas in this manner. This assessment will not discuss the biogas potential in aquatic freshwater macrophytes since the concept is only in its planning phase of development within the WAB project.

In terms of empirical limitations, this assessment assumes that the WAB project will work and will thus analyze projections as presented by the WAB curators. This assessment will not look into biogas production capacities or nutrient intake and storage efficiencies of individual species of algae and macrophytes. The analysis will not look into nutrient removal projections regarding the re-meandering of Tullstorpsån River given the difficulty in obtaining clear data regarding any river for that matter (Alström personal communication, 2009).

5. Method and Materials

Primary Sources

Three in depth interviews were conducted. Each was carried out in an informal, unstructured manner and lasted between one and three hours. The interviews were with three key players in the WAB project. It was hoped that the sets of information drawn from the interviewees would provide a decent picture of the WAB project.

The First interview was with Johnny Carlsson, project manager of the wetland compartment of the WAB project. The interview was essentially a three hour tour of the WAB site was comprised mostly of driving to different areas and gaining a first-hand look at the various stages the wetland compartment of the project was in. Carlsson was chosen because of his role in the development of the agriculture and wetland compartments of the WAB project

The Second interview was with Sten Björk, a leading politician in the WAB project and the head of the Social Democrat party in Trelleborg? The Interview was held at the Social Democrat headquarters in Trelleborg. This was an hour long interview. The first forty-five minutes were filled with Sten’s account of the project followed by an open dialogue and questioning of some particular topics that were of interest in the initial account. Björk was chosen because of his political involvement (at all levels) with the WAB project.

The third interview was with Matilda Gradin, a representative of the Trelleborg Commune working with the Kretsloppet as a whole. The Interview was held at a café in Malmö. Gradin was chosen due to her considerable knowledge about the WAB project as a whole.

Any further specific questions have been asked and answered via personal communication with the interviewees and other individuals of interest.

Secondary Sources

The majority of the secondary sources were journal articles. These sources were used to cross reference the information provided by the interviewees and create an arena for a non-biased investigation and discussion that will occur later on in this paper. Other notable sources were HELCOM and Naturvårdsingenjörerna; each providing specific sets of information that helped to place the WAB project contextually.

Biogas Energy Calculation

The biogas energy calculation provided by Matilda Gradin. It should be noted that any particulars, beyond that which is displayed herein this assessment, are unavailable at this point. This data was then combined with data obtained from the Case Study Trelleborg 2008 and presented as such.

Problem Definition, DPSIR, and Conceptual Models

A plethora of information amounted as a result of the resource base. As a method to clearly understand the problem at hand, a Driver, Pressure, State, Impact, Response (DPSIR) schematic and three conceptual models were used to highlight key components in the case of eutrophication in the Baltic Sea. Examples of DPSIR schematics can be found in: Bell and Etherington, (2009); Ness et al., (2008); Nilsson et al., (2008); and Svarstad et al., (2008).

The conceptual models were designed in relation to the DPSIR scheme and can provide a clear picture of the problem in the case of eutrophication of the Baltic Sea. Examples of conceptualizations can be found in: Lundberg, (2005); Ness, (2008); Patterson et al., (2006); and Rönnberg and Bonsdorf, (2004).

6. Results: Nature-Society System Relations

Both the DPSIR scheme and the conceptual models indicate that the WAB project does not focus its efforts on the actual source of the problem but rather on its symptoms. An interesting vision, in light of the DPSIR scheme, might be an understanding of why this project does not focus more attention on the main *pressure* instead of focusing its efforts on remediating the *state*. Seemingly, at one level the WAB project is merely sustaining the problem, or rather, allowing it to continue, thus prolonging the eutrophication. This interesting notion corresponds to that which was introduced earlier and it is one that will be developed given its particular relevance in determining whether or not the WAB project is on a sustainable trajectory.

The DPSIR Schematic

As presented by Ness et al., (2008) and Svarstad et al., (2008) *drivers* represent the external forces (social, economic or environmental) that carry with them various *pressures* as a consequence. These pressures, in turn, alter the *state* of the environment in some observable manner and consequently result in a variety of *impacts* for the surrounding environment or community. The *responses* are those actions or corrective measures used by society with the aim or remediating the problems created in the previous phases (Ness et al., 2008 ; Svarstad et al., 2008).

The DPSIR scheme depicting the WAB case looks similar to a combination of the DPSIR schemes presented and described in Ness, (2008) and Svarstad et al., (2008) examples. In this case, an increasing demand for food and other agricultural amenities influences the farmer's ambition to maximize the crop yield (driver). This leads to the intensification of agriculture and the inefficient use of and/or fertilizers and thus a subsequent increase in the amount of nutrients that runoff into the nearby rivers and streams (pressure), and in this case the Tullstorpsån. The observable conditions or changes of state that commence herein our example can be represented by the annual growth of different algaes and seaweeds (state) and the eutrophication of the Baltic Sea that follows. The changes that occur in the marine life and biodiversity as a result of the eutrophication represent the (impact) this state has on the surrounding environment and community. The (response) is represented by the WAB project itself, aimed to counteract the eutrophication, and the subsequent changes in land use and management that occur. A visual of this DPSIR scheme is shown below (Figure 5).

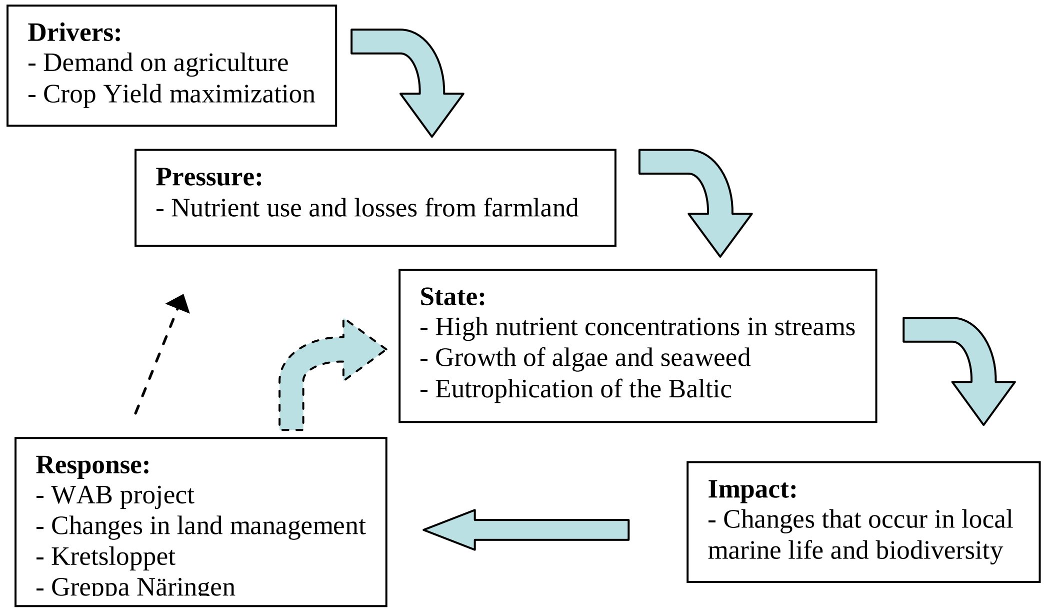

Figure 5. The DPSIR scheme depicting this case of eutrophication in the Baltic Sea. The DPSIR scheme here depicts the driver, pressure, state, impact, response framework described above. The arrows represent the influence the former has on the latter. The arrow heading from Response to State signifies the current general focus of the WAB project (i.e. remediation of the nutrient concentrations in the streams). The arrow heading from Response to Pressure signifies the concept that more focus should be put on facilitating this realm (i.e. nutrient use and losses from farmlands).

The Conceptual Models

The case of eutrophication of the Baltic Sea was examined in three scenarios. The First (Figure 6) depicts a business as usual (BAU) approach and reflects the present strategy for nutrient control in the Trelleborg Commune. The Second scenario (WAB) (Figure 7) depicts the BAU scenario in conjunction with the main components in the WAB project. A third scenario (MSWAB) (Figure 8) offers the same WAB framework as in scenario two only with some additional measures that will make the nutrient reduction goals more easily attainable and subsequently move the project further along its sustainable trajectory.

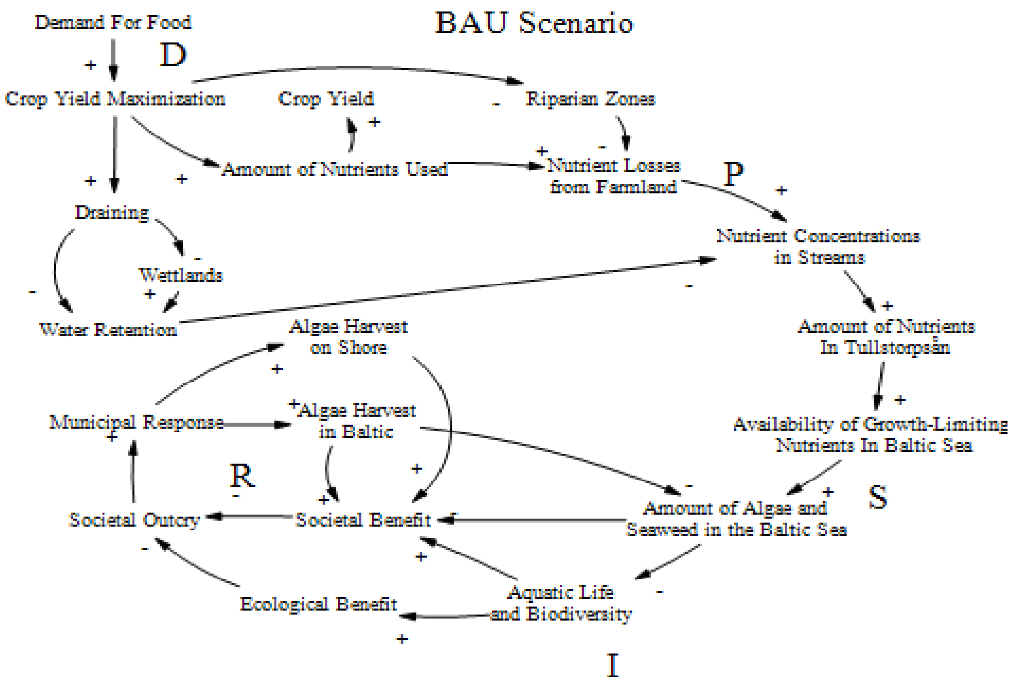

Figure 6. Conceptualization of the nature-society relationships that are currently present in the Trelleborg Commune in consideration of a business as usual approach. Note the main components of the DPSIR schematic.

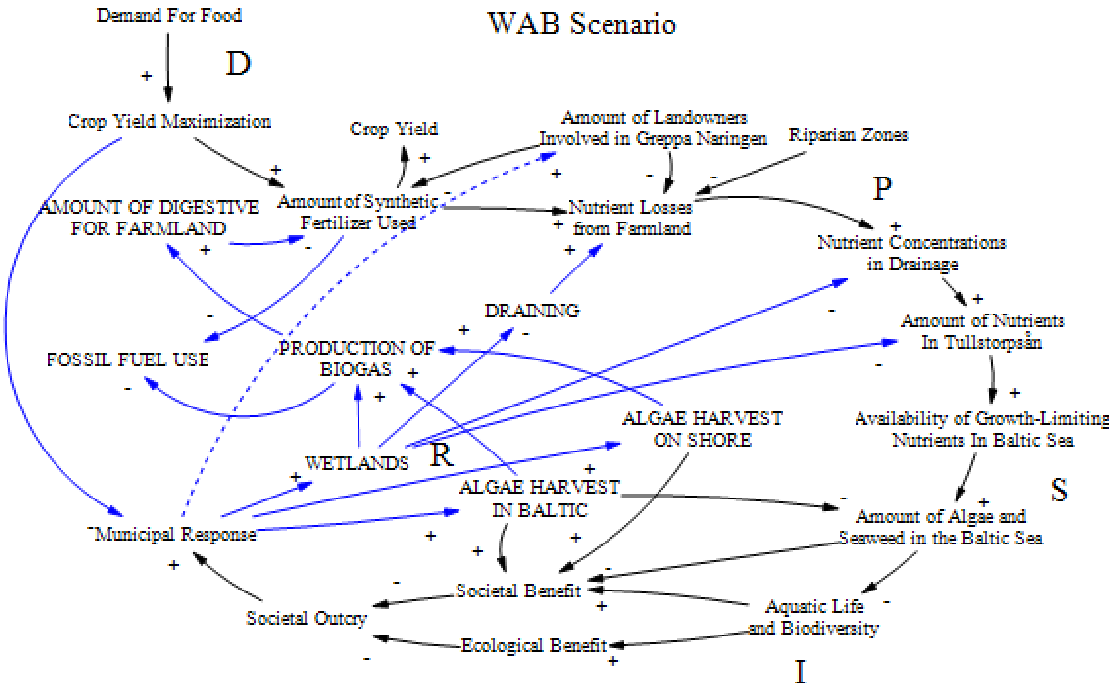

Figure 7. Conceptualization of the nature-society relationships that are present in the Trelleborg Commune in light of the WAB project. Note the main components of the DPSIR schematic. New components, or those that should be further developed in this scenario, are shown in capital letters and their corresponding causal loops drawn in blue. The checked line represents a weaker interaction.

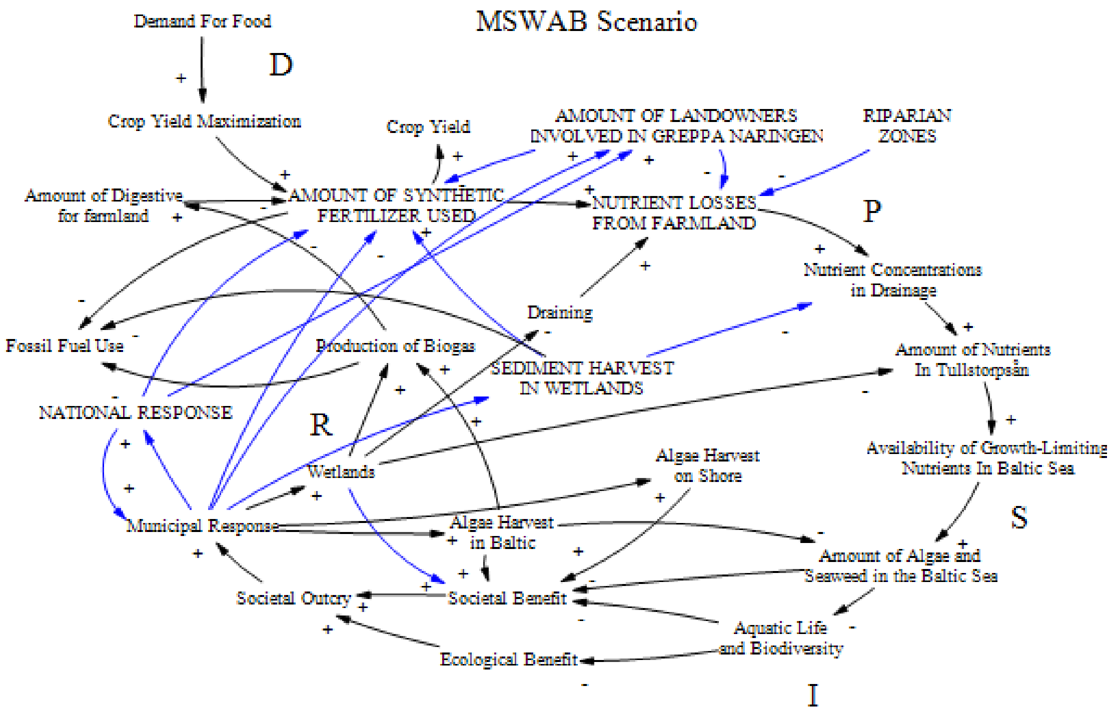

Figure 8. Conceptualization the nature-society relationships that are present in the Trelleborg Commune in conjunction with a more sustainable version of the WAB project. Note the main components of the DPSIR schematic. New components, or those that should be further developed in this scenario, are shown in capital letters and their corresponding causal loops drawn in blue. This scenario directs the efforts of the WAB project more towards attacking the problem as well as symptoms.

Three Important Aspects of Sustainability

It was earlier noted that there exists three important aspects of sustainability: what is to be sustained, what is to be developed, and an intergenerational component. The conceptual models from above provide a clear indication of the first two aspects. It is difficult to exemplify the third important aspect since these models only show a static point in time. The WAB scenario shows glimpses of where the project might be headed in the future. The difference with the MSWAB scenario, on the other hand, is that it was designed in consideration of all three aspects. Subsequently, the table below summarizes the three scenarios and their relationship with each of the three important aspects of sustainability.

Table 5. A brief summary of the three scenarios in conjunction to their relationship with the three important aspects of sustainability.

Scenario	What is to be sustained?	What is to be Developed?	Intergenerational Considerations
BAU	Life-Support and community	Life-support and community	Slight
WAB	Life-Support, community, local economy, small scale nature	Life-support, community, and local economy	Some
MSWAB	Life-Support, community, local economy, nature	Life-Support, community, local economy, nature	Substantial

7. Discussion and Analysis

Theoretical Framing

Following on from the fact that this is a sustainability assessment, the theoretical framework provided mostly by Kates et al., (2001) and Ness et al., (2006) offered what was regarded earlier as an itinerary for sustainable development. This itinerary helped to narrow the scope of this assessment to the point where it highlighted some of the important concepts within sustainability science. These specific concepts were then used to place the WAB project into the context of sustainable development. From there, it was possible to locate the WAB project in its own context within the Trelleborg Commune. Once these contexts were solidified, it was possible to note that the WAB project is on a sustainable trajectory, but perhaps not as far along as it could be. A problem located within this theoretical frame may stem from the very nature of sustainability science itself. In an attempt to be all-encompassing; taking into consideration the environment, society, and economy in a local to global, short to long term perspective, it is quite apparent that an analysis on this level must draw the limit somewhere. The limit in this case was that of which was included in the itinerary. The problem lies in the fact that perhaps this itinerary did not encompass all it was supposed to and/or set the proper scope for the resulting assessment and analysis.

Limitations and Thought-Provoking Considerations

By taking upon the assumption that the WAB project will work in the way that it was claimed, this assessment was able to maintain its scope and provide a glimpse of the Project as a whole. In setting these limitations; however, the assessment did not take into account specific parameters surrounding, for example, the functioning of wetlands and production of biogas. Nonetheless, it is interesting and important to discuss some of particulars surrounding the WAB project.

Nutrient removal and Biogas potential via Algae/ Seaweed collection and Harvest in the Baltic Sea

According to the Trelleborg Commune, there is an approximated annual average of 2000 m3 of algae and seaweed collected on the public beaches along the coast of Trelleborg (Muller, 2008; Gradin interview, 2009). There are nine public beaches in Trelleborg, representing approximately 17%, or 5 km, of the total 30 km-long coastal strip of the Trelleborg municipality (Gradin personal communication, 2009). For ease of understanding, the beaches are divided into two types: one with mainly rock/ gravel substrate, spanning approximately 13 km; and one with mainly sand, spanning approximately 17 km (Muller, 2008**)**. Due to the recreational value they possess, the beaches that are cleared of seaweed are the ones composed mainly of sand. According to the Trelleborg Commune, approximately 2,000 m3 of algae and seaweed is collected annually (Muller, 2008). Apparently, this amount could potentially be expanded to 10 000 m3 provided sufficient harvesting assemblages were in place along the Trelleborg coast (Muller, 2008).

The cleanup of the entire coast of Trelleborg and leaving 30% untouched, provides an estimated 6 000 tonnes of dry matter seaweed, which contains about 180 tonnes of nitrogen and 18 tonnes of phosphorus. The entire coast, from Malmö to Simrishamn, would yield approximately 43 000 tonnes of dry matter (Gradin personal communication, 2009).

As presented by Muller in Case Study Trelleborg, (2008) the biogas production potential arising from the biomass harvested from the Baltic Sea is described in three cases. Case 1 has examined the biogas production potential located in the amount of algae and seaweed that is currently collected by the Trelleborg municipality; as previously mentioned, approximately 2000 m3. The estimated energy potential in this case would amount to 0.72 GWh / year. Case 2 has examined the biogas production potential that would be located in the amount of algae and seaweed if entire coast of Trelleborg was harvested with the aim of producing biogas (approx. 10 000 m3). The estimated energy potential in this case would amount to 14.5 GWh / year. Case 3 has examined the biogas production potential that would be located in the amount of algae and seaweed if the entire coastline from Malmö to Simrishamn were harvested (approx. 73 000 m3). The estimated energy potential in this case would amount to 103 GWh / year (Muller, 2008).

In order to provide some form of tangible indication of what this production potential means, the energy production potential in these three cases can be compared with the current energy demand for heating of houses or fuel needs for cars. According to SCB Statistika Centralbyrån (Statistics Sweden), the approximate heating requirements for a normal house is about 15 000 kWh / year (SCB, 2005). The approximate fuel requirement of a car running for 15 000 km is about 9900 kWh / yr (SCB, 2005). The energy potential located in the harvested biomass in each of the three cases is summarized in the table below. The table also shows this energy potential translated into either capacity or fuel capacities of these corresponding harvests.

Table 6. The amount of seaweed/ algae collected in each of the three cases along with the energy potential, heating capacity and fuel capacity that is possessed within each corresponding harvested amount. The table also shows in brackets the amount of CO2 that would not need to be generated via fossil fuels (Gradin personal communication, 2009; Muller, 2008; SCB 2005).

Case	Collected Amount	Energy Potential	Heating Capacity	Fuel Capacity
1	2000 m3	0.72 GWh / yr	48 houses	73 cars (139 t CO2/ yr)
2	10 0000 m3	14.5 GWh / yr	966 houses	1465 cars (327 t CO2/ yr)
3	73 000m3	103 GWh / yr	6867 houses	10 400 cars (2327 t CO2/ yr)

On top of this, it should be noted that the digestive residues that amount from the production of biogas can be used as fertilizer for agricultural purposes (Björk, Carlsson, and Gradin interviews, 2009). According to the Case Study Trelleborg, this factor would mean more environmental gains via the recycling of nutrients, as well as a reduced use of fossil fuels located in the production of commercial fertilizers (Muller, 2008). There are no projections as to the amount of nutrients that can be re-used as fertilizer.

Wetland Parameters - Things to consider

In determining whether or not the WAB project is on a sustainable trajectory, an important consideration is whether or not the components that this project is comprised of point it in that particular direction. Since a main objective of this project is the reduction of nutrients in the Baltic Sea, it would seem appropriate to investigate various components of the wetland compartment of the WAB project and the various roles they play in obtaining this goal.

An interesting distinction, and rather important realization, was formulated by Gottschall et al. in their study that investigated the role of plants in the removal of nutrients at a constructed wetland that treated agricultural wastewater. In their account, Gottschall et al. offered the notion that while there have been many analyses done regarding the performance of constructed wetlands, there exists a lack in the value placed on determining the impact that various system components have on the overall performance of the wetland (Gottschall et al., 2007). It is quite apparent that performance would be of high value in the WAB project, so it is seemingly important to know if the components that form this project facilitate its success as well. At this point it would be useful to take brief look at some important system components and their relationship with one another in recognition of the fact that these components are main determinants of the success of the project. Some projections were shown earlier that depicted the potential efficiency of the wetland compartment of the WAB project as maintained by the curators of the project.

According to Gottschall et al., (2007) higher nutrient removal efficiencies have generally been associated with lower nutrient loading rates even though the total uptake amount might be higher with a greater nutrient availability (Gottschall et al., 2007). This notion is of particular relevance when applied to the wetlands in the WAB system. For instance, with better management of nutrients at an agricultural level, efforts would be directed more towards the source of the problem instead of at the site of the problem or at the water level. As a result, theoretically there could be fewer nutrients entering the water, thus allowing the wetlands to proportionately increase their nutrient uptake efficiency. In this sense it would be better to decrease the amount of nutrients that enter the wetland to a level where the wetland can actually be efficient at what it does. It is seemingly counteractive to not decrease the amount of nutrients going into a wetland and expect it to be efficient at treating the water going through it. In the case of the WAB project, if the amount of nutrients that are going into these wetlands is not decreased, then the wetlands will have to be larger and there will have to be more of them in order to reach a stage where one might consider these wetlands efficient at what they do. Generally speaking, the plants within a wetland will remove nutrients from the water until the point where they are deprived of some limiting factor. In this case, a limiting factor might simply be saturation and so the size of the wetland could be too small for the amount of nutrients that enter.

Granted the wetlands are not the only parts of the landscape doing the nutrient reduction work within this system; however, if we consider the 22 375 000 kr it costs to create them, then we can see that perhaps the money could be spent more efficiently, or at the source of the problem for example. But why are we focusing on the N. It will not become a limiting factor and P is a more important actor in the case of the eutrophication of the Baltic.

An Ecological Fitting

In consideration of the above dialogue, it would be equally useful to investigate the functioning of these system components when put together, combined in the form of a wetland. This combination of system components will ultimately determine if this specific wetland is a proper fit for the particular area in question. In a study that investigated the linking of ecosystem processes with wetland management goals, Euliss et al., (2008) expanded on the idea of system components and attempted to combine this content with regards to an important overlying inquiry of whether or not a wetland is ecologically fit for its surroundings. According to Euliss et al., (2008) an ecological fit can be defined by how well a specific land use or management activity "fits" within the specific ecosystem processes that characterize the specific location; whether natural or influenced by man. Ultimately, in light of the current dialogue, if one or more of the wetlands in the WAB project is/ are not ecologically fit for the area in which it is constructed in, then it is fairly safe to say that the wetland might not be as suitable as it could be in terms of the role it plays in that particular ecosystem. Having ecologically fit wetlands will certainly assist the WAB project along a sustainable trajectory.

It was stated by Euliss et al., (2008) that the majority of managed wetlands are "manipulated to maintain a static temporal relationship between wildlife productivity and specific habitat conditions…Yet, the ecosystem processes that sustainably yield specific habitat conditions and wildlife productivity have an important temporal component to consider". Therefore, it is important to regard these wetlands in the context of the bigger picture. In order to achieve sustainability, there must be an ecological fit between management directives and the location of wetlands in space and time (Euliss et al., 2008). It is possible to see a dichotomy between the static temporal that the authors mention and the spatial and temporal fluidity of real-life in that the design of a controlled system may not accurately take into account the correct simulations or occurrences in the fluid temporal setting (Euliss et al., 2008). A useful example was provided by Euliss, showing that one can attempt to construct a wetland or try to recreate what was once there; however, without recreating the hydrologic processes that form and maintain them, they may lack the desired biotic activity. This is a clear example of the importance in ascertaining not only, whether or not a wetland is ecologically fit, but where it fits spatially and temporally.

One Wetland versus Fifty

When taking into account the overall objectives of the WAB project, it is interesting to ponder about how many wetlands may actually be needed in order to satisfy the objectives. For the sake of this discussion, it might be possible to say that the effectiveness of a wetland at performing a certain task is a function of; among a plethora of other things, its placement, and water holding time. That said, it should be noted that the key to constructing an effective wetland is located in its design (Brix, 1997; Srivastava et al., 2008; Tonderski et al., 2007). According to Benyamine et al.,(2002) it should be noted that many constructed wetlands have succeeded when targets to one specific function; however, when it comes to multi-objective management in constructed wetlands, as is seen in some of the WAB wetlands (Carlsson interview, 2009), scientific experience is small and the successful outcome of such projects is unlikely (Benyamine et al., 2002).

In general, it is seemingly difficult to have a really efficient wetland, for it must be precisely designed and it seems even more difficult to have 49 of them in the right place and be perfectly designed. Could it be possible that the WAB project could contain 20 some very efficient wetlands for a lot less money and have them perform the same amount of work as the 49 wetlands may end up doing 20 years from now? Given the fact that wetlands appear to work on a 'wait and see' basis, as various parameters suggest, this question is too difficult to answer at this point. Nonetheless, with regards to the WAB objective, if the wetlands are constructed in the proper manner, the more wetlands the better.

Another interesting design consideration touched on above is that of land use. In Skåne, where one can find some of the most valuable soil in all of Sweden, it may be the case that the plot of land set aside by the landowner for the construction of a wetland is not suitable land for a wetland. This is just one more potential design caveat; that wetland placement becomes an issue and thus a determinant of the overall effectiveness of a wetland.

Another simple example might be the placement of the wetland in terms of being positioned as a filter for culverts coming from agricultural land or being placed at points and then having the Tullstorpsån run through the wetlands. One would need very different sizes of wetlands in order to have the same effect on nutrient retention in each corresponding case.

What about the size of the wetland versus the size of the catchment? This is an interesting notion and certainly one to ponder as well. As a simple principle, for a wetland to be efficient at reducing the amount of nutrients in it outflow, the wetland should be large enough to retain, for some time, the amount of water that is entering it. Since the length of time the water stays in the wetland is another determinant of how efficient the wetland really is, it is important to implement this element of water retention.

The bottom line is that even with all of these wetlands in the WAB project, they are still only removing a small proportion of their reduction target. Therefore, there must be other measures and methods for nutrient removal involved in the WAB project. As was shown earlier in Table 4, the WAB project might also apply a number of other "possible" management strategies within the catchment. Instead of having these strategies as possibilities, management goals should make them realities. For, in reality, it is these possibilities that are really going to make the difference regarding an effective nutrient removal framework. It is these possible management strategies that were highlighted in the DPSIR schematic and MSWAB contextual model earlier as methods of nutrient control that will really make the difference.

DPSIR and the Contextual Models

It is important to discern whether or not the system components and ecosystem processes of the WAB project relate to the proposed outcomes of the project itself. In doing so, the DPSIR and Conceptual models were used to exhibit the nature-society relationships within the catchment and show the subsequent influence of the WAB project.

According to Svarstad et al., (2008) a DPSIR scheme is a very effective tool for capturing the key relationships between the actors in society and those of the environment. It is for this reason that made the use of this DPSIR function worthwhile herein this assessment. The DPSIR was able to point out that the WAB project indeed focuses more effort on remediating the point-source symptoms as opposed to the real problem regarding nutrient use and losses from farmland. This fact was clearly exemplified in Ness et al., (2008). In their article that discusses the problems with structuring unsustainability with the use of multilevel DPSIR frameworks, The authors point out that policy responses for Swedish eutrophication problems are not generally directed at problem driving forces but rather to the consequential stages of the problem in the form of more immediate, point-source measures. Examples of this form include: locally-initiated river re-meanderings, wetland creation projects, or "the establishment of spongy national or regional environmental goals." Understandably, the authors believe that such responses lead to inadequate problem-solving results (Ness et al., 2008). In further consideration of the recently exemplified belief, the conceptual models also indicated that the WAB project does not focus its efforts on the actual source of the problem but rather on its symptoms.

Movement Along a Sustainable Trajectory

Table 5 was developed earlier to highlight the relationship between the BAU, WAB, and MSWAB scenarios and the 3 important aspects of sustainability. It is at this point this relationship will be expanded upon and from there it should be possible to discern how these scenarios relate to the sustainable trajectory.

The BAU Scenario

This scenario depicted the nature-society relationships that are currently present in the Trelleborg Commune in conjunction with the case of eutrophication in the Baltic Sea. It should be noted that strategies for improving the quality of water that flows into the Baltic are very limited. The BAU approach focuses on the short term betterment of life for the Trelleborg Commune but pays little attention to future livelihood. In this scenario, there is nothing to keep the threat of eutrophication from getting any worse. The relationship between this scenario and the three important aspects of sustainability is shown in the table below.

Table 7. The relationship between the BAU scenario and the three important aspects of sustainability.

What is to be sustained?	What is to be Developed?	Intergenerational Considerations
Life-Support: Agriculture **Community:** recreation	**Life-Support:** Agriculture **Community:** recreation	Unsustainable, not on a sustainable trajectory

The WAB Scenario

This scenario depicted the same nature-society relationships that are present in the BAU scenario; however, in light of the WAB project. In this scenario, efforts are being made to remediate the point source symptoms resulting from nutrient losses from farmland and subsequently the nutrient concentrations in the Tullstorpsån. This scenario focuses on the production of biogas via algae harvest and the creation of wetlands as a means to remediate the nutrient concentration in the Tullstorpsån. It should be noted that in this scenario, there is not enough emphasis placed on the importance of the possible management strategies that could also be applied as part of the WAB project. The relationship between this scenario and the three important aspects of sustainability is shown in the table below (Table 8).

Table 8. The relationship between the WAB scenario and the three important aspects of sustainability.

What is to be sustained?	What is to be Developed?	Intergenerational Considerations
Life-Support: Agriculture, local water resources,	**Life-support:** Agriculture, local water resources,	On a sustainable trajectory but could be further. This scenario is

Community: land management for local land owners; recreation **Local Economy:** via biogas production **Environment:** increased biodiversity, attractiveness flood control.	**Community:** land management for local land owners; recreation: clean beaches **Local Economy:** via biogas production; job market.	looking to the future; however, the sustainability of this venture is questionable.

The MSWAB Scenario

This scenario depicted the same nature-society relationships that are present in the first two scenarios; however, it is merely an extension of the WAB scheme. This scenario focuses on attacking the main problem as well as the point source symptoms. This scenario features the additional implementation of harvesting and recycling of sediment as a means of reducing the amount of synthetic fertilizers used. An increased municipal response to the threat of eutrophication has lead to an increase in the amount of landowners involved in Greppa Näringen to the point where it has become a national phenomenon. Riparian zones have been increased and the other possible management strategies developed further. This scenario also focuses on spreading knowledge and commitment beyond the local level with the aim of the future in mind. The relationship between this scenario and the three important aspects of sustainability is shown in the table below.

Table 9. The relationship between the MSWAB scenario and the three important aspects of sustainability.

What is to be sustained?	What is to be Developed?	Intergenerational Considerations
Life-Support: Agriculture, local water resources, **Community:** land management for local land owners; recreation **Local Economy:** via biogas production **Environment:** biodiversity (local and regional), attractiveness; flood control; functioning wetlands and Tullstorpsån; amount of Phosphorus	**Life-support:** Agriculture, local water resources, **Community:** land management for local land owners; involvement in Greppa Näringen; recreation: Allemansrätten, hiking trails; regional and national knowledge and commitments **Local Economy:** via biogas production; job market **Environment:** increased biodiversity (local and regional); movement of species; attractiveness; flood control; functioning wetlands and Tullstorpsån; riparian zones; sediment traps, harvest, and recycling of Phosphorus	Further along on a sustainable trajectory. This scenario is looking more into the future and has capitalized on some important aspects that make it more sustainable. Regional and National knowledge and partnerships would make this scenario more sustainable.

The Big Picture

The nutrient reduction targets set by HELCOM are a result of an ambition to remediate the eutrophication in the Baltic Sea. Individual countries must then do their part to attain these goals. At an international level, it may be the case that the WAB project does not register empirically as a viable means of direct nutrient control. At a local level; however, the project is considerably adept at what it does. The big question is whether or not this project will be able to keep up with the speed that society moves at. This will be a decisive factor regarding the success of the project some years from now. This important realization is indicative of the fact that the speed of a society's developments can greatly exceed the self organization and adaptation capabilities of the natural system (Helming and Wiggering, 2003). In consideration of this, how will the WAB project suit society over time given the constant state of flux within the system components of each realm? Further, will society provide the correct mechanism for the system components of the WAB project such that the desired outcome of the project is facilitated 5, 10, 50, or 100 years down the road?

Stakeholders

In consideration of the fact that the WAB project is a pilot project, unique in it own right (Björk interview, 2009), one would assume that the project should be able to gain some warranted attention at a regional, national, and international level. Administrators in the Sopot municipality, an area of Poland heavily affected by eutrophication, for example, are very intrigued at what is going on here in Sweden and are already showing signs of future interest in the development of projects similar to WAB (Björk interview, 2009). Perhaps this is an underlining objective of the project; to get noticed and influence others into doing the same. This idea of partner involvement, to be used as a method for success, was certainly explicit in the Björk interview. The charm in a project like this is that it is easily marketable and this is something that the Trelleborg commune has cleverly honed in on. In an attempt to have this desired influence on others, a concept such as this one must be easily sold.

Further, as Mander, (2007) would have it, a landscapes structure and function both, affects and are affected by human perception, cognition and values. Further, the value of a landscape's functions depends heavily on the economic interest of those who use them. Thus there is great importance not only in the role of the stakeholders but in their attitudes as well. That said, it should also be acknowledged that attitudes vary significantly on both spatial and temporal scales (Mander, 2007).

In attempting to promote the MSWAB scenario, it is important to consider stakeholder involvement on the basis of how it might be possible to sell the idea. Ultimately, if you do not have the support of those involved, the scenario does not have a chance at success, let alone in becoming a reality. The WAB project has already been sold and is in commission. At the end of the day, it is quite apparent that having sufficient funding is ultimately the deciding factor. If the curators of the WAB project can manage to convince lead facilitators that these new components of the project will direct the current project further along a sustainable trajectory then the current desired outcomes may be easier to obtain. Effectively, the WAB project needs to be extended in order to make it really worthwhile spatially and temporally in the future.

What sold the WAB project in the first place? It is an intriguing thought that perhaps the wetland compartment was just a way to make the biogas compartment 'politically correct?' The interviews seemed to hint to the fact that the wetland compartment was the 'missing link" in the Kretsloppet. Perhaps it was the missing link in getting funding for a biogas plant as well. Thus, it is interesting to think about whether or not it was difficult to sell a project that really does target a land-based problem. In consideration of the wetland compartment, it might be also interesting to determine: whether or not plans changed with respect to their development within the Kretsloppet; if the compartment was more sustainable before development within the

Kretsloppet; if it be sustainable now; and if not, what it will really take to make it that way or to sell a sustainable version.

Recreation and Biodiversity

In consideration of the WAB project in general, if the only purpose of the wetlands was focused on the removal of nutrients, then perhaps they would not be as successful as proposed. Therefore, there must some other reasons and/or benefits to these wetlands. Certainly two of those benefits are recreation and biodiversity.

The WAB project seemingly lacks a recreational element in its wetlands/ Tullstorpsån compartment even though its curators claim that it exists (Carlsson interview, 2009). This is certainly one element that should be expanded, if not for the benefit of local residents and their surrounding ecosystems, then perhaps as a way to increase publicity and future partnerships. A simple example might be the implementation of more extensive Riparian zones along the Tullstorpsån. On top of their traditional functions, these Riparians could serve as hiking, bird watching, and fishing trails that facilitate not only the migration of people, but animals as well.

In light of this discussion, it would seem appropriate to touch on other such land usages in the Tullstorpsån watershed. Unlike many other regions in Sweden, the Trelleborg Commune has a small amount of land set aside for Allemansrätten, or the Swedish right of passage. Approximately 2% of the land is recognized as Allemansrätten, the rest comprised mostly of agricultural land (Gradin, personal communication, 2009). Even within the Tullstorpsån watershed, if one compares the amount of land that is currently used for agriculture to the amount of land that these new wetlands and re-meanderings will consume, one will notice that this amount of land used for the wetlands is still a relatively small area. Therefore, there certainly seems to be room for the development of and extended Allemansrätten

If we swing back to the beaches and the topic algae/ seaweed collection for a moment, it might be possible to take note of an example where we see a clash between recreation and biodiversity On the one one hand, the collection of algae may be useful as a means of producing biofuel and increasing recreation, but on the other, these methods often carry with them a rather unfortunate consequence. It is known that collection technologies tend to disturb large proportions of the sand, in turn affecting many of the species that inhabit these harvested areas.

Another brief yet intriguing discussion point that is worth mentioning concerns that of public access. It may be simple to ask: how will inhabitants of the Trelleborg Commune access recreational areas? After all, it is quite evident that many wetlands that would be nice to use, are quite far away and out of easy access to any person other than the landowner (Carlsson interview, 2009).

Proof That More is Needed

In an investigation of a catchment model in Southern Sweden aimed, much like the WAB project, at the reduction of nutrients, Arheimer et al., (2005) suggest that when estimating the potential effect of countermeasures, no one countermeasure is enough on its own as a means of reaching the Swedish nutrient reduction goals. In the case of the wetlands, the authors also mention that the wetlands in their system were very expensive and did not have an effect on the reduction targets. It was also noted that the wetlands that were under construction, or were recently constructed, in the catchment yielded a very low influence on the load into the sea. The authors stressed that much larger areas must be converted to wetlands and these areas must be situated correctly in order for them to be effective on a large scale. The authors also noted that even with the most radical adaptation of agricultural practices and crop cultivation, the efforts were not enough (Arheimer et al., 2005).

In their study, Arheimer et al., (2005) examined the effectiveness of four different approaches aimed at attaining the Swedish nutrient reduction targets. These approaches were discussed in four scenarios. The authors note that the present strategy for nutrient control (scenario 1), which focused on point sources, was insufficient. Their third scenario, which focused on the abatement of diffuse sources, showed that this approach was more sufficient. In scenario 4, it was stated that the reduction target should be equally distributed among the polluting sectors in the catchment. It should be noted that this scenario was successful in reaching the reduction goals in every sector except the industrial one (Arheimer et al., 2005). These authors have effectively shown that Swedish policy responses, typically directed at consequential stages of a problem in the form of more immediate, point-source measures, are not as effective as they could be. Therefore, it is necessary to focus on a wide array of problem sources and not just the point sources.

Scenario 4 from the dialogue indicated a rather interesting notion worth mentioning. The WAB project is largely funded by the European Regional Development Fund and the Swedish State (Carlsson interview, 2009; Gradin personal communication 2009). As a result, there is little onus placed on the landowners to deal with the problems inherent within their practices. Certainly they are allotting sections of their land for use other than agricultural purposes, but it is a small fraction and perhaps that land was not suitable for agriculture in the first place. Further, the land allotted may not be useful for wetland or a re-meandered river either. The point is, there is really nothing in the WAB project that concerns a polluter pays principle and this fact certainly takes away from the sustainability aspect of the project.

Room For Improvement

The interviews with the three key players in the WAB project generated individual sets of information that were valuable in constructing a decent picture of the WAB project and locating it spatially and temporally. Also interesting was the generally enthusiastic and convincing tone that these interviewees portrayed when speaking about the project. The problem with the interview process; however, was simply that more interviews should have been conducted. The data obtained from these three was very sufficient and the interviews were extremely rewarding. As is the case with a sustainability assessment, one can never have enough good information. Even though Carlsson's role as project manager of the wetland compartment entails him to be in close contact with the local landowners thus enabling him to provide suitable information regarding any inquiries surrounding them, it still would have been beneficial to speak to some of the local landowners. Representatives from EON or DETOX, the facilitators of the biogas component of the WAB project should have been contacted as well. It could have also been interesting to contact Naturvårdsingenjörerna.

Another idea that would have been interesting to expand on in this assessment was that regarding calculations surrounding offset of biogas that result from the WAB project itself (i.e. algae harvest and transport, wetland creation, movement of people etc.).

On that note, it would also have been beneficial to look at any supply chain problems that might arise from the switch over to biogas – will there be enough biogas?

One more element that was insufficiently investigated was that concerning the cost efficiency of the wetlands. Perhaps another form of N removal would be more sustainable in a long-term perspective. A treatment plant, for example might be a good way to get a cost effective and guaranteed annual rate of removal.

8. Conclusion

Concluding Remarks

This assessment set out to answer the following three questions:

- What are the implications of carrying the WAB project through?
- What does the WAB project mean for the Trelleborg Commune?
- What will the WAB project imply for sustainable development in general?

In answering the first question, this assessment analyzed many of the parameters surrounding the wetlands/ Tullstorpsån, algae/ biogas, and agriculture compartments of the WAB project. It was determined that WAB project was generally beneficial for all levels within the local environment, economy, and society. Aside from its cost and some particulars regarding the wetland compartment, the WAB project should be viewed as a positive from of development for the Trelleborg Commune.

The DPSIR schematic and conceptual models played a large role in answering the second question. These tactics were used to exemplify and highlight the nature-society relationships that are important to consider when assessing the sustainability of the WAB project. It can be determined that the WAB project instills a form 'good will' in the Trelleborg Commune. Simply put, the project will seemingly increase, in many ways, the perceived value of the land for the inhabitants of the Trelleborg Commune.

The objectives and scope that were generated from the literature of Kates et al., (2001) and Ness (2008) were the main basis upon which the third question was answered. The WAB project is step in the right direction. In the bigger picture, its impact empirical impact is minimal but theoretically, it shows promise. At a local level, the WAB project has a considerable empirical and theoretical influence. At a mental level, individuals of the Trelleborg Commune can feel proud of their WAB project. All things considered, the WAB project is certainly on a sustainable trajectory but it could be further along.

Observations

In consideration of the content within this thesis, a list of observation can be made that focus on some general concepts in light of the future of the WAB project. The list is as follows:

- Ultimately, the eutrophication of the Baltic Sea is a consumer based problem,
- Agriculture practices are the main problem; however, they are supported by the Common Agricultural Policy and it is such that if consumers are not supplied with food that is sustainable, then they will not consume food that is sustainable,

- Consumer behaviour is difficult to discuss and the regulation of agriculture even more difficult, but even if we fail to hit on the actual driver - the consumer - we can still do a lot by hitting at the pressures,
- One could do accomplish a lot for nature by hitting on regional and national agricultural policy and subsidy systems.
- A simple example of the unsustainability of agriculture production lies in the fact that chemical runoff makes pond water useless not only for agriculture, but for life in general.
- Phosphorus is a limited resource, so why not recycle it?
- But how is it possible to connect the subsidy system to a point where phosphorus is measured more in depth? And
- Societal actions must embrace the variability and flux of the system components that facilitate society's very own existence.

Recommendations

A list of recommendations can be made that focus on some general concepts in light of the future of the WAB project. The list is as follows:

- Take into consideration the three important aspects of sustainability,
- When implementing remediation efforts, take closer aim at the drivers and pressures; a more resilient spatial and temporal fix could be found here.
- Concentrate efforts in mind of sustaining system components instead of inhibiting them, and
- Increase efforts to make partnerships at regional, national, and international levels.

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