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Article

Forests, Forestry and the Water Framework Directive in Sweden: A Trans-Disciplinary Commentary

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Abstract: The Water Framework Directive (WFD) is an ambitious piece of legislation designed to protect and improve water quality throughout Europe. However, forests are only mentioned once in the WFD, and forestry is not mentioned at all, despite its potential implications for streams, rivers and lakes. Here we present a transdisciplinary commentary on the WFD and its implications for forests and forestry in Sweden. This commentary has been prepared by forestry stakeholders, biophysical and social scientists. While we were cognizant of a large body of discipline-specific research, there are very few inter- or trans-disciplinary commentaries which link academic and stakeholder perspectives on the

WFD. We had originally felt that there would be little commonality in our concerns. However, we found significant areas of agreement. Our key areas of concern about the implications of the WFD for forestry in Sweden included: (i) concerns about what is meant by good ecological status and how it is assessed; (ii) a perceived lack of clarity in the legal framework; (iii) an inadequate environmental impact assessment process; and (iv) uncertainties about appropriate programs of measures for improving water quality. We were also concerned that ecosystem services provided by forests and the positive effects of forestry on water quality are inadequately recognized in the WFD.

Keywords: Water Framework Directive; Sweden; buffer; Environmental Impact Assessment; metrics; transdisciplinary workshop

1. Introduction

Forests are of the utmost importance for the Nordic landscape, culture and economy. The forests which cover two thirds of Sweden and contain the headwaters of most of the country's main rivers are a key part of the national identity. Human activity, including wood harvesting for timber and firewood and animal pasturage, has caused extensive modification to Swedish forests over the past thousand years. Today, almost all forests bear the mark of human activity. There has been a shift in species composition from broadleaved trees to conifers in southern Sweden. The natural fire cycle is now largely suppressed. Most forests have been planted and are managed with a goal of maximizing timber, and more recently, biofuel production. There is a relatively small area of old growth, unmanaged forest. The forested landscape is also used for other activities. Hunting (260,000 licenses were sold in 2009), game fishing and other recreational activities such as walking, skiing, mushroom picking, *etc*. are popular. In addition, commercial berry picking is common in many Swedish forests and commercial reindeer herding is practiced in many northern forests.

Forestry is an important industry, both in the employment it provides and for the national export income. Water quality in the Swedish forest landscape is generally thought to be good but there remain many uncertainties associated with nutrients, metals and persistent organic pollutants [1]. While Sweden has a very extensive surface water monitoring programme, only a small fraction of water bodies are visited on a routine basis. There is very little before/after data available to assess the impact of forestry operations on water quality and there is a great deal of natural variability which complicates the interpretation of disturbance effects.

The Water Framework Directive (WFD, EC2000/60) is an important piece of European legislation designed to protect and improve water quality throughout Europe. The WFD sets out a number of new and important concepts. It presents an ambitious agenda to define water quality in ecological terms and to develop firm time-lines for remedial actions. By placing ecosystem stability at the center of water management strategies, the WFD represents a radical shift in water management traditions [2]. The WFD is focused on agricultural and urban waters. Forests are mentioned only once in the WFD (Annex II, 1.4). Forestry and forest waters are not mentioned at all.

The WFD mandates that all water bodies shall achieve good ecological status (GES) by 2015. This is defined as "*The values of the biological quality elements for the surface water body type show low levels of distortion resulting from human activity, but deviate only slightly from those normally associated with the surface water body type under undisturbed conditions*" (Annex V, 1.2). The remainder of Annex V consists of a lengthy set of descriptions of high, good, moderate, poor and bad ecological status. Unfortunately, the directive does not provide objective definitions of the concepts.

Programs of Measures (PoM, Article 12) must be developed by EU member states to ensure that GES can be achieved. Ecological status of water bodies is assessed with respect to reference conditions (Annex II) indicative of high ecological status. Reference conditions are defined as "*…no, or only very minor, anthropogenic alterations to the values of the physico-chemical and hydromorphological quality elements for the surface water body type from those normally associated with that type under undisturbed conditions*." (Annex V, 1.2).

Ecological status is assessed using a series of metrics. Metrics are indices of varying degrees of complexity which describe how far the biological and chemical properties of a water body are from reference conditions. There is not a clear consensus in the scientific literature as to how the criteria against which reference conditions should be assessed are defined [3]. Reference conditions differ throughout Europe. Reference conditions for a stream in Sweden are likely to be quite different to those for a stream in southern Europe. An ambitious inter-calibration exercise is being carried out by regional Geographical Inter-comparison Groups (GIGs) with the goal of producing comparable standards for reference conditions across Europe. While this inter-comparison exercise may eventually allow GES to be compared at sites across Europe, it does not answer two of the most fundamental questions about the reference condition approach: (i) whether reference conditions are a reflection of natural conditions and (ii) if the public and stakeholders should have a say in the setting of reference conditions.

The WFD enshrines a requirement for public consultations in Article 14 which states "*Member States shall encourage the active involvement of all interested parties in the implementation of this Directive, in particular in the production, review and updating of the river basin management plans*." There are important questions as to what constitutes implementation; whether it is restricted to the River Basin Management Plan (RBMP) process, or if it also includes input into the GIGs, metrics and classification schemes used in the WFD.

The WFD mandates cost-recovery for water services in Article 9 which states that "*Member States shall take account of the principle of recovery of the costs of water services, including environmental and resource costs, …, and in accordance in particular with the polluter pays principle*" (Article 9). Cost recovery is assessed in purely negative terms. It ensures that the societal and environmental costs associated with impairments to water quality are paid for by the agents responsible. Because it is defined in purely negative terms, Article 9 does not provide any facility for payment for ecosystem services, such as pollution prevention, provided by land managers including forest owners.

There are many positive features of the WFD. There has been a shift from solely managing pollution at the source using emission limit values (ELV) to a combined approach assessing ecosystem effects which also includes environmental quality standards (EQS). This shift has been accomplished with binding targets. This is an important achievement for the EU as it could not be achieved, even by the more advanced member states, using national legislation and it may successfully put the

environment first. Many parts of the scientific community are also responding very positively to the WFD. There is strong support for the shared knowledge and improved expertise which is arising from WFD implementation [4,5]. While the goals of the WFD are laudable, there are a number of potential problems in its implementation which are of concern to both social and biophysical scientists. Both the governance structures for WFD implementation and the underpinning science have been criticized [6]. Amongst biophysical scientists, there are concerns about assessing ecological status using existing metrics, using reference conditions as a benchmark for ecological status and proper accounting for natural variability. Amongst social scientists, there are concerns that the existing governance structures may lead to difficulties in WFD implementation [7,8].

There are also specific concerns about the WFD, forests and forestry. Social scientists are concerned about the implications of the WFD for forest governance [9,10]. Biophysical scientists are concerned that criteria developed for ecological status assessment may not work in Swedish forest waters [11,12]. Members of the forestry sector are concerned that criteria for impact assessment and the surrounding legal framework are too vague and that implementation of the WFD in Sweden will impose unwarranted costs and constraints on their operations. Finally, there are concerns being expressed in the Swedish media about the manner in which the WFD will be implemented and the effect it will have on forestry and other land-based industries [13].

Because of its scope and complexity, the WFD may not be possible to understand using traditional single-discipline approaches. Instead, an integrated, transdisciplinary approach may provide greater insight into the complex and interlinked network of social, ecological and socio-ecological problems raised by the WFD [14-16]. While there is no single definition of transdisciplinarity it does have the following characteristics [17]: (i) it addresses real world problems; (ii) it includes interactions with societal actors; (iii) it integrates practical knowledge with constructs from the social and biophysical sciences; and (iv) it is context sensitive [18].

There is a huge body of discipline-specific literature on the WFD in the academic literature from both the biophysical and social sciences. The WFD also receives attention in the popular press. Unfortunately there is very little evidence of transdisciplinary research. Two notable exceptions to this are a study of WFD implementation in Scotland [19] and a transdisciplinary study of fish declines in Germany [20].

In Sweden, a number of issues relating to the WFD have been addressed in the social science literature. These include forest governance [9,21] multi-level governance [7,8,10] stakeholder involvement [22,23] and forest certification [24]. There is also a considerable body of ecological research in the biophysical science literature [11,12].

In this study we explored the benefits of an integrative, transdisciplinary approach to understanding the implications of the WFD for forests and forestry in Sweden by convening a dialogue between members of the forestry sector, social scientists and biophysical scientist. The goals of this dialogue were an improved understanding of challenges to successful WFD implementation and creation of new insight into the best way to protect water quality in Sweden while preserving a healthy forest sector. Preliminary discussions have revealed three points of concern: (i) Forestry stakeholders, social and biophysical scientists have framed their understanding of the WFD in different, non-overlapping and potentially incompatible ways; (ii) As a result of their different framing of problems associated with the WFD, the three groups are mutually unaware of each others' concerns; (iii) There are concerns that

objective biophysical indicators are used in an inappropriate manner to support contested and potentially competing societal goals and values.

To reach this goal, we held a small workshop with participants from the forestry sector and academia. The workshop objectives were to (i) identify sectoral (social science, biophysical science, foresters) concerns about the WFD in Sweden; (ii) map out commonalities and differences between concerns raised by different sectors; and (iii) synthesize the concerns from a Swedish perspective.

The workshop included participants from universities, the forest regulatory agency, forestry companies and a journalist working on forestry issues. The workshop agenda consisted of an introduction and short presentations by all participants on their concerns about the WFD followed by a group discussion. An audio recording was made of the entire workshop. One of us acted as chairperson (H.L.) and another as secretary (M.N.F.). Immediately after the conclusion of the workshop, a workshop summary was prepared by M.N.F and A.S. This summary was checked against the audio transcript and MS-Powerpoint slides from participant presentations. The workshop summary, which forms the basis of this paper, was then circulated to all participants. Over the following six weeks, the summary was edited and rewritten by all workshop participants to produce this paper.

This paper is a commentary on issues prepared by a group of experts on the WFD, forests and forestry in Sweden. The issues in this commentary are reflective of the interests of the authors so this list is not exhaustive. Different experts would raise different issues, or place different priorities on the issues raised in the meeting reported here.

In the following sections, we discuss some of the challenges associated with (i) concept of good ecological status, (ii) WFD implementation and governance, (iii) legal issues, (iv) programmes of measure, (v) provision of ecosystem services and (vi) positive effects of forests and forest management on water quality.

2. Good Ecological Status

Good ecological status (GES) is at the heart of the WFD. It is defined as "*The values of the biological quality elements for the surface water body type show low levels of distortion resulting from human activity, but deviate only slightly from those normally associated with the surface water body type under undisturbed conditions*" (Annex V, 1.2). This definition raises several questions, many of them having to do with so-called "reference conditions". For example, are "reference conditions" the same as "natural waters"? Are "reference conditions" possible to assess in a landscape like much of the Swedish forest that has been subject to significant human activity for over 1,000 years? What is the best (or most credible) way to measure distortions to biological quality elements resulting from human activity? What constitutes a "slight" deviation from undisturbed conditions? Is the classification scheme for expressing deviation from reference conditions in terms of high, good, moderate, poor and bad ecological status credible and comprehensible?

2.1. Reference Conditions and Natural Waters

Reference conditions are defined in the WFD as " *type-specific hydromorphological and physicochemical conditions …representing the values of the hydromorphological and physicochemical quality elements specified in point 1.1 in Annex V for that surface water body type at high ecological*

status" (Annex II, 1.3). High ecological status is defined as "… *no, or only very minor, anthropogenic alterations to the values of the physico-chemical and hydromorphological quality elements for the surface water body type from those normally associated with that type under undisturbed conditions*." (Annex V, 1.2). The argument has been made that "high ecological status" should be equated with "natural" [25]. While this argument may be justified, it cannot be supported by a close reading of either the WFD or the Swedish Environmental Code (DS 2000:61). However, the argument may be present in the Swedish Environmental Objectives (www.miljomal.se).

The overall objective of Swedish Environmental Code is to promote sustainable development (ch.1 s. 1). The section is not a "rule", that is, cannot be legally applied; it serves as an interpretation imperative. The section is moreover fleshed out with how the Code shall be applied, for example, to protect and conserve valuable natural areas, *etc*. On water, section 1, paragraph 2 states that, for example, water shall be used to secure long-term economic development and security. Secondary goals of the Swedish Environmental Code include preservation and protection of the natural environment. The Swedish Environmental Objectives are based on an assessment of departure from natural conditions. The environmental objectives are not legally binding, they are not legally connected to for example the Swedish Environmental Code or the WFD.

There is some debate as to whether the goals of the Swedish Environmental Objectives and the WFD are knowable, attainable or desirable. It has been suggested that there is a need to explore how (and whether) the term 'natural' became embedded in the objectivity paradigm of positivist science. Alternative procedures for defining the environmental objectives of society which combines both natural science knowledge, and the values and needs of society without jeopardizing either the quality of science or the democratic political procedure must be established. These ideas generated considerable debate, *i.e.*, who determined that we should have pristine waters and what are the views in other European jurisdictions?

The WFD is primarily about water quality, with a focus on biodiversity. Chemistry and hydromorphology are secondary concerns. Water quantity is a minor issue in the WFD and may be better addressed through the EU Adaptation Framework or the Floods Directive (2007/60/EC). Because of a lack of biological data, water body status is assessed primarily on the basis of hydromorphology. Hydromorphological criteria include ditches and stream crossings. Features such as bridges, culverts and semi circular culverts which have no ecological impact as they do not affect stream continuity or constitute obstacles to migration can be used to downgrade the ecological status of a water body. This point is particularly relevant for forestry in Sweden, since the building of culverts is frequently seen as a way to protect watercourses.

In Sweden, the main reason for failing to meet GES is historical hydromorphological disturbance. Dam building and river "improvement" to facilitate timber flotation prior to 1960 are the major forestry-related hydromorphological alterations. Dam building for hydro-electricity generation is another major cause of hydromorphological alteration. As remediating the effects of historical hydromorphological alteration is an unsolved problem in Sweden, we suggest that more sites which have been subject to historical hydromorphological disturbance should perhaps have been classified either as heavily modified water bodies (HMWB) or, if protected by the Cultural Heritage Act, special water bodies (SWB).

2.2. Assessing Water Body Status, Metrics and Natural Variability

Different groups have different perceptions as to the most important issues related to GES. Biophysical scientists identified issues with reference conditions and the difficulties of developing appropriate metrics. Social scientists were concerned about the link between legislation, policy and the biophysical sciences. Members of the forest sector were concerned about a perceived lack of causal relationships between the metrics used to assess ecological status and the environmental effects of forestry as this would lead to uncertainty about forestry effects and potentially impose unnecessary costs. Stakeholders are reluctant to base management actions or accept enforcement actions based on inadequate data and indices which are insensitive to causality. All groups expressed concerns that the indices used to assess ecological status are overly complex. From the beginning of the WFD process, the forest industry sector has been concerned about legally binding quality standards. These standards are based on indices and classification schemes that are perceived to be flawed and supported by inadequate information. There is a perception that existing water monitoring may be inadequate and it may be too costly to implement the degree of monitoring needed to accurately assess ecological status of all water bodies in Sweden. There are three types of water quality monitoring conducted in Sweden in agreement with the WFD definitions: (i) routine, (ii) at risk of failure and (iii) investigative. About 45% of WB should be the subject of investigative monitoring. "At risk of failure" monitoring should also be undertaken at more water bodies, and in support of the development of more detailed measures to respond to areas targeted in PoM developed at the water authorities. However, perceived concerns about costs of monitoring have yet to be solved.

Classification of water bodies in the WFD is very uncertain. Data exist for between 2,000 and 3,000 of the approximately 22,000 water bodies in Sweden. There is no information about the vast majority of water bodies (and even less for groundwater). Their classification is based on source apportionment and risk assessment. This results in poor classification and a high degree of uncertainty as well as in large needs for increased monitoring during present and upcoming implementation cycles.

Questions were raised about the difficulties of assessing ecological *versus* chemical status. In one of the few surveys of headwater stream chemistry, the variation in water quality in undisturbed forest streams, spanned the range of water qualities identified under the WFD, characterizing bad to high water quality [26]. Concerns about natural variability and the assessment of ecological status have been raised by others [2,4-6,12,27]. A high degree of natural variability and a paucity of monitoring data make it difficult to draw firm conclusions as to the ecological status of all water bodies relevant under the WFD.

The WFD assessment procedure is based on the lowest score in an ensemble of metrics. This is a pessimistic method as it gives greater weight to individual measures which may or may not be indicative of poor quality. For example, in an ensemble of six metrics, if five are indicative of "good" water quality and one of "poor", an ecological status of "poor" will be reported. This approach has been criticized earlier [11].

We had many questions about metrics. For example, are there alternatives to non-transferable, region-specific metrics? Does the GIG process imply we have a fixed set of metrics, or is the system in a state of flux? It appears that the WFD is still under revision, *i.e.*, the GIG exercise will alter values and thresholds for GES. The question can be asked as to whether or not inter-calibration solves any of

these problems. Unfortunately, the answer seems to be "no". International inter-calibration has been tried in Denmark, Sweden and Finland but data were not collected in a similar way and some data were lacking. This made it impossible to achieve credible inter-calibration, even in a relatively homogeneous area of Europe.

2.3. Classification Schemes

Criticisms have been raised about the classification schemes and metrics used to assess GES. A number of concerns were expressed about the complexity of metrics and the difficulties of determining causality. Many of the metrics used to assess GES are too complex and cannot easily be communicated to stakeholders. The suggestion was made that simpler metrics, such as those used in Denmark should be used in Sweden. Denmark has adopted a simpler scheme based on chlorophyll for lakes and the Danish Stream Fauna Index for running waters.

Many of the metrics used for assessing status cannot assign causality. The most commonly cited example was the stream invertebrate index which is able to tell if a stream community is typical of a low pH environment, but not whether the stream is anthropogenically acidified or naturally acidic. Difficulties in assigning causality reduce the credibility of the classification process.

Finland and Sweden have similar classification schemes but the Finnish implementation is seen as more pragmatic. When looking at effects of forestry, the Finnish focus is mostly on site preparation and ditch cleaning. These activities are major sources of sediment transport which can negatively affect hydromorphological and nutrient status of a water body. Sweden has a legacy of concerns about acidification from long range pollutant transport and agricultural eutrophication. This combined with the restrictions on new ditch creation in Sweden, influences Swedish perspectives on forestry impacts on water quality. The value of buffer strips and other near-stream measures for water protection may have been recognized earlier in Finland than in Sweden. However, educational campaigns designed to raise awareness amongst forestry workers about ways of minimizing the impacts of forest management operations on Swedish surface waters have recently been developed [28].

Some concerns were expressed that stakeholders should have a say in the GIG process and in evaluating metrics and defining criteria for GES. It does not appear that this was the purpose of Article 14 of the WFD. However, any such inclusion might lead to concerns that the standard setting process had been taken over by special interest groups [29]. Better ways of dealing with criteria for GES are needed. Several participants suggested that scientifically generated metrics are not necessarily the best descriptor of water quality and that metrics are too complex. While expert judgment may be an alternative to indexes, legally binding expert judgment is a troubling concept as it lacks transparency. Expert judgment can be condemned as subjective and experts do not necessarily agree.

The inter-calibration exercise is not seen to be transparent. It defines upper and lower boundaries for GES. The reference standards have been negotiated across member state GIGs. For the most part, this was a "scientific process", although the charge might be made that this was part of a positivist, objectivist spin on a political process. In parts of the inter-calibration exercise, some participants expressed a concern that politics had crept into the process, and that this may have led to reference values being changed. Some participants expressed a concern there has not been sufficient political involvement in Sweden in the setting of criteria for GES. The relative commitment of member states to

the inter-calibration process is sometimes not clear. It appears that there have been delays and inaction in some member states. There is some question as to whether or not boundary values can be implemented in legislation, and if they can be implemented, whether or not they can be enforced.

2.4. Provision of Ecosystem Services

In addition to the areas above that target implementation of actions under the WFD, concerns also exist in areas that are not included under the WFD in particular with regard to forests and forestry. While the WFD implements the "polluter pays principle", it does not express appropriate consideration for the positive ecosystem services forests provide. There are many positive effects of forest management and forestry on the delivery of ecosystem services from forests. The provisioning of water-related ecosystem services is not clearly recognized in the WFD. There is a clear idea that the polluter must pay, but no indication that actors who prevent pollution should be rewarded. Forests provide a number of water-related ecosystem services including: (i) purification of drinking water [30]; (ii) minimizing floods and periods of low flows [31]; (iii) protecting surface waters from polluted runoff [30]; and (iv) potentially making a positive contribution to the precipitation regime [32].

These ecosystem service values are not recognized in the WFD. Compensation could be provided through water-pricing schemes, payments for ecosystem preservation/promotion or direct payments to forest owners for water-related land management practices. However, the principal WFD focus is on payments for degradation of water resources, and there is inadequate or no attention paid to water improvement.

One important ecosystem service provided by managed forests is nitrogen (N) retention. Over the course of a rotation, approximately 90% of atmospherically deposited N is retained in the forest landscape. This has potentially large implications for Baltic Sea eutrophication. Retention of the vast majority of atmospherically deposited N in the forest landscape means less nutrient inputs to the marine environment. For example, it has been suggested that forest harvesting is a minor contributor to inorganic N loading to the Baltic [33]. However, we need to clarify the link between pollution in the Baltic Sea and forests. Improved calculation of the value of forest ecosystem services could be incorporated into policy and consideration taken to increase environmental values. This issue may also respond to that of financing for actions, as going beyond legal requirements may qualify for some form of compensation under some circumstances.

3. Governance Issues

We identified several governance issues related to the WFD in Swedish forests. Challenges arise when implementing policies which have conflicting goals. Issues related to implementation, including whether regulatory or voluntary instruments are the best means to achieve environmental goals must be addressed. We felt the environmental assessment process is less than satisfactory and that the legal framework surrounding the WFD is not clear to all stakeholders.

3.1. Goal/Policy Conflicts

There are challenges in balancing competing legislative goals. That conflict can arise when attempting to balance multiple demands on the forest landscape has been long recognized in Sweden [34]. Conflict can occur when attempting to balance the competing goals of EU legislation. The WFD and Natura 2000 directives may conflict with demands for, for example, greater use of renewable energy as espoused by the EU Directive on Renewable Energy (EU 2009/28/EC). Goals of the WFD and Natura 2000, which include anthropogenically formed habitats, can conflict with each other. For example, the PoM to achieve GES through nutrient reductions in lakes may lead to biodiversity loss [35]. There can also be conflicts within a single piece of legislation. A good example of this is the Swedish Forestry Act which mandates a mixture of production and conservation [36].

Policy conflicts are not adequately recognized or managed in the WFD or in the implementation process where conflicts may arise between different aims. Possible conflicts in Swedish forests include but are not limited to: timber production *versus* buffer zones; biodiversity *versus* carbon sequestration. Maximizing forest harvest may conflict with a goal of leaving buffer strips or water protection zones. Carbon sequestration may be best achieved in heavily fertilized mono-cultures, resulting in biodiversity losses.

Concerns about the WFD thus include a lack of clarity as to how conflicting interests and priorities will be balanced and a perceived lack of transparency concerning status classifications. To be successful, the GES classification system must be easier to implement, understand and communicate. Measures to be taken need to be clearly defined in relation to boundaries of authority and scientific certainty as well as manageable in terms of resources. We were uncertain as to how PoM would be financed and they were also perceived as being too general, as similar programmes are directed to different authorities.

3.2. Implementation

There are a number of issues surrounding WFD implementation and governance [37-39]. In a broader European perspective, the question can be asked as to how we arrived at where we are, and why member states signed on to the WFD. These questions are worth asking as there is some debate about the WFD and centralization of powers in the EU. In some ways, the WFD has strong centralizing tendencies while in others, it promotes decentralization. For example, the WFD has a centralizing tendency as it introduces River Basin Districts (RBD, Article 3). The RBD add another level of governance across Europe [37]. In Sweden, it is not clear how the RBD will interact with the counties which had historical responsibility for implementing state regulation on water issues [38]. While selected county administrative boards have been appointed water authorities, these may decentralize certain tasks to other of the county administrative boards that fall under the district. The means by which any of these will act to develop detailed measures to implement PoM remains to be seen. More so, it is not clear how municipalities, which are responsible for all planning in Sweden, will act to develop measures and implementation of water management. The new governance structures based on river basins instead of county boundaries also result in changes in governance practice, although they may be interpreted in relation to established practices and distribution of authority

within the Swedish system.

A new central water authority in Sweden may further complicate the situation. A single authority will have primary responsibility for marine and freshwaters while separate authorities will manage soils and groundwater. Additionally, the responsibilities of the five water districts will remain unchanged. It will be a challenge to achieve consensus on implementation when the management of waters is distributed across more than one agency.

There are also arguments that the requirement for public consultation (Article 14) is to be interpreted as a call for democracy in the WFD implementation. Differences of interpretation can also arise because of the requirements that legislation be translated into several languages. The idea that requirements "should" be met in Sweden has been interpreted as "must" in other jurisdictions. This complicates the equitable application of the WFD across Europe.

Until now, participation in the RBMP process has not always been strongly or evenly implemented across states. The first implementation cycle of the WFD in Sweden focused on providing basic information to the public as well as developing water councils, the latter drew on existing stakeholder bodies for water management. However, these processes may differ strongly across water districts. In general in Europe, concerns exist in terms of infringement proceedings initiated against some member states, resulting in impacts on the legitimacy of water management. For example, issues have been raised on the democratic participation throughout public consultation and the risk of it turning into a vehicle for stakeholders (and not individual citizens) to influence the process [40].

Questions about why member states signed on to the WFD and its perceived centralizing tendencies raise a number of questions about implementation. Specifically, we had concerns as to whether such a grand scheme even can be implemented in practice. More information is needed about the basic elements of flexibility in the system. For example, the participatory framework is circumscribed by needing to relate to targets and standards, with the result that the main areas for stakeholders to gain an impact may be in RBMP implementation. This is as stakeholders do not necessarily have an ability to influence the setting of targets or boundary conditions defining good, moderate and poor ecological status. This is an important question as it raises issues about the extent of the consultative process in EU legislation. The impact during WFD implementation may be considerable, in particular if county administrative boards and municipal level are given a greater role in defining detailed measures under the PoM aimed at achieving GES.

Early thoughts about participation under the WFD amongst forestry stakeholders were not overwhelmingly positive. There was a lack of knowledge about the WFD and its possible implications. This caused feelings of frustration and resignation and a fear that more administration, bureaucracy and restrictions on operations might develop. However, the delineations for measures to be taken to implement GES are still under development, and will rely among other things on specifications in different sectors. For instance the Swedish Forest Agency (SFA), after consultation with the Swedish Environmental Protection Agency (SEPA) and the Swedish Board of Fisheries develops regulations and/or other means of control for appropriate buffer zones and other protective measures close to water so that good chemical and good or high ecological status is maintained or achieved.

In Sweden, an informal grouping of stakeholders in the forest industry (the Forestry Water Council, FWC) has had generally positive experiences with the RBD as a venue for meeting and discussion.

However, there are still difficulties with the practical implementation of the WFD. It is difficult to relate the EQS to the real world, and the water quality of most of the surface waters in Sweden is poorly known. In addition, the WFD focuses on larger water bodies (the smallest rivers specified in the WFD are those draining catchments of 10–100 km^2 and the smallest lakes have an area of 50–100 ha). These exclude the vast majority of surface waters which are found in first and second order streams. There are very few data about these surface waters, begging the question as to how well can water quality be assessed in the forest landscape. There is a large variability in forest stream water quality [41], and the ecological status of forest waters is influenced by spatial scale [12], further complicating the interpretation of forestry impacts.

Given its emerging character, financing the implementation of the WFD is a major concern. A question was raised as to whether authorities can afford to implement the WFD. Given that detailed planning has regularly been undertaken at municipal level, municipalities and other stakeholders may also be looked to for financing of measures. In addition, different ministries are responsible for different aspects that may relate to WFD implementation. While the Ministry for Environment is responsible for WFD, forestry is regulated by the Agriculture Ministry. Given that forestry is traditionally not subsidized while agriculture is, issues of distribution of funding and responsibility are likely to become very important over the current implementation cycle both across sectors (for instance in any comparisons between agriculture and forestry) as well as between levels (such as proportions of measures or monitoring funded by the state in any support schemes to be developed, water authorities as a part of their mandate, or municipalities as a part of the responsibility attributed through the local planning monopoly). Thus, there is a perception that measures developed by RBD as part of the RBMP process are not currently adequately funded in Sweden.

With regard to forestry, some PoM to achieve GES may have to be paid for by the forest owner. However, there are limits to financial burden which can be imposed on forest owners for the purpose of meeting environmental goals. Imposing costs on the forest sector to achieve GES is not popular when the tools for defining GES are perceived as faulty.

The RBD are thus subject to a number of constraints. There is a high degree of uncertainty associated with the political process, especially how WBD will function in relation to existing governance structures in Sweden [7,8]. A note has also been made of the very short timelines associated with WBD implementation. Meeting GES for all water bodies by 2015 is seen as a difficult, if not impossible task, and in areas with severe anthropogenic impacts, a large proportion of water bodies may also have been termed as heavily modified waters (HMWB). Finally, there is a perception that there is not enough money available to actually implement the ambitious goals described in the RBMP. Exceptions have been proposed which will defer GES to 2021 for many water bodies. The exceptions process may be thought of as another form of inter-comparison exercise. It seems that member states throughout the EU have applied different criteria for identifying HMWB and water bodies where there may be disproportionate costs of achieving GES by 2015. This implies that there are two kinds of inter-calibration; the GIGs exercise between countries and choosing different end points within a country.

At present, it seems that the implementation plans for PoM to deal with water bodies failing GES are not sufficiently detailed. Many of the activities in the present round of RBMP will consist of data collection to give a more credible basis for future actions. This statement must be balanced against a

perception that data collection will be curtailed in the future and that present data collection efforts are inadequate. Given our concerns about the shortcomings of available data and the uncertainties surrounding assessment of effects, additional data collection will likely be necessary. Ideally, any additional data collection will focus on more easy to understand metrics that can be causally linked to forestry or other impacts on water quality.

3.3. Environmental Impact Assessment

The Environmental Impact Assessment (EIA) process was a major concern at the workshop. Although procedures for EIA are described very thoroughly in the Environmental Code, we were concerned that EIA is not being properly implemented in Sweden in comparison with other countries, resulting in difficulties in prioritizing between different PoM. A strategic environmental assessment (SEA) is required for any plan or programme while an EIA is needed for any proposed project. Both the SEA and EIA must describe possible PoM needed for prioritization of measures and identify what is most cost-effective. However, the application of the EIA process in water management has so far played a relatively limited role. Some of us believed that Sweden has not implemented the SEA directive properly; an issue that could lead to legal action by EU, further complicated by the fact that SEA implementation is spread across several pieces of legislation and jurisdictions including the Swedish Environmental Code and the Planning and Building Act.

While there is support in principle for well managed EIA, there is not enough data available on forest streams to determine whether or not for instance forestry has an impact on water quality. Forestry stakeholders suggested that the quality of existing EIA is poor, PoM are too general and that our goal must be to take actions where we achieve the greatest environmental gain. However, a lack of high-quality EIA data precludes the easy identification of the most cost-effective solution to environmental problems. The quality of EIA is thus suffering from the general problem that metrics used to assess water quality are either missing or unclear and difficult to interpret. There were five main concerns expressed about metrics: (i) lack of precision; (ii) difficulty or impossibility in assigning causality; (iii) complexity; (iv) overly pessimistic in their assessment of ecosystem status; and

(v) difficulties with inter-calibration.

3.4. Legal Issues

The implementation of the WFD in Sweden is relatively clear from a legal perspective. However, clarifying case law is still lacking. Legal issues concerning implementation of the WFD are not clear to practitioners in the forestry sector. Participants at the workshop also felt that the legal requirements associated with WFD implementation are not always clear to supervisory authorities. In Swedish courts, current cases with WFD implications include one case about monetary costs for using water. Administrative case law related to the WFD does also exist but such cases do not create precedent. Precedent court cases will have to come from the Supreme Court or the Environmental Court of Appeals or from the EU, which is already suing some countries over WFD infringements and failure to follow participatory framework.

The legal regimes presented by the Environmental Code and the Planning and Building Act are important for the practical implementation of the WFD. The substantial legal rules in the Code as well as in the Planning and Building Act are however sometimes generally specified, and a general lack of legal standards for the benefit of assessment rules makes the prediction of case outcome difficult (decisions must thus be made on a case-to-case basis, with little direction from previous cases). Sectoral rules like the ones in the Forestry Act often lack content and must be fleshed out with prescriptions.

From an environmental protection perspective there are also ownership issues, and these are not only about water. Although ownership in Sweden is negatively defined, meaning that the starting point is that you are free to do what you want with your property, the law can restrict your behavior. Consequently, you *cannot* do whatever you want with something you own. National as well as EU legislation have the authority to permit or restrict, for example, environmentally hazardous activities. The owner is in these cases not necessarily compensated because it is in the common good.

Legally, the WFD will probably have an impact on the granting of permits, which has already been targeted in some PoM as an issue for county and municipal level to review. In most water bodies, permits for use may exist since far back, even if the conditions of the water body have changed. As a result, existing permits as well as the process for granting new permits (often subject to EIA) need to be reviewed. The legal and procedural possibilities for this are not yet clear. There is some discussion as to the post appropriate permitting requirements and whether they should be based on EIA or voluntary compliance. However, this may be a minor concern in forestry as relatively few forestry activities, with the exception of drainage, require permits but may have a large impact on water use in general.

The EQS are very important from the perspective of the implementation of the WFD. The use of EQS is relatively new in Sweden (the instrument was introduced with the Environmental Code in 1998). Unlike an ELV which starts from the polluter, an EQS starts from the environment. EQS are therefore attractive as it is difficult to achieve high environmental quality only by source regulation (there are many point and diffuse sources of pollution and the collective effect of their regulation is vastly difficult to control and foresee). Thus, unlike ELV, which set thresholds and standards for individual polluters, EQS provide a boundary for all activities that impact, for example, water bodies.

EQS are an important part of the WFD where they are defined as "*The concentration of a particular pollutant or group of pollutants in water, sediment or biota which should not be exceeded…*" (Article 2, paragraph 35). The wording is however subject to interpretation. To address the legal effect of the EQS, one must answer the question as to whether "should not" is the same as "must not". The purpose and general scheme of the WFD implies legally binding requirements, which must not be exceeded. By using EQS, stricter requirements than what has been achieved via other instruments (emission control using best available technologies) can be imposed under the WFD scheme**.** In conclusion, member states should have legal system that allows for this. However, the manners in which EU directives and their objectives must be implemented are subject to discretion.

According to Swedish law (after 1/9 2010), EQS in keeping with chapter 5 in the Environmental Code are divided into different categories with different legal effect. Although it is said that all EQS shall be followed and that PoM shall be implemented if necessary, the tangible legal effects are different. The legal effect of a *limitation standard* (that is, an EQS in accordance with s. 2, para. 1, and

p. 1) is that it has implications, for example, the permit trial and the conditions for permit. According to the Environmental Code, every activity must in principle comply with the (environmental) consideration rules regarding for example the choice of location and precautionary measures (Chapter 2, the Environmental Code). Since the rules can imply rather rigorous demands, a cost-benefit assessment of the total requirements shall be applied in order to make sure that they are not *unreasonable* with regard to the single activity on trial. However, in the presence of a limitation standard that runs the risk of being violated, no cost-benefit assessment shall be made. This means that there can be no mitigation of the demands regarding for instance the use of best available technologies even though the costs associated with such a technique would have been seen as unreasonable or other precautionary measures.

EQS for water under Swedish law are not expressed as limitation standards, but as standards that follow from EU-law (*i.e.*, in accordance with s. 2, para. 1, and p. 4). Regarding the legal effect of this type of standard the law (simply) states that it shall be followed and that PoM shall be implemented if necessary. However, EQS for water cannot be upheld with the same strength as EQS expressed as limitation standards [10].

Achieving GES is treated in the same way as ELV for chemical status. Ecological status is a goal and chemical status is a threshold. The perception that they are being treated in the same way has potentially far-reaching consequences for forestry. Many implications of legal status are still not known. Even though the government with their proposition 2009/2010:184 clarified how the EQS are to be interpreted during supervision, a comparison of EPA guidance and the government proposition suggests significant differences of opinion between the Swedish EPA and the County Administration Boards. While the WFD has been implemented into Swedish policy, there is still a lack of any case law about WFD. As a result, we will not know for sure how the WFD will be implemented until it has been fully tried in the Environmental Courts.

3.5. Legal and Market-Based Instruments (Including Certification)

There are in general two ways to achieve environmental goals in forests: using the more conventional legal and policy instruments or the market-based practice of certification. The Swedish Forest Act is somewhat limited with regard to water. Ordinances specify limitation of damage as a result of management and mandate the use of buffer zones in relation to water. A Swedish government appointment has been made to the SFA on assessing need for revision of laws in implementing the WFD. The appointment specified that the SFA should (i) follow the process of classification of waterbodies, (ii) participate in the PoM development process, (iii) suggest how forestry can contribute to the achievement of the WFD goals, (iv) analyze the need for adjustments in the regulations (the forestry act) or other measures, and (v) to analyze the consequences of suggested adjustments. In response to this, the SFA suggested including water quality in the ordinance for paragraph 30. This would provide a justification for buffer zones to limit leakage of nutrients following to clear cutting. The SFA response also recommended including water quality in forest plans; and the development of monitoring programmes which include water. An SFA internal water policy also suggests that functional buffer zones may play a large role in implementation of the WFD. Other practices such as limiting driving in areas close to water may also be supportive of this goal.

Swedish forest policy including environmental considerations such as buffer zones is, to a large extent, implemented with the support of certification. This use of market based practices has been referred to as "governing without government" [24]. Certification is a market based mechanism whereby a third party ratifies practice based on the standards. Ratification allows for the use of the certification label, which is largely becoming a market demand. It may be easier to achieve some environmental goals through certification schemes, as implementation is at least partly controlled through the third-party assessment system that certification constitutes.

As certification standards add to and go beyond legal and policy requirements, they are integral in implementing Swedish environmental aims including the Forestry Act goals of both production and environmental values. Both the Forest Stewardship Council (FSC) and the Program for the Endorsement of Forest Certification (PEFC) endorse the use of riparian buffer zones. Amongst other things, the FSC certification scheme (within minimum 5% consideration) promote buffer zones without ground treatment in border zones to water and consider water environments during setting-aside of forest land and within hydrological context [42]. Water protection can thus also be achieved through voluntary initiatives. The PEFC states that buffer, border or consideration zones, are important for protection of lakes and watercourses and should be left according to the guidelines and recommendations in Swedish Forest Law [43]. While certification is widely relied on, it is far from perfect, especially in that it requires the operational translation of relatively complex requirements. The way in which certification aims are implemented may also differ depending on specific natural conditions in the particular case, and on education, knowledge and time for planning forest management activities among entrepreneurs and forestry planners.

Buffer zones are thus included in both PEFC and FSC standards as well as being explicitly mentioned in Swedish policy. They are easily measured on aerial photographs, and are the only action explicitly mentioned in PoM for forests. However, there is debate in scientific literature as to the benefits which buffer zones may provide in the forest landscape [44]. There is some evidence of biodiversity protection but there is less evidence of buffer strip ability to prevent pollutant loading to receiving waters. It is not clear what types of buffer zones are required, whether they must be treed, whether they should be strips around water bodies, or if they should function more as water protection zones which prevent driving damage and water impacts. Buffer zones may also be desirable for aesthetic reasons. The simple existence of a buffer zone is not necessarily indicative of water protection and the absence of a buffer zone does not always equate to degraded water quality.

The desired size of a buffer zone vary highly depending on circumstances, and among some environmental organizations, there is a perception that current practices for buffer strips do not provide sufficient benefits to water quality. There is a need for increased water course perspectives, not only that of the individual owner if buffer strips are to be accepted. There is also a need to prioritize the location of buffer strips. If what is perceived as too much forest land is retained or set aside under certification, the acceptability of large buffer strips may be reduced.

The focus on buffer strips could perhaps be changed to water protection zones. Buffer strips are not needed along all water courses. Poorly placed buffer strips will not necessarily help achieve GES and may not be cost effective for the forest owner. Excluding forestry operations from sensitive areas, such as wetlands and some riparian zones, may give greater benefits for ecological status of Swedish waters and may have lower costs for the forest owner [28].

4. Summary

We assembled a transdisciplinary workshop with the goal of developing a better understanding of the Water Framework Directive and its implications for forests and forestry in Sweden. We reached greater common ground than we had expected going into the workshop. Different people with different backgrounds raised many of the same issues. People shared interests outside their disciplinary boundaries, suggesting that there are many good opportunities for future collaboration. A key point of agreement was that the WFD is a laudable and desirable piece of legislation. The problems with implementation do not negate the benefits.

Our main concerns were about the lack of mention of forests in the WFD, the manner in which ecological status is assessed, the role of River Basin Districts within Sweden's existing framework, perceived shortcomings in the environmental assessment process, a perceived lack of clarity in the legal framework and doubts about the efficacy of riparian buffer strips as part of a PoM for protecting or mitigating water quality. Our concern about the manner in which ecological status is assessed is shared by others in the research community [4] and amongst water planners in Sweden [8].

Many unanswered questions were raised during this dialogue. It was clear that there are problems with the GES assessment process. There are high uncertainties in the classification scheme and a lack of confidence in the metrics used for classification. There were concerns about implementing decisions with economic consequences based on metrics that were not seen as adequate for the task. The next steps in WFD implementation are that authorities, municipalities and perhaps forest owners will be made to implement PoM so as to achieve GES. This needs to be based on adequate classification of present-day impacts and an appropriate assignment of responsibility for deviation from GES. Metrics are fixed, but may need to be changed. It may be relevant to examine how the public consultation process can influence both the choice and implementation of metrics, and how scales for effect assessment can be best defined.

The current classification system may also be too complicated and very difficult to communicate to stakeholders. There is some debate as to the value of the inter-calibration exercise as all the indices being compared may be too complex. The inter-calibration exercise can also be criticized as it does not feed back to stakeholders. Different quality factors and different metrics lead to different results. Some metrics may classify the ecological status of a water body as "good" while others classify it as "poor". This can lead to a large number of water bodies failing to meet GES as the status classification is based on the lowest value. A different approach might be to identify the worst water quality in Sweden and build metrics from that.

The role of expert judgment in assessing GES needs to be explored further. While there are valid criticisms of expert judgment, it may ultimately provide a more credible way of assessing deviation from reference conditions and prioritizing PoM.

As of present, there are also insufficient links made between quality factors and disturbances. This lack of causality makes it hard to assess the true degree of impacts and to develop appropriate remedial measures. It also makes it more difficult to prioritize water bodies that ought to be the targets of remedial actions. Some of us had a perception that the water authorities do not make optimal use of classification data in priority setting—potentially a result of the classification scheme being seen as too complex, and that water authority staff may prefer to rely on expert judgment. However, assessments

made on the basis of expert judgement may be less acceptable than those made with what are seen as objective criteria [8,29]. Also, the water authorities may be skeptical towards classification data as they suggest that an unacceptably large number of Swedish water bodies (53%) fail to meet GES. This may be, in part, because the good/moderate boundary is poorly specified, or a result of water authorities having problems with what they believe to be a large number of complicated indexes and a desire to measure determinants more directly related to water quality problems (e.g., chlorophyll as a metric for eutrophication).

"Natural" conditions may not be possible in all areas (or desirable, as it would require removing the often economically important practices that result in disturbances or negatively impacting artifacts and ecosystems of cultural heritage value). There will be production losses when attempting to meet GES in water bodies which are not in need of remedial action. This is due, in part, to the lack of an unambiguous causal relationship between the functionality of stream ecosystems and what is measured by indexes. Future change may also come to impact the quality of water bodies: the issue of climate change is not considered in the WFD, but the RBP's should be "climate proof" [45]. There are a number of issues related to soil and water quality in a future Swedish forest landscape. Changing climate, increased fertilization and shorter rotation periods may all have deleterious consequences for water quality [1].

As a result of the novelty of the WFD process, there are unanswered questions as to what may happen in the next round of RBPs [8,16]. Some PoM note that climate change will have a crucial impact on the possibilities for waters to meet GES in the future. Ideally, the additional data collection proposed for the current round of RBP will allow for better classification of water body ecological status in 2021. There is a need to improve the use of HMWB and special waters, especially for water bodies subject to historical hydromorphological alteration. Public and stakeholder participation will be a key part of addressing assessment, measure development and other questions.

The concerns we have about the implications of the WFD for Swedish forestry may have broader implications. It is clear that the WFD is an important piece of European legislation. It is less clear that the WFD will help to promote sustainable forestry in Sweden. It did not seem to us that the WFD had been drafted with reference to the unique conditions in the Swedish forest. We should try to ensure that a similar situation does not occur if the proposed EU Forests directive becomes law. We should ask ourselves what we have learned from other issues. Is there anything we can learn from acidification or nutrient control that has implications for the WFD and can we learn from other initiatives such as REDD? We need legislation and policy that supports sustainable forests, both by protecting the environment and by not imposing unnecessary costs on forestry, as well as requiring actors to work together to implement measures for improved water quality.

5. Conclusions

We realized that there was more agreement across disciplines than we had originally expected. Finding and building on this common ground shows the strength of a transdisciplinary approach to the WFD and other complex issues. The WFD is an important piece of legislation which has the potential to improve water quality throughout Europe. However, it is not without shortcomings. Failure to adequately include forestry and forest related issues in the WFD has made its application more difficult in Sweden. This is likely to be the case in other jurisdictions also. Our key concerns were with the manner in which ecological status is assessed, uncertainties about appropriate PoM and a perceived lack of clarity in the legal framework. The tools for assessing ecological status are unable to adequately detect anthropogenic impacts and it is not clear how current conditions should be compared to a reference state. The high degree of variability in waters that are not believed to have any severe anthropogenic impacts, and the lack of before/after data, makes assessment more difficult and compromises the credibility of ecological status assessments with stakeholders. Because we perceived the ecological status assessment process to be inadequate, we had concerns about PoM. There was broad agreement that water protection zones in near-stream and sensitive areas can have beneficial effects on ecological status, but we were concerned that unselective use of buffer strips would not provide the most cost effective means of protecting or restoring water quality in the forest landscape. The failure to consider ecosystem services provided by forests and forestry calls into question the fairness of the “polluter pays” principle. Focusing only on pollution does not recognize the many beneficial ecosystem services provided by well managed Swedish forestry.

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