ECNC

european centre for nature conservation

Impacts of biofuel production on biodiversity in Europe

Impacts of biofuel production on biodiversity in Europe

Authors
Merijn Biemans, Yuca Waarts, Ana Nieto, Vineta Goba, Lawrence Jones-Walters and Christoph Zöckler
ECNC-European Centre for Nature Conservation
Tilburg, the Netherlands, 2008

Prepared by: ECNC–European Centre for Nature Conservation, Tilburg, the Netherlands

Citation: Biemans, M., Y. Waarts, A. Nieto, V. Goba, L. Jones-Walters, C. Zöckler (2008) *Impacts of biofuel production on biodiversity in Europe.* ECNC–European Centre for Nature Conservation, Tilburg, the Netherlands.

Available from: ECNC–European Centre for Nature Conservation
PO Box 90154
5000 LG Tilburg
The Netherlands
E-mail: ecnc@ecnc.org
www.ecnc.org

ISBN: 978-90-76762-27-2

Funded by: Manfred-Hermsen-Stiftung, Bremen

Cover pictures: P. von Meijenfeldt, Saxifraga/Jan van der Straaten

Table of contents

Preface

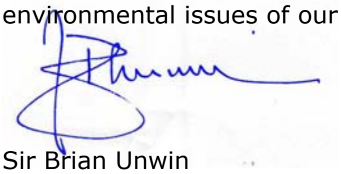
The global increase in land put aside for growing crops that can be processed for the production of biofuels has become a topic of intense discussion amongst the press and media, politicians, nature conservationists and environmentalists and the interested public. Initially the general perception created in the public mind was that production of biofuels could become a crucial, if not the main, solution to the problem of non-carbon-emitting energy and fuel creation. But this is not so. Although biofuels may have a significant role to play, the situation is much more complicated than that. There are serious implications for food production and therefore prices, and also - the main interest of ECNC - for nature and biodiversity conservation. These issues have not yet been adequately explored, and the purpose of this report is to help inform and stimulate further exploration and discussion.

The report focuses on the European perspective as this has received less attention in the global context, and the European Union has already set ambitious biofuel production targets for its Member States before the full implications of achieving those targets have been fully researched and analysed. The basis and implications of these targets therefore need more rigorous analysis. There is clearly a link between rising food prices and the scarcity of land for food production as a result of their conversion to biofuel crops. But linked to this competition for natural resources, particularly in relation to land use and management, is a significant threat to biodiversity in Europe. In Europe not only because extensively managed or 'non-productive land', whose main current use is for wildlife conservation, may become the target for food or energy crop production, but also because the side effects of intensification of land use (for food or energy crops) can have significant consequences for ecosystem services, ecosystems and their related biodiversity.

Many of the major environmental and nature conservation NGOs have joined the debate through the production of strong position statements, political interventions and press and media campaigns (largely opposing biofuels). The issue of biofuels and their potential impact on biodiversity was discussed in depth at the ninth meeting of the Conference of the Parties (COP9) to the Convention on Biological Diversity in Bonn, Germany. National governments in Europe are reconsidering their policy in relation to biofuels and, as a consequence of this widespread concern, the European Commission has published a Proposal for a Directive on the promotion of the use of energy from renewable sources, which includes criteria in relation to potential social and environmental impacts of biofuel production.

There is therefore a pressing need to 'take stock' of the current situation, to provide a quantified assessment of the likely impacts of biofuels (based as far as possible on the present position and empirical evidence) and to have a reasoned discussion about the way forward. Such an approach will provide a platform for intervening in the cross-sectoral policy agenda with a view to achieving a sustainable way forward. Manfred-Hermsen-Stiftung, in recognizing the need for an analysis of the present position, particularly in relation to 2nd generation biofuels, therefore commissioned ECNC-European Centre for Nature Conservation to produce this report on the impact of biofuel production on biodiversity in Europe.

The report focuses on 2nd generation biofuels, which have great potential for reducing carbon but which may also have a significant impact on biodiversity. The main themes have been set out in the recommendations of the report and are presented in a reasoned and balanced way. As I have already stated above, there is a pressing need for a further exploration of the values and best practices for biodiversity in European agricultural habitats - perhaps identifying the top three to five priorities across the areas of research and monitoring. I sincerely hope that this report will provide the basis for the future consideration of these and other issues, and that it will contribute to establishing a platform for the debate that is required in relation to policy and practice at international, national, regional and local level. I therefore commend it to the reader as an even-handed introduction to one of the most pressing environmental issues of our time.



Sir Brian Unwin
President, ECNC-European Centre for Nature Conservation
October 2008

Summary

During recent years the quest for new energy sources has increased rapidly and, within this context, biofuels have been presented as a promising replacement for fossil fuels. However, biofuels have been the subject of much debate amongst environmentalists, since the processes around biofuels do not always perform well with regard to environmental issues. Moreover, it is not always clear whether the environmental benefits claimed by their advocates (e.g. reduced climate change), outbalance the negative effects.

As a response to climate change, European policy instruments targeted at biofuels have sought to increase the market share of biofuels in Europe. Nearly all EU countries make use of transport biofuels and some have committed themselves to obligations or tax concessions aimed at maintaining or increasing current levels of biofuel utilization. However, after some years of actively supporting biofuels and attempting to increase their market share in Europe, the recent criticism of their potential environmental impact has recently stimulated the European Commission to develop adjusted policies, which contain criteria related to sustainability and the environment. Presently these policies mostly concern 1st generation biofuels. It is, however, necessary to also make a proper inventory of the possible impacts of 2nd generation biofuel production, since the commercial application of these is currently under development. This report addresses the question of the impacts of 2nd generation biofuels, specifically in relation to biodiversity.

At this moment bioenergy crops such as willows, poplars, miscanthus species and reed canary grass are the most promising species, with the potential to supply large amounts of biomass for the production of 2nd generation biofuels. The impacts they may have on biodiversity can be negative as well as positive. If established in existing areas of value for biodiversity (e.g. semi-natural grasslands or forests) they will have a direct negative impact; however, willow or poplar plantations in particular, could positively contribute to biodiversity if they are planted in less diverse, intensively farmed landscapes. In addition to this they do not require significant inputs of agrochemicals, which gives them an advantage over most 1st generation biofuel crops (e.g. rapeseed).

The second potential area for biomass provision originates from the waste products of forestry and agriculture. Waste products from sawing mills should not negatively affect biodiversity, but the removal of forestry waste products (e.g. branches and litter layers) from forests could severely affect fungi and invertebrate species which are dependent on dead wood. On the other hand, the removal of dead wood could reduce the risk of forest fires whose increasing frequency beyond natural levels, particularly in southern Europe, may have a detrimental effect on many organisms. Agricultural, non-food waste products (e.g. straw) potentially enhance soil biodiversity and soil quality if they are incorporated or left to decompose naturally on the arable lands. This will not happen, or the effect will be reduced, if the majority of the waste is used for the production of biofuels. An opportunity exists in relation to the conservation of semi-natural grasslands which have value for biodiversity; positive management for such habitats includes the removal of the organic biomass, for instance by cutting (a requirement for maintaining hay meadows). The cut material can then be used for the production of biofuels.

Three case studies are described in the report, in order to provide a tangible illustration of the positive and negative impacts on biodiversity of harvesting biomass. It was found that bioenergy production from wood chips in a nature area (the Netherlands) can contribute significantly to the development of sustainable 2nd generation biofuels, but their potential impact on biodiversity (in particular soil organisms and fertility) is uncertain. Growth of reed canary grass for bioenergy purposes on abandoned peat cutting fields (Finland) potentially points to a huge opportunity for biofuel harvest. However, the present agricultural practice in relation to the management of the crop does not take any impact on biodiversity into consideration. Potentially the impact on biodiversity is positive, but not as positive as when the abandoned peat cutting fields are restored and turned into wetland areas. The reed or rush cutting from wetlands (Poland) is promising, particularly for the enhancement of grassland biodiversity.

The search for new energy resources requires a balanced overview and consideration of all the potential opportunities and threats. This will facilitate a well-founded and therefore wise adjustment of policies, which should be framed to include environmental criteria. A part of these environmental criteria should particularly take into consideration the importance of habitats and species when converting land into bioenergy crop land. Furthermore, any policy frameworks should take account of the impacts of

bioenergy crops on biodiversity and, specifically, provide measures for biodiversity protection and management that contribute to halting the loss of biodiversity by 2010, which has been set as one of the key biodiversity targets of the EU. In relation to this, it is recommended to be very cautious with 1st generation biofuels and to emphasize the opportunities perennial biomass crops could bring for biodiversity.

1 Introduction

Using biofuels (or agrofuels) from renewable sources seems to be an attractive means for potentially reducing greenhouse gas emissions, ensuring energy security and providing support to rural development objectives (JNCC, 2007). The financial incentives associated with biofuel production certainly provide a strong incentive for the farmer and landowner to change their operations from food production. However, biofuels are also proving to be a controversial subject and have attracted much interest and comment from environmental NGOs, statutory institutions, the media, politicians and the concerned public. In some cases this has stimulated a response from policymakers (see Section 2). The increasing amount of land in the European Union devoted to the production of biomass for energy use could pose a serious threat to biodiversity in Europe and globally (EEA, 2007) and among other suggested new ways of providing energy for society (e.g. nuclear energy, wind power, etc.), it needs to be clarified what the potential, sustainable contribution of biofuels on future energy supply can be.

Biomass can, after a conversion process, be used for energy generation in three sectors: transport, electricity generation, and heating and cooling. This report mainly considers the production of biomass for transport biofuels, although the way the biomass is processed (e.g. for transport or electricity) does not necessarily imply different agricultural practices prior to the processing.

Transport biofuel production is differentiated between 1st and 2nd generation biofuels (and more recently also 3rd generation; see Table 1). 1st generation biofuels, mainly bioethanol and biodiesel, are substitutes for petrol and diesel. These biofuels are made from plants from which the oil (e.g. rapeseed, sunflower), sugar (e.g. sugar cane, corn, sugar beet) and starch (e.g. potatoes) are directly extracted and easily processed. These sources can also be used as food or fodder.

2nd generation biofuels are produced from the lignocellulosic material from plants. Before bioethanol is obtained, the lignocellulosic material is processed. This process is technologically advanced and not yet commercially available. Many crops, such as perennial grasses and short rotation coppice such as willow and poplar, can be used to produce 2nd generation biofuels. Waste products from agriculture and forestry can also be used to produce 2nd generation biofuels.

From the current perspective, 3rd generation biofuels, which can be derived from algae, are much more promising as they do not compete with food crops and can be grown nearly everywhere. However, 3rd generation biofuels are an ‘issue for tomorrow’, since it will still take many years before this technique is sufficiently developed for it to be applied. Therefore, the impact of 3rd generation biofuels on biodiversity is not considered in this report, although it is expected to soon become an issue.

There has been (and continues to be) some discussion over the exact definition of biofuels; indeed, in much of the available literature there is a lack of consistency about how the differentiation is made. In this report biofuels are therefore considered to be: ‘fuels that are derived from dead organic material which are especially developed to replace fossil fuels’. Although the biofuels can be solid, liquid or gas, generally speaking it is referring to liquid biofuels which are or will be particularly useful as transport fuels. The biomass that is combusted for the generation of electricity or heat is therefore not considered to be a biofuel. However, since it is derived from plant biomass (with the same origin as 2nd generation biofuels) it does fall under the definition of bioenergy and certainly contributes to the replacement of fossil fuels. For this reason electricity and heating are included in Table 1 on the next page, but are given a separate column.

Table 1. Biomass for bioenergy

Biomass for bioenergy				
1st Generation biofuels		**2nd Generation biofuels**	**Electricity and heating**	**3rd Generation biofuels**
Biodiesel (directly extracted from plant)	Bioethanol (fermentation of sugar or starch)	Bioethanol (fermentation of lignocellulosic plant parts)	Combustion of plant biomass	Bioethanol, biodiesel, etc.
• Palm oil • Rape seed • Sunflowers • Soy beans	• Corn • Sugar cane • Sugar beets • Potatoes • Wheat	• Willows • Poplars • Grass • Waste products from agriculture (e.g. plant residues) • Waste products from forestry (e.g. wood chips)		• Algae

Recently there has been much debate in the public arena on the impacts of biofuel production on the environment, on the availability of food and on food prices. With regard to the impacts on the environment, the discussions are mostly geared towards whether the production and use of biofuels decreases CO_2 emissions compared to the production and use of fossil fuels. However, not much attention has been given to the impact of the production of biofuels on biodiversity and among environmentalists the debate is often somewhat polarized towards negative impacts. NGOs such as Greenpeace and Friends of the Earth are repeatedly stressing the devastating impacts of biofuels on biodiversity (e.g. Greenpeace, 2008; Friends of the Earth, 2008). Also, if impacts on biodiversity are described they almost exclusively refer to impacts in the tropics and outside of Europe, while the encouragement of biofuel usage may also affect European land use and biodiversity, particularly in Eastern Europe (which therefore remains relatively neglected as an issue).

This paper provides a contribution to the debate and discussion around the impacts of the production of 2nd generation biofuels on biodiversity in Europe; it defines the policy context and highlights its positive and negative impacts on biodiversity. Three pilot areas of existing biofuel production are studied in detail in this paper in order to provide a better understanding of the potential impacts of biofuels on biodiversity at subnational level in Europe. Information on these impacts was obtained by conducting a literature survey, and preparing a questionnaire that was sent to the managers of the selected pilot areas to assist in collecting information about the sites.

The paper is targeted at policy officials who are responsible for the development and the implementation of biomass and biodiversity policies in the EU and pan-European setting. In particular, the analysis and conclusions derived from this report are intended as a contribution to the process of creating policy frameworks under the responsibility of the Convention on Biological Diversity (CBD), the European Commission DG Energy, DG Agriculture and Rural Development and DG Environment (as it is recognized that the promotion of biofuels for energy production concerns all three policy areas), as well as a broad audience of national and subnational level policy officials.

2 Policy background

The EU is currently framing its support for bioenergy production in the context of contributing to objectives such as meeting climate change commitments, securing environmentally-friendly energy supply and the promotion of renewable energy sources. However, there is increasing evidence that the carbon offset by 1st generation biofuels is not as positive as expected. A trade-off exists between lower greenhouse gas emissions and the adverse effects of this expansion and intensification in terms of, for example, biodiversity (Scenar 2020, 2007). The contribution of biofuels to climate change mitigation seems not to be as positive as hoped for, although the impacts of 2nd and 3rd generation biofuels are still to be explored. It might be that at least some biofuels do not even provide a suitable response to climate change. In the meantime the climate continues to change rapidly and the quest for new energy resources remains a necessary priority. The European Commission is fully aware of these issues and it continues to develop adaptation strategies and policy frameworks. The possible impacts of biofuel production on biodiversity is already given explicit recognition in the Convention on Biological Diversity (CBD).

In 2003, the EU adopted a Biofuels Directive 2003/30/EC setting indicative targets (2% by 2005 and 5.75% by 2010) for the production of fuels produced from biomass feedstocks (mainly from cereals and sugar beet). Under the Energy Tax Directive 2003/96/EC, the Commission also allowed Member States to grant exemptions or reduced tax levels for biofuels. For the EU 25 the target would require 18.6 million tons of biofuels by 2010. Additionally, Member States should ensure that a minimum proportion of biofuels and other renewable fuels are placed on their markets and, to this effect, they have to set national indicative targets. In particular, a reference value for these targets will be 10% for the contribution of biofuels to the total fuel consumption by 2020, set on the basis of the Directive. In addition, at the March 2007 meeting of the Council of the European Union, the 27 EU heads of state or government agreed on a 10% increase in the use of biofuels and a binding 20% target in relation to the use of renewable energy sources by 2020 (European Commission, 2007). The European Commission is currently developing a Renewable Energy Directive which will incorporate the 10% biofuels target but also a set of sustainability criteria in order to ensure that biofuels production is sustainable in relation to social, environmental and economic factors. Moreover, on 23 January 2008, the European Commission has already published a Proposal for a Directive on the promotion of the use of energy from renewable sources, which includes environmental sustainability criteria and verification requirements for biofuels and other bioliquids (BTG, 2008).

In 2005 (the most recent figures available), transport biofuels were used in 17 of the 21 Member States for which data were available. The European Commission indicates a significant increase in market share, reaching 1% on average (it has doubled in two years). Nonetheless, this figure is below the reference of 2% as fixed in Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport. In addition, the advances have been very varied: only Germany (3.8%) and Sweden (2.2%) achieved the reference value. To achieve this, 1.9% of the total available European arable land (1.8 million hectares out of the total 97 million hectares) was used for 90% of the production of raw materials for biofuels, whereas the other 10% was imported. The recent increase in oil prices and a growing interest for new markets for agricultural products in the light of the general reform of the Common Agricultural Policy (CAP) – and the sugar regime in particular – have led to a wider appreciation of biofuels at European level. However, due to fears of intolerable rises in food prices, mass deforestation, water shortages and threats to biodiversity, the goals outlined above are subject to a debate which is likely to result in adjusted policies. Furthermore, it is expected that the European Commission’s recently announced proposal for a Common Agricultural Policy (CAP) 'Health Check' will take up and respond to the current criticism and will provide a further elaboration of the issues around biofuels and biofuels policy.

Currently, the EU meets 4% of its total energy needs from biomass (CEC, 2005) and if it made full use of its potential, it would more than double biomass use by 2010 (Table 2; from 69 million tons in 2003 to about 185 million tons in 2010), while complying with good agricultural practice and safeguarding sustainable production of biomass and without significantly affecting domestic food production. Bulgaria’s and Romania’s accession to the EU improved the availability of biomass, and imports still offer more potential. Together, this could lead to an increase in biomass use to about 150 Mtoe (Million Tons of Oil Equivalent) in 2010 or soon after.

Table 2. EU biomass production potential (Source: CEC, 2005)

Million Tons of Oil Equivalent (Mtoe)	**Biomass consumption, 2003**	**Potential, 2010**	**Potential, 2020**	**Potential, 2030**
Wood direct from forest (increment and residues)	67[1]	43	39-45	39-72
Organic wastes, wood industry residues, agricultural and food processing residues, manure		100	100	102
Energy crops from agriculture	2	43-46	76-94	102-142
TOTAL	**69**	**186-189**	**215-239**	**243-316**

Looking beyond 2010, biofuels could have a bigger role to play if oil prices increase further, with a reformed agricultural policy, new technological breakthroughs and the challenge of imports from third countries. Under Article 16 of the Energy Tax Directive, Member States may grant exemptions or reduced levels of taxation for biofuels. Under state aid rules, Member States have notified the Commission of tax reductions in the order of €0.3 to €0.6 per litre of biofuel, which is the level deemed necessary to compensate for the higher production costs of biofuels compared to fossil fuels.

The current most tangible European policies (potentially) in support of biofuels are:

- **Tax concessions**; e.g. Germany currently applies a 100% tax relief, but will soon go over to obligatory shares of biofuels in transport fuels instead of tax policies; the United Kingdom, the Netherlands and Slovenia are currently reframing their biofuels policy and might also introduce obligations.
- **Obligatory share of biofuels in transport fuels**; e.g. in Austria, the Czech Republic and France oil companies are obliged to ensure the use of biofuels by the market (e.g. by mixing biodiesel with regular diesel).
- **Recultivation of set-aside land**; the 1992 Obligation which introduced set-aside as a tool to balance the cereals market, has now been amended (up to 0% of set-aside land in 2008; European Commission, 2007) which creates opportunities for the growth of biofuel crops.
- **Special aid for energy crops**; in 2003 CAP reform introduced a premium of €45 per hectare that could be made available for energy crops (for a maximum of 1.5 million hectares).

However, if the energy policy objectives of the European Union are to be met, much more bioenergy will have to be brought into the market than at present. This was the conclusion of the Commission Communication (2004) *The share of renewable energy in the EU*, which specified that bioenergy should contribute an additional 74 million tons by 2010 (EU 15 only) if the indicative target was to be achieved. This will require EU policy instruments to support biomass and biofuel production. However, the required increase in cultivation of bioenergy crops will lead to increased demand for agricultural land, and is currently causing highly publicized alarm at the apparently linked rise in food prices. This may cause a consequent demand on land, at present extensively farmed or not farmed at all, and therefore threaten natural and semi-natural habitats (e.g. extensively farmed and managed grasslands, which are already under pressure from conversion and intensification, are especially vulnerable); if this threat is realized it could contribute significantly to any potential failure to reach the European target expressed in the Communication from the European Commission in 2006, to: 'Halt the loss of biodiversity by 2010 – and beyond'. In addition to that the World Wildlife Fund (WWF, 2007), BirdLife International (BirdLife International, 2008) and other NGOs are stressing that, in addition to the climate change benefits of producing biofuels, direct environmental effects should be taken into consideration as well. One of the suggested responses to the negative effects of biofuels is to set up strong sustainability criteria, which

[1] This figure includes 59 Mtoe of wood and wood wastes, 3 Mtoe of biogas, and 5 Mtoe of municipal solid waste.

could be introduced in a mandatory eco-certification for all biofuels that are produced in the EU or imported from outside. Moreover, it has been suggested by the European Environment Agency (EEA, 2007) that the European Commission biofuels policy could, through a system of incentives and support, be directed in a way that ensures the increase of greenhouse gas benefits and minimizes the environmental risk (including the protection of biodiversity), for instance:

- the discouragement of the conversion of land with high biodiversity value for the purpose of cultivating biodiversity feedstocks;
- the discouragement of the use of systems with negative environmental consequences for biofuel production;
- the encouragement of the use of 2nd generation production processes.

What is clear in relation to the policy, is that the greatest current challenge is to maintain the balance between the two policy targets, one primarily aimed at combating climate change and securing energy supply, the other aimed at safeguarding nature protection interests.

3 Impacts of bioenergy crop production on biodiversity

3.1 Introduction

The use of 1st generation biofuels is already increasing and has been the subject of many discussions because the production of biofuels has potentially far-reaching social and environmental impacts (for instance, in relation to palm oil in Indonesia, reed plantations in South America or the loss of set-aside land in the EU). Furthermore, the production of 1st generation biofuels has raised urgent questions about whether they are an effective or economic way of making a contribution to combating climate change, what their effect on biodiversity is and how they compete with food production.

Usually, a difference is made between direct and indirect impacts on biodiversity. However, there exists much vagueness with regard to the boundary line between direct and indirect impacts. In relation to impacts on biodiversity: indirect impacts mostly refer to saving species by climate change mitigation (e.g. biofuels decrease carbon emissions and thus reduce climate change, and climate change therefore has a reduced consequential impact on biodiversity); whereas direct impacts refer to interferences in ecosystems (e.g. the direct removal of existing high biodiversity value forests for palm oil plantations). From this point of view, the impacts described here mainly reflect direct effects. Although indirect impacts certainly deserve attention, there has already been an emphasis in the current debate on indirect impacts while direct impacts have received less consideration.

The bioenergy crop production types which are discussed in this chapter were selected on the basis of their likely delivery. The bioenergy crop production systems which currently have the best prospects of becoming commercially applied are reviewed and the impacts their application could have on biodiversity are explored. Their carbon offsets and possible impact on climate change are not elaborated.

In general, the production of 1st generation biofuels implies intensive agricultural practices (e.g. the high application of fertilizers and pesticides, for example to rapeseed) (Russi, 2008); increasingly it also suggests that there will be competition for land use and that natural land (forest or grassland) may therefore be converted into arable land; it may also compete with food production, which causes increasing food prices that will mainly harm those on low or subsistence incomes.

2nd generation biofuels are expected to score better on all these issues; it has been predicted that they will deliver greater reductions in greenhouse gas emissions and it is claimed that they are less competitive with food for land use. However, this also depends on the origin of the crop which is selected to deliver the biomass for the production of the biofuel. Biomass that originates from intensively managed grasslands implies a great difference in impacts on the environment than when the biomass originates from forestry residues. Currently biomass is widely used for the production of energy, in Europe that being mainly electricity. The direct impact that biomass production has on biodiversity does not depend on whether the biomass is used for the production of electricity or bioethanol. However, before it is introduced on a massive scale, it is crucial to analyse possible inherent impacts on the environment prior to planting the crop, and not following its establishment because the construction of biofuel plants is expensive and it is hard to reverse the damage caused to biodiversity by any direct impacts. At this moment the conversion of biomass into (2nd generation) biofuels (bioethanol) is still under development, not yet commercially available and its impacts on the environment and biodiversity have not been widely studied (FOE, 2008).

Biomass for the production of 2nd generation biofuels can be extracted from any biomass producing plant. Currently in use, mainly for the production of electricity, and with the best prospects of becoming commercially applied are plantations of willow (*Salix spp.*), poplar (*Populus spp.*) or stands of grass and sedge species (e.g. *Miscanthus*, canary reed grass, reed beds, etc.), or several types of waste products from agriculture (e.g. straw and crop residues) or forestry (e.g. residues from sawing-mills). Extraction of biomass from forests (e.g. litter layers and woody debris) is also suggested but that is expected to have more severe impacts on the ecosystems concerned. The overall impact, be it positive or negative, that biofuels have on greenhouse gas emissions, ecosystems and livelihoods, depends on the type of feedstock used, how and where it is grown, how and where the biofuel is processed and transported, and for whom (IUCN, 2007).

This section of the paper explains the positive and negative impacts on biodiversity of the growth of perennial crops for 2nd generation biofuels, short rotation coppice and energy grasses. Information is also compiled on the use of waste products from forestry and agriculture for 2nd generation biofuels. This information is summarized in Table 3.

3.2 Perennial crops grown for biofuel production

Arable land, currently used for food or forage production, can be converted into perennial energy crop land and supply power plants with valuable source material. The cellulose of the plants forms the basis for a process whose output is the biofuel bioethanol. The most valuable crops used for cellulosic bioethanol are willows (*Salix spp.*), to a lesser extent poplars (*Populus spp.*) and grass and sedge species (e.g. *Miscanthus*). Studies of the impacts of these plantations on biodiversity have been limited. However, from the available literature it is clear that plantations of willows, poplars or grasses may have positive as well as negative effects, depending on how the plantations are located in the landscape, how they are managed and what type of land use they are replacing.

Willow and poplar plantations (Short Rotation Coppice – SRC)

<u>Positive impacts</u>

One of the positive effects of growing willow and poplar is the relatively low use of agrochemicals. Once established, the willows and poplars do not have any serious competitors, and therefore the amount of pesticides needed is low, as weeds do not have to be suppressed. The use of pesticides and fertilizers impacts negatively on biodiversity, including the community structure of insects, populations of soil invertebrates, micro-organisms and plant communities.

Normally, depending on present management methods and earlier land use, the composition of the ground flora in *Salix* cultivations is dominated by common weed species, but rare species could also occur (Börjesson, 1999). The diversity and occurrence of soil micro-organisms and soil fauna, especially decomposers such as earthworms (*Oligochaeta*), woodlice (*Isopoda*), harvestmen (*Opilionida*) and carabides (*Carabidae*), is, in general, higher in energy crops than in annual food crop cultivations (Sjödahl Svensson *et al.*, 1994; Makeschin, 1994; both cited in Börjesson, 1999). SRC is known to support an abundant and diverse invertebrate community (Sage & Tucker, 1997; Sage, 1998; both cited in Sage *et al.*, 2006). The increased presence of soil organisms, caused by the increased input of organic material, such as leaves, will attract birds and other animals feeding on those soil organisms. The soil will be constantly improving during part of each rotation (Ranney & Mann, 1994), which may be favourable for biodiversity conservation or enhancement.

Another beneficial effect of willow plantations in particular is the early spring flowering of the male *Salix spp.*, which will be very beneficial to pollinating insects such as bees and bumble-bees (Börjesson, 1999); there will also be benefits for insects living on wood such as beetles and moth larvae.

A major potentially positive effect of energy tree plantations is their capacity to take up lost nutrients out of the groundwater. A conversion from annual to perennial herbaceous or woody crops will reduce groundwater and surface-water contamination significantly (Ranney & Mann, 1994). For instance, the effects of hedgerows on water quality by reducing soil runoff and the uptake of lost nutrients, have been studied intensively (Peterjohn & Correll, 1984; Merot, 1999; Sheridan *et al.*, 1999; Caubel-Forget *et al.*, 2000; Tabacchi *et al.*, 2000). Though the architecture of a row or field of willow trees is different from a hedgerow, the positive effects of hedgerows can still be applied to these plantations. Their beneficial effects, however, are highly dependent on the local environment. The uptake of nutrients from the groundwater is greater and particularly useful in places where fertilizer applications are relatively high, a practice that has become very common, for instance in the Netherlands, because of intensifying agriculture. The excessive nutrient loading can have significant negative ecological effects on the receiving waters of lakes, streams and estuaries (Peterjohn and Correll, 1984), so planting perennial energy crops might have substantial benefits for many organisms that depend on clean water. The filtering effect of a hedgerow will furthermore depend on the dominant groundwater stream direction. If the groundwater stream is interfered with by the roots of a hedgerow, the uptake of nutrients can be significant and positive effects on water quality may be noticed in nearby streams or pools. Moreover, the direct shadowing effect of a hedgerow on streams and pools contributes to lowering the water temperature, which prevents pools and streams from becoming exposed to serious eutrophication, often otherwise disastrous to biodiversity.

Certainly for birds, SRC would be mainly beneficial in large monotone areas of intensive agriculture, in which perennial crops can substantially contribute to the variety of the landscape (Sage *et al.*, 2006) and promote biodiversity. This may also be the case for other species groups depending on their preference to the habitat type concerned (Louette *et al.*, in press).

Negative impacts
The application of herbicides is desirable from an agricultural point of view when weeds are strongly restricting the growth of the willow and poplar trees (Davies, 1987), which is particularly the case during the establishment period during which the unrooted willows and poplars are particularly uncompetitive (Sage, 1998). The amount of herbicides required during the establishment phase is higher than for other crops (e.g. sorghum, corn, wheat) (Ranney & Mann, 1994).

Another concern is the introduction of non-native species as energy crops, as they may spread into the wild or surrounding areas and either displace native species or become a serious pest (Ranney & Mann, 1994). In Europe there is a wide variation of willow and poplar species, and therefore species that are locally native and from the same genetic source should preferably be selected as energy crops (or used as a basis for hybrids), so that they are not a potentially threatening invader.

It is important to mention that, for birds, SRC would definitely not be a good replacement for other woodland or scrub habitats (Sage *et al.*, 2006). Furthermore, the organisms that benefit most from SRC may not be the ones that really need protection or are at risk of extinction. Several of the birds and mammals occupying energy crop plantations are often widespread and regionally abundant in other landscape types (Christian, 1994; cited in Börjesson, 1999). The net balance for biodiversity (profiting species or declining species) is likely to be mostly negative (Louette *et al.*, in press).

Perennial biomass grass crops
Positive impacts
Perennial crops, such as grasses, are attracting increasing interest as potential biofuel crops. Perennial crops have significant advantages over many annual crops because they require less energy input during growth than annual crops, which not only need to be planted each year, but typically require more fertilizer, herbicide and pesticide input (Schmer *et al.,* 2008).

Figure 1. Reed cutting in Narew National Park, Poland (Source: EURONATUR, 2008)

Previous research on cellulosic crops, such as grasses, has only been conducted on small scales, leaving open the questions of how feasible and efficient farm-scale production would be and what the impacts are on biodiversity and the environment. Depending on the species applied, perennial biomass grass crops can provide substantially improved habitat for many forms of native wildlife (mammals, birds and invertebrate populations), due to the low intensity of the agricultural management system and the untreated headlands.

Miscanthus fields are richer in weed vegetation than arable fields. Bird use of the biomass crop fields varies depending on species. Especially open-ground bird species such as skylarks (*Alauda arvensis*), lapwings (*Vanellus vanellus*) and meadow pipits (*Anthus pratensis*) appear to be relatively large in number within Miscanthus fields (Semere *et al*., 2006).

Figure 2. Meadow pipit (*Anthus pratensis*)

With regard to the crop type, small mammal species seem to have no particular preference, but they do show a preference for good ground cover and little land disturbance, which is provided by both Miscanthus and reed canary grass (*Phalaris arundinacea*) crops. Ground flora, small mammals and most of the bird species (except open-ground birds) are found more abundantly within field margins and boundaries than in crop fields, indicating the importance of retaining field structure when planting biomass crops.

The great diversity of weed flora within Miscanthus fields has positive impacts on invertebrates. Ground beetles, butterflies and arboreal invertebrates are abundant and diverse in the most floristically diverse Miscanthus fields (Semere *et al*., 2006).

Negative impacts

Miscanthus species originate from South-East Asia and Africa. Introducing alien species, such as Miscanthus, into Europe as biofuel sources can cause serious environmental harm as invasive species. The impacts of alien invasive species can be immense, insidious, and usually irreversible. Invasive species are second only to habitat destruction as the most significant cause of species extinction worldwide (IUCN-Med, 2008).

Internationally, there has been little success in eradicating or even controlling an invading grass (Raghu *et al.*, 2006). Therefore, as a proposed species introduction it should be subject to rigorous ecological assessment before full-scale commercial production (Semere *et al*., 2006).

3.3 Waste products from forestry and agriculture

The second main source for the production of 2nd generation biofuels is waste products that come from industries related to forestry or agriculture (from tree plantations or perennial crop plantations).

There has been no complete assessment of the consequences of using large amounts of biomass from waste products on food production, ecosystems, global greenhouse gas emissions, soil fertility or water supplies. This means that there is no evidence that large-scale 2nd generation biofuels from waste products would be either sustainable or climate friendly.

Removal of forestry waste products from forests

Woody waste products may come from sawing mills, or more directly they can be harvested from forests, where they are normally left behind as leftovers from timber products.

The removal of dead and dying trees from managed forests is already leading to large-scale biodiversity losses, and also to lower carbon sequestration in forests. For instance, in Germany, 20-25% of all woodland species depend on 'forestry waste' being left in woodlands (Paul & Ernsting, 2007).

In boreal forests dead wood is a key factor for biodiversity as it hosts a large number of fungi, bryophytes, lichens and invertebrates (Siitonen, 2001). Although the positive effects that thick stems have on biodiversity have been widely recognized for many years (e.g. Bader *et al.*, 1995; Jonsson *et al.*, 2005), the value of thinner branches or fine woody debris for biodiversity has only been recognized in recent years. They are found to be important as well (Kruys & Jonsson, 1999; Nordén *et al.*, 2004). Fine Woody Debris (FWD; diameter 1-10 cm) is more important than Coarse Woody Debris (CWD; diameter > 10 cm) for species density of wood-inhabiting fungi species (e.g. ascomycete and basidiomycete species) and some of these, including some Red List species, are even found exclusively on FWD (Nordén *et al.*, 2004).

Figure 3. Ascomycete fungi (*Galliela spp*.) (Source: Clark University, 2008)

Most species of fungi tend to be present if there are different volumes of dead wood, (e.g. logs, branches, and twigs of various diameters and lengths), and a range of degrees of decomposition (Küffer & Senn-Irlet, 2005). The same principle applies in relation to several beetle species, including Red List species, some being more associated with fine wood than coarser wood (Jonsell *et al.*, 2007).

Furthermore, the rich variety of arthropods that is facilitated by dead wood attracts many species on higher levels, such as birds. It is clear that logging residues that could be used for bioenergy provide habitats for many species and it is reasonable to expect that more woody debris would allow more species to colonize a site and possibly also to reduce the risk of extinction (Bader *et al.*, 1995).

Permanent extraction of dead wood seriously stresses forest productivity (Egnell & Valinger, 2003) and sustainable extraction of forest resources for biofuels might only be possible if not the whole tree is harvested and at least part of the wood is left behind, the decaying wood functioning as a major nutrient source for new growth. Another possibility would be that only forests that do not meet the criteria for biodiversity interest (e.g. rareness, fragility, geographical isolation, naturalness, richness, etc.) can be selected for intensive extraction of wood, leaving untouched those forests that host many species.

On the other hand, if the waste products from forestry are removed and used for biofuel production, the risk of forest fires can be reduced, which may have a positive impact on biodiversity. This is especially relevant for the Mediterranean region.

Agricultural, non-food waste products

Many different agricultural, non-food waste products can be used for the production of bioenergy, for instance straw and grassland cuttings. Whether the effects are potentially negative or positive mostly depends on the waste products and the habitat they are derived from.

Positive effects

Grassland cuttings can be used for energy purposes and in addition they offer an opportunity to conserve semi-natural grasslands from natural succession, helping to prevent the loss of species-rich open habitats (EEA, 2006). Removing grassland cuttings prevents the grassland from turning into a possibly less attractive and diverse ecosystem such as a woodland, since tree seedlings can also be removed with the cuttings. Although early stage woodland is fairly rich in plant and insect wildlife, the development of woodland results in the rapid disappearance of many species (BGS, 2008). If left unmanaged, a grassland is rapidly, naturally afforested (Hansson & Fogelfors, 2000), which stresses the importance of management regimes. Moreover, nutrient-rich grasslands in general contain fewer species than nutrient-poor grasslands and, therefore, decreasing the soil nutrient richness by removing plant litter effectively supports the increase or maintenance of the species richness of certain grasslands (Verhoeven *et al.*, 1996; Foster & Gross, 1998; Hansson & Fogelfors, 2000).

Another important, potentially valuable advantage of semi-natural grassland with a low fertilization rate and high species diversity is its potentially high bioenergy yield, which can be greater than for example monoculture corn or soybean yields (Tilman *et al.*, 2006). Moreover, grasses can be produced on agriculturally invaluable and unproductive lands and thus not necessarily compete with food production (Tilman *et al.*, 2006).

Negative effects
One of the most important agricultural waste products that is considered for energy purposes is straw, which is a leftover of crops such as wheat and barley. Straw is often used as ground cover in animal stables or it is incorporated in the soil. An initial consideration of the possible effects of the use of agricultural waste products for the production of bioethanol suggests that there may be no harmful effects. However, since the number and types of soil organisms are enhanced by tillage systems which incorporate organic matter (e.g. straw) into the soil it is expected that the use of straw for other purposes would especially harm these soil species. The tillage system determines the amount of organic matter input into the soil and can positively affect biological activity and biodiversity of soil organisms (e.g. Pankhurst *et al.*, 1996; Sharma *et al.*, 1998; FAO, 2008). This can even be used as an indicator of soil quality and ecosystem stability (FAO, 2008). The use of the 'waste product' straw for bioenergy purposes might not be very attractive, unless high quality substitutes for the loss of organic matter are available and can be applied to the soil.

Furthermore, the removal of organic residues from fields will probably imply greater use of nitrate fertilizers, which has devastating impacts on biodiversity, on land and on freshwater ecosystems (Paul & Ernsting, 2007).

The information contained in Chapter 3 is summarized in the table below.

Table 3. Impacts of bioenergy production on biodiversity

Bioenergy source		**Positive impacts**	**Negative impacts**
Perennial crops	Short rotation coppice (willow and poplar plantations)	• Relatively low use of agrochemicals (e.g. fertilizers and pesticides) after the establishment period. • Diversity and occurrence of soil micro-organisms and soil fauna higher than in annual food crop cultivations. • Increased presence of soil organisms attract birds and mammals that feed on them. • Spring flowering of willow is beneficial to pollinating insects and insects living on wood. • Tree plantations take up lost nutrients from the groundwater and reduce soil runoff. • Tree plantations significantly reduce groundwater and surface-water contamination. Tree plantations have a shadowing effect on streams and pools, lowering the water temperature and eutrophication.	• The high use of herbicides during the establishment period. • The introduction of non-native species as energy crops may displace native species or become pests. • When tree plantations replace woodland or scrub habitats, this will not be a good replacement for bird populations. • Lowering groundwater level in neighbouring habitats.

Bioenergy source		**Positive impacts**	**Negative impacts**
	Miscanthus species, reed beds and reed canary grass	• Lower use of herbicides, pesticides and fertilizers than annual crops. • Perennial biomass grasses provide a good habitat for many forms of native wildlife (birds, mammals and invertebrate populations). • Lowland disturbance and good ground cover due to Miscanthus and reed canary grass cultivation is preferable for small mammal species. • Miscanthus fields offer a great diversity of weed flora and related invertebrate species.	• Miscanthus is not a native European species and may become invasive, causing extinction of native species. • Invading grasses are very difficult to control; proposals to introduce such species should be assessed rigorously.
Waste products from forestry and agriculture	Removal of forestry waste out of forests	• By removing the waste products from forestry, the risk of forest fires can be reduced, which may have a positive impact on biodiversity.	• Forestry waste extraction often has a large negative impact on biodiversity as many woodland species depend on forestry waste being left in woodlands. • The removal of dead wood may lower carbon sequestration in forests. • Species of fungi and beetles are found to be more abundant when there are different volumes of dead wood available in forests. • Bird species are dependent on a variety of arthropods that are facilitated by dead wood.
	Agricultural, non-food waste products	• Removing grassland cuttings prevents the grasslands turning into a possibly less attractive and diverse ecosystem (natural succession). • Removing plant litter decreases the soil nutrient richness and other soil processes, supporting the increase or maintenance of biodiversity.	• Removing agricultural waste products requires a greater use of nitrate fertilizers, which has a detrimental impact on biodiversity and its surrounding water bodies. • Removing agricultural waste products negatively affects soil organisms. • Removing agricultural waste products probably accelerates topsoil losses.

4 Case studies

In this section information has been compiled on three pilot areas (in the Netherlands, Finland and Poland) of existing biofuel production at subnational level in Europe. These case studies are presented in order to give actual demonstrations of the potential positive and negative effects of bioenergy production in Europe. A questionnaire was prepared and sent to the managers of the selected pilot areas to assist in the collection of information about the sites. Interviews were also held with the site managers to support, clarify and add to the information provided in the questionnaires.

4.1 Bioenergy production from wood chips in the nature area Sonse Heide (the Netherlands)

Site characteristics
The Sonse Heide (Son Heathland) and the Nieuwe Heide (New Heathland) are nature areas with forested dunes, heathland areas and several pools which are located in the Province of Noord-Brabant, in the South of the Netherlands. Together, they cover around 600 hectares.

Figure 4. Sonse Heide with Oud Meer and Nieuwe Heide (Source: Google Maps)

In January 2004, Staatsbosbeheer (SBB - State Forestry Service of the Netherlands) took over the management of the area 'Sonse Bossen' in the Municipality of Son and Breugel to which the Sonse Heide belongs. SBB and key stakeholders (e.g. local authorities, local and interested citizens) carried out an evaluation to agree on the best approach to manage the area. This evaluation revealed that in order to maintain the heathland ecosystem and avoid its conversion into forest, all young trees around the Oud Meer (Old Lake) would need to be removed as well as the trees at the edge of the forest. If no action is undertaken, the heathland will no longer exist in 2015 (Municipality of Son and Breugel, 2007).

Following this approach, SBB, together with key stakeholders, created a forest management plan for this area, which includes the use of waste products for the production of biofuels. This vision and management plan have been approved by the Municipality for the period 2005-2015 (Municipality of Son and Breugel, 2007).

Forest management and bioenergy production
In November 2007, SBB started felling trees, including all the young pine and birch trees that border the north side of the Oud Meer (Old Lake). This was done in part by grazing the area with large herbivores combined with manually pulling out the young trees. Furthermore, to avoid the heathland area being taken over by the forest, the forest edges around the heathland were also cleared, in an effort to ensure that the seeds are not distributed to the heathland area.

The trees are cut by a wood processor, and logs and branches are driven to the exit roads in a removal truck. There, the logs are collected in trucks and taken to mills to produce wooden planks.

Some of the branches are left in the forest as they help the development of the new young forest which ensures layers that divide the old growth forest and the heathland. In this zone, refuge opportunities are created for many plants and animals.

The remaining branches and the tree-tops are chipped and transported to a power station located in Cuijk, the Netherlands, to produce electricity. This is the first bioenergy power station in the Netherlands and it is now about five years old.

Figure 5. Collection of logs for removal from the site (Source: ECNC)

Impact on biodiversity of harvesting biomass for energy on this site

The maintenance of open space contributes to the survival of the heathland ecosystem and its related species. If the trees were not cleared, the forest would take over the heathland ecosystem, including the pools. This would have a consequent and negative effect on biodiversity because the characteristic and often rare species associated with heathland ecosystems would lose the abiotic and biotic factors necessary for their survival. Ecological connectivity may have also been enhanced for certain types of species that require open space to travel from one site to another (e.g. butterflies).

Furthermore, felling trees in the area surrounding the heathland ecosystem also creates opportunities for their natural regeneration, which in turn provides refuge opportunities for many plants and animals.

Forestry waste is usually not removed from the forest, unless there is a specific reason to do so (e.g. to safeguard the conservation of an ecosystem or a particular species). This is because the removal of forestry waste may have a negative impact on many woodland species that use dead wood and branches as their refuge or for feeding opportunities. On this site, forestry waste is removed from the heathland area to enhance the heathland ecosystem. Forestry waste is also removed from the forest edge to avoid natural regeneration in the forest.

4.2 Growth of reed canary grass for bioenergy purposes on abandoned peat cutting fields (Finland)

Site characteristics

The sites on which reed canary grass (*Phalaris arundinacea*) is grown are located on abandoned peat cutting fields, which are widespread in the southern part of Finland. In total, about 30 per cent of the Finnish land surface is mire area; of this area approximately 2 per cent is used for peat cutting fields, i.e.

0.6 per cent of the total Finnish land area; about 0.1 per cent of the total land surface consists of abandoned peat cutting fields. The soils of these cutting fields consist entirely of peat.

Figure 6 illustrates the appearance of peat cutting fields that are still in use. These land-use types are considered to be very species poor.

Once abandoned, the fields are exclusively grown with reed canary grass. This results in monocultures of reed canary grass, as illustrated in Figure 7. The plants reach a maximum height of 1.5 metres. After the harvest, the grass can directly be combusted in energy plants or its cellulose can be converted into ethanol, which is a process that is currently under development.

Figure 6. Still used peat cutting field (Source: Raimo Heikkilä)

Figure 7. Recently abandoned peat cutting field currently used for growing reed canary grass (Source: Timo J. Hokkanen)

Site management

In general, no agrochemicals that would be damaging to biodiversity are applied to the reed canary grass monocultures, since the peat soils are very rich in nutrients, at least for the first ten years. Every spring, the grass is harvested and transported to bioenergy plants. The reed canary grass regrows naturally, and thus no specific measures need to be taken to stimulate the regrowth.

Impact on biodiversity of the conversion of abandoned peat cutting fields

The impacts of peat cutting on biodiversity are large. In order to extract the peat the surface vegetation needs to be removed. The consequence of this activity is, therefore, that typical plant and animal species on these sites (about 20 plant species and 15-20 bird species, some of them threatened wetland birds in Finland) will become locally extinct. The abandonment of peat cutting fields creates great opportunities for biodiversity. Establishment of reed canary grass fields is beneficial to some species, except for plant species which do not have the chance to establish themselves because reed canary grass is a very dense, dominating species. Birds will use the fields as a refuge and might even breed in them. Elks (*Alces alces)* could be attracted to the sites and could forage on the grass.

Compared to the practice of peat extraction, the abandonment of peat cutting fields is considered to be very beneficial to biodiversity. However, in general, the opportunities for maximizing biodiversity are not fully used. Restoration of the abandoned peat cutting fields can result in very valuable wetland areas, which are beneficial to many wetland birds, currently at risk of extinction in Finland. Dryland birds are the species that benefit most from reed canary grass fields.

Figure 8 on the next page shows a recently abandoned peat cutting field, while Figure 9 shows a peat cutting field after rewetting and a longer time of abandonment. Willows and grasses are growing along the ditches of the recently abandoned peat cutting field. Under the right management regime, it could turn into an area that looks like that in Figure 9, where shallow lakes with common reed (*Phragmites australis*) attract many birds. Figure 7 reflects the situation in which the abandoned peat cutting field is used for growing reed canary grass.

Figure 8. Recently abandoned peat cutting field (Source: Raimo Heikkilä)

Figure 9. Abandoned, rewetted peat cutting field with common reed (Phragmites australis), attracting many birds (Source: Raimo Heikkilä)

4.3 Reed harvesting for biofuel production in the Narew National Park (Poland)

Site characteristics

The upper part of the Narew River valley (NE Poland) upstream of Rzędziany is one of the last extensive undrained, non-reclaimed valley wetlands in Central Europe. Internationally important wetlands developed in the wide, flat bottomed river valley and floodplain, together with the sinuous and completely natural passage of the river, are relics of a landscape that has almost vanished throughout Europe. From 1969 to 1980, the lower course of the Narew River between the junction with the Biebrza River and Rzędziany village (ca. 50 km) was comprehensively regulated and modified to change its natural course and prevent it from behaving as a natural system (through the channelization of the watercourse, and other river engineering works). This regulation lowered the average river level (Mioduszewski and Gajewska, 2000), resulting in a decrease in flooding frequency and depth, which had a rapid and negative effect on the hydrology, soil, vegetation and wildlife of adjacent marshes. The valuable river system and extensive peatlands have survived only in the valley between Rzędziany and Suraż. Since 1996 this part of the valley is protected as Narew National Park (NNP). NNP has a total area of 6810 ha (see Figure 10).

The vegetation of NNP consists of natural peat-forming plant communities: sedge (*Caricetum elatae*) and *C. gracilis* communities and reedy rushes (*Phragmitetum communis*). Small clusters of osier communities (*Salicetum pentandro-cinereae*) and single arborescent willows occur locally. Alder carrs (*Ribo nigri-alnetum*) are found sporadically at the valley margins (Dembek *et al.*, 2002). In total, 58 plant communities are found in the area. The Park contains more than 650 species of vascular plants, including many protected species (e.g. Siberian iris - *Iris* sibirica, Greek valerian - *Polemonium caeruleum*, common sundew - *Drosera rotundifolia*, gladioli - *Gladiolus spp.* and orchids - *Orchis spp.*).

NNP supports a number of breeding populations of bird species of national conservation concern (e.g. Black stork - *Ciconia nigra*, Spotted crake - *Porzana porzana* and Common redshank - *Tringa totanus*) as well as globally threatened species (e.g. Corn crake - *Crex crex* and Aquatic warbler - *Acrocephalus paludicola*). Due to its exceptional importance for birds, NNP has been designated a Wetland of International Importance under the terms of the Ramsar Convention. About 203 species of birds breed in the various ecosystems of the Narew wetlands and many migrating birds stop over. The Narew National Park harbours 40 species of mammals, the most characteristic of which – beaver – and others are connected with water or marshy areas. In addition, 13 species of amphibians and many fish species can be found in the NNP.

Site management

During the seventies the Narew River was channelled, resulting in a drawdown of the groundwater level. Because of this, the farmers reduced their agricultural activities and their management of the grasslands, reed and sedge areas. This was the stimulation for EURONATUR, a German NGO, to rebuild the old river system, in cooperation with farmers. Farmers then returned to the old fields and started to use them again for harvesting biomass; this was fed as hay to their animals and cut reed was used in stables. The removal of biomass from the wetland has a positive impact on regionally valued birds that only breed in grasslands; if reed is not cut back regularly, the grasslands would be overgrown. These birds are now returning to Narew National Park.

Figure 10. Narew National Park (Source: EURONATUR)

The management plan of the Narew National Park scheduled reed cutting on 2,000 hectares of the Park. However, they did not know what to do with the biomass. EURONATUR worked on the idea of producing heating materials from this biomass (especially reed), as harvesting and selling this biomass is a very good example of how nature conservation and sustainable rural development can be brought together. This, however, was not easy because of the situation in the Park. The Park consists of a complicated river system with small isles and river arms, which make it difficult to harvest the biomass. Furthermore, the ownership structure of the area is very complicated, as the fields are very small and belong to different farmers, some of whom have abandoned the area. A large part of the National Park is owned by the National Park Authority.

Figure 11. Briquettes made by using the reed in the Narew area (Source: Jutta Krumnacker)

One of the farmers, from the village of Zaczerlany, saw a good opportunity in harvesting the naturally growing common reed as biomass to produce heating materials (briquettes) and so to obtain an additional income. In the winter of 2007/2008, this farmer harvested 20 hectares of reed, and sold the briquettes to local consumers and neighbouring farms. If the demand for heating materials made from reed increases, the area will increase to 2,000 hectares. He has a contract with the National Park Authority, as he only harvests reed in the area owned by the National Park. More farmers may be willing to harvest reed to produce biofuels in the future, as the briquettes produced last winter have already been sold. If this trend continues, it may provide an incentive for other farmers to become biofuel producers. The only issue would then be to improve the access to the Park areas which need to be harvested; bridges would be necessary to access some fields.

Impact of reed harvesting on biodiversity in the Narew National Park

The area of reed in the Narew region was already quite large, but increased when agricultural activities in parts of the region ceased in the seventies. The increase in reed meant a decrease in the area of grassland. Certain species of birds require grasslands for nesting, so harvesting the reed biomass has a positive impact on these bird populations. The reed is only cut in winter and not during the breeding period.

If this reed were not cut, the numbers of grassland birds would decrease, and the goal of the Narew National Park management plan (cutting 2,000 hectares) would not be achieved. Furthermore, harvesting the naturally growing biomass in this area does not impact negatively on biodiversity, as the harvested amount is relatively small because such large quantities are available.

Advantages of reed harvesting for biofuel production are:

- securing the Narew wetlands against plant succession; protection of biodiversity;
- regional benefits through economic development – new 'green' jobs;
- renewable energy for the region.

Limitations of reed harvesting in the NNP are:

- inaccessibility of the mire area;
- environmental reasons; only a limited area within the NNP may be used for commercial activities;
- fragmented ownership: state property, where large-scale management could be implemented, amounts to only ~20% of the area;
- harvesting possibilities strongly depend on weather conditions.

The sustainable harvesting of reed to be used as biofuels has positive impacts on biodiversity in the Narew region and also offers opportunities for sustainable rural development, as the sale of reed pellets provides extra income for the local inhabitants.

5 Conclusions and recommendations

One of the most important issues emerging from this report is that the most recent figures available for the production of biofuels within Europe date from 2005. It is therefore recommended that the current situation in relation to biofuel production in Europe should be urgently reviewed; this lack of data and understanding may actually be one of the causes of the problem in relation to the controversy of the subject.

Furthermore, the review and case studies underpinning the current discussion paper suggest the following additional recommendations for urgent consideration:

- The urgent need for an extension of the existing policy frameworks at key decision-making levels in order to provide the basis for integrating decisions about biodiversity and bioenergy production.
- These issues need to be fed in to the general reform of the CAP and the European Commission’s recently announced proposal for a CAP 'Health Check'.
- Establish a common policy (within the CAP, but also within DG Environment and Transport) that acknowledges the contribution and synergies of biofuel production.
- Maintain the second pillar compensation scheme within the CAP and use it to fully support and promote the development of 2nd generation biofuels.
- The current policy frameworks, in particular at national and regional level, that govern the conversion of land for bioenergy crop production should be subject to Strategic Environmental Assessment to establish their potential effect on biodiversity.

Whether 1st generation or 2nd generation biofuels have a positive or negative impact on biodiversity depends on many factors, such as the intensiveness of the biofuel production, on how the energy plantations are designed in the landscape, how they are managed and the type of land use prior to conversion. Key issues and recommendations include:

- The conversion of habitats for bioenergy crop production should take into consideration the biodiversity importance of habitats and species; both prior to conversion and also during production.
- The policy integration proposed above should include an integration of the spatial mapping systems used by the key stakeholders, in order that early warning of potential impacts will be available to all decision makers.
- All land conversion for bioenergy crop production of a defined scale and significant impact should be subject to mandatory Environmental Impact Assessment.
- If Europe is to reach its biodiversity target it must be very cautious with 1st generation biofuels and certainly avoid the negative effects associated with the production of 1st generation biofuels, which have high impacts on valuable habitats due to massive habitat conversion and the required intensive agricultural practices.
- The conversion of land with high biodiversity value into bioenergy crop production land should be strictly avoided.
- Policy guidelines need to be developed that ensure the conservation of these areas even outside protected areas or Natura 2000 sites.
- The cultivation of perennial biomass crops should be very much favoured for 2nd generation biofuels as they appear to provide considerably more benefits to biodiversity than most arable crops.

- Converting land to perennial bioenergy crop production can in certain cases change crop rotation systems in favour of biodiversity conservation or enhancement.

Furthermore, biofuel production may have social and economic benefits. It may improve the profitability of farmers, contributing to maintaining farming activities that are conservation oriented. This includes the quality and stability of soils and the avoidance of irreversible landslide damage as well as maintaining high levels of biodiversity. Therefore:

- Producing biomass from nature management activities in certain ecosystems where biodiversity is high or exceptional can have a clear advantage for biodiversity, safeguarding these ecosystems from being taken over by other ecosystems of lesser conservation value.

- In order to further promote the use of the biodiversity-friendly biofuel projects at a wider scale in Europe, we propose the establishment of further case studies, which are also accompanied by biodiversity monitoring schemes that illustrate the benefits in selected biodiversity indicators.

- Policy should be developed to stimulate and promote such studies and to utilize the results in order to further refine the production of 2^{nd} generation biofuels.

Waste products that come from industries related to forestry or agriculture are another promising source for the production of 2^{nd} generation biofuels. Thus:

- Removing biomass from wetlands and other water bodies may enhance the quality of the ecosystems and their related biodiversity. However, extracting forest residues from a site may negatively affect the local soil nutrient balance, and the risk of erosion may increase.

- Removing branches and other waste from forests may also have implications for those organisms that are dependent on them for their survival.

The regional perspective for the production of biofuels is quite varied in Europe. For instance, the introduction of bioenergy crops in intensive agricultural systems, which are predominant in large parts of Western Europe, will most likely not impose additional pressures on the state of nature and biodiversity. On the other hand, the introduction of biomass crops in the Mediterranean region or in Central and Eastern Europe, characterized by low intensity farming systems and the abundance of abandoned agricultural lands, could pose a threat to farmland biodiversity. However, a great potential for expanding the 2^{nd} generation biofuels in wet grassland areas or abandoned lands across Eastern Europe exists. This potential should be fully explored and in particular consider the benefits for biodiversity. It is therefore important to realize that:

- Cultivating bioenergy crops in these areas could be an opportunity to bring abandoned lands into use again, as long as: sustainability principles are applied; intensive farming practices and loss of semi-natural grassland areas are avoided; and the activities are compliant with the overall conservation vision for the region.

- It is clear that a site-by-site approach needs to be taken in relation to the conversion of land to energy crop production. It is not possible to apply a 'one size fits all' approach and it is therefore recommended to make a land inventory which explores the opportunities and necessary restrictions concerning the cultivation of biomass for bioenergy purposes.

- National policy, whilst essential in providing a strategic framework at country level, may not be the best place to provide detailed plans for the location and delivery of more energy crops.

- Regions and sub-regions need to be encouraged to produce their own policies (linked to the national frameworks) in order to provide a more subtle and sensitive approach that takes into account local circumstances and fully integrates biodiversity at an ecosystem and site level.

6 Acknowledgements

We would like to thank the funding organization, Manfred-Hermsen-Stiftung, for its support and EURONATUR for its input to this work. We also thank Dr Pjotr Banaszuk, Dr R. Heikkilä, Dr T.J. Hokkanen, J. Krumnacker and R. van Straaten, who generously and without any request for reimbursement, contributed valuable information to this paper.

7 References

Bader, P., S. Jansson & B.G. Jonsson (1995) Wood-inhabiting fungi and substratum decline in selectively logged boreal spruce forests. *Biological Conservation* 72, 355-362.

Banaszuk, Dr Piotr (2008) Technical University of Bialystok, Bialystok, Poland. Written contact.

BGS – British Geological Survey. http://www.bgs.ac.uk/eqr/Nat_Succession.htm, April 2008.

BirdLife International (2008) Why is BirdLife concerned about biofuels? http://www.birdlife.org/action/campaigns/farming_for_life/Biofuels_EuropeanVoice.html, April 2008.

Börjesson, P. (1999) Environmental effects of energy crop cultivation in Sweden-1: Identification and quantification. *Biomass and Bioenergy* 16, 137-154.

BTG – Biomass Technology Group (2008) Sustainability Criteria & Certification Systems for Biomass Production.
http://ec.europa.eu/energy/res/sectors/doc/bioenergy/sustainability_criteria_and_certification_systems.pdf, August 2008.

Caubel-Forget, V., C. Grimaldi & F. Rouault (2000) Contrasted dynamics of nitrate and chloride in groundwater submitted to the influence of a hedge. *Earth and Planetary Sciences* 332, 107-113.

CEC (2005) *EU Biomass Action plan*. COM(2005) 628 final – Brussels, Commission of the European Communities.

Commission of the European Communities (2004) Communication from the Commission to the Council of the European Parliament: *The share of renewable energy in the EU*. Brussels, 26.5.2004 COM (2004) 366 Final.

Davies, R.J. (1987) Trees and weeds: Weed Control for successful Tree Establishment, in *Forestry Commission Handbook 2*. HMSO, London.

Dembek, W., M. Szewczyk & Z. Oświęcimska (2002) *Ochrona Ekosystemów lądowych*. Plan Ochrony Narwiańskiego Parku Narodowego, manuscript.

EEA (2006) *How much bioenergy can Europe produce without harming the environment?* EEA Technical report No. 7/2006. EEA, Copenhagen.

EEA (2007) *Estimating the environmentally compatible bioenergy potential from agriculture.* EEA Technical report No. 12/2007. EEA, Copenhagen.

Egnell, G. & E. Valinger (2003) Survival, growth, and growth allocation of planted Scots pine trees after different levels of biomass removal in clear-felling. *Forest Ecology and Management* 177, 65-74.

European Commission (2007) *Ambitious target agreed to reduce global warming*. Press release by the European Commission. Available at:
http://ec.europa.eu/news/environment/070309_1_en.htm, April 2008.

European Commission (2007). Cereals: Commission proposes to set at zero the set-aside rate for autumn 2007 and spring 2008 sowings. Press release by the European Commission. Available at:
http://europa.eu/rapid/pressReleasesAction.do?reference=IP/07/1101&format=HTML&aged=0&language=EN&guiLanguage=en, April 2008.

FAO - The Food and Agriculture Organization of the United Nations; http://www.fao.org/AG/agl/agll/soilbiod/soilbtxt.stm, April 2008.

Fargione, J., J. Hill , D. Tilman, S. Polasky & P. Hawthorne (2008) Land Clearing and the Biofuel Carbon Debt. Published online 7 February 2008; *Science* DOI: 10.1126/science.1152747.

FOE – Friends of the Earth (2008) *Agrofuels: Fuelling or Fooling Europe? – The problems of using plant-based oils in power stations and vehicles*.

FOE - Friends of the Earth (2008) Stop the biofuels targets. http://www.foe.co.uk/campaigns/biodiversity/press_for_change/biofuels/index.html, August 2008

Foster, B.L. & K.L. Gross (1998) Species richness in a successional grassland: effects of nitrogen enrichment and plant litter. *Ecology* 79 (8), 2593-2602.

Greenpeace (2008) Biofuels under (belated) scrutiny. http://www.greenpeace.org/international/news/biofuels-not-so-green-150108, August 2008.

Hansson, M. & H. Fogelfors (2000) Management of a semi-natural grassland; results from a 15-year-old experiment in southern Sweden. *Journal of Vegetation Science* 11, 31-38.

Heikkilä, Dr R., April 2008. Leading researcher of the Finnish Environment Institute, Research Programme for Biodiversity. Telephone and written contact.

Hokkanen, Dr T.J., April 2008. North Karelia Regional Environment Centre. Dr Hokkanen is the coordinator of North Karelia Biosphere Reserve.

IUCN (2007) *Climate change briefing – Biofuels, nature and people: implications for environments and livelihoods.* The World Conservation Union.

IUCN-Med (2008) Invasive Alien Species in the Mediterranean. http://iucn.org/places/medoffice/invasive_species/index_en.html, April 2008.

JNCC (2007) *Transport Biofuels and Biodiversity* - Joint Nature Conservation Committee Position Statement. http://www.jncc.gov.uk/pdf/2007_positionstatement_Biofuel_nov07.pdf, April 2008.

Jonsell, M., J. Hansson & L. Wedmo (2007) Diversity of saproxylic beetle species in logging residues in Sweden – Comparisons between tree species and diameters. *Biological Conservation* 138, 89-99.

Jonsson, B.G., N. Kruys & T. Ranius (2005) Ecology of Species Living on Dead Wood – Lessons for Dead Wood Management. *Silva Fennica* 39 (2), 289-309.

Krumnacker, J. April 2008. Stiftung Europäisches Naturerbe / European Nature Heritage Fund (EURONATUR). www.euronatur.org. Telephone and written contact.

Kruys, N. & B.G. Jonsson (1999) Fine woody debris is important for species richness on logs in managed boreal spruce forests of northern Sweden*. Canadian Journal of Forest Research* 29, 1295-1299.

Küffer, N. & B. Senn-Irlet (2005) Influence of forest management on the species richness and composition of wood-inhabiting basidiomycetes in Swiss forests. *Biodiversity and Conservation* 14, 2419-2435.

Louette G., D. Maes, R.M. Alkemade, L. Boitani, B. de Knegt, J. Eggers, A. Falcucci, E. Framstad, W. Hagemeijer , S.M. Hennekens, L. Maiorano, S. Nagy, A. Nieto Serradilla, W.A. Ozinga, J.H.J. Schaminée , V. Tsiaousi , S. van Tol & B. Delbaere (in press) Cost-effective assessment of policy impact on biodiversity using species sensitivity scores.

Makeschin, F. (1994) Effects of energy forestry on soils*. Biomass and Bioenergy* 6, 63-80.

Merot, P. (1999) The influence of hedgerow systems on the hydrology of agricultural catchments in a temperate climate. *Agronomie* 19, 655-669.

Mioduszewski, W. & B. Gajewska (2000) The effect of the Narew River regulation on water level in the lower part of the Biebrza River. In: Mioduszewski, W. & M.J. Wassen (Eds) *Some Aspects of Water Management in the Valley of Biebrza River*. Wyd. IMUZ Falenty, pp. 59–70.

Municipality of Son and Breugel (2007) *Staatsbosbeheer kapt bomen in Sonse Bossen*. News item on the municipality's website, 19-11-2007. http://www.sonenbreugel.nl/index.php?simaction=frameset&mediumid=2&jaar=2007&pagid=39&stukid=13222, April 2008.

Nordén, B., M. Ryberg, F. Götmark & B. Olausson (2004) Relative importance of coarse and fine woody debris for the diversity of wood-inhabiting fungi in temperate broadleaf forests. *Biological Conservation* 117, 1-10.

Pankhurst, C.E., K. Ophel-Keller, B.M. Doube & V.V.S.R. Gupta (1996) Biodiversity of soil microbial communities in agricultural systems. *Biodiversity and Conservation* 5, 197-209.

Paul, H. & A. Ernsting (2007) *Second Generation Biofuels: An Unproven Future Technology with Unknown Risks*.

Peterjohn, W.T. & D.L. Correll (1984) Nutrient dynamics in an agricultural watershed: Observations on the role of a riparian forest. *Ecology* 65 (5), 1466-1475.

Raghu, S., R.C. Anderson, C.C. Daehler, A.S. Davis, R.N. Wiedenmann, D. Simberloff & R.N. Mack (2006) *Adding Biofuels to the Invasive Species Fire?*

Ranney, J.W. & L.K. Mann (1994) Environmental considerations in energy crop production. *Biomass and Bioenergy* 6 (3), 211-228.

Russi, D. (2008) An integrated assessment of a large-scale biodiesel production in Italy: Killing several birds with one stone? *Energy Policy* 36 (3): 1169-1180.

Sage, R., M. Cunningham & N. Boatman (2006) Birds in willow short-rotation coppice compared to other arable crops in central England and a review of bird census data from energy crops in the UK. *Ibis* 148, 184-197.

Sage, R.B. (1998) Short rotation coppice for energy: Towards ecological guidelines. *Biomass and Bioenergy* 15 (1), 39-47.

Scenar 2020 (2007) Scenario study on agriculture and the rural world. European Communities.

Schmer, M.R., K.P. Vogel, R.B. Mitchell & R.K. Perrin (2008) Net energy of cellulosic ethanol from switchgrass. *Proceedings of the National Academy of Sciences* 105(2):464-469.

Semere, T., F.M. Slater (2006) Ground flora, small mammal and bird species diversity in miscanthus (Miscanthus giganteus) and reed canary-grass (Phalaris arundinacea) fields. *Biomass and Bioenergy* 31.

Sharma, S., A. Rangger, M. von Lützow & H. Insam (1998) Functional diversity of soil bacterial communities increases after maize litter amendment. *European Journal of Soil Biology* 34 (2), 53-60.

Sheridan, J.M., R. Lowrance & D.D. Bosch (1999) Management effects on runoff and sediment transport in riparian forest buffers. *American Society of Agricultural Engineers* 42 (1), 55-64.

Siitonen, J. (2001) Forest management, coarse woody debris and saproxylic organisms: Fennoscandian boreal forests as an example. *Ecological Bulletins* 49, 11-42.

Sjödahl Svensson, K., U. Granhall & O. Andrén (1994) *Soil biological aspects on short-rotation forestry*. Swedish National Board of Industrial and Technical Development (NUTEK), Stockholm.

Staaten, R. van, 2007. Employee of Staatsbosbeheer. Telephone conversation.

Tabacchi, E., L. Lambs, H. Guilloy, A. Planty-Tabacchi, E. Muller & H. Décamps (2000) Impacts of riparian vegetation on hydrological processes. *Hydrological Processes* 14, 2959-2976.

Tilman, D., J. Hill & C. Lehman (2006) Carbon-Negative Biofuels from Low-Input High-Diversity Grassland Biomass. *Science* 314, 1598-1600.

Verhoeven, J.T.A., W. Koerselman & A.F.M. Meuleman (1996) Nitrogen- or phosphorus-limited growth in herbaceous, wet vegetation: relations with atmospheric inputs and management regimes. *Tree* 11 (12), 494-497.

WWF (2007) WWF Position on Biofuels in the EU. World Wildlife Fund, European Policy Office, Brussels, Belgium.

ISBN: 978-90-76762-27-2

www.ecnc.org