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Scoping document: European impact on global biodiversity loss

Holger Gerdes, Timo Kaphengst, McKenna Davis

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Authors' affiliation:

Holger Gerdes, Ecologic Institute (DE)
Timo Kaphengst, Ecologic Institute (DE)
McKenna Davis, Ecologic Institute (DE)

EEA project manager:

Frank Wugt Larsen, European Environment Agency (DK)

ETC/BD production support:

Muriel Vincent, Muséum national d'Histoire naturelle (FR)

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European Topic Centre on Biological Diversity
c/o Muséum national d'Histoire naturelle
57 rue Cuvier
75231 Paris cedex, France
Phone: + 33 1 40 79 38 70
E-mail: etc.biodiversity@mnhn.fr
Website: http://bd.eionet.europa.eu/

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1 Introduction

1.1 Main drivers of global biodiversity loss (and the role of the EU)

The UN Convention on Biological Diversity recognizes five major drivers of global biodiversity loss (Secretariat of the Convention on Biological Diversity 2010), namely:

- habitat loss and degradation;
- over-exploitation and unsustainable use;
- climate change;
- excessive nutrient load and other forms of pollution; and
- invasive alien species.

Habitat loss and degradation, exacerbated by projected climate change, currently pose the most significant threats to global biodiversity (Dennis et al. 2013). These threats largely stem from the conversion of land from natural areas to agriculture or built infrastructure and deforestation (Secretariat of the Convention on Biological Diversity 2010). Though land conversion has historically been predominantly driven by local needs for food, fibre and fuel, the role played by international trade and globalization has become a dominant driver in recent decades. Approximately 30% of global species threats today are a result of international trade, driven by ever-growing consumer demand in developed regions such as the EU for products from developing countries (Lenzen et al. 2012). Compounding the significance of this threat is the fact that many of the countries whose economies and exports are dominated by agriculture are also hosts to significant portions of the world's biodiversity (UNEP 2010).

Habitat fragmentation is a further underlying driver of the aforementioned threats. Rapid fragmentation of habitats as a result of human development and landscape changes has negative consequences for genetic and species diversity and threatens individual and species fitness (Habel and Zachos 2012). Additional complexity arises from the common time lag associated with the impacts of habitat fragmentation on biodiversity; species diversity often decays over long periods of time after an initial disturbance, as species which can survive in fragmented habitats in the short term often lack the ability to cope with the associated pressures in the long term (Gonzalez 2013). This aspect combined with global warming means that species have less ability to migrate to suitable habitats as global temperatures and weather patterns change. It is possible to combat fragmentation with appropriate infrastructure design, which guarantees optimal biodiversity protection while taking into account the realities of economic constraints; however, this approach has been implemented insufficiently to date. This is especially a problem in developing countries, where much infrastructure and settlement development is informal, lacking standards and foresight.

Widespread declines in both terrestrial and aquatic biodiversity have also largely been driven by over-exploitation and unsustainable use. Deforestation, overfishing, meat consumption and requirements of feed are particularly relevant examples of humans exploiting natural systems to their tipping points, beyond which recovery is questionable. The harvesting and trade of timber is a major source of environmental degradation in developed and developing countries, particularly regarding illegally harvested tropical timber. Not only is illegal logging connected to biodiversity loss, poor forest management, resource conflicts, and greenhouse gas emissions, but the trading of illegally harvested timber undermines profitability for legitimate producers striving for sustainable production (European Commission 2013a). It is estimated that illegal logging makes up 15-30% of the global timber production (Nellemann 2012). Given that the EU accounts for 37% of global timber trade (European Commission 2013a), its efforts to improve monitoring and enforcement can have a major impact on world timber markets (Giurca et al. 2013). In addition to the direct impacts of forestry, the "embodied deforestation" associated with the EU's consumption is estimated to be over 7 million ha per year –

referring to the deforestation caused directly and indirectly by European demand for goods and services (European Commission 2013b). The EU was responsible for 36% of internationally traded embodied deforestation, the highest share of which is in embodied in international crop trade (European Commission 2013b).

In the same vein, overfishing has been recognized as a further major global challenge. Nearly 30% of fish stocks were overexploited or depleted in 2009, and a further 57% were fully exploited, where catches were at or near maximum sustainable yields (FAO 2012). The EU produces only 38% of its own consumption of fish and the remaining 62% is imported, making the EU the world's largest importer of seafood. Over 25% of catches by EU fishing vessels are taken from outside EU waters, either from countries with which the EU has fishing agreements, or more commonly from international waters (EU Fish Processors and Traders Association 2012). As healthy fish stocks are key to both ecosystem health and global food security, there are concerns that action to stop overfishing is being taken too slowly.

Climate change has been mentioned as a compounding factor to biodiversity loss within the context of habitat fragmentation and ecosystem degradation. More specifically, weather and temperature pattern changes, ice melts, sea level rise, changing biota growth cycles, disease spread, and ocean acidification represent additional threats to the survival of wild species and ecosystems, as well as agricultural biodiversity (Secretariat of the Convention on Biological Diversity 2010). Developing countries will bear the worst of the climate change impacts, although historically developed countries have contributed more of the greenhouse gases (GHG) responsible for global warming. The EU is currently responsible for about 10% of the world's GHG emissions (European Commission 2014a).

The increasing use of nitrogen and phosphorous fertilizers in agriculture presents another challenge to global biodiversity. Nutrient overload from the improper use and storage of mineral and organic fertilizers leads to hypoxia and eutrophication, disrupting aquatic ecosystems. Nutrient overloads create environments favouring generalists, effectively wiping out nutrient-poor conditions to which specialist species are adapted (Secretariat of the Convention on Biological Diversity 2010). They also negatively impact the balance and biodiversity of soil biota (EEA 2009), the specifics of which are still poorly understood. Increasing meat production in the EU and worldwide is a major contributor to nutrient overload as is intensification of agriculture, spurred by economic globalization and development strategies.

Invasive species travel from their original habitats to new locations as a result of migration and trade processes, amongst other causes. Estimates for Europe suggest that one in ten invasive species has a significant ecological impact, and even more have economic impacts; global trends suggest these effects are of a similar nature globally (Secretariat of the Convention on Biological Diversity 2010). The increasing global connectivity of markets indicates that this trend will continue to rise, along with the effects of trade driven by EU demand.

The outlined drivers of biodiversity loss are not isolated threats, but rather compound one another and present complex and multifaceted challenges to halting global biodiversity loss. As a consequence of the EU's standing and role within the global economy, domestic actions have consequences both within Europe and globally.

1.2 EU policies affecting global biodiversity

- **EU Biodiversity Strategy and UN Convention on Biological Diversity**

The EU is party to the UN Convention on Biological Diversity (CBD) and has agreed to implement the Aichi biodiversity targets by 2020. These include halving and - where possible - halting the rate of habitat loss by 2020 and conserving 17% of terrestrial and inland water areas and 10% of marine and coastal areas through area-based conservation measures (European Commission 2014c). The EU and all of its Member States are mandated to implement these targets.

The EU Biodiversity Strategy to 2020 establishes the framework for the EU's action on biodiversity. It consists of six mutually supporting targets addressing key drivers of biodiversity loss in the EU and contributing to international biodiversity conservation. The actions in the strategy fulfil existing commitments and, recognizing the EU's power as the world's largest trading bloc, aim to reduce the impact of the EU's consumption on international biodiversity and assist developing countries in conserving and sustainably using biodiversity. The Fifth National Report of the European Commission to the Convention on Biological Diversity describes the common implementation framework involving the European Commission, Member States, and key stakeholders and civil society. It establishes a governance framework, involves stakeholders in implementation at all levels, ensures the involvement of stakeholders beyond "traditional" biodiversity stakeholders, and streamlines workflows (European Commission 2014d).

Although these policies represent important steps towards halting biodiversity loss, the Aichi and EU Biodiversity Strategy targets have yet to be effectively integrated into targeted policy areas, such as agriculture and trade policy.

- **Fisheries and marine policy**

The goal of the Common Fisheries Policy (CFP), the EU's key fisheries policy, is to ensure that EU fisheries and aquaculture are environmentally, economically and socially sustainable and protect EU food security. In the 2013 reform of the CFP, the EU recognized that previous reforms had not led to a sustainable fishing fleet and that substantial sums of public money were flowing to fishery investments that did not help meet stated CFP goals (European Commission 2011). The 2013 reform implemented some positive reforms for protecting fish stock and marine ecosystems (Naver 2014) and overall subsidies for the fishery sector are expected to decrease, but it still retains unsustainable provisions that support an oversized capacity. This affects overfishing within and beyond European waters.

The EU's Integrated Maritime Policy (IMP) attempts to bring all sectors of marine management together under one policy umbrella. It covers blue growth, marine data and knowledge, maritime spatial planning, integrated maritime surveillance, and sea basin strategies. Although the policy has made strides in some areas of national and international marine protection and sustainable use, there are significant variations in national implementation of IMP policies and their effectiveness at promoting sustainable marine management (European Commission 2012a).

- **Common Agriculture Policy**

The EU Common Agricultural Policy (CAP) is the central policy related to land use in Europe. Of all the policies affecting biodiversity and ecosystems within Europe, the CAP is the most influential, since it determines where the bulk of EU funding for biodiversity action and land use and determines the structure of land use. The current CAP fails to effectively protect biodiversity within the EU, supporting instead the trend towards consolidation and unsustainable land use with extremely weak ecological requirements (Pe'er et al. 2014). It also has a significant effect on biodiversity outside Europe's borders. CAP reforms over the last 25 years have exerted increasing pressure on agriculture to become more integrated into global markets. Cheap agricultural exports from the EU to developing countries price local suppliers out of production, leading to the abandonment of farms and pastures and consequently the loss of local agricultural biodiversity and degradation of agricultural ecosystems.

CAP support for increasing production of animal products in the EU is also an important driver of indirect land use change. It is estimated that crop production for feed accounts for 11% of global embodied deforestation related to agriculture (European Commission 2013b).

- **Trade**

Policies governing trade in agricultural products are major drivers of changes in land use and agricultural practices affecting biodiversity (UNEP 2010). Land use change in EU trade partner countries is driven by trade liberalization through policies and processes such as bilateral and multilateral trade and investment as well as World Trade Organization (WTO) agreements.

There are possibilities for improvement in trade policy. The EU Timber Regulation (EUTR) and its 2013 reform, for example, represent a step forward. Evidence suggests the EUTR, together with other international sustainable forestry policy measures, supports improvements in legality verification and certification uptake in tropical wood producing countries (Giurca et al. 2013), which reduces the threat of unsustainable forest use and deforestation to biodiversity.

EU Member States are also required to implement the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), a multilateral treaty preventing trade in live wildlife and wildlife products whose populations are threatened.

- **EU energy policy**

EU energy policy's largest effect on biodiversity stems from its biofuel policy. EU biofuel requirements and support schemes, part of the Climate and Energy Package, have spurred land conversion across the globe. Although the sustainability criteria adopted under the Renewable Energy Directive and the Fuel Quality Directive attempt to hinder the use of biofuels from land where degrading land use changes took place for their cultivation, these measures have had a limited impact. While they prevent direct land conversion, they do not limit the total demand for agricultural commodities worldwide, which the biofuel requirements drive upwards (European Commission 2012b). This has been connected to land use change across the globe, as non-biofuel agriculture is displaced onto previously natural land by a switch to biofuel production on established agricultural land (European Commission 2013b). This has negative consequences for ecosystems and biodiversity.

- **Other relevant policy actions**

The Roadmap to a Resource Efficient Europe establishes a European strategy for economy-wide increases in resource efficiency. Unsustainable and inefficient harvesting, use, and disposal of many natural resources driven by EU consumption threatens habitats worldwide. Many of the resources the EU consumes are imported, and their production has impacts all along global supply chains. Resources particularly relevant to biodiversity include food, timber, metals, plastics, chemicals, fossil fuels, and textiles. The Roadmap outlines strategies and measures to increase resource productivity and decouple economic growth from resource use and its environmental impact, but is currently only in an early phase.

The European Water Framework Directive (WFD) governs the management of water resources throughout Europe. The WFD, flanked by other measures including the Nitrates Directive, has managed to improve the quality of many aquatic ecosystems and water resources across Europe and represents progress against biodiversity threats such as nutrient pollution (Secretariat of the Convention on Biological Diversity 2010). As the WFD also regulates transboundary waters, the WFD impacts aquatic ecosystems both in the EU and in neighbouring countries.

1.3 Scope of the document

This scoping document provides an overview of the state of knowledge with regard to EU impacts on global biodiversity, focussing on six selected commodities. In this context, the regions and ecosystems which are most affected by relevant consumption and production patterns and existing knowledge gaps are identified (Chapter 2). Relevant EEA and international activities are reviewed, which can potentially contribute to an assessment of the European impacts on global biodiversity. These include accounting frameworks, indicators and modelling approaches. Existing knowledge and data gaps regarding global biodiversity indicators and related activities are identified (Chapter 3). Based on these findings, the scoping document concludes by outlining the role which the EEA and the European Topic Centres could play in a) filling the identified knowledge gaps, and b) carrying out a comprehensive assessment of the European impacts on global biodiversity. Specific recommendations are drafted for ETC/BD activities to be achieved in 2015 and beyond (Chapter 4).

2 EU impacts on global biodiversity

The production and consumption habits of EU citizens have important implications for biodiversity in other parts of the world, but often go unmeasured and realized since the impact takes place in a location different than that of production and/or consumption. In this section, the causal links between the production and consumption of six selected commodities and their associated impact on global biodiversity will be analysed. These commodities are cotton, timber, soy, beef, fish and gold; and were chosen based on their proven significance in terms of their detrimental impact on biodiversity. The chapter is based on the results of a service contract (Arcadis, in press), which has been commissioned by the European Commission’s DG Environment.

The production and consumption habits of the EU vary by Member State and culture, but it is possible to make some general statements about the EU market as a whole. The first, distinctive aspect about EU production and consumption habits is the fact that very little raw commodities are imported. Instead, semi finished, finished or products in their “embodied” form are imported. For example, rather than importing raw cotton, the EU imports large amounts of cotton in the form of clothing, a finished product. Arcadis (in press) differentiate and include commodities not only in their raw form but in their final form and use as various products. It is important to note that the biodiversity impacts of the production and consumption of a specific commodity will vary significantly depending on the source country and the techniques used to procure it. It is even possible that the same commodity has very different biodiversity impacts depending on where it is produced.

The availability of information and transparency of supply chains in specific commodities and countries affects the analysis of associated biodiversity impacts. Some commodities and/or sectors are more transparent than others, thus while the biodiversity impacts may be direct and evident in the supply chains of some commodities, they may be difficult to prove or distinguish in others. For example, tracing gold to its source is very difficult since the metal can be recycled several times and while the geographic location is decipherable the specific mine is not (Arcadis, in press). On the other hand, soy is more easily traced back to its source.

This section was informed by the Arcadis study, currently in the course of publication. The Arcadis study worked with the Commission to identify several commodities for which the consumption and production patterns of EU Member States had a known and significant impact on biodiversity. The selected commodities are not comprehensive in their coverage; however, they do illustrate the connectivity of production and consumption markets of the EU and the world, and the associated impacts on biodiversity.

2.1 Cotton

- **Usage**

Cotton is an agricultural commodity crop that exists either as cotton lint which is most commonly used in clothing, for textiles, yarn and fabric, and cotton seed which is used as an animal foodstuff.

For the purpose of this scoping document, the focus will be on cotton lint since that is the type most relevant for production and consumption in Europe.

- **Production and consumption patterns**

The EU is a minor producer of raw cotton accounting for less than 300,000t which represents 1% of global cotton production. European cotton production has fallen 50% since 2006 after support subsidies and market barriers were removed under the reform of the CAP (Bettini et al. 2012). The major European producers of cotton are Greece and Spain which account for 85% (230,000t) and 15% (40,000t) of European raw cotton production (European Commission 2014b). In terms of manufacturing cotton products (e.g. textiles and clothing), the most significant European players are Italy, Germany, France, Spain and the UK; however, imports of raw cotton for European clothing manufacturing industries have decreased in the last decade as low-cost producers in China and East Asia dominate the market (European Commission 2014b)

The EU is not a significant world importer of raw cotton, accounting for just 3-4% of global imports, however, it is responsible for 15% of the consumption of finished cotton products. Finished clothing and textile products make up 75% of the EU's cotton imports. Thus, the ratio of cotton production compared to consumption is dramatic: 300,000t is produced while 3.5 to 4 million tonnes of raw material equivalent are consumed in intermediate or finished clothing and textiles. Another important factor is that within the EU the recycling and reuse of textiles is poor, with approximately 5.8 million tonnes thrown away each year in a landfill or incineration compound (Friends of the Earth 2013).

Synthetic clothing is competing with cotton in many parts of the world, particularly in developing countries as a less expensive alternative to cotton fibres. The demand for synthetic fibres and textiles in developing countries is increasing while the demand for cotton has declined. In Europe, however, the consumption of cotton has remained consistent as a quality good which could be attributed to social and cultural preferences in the EU of cotton over synthetic fibers. While over 43% of the clothing bought in the EU is cotton-based, cotton only accounts for 26% of clothing sold in developing countries (Arcadis, in press).

- **Biodiversity impacts**

Farming cotton has direct impacts on biodiversity. As an agricultural commodity crop it is particularly water intensive. Over the long-term artificial irrigation can cause soil erosion and high levels of salinity. Excessive irrigation over the long term causes significant water shortages as the groundwater sinks and rivers, lakes, wetlands dry out, as happened with Lake Aral in Central Asia. Cotton is also prone to industrial monoculture production which corresponds to large inputs of pesticides. Cotton accounts for 11% of all pesticides used annually world-wide, a disproportionate figure as it covers just 2.4% of the world's arable land (Arcadis, in press). As cotton absorbs important water sources, it can compete with existing species for resource use, and irrigation systems can disrupt the natural hydrological balance of an ecosystem. The runoff from the excessive use of pesticide and fertilizer inputs also pollutes waterways and over time can erode soils, which has repercussions for flora and fauna. Perhaps the most direct impact on biodiversity is the clearing of land for cotton production, which can involve the draining of marshland or clearing of forest to make way for farming land.

Interestingly, the demand of cotton in the last decades has not coincided with a proportional increase in land-use which is attributed by some authors to technological innovations with GMO crops that provide for more improved productivity. However, the use of GMO crops in turn poses new threats to biodiversity, particularly agricultural biodiversity as different varieties are replaced with a single monoculture.

Cotton production is, however, extremely heterogeneous depending on the country and specific region where production is taking place. Thus the impact on biodiversity varies depending on local particularities. For example, in regions where GMOs are used, producers may be able to achieve increased yield without increasing land coverage but the agricultural diversity is limited to a single crop type.

- **Most affected regions**

It is difficult to determine the source country of finished cotton goods. Cotton cultivation in biodiverse regions with fragile ecosystems clearly has the most detrimental impact, for which Madagascar is known. Since cotton production is so widespread, the impact on ecosystems includes wetlands that experience changes in water quantity and quality and tropical forests that are cleared for monoculture cotton production.

2.2 Timber

- **Usage**

Wood is a versatile material that is used in a variety of functional products. Wood and wood-based fibres are used in products (e.g. furniture, paper, construction materials, books, kitchen accessories, hygienic paper, paper etc); in packaging of products (e.g. beverage cartons, transport packaging (e.g. cardboard boxes); and in communication materials (e.g. brochures, catalogues, posters). Logging is the source of all timber.

- **Production and consumption patterns**

Before the economic crisis, Europe was the single largest importer of timber products, accounting for 22% of global trade. In 2011, the EU declined to become the second biggest importer of timber products, representing 17% after China, which accounted for 19% (ETTF 2011). Domestic production of wood products has faired better than the importing sector. By volume, it increased the market share from 72 to 77% between 2007 and 2011. In 2011, total European consumption of wood comprised 176 million m^3 domestic and 53 m^3 of imported harvest saw and veneer logs (ETTF 2011). In part, taxes on Russian exports drove Finnish and Swedish to produce more for the domestic market.

While the import of primary wood products (e.g. logs and veneers) has been on the decline, the import of composite wood products (e.g. pulp) has increased. The import of primary wood products commonly used by the construction sector were affected more directly by the economic crisis, thus imports decreased; however, this was offset by an increase in imports of processed timber products in paper (Oliver 2013). In observing the EU's trade with specific countries such as Brazil, these trends are also visible. The EU has decreased its trade with Brazil of primary wood products, but has increased its imports of wood pulp which are mainly sourced from plantations in southern Brazil rather than in Amazonia. The driving factor behind the increased trade in chemical hardwood pulp is the increasing use of recycled fibres for paper manufacturing in Europe.

- **Biodiversity impacts**

The EU's effort to improve monitoring and enforcement have had a major impact on the Union's import of tropical timber (Giurca et al. 2013). In addition to the direct impacts of forestry, the "embodied deforestation" associated with the EU's consumption is estimated to be over 7 million ha per year – referring to the deforestation caused directly and indirectly by European demand for goods and services (European Commission 2013b).

European forests are strictly managed and the accruing impacts on biodiversity are low, mainly because land is already under timber harvest production and because biodiversity levels are less significant than in tropical countries. The main threat posed to biodiversity by logging occurs when timber is sourced from regions where timber legislation and enforcement is low and biodiversity is significant. Illegal logging can be defined as the harvesting of timber in contravention of the laws and regulations of the country of harvest. Illegal timber and timber products are estimated in a 2014 UNEP-Interpol report to constitute 30% of global timber trade, and 50-90% of the volume of all timber production in key tropical countries, mainly in the Amazon Basin, Central Africa and Southeast Asia (Nellemann et al. 2014). While the EU has a range of policy instruments in force to monitor and prevent the illegal trade of timber, it remains a major problem undermining sustainable forestry and having rapid and devastating impacts on biodiversity in regions that are especially important to ecological biodiversity. There are, however, a variety of legislative instruments in place at the EU and international level to monitor and prevent the illegal harvest and trade of timber. The main instrument is the 2003 Forest Law Enforcement, Governance and Trade Action Plan (FLEGT Action Plan) that introduced steps against illegal harvesting and trade. Buttressing this are Voluntary Partnership Agreements, which are bilateral agreements between the EU and timber exporting countries. As of 2013, the EU has signed VPAs with Ghana, Cameroon, Republic of Congo, Liberia, the Central African Republic and Indonesia with nine additional VAPs currently under negotiation (European Commission 2013b). After all, the EU's import of tropical timber has decreased dramatically as a result of changing attitudes about tropical timber, VPAs and economic recession.

- **Most affected regions**

Illegal logging in tropical forests in Asia, Africa and Latin America has the most severe impact on biodiversity.

2.3 Soy

- **Usage**

Soy comes in three forms: soybeans, soymeal and soy oil. Soy and soy-based products are used for human consumption as well as animal consumption. Soybeans are used in human consumption, soy meal is generally used for animal consumption and soy oil can be used for both human consumption and biodiesel for energy.

- **Production and consumption patterns**

The bulk of EU soya consumption is in soybean meal which is used as a feed for animals, particularly for the EU's growing swine and chicken production. Soybean meal accounts for 60% of animal feedstuffs with 41% of soybean meal directed towards swine feed and 32% directed towards industrial chicken production (broilers), 10% to laying hens and 13% to cattle (Arcadis, in press). The EU is the largest soymeal importer although this has declined in the last decade by about 30% (Arcadis, in press). With the onset of the economic crisis Europeans increased their consumption of pig and chicken which are cheaper than other types of meat. For soybean oil, two thirds is used for consumption and the remaining third is used for biodiesel, some of which is re exported outside the EU (Arcadis, in press).

The EU production of soy is minimal accounting for just 3% of total soy production and is generally directed towards the non-GMO food market (Arcadis, in press).

- **Biodiversity impacts**

Between 2000 and 2010, 10 million hectares of land was converted for soy production in Brazil, an area approximately equal to the size of South Korea. 8 million hectares were added in Argentina during the same time period, of which approximately half is newly deforested. Land use change and the insatiable demand for increased global production of soy, coupled with new varieties that have led soy to be planted in areas previously inhabitable to agriculture, have had enormous impacts on biodiversity loss. The EU's main importing partners are in South America: Brazil produces some 30% of the world's soya harvest and is the main trading partner of the EU, Argentina provides some 20% (KPMG 2013). The growth in recent years of the soy sector in Brazil and Argentina and South America more generally has come at the expense of tropical forest and savannah which has been transformed into areas for agricultural production. There is no question that global demands for soy are pushing cultivation which is one of the major drivers behind deforestation, the degradation of ecosystems and biodiversity loss. The encroachment of monoculture soya crops leads to a near complete reduction in forest species in those fields. Moreover, 100% of soybean production in Argentina is GMO (Kaphengst and Smith, 2013). This means that agricultural biodiversity is non-existent and the widescale introduction of GMO crops poses potential threats to biodiversity more generally. Some known examples of the impact of soy farming on biodiversity are the Atlantic forest in Southern Brazil which has essentially been cleared for soya production. The Cerrado, a once pristine grassland has of nearly 200 million hectares, has been cleared for cattle grazing pasture and agricultural production.

A significant amount of soya cultivation in South America is large-scale industrial monoculture farming which relies on large inputs of fertilizer and pesticide which in turn can cause eutrophication and pollution of groundwater which negatively effects biodiversity. Soy is a water intense crop and its increased cultivation could affect long term water supply which could threaten biodiversity with longer dry seasons and water security issues between users. Finally, the infrastructure of roads and storage facilities that has been built to manage increasing levels of soya production leads to habitat fragmentation and increased accessibility by humans and company into what was once densely forested or difficult to access land.

- **Most affected regions**

Soybean imports tend to come from Brazil (50%), Paraguay (17%), and the US and Canada (22%). The import of soybean meal for livestock is mostly from Brazil and Argentina but also India which is an important supplier of non-GMO soy. Some of the imports of raw soybeans are processed to make oil and re-exported, mostly to North African countries (Algeria and Morocco) and Brazil. Tropical forests and savannah in South America are severely affected regions as a result of land use and cover change, with specific impacts in Brazil and Argentina.

2.4 Beef

- **Usage:**

The consumption of meat and beef in particular is relatively stable in Europe but on the rise globally. Beef consumption is serendipitous with economic growth, therefore, on a global scale the most significant and substantial increases in beef consumption are occurring in countries experiencing rapid economic growth. Meat and beef consumption rise alongside increased incomes and changing socio cultural preferences as increasing incomes drive socio-economic and cultural changes.

An important consideration when evaluating beef production and consumption is the tendency for most countries to consume what they produce. Beef is highly perishable and the need to refrigerate it and keep it fresh means that transport and storage over long periods of time is not possible (Arcadis, in press).

- **Production and consumption patterns**

Within Europe beef consumption has increased in a stable and predictable way and has even slowed down in recent years due to cultural and health preferences. Generally speaking, meat consumption has increased substantially in the last half century, with increases in beef consumption as well. However, in the last decades the amount of per capita chicken consumption in proportion to beef consumption has increased (Kanerva 2013). This could be due to cultural and health preferences as well as financial ones.

At a national level or regional level, most countries produce beef for their own domestic consumption needs. In the EU, 95% of beef is produced domestically with France, Italy and Germany being the main producer countries (Arcadis, in press). Total EU beef consumption is about 7.850 million tonnes, 7.5 million tonnes is domestically produced and 350,000 tonnes is imported. The EU mainly imports from Brazil, but also Argentina, Uruguay, Australia and the US (Arcadis, in press). The main driver of domestic production relates to the fact that beef is not an easy product to transport because it is perishable and requires refrigeration. It is therefore not uncommon that most countries produce to meet their own consumption needs. In Europe, imports from abroad are heavily restricted, in part because of the outbreak in 2005 of food and mouth disease which came from imported beef from Brazil. As a result, strict regulations were put in place that limit European imports of beef and also that support domestic production.

- **Biodiversity impacts**

At a global level, the FAO estimates that two thirds of agricultural land and one third of total land surface is currently used in animal production, either directly as pasture and grazing land or indirectly as crops that are cultivated and harvested for the purpose of feeding livestock (Kanerva 2013). Thus, while the specific biodiversity impacts of rearing livestock are very much dependent on the type of farming (industrial versus small scale) and the geographic location (Europe versus converted rainforest in Brazil), the overall impacts of consuming meat are indirectly and directly drivers of deforestation, land use change, and intense resource use which all invariably impact biodiversity. Westhoek et al. (2011) estimate that 30% of human induced biodiversity loss is related to the production of livestock.

The efficiency gains of beef production are also important in terms of measuring ecosystem impact. Beef production has a low efficiency level meaning that the consumption of fodder over the course of a cows lifetime is not efficient compared to the amount of beef the animal produces. The EU imports four fifths of the fodder or protein rich feed for its domestic beef production. This means that the EU indirectly influences problems associated with meat production that include high energy consumption or inputs and the problem of land conversion for crop production. Thus EU domestic production of beef remains relevant for biodiversity loss in other parts of the world because domestic production is highly dependent on grain inputs from abroad to feed domestically produced cattle, thus, the connection of soya production is one example of indirect biodiversity impacts. It is then necessary to consider the influence of European demands for soya as a fodder for domestic cattle reduction and the impact this has on the conversion of land for agricultural production. Since the EU depends on imports from Brazil of soya to feed its domestically produced cattle, the simultaneous conversion of tropical forests and savannah land for soya production must be evaluated.

A second impact is related to the reduction of agricultural biodiversity with biodiversity loss taking place on the farm itself. In Europe and countries with industrialized systems of agriculture, only few select breeds are chosen for production and consumption. Breeds are chosen based on their ability how much meat they bring to market, how fast they mature, how well they withstand commercial production and other characteristics based on commercial and consumer preferences

- **Most affected regions**

Given that the vast majority of beef is produced domestically the significant affected region could be European farms themselves as a form of reduced agricultural biodiversity. In relation to affected regions from beef imports, Brazil is an affected region.

2.5 Fish

- **Usage**

Fish and fish products are predominantly harvested and produced for human consumption. Fish foodstuffs take a variety of forms, ranging from fresh caught to powdered and processed, representing a variety of levels of production. Fish is also harvested for other less known usages and can be used in pharmaceutical items, for ornamental purposes, as exotic pets, as bait for fish sport activity, as animal feedstuff and even can be used as a fertilizer in agriculture. Despite its wide variety of usages, in the EU fish predominantly is consumed as a food source.

- **Production and consumption patterns**

Europeans are major consumers of fish and the EU is the largest importer of seafood products which compliment domestic production. A variety of cultural and societal diet preferences are driving the demand for fish products. In the last decades, changes in diet and emerging demands for luxury seafood products have transformed the way the world and Europe consumes fish and fish products. Demand for shrimps and prawns and other value-added products (e.g. sushi) has increased substantially in the last decades. Fish that is processed or already in a certain state of preparation, such as fish filets and nuggets, are also popular for their convenience. Exotic species such as tilapia, Nile Perch or Chilean Sea bass are in high demand as luxury food items. Finally, health conscious consumers seeking high protein and low fat options are driving increasing preference for fish and fish products.

Due to declining fish stocks in European waters and increasing financial and technological capacity to fish farther out, the EU's reliance on imports has increased while its domestic production has fallen. As of 2011, domestic EU production accounted for just 3.4% of the world total, a figure declining since 2005 (4.5%) (EUMOFA 2014). In relation to aquaculture production, the EU produces approximately 1.24 million tonnes which is 1.5% of the global total. Currently, the EU is the largest importer of seafood products and 62% of its own fish consumption is imported (EUMOFA 2014). In 2011, the EU imported 12.3 million tonnes of seafood products, amounting to EUR 52.2 billion in product value (CTA AgriTrade 2014). In 2011, each EU citizen consumed on average 24.5 kg of fish making a combined total of approximately 12.3 million tonnes annually which is relatively consistent and slightly less than previous years. Of the 24.5 kg per citizen, 18.7 kg of the fish consumed were from fishing activities while 5.8 kg were from aquaculture (EUMOFA 2014).

Seafood consumption varies significantly between Member States in terms of quantity and in type of fish consumed, with for instance, Northern Member States consuming more processed fish while Southern Member States consume live fish, with Central and Eastern European Member States generally consuming less fish. Portugal is the biggest per capita fish consumer in the EU, but other countries like France, Germany, Spain or the Netherlands also increased their consumption by between 50 and 100% between 1961 and 2005 (Balata and Devlin 2014).

- **Biodiversity impacts**

The EU procures fish through its own fishing fleets and from imports. While the majority of fish is imported, the EU fishing fleet is one of the largest and highly industrialized. Thus, while European 'production' of fish is only 3.4% of the world's total production, the destructive and industrial nature of European fishing fleets makes its environmental impact extreme. Overfishing is the first and most direct cause of biodiversity loss. In Europe, 63% of the assessed fish stocks in the Atlantic and 82% in the Mediterranean are overfished (Schroeer et al. 2011).

As a result of overfished domestic waters, the EU fishing fleet has increasingly travelled farther afield. Fish is increasingly caught abroad by the EU's distant-water fleet, which operates in other countries' exclusive economic zones, under fisheries agreements and international waters, yet their catch is classified as EU produce (Balata and Devlin 2014). About a quarter of the EU's domestically produced fish are caught in waters outside of the EU. Some 8% of the EU's domestic catch are made via agreements with developing countries, so called Fishery Partnership Agreements, (e.g. Africa) and 20% are procured on the high seas (EUMOFA 2014).

Fishing in foreign waters has the dual impact of rapidly fishing out marine waters that have some of the oceans remaining biodiversity as well as competing with local small scale artisanal fishing industries that are generally more sustainable. With EU fleets fishing in third countries' waters, they are transferring the environmental impacts and problems that occur within EU waters to these countries. Most of the Fishery Partnership Agreements are concluded with developing countries[1] which often do not have the capacity to monitor the impact on biodiversity, and depend on the funding that comes with these agreements.

Of particular issue is the EU's heavy subsidies of the fishing industry, which create conditions where overfishing takes place despite the fact that is it economically unviable and ecologically unsound. Schroeer et al. (2011) state that fishing subsidies create incentives to fish more, even when stocks are declining, leading to overfishing and fleet overcapacity. These excessive fishing activities damage the marine environment through greater catch of non-target and protected species. The authors estimate that about two thirds of the EU subsidies are promoting overfishing by being either ambiguous or capacity enhancing. The level of subsidies received varies by Member State. The UK, Portugal and the Netherlands have low per capita subsidies while Austria, Hungary Luxembourg, Slovakia and Switzerland have no subsidies for wild caught fish, however, they also lack any marine fleet. Spain and Greece have the highest levels of fish subsidies that are considered harmful for fish stocks, and while Norway has high subsidies in place they have been re-worked so as address issues of biodiversity and fish stocks.

Apart from the impacts of fishing marine waters, also aquaculture has an impact on biodiversity. Aquaculture production in the EU increases as wild catches decline, however, it has to be noted that aquaculture with carnivorous species has a dual role of both producer and consumer of fish, as they are dependent on fresh fish or fish meal produced from wild fish catches to feed the farm species. So aquaculture with those species, instead of releasing the pressure on wild fish, could even increase this pressure. Other detrimental environmental impacts of aquaculture include the introduction of alien species, impacts from genetically modified and escaped fish, habitat modification and pollution and antibiotics use (Balata and Devlin 2014). Shrimp farming has been closely linked with reduction in mangrove swamps across the tropics. According to the Network of Aquaculture Centres in Asia-Pacific (NACA) 20-50% of all mangrove deforestation is due to shrimp farming, which negatively impacts critical habitats for many aquatic and terrestrial species.

In addition to its own fishing activities, the sheer amount of fish consumed in the EU annually indicates that the impact of consumption habits on biodiversity is great.

- **Most affected regions**

For wild caught fish it is difficult to pinpoint a specific region given that biodiversity levels in the world's oceans are all severely impacted by modern industrial fishing practices. Many fish are also

[1] The EU has currently fisheries agreements with Cape Verde, Comoros, Côte d'Ivoire, Gabon, Greenland, Kiribati, Madagascar, Mauritania, Mauritius, Mozambique, São Tomé and Principe and Seychelles (http://ec.europa.eu/fisheries/cfp/international/agreements/index_en.htm)

migratory complicating the identification of a specific affected region. Aquaculture also has impacts on biodiversity with production highly concentrated in Asia.

2.6 Gold

- **Usage**

Gold can be used to make objects such as jewellery or it can be used as a part or component of products, such as technological or medical/dentistry items. Gold is also a chemical element that holds value in exchange on the international stock market and can be bought and traded.

For finished products, the majority of total over-ground stocks of gold are used in jewellery (84,600t) and technology/medical uses (21,200t). Gold held for investment purposes makes up the difference and is held by both public and private investors around the world. The US government has 8,000 t and European Union has 10,000t (Arcadis, in press).

Gold is easily re-used, smelted down and recycled for new purpose and for this reason it can be sourced either from mines (original source) or through recovery. Because of its high value, very little is wasted and the overall amount of gold on the market is in a state of steady accumulation. The amount of gold on the market is 21 times the amount currently being mined. In other words, annual gold production from mines is 2,600 tonnes per year and the recycling of gold scrap is about 2,000 tonnes per year, representing a small fraction of the total amount of available gold on the market which is some 175,000 tonnes (Thomson Reuters GFMS 2013).

- **Production and consumption patterns**

In Europe, there has been a downward trend in the production and consumption of fabricated gold jewellery, but its industrial uses in electronics and dentistry products has stayed consistent.[2] Within Europe and the world, there is an increasing trend in investment of gold.

The value of gold increased significantly between 2000 and 2012, increasing eight fold. Since 2012, its value on the international commodities exchanges has decreased significantly, therefore, there is fluctuation in its value as a traded commodity. Europe is a net exporter of gold ore, but sources mostly from recycled gold or exported investment, whereas other net exporters such as South America and Sub-Saharan Africa typically source from mines. Within the EU, Italy emerged as the second largest source of gold scrap with the UK as third, recycling approximate 69 tons.

- **Biodiversity impacts**

The EU’s production and consumption of gold is complicated by the fact that it sources and is a major player in recycled gold and not mined gold. European production and consumption of mined gold accounts for less than 1% of world mined production. It is extremely difficult to estimate figures for recycled gold; however, Italy and the UK are ranked second and third in the world for gold scrap production.

Some general statements can however be made as gold can have both direct and indirect impacts on biodiversity. The creation of gold mines in itself impacts local biodiversity as facilities are

[2] Production in gold products (jewelry and technology) is more concentrated in India and China where fast growing middle class populations that have driven consumer demand.

constructed and infrastructure is built to transport gold out of a mine. The clearing of land and establishment of roads fragments habitats and accelerates accessibility by humans leading to further man made development and land clearing. There are also indirect pollution related impacts of gold mining as chemicals are used to separate gold. The use of and improper disposal of extremely toxic substances is a major threat to waterways, biodiversity and human health. Toxic mine waste contains as many as three dozen dangerous chemicals including: arsenic, lead, mercury, petroleum byproducts, acids, and cyanide. Improper management or dumping by mining companies of toxic waste into rivers, lakes streams and oceans contaminate water and have cataclysmic impacts on plant and animal biodiversity and human health impacts.

In addition unreported and unregulated artisanal mining is a major source of pollution, particularly in relation to mercury poisoning. Artisanal gold mining refers to mining activities that use rudimentary methods to extract and process minerals and metals and is undertaken by individuals and communities rather than companies. Artisanal mining is most prevalent in developing countries and results from lax or absent government oversight and poverty. The informal nature of artisanal mining lends itself to improper use and disposal of toxic chemicals and the use of mercury by artisanal minors to separate gold is not only a deadly threat to biodiversity, it is also one to human health. UNEP estimates that some 800 tonnes of mercury from artisanal gold mines is released each year into waterways and on land (UNEP 2013).

Tracing gold and recycled gold specifically to its source is difficult. The geographic origin can be determined but often the specific mine cannot. The techniques used in the mine are often the main determinants of its environmental impact. Some 20 gold mining companies control 65% of the market; however, the remaining 35% is from small scale informal minors (Arcadis, in press). For this reason, statistics are often incomplete or not reliable. The environmental impacts of artisanal mining are also of significant concern and two areas affected are the Congo Basin and the Amazon Basin.

2.7 Summary and knowledge gaps

There is agreement that agriculture, fisheries, forestry, mining and energy have significant impacts on biodiversity and from this sectoral approach a few tradable commodities were selected for the purpose of this scoping paper. The selection is not intended to be comprehensive but instead provide a basis that can be applied to other commodities when identifying drivers of biodiversity loss. A noted shortcoming of such an approach is the fact that any selection process of which commodities to include narrows the scope significantly so as to provide an incomplete picture of factors driving biodiversity loss.[3] Moreover the volume of trade is not necessarily synonymous with the associated extent of biodiversity loss, in other words, there might be situations whereby a country accounting for a small volume of trade might have a disproportionate amount of biodiversity loss by virtue of the fact that the cultivation of the commodity takes place in a particularly biodiverse or vulnerable region. Thus, the selection of just six commodities is one notable gap in knowledge while measuring selected sectors by volume is another. Finally, choosing commodities as the start-point could affect the research outcomes, as another approach would be to select sectors (also to account for possible substitution effects among traded commodities). For example, tourism would be a sector that has significant impacts on biodiversity loss, but is not a tradable commodity and therefore not dealt with here.

[3] Other important commodities not considered in this case study are: Important commodities are bananas, coffee, sugarcane, crude petroleum, iron ores and concentrates and palm oil.

Data for tradable commodities are easily available using databases such as FAOSTAT that measure legal trade between importing and exporting countries. These trade databases give an indication of overall trade volumes of legal commodities or derivatives thereof, however, they are imprecise in determining the associated biodiversity loss. Inversely, a database like the IUCN Red List database provides precise information on species decline and biodiversity loss, but does not connect this information to the associated drivers e.g. consumption patterns. Therefore, the databases currently available are often limited in the information they provide, either strictly environmental or strictly economic. It is important to keep in mind that such data may provide part of the picture, but the disconnect between data on economic activities on the one hand and biodiversity on the other, make it difficult to draw clear conclusions on drivers and impacts. There is also a lack of environmental statistics, particularly in relation to biodiversity and ecosystems.

The identification of the origin or source country has a significant influence on the level of biodiversity loss while the identification of the importing country might provide opportunities to understand trends in consumer behaviour that in turn drive economic activity and trade. It is not uncommon that source countries are characterised by both high levels of land use-change and rich biodiversity habitats. For example, Brazil is a major source country for several tradable commodities: timber, soybean, sugarcane and beef; sectors that drive land-use change and require a large area for production. Brazil is also a country richly endowed with biodiversity. It is equally important to understand the drivers and consumption habits in consumer or importing countries. For example, cultural preferences for cotton material over synthetic fibres in Europe is an important factor to consider when evaluating drivers for the trade of the commodity. To understand the connection between biodiversity loss and European consumption habits, it is necessary to evaluate the drivers and impacts on both ends of the supply chain—the impacts at the level of the source country and drivers at the end of the consuming country.

For many of the commodities dealt with in this scoping document, the economic activity associated with biodiversity loss is complex and dependent on a variety of case specific factors. For example, how a commodity was produced and harvested influences the level of biodiversity loss. For fish for instance, the type of fishing gear and practices used must be taken into consideration when attempting to quantify the impacts of trade on biodiversity. For example, a shrimp trawler typically throws 80-90% of the marine creatures caught back overboard which means that for one kilo of shrimp another 9 kilos is wasted as bycatch (Ending Overfishing 2012). If only the amount of shrimp consumed by humans is considered, the actual impact of the trade remains highly inaccurate. Thus, the complexity of each type of each commodity requires a real investigation that not only indicates the importing or exporting country but also the details and specific impact it has on the local level or source level on a case by case basis.

Commodity	Drivers of Consumption	Drivers of EU Consumption	Pressures and Impacts in Source Country	Regions/Ecosystems Affected
Cotton	• Finished clothing products • Yarn for industry • Raw cotton for manufacture	• Demand for finished clothing products	• Pollution/Soil degradation • Permanent Land Intake • Agricultural biodiversity loss as a result of monoculture production • Affects water quality and quantity	Difficult to distinguish country of origin, but Madagascar despite being a very small cotton producer has a disproportionate biodiversity footprint
Timber	• Building Materials • Packaging • Print/Communication Materials	• Consumption curbed with restrictions on tropical timber • Recession means less demand for building	• Permanent Land Intake • Fragmentation • Over-exploitation • Biodiversity loss • Ecosystem degradation	Tropical Ecosystems in Asia, Africa and Latin America
Soy	• Animal Feed • Biofuel Production • Diet Change (Processed Food)	• Diet change • Increase in meat consumption (i.e. used in animal feed)	• Biodiversity Loss • Permanent Land Intake • Agricultural Biodiversity Loss • Pollution (water, soil)	Savannah, Grassland and Forest. Brazil and Argentina are main source countries. Moldova, Malawi and Cambodia may not be largest source countries but experience highest biodiversity loss linked to soy cultivation.
Beef	• Diet change • Economic growth • Population Growth	• Decreasing consumption of beef, particularly from abroad	• Biodiversity Loss • Permanent Land Intake • Fragmentation • Desertification	Brazil and Argentina make up largest exports to EU; however, countries with highest levels of biodiversity loss attributed to EU consumption of beef are Madagascar, Cameroon, Albania and Morocco.
Fish	• Diet Change and Cultural/Societal Preferences • Economic Growth	• Government subsidies for industrial fishing fleet • Diet Change	• Biodiversity Loss • Over-exploitation • Ecosystem collapse	Global but particularly problematic is the industrial fishing fleets that are going farther afield to less exploited waters in developing countries.
Gold	• Trade on commodity exchange (volatile) • Use in jewellery and electronics	• Declining consumption for jewellery and products • Investor demand	• Pollution (water, soil) • Biodiversity Loss • Land Clearing for Access	Difficult to distinguish country of origin once smelted.

*This table was informed by the Arcadis study which used the Eora Trade Database to determine affected ecosystems and regions.

3 Measures and indicators for assessing EU impacts on global biodiversity

3.1 Relevant EEA activities

While the EEA's activities (i.e. assessments) generally focus on the 33 EEA member countries, there are a number of activities which relate to global initiatives, particularly – but not exclusively – in the context of UN accounting frameworks. These initiatives reference the globally embedded nature of European activities and seek to measure Europe's impact on global biodiversity as well as the impact of global activities and trends on European biodiversity. A common theme in many of the EEA's activities is to avoid redundancy and duplication; use existing data where possible; involve stakeholders; and simplify, standardize, and streamline indicators and measurements. Many of the initiatives also examine not only direct indicators of the state of biodiversity, but also target indicators of pressures on ecosystems and biodiversity to understand drivers of biodiversity loss.

- **Biodiversity Information System for Europe (BISE)**

The Biodiversity Information System for Europe (BISE) provides a platform for data and information supporting the EU's biodiversity targets and implementation of the Aichi targets in Europe. It serves as a clearing house for the EU within the CBD, facilitating international and European cooperation. Its goal is to organize information about policy, research, and data relevant to European biodiversity and Europe's impact on global biodiversity.

- **Streamlining European Biodiversity Indicators (SEBI)**

There are specific indicators discussed and used on EU level – mainly by the EEA and EUROSTAT – to monitor the trends and losses in biodiversity. In 2005, the EEA began an initiative together with other EU and international institutions to "Streamline European Biodiversity Indicators" (SEBI). The SEBI indicators cover 26 measures of biodiversity and pressures on ecosystems. The qualitative indicators span a range of sectors, activities, and disciplines. They include both simple indicators, such as abundance and distribution of selected species, as well as complex or index indicators, such as Ecological Footprint. Many of the selected indicators were not designed to measure biodiversity directly or progress towards a biodiversity target, but represent types of pressures on biodiversity (EEA 2012). The indicators build on existing external programmes and processes at the national, European, and global levels to avoid duplication and to complement other efforts at measuring and describing biodiversity. The proposed indicator set is meant to deliver a holistic picture of biodiversity trends and challenges and stresses the interlinkages between indicators. The power of the indicator set as a whole allows it to deal with uncertainty in individual indicators. SEBI creates links between the global framework created by the CBD and national and regional level work. Indicators were designed to be user friendly and give policymakers useful tools to increase policy effectiveness (BISE 2012).

The SEBI process resulted in several important lessons learned for European biodiversity indicators relevant for global biodiversity (EEA 2012). The specificity of targets and their direct link to drivers and sectors is helpful in determining useful conclusions from measurements. Lack of coordination between developments of models, monitoring, targets, and baselines was found to impede drawing of sound conclusions from indicators. Methods were proposed for improving the clarity of indicators in the future. Obtaining accurate, up to date, and comparable data remains a major challenge for international biodiversity indicator streamlining.

The SEBI indicators are part of the 2010 Biodiversity Indicators Partnership (BIP) mandated by the CBD to provide comprehensive global information on biodiversity trends. SEBI indicators have played a role in many international policy and monitoring processes. This includes the Environment Policy Review to monitor progress on the implementation of the 6th EU EAP, the 2010 assessment of the EU Biodiversity Action Plan. SEBI provided an example for regional-regional cooperation and gave stimulus to projects such as the indicator capacity strengthening of the BICS Africa project and the ASEAN biodiversity outlook (EEA 2012).

- **Common International Classification of Ecosystem Services (CICES)**

The purpose of CICES is to standardize international classifications of ecosystems services (ES). It developed from the EEA's work on environmental accounting and supports the EEA's contribution to the revision of the UN's System of Integrated Environmental Economic Accounts (SEEA). Standardisation in classifying ecosystem services, including biodiversity and biodiversity-related ES, is crucial for making international comparisons, especially in relation to economic accounting. As with the experimental framework for ecosystem capital accounting described below, CICES recognizes the need for ES classification that is useful in both physical and economic accounting (Haines-Young and Potschin 2013). The CICES process began in 2009 and, though adopted in Volume 1 of the SEEA Central Framework by the UN Statistical Council in 2012, it was determined that certain accounting issues remain to be settled within CICES. Though significant change to CICES is not expected, work on the classification is still underway (Haines-Young and Potschin 2013).

CICES is meant to have relevance to other widely used frameworks as much as possible to encourage widespread uptake. CICES builds on the ES typology of the Millennium Ecosystem Assessment (MA). CICES has also been used beyond accounting purposes, for example in the EU Mapping and Assessment of Ecosystems and their Services (MAES), in line with the MA (Haines-Young and Potschin 2013).

- **An experimental framework for ecosystem capital accounting in Europe**

Socioeconomic indicators related to biodiversity are crucial for communication of the value of biodiversity in policymaking; yet developing and operationalizing this information in the form of indicators is difficult. Integrating natural capital accounting into capital accounting measures such as GDP presents policymakers with considerable methodological and data collection challenges. The EU passed regulation No 691/2011 to mandate the inclusion of such a framework in European capital accounting. In order to simplify this process, clarify the relationship between the economy and the environment, and encourage greater uptake of capital accounting for ecosystem services, the EEA developed an experimental framework for ecosystem capital accounting in Europe. This process supplements the UN's System of National Accounts with information on the value of natural capital and builds on the SEEA developed by the United Nations, the European Commission, the International Monetary Fund, the Organisation for Economic Cooperation and Development and the World Bank (European Parliament and Council 2011). Measures and indicators cover ecosystem capital accounts in terms of both physical output and monetary value (EEA 2011a).

The experimental framework explicitly recognizes Europe's role in global biodiversity and includes this in its ecosystem accounting framework. Utilizing natural capital accounting in this form was chosen in order to preserve the familiar and easily communicable GDP measure while supplementing it with information about natural capital accumulation, degradation, and debt. This helps to accurately reflect natural values, including biodiversity values, in national accounting in easily understood terms. The framework will flow into SEEA Volume 2.

- **The European environment — state and outlook 2010: assessment of global megatrends**

The report on The European environment — state and outlook 2010 (SOER 2010) was comprised of an 'assessment of global megatrends'. In contrast to previous SOERs, the 2010 report examines environmental pressures in Europe within the global context, incorporating an "enhanced understanding of the links between environmental challenges combined with unprecedented global megatrends" (EEA 2010a). The report acknowledged that European consumption contributes to global environmental pressures and that global changes outside of Europe have direct and indirect impacts on Europe. The SOER consists of 4 main parts:

- Part A – an assessment of global megatrends and their impact on Europe and European policymaking
- Part B – Thematic Assessments focused on European environmental indicators, including brief analysis of their global impact and implications for policy
- Part C –- country-level assessments of EEA member countries
- SOER Synthesis summarizing the indicators and conclusions of Parts A-C and drawing links to European policy-making

The SOER is structured to reflect existing European strategic priorities, creating a direct link to policymaking. It concluded that "Accelerating global demand threatens the natural systems that sustain us" (EEA 2010b).

The report includes assessments on key trends within these priorities to examine environmental pressures from different perspectives. Biodiversity loss is examined as one of 13 Thematic Assessments and falls under Global Megatrend 8, decreasing stocks of natural resources (EEA 2010a). The Thematic Assessment states that "the loss of biodiversity is an issue of global, regional and local concern," though as part of Part B, the assessment focuses mainly on biodiversity indicators within Europe. The report concludes that four measures are required to reach the global target of halting or reversing biodiversity loss by 2020: enhanced implementation of measures to conserve biodiversity, policy coherence with other sectors, a more integrated ecosystem management approach, as well as public awareness of the relevance and value of biodiversity and the consequences of its loss at all scales. The Global Megatrend analysis identifies land conversion due to changing human consumption patterns as the primary driver for declining natural resource stocks, including biodiversity.

SOER is set to be updated in 2015. Currently each global megatrend and thematic assessment is undergoing an individual review process, with each update set to be individually published over 2014 in preparation for the 2015 SOER synthesis report (EEA 2014). The 2015 report should involve more stakeholders and focus on existing indicators rather than developing new ones (EEA 2013).

- **EEA Technical Report No 2/2013: Environmental pressures from European consumption and production (ETC/SCP)**

In 2013, the European Topic Centre on Sustainable Consumption and Production (ETC/SCP) published a technical report entitled 'Environmental pressures from European consumption and production: A study in integrated environmental and economic analysis'. The report describes how environmentally extended input output analysis (EE-IOA) can be used to quantify environmental pressures caused by European consumption patterns and economic production sectors.

3.2 *Relevant international activities*

3.2.1 Relevant indicators to measure the EU's global biodiversity impact

There is no global, harmonized observation system for delivering regular and suitable data on biodiversity change (Pereira et al. 2013). Despite progress in digital mobilization of biodiversity records and data standards, there is still insufficient consistent national or regional monitoring as well as sharing of such information (Marques et al. 2013).

Moreover, as a rather broad and cross cutting issue biodiversity can be expressed in a wide range of different indicators, which impedes a straightforward and widely applied indicator approach to assess biodiversity across regions. Hence, monitoring of biodiversity is often confronted with the question: What to measure exactly and how making it comparable to other areas?

The Group on Earth Observations Biodiversity Observation Network (GEO BON) has proposed a set of Essential Biodiversity Variables (EBVs), which form the minimum biodiversity aspects that should be used in order to study and monitor biodiversity change, based on their suitability across taxa and ecosystems, their temporal sensitivity and their feasibility (Pereira et al. 2013):

- genetic composition;
- species populations;
- species traits;
- community composition;
- ecosystem structure; and
- ecosystem function.

While the last two categories focus on broader services and characteristics of ecosystem services, the other categories could be regarded as biodiversity aspects in a stricter sense. They encompass measures and indicators related to living or biotic entities (individuals, species and populations).

- **Land-use related indicators**

A more integrated approach for a biodiversity indicator than the selection made be SEBI is from Switzerland and directly relates land use to biodiversity impacts. Based on an LCA approach, the indicator proposed by (de Baan et al. 2013) addresses land occupation impacts, quantified as a biodiversity damage potential (BDP). The key measure behind this indicator is animal and plant species richness, which is compared between land use types and their (semi-)natural regional reference situations and thereby examines impacts of types of land use within biomes on biodiversity. However, this measure cannot be calculated (yet) per unit of output (de Baan et al. 2013). For their calculations, the authors used data on multiple species groups derived from a global quantitative literature review and national biodiversity monitoring data from Switzerland. While the strength of this indicator is its wide (global) applicability, they also see limitations on indicators building on species richness such as their high dependence on sampling effort, missing information on abundance and no link to conservation targets. Due to data and information gaps, for example on regeneration times of ecosystems and transformation impacts, the approach can be seen as a "first attempt to quantify land use impacts on biodiversity within LCA across world regions (…)" (de Baan et al. 2013). Frischknechtl et al. (2013) see certain flexibility in bridging data gaps for the BDP through by using biome-specific averages.

In an earlier approach to assess the global loss of biodiversity, a combined model was developed, which is built on a set of equations linking environmental drivers and biodiversity impacts (cause-effect-relationships) (Alkemade et al. 2009). This so-called GLOBIO3 model describes biodiversity as “the remaining mean species abundance (MSA) of original species, relative to their abundance in pristine or primary vegetation” (Alkemade et al. 2009). Conceptually, the model builds on various preceded efforts to assess the loss of global biodiversity, its data are mainly derived from IMAGE model[4], which is widely applied at international level to calculate changes in land and land use. The GLOBIO3 model can assess the impacts of environmental drivers on MSA and their relative importance, expected trends under various future scenarios, and the likely effects of various responses of policy options.

Galli et al. (2013) describe how the Ecological Footprint indicator could be used in tracking human-induced pressures on biodiversity. They provide information on the main features of the Footprint indicator and its dataset, the ongoing work to improve the methodology as well as the geographical (more than 150 countries covered) and temporal coverage (a period of almost five decades) of the Ecological Footprint accounting tool. As with other footprint indicators (Land Footprint, Water Footprint, Carbon Footprint etc.), the Ecological Footprint depicts changes in ecological conditions on a per hectare basis. In this context, one needs to determine to what extent these indicators can provide sufficient information with regard to the status of biodiversity, e.g. the ‘variation of life’ (species and ecosystems) in a specific location.

- **Trade and commodity-based indicators**

Another approach worth considering is the one developed by Lenzen et al. (2012) who linked data on threatened species to supply chains of various commodities across the globe. The study showed that 30% of global species threats are due to international trade, invasive species not included in this figure. A major cause of this threat are the consumption patterns in developed countries, which effect species through their demand of commodities that are ultimately produced in developing countries. This approach was taken up by Arcadis (in press), see Chapter 2.

In their model, the authors integrated the IUCN Red List of Threatened Species plus a compatible list of threatened bird species from Bird Life International with a new high-resolution global multi-region input–output database on economic activities (see Lenzen et al. 2012). Hence, they linked data on threatened species with relevant commodities and their supply chains across the globe. However, the effort and the data requirements seem extremely high. It needs to be thoroughly assessed whether the available data are sufficient to explain the EU impact on global biodiversity, and whether the data are updated in a regular manner in order to show recent developments.

Lenzen et al. (2012) linked 25,000 Animalia species threat records to more than 15,000 commodities produced in 187 countries and evaluated more than 5 billion supply chains in terms of their biodiversity impacts. However, while red list animal species can serve as a proxy for threatened biodiversity, the ecosystem dimension as well as the link to land use practices is missing in this approach (while for land-based indicators the link to biodiversity is missing to some extent). The “biodiversity footprint” developed in this study, which quantifies threats caused directly and indirectly as a consequence of the expenditure of a final consumer, was generated by applying Leontief’s standard input–output calculus (Leontief and Ford (1970) cited in Lenzen et al. 2012). One of the major conclusions for policy making in this study is: “(…) policy aimed at reducing local threats to species should be designed from a global perspective, taking into account not just the local producers who directly degrade and destroy habitat but also the consumers who benefit from the degradation and destruction” (Lenzen et al. 2012).

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[4] For further information, see: http://themasites.pbl.nl/tridion/en/themasites/image/overview/components/index-2.html

Defra (2013) present a new method for analysing the global impacts of UK consumption, which the authors state "is potentially highly powerful for undertaking an assessment of potential drivers of biodiversity loss in producing regions, and simultaneously assessing a variety of different commodities in a consistent, comparable and repeatable manner." While the published study focussed on 12 selected commodities, the authors claim that the methodology could potentially be applied to a set of over 200 commodities. Together with the Arcadis (2013) study, the efforts by Defra represent the latest and probably most advanced attempt to link local production and consumption patterns to global biodiversity impacts.

- **Other**

Habitat fragmentation can be caused by geological processes that slowly alter the layout of the physical environment or by human activity such as land conversion, which can alter the environment much faster and cause biodiversity loss. One of the major ways that habitat fragmentation affects biodiversity is by reducing the amount of available habitat for all organisms in an ecological niche. Habitat fragmentation also invariably involves some amount of habitat destruction. Mobile animals (especially birds and mammals) retreat into remnant patches of habitat. This can lead to crowding effects and increased competition. The remaining habitat fragments are smaller than the original habitat. Species that can move between fragments may use more than one fragment. Species which cannot move between fragments must make do with what is available in the single fragment in which they ended up.

One quite common applied measure to monitor landscape fragmentation is the effective mesh size, which has proven as most suitable compared to other measures due to its mathematical characteristics and its intuitive interpretation (Jaeger 2000). Moreover, it aggregates the information on landscape fragmentation into a single value that can be easily obtained and interpreted (Jaeger et al. 2008). The effective mesh size can be defined as the likelihood that any two randomly chosen points in the region under observation may or may not be connected. The more barriers (e.g., roads, railroads, urban areas) erected in the landscape, the less chance that the two points will be connected (Jaeger 2000). As a mere mathematical measure the mesh size needs empirical underpinning, but it has demonstrated its implacability in the Swiss Monitoring System of Sustainable Development (MONET) (Jaeger et al. 2008). Also the German Federal Environmental Agency (UBA) has already adopted the effective mesh size ("Mittlere effektive Maschenweite") to propose limits to landscape fragmentation in Germany (Penn-Bressel 2005; Umweltbundesamt (UBA) 2003, Schönthaler and Peck 2012). So far, the effective mesh size has been mostly applied at regional level, but attempts to extend its application to the national scale are underway, e.g. in Germany and in Canada. More recently, the EEA has published a report on landscape fragmentation, where the effective mesh size has been applied across all 28 EU Member states (EEA 2011b).

The creation of protected areas and area networks helps to reduce biodiversity loss and provides significant contributions to global conservation efforts. However, despite the fact that the surface area of designated protected areas has steadily increased since 1970, the rate of biodiversity loss continues to increase (IUCN 2014). The relevance of an indicator that informs about the change in size (and number) of protected areas is therefore not very high, but provides additional helpful information. The discrepancy between the trends in increasing protected area coverage but declining biodiversity over the last four decades may relate to two key factors: (1) the degree to which protected areas deliver biodiversity outcomes; and (2) the degree to which significant biodiversity is represented within protected areas (IUCN 2014) (i.e. that some protected areas might not be very high in biodiversity compared to other unprotected areas). Another downside of protected areas as an indicator for biodiversity is that the level of demand/ requirements for biodiversity protection is very different in the different protected area categories. This indicator can be measured as % of protected land and might be further differentiated according to the different categories of nature protection (e.g. protected wetlands, biosphere reserves, national parks etc.).

The IUCN Red List Index is an indicator of the changing state of global biodiversity. It defines the conservation status of major species groups, and measures trends in extinction risk over time. It has been shown that the Index can be linked to EU consumption and production patterns (Lenzen et al. 2012 and Butchart et al. 2010).

4 Towards an assessment of the European impacts on global biodiversity

Based on the findings of the previous sections, Chapter 4 will outline the aspects which should be taken into consideration when developing a methodology for a comprehensive global assessment of EU biodiversity impacts. Here the focus is on further developments related to indicators and additional basis for a potential global assessment of EU biodiversity impacts.

4.1 Streamlining of biodiversity-related indicators beyond EU countries

A very first step on the way towards a global assessment of EU biodiversity impacts would be to take efforts to streamline biodiversity-related indicators beyond European boundaries. Trade and its impacts are inherently international with consumption patterns in one part of the world affecting source regions in another. For this reason, biodiversity-related indicators must be streamlined from the perspective of the supply chain and certainly beyond EU borders so as to include producer countries. Also important is the development of appropriate biodiversity-related indicators that are sensitive to the context of the country (e.g. importer, processor, consumer). A starting point would be to use SEBI and Butchart et al. (2010) to attempt to integrate those efforts with global and national data sets of relevant countries (e.g. Brazil, Argentina; see Chapter 2). Data could be provided by public agencies (statistical offices) or by scientific/academic institutions, depending on where suitable data sets are maintained.

4.2 Towards a global 'biodiversity footprint standard'?

Arcadis (in press) recommend the development of a global 'biodiversity footprint standard' to track the European impacts on global biodiversity. Furthermore, they hold that "land use change, embodied deforestation and the threatened species index seem to be suitable (proxy-) indicators for measuring biodiversity impacts induced by international commodity trade. Combining these indicators or expanding the set of indicators with additional state- or pressure-related indicators will certainly enhance robustness of outcomes but requires more efforts."

As a starting point, the approach from Lenzen et al. (2012), which was applied by Arcadis (in press) using the Eora MRIO database, seems the most promising approach for a global assessment, since data is in principle available and the IUCN red lists are updated on a regular basis. However, weaknesses of this approach need to be considered (see Chapter 2.7), of which some can only be overcome to a limited extent.

A noted shortcoming of the approach is the fact that any selection process for commodities narrows the scope significantly, providing an incomplete picture of factors driving biodiversity loss. Arcadis (in press) started with six commodities, which constrained general conclusions on the EU impact of global biodiversity. An obvious step to improve the analysis would be to include additional commodities identified by the literature as significant for biodiversity such as bananas, coffee, sugarcane, crude petroleum, iron ores and concentrates, and palm oil. Including these commodities and additional ones would require further research.

Other "products" such as tourism or hunting, which might have a significant impact on biodiversity, do not appear in the database, because they are non-tradable commodities. Tourism can theoretically be related to consumption (of fuel, building infrastructure or land conversion), which impacts biodiversity, but there are significant uncertainties in the methodology. First, linking activities of tourists to consumption of products, materials etc, which in turn impact biodiversity seems dubious and requires numerous unproven assumptions. For example, it will be difficult to separate activities that can only be attributed to tourism and not to other sorts of activities (e.g. in the construction sector). Second, if EU impacts on biodiversity in third countries through tourism should be detected, it seems almost impossible to distinguish between EU tourists and tourists from other parts of the world when assessing the negative activities. While these examples show that an integration of non-tradable commodities into the same database and models seems impossible, research could unveil how (semi-) qualitative assessments could complement the quantitative assessments done on the basis of the Eora MRIO model. Such qualitative assessments could even amend the quantitative analysis of traded commodities to increase the information basis of biodiversity impacts and potentially fill data gaps. For example, within fishing production the impact on biodiversity is highly dependent on the method used for fishing, the type of fish being caught and the geographical location.

More detailed information can also be collected by supply chain analysis that takes into consideration actors, specific products and/or companies (see also recommendations in Arcadis, in press). A supply chain analysis generally affords more consideration to qualitative factors through improved levels of traceability and transparency. However, the Arcadis report also states that supply-chain studies are often incomplete in assessing the biodiversity impacts that occur outside of the immediate supply chain, but nevertheless result from it. For example, in relation to the mining of a mineral resource, a supply chain analysis might not consider or quantify the downstream biodiversity impacts of extraction that could for instance include pollution of water resources that affect biodiversity loss. It is extremely difficult to allocate the biodiversity impact of specific products to biodiversity loss in the river basin. Thus, even if supply chain studies existed for the vast majority of products and companies, the results would account for only part of the total biodiversity threats. However, supplementing currently available research with a supply chain analysis would also allow for the inclusion of non-tradable commodities such as tourism.

Such an approach combining quantitative and qualitative aspects of trade flows could also include a more regionally specific analysis of the impacts. It can draw on trade flows of relevant commodities to determine as far as possible the exact origin of the raw material of the products in order to specify where the actual impact of EU consumption occurs. Questions like which countries, regions or ecosystems are most affected by EU consumption could then be answered, providing more transparency and awareness about the impacts of individual consumption habits.

There are also challenges for such an approach, because it requires comprehensive data of trade flows across the globe, which are sometimes not available (i.e. lack of transparency in supply chains). For instance, many raw products from foreign countries arrive in Rotterdam and are further distributed across European countries. National trade statistics often put the origin of the commodity as the Netherlands rather than the source country. While this might be less problematic if the focus was on the EU exclusively, it can also occur in an even wider context (raw materials exported from Brazil to the US and from there further exported to the EU in a further processed form). Some statistics take this into account but there are limitations when commodities are re-exported. The more processed a product is upon arrival in the EU the more difficult it is to trace it back to its origin.

It also needs to be noted that the Eora MRIO model is very much species-related and does not account for changes in quality of ecosystems, which can be regarded as a more integrated and comprehensive measure of biodiversity loss. Thus, the approach has no direct link to ecosystem services and the EEA activities currently underway in terms of mapping and assessing ecosystem services. On the other hand, the link between ecosystem services and biodiversity is not always clear, too. So concentrating on species as a means to assess (global) biodiversity might also be the most direct and therefore most plausible approach.

4.3 Additional policy analysis

In addition to the aforementioned approach and bearing in mind that imports of products are a mere quantitative measure, a critical and qualitative policy analysis building on the rough assessment made in Chapter 1.2 is suggested. In brief, one should identify the major policies influencing consumption and production patterns of the EU in one direction or the other, eventually fostering pressures on ecosystems and societies in other countries. Major questions/issues for an assessment could be:

- How do we improve the transparency and traceability of finished products and the components thereof? What role do processing countries (if different to exporting/importing countries) play?
- For a commodity such as gold is it important (and if so how?) to focus on the illegal artisanal trade in addition to the established corporate mines?
- For commodities where illegal trade is prevalent (timber, fish, gold) what tools or processes could be put in place to better regulate and certify the commodities? What policies are currently in place that may facilitate or encourage illegal activities (e.g. subsidies to European fishing industry?)
- What policies are in place at the European level that regulate consumption patterns? Have they been particularly successful? Are there other drivers of change in consumption patterns, if so what are they (e.g. foot and mouth disease in the UK and beef imports)?
- What policies are in place at the international level that regulate consumption and production patterns?
- Main direction of policy: Increasing consumption or leading to more sustainable consumption patterns and higher awareness among consumers?
- Status of implementation and effectiveness of measures leading to better biodiversity protection world-wide and to more sustainable consumption and production patterns
- Coherence between measures and policies (trade-offs, indirect effects)
- Coherence between standards established on EU territory and requirements for the same products from other countries (potential leakage effects)
- Conclusions of major gaps in EU policy design addressing global impacts on biodiversity.
- Develop certification for transparency of supply chain that can be applied to multiple sectors (e.g. building on the work of Transparency international), that could then be connected to a variety of socio-economic-environmental indicators/certificates.

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