Notes on

THE ECONOMIC VALUE OF BIODIVERSITY

1. Losses of biodiversity up to the present

1.1 General statistics

- **By the year 2000, only about 73% of the original global natural biodiversity was left.** The strongest declines have occurred in the temperate and tropical grasslands and forests, where human civilizations first developed.[1]
- **The human-caused (anthropogenic) rate of species extinction is estimated to be 1,000 times more rapid than the "natural" rate of extinction** typical of Earth's long-term history (Millennium Ecosystem Assessment 2005b). [2]
- In 2006, the IUCN Red List contained 40,177 species, 16,119 of them threatened with extinction. Of the groups for which every species has been assessed globally, 12% of all birds are classified as threatened, 23% of mammals, 33% of amphibians, approximately 42% of turtles and tortoises, 25% of conifers and 52% of cycads. [3]
- The 2007 IUCN Red List of Threatened Species identified a significant increase in species under threat during this decade. It estimates that 70%of the world's plants are in jeopardy (IUCN 2008). [4]

- **Even among species not threatened with extinction, the past 20–40 years have seen substantial declines in population size or the extent of range** in most groups monitored. Rates of biodiversity decline vary. Some species and species groups are more vulnerable to change than others. Some generalist species are expanding their ranges, either naturally or as invasive aliens, whereas many ecological specialists are in decline. [5]
- **The effect of trends such as these is that approximately 60% of the Earth's ecosystem services that have been examined have been degraded in the last 50 years**, with human impacts being the root cause. [6]

1.2 Marine and freshwater

- **A third of all assessed freshwater species are threatened with extinction**, and populations of freshwater species have declined by 30% overall.[7]
- 56% of Mediterranean endemic freshwater fish species are threatened (Smith & Darwall, 2006). [8]
- Fishing pressure has been such in the past century that the biomass of larger high-value fish and those caught incidentally has been reduced to 10% or less of the level that existed before industrial fishing started.[9]
- Between 1974 and 1999, the number of stocks that had been overexploited had increased steadily and by 1999 stood at 28% of the world's stocks for which information is available. The most recent information suggests that just over half of the wild marine fish stocks for which information is available are moderately to fully exploited, and the remaining quarter is either overexploited or significantly depleted. [10]
- **Over the last 25 years, 3.6 million hectares of mangroves, about 20 percent of the total extent found in 1980, have disappeared worldwide.** In 1999, it was estimated that approximately 27% of the world's known reefs had been badly degraded or destroyed in the last few decades.[11]
- **Since 1900 over half of wetlands worldwide have disappeared**. [12]
- **Some 20% of the world's coral reefs – which generally have a high biodiversity matching tropical forests - have been effectively destroyed** by fishing, pollution, disease and coral bleaching and approximately 24% of the remaining reefs in the world are under imminent risk of collapse through human pressures.[13]

1.3 Forests

- **In the last 300 years, global forest area has shrunk by approximately 40%**. Forests have completely disappeared in 25 countries, and another 29 countries have lost more than 90% of their forest cover. The decline continues. [14]

1.4 Agricultural crops

- An estimated ¾ of planet's crop agricultural diversity is already destroyed[15]

2. Projected future losses of biodiversity

2.1 General statistics for drivers of biodiversity loss

- While conversion to agricultural land was the major factor in historic biodiversity loss, the major increase between 2000 and 2050 in the respective contributors to the biodiversity loss are to found in the expansion of infrastructure and climate change. [16]
- Natural areas will continue to be converted to agricultural land, and will be affected by the expansion of infrastructure and by climate change. **By 2050, 7.5 million square kilometres are expected to be lost, or 11% of 2000 levels.**[17]
- Land currently under extensive (low-impact) forms of agriculture, which often provides important biodiversity benefits, will be increasingly converted to intensive agricultural use, with further biodiversity losses and with damage to the environment. **Almost 40% of land currently under extensive agriculture is expected to be lost by 2050.** [18]
- **Up to 2030, it is projected that global agricultural production will need to increase by more than 50% in order to feed a population more than 27% larger and roughly 83% wealthier than today's.** Although it is assumed that productivity of land will increase substantially, the global agricultural area will have to increase by roughly 10% to sustain this production, roughly the current agricultural area in the US, Canada and Mexico together. [19]
- In developing countries, agricultural production is growing four times faster than in OECD countries, due to faster economic and demographic change, and availability of new agricultural areas. In OECD countries, per capita consumption of agricultural products is almost stable, while it is projected to grow by 70% in developing countries to 2030. [20]
- The energy consumption for the OECD Baseline follows more-or-less the 2004 World Energy Outlook scenario of the International Energy Agency, adjusted for small differences in economic growth assumptions of this Baseline and for the higher energy price trajectory adopted from WEO 2006. This implies that final energy consumption increases from 280 EJ (exajoules/year) in 2000 to 470 EJ in 2030, somewhat faster than the historic trend. [21]
- The Baseline simulation for water demand reveals a considerable increase of about 26% for overall water withdrawals between 2005 and 2030[22]

2.2 General statistics for biodiversity loss itself

- The global annual rate of loss increased dramatically in the twentieth century, especially in Europe, in comparison to previous centuries. The expected loss rate for Europe seems to decrease but does not halt, while the global average still increases. **The total biodiversity loss resulting from land conversion and other pressures between 2000 and 2050, representing the projections of the driving forces and environmental pressures as described in the OECD Baseline scenario is 11% points (73 to 62%).**[23]
- **This corresponds with an area of 1,300 million ha (about 1.5 times the United States) which would lose its entire original biodiversity, for example changing from pristine to asphalt.** The relative loss is greater when the desert, tundra and polar biomes are excluded from the equation: 12 %-point in 50 years. With these loss rates, the global and European 2010 targets will not be met, not in 2010, and not in 2050. [24]
- **Current rates of species extinction are at least 2 orders of magnitude above background rates and are expected to rise to at least 3 orders above background rates while 20% of all species in those groups that have been comprehensively assessed are believed to be threatened with extinction in the near future (MA, 2005b).**[25]
- The future changes in biodiversity (in terms of MSA = the product of area and remaining % biodiversity) between 2000 and 2050, both absolute and relative, are projected to be most dramatic in the Savannah Biome (270 million MSA-ha, and ca. 17 % of original natural area in the biome. The Grassland & Steppe biome (ca 220 million MSA-ha, 11%) and the Boreal Forest Biome (160 million MSA-ha, almost 9%) are hit hard as well. The tropical forest and woodland biomes together lose more than 200 million MSA-ha or ca 13% of their original biodiversity. Surprisingly at first sight, the desert biome also loses quite a lot of biodiversity, but that is mainly the result of its large area (just 8% relative loss). In the savannah, grassland and steppe biomes, the biodiversity had already dropped to about 70% of the pristine situation in 2000, and declines to about 50% by 2050.[26]
- The number and extent of protected areas have been increasing rapidly worldwide in recent decades; they now cover almost 12% of global land area. However, the biomes represented in that coverage are uneven. Moreover, not all biodiversity is included in protected area networks – some 20% of threatened species do not occur in any protected area, with birds and amphibians being particularly under-represented (Rodrigues et al., 2004).[27]

2.3 Marine and freshwater specifics

- **60% of coral reefs could be lost by 2030** through fishing damage, pollution, disease, invasive alien species and coral bleaching, which is becoming more common with climate change. This risks losing vital breeding grounds as well as valuable sources of revenue to nations (Hughes et al. 2003). [28]
- **If current levels of fishing continue, there is the risk of collapse of a series of fisheries.** The global collapse of most world fisheries is possible by the second half of the century unless there is an effective policy response – and enforcement. [29]

- Different scenarios for depletion of fish stocks between year 2007 and 2047 all produce negative global mean values, indicating a further depletion of the marine biodiversity.[30]

3. Known economic benefits of biodiversity

3.1 Medicines

- Approximately half of synthetic drugs have a natural origin, including 10 of the 25 highest selling drugs in the United States of America.[31]
- Internationally, the trade in medicinal plants is estimated to be worth US$60 billion per year.[32]
- **In 2002-2003, four-fifths of new chemicals introduced globally were inspired by natural products.**[33]
- Of all the anti-cancer drugs available, 42% are natural and 34% semi-natural.[34]
- The turnover for drugs derived from genetic resources was between US$ 75 billion and US$ 150 billion in the United States of America in 1997.[35]

3.2 Forests

- The global value of timber harvested in 2000 was around $400,000 million, and around 25% of that entered into world trade, representing some 3% of total merchandise trade.[36]
- **The global forestry sector annually provides subsistence and wage employment of 60 million work years, with 80% taking place in the developing world.**[37]
- Fuel wood is the primary source of energy for heating and cooking for some 2.6 billion people, and 55% of global wood consumption is for fuel wood.[38]
- Forests annually provide over 3300 million cubic meters of wood (including 1800 million cubic meters of fuel wood and charcoal), as well as numerous non-wood forest products that play a significant role in the economic life of 100s of millions of people; contain about 50% of the world's terrestrial organic carbon stocks, and forest biomass constitutes about 80% of terrestrial biomass.[39]

3.3 Coral reefs

- **Coral reefs provide a wide range of services to around 500 million people. Some 9-12% of the world's fisheries are based directly on reefs, while a large number of offshore fisheries also rely on them as breeding, nursery or feeding grounds.** Tourism generally is the dominant benefit. Reef recreation has been estimated at US$ 184 per visit globally, at US$ 231-2,700 per hectare per year in Southeast Asia and at US$ 1,654 per hectare per year in the Caribbean.

Coral reefs provide genetic resources for medical research, and ornamental fish and pearl culture are extremely important for the economies of some insular states, such as French Polynesia. The reefs protect coastal areas in many islands: this vital service has been estimated to be worth US$ 55-1,100 per hectare per year in Southeast Asia.[40]

- Caribbean coral reefs have been reduced by 80% in three decades. As a direct result, revenues from dive tourism (close to 20%of total tourism revenue) have declined and are predicted to lose up to US$ 300 million per year. That is more than twice as much as losses in the heavily impacted fisheries sector.[41]
- The benefits of services derived from different ecosystems go from several hundred to over US$ 5,000 per hectare annually and in some cases much more. An extreme case is that of coral reefs, for which **UNEP estimated an overall value of ecosystem services at between US$ 100,000 and US$ 600,000 per square kilometre**; based on an estimated cost of US$ 775 per square kilometre for maintaining marine protected areas, the management costs of coral reefs could be as little as 0.2% of the value of the ecosystem protected (UNEPWCMC 2007) – the opportunity costs of coral reef conservation are not included in this comparison.[42]
- **Coral reef tourism has increased in visitation levels and value, with a current net present value estimated at $9,000 million**. The Great Barrier Reef attracts 1.6 million visitors each year and generates over $1,000 million annually in direct revenue. Marine fisheries are increasingly valuable for recreation, particularly in developed countries. In the US alone, in 2006 nearly 13 million anglers made more than 89 million marine recreational fishing trips on the Atlantic, Gulf and Pacific coasts, capturing almost 476 million fish, of which 55% were released alive. In the European Union (EU 15), an estimated 8 million recreational sea anglers spend an estimated €25,000 million a year, compared to a €20,000 million value for commercial landings in 1998.[43]
- **Most of the estimated 30 million small-scale fishers in the developing world are dependent on coral reefs for food and livelihood.** Reef fisheries in the Caribbean generate some US$310 million a year, and in South-East Asia US$2,400 million a year. Some estimates suggest that reefs contribute up to 25% of the total fish catch in developing countries, providing food for 1 billion people (UNEP-WCMC, 2006).[44]

3.4 Mangroves

- Due to their function as nurseries for many species, fisheries in waters adjacent to mangroves tend to have high yields; **annual net values of $600 per hectare per year for this fishery benefit have been suggested**. In addition, an annual net benefit of $15 per hectare was calculated for medicinal plants coming from mangrove forests, and up to $61 per hectare for medicinal values.[45]
- Some significant values have been estimated for water regulation, although they are highly context-specific. The value of the watershed protection provided by

intact coastal ecosystems, such as mangroves and other wetlands, has been estimated at US$ 845 per hectare per year in Malaysia and US$ 1,022 per hectare per year in Hawaii, United States of America. Overall, the values of the multiple watershed services tend to range from US$ 200 to 1,000 per hectare per year (Mullan and Kontoleon 2008). The value of bee pollination for coffee production has been estimated at US$ 361 per hectare per year (Ricketts et al. 2004), although the benefits only accrued to producers within 1 kilometre of natural forests.[46]

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3.5 General fisheries

- **It is estimated that 1 billion people worldwide are dependent on fish as their sole or main source of animal protein, while fish provided more than 2.6 billion people with at least 20 percent of their average per capita animal protein intake.**[48]
- Recreational fishing is an important economic activity in some countries; in the United States it is worth approximately $21,000 million a year; in Canada, $5,200 million a year and in Australia, $1,300 million a year.[49]
- **Coastal communities: coastal capture fisheries yields are estimated to be worth a minimum of $34000 million annually.**[50]

3.6 Miscellaneous

- Healthy reefs and mangroves can absorb 70-90% of the energy in wind-generated waves, thus protecting shorelines from storms and hurricanes. They also support a range of fisheries, and fish nursery habitats and, in the case of reefs, tourism and recreation (valued in some places at up to $1 million per km^2 if the cost of maintaining sandy beaches is considered). Both ecosystems contribute significantly to national economies, particularly those of small island developing states, 90% of which have reefs and 75% of which have mangroves.[51]
- The market for sustainably produced commodities could reach US$ 60 billion a year by 2010.[52]
- **Protected areas could produce benefits from goods and ecosystem services worth between US$ 4,400 and 5,200 billion a year.**[53]
- Centuries ago, restoration of forests in the watershed above Malaga, Spain, ended the flooding that had been recorded at regular intervals over 500 years.[54]
- **Case study:** In Masoala National Park, Madagascar, the following economic benefits of biodiversity have been suggested:[55]
    - Medicines (e.g. anti-cancer drugs): estimated value of US$ 1,577,800
    - Erosion Control (incl. reduced sedimation of rice paddies and fish nurseries): estimated value of US$ 380,000

- Carbon Storage (reduced impacts of climate change): estimated value of US$ 105,110,000
- Recreation (tourism): estimated net present value of US$ 5,160,000
- Forest Products (locals obtaining food, medicines, materials for construction and weaving): estimated sustainable net present value of US$ 4,270,000

4. Projected economic costs of not meeting 2010 biodiversity targets

4.1 General statistics

- **We are currently losing each year land-based ecosystem services worth around €50 billion** (this is a welfare loss, not a GDP loss, as a large part of these benefits is currently not included in GDP). These losses continue over time, and are added to by losses in subsequent years of more biodiversity. **The costs could be equivalent in scale to 7% of GDP by 2050.** This is a conservative estimate.[56]
- The loss of welfare in 2050 from the cumulative loss of ecosystem services between now and then amounts to $14 trillion (10^12 or million * million) Euros under the fuller estimation scenario – this is equivalent to 7% of projected global GDP for 2050. The loss grows with each year of biodiversity and ecosystem loss.[57]
- Overall, the analysis suggests that without halting biodiversity loss, the world in 2050 shall benefit much less from the flow of ecosystem services than in 2000. The loss in the value of the flow of services by 2050 would be equivalent to between 1% to 7.1% of GDP each year were 2000 to be taken as the biodiversity level of reference, and between 0.8% and 6% if 2010 were to be taken as the reference point (which due to continued incurred losses since 2000, of course, has a lower worldwide biodiversity value left than 2000). These values related to the losses of services from land based ecosystem services alone, i.e. not taking into account marine fisheries, coastal, wetlands, coral reefs or the impact of invasive alien species (IAS). The total global loss across ecosystem types shall in fact be much greater [58]

4.2 Regional statistics

- **While the welfare losses presented as an average of global GDP is 7%, the welfare losses due to ecosystem and biodiversity losses in the regions range from very small in the Middle East to 17% in Africa, 23 to 24% in Brazil, "Other Latin America & Caribbean" and Russia, and around 40% in Australia/New Zealand.**[59]
- When seen from an absolute loss (Billion EURs) point of view, the regions most affected are: [60]
    - North America: 3.4 trillion (10^12)EUR loss in 2050 from lost natural areas and overall 2.9 trillion EUR (10^12) loss in the High estimation scenario for 2000 to 2050.

- Africa: 3.15 trillion EUR (10^12)loss in 2050 from lost natural areas, and overall near 2.4 trillion (10^12) loss in the High estimation scenario for 2000 to 2050.
- And then other Latin America & Caribbean, Russia, other Asia, and Europe, and then Brazil and China, where losses are of the order of 1 trillion EUR in each (more in the earlier first countries in the list (e.g. Russia with near 1.5 trillion) and less in the last (China with 0.8 trillion EUR).

4.3 Forest biomes

- **The greatest losses are from the tropical forest biomes.** The next greatest total losses are from other forest biomes. Total losses from Savanna and Grassland are estimated to be less. The losses of services from the change in land use and biodiversity for the 6 forest biomes together are equivalent to 1.3 trillion (10^12) EUR (partial estimation) and 10.8 trillion (10^12) EUR (fuller estimation) loss of value in 2050 from the cumulative loss of biodiversity over the period 2000 to 2050. These numbers have been calculated using values for 8 ecosystem services. When compared to the projected GDP for 2050, these values equate to 0.7% of GDP for the partial estimate, and 5.5% of GDP for the fuller estimate.[61]

5. Quotes

- From America's Living Oceans in the Pew Oceans Report, 2003: "In the long term, economic sustainability depends on ecological sustainability."

- American author and essayist Edward Abbey (1927-1989): "Growth for the sake of growth is the ideology of the cancer cell."

- American biologist Paul Ehrlich: 'An extrapolation of currents trends in the reduction of diversity implies a denouement for civilization within the next hundred years comparable to a nuclear winter.'

- Portuguese biologist Miguel Bastos Araújo in a 2008 interview: 'The priorities of conservation science are human and not ecological.'

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[1] TEEB
[2] Living beyond our means: Natural Assets and Human Well-being,2005
[3] COPI
[4] TEEB
[5] COPI
[6] Ecosystems and Human Well-Being: Synthesis, 2005
[7] 2010 and Beyond: Rising to the Biodiversity Challenge, 2008
[8] COPI
[9] *Ibid*

[10] *Ibid*
[11] *Ibid*
[12] *Ibid*
[13] *Ibid*
[14] *Ibid*
[15] 2010 and Beyond: Rising to the Biodiversity Challenge, 2008
[16] COPI
[17] TEEB
[18] TEEB
[19] *Ibid*
[20] COPI
[21] *Ibid*
[22] *Ibid*
[23] *Ibid*
[24] *Ibid*
[25] *Ibid*
[26] *Ibid*
[27] *Ibid*
[28] TEEB
[29] *Ibid*
[30] COPI
[31] TEEB
[32] 2010 and Beyond: Rising to the Biodiversity Challenge, 2005
[33] *Ibid*
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[36] COPI
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[59] *Ibid*
[60] *Ibid*
[61] *Ibid*