APPENDIX 1

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Appendix 2

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APPENDIX 3

Abbreviations and Acronyms

CBD	Convention for Biological Diversity
CGE	computable general equilibrium (model)
CV	contingent valuation
DAF	decision analytical framework
DPSIR	driver-pressure-state-impact-response
EEA	European Environment Agency
EGS	ecosystem global scenario
EIA	environmental impact assessment
ESA	Endangered Species Act (of the United States)
FWS	Fish and Wildlife Service (of the United States)
GEO-3	*Global Environmental Outlook 3*
GCM	general circulation model
GSG	Global Scenario Group
IP	International Paper
IPAT	impacts = population × affluence × technology
IPCC	Intergovernmental Panel on Climate Change
ISEH	International Society for Ecosystem Health
IUCN	World Conservation Union
MA	Millennium Ecosystem Assessment
NGO	nongovernmental organization
OECD	Organisation for Economic Co-operation and Development
PSIR	pressure-state-impact-response
SMS	safe minimum standard
SRES	Special Report on Emissions Scenarios (of the IPCC)
TEV	total economic value
UNEP	United Nations Environment Programme
WBCSD	World Business Council on Sustainable Development
WSSD	World Summit on Sustainable Development
WTA	willingness to accept
WTP	willingness to pay
WWV	World Water Vision

APPENDIX 4

Glossary

Adaptive management: The mode of operation in which an intervention (action) is followed by monitoring (learning), with the information then being used in designing and implementing the next intervention (acting again) to steer the system toward a given objective or to modify the objective itself.

Baseline: A set of reference data sets or analyses used for comparative purposes; it can be based on a reference year or a reference set of (standard) conditions.

Bayesian probability: A subjective characterization of probabilities of outcomes arising from a certain decision.

Benefits transfer: Economic valuation approach in which estimates obtained (by whatever method) in one context are used to estimate values in a different context. This approach is widely used because of its ease and low cost, but is risky because values are context-specific and cannot usually be transferred.

Bias: Systematic error in a data set due to approaches and methods and their application in sampling, investigation, measurement, classification, or analysis.

Biodiversity: The variability among living organisms from all sources including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within and among species and diversity within and among ecosystems.

Biomass: The mass of living tissues in either an individual or cumulatively across organisms in a population or ecosystem.

Boundary organizations: Public or private institutions that synthesize and translate scientific research and explore its policy implications to help bridge the gap between science and decision-making.

Capability: The combinations of doings and beings from which people can choose to lead the kind of life they value. Basic capability is the capability to meet a basic need.

Capacity building: A process of strengthening or developing human resources, institutions, or organizations.

Capital value (of an ecosystem): The present value of the stream of future benefits that a ecosystem will generate under a particular management regime. Present values are typically obtained by discounting future benefits and costs; the appropriate rates of discount are often a contested issue, particularly in the context of natural resources.

Change in productivity approach: Economic valuation techniques that value the impact of changes in ecosystems by tracing their impact on the productivity of economic production processes. For example, the impact of deforestation could be valued (in part) by tracing the impact of the resulting changes in hydrological flows on downstream water uses such as hydroelectricity production, irrigated agriculture, and potable water supply.

Characteristic scale: The typical extent or duration over which a process is most significantly or apparently expressed.

Command and control: The policy framework in which environmental (e.g., emission standards for each source and each pollutant) and resource (catch or logging limits for each site or species) management rules are prescribed by the regulator, leaving little flexibility for actors in the implementation.

Common pool resource: A valued natural or human-made resource or facility in which one person's use subtracts from another's use and where it is often necessary but difficult to exclude potential users from the resource. See also *common property resource*.

Common property resource: A good or service shared by a well-defined community. See also *common pool resource*.

Constituents of well-being: The experiential aspects of well-being, such as health, happiness, and freedom to be and do, and, more broadly, basic liberties.

Conservation value: See *existence value*.

Consumptive use: The reduction in the quantity or quality of a good available for other users due to consumption.

Contingent valuation (CV): Economic valuation technique based on the stated preference of respondents regarding how much they would be willing to pay for specified benefits. A detailed description of the good or service involved is provided, along with details about how it will be provided. CV is designed to circumvent the absence of markets by presenting consumers with hypothetical markets in which they have the opportunity to buy the good or service in question. The methodology is controversial, but widely accepted guidelines for its application have been developed.

Core data set: Data sets designated as having wide potential application throughout the Millennium Ecosystem Assessment process. These data sets will be made available to all working groups and scientists within the program, and their common use will maximize consistency among analyses. Examples include land use, land cover, and population data sets.

Cultural landscape: See *landscape*.

Cultural services: The nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experience, including, for example, knowledge systems, social relations, and aesthetic values.

Decision analytical framework (DAF): A coherent set of concepts and procedures aimed at synthesizing available information from relevant segments of the given ecosystem management problem in order to help policy-makers assess consequences of various decision options. DAFs organize the relevant information in a suitable framework, apply decision criteria (both based on some paradigms or theories), and thus identify options that are better than others under the assumptions characterizing the analytical framework and the application at hand.

Decision-maker: A person whose decisions and actions can influence a condition, process, or issue under consideration.

Decomposition: The ecological process carried out primarily by microbes that leads to a transformation of dead organic matter into inorganic mater; the converse of biological production. For example, the transformation of dead plant material, such as leaf litter and dead wood, into carbon dioxide, nitrogen gas, and ammonium and nitrates.

Determinants of well-being: Inputs into the production of well-being, such as food, clothing, potable water, and access to knowledge and information.

Direct use value: In the total economic value framework, the benefits derived from the goods and services provided by an ecosystem that are used directly by an economic agent. These include consumptive uses (e.g., harvesting goods) and nonconsumptive uses (e.g., enjoyment of scenic beauty). Agents are often physically present in an ecosystem to receive direct use value. Compare *indirect use value*.

Domain (of scale): The combined range of characteristic scales for a given process in both space and time.

Downscaling: The process of converting data or information at a course resolution to a finer resolution.

Driver: Any natural or human-induced factor that directly or indirectly causes a change in an ecosystem.

Driver, direct: A driver that unequivocally influences ecosystem processes and can therefore be identified and measured to differing degrees of accuracy.

Driver, endogenous: A driver whose magnitude can be influenced by the decision-maker. The endogenous or exogenous characteristic of a driver depends on the organizational scale. Some drivers (e.g., prices) are exogenous to a decision-maker at one level (a farmer) but endogenous at other levels (the nation-state).

Driver, exogenous: A driver that cannot be altered by the decision-maker. See also *endogenous driver*.

Driver, indirect: A driver that operates by altering the level or rate of change of one or more direct drivers.

Ecological footprint: The area of productive land and aquatic ecosystems required to produce the resources used and to assimilate the wastes produced by a defined population at a specified material standard of living, wherever on Earth that land may be located.

Ecological security: A condition of ecological safety that ensures access to a sustainable flow of provisioning, regulating, and cultural services needed by local communities to meet their basic capabilities.

Ecosystem: A dynamic complex of plant, animal, and microorganism communities and their nonliving environment interacting as a functional unit.

Ecosystem approach: A strategy for the integrated management of land, water, and living resources that promotes conservation and sustainable use in an equitable way. An ecosystem approach is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompass the essential structure, processes, functions, and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of many ecosystems.

Ecosystem assessment: A social process through which the findings of science concerning the causes of ecosystem change, their consequences for human well-being, and management and policy options are brought to bear on the needs of decision-makers.

Ecosystem boundary: The spatial delimitation of an ecosystem, typically based on discontinuities in the distribution of organisms, the biophysical environment (soil types, drainage basins, depth in a water body), and spatial interactions (home ranges, migration patterns, fluxes of matter).

Ecosystem function: An intrinsic ecosystem characteristic related to the set of conditions and processes whereby an ecosystem maintains its integrity (such as primary productivity, food chain, biogeochemical cycles). Ecosystem functions include such processes as decomposition, production, nutrient cycling, and fluxes of nutrients and energy.

Ecosystem health: A measure of the stability and sustainability of ecosystem functioning or ecosystem services that depends on an ecosystem being active and maintaining its organization, autonomy, and resilience over time. Ecosystem health contributes to human well-being through sustainable ecosystem services and conditions for human health.

Ecosystem interactions: Exchanges of materials and energy among ecosystems.

Ecosystem properties: The size, biodiversity, stability, degree of organization, internal exchanges of materials and energy among different pools, and other properties that characterize an ecosystem.

Ecosystem services: The benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on Earth. The concept "ecosystem goods and services" is synonymous with ecosystem services.

Ecosystem stability: A description of the dynamic properties of an ecosystem. An ecosystem is considered stable if it returns to its original state shortly after a perturbation (resilience), exhibits low temporal variability (constancy), or does not change dramatically in the face of a perturbation (resistance).

Emergent property: A phenomenon that is not evident in the constituent parts of a system but that appears when they interact in the system as a whole.

Equity: Fairness of rights, distribution, and access. Depending on context, this can refer to resources, services, or power.

Existence value: The value that individuals place on knowing that a resource exists, even if they never use that resource (also sometimes known as conservation value or passive use value).

Extent: The length or area over which observations were made or for which an assessment was made or over which a process is expressed.

Externality: A consequence of an action that affects someone other than the agent undertaking that action and for which the agent is neither compensated nor penalized. Externalities can be positive or negative.

Forecast: See *prediction*.

Freedom: The range of options a person has in deciding the kind of life to lead. Freedom is similar to the concept of capability and can be used interchangeably.

Functional redundancy: A characteristic of species within an ecosystem in which certain species contribute in equivalent ways to an ecosystem function such that one species may substitute for another. Note that species that are redundant for one ecosystem function may not be redundant for others.

Geographic information system (GIS): A computerized system organizing data sets through a geographical referencing of all data included in its collections. A GIS allows the spatial display and analysis of information.

Global scale: The geographical realm encompassing all of Earth.

Good social relations: Social cohesion, mutual respect, good gender and family relations, and the ability to help others and provide for children.

Grain (of a phenomenon): A spatial unit that can be considered internally homogenous. Grain (of observation) is the fundamental (that is, the smallest) unit of observation.

Habitat: Area occupied by and supporting living organisms. Also used to mean the environmental attributes required by a particular species or its ecological niche.

Health: Strength, feeling well, and having a good functional capacity. Health, in popular idiom, also connotes an absence of disease. The health of a whole community or population is reflected in measurements of disease incidence and prevalence, age-specific death rates, and life expectancy.

Hedonic price methods: Economic valuation methods that use statistical techniques to break down the price paid for goods and services into the implicit prices for each of their attributes, including environmental attributes such as access to recreation or clean air. Thus the price of a home may be broken down to see how much the buyers were willing to pay for a home in a neighborhood with cleaner air.

Herbivory: The consumption of plants by animals.

Hierarchical systems: Systems that can be analyzed into successive sets of nested subsystems.

Indicator: Information based on measured data used to represent a particular attribute, characteristic, or property of a system.

Indirect use value: The benefits derived from the goods and services provided by an ecosystem that are used indirectly by an economic agent. For example, an agent at some distance from an ecosystem may derive benefits from drinking water that has been purified as it passed through the ecosystem. Compare *direct use value*.

Institutions: The rules that guide how people within societies live, work, and interact with each other. Formal institutions are written or codified rules. Examples of formal institutions would be the constitution, the judiciary laws, the organized market, and property rights. Informal institutions are rules governed by social and behavioral norms of the society, family, or community.

Instrumental: A means to an end.

Interventions: See *responses*.

Intrinsic value: The value of someone or something in and for itself, irrespective of its utility for someone else.

Irreversibility: The quality of being impossible or difficult to return to, or to restore to, a former condition. See also *option value*, *precautionary principle*, *resilience*, and *threshold*.

Kantianism: A theory of ethics that ascribes intrinsic value to rational beings and is the philosophical foundations of contemporary human rights and the extended ascription of intrinsic value to a wide spectrum of nonhuman natural entities, including ecosystems.

Land cover: The physical coverage of land, usually expressed in terms of vegetation cover or lack of it. Influenced by but not synonymous with *land use*.

Land use: The human utilization of a piece of land for a certain purpose (such as irrigated agriculture or recreation). Influenced by but not synonymous with *land cover*.

Landscape: An area of land that contains a mosaic of ecosystems, including human-dominated ecosystems. The term cultural landscape is often used when referring to landscapes containing significant human populations.

Length of growing period: For the purposes of the system definitions used in the Millennium Ecosystem Assessment, this is defined for terrestrial ecosystems as the total number of days in a year during which rainfall exceeds one half of potential evapotranspiration.

Level: The discrete levels of social organization, such as individuals, households, communities, and nations. See also *scale*.

Market failure: The inability of a market to bring about the allocation of resources that best satisfies the wants of society. In particular, the overallocation or underallocation of resources to the production of a particular good or service caused by spillovers or informational problems or because markets do not provide desired public goods.

Megadiversity country: One of 17 countries (Australia, Brazil, China, Colombia, Democratic Republic of Congo, Ecuador, India, Indonesia, Madagascar, Malaysia, Mexico, Peru, Philippines, Papua New Guinea, South Africa, United States, and Venezuela) home to the largest fraction of known species in the world.

Metadata: The collection of information related to the type and characteristics of data sets and their location in a data archive.

Open access resource: A good or service over which no property rights are recognized.

Opportunity cost: The benefits forgone by undertaking one activity instead of another.

Option value: The value of preserving the option to use services in the future either by oneself (option value) or by others or heirs (bequest value). Quasi-option value represents the value of avoiding irreversible decisions until new information reveals whether certain ecosystem services have values society is not currently aware of.

Parasitism: The consumption of one individual by another in which the consumer resides on (ectoparasite) or within (endoparasite) the body of its host or victim.

Passive use value: See *existence value*.

Pastoral system: The use of domestic animals as a primary means for obtaining resources from habitats.

Policy failure: A situation in which government policies create inefficiencies in the use of goods and services.

Policy-maker: A person with power to influence or determine policies and practices at an international, national, regional, or local level.

Pollination: The completion of the sexual phase of reproduction in some plants by the transportation of pollen. In the context of ecosystem services, pollination generally refers to animal-assisted pollination, such as that done by bees, rather than wind pollination.

Precautionary principle: The management concept stating that in cases "where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation," as defined in the Rio Declaration.

Precision: The ability of a measurement to be consistently reproduced. Also, the degree of accuracy.

Predation: The consumption of animals by other animals.

Prediction (or forecast): The result of an attempt to produce a most likely description or estimate of the actual evolution of a variable or system in the future. See also *projection* and *scenario*.

Primary production: Assimilation (gross) or accumulation (net) of energy and nutrients by green plants and by organisms that use inorganic compounds as food.

Private costs and benefits: Costs and benefits directly felt by individual economic agents or groups as seen from their perspective. (Externalities imposed on others are ignored.) Costs and benefits are valued at the prices actually paid or received by the group, even if these prices are highly distorted. Sometimes termed "financial" costs and benefits. Compare *social costs and benefits*.

Probability distribution: A distribution that shows all the values that a random variable can take and the likelihood that each will occur.

Projection: A potential future evolution of a quantity or set of quantities, often computed with the aid of a model. Projections are distinguished from "predictions" in order to emphasize that projections involve assumptions concerning, for example, future socioeconomic and technological developments that may or may not be realized; they are therefore subject to substantial uncertainty.

Property rights: An institution that gives someone possession rights to use things and to prevent others from using them; includes private, collective, common, public, and state property rights.

Provisioning services: The products obtained from ecosystems, including, for example, genetic resources, food and fiber, and fresh water.

Rangeland: An area where the main land use is related to the support of grazing or browsing mammals, such as cattle, sheep, goats, camels, or antelope.

Regulating services: The benefits obtained from the regulation of ecosystem processes, including, for example, the regulation of climate, water, and some human diseases.

Reporting unit: The spatial or temporal unit at which assessment or analysis findings are reported. In an assessment, these units are chosen to maximize policy relevance or relevance to the public and thus may differ from those upon which the analyses were conducted (e.g., analyses conducted on mapped ecosystems can be reported on administrative units).

Resilience: The capacity of a system to tolerate impacts of drivers without irreversible change in its outputs or structure.

Resolution (of observation): The spatial or temporal separation between observations.

Responses: Human actions, including policies, strategies, and interventions, to address specific issues, needs, opportunities, or problems. In the context of ecosystem management, responses may be of legal, technical, institutional, economic, and behavioral nature and may operate at local or micro, regional, national, or international level and at various time scales.

Risk: The probability or probability distribution of an event or the product of the magnitude of an event and the probability of its occurrence.

Safe minimum standard: A decision analytical framework in which the benefits of ecosystem services are assumed to be incalculable and should be preserved unless the costs of doing so rise to an intolerable level, thus shifting the burden of proof to those who would convert them.

Scale: The physical dimensions, in either space or time, of phenomena or observations.. See also *level*.

Scenario: A plausible and often simplified description of how the future may develop, based on a coherent and internally consistent set of assumptions about key driving forces (e.g., rate of technology change, prices) and relationships. Scenarios are neither predictions nor projections and sometimes may be based on a "narrative storyline." Scenarios may be derived from projections but are often based on additional information from other sources.

Security: Access to resources, safety, and the ability to live in a predictable and controllable environment.

Social costs and benefits: Costs and benefits as seen from the perspective of society as a whole. These differ from private costs and benefits in being more inclusive (all costs and benefits borne by some member of society are taken into account) and in being valued at social opportunity cost rather than market prices, where these differ. Sometimes termed "economic" costs and benefits. Compare *private costs and benefits*.

Spatial resolution: See *resolution*.

Stakeholder: An actor having a stake or interest in a physical resource, ecosystem service, institution, or social system, or someone who is or may be affected by a public policy.

Statistical variation: Variability in data due to error in measurement, error in sampling, or variation in the measured quantity itself.

Strategies: See *responses*.

Supporting services: Ecosystem services that are necessary for the production of all other ecosystem services. Some examples include biomass production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat.

Sustainability: A characteristic or state whereby the needs of the present and local population can be met without compromising the ability of future generations or populations in other locations to meet their needs.

Taxa: Nested groups of species that reflect similarity. Familiar taxa are birds (which belong to the class *Aves*) and fig trees (which belong to the genus *Ficus*).

Taxonomy: A system of nested categories (*taxa*) reflecting evolutionary relationships or morphological similarity.

Threshold: A point or level at which new properties emerge in an ecological, economic, or other system, invalidating predictions based on mathematical relationships that apply at lower levels. For example, species diversity of a landscape may decline steadily with increasing habitat degradation to a certain point, then fall sharply after a critical threshold of degradation is reached. Human behavior, especially at group levels, sometimes exhibits threshold effects. Thresholds at which irreversible changes occur are especially of concern to decision-makers.

Time series data: A set of data that expresses a particular variable measured over time.

Total economic value framework: A widely used framework to disaggregate the components of utilitarian value, including *direct* and *indirect use value*, *option value*, quasi-option value and *existence value*.

Travel cost methods: Economic valuation techniques that use observed costs to travel to a destination to derive demand functions for that destination. Developed to value the recreational use of protected areas, they have limited applicability outside this context.

Uncertainty: An expression of the degree to which a future condition (e.g., of an ecosystem) is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from quantifiable errors in the data to ambiguously defined terminology or uncertain projections of human behavior.

Upscaling: The process of aggregating or extrapolating information collected at a fine resolution to a courser resolution or greater extent.

Utilitarian: An approach that focuses on the satisfaction of human preferences. In some cases, this is taken further and made the basis of a moral viewpoint. See also *utilitarianism*.

Utilitarianism: A creed that accepts utility or the greatest happiness as the foundation of morals and holds that actions are right in proportion as they tend to promote happiness.

Utility: In economics, the measure of the degree of satisfaction or happiness of a person.

Value: The contribution of an action or object to user-specified goals, objectives, or conditions.

Value systems: Norms and precepts that guide human judgment and action.

Valuation: The process of expressing a value for a particular good or service in a certain context (e.g., of decision-making) usually in terms of something that can be counted, often money, but also through methods and measures from other disciplines (sociology, ecology, and so on).

Well-being: A context- and situation-dependent state, comprising basic material for a good life, freedom and choice, health, good social relations, and security.