THE VALUATION OF ECOSYSTEM SERVICES: ARE THE CHALLENGES TOO MANY TO ENSURE THE MAINTENANCE OF ECOSYSTEM INTEGRITY?

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One of the key challenges today in relation to the use of and preservation of the environment is how to resolve conflicts between the maintenance of ecosystem structure, functioning and integrity on the one hand, and the use of ecosystems through activities such as food production, aquaculture, transport, hunting, mining, energy production, recreation and building on the other hand.

One approach to address this challenge is to ascribe a value to ecosystem services which can be balanced against the value of other activities. While the potential of this approach has stimulated various national and international initiatives to explicate the value of ecosystem services,[1] this article reviews some major challenges that may lead one to question the degree to which ecosystem services valuation is an appropriate mechanism to ensure the maintenance of ecosystems and the services they provide.

Although the challenges stem from different disciplines, assessed in combination they reinforce one another. The challenges discussed in this paper are related to difficulties with regard to the monetization of the values of ecosystem services, and to the existence of discretionary provisions and principles in environmental law. The paper begins with a review of three key challenges to the use of ecosystem services valuations in environmental decision-making.

Technical Challenges Related To Valuation Methods

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[1] A global study, which is named “The Economics of Ecosystems and Biodiversity (TEEB)” was initiated in 2007 and a first interim report was presented in 2008. Available at http://ec.europa.eu/environment/nature/biodiversity/economics/pdf/teeb_report.pdf. Various TEEB country studies have been initiated, amongst others in Brazil, Germany, Japan, the Netherlands, the Nordic countries, the UK, and South Africa. See further http://www.teebweb.org/teeb-implementation/national-studies/.

Ecosystem services have generally been distinguished into four categories; provisioning, regulating, cultural, and supporting services.[2] These services have a variety of values, ranging from direct use values for provisioning services to non-use values attached to the satisfaction one enjoys from the pure knowledge that a natural resource exists. The method of valuation depends on the type of benefit attached to the ecosystem service, on the characteristics of the case and on data availability. This section will review the most common valuation methods and the difficulties embedded in these methods. It begins with a discussion of valuation of provisioning services.

Provisioning services may be ascribed direct use values. These are relatively straightforward to monetize as most of the products of provisioning services (such as food products, timber, medicinal products) are traded on markets. In this situation, the market price may indicate the value people place on the particular asset, however, this relatively simple method of valuation does contain some limitations. Most importantly, the true economic value of goods and services may not be fully reflected in market transactions.[3] When people purchase a marketed good, they compare the amount they would be willing to pay for that good with its market price. They will only purchase the good if their willingness to pay is equal to or greater than the price. This approach therefore only tells us the minimum amount that people who buy the good are willing to pay for it[4] and that may not appear to be a sufficiently high value to warrant protecting the ecosystem or its services from other uses or activities.

Regulating services, such as pest control, flood control, soil fertilizer, and water filtration are considerably more difficult to monetize than direct use values. These services often provide production inputs,[5] for example a wetland may contribute to the production of crabs,

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[2] Provisioning services includes food and fibre, fuel, genetic resources, biochemicals, natural medicines, and pharmaceuticals. Regulating services include air quality maintenance, climate regulation, and water regulation. Cultural services are the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences. Supporting services are those that are necessary for the production of all other ecosystem services, such as the production of oxygen, and soil formation. See further the Millennium Ecosystem Assessment, 2005. *Ecosystems and Human Well-being: Synthesis.* Island Press, Washington, DC.

[3] This is not a new problem, see for example, Adam Smith in the *Wealth of Nations,* (1776) book I, Chapter IV.

[4] More specifically, the standard economic assumption is that consumers will continue to purchase a good or service until the marginal value of it (or willingness to pay) is equal to the marginal sacrifice (or price). Under these circumstances, the market price is only an expression of the marginal willingness to pay, or the marginal value. The value of the total sales might however be less that the total value to consumers. See L.H. Goulder and D. Kennedy 'Valuing Ecosystem Services: Philosophical bases and empirical methods', in G. Daily *Nature's Services. Societal Dependence on Natural Ecosystems*, (Island Press 1997) 29.

[5] Ibid.

scallops, clams, birds, and waterfowl, through the regulating services it provides. This might appear to point to the possibility of using market value techniques, however, a major problem with this approach is that it is often difficult to distinguish between the production inputs from ecosystem services and other production inputs. In addition, this method requires the links between a quality change in the ecosystem and changes in market prices to be properly specified. Such modelling requires sufficient scientific knowledge of how environmental goods and services support or protect economic activities and it has proven difficult in practice to satisfy this requirement.[6]

Regulating services could also be valued by estimating what people are willing to pay to avoid the adverse effects that would occur if these services were lost, or to replace the lost service. Assessing the replacement cost is not, however, a convincing way of valuing natural ecosystems and the services that they provide. Replacements rarely replace all of the services coming from the original system. A filtration plant for instance replaces only a small part of what a watershed does. So, with this approach we could only reach a partial, or a lower estimate of the value of the services of the ecosystem.[7]

Many ecosystem services, particularly cultural services, do not enter markets at all, so that their 'price' is difficult to establish. Valuation methods have, however, been developed to capture the values of these services too. For instance, the 'travel costs method', has been applied to ascertain some values provided by parks, rivers and lakes, or the costs that result from the loss of these elements of nature.[8] When applied to recreational sites, the travel cost method assumes that the value of the site or its recreational services is reflected in how much people are willing to pay for each visit to the site.[9] This method may, however, lead to over or under estimation of the value of the site. For example, when a trip serves multiple purposes, the value of the site may be overestimated, if instead of calculating the value of the trip as one unit a separate value is ascribed to each purpose. Equally, the value can be underestimated if, for example, those who value certain sites choose to live nearby. In that case they will have low travel costs, but high values for the site that are not captured by the method.[10]

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[6] N. Hanley and E.B. Barbier, *Pricing Nature. Cost benefit analysis and environmental policy,* (Edward Elgar Publishing, 2009) 124.
[7] G. Heal, 'Valuing Ecosystem Services', 3 *Ecosystems* (2000) 27.
[8] Ibid, 33.
[9] J. P. Chavas, 'Ecosystem Valuation Under Uncertainty and Irreversibility' 3 *Ecosystems* (2000)11, 12.
[10] J. Asafu-Adjaye, *Environmental Economics for Non-economists. Techniques and policies for sustainable development,* (World Scientific Publishing, 2005) 124-125.

Another valuation method is the hedonic price method, by which the value of non-marketed services is estimated by looking at the change in the market price of property due to the existence of absence of the particular service.[11] Characteristics such as environmental quality, including air pollution, water pollution, and noise, or environmental amenities, such as aesthetic views or proximity to recreational sites, can increase land and house values if they are viewed as attractive or desirable, or reduce values where they are undesirable.[12] A simplified example of how the method may work is as follows: find two comparable houses, one with and one without views, and compare their prices. The difference reflects the value of the view in the market place. An important limitation of this method is that the value of services that can be measured is limited to attributes that are related to market goods.[13] The method is also relatively complex to implement and interpret, requiring a high degree of statistical expertise, large amounts of data and the time and expense to carry out an analysis.[14]

Many ecosystem services remain that are not easily evaluated by the methods discussed above. In these cases, surveys, based on a hypothetical scenario, can be used to assess individual values. These survey methods are the most widely used methods for estimating non-use values, existence values, option values, and bequest values.[15] The methods can, for instance, be used to measure the value of the basic life supporting services provided by ecosystems, the enjoyment of a scenic vista or a wilderness experience, the appreciation of the option to fish or bird watch in the future, or the right to bequest those options to your grandchildren. It also includes the value people place on simply knowing that, for example, giant pandas or whales exist.[16] A major advantage of these survey methods is their potential as general procedures for assessing the total economic value (use values plus non-use values) of any type of ecosystem. However, it remains the case that even the most sophisticated design of contingent valuation instruments cannot fully capture the total value of ecosystems.[17]

One valuation method which is used more and more frequently is the 'benefit transfer method'. Benefit transfer uses economic information captured at one place and time to make

[11] Ibid.
[12] A. Hussen, *Principles of Environmental Economics*, (Routledge, 2004) 150.
[13] G. Heal, *Nature and the Marketplace: Capturing the Value of Ecosystem Services*, (Island Press, 2009) 26. See also Hanley and Barbier (n.6), 98.
[14] D.M. King and M.J. Mazzotta, 'Ecosystem Valuation' (2000) (available at (www.ecosystemvaluation.org/contingent_valuation.htm).
[15] See Heal (n.13) 28 and Asafu-Adjaye (n.10) 113.
[16] See King and Mazzotta (n.14).
[17] See Hussen (n.12) 160.

inferences about the economic value of ecosystems at another place and time.[18] It is often used when it is too expensive and/or there is too little time available to conduct an original valuation study, yet some measure of benefits is needed.[19] While this method clearly has some advantages, it is controversial as it may lead to value estimates being used in ways that were not intended by the original researchers.[20] Other problems include that the benefit transfer may not be accurate, that it may be difficult to track down appropriate studies, since many are not published, and that the adequacy of existing studies may be difficult to assess.[21]

Discounting the values of future generations

Many decisions made now have consequences that persist well into the future. Exhaustible energy resources, once used, are gone. Biological renewable resources can be overharvested, leaving smaller and possibly weaker populations for future generations. Persistent pollutants can accumulate over time. How can we make choices when the benefits and costs may occur at different points in time?[22] The answer is that all cost and benefit flows are converted into present value, providing a way to compare net benefits received in different time periods. The conversion of future costs and benefits into present value is called discounting.

Discounting reflects the opportunity costs of not having access to money or any other benefits immediately. It suggests that people would value environmental amenities more highly now than if they were provided the same experience twenty years from now. Two

[18] M. A. Wilson and J.P. Hoehn, 'Valuing Environmental Goods and Services Using Benefit Transfer: The state-of-the art and science', 60 *Ecological Economics* (2006) 335.
[19] Demands for environmental valuation estimates are rising in the policy community in both Europe and the US. In Europe, this is partly being driven by the introduction of the Water Framework Directive (Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy, of 22 October 2000, which requires benefit-cost analysis of water quality improvements throughout the European Union, and by greater emphasis on the application of cost-benefit principles in environmental policy design in the EU. Hanley and Barbier (n.6) 70.
[20] Wilson and Hoehn (n.18) 336.
[21] R. Iovanna and C. Griffiths, 'Clean Water, Ecological Benefits, and Benefit Transfer: A work in progress at the U.S. EPA', 60 Ecological Economics (2006) 476. See also B. P. Allen and J. B. Loomis, 'The Decision to use Benefit Transfer or Conduct Original Valuation Research for Benefit-Cost and Policy Analysis', 26 *Contemporary Economic Policy* (2008) 1, who argue for the use of original benefits estimation research in this context.
[22] T. Tietenberg and L. Lewis, *Environmental & Natural Resource Economics,* 8th ed. (Pearson 2009) 24.

explanations have been given for this behaviour: people tend to discount the future because they are myopic or impatient, and people are uncertain about the future.[23]

From an economic point of view, discounting future costs and benefits is the right way to approach the problem of time preference – at least where projects of reasonably short duration, say up to 30 years, are involved. But the method has troubling implications for projects yielding huge gains in the far distant future, because after discounting these gains are deemed to be virtually worthless.[24] Applying a discount rate of say 3-6 per cent, the economic income of the planet over 50-100 years would shrink it to the value of a car. For the purposes of intergenerational equity, this seems indefensible.[25] Yet these are the actual rates applied in practice in some countries. In the Nordic countries (Sweden, Denmark, Norway and Finland) the rates applied vary from 4 to 6 per cent.[26]

The desirability of discounting future costs and benefits has therefore been the subject of intense debate.[27] For our purposes the key point is that the discount rate chosen is critical in determining the direction of social policy, particularly with respect to environmental assets that are long lived. If we discount the future heavily enough, it is possible to justify policies that generate a short-term benefit at the expense of extensive long-term environmental damage[28] impacting on, for example, the provision of fresh water, or moderation of the effects of flooding or droughts. It is perhaps for these reasons that some believe that ecosystem services should not be discounted.[29]

Uncertainty

Another key challenge is that the limitations in scientific understanding are such that we may not fully understand the true value of the services ecosystems provide and yet decisions with regard to use and development must be made today, on the basis of this imperfect knowledge.

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[23] Hussen (n.12) 177. See also: 'Deep discount', *The Economist: Finance & Economics*, (June 24th 1999).
[24] 'Deep discount', The Economist: Finance & Economics, (June 24th 1999).
[25] G. Chichilnisky, 'The costs and benefits of benefit-cost analysis', [1997] 2 *Environment and Development Economics* 1997, 203
[26] Nordic Council of Ministers 2007, *Nordic Guidelines for Cost-Benefit Analysis,* TemaNord 2007:574, 17.
[27]. Hussen (n.12).183.
[28] D.A. Starret, 'Shadow Pricing in Economics', 3 *Ecosystems* (2000) 17.
[29] D. Ludwig, 'Limitations of Economic Valuation of Ecosystems' 3 *Ecosystems* 2003, 33. On the issue of 'zero discounting' Hussen (n.12) 186; D. Pearce, G. Atkinson and S. Mourato, *Cost-Benefit Analysis and the Environment: Recent Developments* (OECD, 2006) 185.

In part uncertainty is caused by the fact that ecosystem functions are quite often complex and poorly understood. As Chavas stated:

> "Ecosystems change over time in complex ways. First, ecosystems involve many ecological variables that interact with each other. Second, ecosystem dynamics can be highly nonlinear, meaning that knowing the path of a system in some particular situation may not tell us much about its behaviour under alternative scenarios. As a result, learning about an ecosystem is difficult, especially if one is interested in its long-term trajectory. Third, ecosystems are subject to unpredictable effects of variables that are not anticipated by decision-makers. These unpredictable effects generate uncertainty due to lack of knowledge and/or lack of information. The best available scientific information typically is incomplete and uncertain for most decision-makers."[30]

Although progress has been made in understanding ecosystem dynamics, uncertainties concerning their long-term evolution remain and likely always will. This uncertainty makes it sometimes problematic to rely on economic values and to decide the best way to manage ecosystems and the services they provide. Equally, controversy may arise because of this problem when projects or activities are carried out that will irreversibly change the ecosystem functioning, structure and services.

Conclusions on the Challenges of Valuation

It is clear that the economic valuation of ecosystem services is not a straightforward exercise. The monetization methods that have been developed contain various difficulties and controversial issues. Even though economists have suggested alternatives to address the technical difficulties embedded in valuation methods and the ethical issues related to discounting, it remains questionable whether valuation of ecosystem services is an appropriate tool to ensure their preservation. This is exacerbated by the fact that other challenges, outside of the field of ecosystem economics, may reinforce the problems of economic valuation: namely the use of discretionary rules and principles in environmental law.

Discretionary Rules and Principles in Environmental Law

[30] J.P. Chavas, 'Ecosystem Valuation under Uncertainty and Irreversibility', 3 *Ecosystem*s (2000) 11-12.

Discretionary rules and principles are problematic because they leave room for the values of ecosystem services to be outweighed by other values. They may, for example, be unclear as to the extent to which ecosystem services need to be valued. Similarly, even where a value is attached to the ecosystem service in question, discretionary powers may leave room for decision makers to place greater emphasis on other values in their decisions than on the value of ecosystem services. This means that when it comes to ensuring the maintenance of the ecosystem's integrity, the process of *weighing and balancing* the values of different potential uses and services is just as important as the valuation exercise itself. Despite this, clear and coherent rules and guidelines on weighing assessments are generally absent in environmental law. Instead it is left open to decision-makers to decide how to weigh and balance diverging values; to what extent the outcome of the weighing assessment is determinative of the final decision; and what consequences will follow from ignoring the results of the process of weighing different assessments.

A number of provisions from Norwegian legislation may serve to illustrate this problem. The first example is drawn from the Norwegian Pollution Control Act, which provides that, in deciding whether to grant a permit for activities that may cause pollution, the competent authorities are required to "pay particular attention to the nuisance arising from the pollution of the project, *as compared with any other advantages and disadvantages of the project".*[31] This wording must be interpreted in the light of the purpose of the Act and the guidelines in Article 2 of the Act. Article 2(3) of the Act states that efforts to prevent and limit pollution and waste problems: "shall be based on the technology that will give the best results in the light of an overall evaluation of current and future use of the environment and economic considerations".[32] This wording makes the Act a rather flexible tool. The main objective is, of course, to prevent pollution and protect the environment. But it will be implemented with due regard to other interests, economic interests in particular. It thus requires that a trade-off is made between environmental considerations and other social needs and objectives,[33] but no clear guidance is given as to how this trade-off should be arrived at.

Another example can be found in the Norwegian Nature Diversity Act of 2009, which states that: "[t]he objective is to maintain the diversity of habitat types within their natural range and the species diversity and ecological processes that are characteristic of each habitat type. The objective is also to maintain ecosystem structure, functioning and productivity to the

[31] Act of 13 March 1981 No.6 Concerning Protection Against Pollution and Concering Waste, Article 11.5.
[32] H.C. Bugge, *Environmental Law in Norway,* (Kluwer Law International, 2011) 72.
[33] Ibid, 71.

extent this is considered to be reasonable".[34] The management objectives of the Nature Diversity Act do not impose any direct obligations upon public or private authorities, but they are important for the interpretation of the provisions and the exercise of discretion under this and other acts.[35] Achieving these objectives will require trade-offs to be made between different alternative courses of action and competing interests. One way to decide where exactly the balance of interests should lie in the final decision is to attach values to the various courses of actions and benefits arising from them. For this to work a value would have to be attached to the relevant ecosystem services. The Act neither prescribes nor prohibits such an approach to decision making[36] and thus the decision as to whether to use this approach and if so, which methods to use to calculate the value of ecosystem services is left to the discretion of the regulators.

A further example from Norway is found in the Energy Act[37] the key provision of which simply states that production or transmission of energy requires a permit, and that the objective of the act is "to ensure that the generation,[…] and use of energy are conducted in a way that *efficiently promotes the interests of society*, which includes taking into consideration public and private interests that will be affected".[38] In a statement, the government underlined that not all of the effects can be priced in a widely accepted and meaningful way[39] yet complying with the Act requires companies and energy authorities to weigh the social benefits and costs. To arrive at a result then they must take into account both the costs and benefits that are valued in dollars and costs and benefits assessed in other ways. No real guidance is provided as to how that assessment is to be carried out and how to compare these different values with each other.

Besides the general problems with discretionary rules outlined above, a further problem is created by the fact that the legislation may be underpinned by environmental principles

[34] Act of 19 June 2009 No. 100 Relating to the Management of Biological, Geological and Landscape Diversity (Nature Diversity Act), section 4.
[35] Ministry of Environment. 'Guiding Document to Chapter II of the Nature Diversity Act – General Principles for Sustainable Use: A practical introduction' (Veileder til naturmangfoldloven Kap.II, - Alminnelige bestemmelser om bærekraftig bruk : en praktisk innføring), 9. Available in Norwegian at http://www.regjeringen.no/pages/36850877/Veileder_Naturmangfoldloven_endelig2.pdf.
[36] B. D. Bongard et al, 'Økosystemtjenester – fra begrep til praksis? Sammendrag av innlegg fra ØKOSIP-seminar 10. januar 2010, NINA Trondheim. – NINA Rapport 673.' P.15. ('Ecosystem services – from concept to practice'). Available in Norwegian at: http://www.nina.no/archive/nina/PppBasePdf/rapport/2011/673.pdf.
[37] Act of 29 June 1990 no. 50 Relating to the Generation, Conversion, Transmission, Trading, Distribution And Use Of Energy etc (Energy Act).
[38] Energy Act, section1-2.
[39] Offical Statement of the Ministry of Petroleum and Energy nr 14 2001-2012 (Meld. St. 14 (2011–2012), par.6.4.1. Available in Norwegian at: http://www.regjeringen.no/nb/dep/oed/dok/regpubl/stmeld/2011-2012/meld-st-14-20112012/6/4.html?id=673880.

which in themselves are open to different interpretations:[40] such as the principles of sustainable development, the precautionary principle and the 'polluter pays' principle. The problem that environmental principles bring is that even if individual legal provisions appear to be clear in requiring, for example, a valuation of ecosystem services to be carried out and the results to be used in decision making, the objectives of the principles may not be clear and so the precise weight to attach to the valuation may be difficult to ascertain. This problem remains even where more procedural principles, such as the principle that 'an environmental impact assessment, … shall be undertaken for proposed activities that are likely to have a significantly adverse impact on the environment and are subject to a decision of a competent national authority'[41] are used as they also leave considerable discretion to the implementing authorities. The decision-making procedure on gas exploitation in the Wadden Sea ecosystem may illustrate this problem.

In 1999, an economic valuation study was performed in order to disclose the costs and benefits of gas exploitation on the Wadden Sea ecosystem. Even though over a hundred services were identified, only 16 of the services were monetized. The study presented different scenarios, covering both the possible benefits and negative impacts. These latter could be considerable, particularly on services like seawater purification, breeding grounds, tourism and recreation and production.[42] Of particular concern was the possibility for subsidence of the sea floor, which would affect the area's tidal flats, sand flats, salt marshes, including its flora and fauna.[43]

The study concluded that if the maximum possible benefits were achieved, the revenue would be €14 billion. If, in the more likely case, benefits lower than the possible maximum were achieved, the revenue would be €2 billion. If the damages from gas exploitation were high through, for instance, the negative impacts of 'soil subsidence', or when the sea level rises faster than expected, societal loss could be up to between €11 and 22 billion. In the least harmful scenario, (no damage in years 1-5, 50% damage in years 6-10, 100% damage in years 11-50), societal loss could be between €3 to 15 billion.

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[40] J.M. Verschuuren, 'Sustainable Development and the Nature of Environmental Legal Principles', 9 *Potchefstroom Electronic Law Journal* (2006) 35-38.
[41] Principle 17 of the Declaration of the United Nations Conference on the Human Environment (UNEP 1972d); the 1992 Rio Declaration, (A/CONF.151/26 vol I).
[42] J. Van Wetten et al, *De Schaduwant van het Waddengas (The Shallow Side of the Wadden Gas),* (AidEnvironment, 1999) 41-49.
[43] Nederlandse Aardolie Maatschapij (Dutch natural gas organization), *Gas extraction under the Wadden Sea,* (NAM, 2006).

Based on this report, the government, applying the precautionary principle, rejected the exploitation plans of the companies. This rejection was made explicit in part 3 of the Third Key Planning Decision on the Wadden Sea in 2001.[44] The Council of Ministers stated that no new exploration activities were allowed in the Wadden Sea and no permission will be given for new gas exploitation activities. However, at the same time the government appointed an advisory board, Committee Meijer, to further investigate the actual consequences of exploitation. The Committee published their findings in a report: 'Space for Wadden'.[45] It emphasized the importance of Wadden Sea gas to supply future energy needs, but did not refer to the ecosystem valuation study that had been carried out. The report concluded that the negative effects on ecology were very limited and gas exploitation should be allowed under strict regulations in order to supply in future energy needs. As a result, based on this report, the government approved the plans of the oil and gas companies and gas exploitation started in 2007.[46] Thus both the Committee's conclusions and the government's final decision were diametrically opposite to the government's original decision, despite the fact that both decisions were made under the same legislation and with reference to the same environmental principle.

The Valuation of Ecosystem Services: Are the Challenges Too Many?

The valuation of ecosystem services in order to facilitate their integration into decision-making procedures has, particularly in the last decade, received much attention. Nevertheless, valuations raise a number of potential problems and questions particularly when applied in the context of broad discretionary powers and principles. The key issues identified in this paper - that discretionary provisions may indirectly refer to the use of cost-benefit analysis, without imposing a duty to use this mechanism; that due to the technical difficulties and uncertainties attached to calculating a valuation the results of ecosystem valuation studies are sometimes controversial; and that discretionary rules and principles allow regulators to give greater weight to other interests and values than to the value of ecosystem services;– point to a further issue. One of the motivations for developing ecosystem valuation methods is to ensure the maintenance of ecosystem integrity and the

[44] Ministry of Housing, Spatial Planning and the Environment, 'Third memorandum Wadden Sea – part 3: Cabinet positionto the Key Planning Decision', 2001. Available in Dutch at http://www.europa-nu.nl/id/vi3ak0pw8qzz/brief_minister_met_het_kabinetsstandpunt.
[45] W. Meijer et al, 'Space for Wadden', Final Report of the Advisory Board on Wadden Sea Policy, The Hague 2004. Availabe in Dutch at http://www.waddenacademie.nl/fileadmin/inhoud/pdf/01-Waddenacademie/Meijer_rapport.pdf.
[46] Part 4 of the Third Memorandum to the Key Planning Decision to the Wadden Sea, 2007. Available in Dutch at http://www.waddenzee.nl/fileadmin/wk/inhoud/Beleid_en_beheer/pdf/Derde_Nota_Waddenzee_deel_4.pdf at 15.

conservation of ecosystem structure and functioning. For these to be maintained, however, there is a need for a legal framework that sets conditions and procedures within which officials can exercise their discretionary powers. More specifically, the legal framework would have to contain rules to ensure the conservation of the basic life-supporting functions of ecosystems. These rules would have to include prohibitions on particular activities or impacts. If the goal is the maintenance of ecosystem integrity and the conservation of ecosystem structure and functioning then ecosystem values cannot simply be counted as one factor to be weighed against others in a decision making process.