Valuing New Jersey's Natural Capital:

An Assessment of the Economic Value of the State's Natural Resources

April 2007

State of New Jersey
New Jersey Department of Environmental Protection
Jon S. Corzine, Governor
Lisa P. Jackson, Commissioner

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PART I:

OVERVIEW

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Table of Contents

ACKNOWLEDGMENTS 3

EXECUTIVE SUMMARY 4

I. INTRODUCTION TO NATURAL CAPITAL 7

A. The Concept of Natural Capital 7

B. Relation to Other Concepts 8

C. The Natural Capital Project 9

D. Components of Natural Capital 10

II. APPROACH AND RESULTS 12

A. Approach for Ecoservices and Ecogoods 12

B. Results by Ecoservice or Ecogood 15

C. Results by Ecosystem 16

D. Analysis of the Results 18

E. Conservatism of the Estimates 19

III. OTHER ECOSYSTEM SERVICES 21

IV. ECOTOURISM BENEFITS 22

V. POTENTIAL POLICY APPLICATIONS 25

A. Planning Applications 25

B. Management Applications 30

C. Conclusion 32

VI. FUTURE RESEARCH NEEDS 34

APPENDIX A: PROVISION OF SERVICES BY ABIOTIC SYSTEMS 36

APPENDIX B: ASSUMPTIONS MADE IN COMBINING RESULTS 38

APPENDIX C: CARBON STORAGE BENEFITS 41

APPENDIX D: ADDITIONAL FOREST ECOSERVICES 43

APPENDIX E: ESTIMATED BENEFITS OF ECOTOURISM 44

REFERENCES 48

EXHIBITS 51

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Executive Summary for Part I

In 2004, the New Jersey Department of Environmental Protection partnered with the Geraldine R. Dodge and William Penn Foundations to undertake an important project to assess the economic value of New Jersey's natural resources. As a result of generous funding from the two foundations, DEP entered into a contract with the Gund Institute for Ecological Economics, Rubinstein Institute of Environment and Natural Resources at the University of Vermont ("UVM"). The UVM researchers were charged with examining the ecosystem services portion of the project, and DEP staff were charged with examining the ecosystem goods part of the project. (Ecosystem services are the processes and functions by which natural ecosystems sustain and fulfill human life; goods are physical commodities that can be weighed, packaged, and transported.)

The result of this collaborative project is a three-part set of reports. This Part 1 serves as an overall summary of the Parts II and III, which are the final report for UVM's ecosystem services study and DEP's ecosystem goods study, respectively. This Part 1 serves to provide essential background information, summarize the combined detailed findings of Parts II and III and their limitations, and explore the policy implications of the project's findings

Section I: Introduction to Natural Capital

The concept behind the field of natural capital is that various naturally-occurring assets provide economic value over an extended period, a period that for some assets is essentially perpetual on any meaningful human time scale. The term **"natural capital"** is being increasingly used to describe these assets. In this report, the physical amount of natural capital is measured in acres, and its economic value is expressed in dollars. This report quantifies the economic value of natural capital as the present value of the goods and services it generates; all present values in this report are based on discounting at 3% per year (the most widely used rate in this type of analysis) in perpetuity.

The benefits provided by natural capital include both goods and services. (As noted above, ecosystem services are processes and functions by which natural ecosystems sustain and fulfill human life, while goods are physical commodities that can be weighed, packaged, and transported.) Goods come from both ecosystems (e.g., timber) and abiotic (non-living) sources (e.g., mineral deposits). While abiotic systems also provide some critical services, many of the services provided by natural capital come from ecological systems ("ecosystems"). On an overall basis, New Jersey's ecosystems are more valuable as providers of services than as sources of harvestable goods.

Sections II-IV: Results of the Studies

The final reports in Parts II and III include extensive discussions on the project's findings. In general, the key findings of the studies are as follows:

- The *annual* value of the ecoservices provided by New Jersey's natural capital is estimated at between $8.6 billion/year (present value $288 billion) and $19.8 billion/year (present value

$660 billion). Freshwater wetlands and marine ecosystems have the highest ecoservice values on both an annual and a present value basis. For a number of reasons, these estimates reflect estimated market values only and do not include consumer surplus, another major component of total economic value. If consumer surplus could be included, the estimated values would in all probability be significantly higher than those given above.

- The annual value of the goods provided by New Jersey's natural capital is estimated at between $2.8 billion/year (present value $93 billion) and $9.7 billion/year (present value $322 billion). Farmland, marine waters, and mines and quarries provide the highest values. These estimates reflect both estimated market values and consumer surplus and therefore present a more complete picture of total economic value.

- Taking the values of goods and services together, the total value of New Jersey's natural capital is estimated at about $20 billion/year (present value $681 billion), plus or minus $9 billion/year (present value $300 billion). This wide range of estimates is not unexpected, given the complexity of the many economic benefits being quantified.

For a number of reasons, the authors believe that even the high-end estimates are probably conservative. Those reasons include incomplete coverage of ecosystems and ecoservices in the economics literature; increased scarcity value as natural lands are developed; and inability of the study to include certain components of economic value. For example, public health benefits related to ecosystems were excluded from this study because of conceptual problems involved in their quantification. Similarly, as Section III shows, inclusion of certain ecoservices provided by New Jersey's forests could add between $630 and $840 million of benefits annually (present value $21-28 billion).

As another example of an important benefit not included in Parts II or III, wildlife-related tourism is estimated to generate about $3 billion of gross economic activity annually representing about $1 billion of wage and salary income annually or about 37,000 jobs. (The jobs are not an additional benefit since the related income is included in the activity figure.) Another common benefit measure, namely total value added (the annual contribution to New Jersey's Gross State Product), cannot be determined. Section IV presents the details of these estimates.

Section V: Potential Policy Applications

As expected, the results of this research points to important immediate and long term applications for statewide public policy and local land use decision-making. This report describes over a dozen potential uses of the findings, affecting conservation and land use planning and regulation, land management, and other areas. Some of these applications may be more promising than others and some may have more immediate application than others.

By conducting this research and presenting it to the public, it is the Department's hope to generate a statewide dialog on how New Jersey can best incorporate natural capital considerations into state and local policy and decision-making. The potential uses outlined in this report are not formally endorsed by the Department; rather they are included here as considerations for public policy and to prompt a dialogue with stakeholders.

Beyond the potential uses outlined in this report, the Department has already begun to incorporate and consider incorporation of the results of this project into its decision-making. Among these more immediate applications, the Department expects to use the project's findings to inform rulemaking, acquisition priorities, and interaction with regional and local planning entities.

Section VI: Future Research Needs

1. The valuation estimates presented in Parts II and III of this report are not the final word on the subject, and this section suggests areas for further research to improve the coverage and reliability of the valuations. The section concludes by noting that while our understanding of the value of New Jersey's natural capital will never be perfect, that fact is not a reason for postponing action to conserve critical natural capital before it is lost forever.

Section I: Introduction to Natural Capital

This section begins the first part of a three-part report on the New Jersey's Natural Capital Project. Part I presents essential background information, summarizes the detailed findings of Parts II and III and their limitations, and explores the policy implications of the natural capital project and the future research needs in this field.

The Concept of Natural Capital

Before we can discuss "natural capital", we need to understand the concept of "capital" in general and the related concept of "assets". In economics, *assets* are entities that possess "exchange" (i.e., market) value and that form part of the wealth or property of their owner (Pearce 1992). *Capital* assets are assets that generate a flow of economic benefits over an extended period. In contrast, the value of operating assets such as gasoline, office supplies, and food is usually used up relatively quickly.

Perhaps the most familiar types of capital assets are *physical* capital such as machinery, buildings, equipment, etc., and *financial* capital; other types of capital recognized by economists include *human* capital (e.g., a population's numbers, skills, training, etc.) and *social* or *cultural* capital (e.g., the ability to own property and enforce contracts and the other institutions that make private economic activity possible).[1] In each case, the use of the term "capital" emphasizes the fact that the assets in question provide value over an extended period.

In recent years, many economists have begun using the term *natural* capital to call attention to the fact that various naturally-occurring entities also provide economic value over an extended period, a period that for some assets is essentially perpetual on any meaningful human time scale. The term "natural capital" differs from the older term "natural resources" in that the latter views nature as essentially a source of raw materials which lack value until they are extracted from their natural environment and put to use. "Natural capital" also differs from "natural environment" in emphasizing nature's role as an active source of economic value.

These distinctions are of great practical importance. If we view something as a long-term source of benefit, we are more likely to invest in maintaining its productive capacity than if we view it as raw material to be used up in the near future. For example, if a forest is seen only as a source of short-term profits on timber sales, there is no particular reason to delay harvesting the resource and reaping the benefits. However, to the extent that the forest is seen as a capital asset, the owner has an incentive to limit the amount of logging in some way to preserve the forest's long-term profitability. This incentive is increased if the forest is seen as an asset that provides things of value in addition to wood, e.g., recreational opportunities.[2]

[1] This taxonomy of capital follows the treatment of many modern environmental economists (e.g., Pearce and Barbier 2000) while departing from the more traditional division of "factors of production" into land, labor, and capital, where "capital" meant only produced goods or financial capital (Pearce 1992).

[2] The incentive effect is reduced to the extent that the owner of the forest cannot capture at least some of the value of the benefits provided to society by charging enough for their provision to realize a profit.

Many of the benefits provided by natural capital come from ecological systems ("ecosystems"); an ecosystem is a dynamic complex of plant, animal, and micro-organism communities and their nonliving environment, all interacting as a functional unit (UNEP 2001-2005). The benefits provided by natural capital include both goods and services:

- "Ecosystem goods (such as food) and services (such as waste assimilation) represent the benefits human populations derive, directly or indirectly, from ecosystem functions" (Costanza et al. 1997).

- "Ecosystem services are the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life. They maintain biodiversity and the production of ecosystem goods, such as seafood, forage timber, biomass fuels, natural fiber, and many pharmaceuticals, industrial products, and their precursors" (Daily 1997). Examples of ecosystem services ("ecoservices") include temporary storage of floodwaters by wetlands, long-term storage of climate-altering greenhouse gases in forests, dilution and assimilation of wastes by rivers, and numerous others. Part II presents a detailed listing of ecoservices.

- Goods are physical commodities that can be weighed, packaged, and transported. Some classification systems treat nature's provision of goods as a type of service ("provisioning" services); for convenience this study treats goods separately. Although goods can come from both ecosystems (e.g., timber) and abiotic (non-living) sources (e.g., mineral deposits), for convenience all goods deriving directly from natural sources are referred to in this report as "natural goods", "ecosystem goods", or "ecogoods".

Part II of this report covers ecoservices, emphasizing the services provided by living systems, i.e., ecosystems. Part III deals with natural (i.e., biotic and abiotic) goods. Sections III and IV of Part I discuss some other sources of economic benefits related to natural capital, including the benefits stemming from ecotourism.

Relation to Other Concepts

Natural capital is different from but related to a number of other concepts used in discussions of environmental value; the following paragraphs briefly highlight some of those other concepts and how natural capital relates to them.

Sustainability. It is common to state as a fundamental criterion for sustainability the preservation of capital (see, e.g., Pearce and Barbier 2000). Ecological economists go further and distinguish two types of sustainability—weak and strong. In weak sustainability, the total amount of capital is preserved, but substitution of one type of capital for another is permitted. Thus, built capital such as roads and housing could substitute for an equal dollar amount of natural capital. In contrast, strong sustainability requires that each type of capital be preserved, including natural capital. In fact, some analysts would go even further and require that previously degraded natural capital be restored to some historical level deemed to be necessary in some sense.

"Green" GNP or GDP. The best-known measures of economic output are Gross National Product (GNP) or Gross Domestic Product (GDP). These metrics are based on the total volume of marketed goods and services produced in a given time period, usually a year. GNP and GDP treat nature as a collection of exploitable resources rather than capital assets; wealth is deemed to be generated only when those resources are harvested and sold for money. In contrast, there are a number of other measures of societal *income* that adjust GNP or GDP in various ways to arrive at a measure of economic activity that takes into account the degradation of natural and other capital. For example, the dollar impact of pollution might be estimated and deducted from GNP or GDP. Examples of such indicators include the Indicator of Sustainable Economic Welfare, the Genuine Progress Indicator, Genuine Savings, the Environmental Sustainability Index, and others.[3] These are all *flow* concepts, i.e., they measure the annual flow of benefits.

Ecological Footprint. This concept was developed and popularized by Wackernagel and Rees (1996). The essential idea is that humanity's use of natural resources is measured in terms of the amount of land (or land-equivalents) needed to sustain a given level of consumption, e.g., the amount of land needed to grow our food, to supply clean water, to absorb our wastes, etc. Ecological footprints are measured in acres and in that respect are similar to natural capital as described below. A main difference is that footprints are not usually monetized, i.e., they are not assigned dollar values; another main difference is that footprint analysis starts with a given consumption level and estimates the amount of land and water needed to support it, whereas natural capital valuation starts with the land and water themselves and attempts to estimate their dollar values. Ecological footprint is essentially a *stock* concept, i.e., it measures the stock of resources needed to support consumption.

As contrasted with these measures, natural capital is a *stock* concept; the goods and services that it provides are the annual benefit *flows*. In this report, the physical amount of natural capital is measured in acres, and its economic value is expressed in dollars. This report quantifies the economic value of natural capital as the present value of the goods and services it generates; no attempt is made to assess whether New Jersey's natural capital is adequate or inadequate.

The Natural Capital Project

As the most densely populated state in the U.S., New Jersey is under more or less constant pressure to convert undeveloped land to residential, commercial, and other uses; the potential for such conversion is one of the top environmental issues for the state's residents and businesses. The case made for development projects usually includes quantitative projections of claimed economic *benefits*, such as jobs, property tax revenues, etc. The arguments made against development increasingly include quantitative projections of claimed economic *costs,* such as the cost of new schools, new or expanded highways, etc.

While projected environmental costs are often part of the case made against land conversion, this type of cost is often expressed in qualitative terms; where it is quantified, the figures cited (e.g., acres of wetlands lost) are usually not expressed in monetary terms. This makes it essentially impossible to quantitatively compare environmental costs with other asserted costs and benefits. Some would say that this inability is for the best, since it protects environmental

[3] See Daly and Cobb (1989), Redefining Progress (2006), World Bank (2006), and CIESIN (2006).

assets from being lost due to hasty or otherwise deficient benefit-cost analyses. Others believe that the natural environment can most effectively be protected if its value as natural capital—expressed in monetary terms—is widely understood.

Recognizing the value of expressing natural resource value in monetary terms, the Department entered into a partnership with the Geraldine R. Dodge and William Penn Foundations to undertake this effort to quantify the economic value of New Jersey's natural resources. With the generous support of the two foundations, DEP engaged the expertise of Dr. Robert Costanza of the University of Vermont to be the principal investigator of the study.

Components of Natural Capital

In economics and finance, the value of a capital asset is determined by the value of the future benefits which the asset is expected to provide; in effect, the benefits represent income in the accounting sense, while the asset values make up part of the balance sheet. Natural capital provides two main types of direct benefit: *services* (such as removal of suspended solids by wetlands) and *goods* or commodities (such as timber). In addition, natural capital can be divided into *biotic* (living) systems such as forests and wetlands and *abiotic* systems such as underground aquifers and mineral deposits. These distinctions give rise to the following classification scheme:

Table 1: Types of Natural Capital and Direct Economic Benefits

Natural Assets	Value from services	Value from goods
Biotic systems, e.g., wetlands	ecosystem services, e.g., sediment removal	ecosystem goods, e.g., fish
Abiotic systems	dilution of air pollutants	provision of groundwater

In addition to these types of *direct* benefit, the natural environment also provides the essential setting for the production of what might be called *indirect* benefits, such as those generated by ecotourism. The benefits of ecotourism differ from the benefits of ecosystem services and natural goods because they derive from the fact that visitors to natural sites spend money in connection with their visits; and those expenditures in turn generate further economic activity as the dollars involved are re-spent. If visitors to natural sites spent a bare minimum on their activities (e.g., getting to the site and back but nothing else), the benefits of ecotourism would decline substantially, but the ecosystems involved would be unchanged, as would the value of the natural goods and ecoservices they provide. For these and other reasons, assessing the economic effects of ecotourism requires different methods from those used for ecosystem services and natural goods.

In the allocation of project responsibilities, UVM has focused on ecosystem services and their contribution to the value of New Jersey's natural capital, while Department staff have focused on natural goods (including both ecosystem goods and goods produced by abiotic systems) and ecotourism. Because of resource and time constraints and the less developed state of the relevant valuation methodologies, the project has paid relatively little attention to the contribution to natural capital value made by services provided by abiotic systems. Appendix A discusses some of the issues involved in quantifying this component of natural capital.

Part I of this report continues by summarizing the approach and results of the other parts of this study. Part II consists of UVM's final report on the value of the services provided by New Jersey's ecosystems. Part III presents the final report by Department staff on the value of the goods provided by New Jersey's natural capital. Parts II and III also translate the value of the services and goods into valuations for the natural assets that provide these benefits.

Section II: Approach and Results

After a brief discussion of methodology, this section summarizes the main results of the detailed studies presented in Part II (on ecosystem service values) and Part III (on natural goods values). Sections III and IV will discuss the approach and results for some other sources of value. Sections V and VI will discuss some of the implications, uses, and limitations of the findings.

Approach for Ecoservices and Ecogoods

As noted in Section I, the value of a capital asset is determined by the value of the services and goods which that asset provides over time. This simple statement reflects a number of important principles and assumptions, as described in the following paragraphs.

Level of analysis. Technically, each locality is unique, but to conduct any kind of analysis at that level of specificity is not realistic at present. Since the goods and services provided vary by ecosystem, the two studies presented in this report used that level of aggregation, e.g., all New Jersey forests, all New Jersey wetlands, etc. Where possible, important distinctions are made at the ecosystem level, e.g., between forested and unforested wetlands.

Natural capital metric. To estimate the dollar value of New Jersey's natural capital, we need to know how much natural capital the state has in a *physical* sense. The generally used metric for this, and the metric used in the present studies, is acreage. As with the level of analysis, this metric treats all acres of a given ecosystem type as fungible, even though each acre may be unique in some relevant sense.

The assumption of fungibility is the most practical at this stage in the application of natural capital concepts to specific geographic areas and can be seen as a first-order approximation. Part II does present two types of analysis that go beyond this assumption: one that analyzes differences in natural capital value based on proximity to human habitation, and another that models differences in ecosystem productivity based on spatial location relative to other ecosystems. However, the main results of the study treat all acres of a given ecosystem type as having the same value.

Ecosystem matrix. In addition to distinguishing among ecosystems, we need to distinguish among the services that each type of ecosystem provides. For example, forests sequester carbon but do not provide fish; the opposite is true for lakes and streams. Every ecosystem provides a unique set or "portfolio" of goods and services, and most ecoservices and natural goods are provided by more than one ecosystem. Therefore, we need to think of the task of valuing natural capital task in terms of an "ecosystem matrix" as shown in Table 2 (next page); valuation can be thought of as filling in the cells in this matrix. Of course, some cells cannot be filled in; tidal estuaries, for example, do not provide pollination services. Most cells, however, could conceivably contain dollar values.

(text continues after Table 2)

Table 2: Ecosystems and Sources of Economic Value (condensed list)

Source of Economic Value	Wetlands (all types)	Forest lands	Riparian buffers	Farmland (all types)	Urban parks	Open fresh waters	Beaches-dunes	Marine waters	Mines & quarries
Ecosystem services: Aesthetic / recreational Biological control Cultural / spiritual									
Disturbance regulation Gas/climate regulation Habitat / refugia									
Nutrient cycling Pollination Soil formation									
Waste treatment Water regulation Water supply									
Natural goods: Farm products Fish (fresh/saltwater) Game and fur									
Raw minerals Raw water Timber/fuelwood									
Ecotourism value									
TOTAL VALUE									

Note: this table summarizes the analytic framework for the natural capital study; the detailed numerical results are presented below.

Basic valuation formula. The basic mathematical relationship for each cell in the ecosystem matrix is extremely simple (* means multiplied by):

$ value/year for good or service X provided by ecosystem Y =

Acres of Y * Units of X provided/acre/year * $ value/unit of X

The acreage of most of New Jersey's major ecosystem types was provided by the Department's Bureau of Geographic Information Systems (BGIS); in the present studies, the values of the other two parameters for a given cell in the ecosystem matrix were obtained either from prior studies or from original analyses by the authors of Parts II and III. To simplify the reporting of results, these parts often collapse the second and third parameters into one, which changes the equation above into the following:

$ value/year for good or service X provided by ecosystem Y =

Acres of Y * $ value/acre/year

This change does not affect the substance of the analysis but only the summary data reported.

Treatment of time. As noted in Section I, capital assets produce value over an extended period, and each year's values must therefore be combined to produce a single "present" value for the asset. In keeping with the standard practice in economics and other fields, this is accomplished by mathematically "discounting" the values of goods and services provided in future years. Parts II and III both contain detailed discussions of how this is done; in essence, the annual future benefits stream is assumed to be constant, and that constant value is discounted at 3% per year in perpetuity to obtain the present value of the natural asset.

Goods vs. services. The need to avoid double-counting of benefits is always a consideration in studies such as the present ones, and the researchers involved in this project have taken care to avoid such double-counting. One type of double-counting concerns the relationship between goods values and service values; later sections discuss some other types of double-counting that need to be avoided.

The issue involving goods and service values is best explained by example. As described in Part II, forests provide a number of valuable services, such as carbon sequestration, control of soil erosion, and others. As described in Part III, forests also provide economically useful timber. The question is how much of each a given forest can provide at the same time. A healthy and sustainably managed forest or other ecosystem can provide both types of benefits over extended periods, and the current studies assume that the levels of service provision discussed in Part II and the levels of goods provision discussed in Part III are compatible.

Results by Ecoservice or Ecogood

We first present the results of Parts II and III by type of ecoservice or natural good, beginning with the ecoservices analyzed in Part II, which provides definitions of the services.

Table 3: Total Annual Ecoservice Values		
Ecoservice	**MM 2004 $/yr**	**Pct.**
Nutrient cycling	$5,074	25.6%
Disturbance regulation	3,383	17.1%
Water regulation	2,433	12.3%
Habitat/refugia	2,080	10.5%
Aesthetic/recreational	1,999	10.1%
Waste treatment	1,784	9.0%
Water supply	1,739	8.8%
Cultural/spiritual	778	3.9%
Gas/climate regulation	246	1.2%
Pollination	243	1.2%
Biological control	35	0.2%
Soil formation	8	0.04%
Totals	**$19,803**	**100%**

As Table 3 shows, a few services appear to account for the majority of the ecoservice benefits. However, if some of the gaps in coverage discussed below could be addressed, these rankings might change, e.g., if newer studies found the less-well-investigated services to have higher values per acre than the existing literature indicates. It should be noted that the value per acre for a given service depends on the ecosystem providing the service. For example, forested land sequesters much more carbon per acre than farmland, even though both provide carbon sequestration services.

These differences in service intensities[4] may have implications for service delivery planning; for example, achieving a given carbon sequestration goal might require fewer acres of forest than of farmland, if both were available for this purpose. These differences could also be related to cost per acre to develop benefit-cost ratios for different ecosystems providing a given service. In addition, such data can help decision makers compare the cost and benefit of service provision by ecosystems to provision by artificial facilities. These and related topics are discussed further in Sections V and VI below.

Table 4 on the next page presents the estimated values of the various natural goods analyzed in Part III. It should be noted that whereas the figures in Table 3 are essentially market values for the services in question, Table 4 presents both market values (MV) and estimated consumer surplus (CS); as explained in detail in Part III, the latter is a second major component of total economic value (TEV).

[4] Differences in dollar value of service per acre per year is actually a proxy for differences in physical service intensities, e.g., tons of carbon sequestered per acre per year. However, unless different ecosystems provide different levels of *quality* levels for a given service, the dollar values should be a reasonable proxy for *quantity* levels.

Table 4: Total Annual Ecogoods Values (MM 2004 $/year)				
Natural Good	**MV**	**CS**	**TEV**	**Share**
Farm products	$447.6	$3,228.4	$3,676.0	62.7%
Fish (total)*	157.0	800.7	957.7	16.3%
Minerals	320.9	266.3	587.2	10.0%
Raw water	169.2	211.4	380.6	6.5%
Sawtimber	48.9	97.8	146.7	2.5%
Fuelwood	38.5	56.6	95.1	1.6%
Game/fur animals	3.4	17.7	21.1	0.4%
Total or avg.	**$1,185.5**	**$4,678.9**	**$5,864.4**	**100.0%**
Commercial fish	123.0	627.3	750.3	12.8%
Recreational fish	34.0	173.4	207.4	3.5%

As is evident, farm products account for well over half of the total value of natural goods. Valuation of farm products presents various conceptual issues, which Part III discusses in detail.

Results by Ecosystem

Table 5 (next page) summarizes the results of Parts II and III by ecosystem instead of by type of good or service; annual values ($MM and $/acre) and present values ($Bn and $/acre) are given. The ecosystems are listed in order by the total value of goods plus services. Appendix B describes some of the technical issues involved in combining the results of Parts II and III.

For both goods and services separately and for the two combined, the figures in Table 5 clearly demonstrate a wide range of both values per acre and total values, spanning two orders of magnitude. Every system except beaches/dunes, barren land, and paved urban land provides both goods and services. Beaches/dunes have by far the highest dollar value per acre due to the extremely high value that many people place on the services provided by this ecosystem.

Table 5 also shows that on an overall basis, New Jersey's ecosystems are far more valuable as providers of services than as sources of harvestable goods, a fact that has important implications for land use and environmental protection. For all ecosystems in the aggregate, the total service value of $19.8 billion/yr. shown in Table 5 equals 3.4 times the total goods value of $5.9 billion/yr. The ecosystems with services-to-goods ratios below this average are farmland, barren land (which includes mines and quarries), and open fresh water (a source of recreationally harvested fish); for these ecosystems, the harvestable goods appear to be more valuable than the ecoservices provided. This conclusion is based on our current understanding of the services provided by those ecosystems and is subject to change as research continues.

Finally, Table 5 demonstrates the high value of New Jersey's natural capital: $25.7 billion/year for goods and services combined (just over $4,600/acre/year) and $856 billion in present value ($154,000/acre). Freshwater wetlands and marine ecosystems have the highest total values. Different value estimates are presented below in a limited sensitivity analysis.

Table 5: Value of New Jersey's Natural Capital (excluding ecotourism) (2004 $)

	Area	NATURAL GOODS*				NATURAL SERVICES				NATURAL GOODS & SERVICES			
Ecosystem	**(acres)**	**$MM/yr**	**$/ac/yr**	**PV $Bn**	**PV $/ac**	**$MM/yr**	**$/ac/yr**	**PV $Bn**	**PV $/ac**	**$MM/yr**	**$/ac/yr**	**PV $Bn**	**PV $/ac**
Freshwater wetland[1]	814,479	$191	$234	$6.4	$7,801	$9,422	$11,568	$314.1	$385,593	$9,612	$11,802	$320.4	$393,394
Marine[2]	755,535	850	1,125	28.3	37,512	5,700	7,544	190.0	251,475	6,550	8,670	218.3	288,987
Farmland** [3]	673,464	3,760	5,583	125.3	186,095	483	717	16.1	23,887	4,242	6,229	141.4	209,982
Forest land***	1,465,668	349	238	11.6	7,934	2,163	1,476	72.1	49,201	2,512	1,714	83.7	57,136
Saltwater wetland	190,520	26	139	0.9	4,617	1,168	6,131	38.9	204,355	1,194	6,269	39.8	208,973
Barren land	51,796	587	11,337	19.6	377,893	0	0	0.0	0	587	11,337	19.6	377,893
Urban[4]	1,483,496	20	13	0.7	450	419	283	14.0	9,420	439	296	14.6	9,869
Beach/dune	7,837	0	0	0.0	0	330	42,149	11.0	1,404,969	330	42,149	11.0	1,404,969
Open fresh water	86,232	79	921	2.6	30,689	66	765	2.2	25,510	145	1,686	4.8	56,208
Riparian buffer	15,146	2	118	0.1	3,934	51	3,382	1.7	112,747	53	3,500	1.8	116,681
Total or Avg.	**5,544,173**	**$5,864**	**$1,058**	**$195.5**	**$35,259**	**$19,802**	**$3,572**	**$660.1**	**$119,059**	**$25,667**	**$4,630**	**$855.6**	**$154,317**

1. Freshwater wetlands													
Forested	633,380	154	244	5.1	8,122	7,327	11,568	244.2	385,593	7,481	11,811	249.4	393,715
Unforested	181,099	36	200	1.2	6,679	2,095	11,568	69.8	385,593	2,131	11,768	71.0	392,272
2. Marine													
Estuary/tidal bay	455,700	513	1,125	17.1	37,505	5,310	11,653	177.0	388,448	5,823	12,779	194.1	425,953
Coastal shelf	299,835	338	1,126	11.3	37,524	389	1,299	13.0	43,297	727	2,425	24.2	80,820
3. Farmland**													
Cropland	546,261	3,291	6,025	109.7	200,828	473	866	15.8	28,855	3,764	6,890	125.5	229,683
Pasture/grassland	127,203	469	3,685	15.6	122,827	10	77	0.3	2,551	478	3,761	15.9	125,379
4. Urban													
Urban (impervious)	1,313,946	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0
Urban green space	169,550	20	118	0.7	3,934	419	2,473	14.0	82,420	439	2,591	14.6	86,354

*middle estimates, including consumer surplus; see Part III for details. ***includes wooded farmland.
**ecosystem service values for farmland have been revised since Part II was finalized; see Appendix B for details.

Analysis of the Results

Because of various limitations on data and resources, it was not possible to perform a formal sensitivity analysis (in which the values of selected input parameters are varied to see how the results change) or a formal statistical analysis of the results (e.g., an analysis of confidence intervals). However, two factors do allow us to get a sense of the range of uncertainty in the results:

- The investigators for Part II examined two types of prior studies. Type A studies consist of original research published in peer-reviewed journals; Type C studies consist of meta-analyses (statistical analyses of prior studies) published in peer-reviewed journals.[5]
- The investigators also calculated two summary measures for each cell with estimated values in the ecosystem matrix, namely the mean and the median of the prior estimates.

These two dimensions—type of prior study and summary measure—yield four possible combinations, as shown in Table 6:

Table 6: Sensitivity Analysis for Ecosystem Services (2004 $)

Ecosystem	Area (Acres)	Type A Only Median	Type A Only Mean	Types A & C Median	Types A & C Mean
		2004 $/acre/year		2004 $/acre/year	
Beach/dunes	7,837	$38,002	$42,147	$38,003	$42,147
Coastal shelf	299,835	n/a	n/a	$1,295	$1,299
Cropland	546,261	$23	$23	$865	$866
Estuary/tidal bay	455,700	$281	$715	$11,289	$11,653
Forested land	1,465,668	$481	$1,283	$688	$1,476
Freshwater wetlands	814,479	$8,234	$8,695	$10,969	$11,568
Open fresh water	86,232	$781	$765	$781	$765
Pastureland	127,203	$12	$12	$77	$77
Riparian buffer	15,146	$797	$3,382	$797	$3,382
Saltwater wetlands	190,520	$1,980	$6,527	$2,771	$6,131
Urban green space	169,550	$1,915	$2,473	$1,916	$2,473
Other urban + barren	1,365,742	$0	$0	$0	$0
Total $MM/yr	**5,544,173**	**$8,633**	**$11,413**	**$17,187**	**$19,803**
Present Value $Bn		**$287.8**	**$380.4**	**$572.9**	**$660.1**

As Table 6 shows, using only the medians of the results from Type A studies gives a total ecoservice value of $8.6 billion/yr for a present value of $288 billion. At the other end, using the means of the results from both Type A and Type C studies gives a total ecoservice value of $19.8 billion/yr for a present value of $660 billion. Tables 3 and 5 reported the results obtained using the means of both Type A and Type C studies. The mean is the accepted summary measure in valuation analysis, and using both types of studies permits the broadest possible coverage of ecosystems and ecoservices.

[5] Type B studies (not used in Part II) include unpublished studies and studies published in non-peer-reviewed form, e.g., studies conducted by government agencies. Part III can be viewed as a Type B study.

As to natural goods, Part III presents three estimates as follows: low-end = $2.8 billion/yr (present value = $93 billion); middle = $5.9 billion/yr (PV=$196 billion); and high-end = $9.7 billion/yr (PV=$322 billion). Tables 4 and 5 reported the middle estimates.

Combining these with the estimates from Tables 3-6 gives the following range of estimated total present values:

Table 7: Total Natural Capital Value (2004 $Bn)				
Columns = natural goods PVs → Rows = ecoservice present values ↓		Low-end $93	Middle* $196	High-end $322
Type A only/medians	$288	381	484	610
Type A only/means	$380	473	576	702
Mean for table			**679**	
Median for table			**684**	
Types A & C/medians	$573	666	769	895
Types A & C/means*	$660	753	856	382

*indicates estimates presented in detail in Tables 3-6.

Based on this analysis, the total value of New Jersey's natural capital appears to be about $681 billion, plus or minus $300 billion. A range of this magnitude is not surprising given the complexity of the ecosystems being analyzed and the uncertainties in each of the many component estimates that make up these grand totals. For reasons discussed below, the authors believe that even the higher estimates in Table 7 are probably conservative.

Conservatism of the Estimates

The results summarized above have to be regarded as initial estimates of economic value rather than as definitive conclusions. In part, this is due to the fact that those results had to leave out a number of sources of value, including (but not limited to) the following:

1. **Limited coverage**. This is perhaps the most important issue. Some ecosystems and ecoservices have not been very well studied, and some have not been studied at all. For example, the results do not reflect the value of the genetic data contained in New Jersey's natural capital, i.e., its plant and animal life. More comprehensive coverage would almost certainly increase the values shown in this report, since no valuation studies to date have reported values of less than zero.

2. **Scarcity value**. The valuations in Parts II and III probably underestimate shifts in the relevant demand curves as the supply of natural capital declines due to continued conversion of undeveloped land to other uses. Such shifts would in all probability result in an increase in society's willingness to pay for the natural capital that remains. If New Jersey's ecosystems are now smaller than assumed here, their value is therefore probably underestimated in this study. Such reductions appear likely as land conversion and development proceed; climate change may also adversely affect New Jersey's ecosystems, although the precise impacts are harder to predict.

3. **Omitted value components**. Because the value transfer method used for ecoservices in Part II is based on average rather than marginal cost, it cannot provide estimates of consumer surplus. However, this means that ecoservice valuations based on averages are more likely to *underestimate* total ecoservice value. (The valuations for natural goods in Part III *do* include estimates of consumer surplus and are thus more complete.) In addition, for various reasons, the benefits of ecotourism are discussed in Section IV.

4. **Externalities**. Distortions in the market prices used to estimate ecoservice values are unavoidably carried through the analysis. These prices do not reflect environmental externalities and are therefore again likely to be underestimates of "true" values.

5. **Secondary effects**. The values reported in Parts II and III only reflect "direct" effects, but "secondary" effects may also be important for some of the goods and services studied. When costs are incurred to produce and distribute natural goods, or when costs are avoided because natural ecoservices eliminate the need for investment in artificial substitutes, at least some of the expenditures made (or the expenditures made with funds saved) stimulate "secondary" economic activity, e.g., as when farmers purchase supplies or equipment or when employees of mining companies spend their wages on goods and services. These benefits are not reflected in the estimates in Parts II and III.

6. **Existence value**. The results do not fully reflect what economists refer to as "existence value". It is well known that people value the existence of certain ecosystems, even if they never plan to use or benefit from them in any direct way. Estimates of existence value in the peer-reviewed literature are rare, and fully including this "service" would again increase the total values.

All of these factors lead to *under*-estimates of value, and there are relatively few factors that would cause *over*-estimates (Part II presents a fuller discussion). The factors described above and other factors that could affect the results are discussed in greater detail in Parts II and III, as are some of the theoretical arguments surrounding the valuation methods used.

Section III: Other Ecosystem Services

As noted in Section II, the results presented in Part II of this report do not address all of the ecosystem services provided by New Jersey's natural capital. These deliberate omissions reflect various factors, including absence of peer-reviewed studies, unavailability of data, lack of accepted analytic techniques, etc. However, these omissions necessarily lead to an understatement of the total value of New Jersey's natural capital. To illustrate the potential magnitude of this understatement, this section presents analyses of several forest ecoservices for which peer-reviewed studies were not available for inclusion in Part II.

Carbon Storage

As this report was being finalized, the Intergovernmental Panel on Climate Change (IPCC) issued its long-awaited Fourth Assessment Report on the causes and consequences of global climate change (see www.ipcc.ch). The report contains the IPCC's clearest warnings to date on the adverse impacts caused by global warming and the ways in which human emissions of greenhouse gases (GHG's)—especially carbon dioxide—are worsening those impacts.

The results presented in Part II of the current study reflect the estimated value of the *sequestration* (removal from the atmosphere) by New Jersey's forests of carbon dioxide. For technical reasons, the current study does not discuss in detail the value of previous forest *storage* of carbon dioxide. Given the growing recognition of the importance of slowing the growth of GHG emissions, Appendix C presents some crude estimates of the value of the carbon storage service provided by New Jersey's forests, which could range from $3.5 to $10.4 billion in present value terms. Because they have not been published in peer-reviewed journals, these amounts are not included in the totals presented in this report, which again underscores the conservatism of this study's approach to valuing New Jersey's natural capital.

Other Forest Services

Carbon storage is not the only forest-related ecosystem service not discussed in Part II of this study. For example, due to a lack of peer-reviewed studies, Part II's estimated ecoservice value for forest land does not include two important services: 1) slowing stormwater runoff, thus reducing peak flows and decreasing the amount of stormwater storage capacity needed, and 2) removing pollutants like sulfur and nitrogen dioxides, carbon monoxide, ozone, and particulates from the air. Based on a non-peer-reviewed analysis, the value of these services from forests may total about $9.0 billion and $8.5 billion respectively in present value terms. Appendix D shows the derivation of these figures.

Section IV: Ecotourism Benefits

In addition to benefits from natural goods and ecosystem services, New Jersey also realizes other types of economic benefits related to the state's natural capital. Ecotourism is a prime example of this: while nature provides the essential setting for this activity, the benefits stem from the money that ecotourists spend rather than directly from nature *per se*. Spending related to ecotourism contributes to New Jersey's economy by supporting business and employment opportunities that result in the production of cash income. This section presents a preliminary estimate of those benefits. As will be discussed below, only a part of total ecotourism spending in New Jersey generates economic benefits for the state; but those benefits are nonetheless substantial, and their inclusion helps us present a more comprehensive picture of the total value of New Jersey's natural capital.

The most comprehensive recent report on spending by ecotourists in the United States was published in 2003 and was based on a survey conducted by the US Fish and Wildlife Service in 2001 (USFWS 2003a). That report provides data on the level of participation and the estimated spending by wildlife watchers, hunters, and anglers in each state, including New Jersey. [6] The report states that wildlife watchers, hunters, and anglers spent a total of $2.2 billion in New Jersey (in 2001 dollars) on travel-related expenses (meals, lodging, transportation, etc.), equipment, and other items.[7]

There is a well-established method for adjusting spending data and using it to estimate the economic effects of tourism, including ecotourism (see, e.g., Stynes et al. 2007a and 2007b); Appendix E contains a detailed summary. First, an amount estimated to equal the dollars that flow to out-of-state producers and suppliers (see above) is deducted from expenditures. As the remaining dollars (i.e., those captured by the New Jersey economy) are spent and re-spent, they support two types of "secondary" economic activity: purchases by one business from another and by employees and other income recipients (see Appendix E). The number of captured dollars is therefore increased to reflect this "multiplier" effect. The result is then adjusted downwards to eliminate double-counting of purchases and sales among firms and to deduct quantities such as depreciation and taxes that do not represent spendable household income.

Based on this methodology, NJDEP prepared an estimate of the annual benefits attributable to spending in New Jersey by wildlife watchers, hunters, and anglers; Exhibits A and B contain backup for the estimate. Using essentially the same approach (with differences as noted below), others had earlier prepared benefit estimates for all 50 states, including New Jersey (see USFWS 2003b, ASA 2002, and IAFWA 2002). Table 8 summarizes the assumptions and results of the two sets of analyses, together with a third estimate based on the average of the other two.[8]

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[6] Because of a lack of expenditure data, the term "ecotourism" as used here follows the USFWS usage and excludes swimming, skiing, and other types of outdoor recreation not directly related to wildlife.

[7] Of the $1.2 billion spent in New Jersey by wildlife watchers, about $0.8 billion was spent on items not detailed in USFWS (2003a) because of sampling issues. This lack of specificity warrants some caution in using the survey results.

[8] For technical reasons having to do with a desire to avoid "interaction terms", the middle estimate in Table 8 uses the geometric average rather than the more familiar arithmetic average.

Table 8: Estimated Annual Benefits to New Jersey from Ecotourism (2004 $MM)			
Variable	**NJDEP Estimate**	**Averaged Estimate**	**USFWS Estimate**
Ecotourism expenditures	$2,380	$2,342	$2,304
% captured by NJ	58%	77%	100%
NJ Direct Sales	$1,383	$1,798	$2,304
Avg. Sales Multiplier	1.57	1.70	1.85
NJ Total Sales	$2,176	$3,061	$4,254
Value Added/Total Sales	65%	n/a	n/a
NJ Gross State Product	$1,405	n/a	n/a
Sal.+Wages / Total Sales	40%	33%	27%
Salaries & Wages	$865	$1,012	$1,160
Jobs per $MM Total Sales	17.54	12.06	8.30
Total Jobs	38,173	36,910	35,305
Avg. Sal./Wages per Job	$22,657	$27,414	$32,843

As Table 8 indicates, none of the three earlier studies based on USFWS (2003a) presented estimates of the amount added by ecotourism to New Jersey's gross state product (USFWS 2003b, ASA 2002, and IAFWA 2002).

The differences in results in Table 8 stem mainly from two factors. First, the Department's estimate recognizes the fact that a substantial portion of the amount spent by wildlife watchers is remitted to out-of-state suppliers and therefore generates no economic benefits in New Jersey; this well-documented phenomenon is called "leakage". For example, when a bird watcher purchases a pair of European-made binoculars from a New Jersey retailer, the store retains its retail margin, and the rest of the purchase price is remitted to the European manufacturer. For such goods, only the dollars that comprise the retail margin (and the wholesale margin, if any) are "captured" by New Jersey and remain in New Jersey to benefit the state's economy. In the Department's judgment, the implicit USFWS assumption of an overall capture rate of 100% is not plausible.

The other factor leading to the differing results in Table 8 relates to how the two analyses divide up the estimated wage and salary income. Relative to the USFWS estimates, the Department's estimates show more jobs created but at a lower average salary. The backup for the Department's assumptions in this regard are presented in Appendix E and Exhibits A and B.

Based on the averaged estimates, ecotourism (defined here to include wildlife watching and recreational hunting and fishing) accounts for about $3.1 billion of economic activity, which supports about 37,000 jobs; this economic activity accounts directly and indirectly for a significant portion of New Jersey's Gross State Product and an estimated $1 billion of wage and salary income to New Jerseyans.

In interpreting the results in Table 8, two basic limitations must be kept in mind:

- First, where labor, materials, and other resources in an ecotourism area are fully employed, the economic activity associated with visitor spending will most likely use resources that would otherwise be employed elsewhere in the economy; as a result, if the amount of ecotourism changes, there may be *no net gain* in total economic activity but merely a reallocation of economic activity within or among sectors.

- Second, to the extent that ecotourists come from elsewhere in New Jersey, the benefits for the locality where a given ecotourism site is located may be offset by reduced spending elsewhere in the state, e.g., on visits to athletic events, local movie theaters, etc. In that regard, of the $2.2 billion of New Jersey spending (in 2001 dollars) reported in USFWS 2003a, only $0.2 billion came from non-residents; the other $2.0 billion came from New Jersey residents. Therefore, it is all but certain that the total amount of *new* spending in the New Jersey economy in 2001 was substantially less than $2.2 billion.

For these reasons, economists distinguish between economic "impacts" and economic "significance". If all of the resources available to provide goods and services to ecotourists would be fully employed elsewhere in New Jersey but for the existence of ecotourism, and if all the visitors to these sites were New Jersey residents, the net impact of ecotourism on the state economy might be nil, but ecotourism would still represent a significant share of the New Jersey economy. In a significance analysis such as the one presented above, the jobs, business opportunities, and income associated with ecotourism are not necessarily "new" to New Jersey, but they are nonetheless important and would need to be replaced if they did not exist. For further discussion of the difference between economic significance and economic impact, see Stynes et al. (2007A and 2007B) and Wells (1997).

As noted earlier, for reasons relating to the availability of data and analytic techniques, the complexity of the natural assets in question, and the number and type of economic benefits being evaluated, ecosystem services, natural goods, and ecotourism were analyzed differently in this study. As a result, care must be taken in comparing the results for ecotourism to those presented earlier for ecoservices and ecogoods. The issues are somewhat technical in nature and are described in Appendix B.

Section V: Potential Policy Applications

The studies undertaken thus far as part of the natural capital project make an important contribution to our understanding of the economic benefits provided by our natural environment. For them to make an equal contribution to public policy and environmental regulation, they must be applied in some way when decisions affecting our natural capital are made. The application of natural capital valuations to policy and regulatory decisions is still in its early stages, and there is no definitive guide yet in this area. However, some promising steps have been taken or proposed, and this section discusses some of the most interesting potential applications reported in the professional literature.

Planning Applications

Framing the discussion. At its most basic, the findings of this study are easy to summarize: land is economically valuable in its undeveloped state. Land provides economically valuable goods and services, and protection of land in its natural state can make economic as well as environmental sense. These statements may seem obvious, but given the large value of New Jersey's natural capital, they deserve emphasis. Grossman and Watchman (undated) collected a number of case studies in which determination and communication of nature's value apparently affected policy discussions and decisions.

Priority setting. In dealing with land use issues, State and local governments need to establish priorities for action in many areas, including but not limited to the following:

- land acquisition priorities—
  - groundwater recharge areas and critical water supply areas.
  - flood-prone properties needed to maintain stream corridor values and functions.
  - areas with the highest natural capital value, such as wetlands.
- project approval priorities—
  - wetland buffer and riparian corridor restoration and enhancement projects.
  - projects in areas environmentally appropriate for growth.
- planning criteria—
  - sustainable development and environmental protection criteria for state, regional and local planning and DEP grant-making.
  - environmental and sustainability criteria for State economic development initiatives and on-going activities.
- funding criteria—
  - DEP grant-making to local governments.
  - Environmental Infrastructure Trust financing.

While natural capital value is not a sufficient basis by itself for establishing such priorities, it can help in doing so by identifying and quantifying an important class of trade-offs, namely the economic benefits provided by natural capital vs. the asserted benefits of development.

Open space acquisitions. Land acquisition for open space preservation is one of the areas in which New Jersey's State and local governments need to set priorities. Where more than one acquisition opportunity presents itself, purchasers with limited funds must choose among those opportunities. The natural capital value of the tracts or parcels available for purchase could be one criterion, albeit not the sole one, in setting acquisition priorities.

Because open space status is a legal rather than a biophysical or ecological category, it was not taken into account in estimating the value of New Jersey's natural capital; the type of land use/land cover (LULC)—rather than the land's legal status—determines the variety and level of natural goods and services provided. However, the results in Parts II and III of this report can be combined with the Department's data on open space status by LULC to estimate the value of the natural capital represented by New Jersey's open space. Table 9 (next page) presents the results, which reflect both ecosystem services and natural goods.[9]

As Table 9 shows, protected open space and preserved farmland comprise 21% of New Jersey's total land[10] area (27.1% of the state's non-urban area) and at $206 billion makes up 24% of the state's total natural capital of $856 billion. In terms of ecoservices and ecogoods, protected open space in the aggregate has a higher average dollar value per acre ($5,272/acre/year) than unprotected land ($4,458/acre/year) because it includes much less lower-ecovalue land such as impervious urban land.

While these figures represent statewide totals and averages, similar calculations can be made for individual parcels being considered for purchase by State, local, and nonprofit organizations. Once the projected purchase price is known, the natural capital value per dollar of purchase price can be calculated. Since budgets for acquisitions are always limited, the resulting ratios can be used as one criterion in setting priorities among potential acquisition opportunities, as suggested in Ferraro (2006). The type of hedonic analysis described in Part II can also be applied to acquisition programs to assess the impact of such acquisitions on property tax assessed values.

It is important to note that while this approach assumes that an acre of protected wetland or forest provides the same level of goods and services as an unprotected acre, protected land can be expected to provide those benefits over a much longer time frame, giving it a higher present value. How much higher depends on what assumption is made regarding the future of the unprotected land (e.g., conversion to residential or other uses); since that factor is unknown, the incremental value of protection is difficult to estimate except conditionally, i.e., except based on an assumed year of conversion, with sensitivity analyses for a range of conversion dates.[11]

(text continues after table)

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[9] Because the ecosystem areas used in Parts II and III derive from different databases than the open space data used to construct Table 9, certain adjustments were made to allocate open space (including ADA areas) among ecosystems. This in turn was necessary because different ecosystems have different natural capital dollar values per acre. For example, portions of Forest and Other Urban open space were reallocated to Urban Green Space because no open space was coded directly to that ecosystem.

[10] As used in this report, "land" includes surface waters, unless the context clearly indicates otherwise.

[11] Some economists have developed empirical models to forecast the date of conversion, e.g., Irwin et al. (2006) and Templeton et al. (2006).

Table 9: Value of Natural Capital Represented by Preserved Farmland and Other Open Space (2004 $)							
Ecosystem	**Farm acres**	**Other acres**	**Total acres**	**$/acre/yr**	**$MM/yr**	**$000 PV/ac**	**$Bn PV**
Freshwater wetland	23,239	242,253	265,492	$11,803	$3,134	$393	$104.5
Forest	13,704	499,969	513,673	1,714	880	57	29.3
Saltwater wetland	1,114	109,473	110,587	6,269	693	209	23.1
Agriculture	77,889	41,875	119,765	6,229	754	210	25.1
Estuary/tidal bay	378	18,626	19,004	12,779	243	426	8.1
Beach/dune	1	4,223	4,223	42,149	178	1,405	5.9
Barren land	343	6,112	6,455	11,337	73	378	2.4
Open Fresh Water	604	34,419	35,023	1,686	59	56	2.0
Urban Greenspace	1,007	51,352	52,359	2,591	136	86	4.5
Riparian buffer	142	5,167	5,308	3,500	19	117	0.6
Coastal shelf	0	1,240	1,240	2,425	3	81	0.1
Other Urban	3,529	34,020	37,549	0	0	0	0.0
Total or Avg.	**121,950**	**1,048,729**	**1,170,679**	**$5,272**	**$6,172**	**$176**	**$205.7**
Rest of State			4,373,494	4,458	19,495	149	649.9
Statewide Total			5,544,173	$4,630	$25,667	$154	$855.6
Preserved share			21.1%		24.0%		24.0%
Forested wetlands 79.7%	18,521	193,067	211,588	11,811	2,499	394	83.3
Unforested wetlands 20.3%	4,718	49,186	53,904	11,768	634	392	21.1
Cropland 81.1%	63,178	33,966	97,144	6,890	669	230	22.3
Pastureland 18.9%	14,712	7,909	22,621	3,761	85	125	2.8

Sources:
Dollar values per acre are taken from Tables 5-6.
Acreage of State-Owned, Federally-Owned, and Nonprofit-Owned Protected Open Space in New Jersey.
Published in 1999 by NJDEP / Bureau of Geographic Information Services (BGIS), updated to October 2003.
Acreage through May 2002 for preserved farmland provided by the New Jersey Department of Agriculture.

As noted above, economic data alone are not a sufficient basis for making decisions on specific open space acquisition opportunities. For example, if one goal of an acquisition program is protection of water quality, priority might be given to parcels located within defined riparian corridors, even if those parcels are among the more expensive (on a per-acre basis) than others available for purchase. Ferraro (2006) shows one way of combining economic and "biophysical" data to maximize environmental benefits within a given open space acquisition budget by quantifying the ratio of benefits to acquisition costs.

Conservation planning. Within the broad category of open space acquisition, acquisition of land for species conservation and biodiversity protection presents some of the most important and difficult conceptual issues involving natural capital.[12] The Department (see Niles et al. 2004) has mapped the New Jersey habitats for various categories of endangered and threatened vertebrate animal species, e.g., those classified as endangered or threatened under the Federal Endangered Species Act, those so classified under State rules, etc. The mapping characterizes habitats by assigning them a "landscape" rank ranging from 1 to 5, with 1 representing areas capable of supporting rare species, and 5 representing areas that support the most critically imperiled species (those federally listed as endangered or threatened). The economic value of habitats comprising a given landscape rank can be analyzed in the same manner as the value of generic open space areas (see above), although once again, natural capital value is only one possible criterion for land preservation.

Protecting endangered and threatened species and their habitats is clearly a legitimate policy goal in its own right. However, numerous studies have shown that habitats supporting such species are not necessarily areas of high biological diversity and vice versa.[13] Therefore, conserving land to protect rare species and their habitats will not necessarily conserve the areas with the highest biodiversity value. In other words, the two policy objectives are different. The existing species habitat maps for New Jersey are based on a subset of the taxonomic groups (i.e., vertebrate animals) that make up a given area's full biological diversity, although the presence of endangered and threatened animal species in a given habitat can be viewed as one indicator of biodiversity value, albeit an imperfect one.

If we were able to define and map biodiversity value, it might seem that protection (or restoration) of biodiversity and maintenance (or enhancement) of the existing levels of ecoservices and natural goods would go hand in hand, since it is becoming clear that loss of biodiversity adversely affects ecosystem services (see, e.g., Worm et al. 2006). However, a new study by Chan et al. (2006) shows that conservation planning (in the sense of identifying overall land acquisition strategies and evaluating specific acquisition opportunities) can produce

[12] The term "biodiversity" is used loosely in a variety of ways, including the number of different species in a given area, the numbers of individuals in a given species, etc. The discussion here is sufficiently general that a precise definition is not required.

[13] See, for example, Arthur et al. (2004), Kareiva and Marvier (2003), Lawler et al. (2003), Maddock and du Plessis (1999), and van Jaarsveld et al. (1998).

different outcomes for biodiversity and for other ecosystem benefits, i.e., an acquisition strategy designed to maximize biodiversity may not maximize the total value of ecoservices.[14]

While the methods used by Chan et al. (2006) are too complex to summarize here, they provide a way to evaluate the trade-offs between biodiversity and other ecosystem benefits and to define a "best" acquisition strategy given the policymaker's objectives. Valuation of ecoservices and natural goods, i.e., of natural capital, is a key element of their approach, and natural capital values therefore have an important role to play in conservation planning. Further exploration of this role is an important priority for future research.

Budgeting. Like any capital asset, natural assets experience constant wear and tear throughout their lives; but whereas built capital such as structures and machinery eventually wears out and needs to be replaced, much of New Jersey's natural capital is potentially self-renewing. However, natural capital can exist in a healthier or less healthy state, and public agencies and interested private parties can contribute to ecosystem health, productivity, and longevity. For example, fire control (where fire is not a part of a natural ecological cycle) can extend forest life and thereby contribute to preservation of an economically valuable asset.

In addition, while much of New Jersey's natural capital has been degraded or destroyed over the years, some of it may be able to be restored through human investment and other activities, e.g., through reforestation, removal of unneeded impervious surfaces, provision of protected animal migration routes, temporary fishing moratoriums, etc. Some of these activities require regulation and enforcement, while others require capital investment in supportive infrastructure. In either case, the expenditures bring economic benefits to New Jersey beyond the satisfaction that many people feel at seeing natural environments preserved or restored.

Pollution control. Healthy ecosystems can impound, dilute, and biodegrade a number of air and water pollutants, and this fact is being capitalized on by various government agencies, e.g., New York City's watershed protection program (Chichilnisky and Heal 1998; Daily and Ellison 2002). Such ecosystem services may in some cases be able to function as supplements or alternatives to publicly-funded infrastructure and/or regulatory approaches to pollution control in meeting water and air quality objectives.

Risk management. In some cases, natural capital valuation can help inform decisions involving the safety of built infrastructure and lives. For example, research currently in progress documents the role that coastal wetlands can play in reducing wave height and storm surge, thereby moderating the effects of violent storms on coastal communities. The loss of such wetlands appears to have been a major factor in the damage caused to New Orleans by Hurricane Katrina. If the lost wetlands were valued on the basis of the damage to New Orleans which they might have helped prevent, the value per acre *for this one ecoservice* would exceed the total value for wetlands from all ecoservices presented in Section II. In effect, coastal wetlands can serve as a major component of a naturally "engineered" system of flood control. Such knowledge can help decision-makers avoid decisions that create undue risk for their communities.

[14] Of course, provision of species habitat is itself an important ecosystem service and as such is included in the estimates in Part II; the emphasis here is on the non-monetary value of protection of biodiversity as a consequence of habitat provision.

Municipal zoning. Where adequate data are available, the value of ecosystem services and natural goods for a given municipality can be mapped by property parcel and zoning class. Officials can then estimate the magnitude of the loss of ecosystem services and natural goods if a full build-out occurs. Similar estimates could be prepared based on hypothetical zoning scenarios. Information such as this can be helpful in assessing alternative futures for a given geographic area, thereby informing the development of master plans and zoning ordinances.

Sustainability measurement. Documents such as New Jersey Future (2000) put forward "sustainability" as a goal for New Jersey, and many New Jersey residents would probably endorse that goal, while differing on its definition and its relationship to economic "growth" or "development". An extended discussion of these issues is beyond the scope of this report; however, since environmental protection and enhancement is usually taken as one of the main components of sustainability, maintenance and restoration of natural capital is clearly required for New Jersey to be considered a "sustainable state". Given that, trends in the dollar value of the state's natural capital—both in the aggregate and by ecosystem—could be used as one indicator of movement towards or away from sustainability. Natural capital and the annual flow of benefits that it provides are also being used to supplement standard measures of economic activity such as Gross Domestic Product (see, e.g., Anielski and Wilson 2007).

Management Applications

Ecosystem management. As Farber et al. (2006) note, "Ecosystem management decisions inevitably involve trade-offs across [ecosystem] services and between time periods, and weighing those trade-offs requires valuations of some form" (cf. Foley et al. 2005). In other words, competing management strategies may affect different ecosystem services differently, and the choice among strategies always involves the valuation (usually implicit) of different services. For example, a decision to foster recreational use of a forest by providing access roads, parking, and other visitor facilities may reduce the value of the habitat protection services provided by the forest even as it increases public enjoyment of the ecosystem (and perhaps generates much-needed revenues). Similarly, a decision to allow farmland to revert to forest to increase carbon sequestration and other forestation benefits may entail loss of at least some of the ecoservices and natural goods provided by farmland (The Nature Conservancy 2006).

Farber and his colleagues (2006) argue that it is better for such decisions to be made with as much knowledge of the physical trade-offs as can reasonably be obtained and with explicit attention to the relative economic values of those impacts where these can be quantified. They also present a simplified approach to compiling and integrating these assessments by ecologists and economists, and they show how the approach can be applied to several different ecosystems. Even when the results of the analysis do not dictate the decision on management strategy, "the attempt to formalize changes in [ecosystem] service flows can be a useful management exercise in its own right" (Farber et al. 2006, p. 128). This approach shows great promise, and its applicability in the New Jersey context deserves exploration.

Cost allocation. An implicit assumption throughout this report is that economic value matters even if no money changes hands, i.e., non-cash values are important. For example, under current institutional arrangements, no money changes hands when forests sequester carbon or when wetlands impound floodwaters, even though these services benefit society and could be replaced by built infrastructure only at a considerable cost. This situation is a classic example of a *positive* environmental externality: private parties may under-invest in environmental protection because they do not realize the benefits of that investment (except to a minor extent in their capacity as individual residents of New Jersey).

A similar calculus applies to governmental bodies faced with a choice between preserving land in an undeveloped state or allowing development: development is often believed to produce additional tax revenues, i.e., cash, while undeveloped land produces only non-cash benefits, e.g., carbon sequestration, flood control, etc. The essential issue here is that the benefits provided by undeveloped land are outside the market economy, since no one has to pay to receive them.

In response to this externality, various efforts have been launched to develop systems of payment for ecosystem services (PES). Most of the PES projects thus far appear to be located in developing countries and seem to be motivated to a significant extent by the desire to secure new funding streams for conservation efforts (see, e.g., WWF 2007). In the United States, a concept known as the "ecosystem service district" or ESD has been developed by economists, legal scholars, and others; Heal et al. (2001) present a detailed exposition. Older models for ESDs include districts established to provide such services as conservation, drainage, natural resource management (e.g., parks), erosion control, water supply (e.g., irrigation), and flood control.

As envisioned by the developers of the concept, an ESD is a legal entity with powers established by statute to manage a given ecosystem to provide specified ecosystem services and the ability to charge what would amount to user fees to those who benefit from the services (Heal et al. 2001). Fee revenues would be used to defray the cost of maintaining the ecosystem in a healthy condition and to provide compensation to property owners where appropriate. Since the user fees would represent cash liabilities, they would address the problem of uncompensated externalities described above, thereby creating fiscal incentives for protection of valued ecosystems. Apart from the older models for ESDs cited above, these concepts appear at present to be largely at the theoretical stage in the US.

Tax policy. Like many states, New Jersey relies heavily on the local property tax to fund public sector expenditures, especially those involving local and regional school districts. Broadly speaking, property tax liability is based on the assessed value of the property in question and the tax rate per $100 of value. In many circumstances, assessment is determined by the property's "highest and best use", usually interpreted to mean the use producing the largest economic return. Very often that use may initially appear to entail use of the property for residential or commercial development, since preservation of land in an undeveloped state may at first appear to generate *no* economic benefits.

The results presented in this report make clear, however, that most undeveloped land in fact provides substantial economic value to society in the form of ecosystem services and natural goods, and that value can be estimated. Whether that value will outweigh the asserted value of development in any given case is a factual question, but estimating the value of land protected from development at least indicates to officials that the value of such land is not zero. The standard of "highest and best use" has already been tempered by preservation policy in the case of farmland, and the valuation results presented in this report may provide a factual basis for extending this to non-agricultural ecosystems.

Open space acquisition financing. A substantial body of research, including that presented in Part II, shows that proximity of residential parcels to protected open space usually enhances the value of those parcels, as indicated by differences in actual home sale prices after other factors are controlled for. Allowing for administrative lags, those increases in value should translate into increased property valuations and, assuming a constant tax rate, increased property tax revenues. If the rest of the local government budget remains constant, those increased revenues could be used to pay for the current open space acquisitions and/or to finance future acquisitions. This concept is presented in detail in Geoghegan et al. (2006).

It should be noted that the per-acre prices actually paid for land and the per-acre natural capital values described in this report will not usually be the same. Natural capital values include services to society that are not paid for under current institutional arrangements and that therefore do not form part of the land's private market value. On the other hand, market prices (at least for "undeveloped" parcels) will reflect the estimated value of the option to sell the land to a developer at a later date, which is not a natural asset but rather a financial one.

Eminent domain. Recent court decisions in Connecticut and other states have suggested that land not being used in the "highest and best" manner may be taken by eminent domain for "redevelopment" on the grounds that it constitutes blighted, unimproved, abandoned, or vacant land. The findings in this report indicate however that undeveloped land may have a substantial value that does not always merit characterization as blighted, unimproved, etc.

Natural resource damage assessment. NJDEP actively pursues a policy designed to make private parties pay monetarily for past damage to New Jersey's natural resources, especially the state's groundwater. Whether natural capital valuation can help define the appropriate level of those payments in specific situations is an area that may be worth exploring.

Conclusion

Economics, in the form of natural capital valuation, should not be the only factor in environmental decisions or even the most important; but it seems difficult to deny that it should be one of the major considerations. Even though the field has substantial room for growth (see Section VI below), valuation analysis has already generated results that shed considerable light on the stakes involved in decisions that affect ecosystems and other types of natural capital. The preceding paragraphs have suggested ways in which that information can help inform the decision-making processes in a variety of contexts and thereby hopefully lead to outcomes more beneficial to society as a whole than decisions made without that knowledge.

This section and the next highlight various research needs, and there is unquestionably much more to learn about ecosystems and their economic value. However, the absence of perfect information is not a reason to delay conservation actions. We will never have perfect information on any of the issues raised in this study, and in that respect ecosystem valuation is no different from any other complex area. Second, research and action provide feedback to each other; the influence does not all run from research to implementation.

In this regard, Heal (2000, pp. 125-126) argues that "incentives are critical for conservation" but valuation is "neither necessary nor sufficient". Heal's analysis emphasizes the creation of incentives that will lead self-interested private parties to invest now in conservation, possibly leading to objective valuations of the natural assets conserved and others of a similar nature (Heal 2006). Since New Jersey has conserved a significant amount of natural capital, it is hard to argue that valuation is *essential*, but numerous case studies indicate that valuation is important and helpful for conservation. Heal is surely correct, however, that valuation is not sufficient, and actions like those described in this section are needed to translate a better understanding of nature's economic value into effective conservation of our natural capital.

Section VI: Future Research Needs

No study of this type can be viewed as the final word on the value of New Jersey's natural capital. The amount of natural capital in the state, our understanding of how natural capital provides goods and services and of the factors that affect per-acre productivity, and the sophistication of our valuation methods all change over time. Therefore, the results presented in this report will therefore change as well. This suggests that policy applications of these results need to have the flexibility to accommodate such changes; it also suggests the need for further research, and this section describes some selected research needs.

Carpenter et al. (2006) identify a number of important research needs in the field of ecosystem assessment in general; those needs include a better understanding of such things as ecosystem dynamics (i.e., how ecosystems change over time), and especially abrupt, non-linear, or catastrophic change; trends in human reliance on ecosystem goods and services, especially noon-marketed ones; development of indicators of ecosystem health and productivity; and others. These needs affect all ecosystem valuation studies and are not limited to studies such as those presented in this report.

In terms of the current studies, Section II-IV and Parts II and III identify a number of areas in which further research would be helpful in refining our understanding of the value of New Jersey's natural capital. In addition, the following seem especially important:

Update results to reflect 2002 land use/land cover data. The amount of natural capital in New Jersey is constantly changing; the results in this report generally reflect 1995-1997 data on land use and land cover, and it is likely that more recent information would show less natural capital in the state due to conversion of land to residential, commercial, and other uses.

Attempt to address some of the gaps in the ecosystem grid. The gaps identified in Part II include gas and climate regulation provided by wetlands; disturbance prevention provided by freshwater wetlands; disturbance prevention, water supply, and water regulation provided by forests; and nutrient regulation, soil retention & formation, and biological control provided by a number of ecosystems. Finer breakdowns of certain ecosystems would also be useful in estimating ecoservice values, including deciduous vs. coniferous forests and forested vs. unforested wetlands. Some of these gaps might be able to be filled by high-quality "grey literature", i.e., non-peer-reviewed studies performed by government agencies and other organizations.

Develop landscape models for New Jersey. As Part II's discussion of dynamic spatial modeling shows, landscapes are integrated systems, and the provision of ecoservices and natural goods by one ecosystem is affected by its location relative to other ecosystems and to developed land. As a start, the Maryland model described in Part II could be calibrated and applied to one or more New Jersey watersheds or subwatersheds. Such modeling might also help us to better understand the relationships between production of services and production of goods.

Expand the economic analyses. The results presented in this report do not include the "multiplier effects" (indirect or induced economic benefits) supported by expenditures on natural goods or expenditures funded with savings generated through reliance on natural ecoservices, nor do they reflect the benefits of ecotourism (see NJAS 1996). Also, the results reflect "gross" economic benefits; if adequate information on producer costs could be developed, future studies could deduct those costs from gross benefits to obtain *net* economic benefits. It would useful as well to identify additional valuation studies (perhaps from the "grey" literature) for particular ecoservices based on the replacement cost method, since this gives an indication of the actual cash outlays that are avoided when important services such as water purification and flood control are performed by natural ecosystems, thereby directly affecting government budgets and tax burdens.

Develop an understanding of the impacts of climate change. Global climate change is a reality, and it will affect New Jersey. Changes in temperature, precipitation, growing seasons, populations of plant and animal diseases and predators, extreme weather events such as droughts, floods, and tropical storms, etc. will affect the make-up and amount of New Jersey's natural capital; human efforts to adapt to climate change are also likely to have an impact. We need a better understanding of the likely range for such changes based on our best understanding of the underlying dynamics of the climate system.

Explore the natural capital value of urban ecosystems. Parts II and III both make the understandable simplifying assumption that paved (impervious) surfaces contribute relatively little in the way of natural goods and services. However, a few studies have attempted to explore this area (see, e.g., Baltimore Ecosystem Study), and more might be done. This issue could be of particular relevance in the environmental justice context.

This list could be extended to include research on the policy applications discussed above.

Progress need not occur equally in all areas for the results to be useful. For example, if we develop a way to measure a previously unquantified ecoservice value for a given ecosystem, our inclusion of that value need not wait on our development of similar methods for other ecosystems. From a scientific viewpoint, the goal of our valuation efforts is to develop as comprehensive an inventory of values as possible, and the fact that one ecosystem may not be as fully analyzed as another is no argument against improving our valuations where we can.

In light of these and other gaps in our knowledge, the Department and interested outside agencies should consider formulating and funding an on-going program of ecosystem research to address the above questions and others that may arise. The current studies are an important start, but more can be done to improve both our understanding of the economic value of ecosystems and other natural capital and our ability to apply our understanding in concrete policy and regulatory contexts. The results presented in this report show that the stakes are high enough to warrant such an effort. Along with our human capital and built physical infrastructure, natural capital is an essential part of the foundation for New Jersey's future, and that foundation needs to be fully valued for us to wisely make the decisions that will affect our common future.

Appendix A: Provision of Services by Abiotic Systems

The bulk of Parts II and III of this report focus on biotic (living) systems, i.e., ecosystems. However, New Jersey also includes abiotic (non-living) systems of great importance, including air, water, and climate.[15] Valuing these types of natural capital presents special problems, as this appendix will discuss.

Air. The atmosphere, especially the portion closest to Earth's surface known as the troposphere, provides oxygen to breathe, which is essential for most forms of life. Because of this essentiality, the economic value of air as a natural good is in principle infinite and therefore cannot really be calculated. However, the atmosphere also functions as a pollution "sink" by absorbing (i.e., dispersing and diluting) air pollutants and thereby reducing their ability to cause morbidity (illness), premature mortality, reduced visibility, and other adverse impacts. It is tempting to consider the value of such pollution-related services as the value of the atmosphere as sink.

Any effort to do so, however, immediately runs into serious conceptual problems:

- In a series of Regulatory Impact Analyses under the Clean Air Act, the U.S. Environmental Protection Agency (EPA) has consistently found that well over 90% of the estimated benefits of the Clean Air Act are related to reductions in premature mortality.

- Those benefit estimates are based on the difference in health outcomes experienced with projected pollutant concentrations under the National Ambient Air Quality Standards (NAAQS) and under projected concentrations without NAAQS.

- We obviously cannot quantify the difference in health outcomes or pollution abatement and control costs with and without an atmosphere, nor does it make sense to attribute to the atmosphere any reductions in pollutant concentrations achieved through pollution abatement and control measures on the ground.

The root of the problem is that the adverse impacts of pollution in excess of any given level (whether NAAQS or a historical or natural background level) are caused by the pollution and not by the atmosphere. In theory one might be able to create a model of what New Jersey's air pollution levels would be (given existing or projected emissions levels in New Jersey and the "upwind" states) in the absence of the prevailing winds that blow across the state, and one could then value that feature of the atmosphere (the winds) in terms of the reduction in air pollution to the levels we actually experience. Such an exercise would involve complex air dispersion modeling and arbitrary assumptions for the counter-factual scenario; the values it produced would vary from day to day and season to season and would have a high degree of uncertainty as well. Such an exercise is beyond the scope of this project.

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[15] Land is dealt with in this report in terms of specific ecosystem types, i.e., specific patterns of land use and land cover.

Water. Parts II and III estimate the value of New Jersey's available water supply and the ecosystem services that help make that water available for human and other uses. However, water also functions as a sink for human and other wastes and therefore, like air, raises the issue of valuation of waste sink services. In this case, economists have been able to develop methods for estimating these ecoservice values, and a substantial part of the value of the marine ecosystem services presented in Part II represents waste dilution and "disposal" services provided by New Jersey's estuaries, tidal bays, and ocean waters with respect to one important class of wastes, namely nutrients such as nitrogen and phosphorus. The key difference from atmospheric sink services is that for water we can estimate the physical amount of waste actually removed from New Jersey, and therefore we can also estimate the cost of dealing with that volume of waste using built infrastructure such as sewage treatment plants.

Climate. As a final element of New Jersey's abiotic natural capital, we can cite the state's climate, which is part of the global climate system. As part of the public debate over the proper course of action to address the dangers posed by global warming, there have been a number of attempts to assign a value to the global climate system, or at least to a given level of change in that system. However, those efforts all suffer from various limitations, and this area of economics is still very much in a developmental stage. Therefore, while New Jersey's climate clearly affects the state's infrastructure, energy use, quality of life, etc., we make no attempt in this report to estimate the value of our climate system.

Appendix B: Assumptions Made in Combining Results

The differences between natural services, natural goods, and ecotourism led to several differences in analytic approach that had to be reconciled in combining the results of Parts II and III. This appendix discusses those differences and their treatment.

Scenarios. The value transfer analysis (VTA) for ecosystem services in Part II was based on a large number of earlier studies, including Type A (original peer-reviewed research) and Type C (peer-reviewed meta-analyses) studies. Each such study reported one or more estimated values for a given cell in the ecosystem matrix (see Sec. II), i.e. for a given ecosystem service provided by a given ecosystem, and multiple values could be represented by their mean or their median. This approach produced four sets of results, depending on whether both Type A and Type C studies were counted and whether the mean or the median was used as the summary measure:

Table 10: Ecoservice Results		
	Means	Medians
Type A and C studies	X	
Type A studies only		

The results presented in Sec. II for ecoservices are those based on the means for both Type A and Type C studies ("X" in Table 10). Similarly, the results presented for natural goods are those for the middle case reported in Part III rather than for the high-end or low-end cases.

Classifications. In reporting results, Part II grouped barren and urban land but separated urban green space on the rationale that neither barren nor paved urban land produce a significant level of ecosystem services as compared with urban green space. However, urban ecosystems are complex entities that combine impervious and permeable space in complex patterns that differ considerably from truly barren land such as quarries. Therefore, Part I groups urban and urban green space but separates barren land. Similarly, Part II treats forested and unforested wetlands as a single category because the literature on ecosystem services is not yet adequate to support a meaningful distinction between the two. However, Part III separates these ecosystems because forested wetlands produce some amount of timber while unforested wetlands do not.

Farmland. After Part II had been completed, it was determined that a substantial amount of "grassland" classified as pastureland should have been classified as cropland; the error was due to difficulties in interpreting aerial photos of fields containing row crops. To correct this, the total agricultural acreage (pastureland plus cropland) from Part II was reallocated to reflect the breakdown of the two in USDA farm data for New Jersey (81% cropland and 19% pastureland, excluding dwellings, roads, woodlots, etc.). The values per acre from Part II were then multiplied by the new acreages to obtain total values for cropland and pastureland.

Present Values. Parts II and III reported detailed results in the form of dollars / acre / year; Part III also reported present value results (dollars / acre) but Part II did not. For the summary presented in Part I, present values were computed for ecoservices based on the annual values reported in Part II and in a manner consistent with the present value calculations in Part III.

Harvest Levels. Part II used studies involving a wide range of individual sites at various locations, mainly in temperate latitudes. For any given study site, the reported ecoservice values implicitly reflect the level of natural goods harvesting for that site. Those harvest levels may differ from the New Jersey levels, but the data for assessing the degrees of difference is rarely available. Therefore, the summary of results presented in Part I assumes that the harvest levels presented in Part III are compatible with the ecoservice levels presented in Part II.

Value Metrics. The differences in analytic approaches among ecosystem services, natural goods, and ecotourism led to the reporting of different measures of economic value in Parts I-III of this report, as the following table indicates.

Table 11: Comparison of Value Measures
(values for blank cells were not estimated in this study)

	Ecosystem Services	**Natural Goods**	**Ecotourism Benefits**
Total Willingness to Play		Total Economic Value	
- Consumer surplus (CS)		Estimated from MV	
= Market value (MV)	"Shadow" price (≈ market value)	In situ value + harvest or extraction cost	Total sales (net of leakage)[16]
- Cost of goods/services sold		Only available for farm products	Business-to-business sales
= Value added		Net farm income	Value added
- Capital costs & taxes			Capital costs/taxes
= Producer surplus			Income
+ Consumer surplus (CS)		Estimated from MV	
= Net economic value	*Ideal measure of net economic benefit to New Jersey*		
Employment (jobs)			Part of above quantities

Note: boldface indicates best estimate produced in the present study (see below).

If we start with market value as the sole measure available for all three value sources, the determination of net value or net benefit would require adding consumer surplus (CS) and deducting producer costs (PC). In those terms, the three sets of estimates compare as follows:

Table 12: Components of Value Metrics

	CS not included	**CS included**
PC deducted	ecotourism values	net benefit to society
PC not deducted	ecoservice values (market value)	natural goods values

While the natural goods and ecotourism value measures approach the closest to net economic value, the ecoservice analysis produced the most detailed coverage, dealing with 12 ecosystems x 12 ecoservices = 144 combinations, of which only 11 were ruled out a priori.

[16] From the broader perspective of the US economy as a whole, ecotourism spending that leaks from New Jersey still accounts for economic benefits for the US as long as the spending is captured by another state rather than a non-US producer.

It is also worth noting that, like ecotourism, ecosystem services and goods support secondary economic activity. By providing economically important services at relatively low cost, ecosystems save society money which can be spent in other economic activities, while the dollars spent to purchase ecosystem goods support secondary activity as they are re-spent by the firms and employees that harvest or extract the goods in question. Except for ecotourism itself, these secondary effects could not be investigated within the time and resource constraints of the present study. This fact represents a further source of conservatism in the estimated values for ecosystem services and natural goods.

Appendix C: Carbon Storage Benefits

As the main text notes, this study does not address in detail the economic value associated with the long-term storage of previously-emitted carbon dioxide in New Jersey's forests, as distinguished from the on-growing sequestration or removal from the air of additional carbon dioxide (which *is* addressed in Part II). Table 13 below presents some crude estimates of the value of the carbon storage service provided by New Jersey's forests.

Table 13: Value of Forest Carbon Storage Services				
Prior Studies Used Metric for Studies	**Type A Only Mean**	**Type A Only Median**	**Types A+C Mean**	**Type A+C Median**
MT-C stored/ha*	191.34	191.34	191.34	191.34
Acres per hectare	2.471	2.471	2.471	2.471
MT-C stored/ac	77.44	77.44	77.44	77.44
2004 $/MT-C**	$92	$31	$82	$31
2004 $/acre	$7,087	$2,362	$6,378	$2,362
NJ forest acres***	1,465,668	1,465,668	1,465,668	1,465,668
PV (Bn of 2004 $)	$10.4	$3.5	$9.3	$3.5
Amortization rate/yr	3.0%	3.0%	3.0%	3.0%
MM of 2004 $/yr	$312	$104	$280	$104
Avg. remaining life (yr)	50	50	50	50
Net PV (Bn 2004 $)	$5.042	$1.681	$4.538	$1.681
MM of 2004 $/yr	$151	$50	$136	$50

Type A studies = original research published in peer-reviewed journals
Type C studies = analyses of original research published in peer-reviewed journals
MT-C = metric tonnes of carbon (1 MT = ~ 2,205 lbs.)
MT-CO_2 = metric tonnes of carbon dioxide (1 MT-C = ~ 3.667 MT-CO_2)
ha = hectare (1 ha = ~ 2.471 acres); ac = acre
PV = present value; Bn = billions; MM = millions

*estimate by NJDEP using the NCASI Carbon On-Line Estimator (see References);
includes trees (live and dead), woody debris, forest understory, and organic soil carbon.
**carbon prices used in valuation of forest carbon sequestration in Part II;
prices shown are equivalent to between $8 and $25 per MT-$CO_2$.
***NJ forest acreage from Part II, including farm woodlots but excluding forested wetlands.

The estimates presented in the middle of Table 13 are based on the assumption of an indefinitely long life span for the existing trees and other carbon-containing plants in New Jersey's forests. The reality, of course, is that those trees and plants will not live forever; and as they die and decay, some part of the carbon they are currently storing will gradually be released to the atmosphere, reducing the value of the carbon storage service they are providing. Another part of the carbon currently stored may simply be converted to another form, e.g., fallen trees may become woody debris and then soil organic carbon, with some loss of stored carbon as the decay process proceeds.

Estimating the overall rate of reduction of carbon storage benefits is technically challenging, in part because each carbon-containing component of a forest has a different average life span. Carbon is usually accounted for in terms of six distinct carbon "pools": live trees, standing dead trees, fallen dead wood, understory vegetation, forest floor, and soil organic carbon. Carbon in harvested wood (forest products) also has to be accounted for. If the carbon in wood products is not included, the calculation of carbon stock change for the forest area that is harvested will indicate that all of the removed carbon was immediately released to the atmosphere, thus leading to significant overestimation of the emissions to the atmosphere.

If all forest plant life had the same average remaining life, and *if* an equal amount of the carbon currently stored was released each year, the carbon storage benefit could be adjusted to reflect the assumed life span and decay pattern. For example, Table 13 shows the net benefits based on an assumed average remaining life span of 50 years for *all* carbon-containing forest components and assuming that an equal amount of carbon is released to the atmosphere every year during that time. As can be seen, under these assumptions the adjusted or "net" benefits are roughly *half* of the theoretically available amount.

This entire subject is the focus of a great deal of active research, and new estimating techniques are likely to be developed in the coming years, especially as reforestation and afforestation become important sources of "offsets" or "credits" under cap and trade systems for carbon emissions. It is clear, however, that the value of carbon storage may be very large *and* that estimates of that value may be very sensitive to changes in the initial assumptions. Because of the technical complexity of this subject, carbon storage was not addressed in the present study.

Appendix D: Additional Forest Ecoservices

As the main text notes, ecosystems provide economically valuable services that are not fully reflected in this report due to a lack of adequate peer-reviewed studies. Two of the specific examples given were as follows:

- the services that forest land provides by slowing stormwater runoff, which reduces peak flows and thereby decreases the amount of built stormwater storage capacity needed.

- the services that trees provide by removing pollutants such as sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, and particulates from the air.

If natural ecosystems did not provide these services, they would need to be provided by built infrastructure to provide the same levels of environmental quality. The question is how to estimate the dollar value of the services.

In 2003, the nonprofit organization American Forests, in conjunction with the United States Forest Service, published a study entitled Urban Ecosystem Analysis, Delaware Valley Region: Calculating the Value of Nature, that examined these services and others. The study focused on the Delaware Valley, defined as the region including Bucks, Chester, Delaware, Montgomery, and Philadelphia Counties in Pennsylvania and Burlington, Camden, Gloucester, and Mercer Counties in New Jersey. Table 14 below shows the result of converting the study's findings to a per-acre basis and then applying them to New Jersey's 1.5 million acres of forest.

Table 14: Estimated Value of Stormwater Control and Air Pollution Abatement Services provided by New Jersey Forests (excluding forested wetlands)

Parameter	**Stormwater**		**Parameter**	**Pollution**
9-county study area (acres)	963,163	*	9-county study area (acres)	963,163
Cubic feet stored/acre	3,011		Lbs. removed per acre per yr.	75.8
Bn cubic feet stored	2.900	*	MM lbs. removed/year	73
Replacement cost/cu ft	$2.03		Replacement cost/lb.	$2.29
One-time replacement cost $Bn	$5.900	*	Annual replacement cost $MM	$167
9-county study area (acres)	963,163	*	9-county study area (acres)	963,163
One-time replacement cost/acre $	$6,126		Annual replacement cost/acre $	$173
NJ acreage (Forest only)	1,465,668		NJ acreage (Forest only)	1,465,668
Present value of ecoservice $Bn	**$8.978**		**Annual ecoservice value $MM**	**$254**
Amortization rate/yr in perpetuity	3.0%		Discount rate/year in perpetuity	3.0%
Annual ecoservice value $MM	**$269**		**Present value of ecoservice $Bn**	**$8.471**

Source: * = American Forests (2003); all others = calculations by NJDEP.

The replacement costs are based on the estimated costs of the most relevant built alternatives, e.g., construction of stormwater retention ponds and other engineered systems. The two services have a total annual value of $523 million and a total present value of $17.4 billion. If confirmed through external peer review, these two services alone would add significantly to the total value of New Jersey's natural capital.

Appendix E: Estimated Benefits of Ecotourism

The standard method used to estimate the economic effects of activities such as ecotourism spending is somewhat involved but can be summarized as follows (capitalized terms are standard usage in this field).

Basic Concepts

1. Total Spending is multiplied by the Capture Rate to obtain *Direct Sales*. The capture percentage may be less than 100%, reflecting the fact that visitor spending on some goods and services is paid to out-of-state suppliers and generates no economic benefits in New Jersey; this phenomenon is called Leakage. For example, when a bird watcher purchases a pair of European-made binoculars from a New Jersey retailer, the store receives its "retail margin", and the rest of the purchase price is remitted to the European manufacturer. Only the dollars that comprise the retail margin (and possibly the wholesale margin, if any) would potentially remain in New Jersey to benefit the state economy. Leakage and capture factors vary by type of good or service; since different capture rates apply to the retail and wholesale margins, those margins are subtracted from Total Spending before capture rates are applied to the various spending categories; the margins are multiplied by their own capture rates.

2. The flows of cash payments involved in Direct Sales generate two types of "secondary" economic activity for each dollar spent: the purchases of goods and services by businesses generate "indirect" effects, and the spending of income creates "induced" effects. Examples of these are as follows:

   - A motel that derives its business from overnight visitors to a nearby site must purchase bed linens, electricity, and other inputs, thereby contributing to the demand for the output of producers of linen goods, electric utilities, etc. Such impacts are known as Indirect Sales. (As noted above, only the value added by each such firm is included in GSP.)

   - Similarly, as the employees and proprietor of the motel spend the income *they* receive, a separate stream of economic activity is generated, referred to as Induced Sales. Purchases of food and clothing by motel employees are a good example of such sales.

   The initial "rounds" of both indirect and induced sales are followed by subsequent rounds, although the economic stimulus decreases at each round. The sum of the direct and secondary sales is termed Total Sales.

3. To quantify this *Multiplier Effect*, Direct Sales is multiplied by a *Sales Multiplier* (derived from the economics literature or prior studies) to obtain *Total Sales*; Secondary Sales equals the difference between Total and Direct Sales. For example, a multiplier of 1.5 means that for each dollar of Direct Sales, 50 cents of Secondary Sales are generated, resulting in Total Sales of $1.50. Multipliers vary according to the type of goods or services involved. The multiplier effect decreases at each round of spending, since at each round some of the dollars spent will go to out-of-state suppliers and some will go for the non-income components of Value Added (see below).

4. Total Sales is multiplied by a value-added percentage (less than 100%) to obtain *Value Added*, which constitutes the net contribution to Gross State Product (GSP)), the generally accepted measure of aggregate economic activity in a state. The retail vendors that provide goods and services to ecotourists purchase inputs from other businesses, e.g., food, utilities, etc. The cost of such inputs is reflected in the retail price paid by ecotourists and is therefore part of the retailer's revenue, but the same amount (minus the retail margin) is also revenue for the wholesalers (if any) and for the producer (minus any wholesale margin).. The use of the value-added percentage avoids double- or triple-counting of these revenues so that GSP will include only the value that each business adds to the inputs it purchases, i.e., sales receipts minus input costs. This is the most accurate measure of an industry's contribution to a state's economic output.

5. Value Added is multiplied by an income percentage (less than 100%) to obtain *Income*.[17] This adjustment reflects the fact that Value added includes three main components: compensation to proprietors and employees (including employee benefits), gross operating surplus, and taxes on production and imports. Gross operating surplus includes profits, economic rents, net interest, allowances for capital consumption (related to depreciation), changes in inventory levels, and certain other items. Taxes on production and imports include state and local property, gross receipts, and sales taxes, Federal excise taxes, customs duties, and certain other levies. Given the complex makeup of value added, it is clear that only employee (and proprietor) compensation represents personal income to New Jerseyans. The ratio of such income to total value added varies depending on how labor-intensive a given sector (lodging, restaurants, etc.) is and on the wage and benefit structure for that sector.

6. Economic activity obviously generates and supports jobs. To quantify this effect, Total Sales is multiplied by the Jobs Multiplier, i.e., the number of jobs supported per million dollars of Total Sales, to obtain *Employment* or *Jobs*. Like the other multipliers and percentages mentioned above, this factor varies from industry to industry and is usually taken from the related economics literature and prior economic impact studies. The salaries for such jobs are not additional benefits but rather are included in Total Sales, Value Added, and Income.

Sources of Spending Data

Within the broad category of "ecotourism", various sub-categories can be distinguished. Some Authorities limit ecotourism to *sustainable* ecotourism, e.g., International Ecotourism Society (1991) and World Conservation Union (1996). While this usage focuses needed attention on the damage to natural systems associated with mass tourism, it is more appropriate for present purposes to consider all ecotourism, whether sustainable or not, while recognizing that the true value of ecotourism should ideally be calculated net of ecotourism's negative impacts. Similarly, while some might not consider hunting and fishing as types of ecotourism, the present study is

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[17] It should be noted that income is sometimes expressed as a function of sales, i.e., Income = Sales x Income Multiplier, or Jobs = Sales x Jobs Multiplier. However, if the ratio of value added to sales is known, this type of income multiplier can be converted to an equivalent income multiplier expressed as a percentage of value added, and this is the approach used in this report. Similar considerations apply to jobs multipliers.

aiming for the most comprehensive possible coverage of natural capital, and therefore this report includes these activities.

An earlier study by staff at the New Jersey Department of Environmental Protection provided estimates for the value associated with visits to New Jersey's State Parks and Forests (Mates and Reyes 2007). That study, however, was limited by design to State parks, forests, and recreation areas and did not include other State lands (e.g., wildlife management areas), lands owned by other levels of government (e.g., county, municipal, and Federal), or privately-held lands. In addition, it implicitly covered all types of outdoor recreation, including both ecotourism and such activities as swimming, cross-country skiing, etc. For these reasons, it is not an ideal source of value estimates for the present study.

As noted in the main text, the 2001 survey conducted by the US Fish and Wildlife Service (USFWS 2001) is the most comprehensive study of the economic benefits of ecotourism. That study, which provides detailed data on estimated spending by wildlife watchers, hunters, and anglers in each state, including New Jersey, is the main data source used in the present analysis.

Sources of Multipliers

The economic effects of ecotourism vary by type of spending, and this analysis therefore requires that values be available *by expenditure type* for seven parameters as follows:

- wholesale margin, retail margin, and capture (or leakage) rate
- sales multiplier (ratio of total to direct sales)
- value-added multiplier (ratio of value added to total sales)
- income multiplier (ratio of income[18] to total sales or to value added)
- employment or jobs multiplier (usually expressed as jobs supported per million dollars of total sales or income)

Information of this type is not readily available through non-commercial sources; even the Bureau of Economic Analysis of the US Department of Commerce charges for providing such information. Fortunately, a suitably detailed model developed for the National Park Service is available on-line at no charge; that model contains default values for geographic areas of various sizes, including rural areas, small cities, metropolitan areas, and entire. The model was developed by Daniel Stynes and other economists at Michigan State University; the version currently available is dated 2001 and is called "MGM2" for Money Generation Model, Version 2. See the References below for a link to the full model, a simplified version, and an accompanying manual. With a few exceptions, the parameter values used here are the MGM2 values for entire states (as opposed to smaller urban or rural areas within states).

Based on the spending survey data in USFWS (2001), Exhibit A presents the detailed calculation of the economic benefits to New Jersey of in-state ecotourism, defined to include wildlife watching, hunting, and fishing, but not outdoor recreational activities like swimming,

[18] Ideally, this would be total income, but in the current study only wage and salary income multipliers were available.

skiing, etc. Exhibit B provides detailed explanations of the calculations and notes a few exceptions to the use of MGM2 parameter values. The main text summarizes the results.

Limitations of the Ecotourism Results

The standard method for estimating economic activity value, which is the method used in this study, has a number of inherent limitations. First, as noted in the main text and in Tietenberg (2000), secondary benefits should only be counted if the increase in demand generated by visitor spending leads to the employment of previously unused or underused resources, e.g., labor. This is most likely to occur in areas with high unemployment. If the increase in demand merely results in a reallocation of previously employed resources among economic sectors, the "increase" in economic activity is not a true increase from an economic *impact* perspective, although it can properly be counted in an analysis of economic *significance* (see, e.g., Wells 1997 and Stynes (A) and (B)).

A second limitation derives from the fact that economic activity analysis is a type of partial equilibrium analysis which is based on input-output models. Such models tend to overstate the labor component of value-added because they use average production costs rather than marginal costs. Even computable general equilibrium (CGE) models may do this, although to a lesser degree (Lahr 2006).

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Exhibit A: New Jersey Ecotourism Benefits (2004 $)										
Type of Expenditure	**Gross Spending**	**Wholesale Sector**	**Wholesale Margin**	**Wholesale Margin ($)**	**Retail Sector**	**% Retail Margin**	**$ Retail Margin**	**Spending - Margins**	**NJ % Capture**	**Direct Sales**
1	2	3	4	5	6	7	8	9	10	11
Food-groceries	$107,897	Groceries	11%	$12,317	Groceries	29%	$30,966	$64,614	53%	$34,246
Food-restaurants/bars	70,590	n/a	n/a	0	n/a	n/a	0	70,590	100%	70,590
Lodging-camping	21,870	n/a	n/a	0	n/a	n/a	0	21,870	100%	21,870
Hotel/motel/cabin/B&B	26,769	n/a	n/a	0	n/a	n/a	0	26,769	100%	26,769
Transportation	107,524	Petrol prod	9%	9,600	Gas sta.	19%	20,645	77,279	29%	22,411
Privilege/other fees (A)	87,956	n/a	0%	0	n/a	n/a	0	87,956	100%	87,956
Boating costs (Note B)	156,464	Petrol prod	9%	13,970	Gas sta.	19%	30,041	112,453	29%	32,611
Heating/cooking fuel	551	Petrol prod	9%	49	Gas sta.	19%	106	396	29%	115
Bait / ice (Fishing only)	43,078	Groceries	11%	4,917	Groceries	29%	12,363	25,798	53%	13,673
Total "trip" costs	**622,698**		**7%**	**40,853**		**15%**	**94,121**	**487,724**	**64%**	**310,241**
Activity equipment	347,279	Misc.	14%	47,246	Sport'g gds	39%	134,744	165,289	4%	6,612
Auxiliary equipment (C)	46,214	Apparel	18%	8,135	Cloth'g stor	46%	21,074	17,005	7%	1,190
Special equipment (D)	316,792	Motor veh.	15%	47,200	Motor veh.	21%	66,526	203,066	3%	6,092
Magazines/books	21,153	Misc.	14%	2,878	Sport'g gds	39%	8,207	10,068	4%	403
Member dues/contribs.	48,495	n/a	n/a	0	n/a	n/a	0	48,495	100%	48,495
Plantings	23,346	Farm prod	4%	852	Garden sup	32%	7,354	15,140	53%	8,024
Miscellaneous (E)	53,047	n/a	n/a	0	n/a	n/a	0	53,047	100%	53,047
Equip/other-specified	**856,326**		**12%**	**106,311**		**28%**	**237,905**	**512,110**	**24%**	**123,863**
Equip/other-unspecified	901,403	Average	12%	111,907	Average	28%	250,428	539,068	24%	130,383
Wholesale margins								259,071	91%	235,755
Retail margins								582,454	100%	582,454
GRAND TOTAL	**2,380,427**		**11%**	**259,071**		**24%**	**582,454**	**2,380,427**	**58%**	**1,382,696**

A. Equipment rental, guide fees, pack trips, and access fees.
B. Boat launching, mooring, storage, maintenance, insurance, pumpout fees, and fuel.
C. Tents, special clothing, etc.
D. Boats, campers, 4x4 vehicles, cabins, etc.
E. Land leasing and ownership, licenses, stamps, tags, and permits.

continued on next page

Exhibit A: New Jersey Ecotourism Benefits (2004 $), cont.										
Type of Expenditure	Producer Sector	Direct Sales	Sales Multiplier	Total Sales	% Added to GSP	$ Added to GSP	Salary + Wage %	Salary + Wage $	Jobs/$MM Tot Sales	Tot Jobs Supported
1	12	13	14	15	16	17	18	19	20	21
Food-groceries	Food proc.	$34,246	1.57	$53,766	40%	$21,506	57%	$12,258	7.70	414
Food-restaurants/bars	Eating/ drinking	70,590	1.64	115,768	56%	64,830	66%	42,788	21.34	2,470
Lodging-camping	Other lodg'g	21,870	1.61	35,211	41%	14,437	49%	7,074	10.53	371
Hotel/motel/cabin/B&B	Hotels/lodg.	26,769	1.70	45,507	60%	27,304	63%	17,202	16.14	734
Transportation	Petrol refin	22,411	1.37	30,703	26%	7,983	42%	3,353	2.67	82
Privilege / other fees (A)	Recreation	87,956	1.66	146,007	61%	89,064	61%	54,329	21.34	3,116
Boating costs (Note B)	Petrol refin	32,611	1.37	44,677	26%	11,616	42%	4,879	2.67	119
Heating/cooking fuel	Petrol refin	115	1.37	158	26%	41	42%	17	2.67	0
Bait / ice (Fishing only)	Food proc.	13,673	1.57	21,467	40%	8,587	57%	4,895	7.70	165
Total "trip" costs		**310,241**	**1.59**	**493,264**	**50%**	**245,368**	**60%**	**146,795**	**15.15**	**7,471**
Activity equipment	Sport. gds.	6,612	1.62	10,711	52%	5,570	57%	3,175	10.54	113
Auxiliary equipment (C)	Apparel mfg.	1,190	1.58	1,880	42%	790	73%	577	12.46	23
Special equipment (D)	Misc. mfg.	6,092	1.59	9,686	48%	4,649	60%	2,789	10.72	104
Magazines/books	Misc. mfg.	403	1.59	641	48%	308	60%	185	10.72	7
Memb/dues/contribs.	Recreation	48,495	1.66	80,502	61%	49,106	61%	29,955	21.34	1,718
Plantings	NJ turf/sod	8,024	1.78	14,309	65%	9,237	62%	5,684	20.43	292
Miscellaneous (E)	Recreation	53,047	1.66	88,058	61%	53,715	61%	32,766	21.34	1,879
Equip/other-specified		**123,863**	**1.65**	**205,787**	**60%**	**123,375**	**61%**	**75,131**	**20.10**	**4,136**
Equip/other-unspecified	Average	130,383	1.65	215,579	60%	129,246	61%	78,706	20.10	4,333
Wholesale margins	Wholesale	235,755	1.57	370,135	67%	247,990	60%	148,794	10.47	3,875
Retail margins	Retail	582,454	1.53	891,155	74%	659,455	63%	415,457	20.60	18,358
GRAND TOTAL		**1,382,696**	**1.57**	**2,175,920**	**65%**	**1,405,434**	**62%**	**864,883**	**17.54**	**38,173**

see Exhibit B (next page) for explanatory notes

EXHIBIT B: CALCULATION OF ECOTOURISM BENEFITS IN EXHIBIT A	
Column	**Source or Calculation**
1-2	Type of expenditure and amount in 2004 $. Converted from 2001 $ as reported in USFWS (2001). Allocations of food and lodging based on NJDEP analysis of data in source; available on request from the author.
3	Most similar wholesale sector from US Census Bureau (BW/05-A).
4	Wholesale margin for sector in Col. 3, expressed as % of retail prices, derived from data reported in US Census Bureau (BW/05-A).* Margins for Activity goods and Magazines/books derived from average of margins for Misc. durables and non-durables.
5	Col. 2 x Col. 4.
6	Most similar retail sector from US Census Bureau (BR/05-A).
7	Retail margin for sector in Col. 6, expressed as % of *retail* prices, as reported in US Census Bureau (BR/05-A).
8	Col. 2 x Col. 7.
9	Col. 2 – Col. 5 – Col. 8
10	Share of Col. 9 spending captured by the NJ economy; other spending flows out of the NJ economy to other states or countries. Default value is 100%, i.e., complete capture by NJ. Other values are from Stynes et al. (2000) with adjustments as follows: -Boating costs and heating and cooking fuel %'s assumed equal to petroleum products (see above). -Bait and ice %'s assumed equal to groceries; Magazine and book % assumed equal to sporting goods (see above). -Plantings % assumed equal to groceries (most similar category available in Stynes et al. 2000). -Capture %'s for specified and unspecified portions of Equipment/other spending assumed equal.
11, 13	Col. 9 x Col. 10. Equals portion of Col. 9 spending "captured" in the NJ economy.
12	Except for Plantings, most relevant producer sector from Stynes et al. (2000).
14	Multiplier for Col. 12 producer sector from Stynes et al. (2000).
15	Col. 13 x Col. 14. Equals total economic activity, including direct, indirect, and induced sales.
16	Multiplier for Col. 12 producer sector, derived from Stynes et al. (2000) multipliers expressed as %'s of total sales.
17	Col. 15 x Col. 16. Equals portion of Col. 15 that forms part of the NJ Gross State Product (GSP); other portions of Col. 15 are deducted from GSP to avoid double-counting.
18	Multiplier for Col. 12 producer sector, derived from Stynes et al. (2000) multipliers expressed as %'s of total sales.
19	Col. 17 x Col. 18. Equals portion of Col. 17 that represents personal income to salary & wage earners, including employee benefits.
20	Multiplier for Col. 12 producer sector from Stynes et al. (2000).
21	Col. 20 x Col. 15 / 1,000. Represents no. of jobs supported by economic activity shown in Col. 15. Not necessarily equal to no. of jobs that would be lost to NJ if the economic activity ceased; in that case, dollars now spent on ecotourism would likely be redirected to other economic sectors after a transition period.

*Data were reported in the source as %'s of *wholesale* prices; these were converted to %'s of *retail* prices.
Note: multipliers in Cols. 14, 16, 18, and 20 include both indirect and induced effects. Multipliers for Plantings are based on NJDEP's analysis of the results of a study of the New Jersey turfgrass and sod industries by Govindasamy et al. (2001); details are available from the author.