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Israel's National Biodiversity Plan

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Israel's National Biodiversity Plan
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Foreword from the Minister of Environmental Protection

The importance of biodiversity for human survival has long been recognized worldwide. Efforts to protect biodiversity, along with measures to mitigate global warming, are at the top of the global agenda and are guided by intergovernmental panels of experts: the Intergovernmental Panel for Biodiversity and Ecosystem Services (IPBES) and the intergovernmental Panel for Climate Change (IPCC), respectively.

Israel's Ministry of Environmental Protection, together with the Nature and Parks Authority and representatives of academia, coordinated and prepared Israel's National Biodiversity Plan. The plan was written by experts dealing with a wide range of biodiversity-related topics and includes a broad and comprehensive action plan for conservation and management.

The accelerated rate of human development and its impacts on open space and on the other ecosystems which sustain it is both large and significant. It is imperative for us to understand that these accelerated development rates, which, among others, have been responsible for climate changes, endanger all of the benefits or "ecosystem services" provided by Israel's ecosystems, which we often take for granted: food, fibers, water and air purification, flood control, pharmaceuticals, material recycling, pollination, recreation, inspiration, and more.

In light of the new understandings and insights on biodiversity and ecosystem services, we must promote the subject using coordinated efforts and diverse tools, including: education and information, spatial planning and management, legislation, economic instruments, scientific development and more. It is incumbent upon us to do so in order to protect ecosystems and their biodiversity and to secure the continuing provision of their services.

I hope that this comprehensive plan will be translated into a government decision and will be advanced by government ministries, each in its own sphere, for the benefit of Israel's society in this and in future generations.

MK Gilad Erdan
Minister of Environmental Protection

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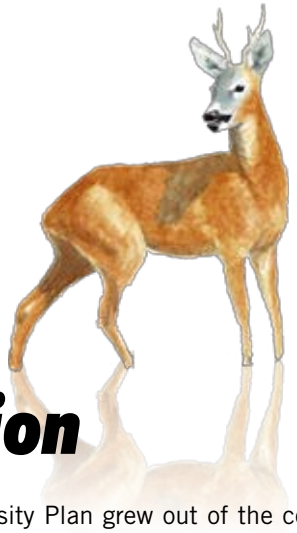

Introduction

Israel's National Biodiversity Plan grew out of the country's commitment under the Convention on Biological Diversity (CBD) and out of a government decision on a "Strategic Plan for Sustainable Development in Israel" (Decision Number 246, dated May 14th 2003, Appendix 1). In its decision, the Government resolved that its policy shall be "based on the principles of sustainable development practice in Israel that combine a dynamic economy, wise use of natural resources, and protection of the ecosystems..." Based on these principles, every government ministry was required to prepare a "Strategic Plan for Sustainable Development that shall include an action plan, means of implementation..." in areas specific to each and every ministry. For example, the action plan of the Ministry of National Infrastructure was required to "set standards for regular water supply for the preservation of nature and landscape..., and supply of water to nature." The action plan of the Ministry of Tourism was required to include planning and development of "environment-sensitive" tourism while "preserving open and sensitive areas.... protecting flora and fauna and efficiently and wisely using natural resources." The Ministry of Environmental Protection's action plan specifically related to biodiversity, namely: to "taking steps toward halting the deterioration of biodiversity and toward rehabilitation of ecosystems harmed by human activity" and "taking action to maintain acceptable environmental conditions...for all residents and for the development of animals and plants." Furthermore, the decision specifically designated the Ministry of Environmental Protection as the ministry responsible for accompanying and helping to consolidate the strategic plan in its entirety.

"Biological diversity" goes beyond the literal meaning of these two words. It is at the base of the conceptual framework that integrates "ecosystems, natural resources and economy," as stated in the beginning of the government decision on sustainable development. In light of this, and in line with this government decision, the Ministry of Environmental Protection initiated the preparation of "Israel's National Biodiversity Plan." This document will help the different government ministries to advance Israel's social and economic practice in accordance with sustainable development principles, thus ensuring the well-being of its people.

Plan Preparation Process

Israel's National Biodiversity Plan was prepared with the broad and comprehensive contribution of dozens of professionals from different sectors: government ministries including Environmental Protection, Science, Education, Foreign Affairs, Justice; the Nature and Parks Authority; institutes of higher education,

including Tel Aviv University, The Hebrew University of Jerusalem, Ben-Gurion University, Haifa University, the Technion - Israel Institute of Technology, Bar Ilan University, The Biological Pedagogical Institute in Haifa, the Netanya Academic College; research institutes, including the Agricultural Research Organization (ARO) – Volcani Center, Israel Oceanographic and Limnological Research (IOLR); and non-governmental organizations, including the Society for the Protection of Nature, the Center for Educational Technology, Ramat HaNadiv Nature Park, the Modiin Ecological Farm, and the Israel Union for Environmental Defense. The Ministry of Environmental Protection set up a small steering committee to organize and accompany the work of the six steering committees for specific disciplines, each chaired by an expert in the field who was appointed by the Ministry. Each of the steering committees was charged with preparing one chapter of the plan, and each held meetings to discuss content and identify authors for different sections of the chapters. The team heads and chapter authors also commissioned a large number of experts in specific fields to contribute sections in the different chapters. Progress was presented in conferences and in seminars. At the completion of the work, final drafts of each chapter were transferred to a scientific editor who edited the chapters in coordination with the authors in order to attain uniformity and continuity throughout the document.

Road Map for the Document

The first chapter of the document presents the concept of "biological diversity"- the involvement of all diverse life forms on earth in the functioning of ecosystems, from which people derive benefits, known as “ecosystem services." This chapter also highlights the centrality of biodiversity in providing "sustainability" to human development, thus attaining sustainable development and promoting human well-being.

The second chapter identifies the risks and threats to the existence and functioning of Israel's biodiversity and thereby to its benefits for human well-beings. It describes the ways by which such damages may be prevented or minimized and the appropriate means of management by which biodiversity and its functions may be preserved, based on existing scientific knowledge, especially in the science of ecology. In addition, the chapter summarizes the efforts made and continuing to be made in Israel to conserve and manage the country's biodiversity, identifies successes and failures and suggests future means of action.

The third chapter identifies the future risks to Israel's biodiversity, based on forecasts of population growth and global climate changes, indicates deficiencies in national master plans with respect to protecting biodiversity against these future threats and suggests steps for requisite updates of these plans.

The fourth chapter deals with the ability of economic tools to valuate the benefits of biodiversity to humans, taking into consideration that many of these benefits are "public goods" with no market value but are rather of existential value to humans

and society. This is important in order to allow the public and policy makers in different government ministries to make decisions based on the costs of protecting biodiversity versus the benefits gained from it.

Assuming that economic tools will not always suffice without a binding legal framework, the fifth chapter deals with legal aspects of biodiversity protection in Israel. This chapter points out the current legal structure in this field and its functional failures and suggests legal tools for improving it.

The sixth chapter deals with the scientific research and monitoring necessary to effectively protect and properly manage biodiversity so that it can successfully function to attain the sustainable development targets, thus securing the human well-being of Israel's population. This chapter too reveals achievements, identifies gaps in knowledge and suggests means of action to close these gaps.

The seventh chapter deals with education and public awareness of the values of biodiversity, based on the recognition that even if gaps in knowledge are closed and tools for protecting biodiversity are improved, public and societal cooperation are vital for achieving goals. Such cooperation requires an investment in education and information at all levels and sectors, and this chapter suggests a range of measures and tools to highlight the importance of biodiversity for human well-being and for the sustainability of Israel's future development.

The eighth chapter surveys the possibilities for Israel's involvement in the international arena in the fields of biodiversity. This is in light of the relatively large number of international legal tools that deal with this subject due to transboundary damages to biodiversity and impacts on it on the global scale. This chapter clarifies both the political benefits and the professional benefits of Israel's involvement in this arena and indicates the need to radically reform the relevant systems.

Each of the chapters also includes specific recommendations, which, together with their justifications, helped to shape the proposed action plan which presents guidelines for tactical and strategic actions to the different government ministries.

Executive Summary: Israel's National Biodiversity Plan

What is biological diversity and what is its significance?

The term "biological diversity," hereafter referred to as "biodiversity," includes the entirety of living organisms, with an emphasis on the diversity of their form and function. Biodiversity is a major component of all ecosystems – the various environments covering the surface of planet Earth. Ecosystems provide benefits, called "ecosystem services," that are invaluable to human well-being and to development. Biodiversity is inextricably involved in the provision of these services. Hence, when development impacts biodiversity it threatens human well-being and impairs the prospects for its own sustainability.

"Biological diversity," or in short biodiversity, is the entirety of individuals of all species combined (animals, plants and micro-organisms) that live and function in the environment, and together with it comprise a functional system, called an ecological system, or "ecosystem." The entire surface of the globe, including that of Israel, is comprised of various ecosystems (woodland, desert, coastal, freshwater and even agricultural, urban, as well as other ecosystems). People derive benefits from the functioning of each and all of these ecosystems; hence these benefits are called "ecosystem services." Biodiversity is actively involved, directly or indirectly, in the provision of all ecosystem services, not only due to the mere size of the species assemblage of each ecosystem, but also, or even mainly, due to the degrees of differences in both form and function among the species within the assemblage. These services not only support the functions and secure the daily existence of human beings, but they also sustain the momentum of development, which has accelerated since the agricultural revolution. However, development has been attained at the expense of ecosystems and their biodiversity. Therefore, in order for development to achieve its long-term goals and become sustainable, a balance must be achieved between the dimensions of development and the dimensions of each of the different ecosystems. Development that adversely impacts biodiversity is likely to upset the required balance, thus minimizing the benefits of development itself, and deterring rather than promoting human well-being.

What are "ecosystem services"?

Food and water, the basic commodities for subsistence and development, are services produced (e.g., food) or provided by ecosystems (e.g., water), and the biodiversity of agricultural and of freshwater ecosystems is directly involved in the provision of these services, respectively. These are only some examples out of a wide range of ecosystems and the services they provide.

A cotton field and an orchard are ecosystems whose services comprise the provision of fiber and food, respectively. They do so by means of several components of biodiversity: the different varieties of cotton and citrus used by farmers but which originate in wild species, the rich diversity of soil organisms that jointly improve soil quality and are involved in the supply of nutrients to the crops,, reptile and bird species that regulate the population size of pest species, and pollinating insects without whose pollination service many crops would not be produced. Lake Kinneret (the Sea of Galilee) too is an ecosystem whose biodiversity components, including small aquatic crustaceans, microscopic algae and fish, as well as a rich riparian diversity of plant and bird species, are jointly involved in providing this lake (managed as the major operational water reservoir of Israel) with the service of water quality control. The lake's biodiversity is further augmented by the vegetation cover of the Kinneret's watershed, which minimizes the amount of

sediment transported to the lake by the rainfall-generated surface runoff and is involved in regulating the fraction of precipitation that enriches the watershed's soil moisture or is transported downhill and stored in the lake. Thus, this terrestrial biodiversity contributes to both the quality and quantity of the country's drinking and irrigation water.

What are the different types of ecosystem services?

At least some 40 different ecosystem services can be listed, grouped into provisioning, regulating, supporting and cultural bundles of services. Many of these services are interdependent, and biodiversity is involved in the provision of all of them. Therefore, damage to biodiversity, even if only to a few of its components, can endanger a large number of ecosystem services.

Only about ten services provide products of biological origin, serving as food, fibers, and pharmaceutics, whether they are actual components of biodiversity (e.g., fish species) or their products (e.g., cotton fibers), whether provided by agricultural ecosystems or by non-agricultural terrestrial or aquatic ecosystems. These provisioning services would not have been generated without the support of ecosystem functions such as primary productivity, nutrient cycling, soil formation and more, about six supporting services in all. These services also support a large group of about 15 services that regulate climate, air and water quality, floods, soil erosion, pests and even parasitic diseases. In addition, at least nine "cultural" services provided by ecosystems, such as inspiration, recreation, tourism, heritage and education services, require the supporting services. Yet another service directly provided by biodiversity, which may be included within the cultural services, is reflected in the perception that biodiversity has an "intrinsic value," an "existence value," and/or a value to be bequeathed to future generations ("bequest value"), which is beyond the practical value of all the other ecosystem services. Therefore, some suggest that it is incumbent upon humankind to respect and protect biodiversity, also (or even mostly) due to its intrinsic and existence value. Finally, the different components of biodiversity involved in the provision of each of these ecosystem services reside in these selfsame ecosystems. Hence ecosystems support biodiversity, thus enabling it to engage in the provision of services, including the service of maintaining the stability of the ecosystem and its service provision. Damage to the components of biodiversity therefore constitutes an impairment of service provision. Since the different groups of services are interlinked, damage to one of the services of one group reduces the provision of services from other service groups.

What is the human effect on ecosystem services?

Humankind intensifies the provision of many ecosystem services, especially the provisioning services, by transforming natural ecosystems to human-managed ecosystems. This transformation also leads to tradeoffs in the supply of many ecosystem services for the service whose intensification required the ecosystem transformation.

Throughout the latter half of the 20th century, most provisioning services were increased beyond their natural rate of provision, largely at the expense of reducing the regulating and cultural services. This trend is expected to continue. Damage to biodiversity is a major contributor to the negative trends observed in the provision of services. In Israel, as in other parts of the world, the most significant damage is to the aquatic and coastal biodiversity, due to changes in the nature and dimensions of the habitats and the chemical pollution of these ecosystems. Thus, the benefits of ecosystem transformation are at the expense of the service tradeoffs; only when the benefits of the transformation and the tradeoff are higher than their damages, within reasonable spatial and temporal scales, will the development that led to the transformations and tradeoffs be sustainable and contribute to the sustainability of human well-being. However, development trends, together with the effects of global population growth and global climate change (minor changes at this point which are expected to intensify) on biodiversity and ecosystem services, endanger human well-being.

What are the components and characteristics of biodiversity?

"Biodiversity" is mainly a functional entity; therefore, an ecosystem's biodiversity is not only characterized by the number of species, but also by the diversity of their functions. Its various components are quantified by technical indices reflecting the functional diversity, thus highlighting the role of biodiversity in molding the quantity and quality of services provided by the ecosystem.

These indices address species composition, quantify their relative abundances and relate to their structural and functional features and to the degrees of similarity and difference among them. The within-species diversity reflects the genetic differences between and within populations of the same species, the between-species diversity expresses the richness (number) and the diversity (relative abundance) of species at the different functional levels, the ecosystem diversity is expressed by differences between adjacent ecosystems, and the landscape diversity is the diversity resulting from the spatial mosaic of these ecosystems. The indices used to quantify each of these biodiversity components jointly reflect the diversity of functional interactions of the species in their ecosystems. The higher the value of these indices, the greater the chance for a diversity of forms, behaviors and functions of the living components of ecosystems, which secure the full supply of a wide range of ecosystem services.

Are all components of biodiversity essential for the provision of ecosystem services?

Ecosystem services differ in the biodiversity components necessary for their provision, but the specific function of at least some of the species in providing ecosystem services is not yet known. Nevertheless, since a single ecosystem provides a large number of different services, it requires most components of biodiversity, even if it is currently difficult to pinpoint the specific function of some of them in providing services.

Species composition and their relative abundance are more important than the mere number of species (the biodiversity component called "species richness") when it comes to supporting and regulating services. All plants comprise the functional component of biodiversity that provides the supporting services of primary productivity and the regulating service of climate regulation while the combination of many microorganisms provides the service of nutrient cycling. For example, the service of food provision requires the support of specific biodiversity components, namely, those of pollinating animal species and pest control species that reside in natural ecosystems rather than in the agricultural systems which they support. On the other hand, services such as providing resilience to the impacts of environmental changes, pesticides and invasive alien species and securing the persistent flow of other ecosystem services largely depend on high species richness per se. Thus, the greater the number of species, the greater the ecosystem stability, but only to a certain point beyond which an increase in species number does not improve the quality and flow of service provision. Nevertheless, these "surplus" species are not "redundant." Their value lies in complementing functions performed by other species, so that even if their contribution to service provision is small, their loss may destabilize the system. Furthermore, even though they may appear to have no role in current service provision, their value may only be manifest in the future, in the wake of foreseen or unforeseen future changes in the natural or human environment or in human needs. Thus, all species need to be conserved. However, the overall goals of biodiversity conservation are not necessarily the restoration of "natural" state; rather, conservation of biodiversity in its entirety can be effective only through ecosystem management that detects and addresses negative trends in population sizes and focuses on the rehabilitation of biodiversity functions, rather than on the wholesale increase of species number.

What is the desirable size of species populations comprising biodiversity?

The population size of individual species in a given ecosystem attracts attention and directs ecosystem management efforts. Several threshold levels of population size are of interest: the size required for effective involvement of the species in service provision, the size

below which the population is at risk of extinction in the ecosystem, and the size above which the species becomes an "eruptive" species, i.e., a menace to other species and to ecosystem functions. The "precautionary principle" should be applied and knowledge gaps should be bridged in order to prevent species extinction or impairment of ecosystem functions due to undesirable changes in the size of species populations.

Different species or identical species in different ecosystems differ in the threshold levels of population size, which more often than not, remain quite uncertain. Given this, the rule of thumb that a large population is preferable prevails with respect to extinction risks, but not always with respect to the function of service provision, and definitely not when it comes to eruptive species. Priorities for investing in the restoration of desired population sizes should be based on the degree of exposure of the species in question to risk factors, on its inherent sensitivity to these threats, on the chances for successful rehabilitation or restoration of its population, and on the significance (known or assumed) of the species' population in service provision by its ecosystem. However, it is generally difficult to quantify most of these parameters and to estimate the deviation of the observed population size from its threshold values, due to the natural inter-annual variation in the sizes of most populations. When knowledge gaps are so large, the "precautionary principle" should be applied and investments should largely be targeted at management aimed at reducing extinction threats, especially when rehabilitation may be difficult or even impossible. Furthermore, knowledge acquisition should be intensified to facilitate quantifying the critical population threshold values and to reveal trends in observed population sizes. This will enable early preparedness for cases whereby observed population size deviates from the boundaries of natural fluctuations to levels of possible extinction or eruption.

Biodiversity conservation is achieved through ecosystem management

Knowledge gaps and resource scarcity impede targeted protection of individual species at risk. However, while species of all kinds can persist and sustain their service provision function only when residing in ecosystems, ecosystems cannot provide services without the sustained existence of these species in them. Therefore, ecosystem management is used to protect each of its species at the appropriate population size for the optimal provision of the majority of services. This can yield positive results even if only limited knowledge exists concerning the function of each individual species in the provision of the different services.

The management of biodiversity is not expressed in the mere protection of ecosystems from human interference ("passive management"), but it strives to preserve options for service provision in a substantial number of ecosystems ("active" management). For example, when a natural ecosystem is transformed to an agricultural one, the management of the latter enhances the service of primary productivity to support the provision of agricultural products, often at the expense of reducing the provision of other ecosystem services. "Active" management searches for ways to preserve the potential of the agricultural ecosystem to continue and provide at least some of the services produced prior to its transformation. Since the expertise and the experience for implementing active management are limited, the required knowledge goes beyond theory and lab experiments to trial and error in field implementation – to "adaptive" management. The objective of this type of management is to enable all ecosystems, irrespective of the influence of people and development, to maximize their service production as much as feasible. Because knowledge gaps for quantifying service provision are very large too, adaptive management is driven by the understanding that the larger the number of species, the greater the differences among them, and the larger the evenness in their population sizes, the greater the chances for each of them to make a unique contribution to the provision of one or several services. Thereby, the ecosystem as a whole is likely to provide a wide diversity of services, which are substantially different from each other. To conclude, it can be assumed that the larger the ecosystem's biodiversity, the greater the diversity of its services and the efficiency of their provision.

Biodiversity as a tool for assessing the efficacy of ecosystem management

While traditional nature conservation focuses on endangered species, indices for assessing the entire biodiversity of a given ecosystem have recently been developed and successfully implemented. These biodiversity indices reflect on the ecosystem functionality and sound warnings concerning negative trends or identify positive trends in its service provision.

The use of indices that assess the state and trends of biodiversity may constitute a tool for guiding ecosystem management and contributing to its efficacy. A promising index in this context is that of the "change in abundance of selected species." This index identifies population sizes that are sufficient for securing service provision rather than detecting population levels that bring populations to the brink of extinction. This implies that population reduction to sizes providing safety from extinction may still constitute a threat to service provision. The use of this index has demonstrated, for example, that until 2000 the global desert ecosystem lost a third of its original biodiversity and that under a scenario of economic growth, which responds to local and regional market forces rather than to global benefits, the deserts' biodiversity would lose an additional 15% by 2050. Most other global ecosystems have already experienced and are projected to suffer similar losses.

What is the within-species diversity (genetic diversity) and what is its significance?

The differences between species, or the between-species diversity, are not the only ones with functional significance which deserves protection, but each of the species also exhibits within-species diversity that is invaluable and merits conservation. The within-species diversity is the entirety of genetic types within a species. Maintaining the species-specific genetic diversity is significant since it secures the functionality of the species in the provision of ecosystem services and contributes to its resistance to threats. The within-species diversity of progenitors and wild relatives of cultivated species is especially significant since it is the source of the varieties of the domestic species, mostly found in cultivated ecosystems. This diversity of races and cultivars affords resilience and stability to the major service of these ecosystems – the provision of food for humanity.

Just as the differences between different species may determine the differences in their ecosystem functioning, so the differences between different individuals belonging to the same species are instrumental in shaping the function of the species in the ecosystems to which they belong. However, while the features that distinguish between species are often visually detectable, the within-species differences among individuals or populations, which may reflect within-species variations in function, are usually difficult to detect visually and require expertise, often at the genetic and even the molecular levels. Such differences among individuals exist in every species, and often different populations of the same species are each characterized by a population-specific genetic structure. All these combined constitute the within-species diversity, which is the genetic diversity. The greater the population sizes and the diversity of habitats and ecosystems included in the species range, the larger that species' genetic diversity. High genetic diversity of a species contributes resilience to detrimental environmental changes and to extinction risks; hence it is instrumental in securing the functioning of the species in providing a diversity of services. Genetic diversity is also the raw material for speciation generated by the currently existing species pool. An important component of genetic diversity is that of cultivated species, each of which is currently represented by a wide range of varieties, races and cultivars that differ in their genetic make-up. These domestic varieties have been selected by humankind from the extensive genetic, within-species diversity of wild species maintained in natural ecosystems. The existing genetic diversity of each of the progenitors of cultivated species living in different natural ecosystems can be further utilized for improving the cultivated progeny currently living only in agricultural ecosystems. Thus, the various natural ecosystems that maintain this component of biodiversity also provide support to the agricultural

ecosystems. In addition, the genetic diversity of wild species enables the selection of those genetic types that may be of economic value, and through artificial selection may become new cultivated species. Finally and most importantly, all conservation and management measures targeting the between-species diversity are also instrumental in conserving the within-species diversity.

Ecosystem diversity and the role of biodiversity in landscape molding

Among other things, biodiversity is also involved in molding the visual appearance of ecosystems, which thus constitute landscape units. The diversity of adjacent ecosystem-linked landscape units ("diversity of ecosystems") creates a landscape mosaic that generates a wide range of cultural and other services, in addition to the services provided by each ecosystem separately.

When defining "biological diversity", the United Nations Convention on Biological Diversity adopts a hierarchical approach, explaining that the term "includes diversity within species, between species and of ecosystems." This implies that "biodiversity" does not encompass organisms only (with their within- and between-species diversity as well as other species-related components), but also includes a higher hierarchical level to which organisms and their diversity are related, but which has attributes of its own. This hierarchical level comprises the overall biodiversity typical of each ecosystem, but its specific attribute derives from biodiversity components that contribute to the visual landscape typical of each ecosystem. Moreover, the aggregate of adjacent ecosystems creates a spatial landscape mosaic that usually includes various "natural" ecosystems, cultivated ecosystems and urban ecosystems, mutually interlinked through ecological interactions (such as slope erosion from natural ecosystems to agricultural ecosystems in the valley), as well as through "visual" interactions that generate aesthetic, inspirational, recreational and tourist values. The combination of these constitutes the "cultural" services provided by each of the ecosystems that make up the spatial mosaic, which further intensifies through their aggregation in a spatial configuration of the mosaic. Many of the landscape attributes are linked to the land's physical infrastructure (mountains, valleys), but land cover, comprised of biodiversity components (woodlands, cultivated crops) also contributes to the landscape form, and in some cases these components actually mold the physical infrastructure of the landscape (e.g., coral reefs). Thus, damaging biodiversity, especially through ecosystem transformation, changes the landscape attributes and affects the provision of its specific services. Hence, biodiversity management should address the level of species, ecosystem, and landscape.

What is the difference between a nature conservation plan and a biodiversity plan?

Structured and legally binding nature conservation emerged in the second half of the 19th century and in Israel in the 1960s. Terms such as "biological diversity," "environmental services," and "ecosystems" became rooted only in the 1970s. The link to "sustainable development" and the recognition that ecosystems and their biodiversity are essential for its attainment first emerged in the 1980s and became established in the 1990s, when they were anchored in international agreements. Sustainable development, which emerged as a global political target at the dawn of the 21st century, is development whose sustainability is granted through the provision of ecosystem services, which are themselves dependent on all components of biodiversity.

When the first nature reserve on earth was established, the human global population was less than 20% of its current size, and when the first nature reserve of Israel was proclaimed, the population of Israel was about 35% of its size today. For these relatively small global as well as national populations the aesthetic pleasure people derived from nature, as well as the recognition of nature's "intrinsic value," sufficed to justify the investment in "nature conservation." However, at the onset of the second decade of the 21st century, global and Israeli population sizes reached 6.8 billion and 7.5 million and population growth rates stood at 1.2% and 1.8%, respectively. Furthermore, with 40% of the global terrestrial natural ecosystems already transformed and only 4% of the land

protected from further transformation, it is necessary to move from mere protection, based on reserves that fence in nature and fence out people ("passive management"), to management that targets biodiversity throughout the land of Israel. This biodiversity is tightly interconnected with people; hence, the "dividing barrier" of nature reserves should be replaced by human activity that maintains biodiversity conditions that enable the utilization of the benefits provided through biodiversity and which secure the long-term existence of people, without which development cannot be sustainable. The 2003 decision on sustainable development taken by the Government of Israel needs to be complemented by positioning biodiversity in the critical crossroad where mere development becomes sustainable development.

What are the components of Israel's National Biodiversity Plan?

The document "Israel's National Biodiversity Plan" aims to complement the government decision on sustainable development, by serving as a master plan for advancing its timely implementation in light of evident adverse environmental trends that affect human well-being at both the global and Israeli scales. The plan includes guidelines for biodiversity management at the local level as well as the national planning scale. It also addresses the need for adopting economic incentives, advancing research, promoting education and information, encouraging legislation and its enforcement, and actively engaging in the international arena of biodiversity conservation. All these constitute a package of measures for advancing conservation and thus securing the functionality of the Israeli biodiversity in providing services to the people of Israel.

The national plan identifies the dangers and threats to Israel's biodiversity and outlines ways of confronting them by implementing responsive methodologies for managing biodiversity and the ecosystems that host it. These methods derive from updated knowledge generated by the science of ecology, but assisted by regional planning tools which internalize the needs of development for ecosystem services. Nevertheless, the implementation of a management plan, as good as it may be, will not succeed, and its objectives will not be achieved without the supportive instruments that make the plan acceptable to the various sectors of society and government. Therefore, the national plan identifies the legal instruments still missing for its enforcement, evaluates economic incentives for implementing the plan at the various levels, and encourages education and increased public awareness to replace the need for enforcement. The plan also identifies gaps in the research required for appropriate biodiversity and ecosystem management and proposes measures for closing these gaps. Finally, the plan highlights the benefits derived from linking biodiversity conservation in Israel with relevant professional and political activities in the international arena. Above all, the plan seeks to find the appropriate management tools to conserve the maximal number of Israeli species and to maintain each in a population size compatible with the needs for optimal provision of ecosystem services.

What causes the changes in species' population sizes in Israel?

Development activities lead to reductions in the sizes of species populations, whether directly through the transformation of natural ecosystems, which reduces the size of species habitats or deteriorates their quality, or indirectly through conditions favorable for invasive alien species and local potentially erupting species, which result in an increase in their populations at the expense of populations of other species.

Each of the species residing in a given ecosystem has a specific population size determined by its inherent traits and the attributes of its habitat within that ecosystem. The larger the ecosystem area, the higher the population sizes of each of its species. Development, which more often than not entails ecosystem transformation, either encroaches on habitat areas or reduces their quality as habitats. Either way, development leads to the reduction of population sizes, sometimes to the point of risk of extinction. Even when only a small proportion of the overall area of ecosystems and their habitats is appropriated for development of transportation

infrastructure, communication, etc., the resulting spatial fragmentation of habitat areas fragments large populations into several small and mutually isolated populations. This exposes each of these shrinking populations to risks of extinction, leading to endangering the species as a whole. Furthermore, expansion of such infrastructure increases the dimensions of fragmentation, leading to even smaller populations and stronger mutual isolation, which may dramatically increase the risk of overall extinction. In addition, the penetration of alien species into Israeli ecosystems, followed by an eruptive increase in their populations, limits the spatial expansion and the population sizes of local, Israeli species. Some Israeli species also become eruptive, and competitively exclude other species from large areas of their habitats, to the point of risking the local extinction of these species. The eruption of alien invasive species is usually attributed to the absence of local predators adapted to prey upon these aliens. The eruption of local species, on the other hand, is attributed to the increase in poorly managed garbage dumps, careless gardening practices and agro-techniques. These create resources that eruptive species are inherently better adapted to exploit than other species, leading to the eventual local extinction of local, non-eruptive species.

What are the threats to the genetic diversity of species in Israel?

The causes of population size reduction also threaten, and even more so, genetic diversity. The within-species diversity is sensitive to reduced population size even before it declines to a level exposed to imminent extinction. However, quantifying genetic diversity is difficult, and detecting the response of genetic diversity to specific threats is usually done indirectly.

The genetic diversity is extremely sensitive not just to the reduction in the size of the species' habitat, but often mainly to the deterioration of its quality, due to a wide range of negative impacts. These lead to an erosion of the genetic diversity, which contributes to the population's vulnerability even before its size declines. A widely accepted rule of thumb is that populations reduced to a size of about fifty individuals are expected to undergo a severe and dangerous loss of their genetic diversity, which reduces the prospects of their persistence. The genetic diversity of populations that are not only small but also isolated can be threatened due to either further increased isolation leading to inbreeding, or to further decreased isolation leading to "dilution" of their locally adapted genome through interbreeding with members of other populations. It follows that the higher the genetic diversity of a population prior to the shrinkage of its habitat and the consequent decline in its population size, the lower the danger that continued damage to the habitat will lead to a further population decline and a further increase of extinction probability. However, methods for detecting negative trends in the dimensions of genetic diversity require fieldwork linked to laboratory work, both of which are highly expensive. Furthermore, even when these advanced methods for quantifying genetic diversity are used for conserving species at the brink of extinction, or for building up founding nuclei for the reintroduction of locally extinct species, efforts aimed at conserving genetic diversity are not usually based on identifying negative trends but rather on the collection of information which is indirectly relevant.

What are the threats to species extinction and how are they addressed?

The number of species defined as highly endangered in Israel is low. Several nature reserves have been established to specifically protect these species, some of which have also been proclaimed as "protected natural assets." Such passive management measures, however, are generally insufficient, and therefore are often augmented by active management measures targeted at accelerating the population growth of these species to enable them to make a fast exit from the vulnerable state of a small population. These measures often include artificial propagation, followed by translocation of carefully assembled nuclei of individuals from propagation facilities to sites within ecosystems that harbor species endangered due to their small population size ("reinforcement"). In contrast to these species,

others, although not many (except species of small body size whose extinction might have gone unnoticed) are known to be extinct in Israel and their rehabilitation in Israel is feasible only by means of a lengthy, expensive and sensitive process ("reintroduction").

Active management of endangered species has been applied to protect the Griffon Vulture, the sea turtle, the softshell turtle, the blue water lily, the Eastern spadefoot toad, the Yarkon bleak (a fish), the dori ray-finned fish, and the Navit ha'mlechot (a fish). Similar measures are planned for protecting the Caucasian squirrel, the sand cat and the Acacia gazelle. Locally extinct species, which have been reintroduced with various degrees of proven success, include the Onager ("wild ass"), the Arabian oryx, the Persian fallow deer, the Carmel roe deer and the white-tailed eagle. Such reintroduction projects mostly promote the provision of cultural services only, but they are of high profile and generate public sympathy, which helps promote societal support for nature conservation. This also positively impinges on conservation and management of biodiversity at large. Thus, despite the relatively small number of highly endangered species and of species already extinct locally but capable of reintroduction, the attention directed to them is invaluable, since it constitutes an effective tactic for promoting the active management and conservation of the ecosystems that harbor these species. This is because sections of society are more aware of and more sympathetic to the protection of individual species, which are tangible entities, than with "ecosystems," which are conceived as a mere academic concept. Thus, while the management of ecosystems promotes the conservation of individual species, there are species whose specific conservation advances the management of entire ecosystems.

What is the extent of species eruptions and what are the measures for reducing them?

The extent of species eruptions is on the increase in Israel, mainly due to the invasion of alien species. Preventing eruptions is more effective than addressing the damages they cause. Such measures include enforcing the laws that address species introductions, and reducing the accessibility of local species with known outbreak tendencies to domestic garbage and other food sources. When these measures do not suffice, population control through regulated extermination is exercised as a last resort.

Replacing open garbage dumps with landfills and preventing accessibility to fruiting crops may reduce the extent of local species' outbreaks. On the other hand, controlled extermination using poisoned baits and culling may often lead to conflicts with society, when people sympathize with aesthetically attractive alien species or when these species are seemingly involved in the provision of certain ecosystem services. There may also be conflicts with the law, when a species enjoying the status of a "protected natural asset" becomes eruptive. To minimize such conflicts, public awareness campaigns highlighting the dangers to biodiversity and ecosystem services inflicted by invasions and outbreaks of alien and local eruptive species, respectively, can be effective. Finally, it is notable that whereas management of endangered species, including projects for reintroducing locally extinct ones, are mostly practiced within nature reserves, management of eruptive and invasive species also, and even mainly, takes place in non-protected areas.

Managing biodiversity within and outside protected areas

Two complementary approaches are appropriate for biodiversity management and conservation in Israel. The first is to expand the currently existing fabric of protected areas, so that it encompasses most of the Israeli ecosystem types and biodiversity components. The second is to manage the non-protected areas in a way that will complement the nature reserve system, and will jointly constitute a national system of areas in which the State's entire biodiversity is protected and conserved, and the optimal provision of the diverse ecosystem services of Israel is secured.

Most areas allocated as nature reserves in Israel were selected due to their low value for development, rather than by virtue of their high value in maintaining biodiversity and in securing the provision of ecosystem

services. This is evidenced by the observation that although 30% of Israel's land is protected, most of the protected areas are in desert regions. It is therefore plausible that these thirty percent do not provide the fullest extent of ecosystem services required by the remaining seventy percent of the State's area. Therefore, since the non-protected areas of Israel also comprise ecosystems with a potential to provide services by virtue of their biodiversity, this biodiversity too requires the protection provided by appropriate management. Thus, for Israel to secure the full range of ecosystem services requires a complete suite of ecosystem types including the biodiversity components and the services specific to each of them. To achieve this, protected and non-protected areas need to be integrated within a combined framework of coordinated management. An assessment of the extent to which the fabric of existing nature reserves represents all of Israel's ecosystems and most of its biodiversity components, and an evaluation of their ability to provide the required services, in terms of both quality and quantity, will assist in locating sites for new nature reserves. This assessment will also identify the most amenable areas outside reserves for the implementation of management, which in conjunction with that practiced in protected areas, would promotes the functionality of Israel's entire biodiversity in most of the country's ecosystems in providing the largest possible array of their services.

Managing the genetic diversity component in and off ecosystems

Protection packages targeting small and isolated populations inadvertently benefit their genetic diversity and its conservation. In some cases, the genetic diversity of such populations must be increased in order to avoid risk while in the case of other populations just the maintenance of their genetic diversity may suffice. Populations at the boundaries of their species' geographic distribution require protection for the very reason that their genetic diversity is inherently high and invaluable. Similarly, the genetic diversity within varieties of domesticated species of agricultural and urban ecosystems and within populations of their wild relatives in natural ecosystems requires special protection measures within their ecosystems, which are complemented by protection in special facilities off their ecosystems.

The selection of measures for managing and conserving genetic diversity requires knowledge of the spatial distribution patterns of species' populations. Protection of populations, by such means as ecological corridors and reinforcement actions, is required if the population's small size and isolation are a result of human activities, in which case it is highly likely that its genetic diversity is defective. On the other hand, populations that are naturally small and isolated need just to be maintained in that state, since they constitute a suite of inter-population diversity which may be harmed by management measures such as corridors and reinforcement with outside con-specific individuals. Such populations can be distinguished from ones that have undergone human-induced fragmentation and shrinkage by means of several methods, beginning with studying the historic changes in population size and range, and ending with field experiments and laboratory procedures elucidating the genetic background of the within-species variations of observable traits. In addition, populations residing in proximity to the distributional boundaries of their species, usually within climatic transition areas, deserve protection from habitat size reduction and other human-induced threats since their genetic diversity is often greater than that of other populations of their species. Components of the genetic diversity of cultivated species of agricultural and urban ecosystems involved in improving yields and upgrading crop quality are ever increasing. However, this is at the cost of losing those components of genetic diversity that are involved in providing resilience to environmental changes to which their ecosystems are frequently exposed. This loss of "old" because of "new" is irreversible, unless efforts are made to preserve the "old" varieties in spite of their yield inferiority through targeted protection in botanic and zoological gardens or in "gene banks," in which seeds of species and varieties of cultivated plants, as well as seeds of their progenitors and of their wild relatives, are preserved. The same species are often also preserved in the natural ecosystems that harbor their wild

populations, and sometimes in dedicated nature reserves. This kind of "in situ" conservation is more effective than conservation in "ex situ" off ecosystem facilities. This is because gene banks "freeze" the natural process of increasing the value of genetic diversity and adapting it to environmental changes through natural selection. In natural ecosystems, on the other hand, these species respond to the changing environment, whereby natural selection molds genetic "raw material" available for further breeding and improvement of the cultivated species.

Some figures - Israeli ecosystems, their services and the threats to which they are exposed

The number of ecosystem types covering Israel's entire land area depends on the criteria for classifying them. According to one classification, 46 ecosystem types were defined, clustered into 11 groups, the largest of which is the woodland and shrubland ecosystems. In addition, 19 services provided by these ecosystems were defined, and 17 threats to their provision were described. Some of the services and threats are provided by and affect, respectively, a large number of these ecosystem types, while other services and threats are specific to a small number of ecosystems only.

Nearly 90% of Israel's ecosystems provide cultural services. Plants that are progenitors or relatives of cultivated plants are supported by 70% of the ecosystem types and close to 60% of the ecosystems harbor and maintain biodiversity which is renowned as high or unique. About half of the ecosystems are involved in water provision and 20% provide water purification and quality control services. Seventeen threats to the biodiversity of ecosystems and hence to the services they provide have been identified. Biodiversity in all ecosystems is threatened by losses of habitat area, with a little more than half threatened by pollution and a third by overexploitation of water. Although this national survey does not cover agricultural and urban ecosystems, and leaves out the services of food provision, primary production and nutrient cycling, regulation of climate and air quality, disease regulation and pollination, it does demonstrate the significance and benefits provided by Israel's biodiversity, which reflect on the dangers of inaction with respect to threats. Following is a more detailed discussion of biodiversity, threats to and management of the major ecosystem clusters of Israel (woodlands and shrublands, wetlands, coastal, marine, agricultural, rangeland and urban ecosystems).

Woodland and shrubland ecosystems

It is common for shrubland ecosystems to be transformed to woodland ecosystems and vice versa, depending on the human-driven use of these two mutually replaceable ecosystems, each with its own specific biodiversity and service provision. Large areas which previously constituted these ecosystems have been transformed into agricultural and urban ecosystems. In areas whose ecosystems have not been transformed, active management is required to maintain most of the biodiversity and services. Such management generates and maintains an optimal spatial mosaic of woodland, shrubland, agricultural and urban ecosystem patches.

Woodland and shrubland ecosystems once extended over most of Israel's regions in which a Mediterranean climate prevails, constituting a mosaic of patches of Mediterranean-type vegetation affected by spatial and temporal dynamics and driven by management practices such as livestock grazing, firewood exploitation, prescribed fires, and crop cultivation. When management was intensive and persistent, it transformed these ecosystems from forest to woodland, to shrubland and grassland, or back to forest when these management practices were relaxed or abandoned. Nevertheless, each of the ecosystems in this succession is characterized by biodiversity and service provision which are specific to it. When the State of Israel first came into being, shrublands and mixed grasslands dominated large areas. Strict enforcement of a ban on grazing, clearing and firewood collection led to a relatively fast and intensive transformation to forest with thick, impenetrable undergrowth. This was succeeded by intensive and extensive development which transformed large areas of these ecosystem types into agricultural and urban ecosystems which were mainly, but not only,

confined to valleys and other lowlands. All these reduced the dimensions of Israel's biodiversity. Management that aims at restoring the historic spatial mosaic through controlled grazing, clearing and prescribed fires would promote the services of water provision, soil conservation and flood regulation. This would be achieved through maintaining the vegetation cover with its biodiversity, in order to secure the infiltration of rainwater into soil, to recharge aquifers, to stop the silting of constructed water storages with flood-transported eroded soil, and to reduce the frequency, intensity and damages of floods. A sizeable portion of the natural Mediterranean type ecosystems of Israel have been transformed to planted forests, mostly pine, which intensify cultural services, especially recreation, but also soil conservation and flood regulation services, albeit at the expense of trading-off these services with those of the natural forests and shrubland ecosystems they replaced, such as forage provision, pollination and maintenance of rich biodiversity.

Coastal ecosystems

Most of the coastal region of Israel currently constitutes agricultural and urban (or built-up) ecosystems. Nevertheless, in the remaining areas, a few unique ecosystems with a relatively rich biodiversity survive, and through them management for restoring the full range of services provided by the coastal ecosystems can be practiced.

The coastal ecosystems and their biodiversity are dominated by herbaceous, shrubby or woody vegetation, depending on the diversity of the coast's physical infrastructure (eolianite ["kurkar"] ridges, kaolinite clay ["hamra"] soils, or sand dunes of various degrees of stability) and on local variations in the coastal wind regime with its wind-transported saline sea spray. Stone quarrying, sand quarrying and the encroachment of urban built up areas into areas that have not been transformed to agricultural (mainly citrus orchards) and urban (the metropolitan centers of Israel) ecosystems, gradually reduce the size and quality of coastal habitats for these ecosystems' biodiversity. Livestock grazing and All Terrain Vehicles transform stable dune ecosystems to shifting sand ones, while absolute protection of shifting sand ecosystems transforms them to fixed ones. Each of the two ecosystem types is endowed by its own unique biodiversity and hence both require protection. The rehabilitation of eolianite and sandy ecosystems not yet transformed to built-up ones, can be effected through translocating biodiversity components from areas not yet, or only slightly damaged.

The desert ecosystems

Israel's wide expanses of desert harbor a relatively rich biodiversity which mostly provides diverse cultural ecosystem services. Threats to this diversity and to ecosystem services are minor compared to those affecting other Israeli ecosystems. Nevertheless, Israel's desert ecosystems have already lost a sizeable portion of their biodiversity.

The Israeli desert, comprising more than half of the State's land, encompasses several ecosystem types that differ in the degree of their aridity, their elevation above sea level and their land infrastructure, i.e., physical and climatic differences that reflect on differences among them with respect to their biodiversity. Despite these differences, all desert ecosystems are characterized by low biological productivity, severely constrained by water availability, which is responsible for a low vegetation cover relative to all other ecosystems. Biodiversity in the more arid ecosystems contains a significant component of the Sahara and Arabian deserts; and in those of lower aridity, much of this component is replaced by that of the Asian deserts. Biodiversity of the desert oases also includes components typical to tropical Africa. Apart from the suite of supporting services, the desert ecosystems provide a wide range of cultural services, partly due to specific biodiversity components such as herds of Nubian ibex concentrated around permanent water sources, as well as hundreds of thousands if not millions of birds of prey and other birds which cross the Israeli desert during their seasonal migration. Military maneuvers and livestock grazing constitute a threat to the desert biodiversity, an expression of which is the degradation of the soil conservation service, leading to

erosion and dust generation. Mining and agricultural activities occur at a relatively small spatial scale, but their damage to biodiversity is sometimes significant. Yet, since human settlements are relatively few, and the desert ecosystems are sufficiently well represented in protected areas, threats to the desert biodiversity seem to be few. In spite of this, use of the index "Change in Abundance of Selected Species" suggests that in 2000 the southern Negev with the Negev Highlands and the northern Negev supported only 70%-80% and 60% of their biodiversity abundance component, respectively. In addition, by 2050, these desert regions may further lose 10%-60% of this biodiversity component, relative to its state in 2000.

Freshwater ecosystems

The services of freshwater ecosystems were and remain pivotal drivers of the State's development. This development entails ecosystem transformation and its resulting service tradeoffs that make these ecosystems and their rich and unique biodiversity the most threatened. Yet, it is still feasible to rehabilitate many of these ecosystems and to compensate for losses of biodiversity and services, mainly through ecosystem construction; though artificial, the management of such ecosystems can bring about spontaneous, self-restoration of biodiversity.

Ecosystems of this cluster are embedded in other ecosystems of all the clusters addressed above. With the exception of Lake Kinneret (the Sea of Galilee), the cluster of freshwater ecosystems includes a relatively large number of small natural and artificial water bodies, a few swamps around springs, ephemeral winter ponds, many ephemeral and a few perennial rivers, most of which are still polluted. For a country that is mostly dominated by a dryland climate, the value of the services of this ecosystem cluster is high, especially water provision, purification and regulating services but also cultural services and the service of supporting a rich and unique biodiversity highly exposed to the most ominous threats. Nearly all the swamp ecosystems have been transformed to agricultural and urban ecosystems, and the water provision services of most other freshwater ecosystems have been intensified at the expense of cultural services and biodiversity maintenance services. As a result, many components of the biodiversity of freshwater ecosystems are currently exposed to the threat of extinction, which may materialize. The need to intensify the service of water provision by Israel's freshwater ecosystems is one of the major drivers of the State's development, which also drives the transformation of large areas of all other terrestrial ecosystems of Israel, mainly to agricultural and urban ecosystems. Rehabilitation of the biodiversity of freshwater ecosystems is carried out by means of dynamic management. This includes legislation and enforcement of water allocations to "nature," removal of water pollution sources, and construction of alternative water bodies mainly for the purpose of supporting biodiversity components that provide cultural services and management of these artificial water reservoirs in a manner which encourages the rehabilitation and maintenance of biodiversity components, without comprising the motives for constructing these reservoirs.

Marine ecosystems

The marine ecosystems of Israel provide a diversity of cultural services due to their unique biodiversity component, as well as the provision of other services. Mainly as a result of deficient law enforcement, these ecosystems are impacted by pollutants, mostly emitted by Israel's agricultural and urban ecosystems, and by damages and hazards inflicted by the users of their services.

The marine biodiversity of the Mediterranean and Red Sea coasts of Israel are poorer and richer than that of many other parts of these seas, respectively. Apart from the service of food provision (commercial fisheries), the marine biodiversity provides cultural services (angling in the Mediterranean, coral reef tourism in Elat), and possibly also coastal protection against storm impacts and erosion (the calcareous component of the coastal marine biodiversity – encrusting calcareous snails in the Mediterranean, coral reefs in Elat). At the same time, Israel's marine biodiversity is vulnerable to a wide range of threats. The Mediterranean biodiversity is exposed to

an increasing invasion of Red Sea species, projected to intensify due to global warming, but especially due to existing and growing threats of chemical and other pollution from domestic and industrial sewage (including power stations, desalination plants and mariculture), and to illegal fishing, collection, etc. Legislation for preventing pollution, regulating and protecting commercial and amateur fisheries, protecting corals as well as all other marine invertebrates, establishing marine and coastal nature reserves, and strictly enforcing legislation are likely to improve the protection of Israel's marine biodiversity and secure its services.

Agricultural ecosystems

Even though the agricultural sector's share in the Israeli economy is quite modest, the transformation of about 20% of the total area of all of Israel's ecosystems to agricultural ecosystems (that consume some 40% of the water provided through all other Israeli terrestrial ecosystems combined), has been instrumental in molding the landscape of the Israeli countryside, as well as the country's national ethos. The agricultural systems have and continue to adversely affect the country's biodiversity. Even though an increasing proportion of these ecosystems is abandoned, it is feasible and advisable to rehabilitate the service provision of the abandoned ecosystems and to adapt the management of those still functioning as agricultural ecosystems in a way that will help maintain and support biodiversity, thus contributing to the overall service provision of the State's ecosystems.

The transformation of many ecosystems to agricultural ones, linked to an intensification of the water provision service of Israel's freshwater ecosystems, were initiated prior to the establishment of the State of Israel and further intensified during the first decades of its existence. Yet, more than 15% of the agricultural ecosystems area has been abandoned in recent decades, of which only a small fraction is being "returned to nature." Soil biodiversity constitutes a biodiversity component of natural ecosystems that persists in agricultural ecosystems. Its involvement in the provision of the nutrient cycling service and in the maintenance of soil moisture is critical for the main service of agricultural systems - the provision of agricultural products. Other natural ecosystems serve the agricultural ones by providing them with the services of pollination, pest control and flood regulation, but leakage of fertilizers and pesticides from agricultural ecosystems harms the biodiversity of other ecosystems, including those that support the agricultural ones. On the other hand, the provision of agricultural products by the agricultural ecosystems is harmed by many other components of adjacent ecosystems (e.g., insects, birds, mammals) that feed on this provision prior to its harvest, thus encouraging some of these species to become eruptive. Furthermore, the measures taken by farmers for minimizing pest damage often harm the biodiversity components of other ecosystems, even those not involved in harming the agricultural ones. On the other hand, agricultural ecosystems somewhat compensate for the biodiversity losses inflicted by the ecosystem transformation that has brought them into being. They often attract certain biodiversity components from other ecosystems that do not affect the provision of agricultural products but that enrich the agricultural ecosystems with the added provision of cultural services and services that support the local and regional biodiversity. Finally, as Israel strives to achieve "sustainable agriculture," it is developing and implementing novel management approaches, a trend that merits encouragement. Thus, agricultural ecosystems can become more involved in protecting Israel's biodiversity, securing ecosystem services, and reducing damages to other ecosystems, without compromising the intensification of their major service, namely biological productivity and its derived agricultural products.

Rangeland ecosystems

Just as natural ecosystems are transformed to agricultural systems, so rangeland ecosystems also constitute transformed woodland and shrubland ecosystems (mainly as cattle ranges), and transformed desert ecosystems (mainly as goat and sheep ranges). However, unlike agricultural ecosystems, the transformation to rangeland ecosystems is barely associated with service tradeoffs.

The important service of these transformed ecosystems is the provision of livestock products, which is supported by the service of natural forage provision. The management of rangeland ecosystems molds the size of the livestock population for a unit of rangeland area, as well as the timing of grazing periods and their duration in each of the area units. This specific management practice is assisted by fencing in some places (amounting to 6% of the State's land). Rangeland management usually maintains most of the components of natural biodiversity, but affects the numerical relations among them. Its impact on adjacent ecosystem is minute, even if in some cases it inadvertently creates conflicts between wildlife and livestock. In addition, faulty management resulting in "overgrazing" often occurs. This alters the composition of the rangeland biodiversity to the extent that the services of forage provision and conservation of soil and its productivity may be degraded.

Urban ecosystems

The transformation to urban ecosystems (built-up areas, including off-city ones) has appropriated only a small proportion of the overall area of Israel's natural ecosystems. However, the increasing urban sprawl of low-rise residential areas has a negative influence on biodiversity and ecosystem services, through appropriation of land, which reduces the biodiversity of the habitat area and curtails the water provision service. It also increases the demand for many other services from most other ecosystems, and intensifies the detrimental effects on biodiversity, which infiltrate from the urban areas to the off-cities ecosystems. On the other hand, urban ecosystems also have a positive influence on biodiversity, at both local and national scale, thanks to city gardening and the adaptation of biodiversity components to urban ecosystems.

Urban ecosystems (or just "systems") comprise built-up areas, mainly in cities but also in localities not categorized as cities, as well as built-up centers in rural areas. Part of the biodiversity of urban ecosystems is imported but most of it comprises an integral component of Israel's biodiversity whose "natural" habitat is in these ecosystems. Another component of this biodiversity comprises domesticated or wild species originating in other ecosystems, either adjacent to or even distant from the urban ones. Just five percent of the State's area has been transformed to urban ecosystems, yet at a cost of losing a sizeable proportion of the country's water supplies, provided by the natural ecosystems prior to their transformation. More than 98% of the population currently resides in urban ecosystems, whose biodiversity mostly provides cultural services, while all other services used by the urban population are provided by most of the other non-urban ecosystems of Israel. The negative impacts of urban systems include urban pollution infiltrating to adjacent ecosystems, as well as pets that are hazardous to non-urban biodiversity and cultivated garden plants that often become eruptive species. Yet, urban ecosystems also provide supporting services for some components of biodiversity and thereby reduce their risk of extinction at the national scale. This is because city buildings and gardens combined comprise biodiversity habitats which somewhat compensate for the loss of habitats of these species in other ecosystems prior to their transformation. Furthermore, some components of the State's endangered biodiversity find refuge in urban ecosystems where they benefit from public sympathy and the support of local authorities, leading to local biodiversity protection initiatives, which increase awareness and public support for biodiversity conservation at large.

What are the projected threats to the biodiversity of Israel?

The processes projected to threaten biodiversity and its attendant services include accelerated human population growth west of the Jordan River and climate changes resulting from the expected acceleration in global warming. Population growth would further encroach on habitat areas, which together with reduced rainfall and warming, would increase extinction risks and alter the composition and dimensions of biodiversity in most Israeli ecosystems.

Population growth (threefold by year 2050) will increase the extent of built-up areas, thus reducing the total area of non-urban and non-agricultural ecosystems and their consequent ability to support biodiversity. The intensive population growth which is projected in the Palestinian

Authority would not only damage biodiversity in its areas, but would also endanger biodiversity within Israel. The projected temperature rise, reduced rainfall and increased climatic instability would boost the risks of extinction of many biodiversity components, as well as the dimensions of invasion and eruption of many species, some hazardous for agriculture, human health and Israel's biodiversity itself. The terrestrial ecosystems are likely to lose species, since emigration northward or to higher elevations from areas undergoing warming would be impaired by impassable built infrastructures and habitat fragmentation, or by the lack of very high mountain ranges in Israel, respectively. As a result, biodiversity in most Israeli ecosystems may experience extinctions and changes in its composition, leading to changes in service provision. The rise in sea surface temperatures in both the Mediterranean Sea and the Gulf of Elat would intensify the invasion of Mediterranean marine ecosystems by Red Sea species, and would endanger the Elat coral reef communities, respectively. The projected global warming-driven sea level rise in both the Mediterranean and the Gulf of Elat may detrimentally affect the marine biodiversity component providing the service of coastal protection, and intensify the exposure of coastal ecosystems and their biodiversity to seawater spray. The projected increases in evaporation rates and frequency of droughts, combined with increased population rates, would boost the water demands of the urban and agricultural systems, leading to reductions in quantity and quality of water of freshwater ecosystems, and hence to severe damage to their biodiversity and the provision of their services.

Preparing for projected threats – biosphere regions and ecological corridors

A prerequisite for securing the provision of ecosystem services in the face of the projected threats is the recognition that biodiversity conservation supports rather than conflicts with development. Two measures may then be adopted. Firstly, innovative national planning should be introduced in which most of the country's area would function as an aggregate of biosphere regions, each encompassing a spatial gradient in which moderately declining development intensity would be linked with a parallel moderately increasing conservation intensity. Secondly, the biosphere regions should be interlinked with corridors established along the country's climatic gradient to facilitate the dispersal and migration of plants and animals between regions of varying threat levels.

The projected threats to biodiversity need to prompt major steps such as a country-wide re-planning. Though population growth projections were at the background of a few national master plans with some relevance to biodiversity, most if not all of them ignored the threat of global warming and were not guided by the understanding that biodiversity and human development are not in conflict and that development actually requires biodiversity. Therefore, national planning is required that would apply a gradation of biodiversity conservation to most of the country, using two different but complementary planning tools. One is planning for the establishment of "biosphere regions" (also called "biosphere reserves"), in which human activities differing in the intensity of their impact on biodiversity, are spatially interlinked with a respective application of different intensities of management and conservation of biodiversity. These complementary intensities of development and conservation are determined by the types of ecosystems and human communities in each of the biosphere regions, but national perspectives too are to be involved in the planning process of each of the biosphere regions. The joint development-conservation gradients of the biosphere regions is designated to mitigate the expected damages to biodiversity brought about by the projected population growth and secure the continuation of service provision. The second planning tool is ecological corridors, an instrument for mitigating the damages of the projected increase in the spatial dimension of ecosystem fragmentation driven by human population growth. These corridors would enable migration between otherwise mutually isolated fragments, thus reducing species extinction risks. Corridors to be positioned along the country's climatic gradient would respond to the threat of climate change by providing pathways for the "migration" of dispersing individuals of species, from southern or from low altitude regions, whose warming

climate becomes inhospitable, to more northern or higher elevation regions whose climate would become favorable to these biodiversity components, enabling them and their services to persist.

Is the pricing of services for financing biodiversity conservation feasible?

While some provisioning and cultural services are marketable, nearly all supporting and regulating services, and especially the "existence value" of biodiversity, have no market value and therefore the biodiversity involved in their provision suffers from both damages inflicted by service users and from inadequate financial resources for its conservation.

Biodiversity is involved in the provision of all ecosystem services, and all of them, by definition, are of value to humanity and society. However, despite the demand for most of them and the willingness of users to pay, it is impossible to deny their use from users who do not pay, especially when their use does not reflect on the benefit derived by others. Therefore, biodiversity and especially its components involved in regulating and supporting services becomes a "public good" whose consumption is publicly shared and non-competitive, so that competitive markets cannot reflect its real value to users. The inability to collect fees for services with no market imposes the cost of conservation on the authorities, but even then, the free access to services often jeopardizes the biodiversity involved in their provision, which may inflict damages whose remediation costs are tangibly great. However, some provisioning and cultural services are "marketable" services, which enable the charging of usage fees, to be invested in financing protection measures for the biodiversity involved in their provision.

Development plans need economic analysis of ecosystem services to be affected

A decision to transform an ecosystem for the sake of development requires economic analysis in order to assess the value of the ecosystem in the provision of all its services, and the function of biodiversity in this provision. The resulting cost estimates need to be assessed vis à vis the benefit from development and the attendant ecosystem transformation and consequent loss or tradeoff of services – an outcome of the damage to biodiversity inflicted by such development. Such an evaluation includes services with use value as well as those with non-use value.

The assessment of ecosystem services requires the cooperation of ecologists and economists, whereby ecologists would identify all the services, the components of biodiversity engaged in their provision and the services expected to be damaged by the proposed development, and economists would assess the value of services whose provision is expected to be affected. The resulting estimate will be added to the cost of development, and this overall development cost would be compared to its expected economic benefits. Such economic evaluations of ecosystems that are candidates for development-induced transformation mostly relate to marketable services facilitated by biodiversity, but also to less tangible benefits, such as the non-marketable regulating and supporting services. They even relate to non-use values, such as biodiversity's existence value, the value of its potential use, its use when serving only certain sectors of society, the value of bequeathing it to future generations, and its altruistic value. Most of these services are non-marketable, yet they can be evaluated using direct methods such as willingness to pay in a hypothetical market, or indirect methods. The latter internalize the non-use value of a non-marketable service, when it is utilized by a linked marketable service, the cost of which serves as a basis for estimating the economic value of the non-marketable service.

Biodiversity conservation needs the support of economic incentives in the face of development

When economic cost-benefit analysis demonstrates that the economic benefit is still higher than the cost (in which the cost of lost ecosystem services is internalized), the ecologist needs to identify ecosystem management measures that would minimize the projected development's damage to biodiversity. The economist

would then estimate the cost of these measures and propose economic incentives to help finance or reduce the cost of these measures. These would minimize the development-inflicted damages to biodiversity, leading to the optimal and sustainable provision of benefits derived from both biodiversity and development. Such economic incentives or instruments should be used alongside regulative and public awareness tools.

Economic incentives for biodiversity conservation include imposing taxes that increase the price of products and actions which endanger biodiversity (such as pesticide use and land consumption for low-rise buildings), as well as imposing financial responsibility for damages to biodiversity. Incentives also include remuneration through tax breaks or subsidies for benefits to biodiversity due to actions with positive externalities on biodiversity (such as environment-friendly cultivation practices, construction of high-rise buildings, and releasing lands zoned as agricultural or urban for biodiversity conservation). In many developed countries but also in developing ones, a wide range of incentives already assist in biodiversity conservation and secure its service provision. These incentives target both individual members of the public (by means of tax breaks and fines) and corporations (by means of incentives for accreditation programs and standards for environment- and biodiversity-friendly products). These incentives are implemented at both the community level (e.g., incentive for purchasing areas designated for biodiversity conservation or benefits for refraining from exploitative use of community forests) and the global scale (e.g., the carbon credits market that comprises an economic incentive for protecting the global climate regulation service, whose transboundary provision is assisted by the biodiversities of all states combined).

What gaps in knowledge should be bridged for conservation and management of biodiversity?

Although knowledge on biodiversity and experience in its conservation have already been accumulated, they do not suffice for directing the actions necessary for securing the continued existence of biodiversity and the optimal provision of ecosystem services. Management methods and conservation means are still deficient since many species are altogether unknown, the function of species in service provision and the risk level of many of them have not been determined, approaches for incorporating biodiversity considerations in planning processes have not been developed, and the updating of master plans in the face of projected threats to biodiversity has not been attempted.

Despite the extensive knowledge assembled by generations of researchers on the composition, dimensions and distribution of components of Israel's biodiversity, and despite a rich experience in conservation and management accumulated since the establishment of the State, knowledge gaps relevant to different components and levels of biodiversity and its management are still wide and deep. As a result, Israel does not derive the fullest benefits from the biodiversity assets at its disposal. It is even plausible that risks to biodiversity would worsen unless efforts and measures for closing these gaps are taken. The paucity of specific experts has resulted in a lack of knowledge concerning small-bodied species which are of critical significance in service provision, including many of the insect species and their related animal groups and the various worms and microscopic groups of species. The large number of species in each of the ecosystem types, whether already known or not yet known, and the lack of expertise needed for distinguishing between different species makes the assessment of the population size of each difficult. Therefore, for many species it is not known whether their populations are small to the point of endangering their service provision or so small as to risk their extinction. Furthermore, the causes for species' rarity are often unknown so that it is impossible to devise means for their management and conservation. In addition, the specific functions of many species and their relative role in the provision of each of the services usually remain obscure. Furthermore, it not known which of the easily identified species could be used as indicators either for the state of many other species whose identification is difficult, or for the overall state of their ecosystems and the condition of their service provision. Also missing is solid knowledge for determining the size of water quotas allocated by the State to natural ecosystems, for fixing

quotas for wildlife sport hunting, for advancing measures to protect biodiversity from invasive alien species, and for the projected effects of genetically engineered organisms. Finally, knowledge of the extent of the genetic diversity of selected groups of species, such as relatives of cultivated plants and species with fragmented and disjunct populations, is seriously insufficient. All these knowledge gaps can be bridged through investments in scientific research that would extend their scope beyond biodiversity itself to the development of means for incorporating the significance of biodiversity in planning development activities and policies at the local and national levels. This should include examining existing and projected master plans and updating them to take account of the threats to biodiversity posed by the demographic and climate change trends projected for the 21st century.

Biodiversity monitoring – what is it, why is it required and how is it implemented?

Even when currently identified knowledge gaps are bridged, new ones are likely to emerge due to the dynamics of environmental, societal and economic processes. These generate new challenges to biodiversity that make new management intervention imperative. Therefore, an extended follow-up of the responses of biodiversity to changes is required to guide further management and research activities aimed at assisting biodiversity to confront the new challenges. Such activity should be carried out through a network of coordinated countrywide monitoring stations, but the development and operation of this network should be interwoven with scientific research.

Bridging knowledge gaps requires research, an activity focused on a quest to solve a well-defined question. Monitoring, on the other hand, is an extended follow up that documents variations and trends of carefully selected variables, leading to the detection of problems that need to be solved. Monitoring then follows up on the implementation of the solution to the problems, thus assisting research aimed at evaluating its proposed solutions. Biodiversity monitoring is of utmost importance, due to the inherent dynamics in the dimensions and functions of all biodiversity components, resulting from the intensive changes all Israeli ecosystems have undergone, are undergoing and will undergo under the pressures of development, population growth and climate change. Biodiversity monitoring also serves as a tool for examining and evaluating the efforts and measures taken for biodiversity management and conservation. A number of monitoring activities directed at a small number of species and selected ecosystems (especially aquatic ones) are already operational, but these do not respond to the needs of biodiversity management in Israel at large. This deficiency is due to a failure to recognize the benefits of monitoring, and to gaps in the knowledge required for its planning and operation. Directed research may guide and help establish a biodiversity monitoring system, based on a network of permanent stations for monitoring, operated according to harmonized standards at the national level. Such a network would provide early warning and would catalyze improvements and adaptation of conservation and management tools, thus contributing to the "adaptive management' approach. Such a network would also detect knowledge gaps resulting from changes in the state of ecosystems and assist in allocating priorities to research directed at emerging problems and responding to the changing needs of biodiversity.

Tools and infrastructures for bridging gaps in knowledge required for biodiversity management and conservation

The main tool for bridging gaps in knowledge is scientific research of biodiversity and its conservation methods, while its supporting infrastructures include monitoring, databases and scientific collections of preserved specimens. Though available in Israel, the tool and its infrastructure are not appropriately used to effectively meet their objectives of supporting biodiversity conservation and management. Creating frameworks designated to efficiently operate both this tool and its supporting infrastructures, including dedicated financial instruments, would lead to coordination in the use of all these means, determining appropriate priorities in resource allocation, and maximizing the benefits derived from efforts to bridge currently existing and emerging knowledge gaps.

Several entities are entrusted with research duties and

others are charged with protecting and managing Israel's biodiversity, but a framework designated to generate research that would bridge the gaps in knowledge required for conservation and management of biodiversity is non-existent. Similarly, the knowledge for constructing and operating a biodiversity monitoring system, which feeds research and constitutes one of its infrastructures, is also deficient. This is also the case regarding additional but invaluable infrastructures supporting the research required for conserving and managing biodiversity, namely the databases expected to store both the monitoring data and the information encapsulated in and derived from the scientific biological collections. These latter facilities document, by means of the preservation of specimens collected throughout the country, the inventory of Israel's biodiversity with all its components, and comprise one of the most important tools for those engaged in research and monitoring of biodiversity conservation and management in Israel. While these all exist and are operated in a number of institutions, the lack of coordination and integrated vision, and at times the disconnection between research, monitoring, databases and collections, detract from the benefits of each and from their contribution to biodiversity conservation and management. Most serious is the lack of designated budgetary instruments for activating research which advances the attainment of biodiversity management goals, as well as for establishing and operating the infrastructures securing the success of this research, such as monitoring systems, databases, and scientific biological collections. The few budgetary tools for advancing relevant scientific research as well as maintaining the scientific collections that do exist in Israel have proved insufficient and hence ineffective.

What are the legal instruments addressing the conservation of biodiversity in Israel?

Israeli legislation provides protection to a large number of species, either specifically and directly, or generically and indirectly through legislation applied to land and water resources, but with biodiversity implications, since these resources serve as ecosystem infrastructures. Thus, even if these legal instruments do not explicitly address "biodiversity," "ecosystems" and their service provision, they can be effectively used for advancing the conservation and management of biodiversity, even though some of its components do not yet enjoy direct legal status.

The "National Parks, Nature Reserves, National Sites and Memorial Sites Law" and its attendant regulations, orders and declarations, in combination with the "Wildlife Protection Law," jointly protect individual species, and/or groups of species (such as all species belonging to the plant genus Iris, or all reptile species, namely the whole class of Reptilia). The first law provides absolute protection to sites proclaimed as national parks or nature reserves, as well as to "Protected Natural Assets". The second law protects "wild animals" (i.e., vertebrate species), but licenses the hunting of several species under restrictive conditions; hence it can also serve as a legal instrument for active biodiversity management through population control. The two laws jointly protect many species, some of which are protected by both, and the "Forest Ordinance" protects all species of indigenous wild trees. In addition, populations of all species residing in nature reserves (comprising more than 30% of the State's area) enjoy absolute protection. However, important components comprising a sizeable portion of biodiversity, such as all insect species of Israel, remain legally unprotected, save insect species in nature reserves. Indirect protection of habitats is provided through legal instruments that regulate the use of land and water – the natural resources that comprise the physical infrastructures of most of Israel's ecosystems. These instruments include the Planning and Building Law which relates to Israel's National Master Plans and addresses the national resource of the highest significance for the conservation and management of biodiversity – the land area of the country. The most important of these master plans include National Master Plan 8 for Nature Reserves and National Parks, National Master Plan 22 for Forests and Afforestation, National Master Plan 13 for the Protection of Coasts and National Master Plan 35 for Building, Development and Conservation. Together with regulations and orders such as the "Soil Erosion Ordinance" and the "Forests Ordinance," these legislative instruments address "open areas," "nature" and even "ecosystems," and are

therefore relevant to the conservation and management of the country's biodiversity. The "Water Law" even directly protects "animal and plant life" from pollution, and an amendment to this law secures water allocation to "wetlands." The "Springs and Streams Authorities Law" regulates activities for "protecting natural landscapes and nature's treasures," and the "Springs and Streams Authorities Order" regulates the physical management of freshwater ecosystems and specifically addresses the "protection of biodiversity" of streams. Other laws address the protection of seas and coasts mainly from pollution, mining and construction, and highlight the need for "conserving nature and landscape resources, and nature and heritage values." In addition, Israel's biodiversity indirectly benefits from several other laws that specifically target many and diverse environmental hazards and pollution risks to human health. These too, though unintentionally and hence indirectly, also reduce human impacts on many ecosystems and their biodiversity, including reducing the risks of alien invasive species.

What are the limitations of current legal instruments?

Persistent damages to the biodiversity of Israel point at the failure of currently available legal instruments, most of which were not originally targeted at biodiversity conservation even if they are indirectly used to partially address biodiversity. The legal instruments that directly address biodiversity components focus on "protection" and "nature" more than on biodiversity and management. All relevant legal instruments, whether addressing biodiversity directly or indirectly, adopt a passive defensive approach instead of an approach that obligates authorities to be assertively active on behalf of biodiversity conservation and management.

Israel's biodiversity suffers from two limitations of the existing legislation. The first is that the National Parks and Nature Reserves Law and the Wildlife Protection Law are designated for "nature protection," which is similar but not identical to "biodiversity conservation and management." Hence these laws provide solutions for individual species more than they support remedial action for the entire biodiversity and for whole ecosystems under threat. In contrast, all other relevant legal instruments do not address biodiversity at all, but are directed at physical components such as land and water for human use, usually detached from the functionality of biodiversity in the provision of human needs. The second limitation is that the existing legislation imposes restrictions and bans on actions that constitute "threats" to biodiversity instead of obligating authorities to initiate actions, such as government programs for protecting ecosystems and their biodiversity, or mechanisms for granting "endangered" legal status to threatened species, ecosystems and their services, all within a framework of a consolidated and comprehensive national biodiversity policy.

What are the institutional frameworks for implementing the legal instruments and how can they be improved?

Many institutional frameworks are entrusted with the implementation and enforcement of many legal instruments, but only some of these instruments exclusively target biodiversity, and only some of the institutions have the mandate to address it. Furthermore, the degree of inter-institutional overlap and confrontation often obstruct implementation and enforcement of biodiversity-related legislation. Therefore, enhanced inter-institutional cooperation in the implementation of existing instruments, as well as steps taken for advancing specific, biodiversity-targeted legislation to be implemented by a designated, unified and consistent framework are required.

The implementation and enforcement of more than 15 biodiversity-relevant legal instruments (7 laws, 4 ordinances, 4 national master plans and many orders) are entrusted to some 15 institutional frameworks – 6 government ministries, 5 governmental authorities and several springs and streams regional authorities, an administration (Israel Land Administration) and a corporation (Jewish National Fund). Only four of these (Ministry of Environmental Protection, Nature and Parks Authority, and two Streams and Springs Authorities) have an explicit mandate for engaging in the conservation and management of biodiversity. In addition,

only five of the legal instruments are each addressed by a single institutional authority, while all other instruments are each attended by several (ranging from two to six) different authorities. The profusion of frameworks, their overlap and the fragmentation of other responsibilities among them often result in conflicts and create bureaucratic obstacles to effective implementation and enforcement. This multiplicity derives from the wide range of societal-economic endeavors, such as agriculture, fisheries, afforestation, energy, industry, transportation, and urban and rural development, each of which affects biodiversity in a different way. Therefore, a critical examination of the inter-institutional division of responsibilities and authorities and the mapping of the obstacles and identification of their causes may advance the efficiency of the existing legal instruments. Furthermore, developing a biodiversity law, an innovative legal discipline emerging from the interaction between law, science and policy, may advance a new, inclusive legislation targeted at the management of Israel's ecosystems and the conservation of their biodiversity so that its full societal benefits are derived.

Public education and awareness raising as a strategic tool for biodiversity conservation

Despite Israel's nature conservation achievements, which were acquired with the widespread support of civil society, public awareness of the dependence of human well-being on biodiversity is lacking; hence biodiversity conservation is widely perceived as competing with economic development. Therefore, educating the public and raising its awareness of the essence, significance and benefits of biodiversity constitutes a strategic tool designed to strengthen public involvement in biodiversity conservation. Such involvement would not only assist in minimizing damages to biodiversity, but would make the need for legal instruments and their enforcement at least partly redundant. It would also help to mobilize resources for research and monitoring, thus making the management of biodiversity and ecosystems more effective, while reducing the dependency of biodiversity conservation on economic incentives.

Nature conservation has enjoyed widespread public support since the early days of the State of Israel and even earlier, resulting in remarkable achievements, not withstanding the fact that knowledge and appreciation of the country's nature have always been tightly interwoven with the building and development ethos of the State. Nevertheless the notion of biodiversity first began infiltrating the education system and the public consciousness only towards the start of the 21st century; and is still in its infancy, remaining obscure and unusable for most of the public. This is true not only for the term "biodiversity" but more importantly for what it stands for. This is demonstrated, for example, by the finding that public concern over radiation emitted from cellular antennae in Israel is greater than the concern for species extinction. Namely, while environmental activist organizations and the education system do relate to hazards inflicted on habitats and species, they do not identify these hazards as directly affecting people, society and the economy. As a result, a sizeable part of the population views nature conservation as sacrificing invaluable benefits that are too costly to pay for, mainly because most people are unaware of the inter-linkages among living nature, services provided by ecosystems, and sustainability of economic development. Even worse, "biodiversity" is not a unique, recognized entity addressed as such in any of the sectors and levels of the Israeli education system, though certain biodiversity components are at times embedded in the teaching of other topics. This leads to an emerging and widening gap in the knowledge required not only for public enlightenment but also and mainly for training experts in biodiversity management and conservation, who can fill positions in research, education, public relations, planning and management, which jointly secure the functioning of Israel's ecosystems in service provision. Cultivating biodiversity literacy in the Israeli public, enlightening people and making them more involved and ready to take action on the civil plain and to give up short-term gains for the prospects of benefiting from long-term ones may change the current reality, and dramatically facilitate the implementation of measures instrumental for biodiversity conservation.

What is required for advancing education and raising awareness of the value of biodiversity?

Forging wide public support for the innovative outlook of biodiversity requires an infrastructure different and wider than the currently existing one that targets only nature conservation. Such infrastructure would engage in imparting knowledge, values and positions to guide citizens in their daily conduct within the environment in which they live. It would also encourage decision makers in local and national government, local communities, and the education and business sectors to take part in mostly voluntary actions, whose value for the country's future biodiversity may be decisive.

Substantial investments are required in communicating the objectives of biodiversity conservation to the educational system, starting with institutes of higher education and down to preschools. This entails restructuring existing teaching programs and themes around the perception of biodiversity through its linkage to human well-being and the sustainability of economic development. A new national framework needs to be established that evaluates the biodiversity awareness of the various population sectors, follows up on the operation of teaching and information programs and opens up channels for the participation of the public and decision makers in the products of biodiversity research. Its activities would assist in allocating resources to communities, governmental and non-governmental organizations to be used for jointly advancing public recognition of the significance of biodiversity for human life and for society. This may also impact on the conduct of the business sector, where the raising of awareness and sensitivity to biodiversity is of high priority in making this sector more biodiversity-friendly. Another avenue currently neglected but of high potential is awareness raising in local communities, both rural and urban. Such awareness may catalyze these communities to invest in nurturing their local biodiversity, deepen their knowledge of it and detect and avert threats to it. In addition it can help to build partnerships with adjacent nature reserves and encourage shared management, to make contacts with neighboring army units and to elevate the awareness of the military to the local biodiversity, and to forge "green' partnerships with the business and tourism sectors. It is also possible to encourage local and regional museums, wildlife sanctuaries and botanic gardens, information and visitor centers, all focusing on education and information on local, regional and national biodiversities, including their functions and benefits. Finally, disseminating the biodiversity discourse by means of the powerful public relations media tools would widen and deepen the exposure of all public sectors and society to all aspects of biodiversity and its derived benefits.

Multilateral agreements on biodiversity as a tool for promoting Israel's international status

By means of signature and ratification, Israel has become a contracting party to five international agreements under the United Nations, which directly address the conservation and management of biodiversity. These are the Convention on Biological Diversity, the Convention on International Trade in Endangered Species, the Convention on Migratory Species of Wild Animals, the Convention on Wetlands and the World Heritage Convention. In addition, Israel ratified the United Nations Convention to Combat Desertification and the United Nations Framework Convention on Climate Change, both of which indirectly yet significantly address biodiversity. Joining these agreements has provided Israel with an opportunity, hitherto not fully taken, to become an active player on the environmental international platform arena, making use of its accumulated experience in conserving and managing its biodiversity, thus promoting its international image.

The motivation for negotiating these agreements is the damage to the global human society inflicted by transboundary effects through which excessive development in one country damages biodiversity and impairs ecosystem functions not only in neighboring but also in distant countries, even to the extent of detrimentally affecting the functionality of the entire global ecosystem. Even if a country mitigates its self-inflicted damages to its own ecosystems, its exposure to damages caused by other countries will persist. Therefore, just as damage to biodiversity knows no boundaries, its prevention too needs

to be implemented at the global scale. Therefore, the relevant international conventions are destined to secure sustainable use of the global ecosystem services, for example through economic incentives to countries making prudent use of their ecosystem services, and by exacting a price for the ecosystem services used by one country at the expense of other countries. Such actions require tools for implementing the incentives on the one hand and for inspecting and policing this implementation on the other hand. For Israel not to be taken aback by decisions unfavorable to it, involvement in these agreements allows Israel's representatives to have their say in the decision-making processes practiced by the institutions of each of the conventions. Moreover, while Israel has its image problems in the political international arena, it can exploit this same arena within the framework of biodiversity-relevant United Nations conventions. Even though Israel still has a way to go, its accumulated knowledge and experience in the field of biodiversity enable it to gain international exposure and recognition.. Through active involvement in meetings of the parties of these agreements, Israel would become an organic part of the international community and the family of nations, which not only implements global environmental agreements but is also a partner in their formulation. Exposure within the circles of the international biodiversity community would also promote Israel's international prestige and recognition even beyond these circles.

Using biodiversity-related knowledge and experience to promote Israel's foreign aid activities

Even if all state parties to the biodiversity-related conventions, including Israel, commit to optimally conserve the biodiversity within their territorial boundaries, the industrial parties to the agreements (Israel included!) are expected, under all these conventions, to provide foreign aid to the developing states in order to help them conserve their own biodiversity. This is so because much of the global biodiversity, which is of especially high dimensions and qualities and of specific global significance, resides in developing countries, which have difficulties in protecting it, due to the paucity of knowledge, experience and financial and professional human resources.

Israel's annual report on biodiversity conservation is not among the highest priorities in the expectations list of countries that are parties to the Convention on Biological Diversity. Rather, the developed states expect Israel to join them in their efforts to support developing countries to both conserve and to derive benefits from their own biodiversity. Similarly, the developing countries expect Israel's support, whether in the form of transfer of knowledge and experience sharing, or in resource allocation to enable partnership in projects relevant to the conservation and management of their biodiversity. To date, Israel has not taken advantage of the frameworks of biodiversity-related conventions to derive national benefits from foreign aid, in general, and in the area of biodiversity particularly. This latter foreign aid channel is neglected despite the fact that its increasing vigor matches that of Israel's traditional areas of foreign aid - agriculture and human health. Directing foreign aid efforts to a biodiversity-related avenue would bring Israel not only many new ambassadors of good will and promote its image in both the awakening developing world as well as among members of the community of donor states, but also new business opportunities and improvements in foreign relations. Similarly, Israel's active participation in international financial instruments designated to support the implementation of biodiversity-relevant conventions (such as the Global Environment Facility) would be a powerful tool for empowering the status of Israel in the international arena.

International activity under the global conventions is beneficial to the conservation and management of Israel's biodiversity

Global conventions that deal both directly and indirectly with biodiversity constitute a vibrant arena for the exchange of professional information generated the world over, which is constantly updated and directly touches on problems encountered by the institutions and

bodies entrusted with the conservation and management of Israel's biodiversity. These UN conventions also serve as instruments for minimizing transboundary adverse impacts on Israel's biodiversity.

During the course of professional meetings taking place alongside the political conferences of parties and other events of the various conventions, Israeli delegates not only share their accumulated knowledge and experience, but also learn and import new knowledge for advancing the conservation and management of Israel's biodiversity. In addition, the secretariats of each of these conventions produce excellent technical products presented in the form of documents encompassing the best and most updated professional knowledge relevant to issues of concern in Israel. These include documents on treating invasive alien species, guidelines regulating the economic exploitation of specific genetic diversity components, methods for reintroductions and reinforcements, economic incentives for biodiversity conservation, indicators for monitoring management practices, tools for public education and awareness raising, and more. Activities under the umbrella of the biodiversity-related conventions also help Israel to grapple with transboundary threats to its biodiversity. On the global scale, Israel would benefit from the comprehensive implementation of the UN Framework Convention on Climate Change and its protocols as well as the Convention on International Trade in Endangered Species, in order to protect its biodiversity from the local expressions of global climate changes and from introductions of alien invasive species, respectively. On the regional level, Israel would benefit from the implementation of the Convention on Migratory Species thanks to its location on a major old-world bird migration route. The implementation of the Barcelona Convention for the Protection of the Mediterranean Sea against Pollution is also imperative, since the biodiversity of the Israeli Mediterranean coastal and marine ecosystems may be seriously damaged not only by pollution from sources in Israel, but also by pollution originating in other Mediterranean countries.