State of Israel
Ministry of the Environment

CONSERVATION AND SUSTAINABLE USE OF BIOLOGICAL DIVERSITY IN ISRAEL

Report of the State of Israel on the Implementation
of Article 6 of the Convention on Biological Diversity

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Introduction

In juxtaposition to its small land area, Israel is characterized by a wide range of physical conditions and by a rich variety of flora and fauna. Its location at the crossroads of climatic and botanic regions endows the country with a rich variety of plant and animal life including some 2,780 plant species, 7 amphibian, 97 reptile, 511 bird and 116 mammal species. Within the small land area of Israel, two opposing climatic regimes are found--Mediterranean in the north and desert in the south. The central part of the country is a transition area between these two biogeographical regions where desert biota is gradually replaced by Mediterranean biota. Species widely distributed over the entire Mediterranean climate region reach their southern limit of distribution in Israel while Saharan or Asian desert species reach their northernmost limits in this country.

Israel's fauna is extremely varied due to the location of Israel at the meeting point of three climatic and vegetation regions. Although additional surveys and studies are required to fill gaps in knowledge concerning Israel's fauna, the country's foremost zoologists believe that nearly a third of Israel's vertebrates have suffered either extinction or a reduction in their populations in this century alone due to human activity--whether hunting, agricultural practices, urban and industrial development, or poisoning. While some of these changes were inevitable, others were preventable such as the controversial draining of Lake Hula in the 1950s which destroyed a unique wetlands ecosystem.

Israel's location in the Middle East heartland of genetic diversity of many major agricultural crops, coupled with its remarkable geographical and climatic diversity, have helped create a particularly rich collection of habitats and corresponding local varieties. Israel is one of the world's richest areas in progenitors and relatives of domesticated species. In light of spreading urbanization, habitat destruction, intensive farming and the almost universal use of elite cultivars by farmers, the preservation of Israel's wild genetic resources is an imperative.

In Israel, as in the world at large, the decline of biodiversity is largely a result of accelerated development, population increase and the resulting destruction of habitats. While about 20 percent of Israel's land area is preserved within declared nature reserves, most of them are located in the desert areas of Israel, and a large number overlap military training areas. Only about 3 percent of the Mediterranean region is currently protected in nature reserves.

The main problem facing nature conservation in the Mediterranean region is habitat fragmentation. Over 100 declared nature reserves are dispersed within a total area of 250 km^2. Protection of many populations (e.g., bats, sand dwelling reptiles, large predators like wolves, and other mammals such as gazelles) is impossible to achieve within the reserve system, while outside the reserves, development, habitat

degradation and conflicts with agriculture and other human activities, make it difficult to preserve the small Israeli populations.

In the south of the country, the unique desert ecosystem is also endangered, mainly by pressure from development plans. Further scientific research is required to understand the desert ecosystems, explain the mechanisms involved, and thereafter prescribe the correct balance of livestock grazing, reintroduction of extinct wildlife, proper road construction and tourist accommodation.

Legal and Policy Background

Israel ratified the Convention on Biological Diversity in August 1995. Since Israel is a developed country, in terms of both its scientific and technological development and its nature conservation and environmental experience (including law enforcement, management and research), it expects to take an active part in the implementation of the Convention.

The Ministry of the Environment is responsible for implementation of the Biodiversity Convention. The Nature Reserves Authority, acting under the Minister of the Environment, is Israel's scientific advisory body to the Convention. An interministerial committee for conservation of biodiversity was appointed in May of 1996. It includes 12 representatives from the Ministries of Finance, National Infrastructures, Defense, Education, Foreign Affairs, Agriculture, Science, Commerce and Industry, Interior, Transport, Tourism and Environment. Several other governmental and non-governmental organizations are also taking part in the preparations toward the formulation and implementation of Israel's national strategy for biodiversity conservation.

Israel already has the necessary legal and institutional framework to protect its biodiversity and, therefore, a national strategy plan for biological diversity can be implemented through the enforcement of these laws. In addition, Israel has ratified several international conventions related to nature conservation including the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Convention on the Conservation of Migratory Species of Wild Animals and the Convention on Wetlands of International Importance.

The country's commitment to protect natural values also finds expression in national masterplans such as the National Masterplan for National Parks, Nature Reserves and Landscape Reserves and the National Masterplan for Forests and Afforestation. Together with environmental impact assessment regulations, these laws and masterplans constitute the basis of a preventive policy whose goal is to anticipate and prevent future land use and development activities that threaten to harm Israel's biodiversity. Damage to biodiversity is also considered a crime under a long list of Israeli laws, and perpetrators may be prosecuted through the enforcement of these laws.

Objectives of Israel's Biodiversity Strategy

Israel's national biodiversity strategy is based on a national vision whereby society appreciates and respects all life forms and sustainably uses natural resources while preserving and conserving the country's rich biological diversity for the benefit of future generations.

In order to fulfill this national vision, Israel has formulated several targets aimed at protecting, assessing, utilizing and benefiting from biodiversity and its components. These include:

- Developing and implementing a comprehensive plan for preserving biodiversity and for sustainable use of its components;
- Establishing a network of protected areas for the preservation of ecosystems, species and genetic resources which are capable of functioning ecologically and which are related to other open spaces such as agricultural fields;
- Rehabilitating damaged ecosystems in order to promote biodiversity;
- Coordinating the implementation of the plan among all stakeholders including governmental and non-governmental bodies, the private sector, community groups and other target populations;
- Utilizing legislation, rules and procedures, budgetary allocations and other regulatory measures to establish methodologies for conservation of biological diversity and for sustainable use of resources;
- Advancing public awareness concerning the advantages of biodiversity conservation and sustainable development;
- Promoting knowledge and expertise through formal and non-formal education, ongoing research, and increased institutional capabilities.
- Harmonizing national action with international and regional conventions, activities and plans;
- Implementing the precautionary approach through measures intended to forecast, prevent and combat the causes for reduction or loss of biodiversity at source;
- Integrating traditional knowledge on the conservation of biodiversity.

Israel's strategy relates both to habitats and to key species such as endangered species, endemic species, species of international importance and Red Book species. Indicators for implementation are being designated for both habitats and species. Every effort is being made to identify organizational frameworks capable of implementing the program and to strengthen the role of non-governmental organizations. In addition, new or amended legislation is being developed in order to strengthen natural resource conservation, to accord protection from exotic species and to prohibit commerce in indigenous species. High priority will be accorded to integrating the principles of biodiversity in educational programs on all levels.

On the technical level, initiatives will be launched to incorporate ecosystems which are not currently represented in the national network of protected areas, marine reserves and population inventories and surveys. Recommendations for conserving and using different biotic resources will be formulated, and plans for research and management of isolated populations for the purpose of their preservation will be drafted.

On the research front, it will be necessary to strengthen taxonomic and systematic research and to monitor global impacts and ozone depletion. An economic assessment of indigenous genetic resources, genetic engineering and use of popular knowledge of these resources is planned as well.

Implementation of Israel's Biodiversity Strategy

In a country as small as Israel, with a high rate of industrialization and urbanization, nature reserves are important to help secure the biodiversity of the natural environment. Israeli law defines a nature reserve as an area containing unique and characteristic animal, plant and mineral forms which must be protected from any undesirable changes in their appearance, biological composition or evolution. Israel's reserves vary in size, character and use. Together, they represent the entire spectrum of Israel's ecosystems, including Mediterranean forests, marine landscapes, sand dunes, freshwater landscapes, desert and crater landscapes and oases. Outside the confines of nature reserves, hundreds of plants and animal species, including ferns, wildflowers, shrubs, trees and fish, as well as minerals, have been declared "protected natural assets." The Nature Reserves Authority, along with other national agencies, works to protect these natural assets wherever they may be.

To date, 155 nature reserves, spanning an area of some 3.5 thousand hectares, have been declared and 17 more have been approved for declaration. With the declaration of another 202 reserves, now in various stages of planning toward declaration, the total area of the reserves will reach 6.1 thousand hectares.

While none of Israel's reserves is large enough to preserve entire ecological systems which encompass a variety of habitats, efforts have and are being made to move in this direction through the declaration of biosphere reserves. One of Israel's most important regions--Mt. Carmel--was declared a biosphere reserve in April 1996 within the framework of the Man and Biosphere Program of UNESCO. Other areas considered to be appropriate for declaration as biosphere reserves include Mt. Meron in the north and the area encompassing the slopes of the Judean Hills in the transition zone between the Mediterranean and desert biomes.

Largely in order to overcome the problem of habitat fragmentation in Israel, the Nature Reserves Authority and the Jewish National Fund have cooperated on a so-called "Open Landscapes Plan" for Israel. Geographical and lithological data, collected by the JNF, and botanic data, collected by the NRA, is currently being compiled, evaluated and mapped on the Geographical Information System of the NRA. The result will be an ecosystem assessment of the remaining open natural landscapes in Israel which will include an evaluation of each area based on such criteria as unique or rare elements, biodiversity in terms of species and communities, and potential for sustainability based on size and connectivity to other areas.

When selecting the optimal method for assessing Israel's open natural spaces for purposes of nature conservation, the NRA decided to base its assessment on the contribution of open spaces to plant protection. Since plants comprise most of the

biomass of all terrestrial ecosystems, their central role as primary producers makes them prime candidates on which to focus for nature conservation purposes. On the other hand, the assessment method used for the Negev was based on "umbrella species." For the purpose of this assessment, the *Capra ibex nubiana* was selected as the "umbrella species" for the rocky and cliff areas while the *Gazella dorcas* was selected for the valleys and plains

While the open space assessment project currently being implemented by the NRA has a direct impact on the conservation of biodiversity in Israel, all of the country's green bodies have waged a major campaign on behalf of preserving Israel's open spaces in the face of development pressures. Various steps have been taken in recent years to help secure the biodiversity and the natural landscapes of Israel: an interdisciplinary "think tank" was organized by the Society for the Protection of Nature in Israel, the country's foremost non-governmental organization, in 1991; a Public Council for the Protection of Land and Landscape Resources was set up in 1994; and a proposal for a national policy which integrates development with landscape preservation was drafted in 1996. A major component of this national policy proposal is classification of open space landscapes into units according to criteria which relate to the characteristics and functions of each landscape unit including: ecological function, cultural and historic importance, rarity, regeneration capacity, landscape and aesthetic function and potential for leisure and recreation activities. On the basis of these criteria, the level of development which each area can sustain, without damaging its unique value and characteristic image, may be determined. Based on the carrying capacity for development of each area, guidelines for planning and land use will be defined for each category of preservation/development.

Recognition of the unique character of many of Israel's ecosystems has led to a number of initiatives. Thus, special protection and/or management strategies have been formulated for such unique and sensitive ecosystems as Israel's coastlines, on both the Mediterranean, Red Sea and the Sea of Galilee (Lake Kinneret). The National Masterplan for the Mediterranean Coast, for example, aims to prevent development which has no need for a coastal location, to protect large sections of the coastline as nature reserves, national parks and coastal reserves and to allocate coastal areas for tourism and recreation activities. It includes a highly effective clause prohibiting development within 100 meters of the coastline. Four types of nature reserves exist along Israel's Mediterranean coast: marine reserves, coastal reserves, islet reserves and protected natural asset belts. To protect the sensitive coral reef of Eilat, one of the northernmost coral reefs in the world, two marine nature reserves and two coastal reserves have been declared and several research programs have been initiated by a wide range of institutions.

In November 1996, Israel embarked on an ambitious coastal initiative within the framework of the Coastal Areas Management Programme (CAMP) of the Mediterranean Action Plan (MAP). The program has two main objectives which are also expected to facilitate the preparation and implementation of Israel's biodiversity strategy:

- To encourage policy makers of economic development sectors to take responsibility for the environmental impacts of their decisions and to incorporate environmental considerations in their decision making processes;
- To provide the professional basis for policy making on issues not sufficiently covered in current coastal zone management.

Israel is world renowned for its strategies for combating desertification in the arid Negev and for its afforestation efforts. The Jewish National Fund has been instrumental in reclaiming, developing and afforesting the land of Israel since the beginning of the century. To date, the JNF has planted over 200 million trees, creating 280 forests over an area spanning 90,000 hectares--in addition to caring for 40,000 additional hectares of natural woodlands. About half of Israel's woodland is Mediterranean scrub vegetation, with only a small proportion (40,000 hectares) fully grown natural woodland.

One of the most pressing environmental problems in Israel has been the exploitation of water resources, the reclamation of swamps and the diversion of rivers. Most of Israel's major wetlands have been drained totally (coastal wetlands) or partially (Hula wetland), whereas others, especially around the Dead Sea, though small in size, are still relatively intact. Israel's ratification of the Convention on Wetlands of International Importance (Ramsar Convention) in 1996 has accelerated conservation and management efforts in such areas as river rehabilitation, protection of Lake Kinneret, rehabilitation of the Hula wetlands and conservation of coastal wetlands. In line with its obligations under the Convention, Israel has designated two wetland sites for inclusion in the Ramsar List, namely the Hula Reserve and the En Afeq Reserve. The case of the Hula Reserve is especially significant in reviewing the history of Israel's wetlands.

Special attention is now being focused on the rehabilitation of the country's rivers. A National River Administration was established in November 1993 to coordinate and oversee the restoration of the country's rivers and the preservation and renovation of natural and historic sites along riversides. The integration of such considerations as the sensitivity and vulnerability of rivers or sections of rivers to development is expected to help secure biodiversity and to preserve visual resources.

Israel has also accorded and is continuing to accord priority to the collection of information on the distribution and abundance of species. The Nature Reserves Authority database consists of about 200,000 individual records of plant and animal observations throughout Israel from 1963 until the present. It is continuously being augmented by new reports from rangers and biologists of the NRA. Similarly, the Rotem Israel Plant Information Center, a joint project of the Hebrew University of Jerusalem and the Society for the Protection of Nature in Israel, is developing an ecological database of Israel's flora. The Israeli Wild Plant Database now comprises over 430,000 records on the distribution and phenology of Israel's native plants. In 1990, the Nature Reserves Authority commissioned from the Hebrew University of Jerusalem, with the aid of Rotem, a field survey of Israel's rare and endangered plant species. A major task was to find objective criteria to define the rare as well as the vulnerable threatened wild plants. Rotem has already started to monitor 791 species (about a third of the flora) which have been classified into various categories of rarity.

The first part of Israel's Red Book, which focuses on the northern part of Israel and includes comprehensive information on biodiversity "hot spots" in this region, will be published in 1998.

The rapid development of Geographical Information Systems (GIS) in recent years has led to important breakthroughs in the organization and analysis of geographic data for ecological purposes. Israel is using automated cartography in resource management in order to identify areas of environmental sensitivity and areas of conflict.

In the 1960s, the Nature Reserves Authority set out to reintroduce populations of animals present in historical times, as supported by biblical reference, but no longer found within modern Israel. Two breeding cores, Hai-Bar Carmel in the north of Israel and Hai-Bar Yotvata in the south, were established to breed animals suitable for release; the former for Mediterranean species, the latter for desert species. Five species have been chosen: ostrich, roe deer, Asiatic wild ass, Persian fallow deer and white oryx (also known as Arabian oryx). Of these, all except the roe deer are globally endangered.

In addition, Israel is currently developing and implementing action plans for the conservation of various species of fauna, foremost among which are raptors, invertebrates, insectivorous bats and amphibians. The action plan for the country's raptors, for example, includes four components: management measures such as protection of habitats as nesting sites and establishment of feeding stations; surveys and research; captive breeding for the purpose of bolstering endangered species and vulnerable populations; and captive breeding for the purpose of reintroduction.

Israel's exceptionally rich plant genetic resources and advanced scientific and biotechnological expertise combine to create unique opportunities for genetic preservation, characterization, utilization and commercialization. In fact, Israel was one of the first countries to respond to growing awareness in the 1970s of the need to preserve genetic diversity. The Israel Genebank for Agricultural Crops (IGB) was established in 1979 by the National Council for Research and Development (now the Ministry of Science) and the Ministry of Agriculture as a central focus for Israel's highly decentralized plant genetic resource efforts. Today, these two governmental bodies, along with scientists from academic institutes and Israel's seed industry, are working together on the formulation of a policy on the preservation and sustainable use of Israel's genetic resources.

The principal responsibilities of the IGB are: to maintain active and passive germplasm collections, herbaria, gene parks and genetic reserves; to facilitate national and international exchange of plant material; to maintain a database and information network; to promote national and international cooperation and coordination; to organize and participate in workshops, conferences and training activities; to disseminate information; and to guide research on gene bank activities such as dynamic *in situ* conservation methods.

In 1991, a National Committee for Transgenic Plants (NCTP) was appointed for the purpose of approving experiments in transgenic plants in Israel and imported transgenic material. Draft regulations on transgenic plant experiments and on the

import of transgenic material which are based on procedures which are already mandatory under the Plant Protection Law have also been prepared.

Basic to Israel's environmental management program is a policy founded upon cooperation and integration between environmental protection and economic development. Given the rapid rate of development, the focus of environmental policy has always been on preventive measures, largely through the incorporation of environmental considerations into major development projects.

More recently, efforts have focused on the preparation of a sustainable development strategy for Israel. An opening seminar took place in November 1996 and seven target groups (industry, energy, transport, tourism, agriculture, urban sector, and biodiversity) were organized. Discussions are conducted within a round table framework, with the participation of all stakeholders, and are administered by a facilitator. The report of each group will be distributed for wider public comment, and the policy document finalized by the facilitator. The draft strategy will be presented to the directors general of Israel's government ministries for adoption and referral to the government for approval.

In conclusion, several of the components of Israel's national biodiversity strategy are already in place--legal framework, participation in international conventions and initiatives, surveys and research, and concrete programs for the conservation and sustainable use of ecosystems, species and genetic resources. The subject has been accorded greater priority in recent years with the growing awareness that land scarcity in Israel, coupled with unprecedented population and economic growth, threaten to deplete Israel's natural resources and open space landscapes.

Once a national masterplan on open space protection becomes law, all future planning and development would be subject to its provisions. All statutory regional and local planning boards would be obligated to examine the impact on biodiversity of all plans brought before them, and approval would be contingent on compliance of the plan with
the masterplan's provisions.

1. INTRODUCTION

1.1. Historical Roots of Conservation in Israel

Israel's commitment to nature conservation is by no means a recent development. Concern for all living things coupled with prohibitions against environmental degradation may be traced back to biblical sources. Indeed, the first chapters of the Book of Genesis emphasize the vital link between humanity (*adam*) and the earth (*adamah*) and introduce the concept of stewardship by enjoining man to work the earth and to watch over it.

At the beginning of history, according to the Bible, "God took Adam and placed him in the Garden of Eden to work it and guard it"(Genesis 2:15). According to a *midrash* (homily) cited in Ecclesiastes Rabba 7:13, "When the Holy One Blessed Be He created the first man, He took him and warned him about all the trees of the Garden of Eden, saying: See My works, how beautiful and perfect they are, and all I created--I created for you. Beware lest you spoil and destroy My world, for if you will spoil it, there is no one to repair it after you." This *midrash* expands the command for nature preservation to the whole world. The commandment to work the garden and guard it may well be the predecessor of the modern-day commandment for sustainable development. We are enjoined to tread the fine line between using the land and environment to serve humankind while not abusing or destroying the beautiful world which God entrusted to us.

1.2. Biological Diversity in Israel

In juxtaposition to its small land area, Israel is characterized by a wide range of physical conditions and by a rich variety of flora and fauna. Along its 470-kilometer length, Israel embraces landscapes that are normally separated by thousands of kilometers in other countries. Mount Hermon in the north boasts snowy slopes and alpine fauna and flora, while the Gulf of Eilat in the south, harbors spectacular coral reefs and colorful fish that represent the tropical zones. Lying between these two extremes are arid desert areas, lush oases, green Mediterranean woods and forests, and the lowest point on earth--the Dead Sea.

Israel is rich in biodiversity. Its location at the crossroads of climatic and botanic regions endows the country with a rich variety of plant and animal life including some 2,780 plant species, 7 amphibian, 96 reptile, 511 bird and 116 mammal species. The scarcity of wetlands is reflected in the dearth of amphibians as opposed to the wealth of reptiles. Within the small land area of Israel, two opposing climatic regimes are found--Mediterranean in the north and desert in the south. The central part of the country is a transition area between these two biogeographical regions where desert biota is gradually replaced by Mediterranean biota. Species widely distributed over the entire Mediterranean climate region reach their southern limit of distribution in Israel while Saharan or Asian desert species reach their northernmost limits in this country.

In Israel, as in the world at large, the decline of biodiversity is largely a result of accelerated development, population increase and the resulting destruction of habitats. While about 20 percent of Israel's land area is preserved within declared nature reserves, most of them (80 percent) are located in the desert areas of Israel, and a large number overlap military training areas. Only about 3 percent of the Mediterranean region is currently protected in nature reserves.

The main problem facing nature conservation in the Mediterranean region is habitat fragmentation. Over 100 declared nature reserves are dispersed within a total area of 250 km^2. Protection of many populations (e.g., bats, sand dwelling reptiles, large predators like wolves, and other mammals such as gazelles) is impossible to achieve within the reserve system, while outside the reserves, development, habitat degradation and conflicts with agriculture and other human activities, make it difficult to preserve the small Israeli populations. Cooperation and coordination in research, management and development plans are sorely needed to secure nature conservation in this region.

In the south of the country, the unique desert ecosystem is also endangered, mainly by pressure from development plans. Further scientific research is required to understand the desert ecosystems, explain the mechanisms involved, and thereafter prescribe the correct balance of livestock grazing, reintroduction of extinct wildlife, proper road construction and tourist accommodation.

1.3. The Convention on Biological Diversity

The Convention on Biological Diversity is dedicated to three objectives: to conserve biological diversity, to use its components sustainably, and to share fairly and equitably the benefits arising from the utilization of genetic resources. The Convention does not view biological diversity in terms of the extinction of species or disappearance of ecosystems alone. It views conservation of biological diversity as an integral part of the development process, aimed at satisfying the essential needs of both present and future generations. For, in addition to their ecological value, a greater diversity of species means a better potential for significant medical and agricultural developments, as well as possible solutions to such environmental problems as climate change, water pollution and treatment of hazardous materials. Humankind's very life and livelihood depend on preserving the variety of life. In light of significant reductions in biological diversity worldwide, it is vital to anticipate, prevent and tackle the causes of this loss.

The Biological Diversity Convention is the first global convention which relates to all aspects of biological diversity: genetic resources, species and ecosystems. It declares that conservation of biological diversity is a common concern of humankind and an integral part of sustainable development. By joining the Convention, states obligate themselves to preserve the biological diversity of their countries. In addition, the provisions of the Convention have ramifications on the world market and on Israel in terms of international agreements on trade and biotechnologies, access to genetic

resources and gene banks, development of agricultural products, use of natural resources and rehabilitation of ecological systems.
The global and integrated approach which underlies the Convention on Biological Diversity marks a milestone in the world community's movement toward sustainable development. Since humankind is dependent on biological diversity for its very existence, it is now up to the Contracting Parties, including Israel, to undertake the necessary steps toward integrating the provisions of this all-important Convention in their development policies.

1.4. Israel's Role in Implementing the Convention

Israel ratified the Convention on Biological Diversity in August 1995 but, as stated previously, the country's rich tradition of nature conservation is by no means a recent development. Since Israel is a developed country, in terms of both its scientific and technological development and its nature conservation and environmental experience (including law enforcement, management and research), it expects to take an active part in the implementation of the Convention.

Following the second meeting of the parties to the Convention, which took place in November 1995 in Jakarta, Indonesia, Israel's representatives drafted a number of proposals for implementing the Convention in this country including:

1. To establish an interministerial committee for the purpose of preparing a national plan for the conservation of biological diversity.
2. To review organized activity in the realm of protection of shared biological diversity of all the countries in this region.
3. To accelerate the process of declaring designated nature reserves.
4. To formulate a policy on the protection of open spaces and to implement it.
5. To consider preparing a national outline scheme for the conservation of biological diversity.
6. To integrate the subject of conservation of biological diversity in environmental planning, and to prepare guidelines for the protection of biological diversity which will constitute part of the guidelines of the Ministry of the Environment for the preparation of environmental impact statements.
7. To give priority to research proposals on the conservation of biological diversity which will be financed by the Ministry.
8. To increase public awareness of the significance of biological diversity and to introduce the subject as a curricular program in the educational system.
9. To inform all relevant bodies of the provisions of the Convention, including the sections on biotechnology and the protocol on biosafety.

The ministry responsible for the implementation of the Biodiversity Convention is the Ministry of the Environment. The Nature Reserves Authority, acting under the Minister of the Environment, is the scientific advisory body for Israel to the Convention. An interministerial committee for conservation of biodiversity was appointed in May of 1996. It includes 12 representatives from the Ministries of Finance, Infrastructure, Defense, Education, Foreign Affairs, Agriculture, Science, Commerce and Industry, Interior, Transport, Tourism and Environment. Several other

governmental and non-governmental organizations are also taking part in the preparations for the formulation and implementation of Israel's biodiversity strategy.

2. LEGAL AND POLICY FRAMEWORK FOR ISRAEL'S NATIONAL STRATEGY PLAN

A national strategy plan for the protection of biological diversity must have a legal basis which allows for the enforcement of its provisions, both by statutory agencies and by non-governmental organizations. The Israel Ministry of the Environment is the government ministry responsible for the protection of the environment. This ministry is also responsible for the Nature Reserves Authority, Israel's statutory agency for nature conservation. Other government bodies, including the Ministry of the Interior and the Ministry of Agriculture, constitute additional partners within the framework of their responsibility for various laws that are related to the protection of biodiversity.

Sensitivity to and awareness of nature conservation is well developed in Israel; in fact, it preceded environmental awareness by about two decades. This is manifested in legislation and the establishment of institutions that address themselves to the subject.

The following list of existing legislation enables the implementation of any national plan for the protection of biological diversity:

- National Parks, Nature Reserves, Memorial Sites and National Sites Law, 1992 (henceforth "the Nature Reserves Law");
- Wildlife Protection Law, 1955;
- Forest Ordinance, 1926;
- Streams and Springs Authorities Law, 1965;
- Prevention of Marine Pollution by Oil Ordinance, 1980;
- Prevention of Marine Pollution (Dumping of Waste) Law, 1983;
- Prevention of Marine Pollution from Land Based Sources Law, 1988;
- Water Law, 1959;
- Fishing Ordinance, 1937
- Plant Protection Law, 1956;
- Hazardous Substances Law, 1993;
- Planning and Building Law, 1965;
- Planning and Building Regulations (Environmental Impact Statements), 1982;
- National Masterplan for National Parks, Nature Reserves and Landscape Reserves, 1981;
- National Masterplan for the Mediterranean Coast, 1983;
- National Masterplan for Afforestation, 1993.

In addition to its national legislation, Israel has ratified several international conventions related to nature conservation including the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Convention on the Conservation of Migratory Species of Wild Animals. More recently, it ratified the Convention on Wetlands of International Importance, and has so far designated two wetland sites for inclusion in the international list of wetlands. Israel is also in pre-ratification stages for the Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean within the framework of the Barcelona Convention for the Protection of the Mediterranean Sea against Pollution.

2.1. Israel's Nature Protection Legislation

In order to assess the efficacy of Israel's national legislation, each of the above-mentioned laws will be examined separately vis a vis its provisions regarding the protection and conservation of biological diversity.

Nature Reserves Law: Recognition of the need to protect Israel's precious natural and landscape resources first led to the enactment of the National Parks and Nature Reserves Law in 1963. This law, which was revised in 1992, remains the fundamental statute regarding the protection of biological diversity. It provides the legal structure for the protection of natural habitats, natural assets, wildlife and sites of scientific, historic, architectural and educational interest in Israel.

The law establishes systems for the establishment of nature reserves and for the listing of protected natural assets. The Minister of the Environment is authorized to list natural assets as protected natural assets. The Nature Reserves Law prohibits the taking, destroying, possessing or trading of protected natural assets (except with the permission of the Nature Reserves Authority).

Pursuant to this law, two authorities were created: the Nature Reserves Authority (NRA) and the National Parks Authority (NPA). The NRA was established in 1964 as the main authority charged with preserving and developing nature reserves and natural assets, protecting wildlife, and safeguarding landscape quality. Israeli law defines a nature reserve as an area containing unique and characteristic animal, plant and mineral forms which must be protected from any undesirable changes in their appearance, biological composition or evolution. Outside the confines of nature reserves, hundreds of plant and animal species, as well as inanimate natural assets such as fossils and beach rocks, have been declared "protected natural assets." Animals such as the leopard, gazelle, ibex and vulture have been declared protected species, and special rescue operations, including establishment of feeding stations and nesting sites, have been initiated to protect them.

Wildlife Protection Law: Side by side with the protection of "natural assets," the Wildlife Protection Law has proved to be an effective instrument in the protection of wildlife in Israel. This 1955 law, which was designed to protect birds, mammals, reptiles and amphibians, has been responsible for the recovery of many wildlife species. The Wildlife Protection Law defines protected wildlife as any animal that has not been designated as a "pest" or "game". The law requires a hunting license for game hunting or for the extermination of pests, and prohibits the hunting of protected species except by special permit and for specific purposes as listed in the law. In addition, the law prohibits certain methods of hunting, including the use of traps, explosives, poisoning, and shooting from a moving vehicle. Hunting of game and pests is restricted to the hunting season (September 1 to January 31) and to limited areas, and requires a license and strict compliance with established guidelines. Hunting of hares, wild boars, partridge and some duck species is permitted, although in limited numbers. The Wildlife Protection Law is also Israel's implementation tool for the Convention on International Trade in Endangered Species of Wild Fauna and

Flora (CITES) and thus prohibits trading, possessing or transporting protected species without a permit.

Forests Ordinance: This early ordinance authorizes the Minister of Agriculture to declare forested land as a "forest reserve," a status that gives the forest legal protection from anyone wishing to utilize any of the forest's products, to uproot or burn a tree or damage it in any other way, to graze livestock in it, to dig up the earth, to build a dam or otherwise stop the flow of any river or stream, or develop it in any manner. In addition, the minister is authorized--and has used this authority--to declare specific trees as "protected trees" throughout the whole country or in a smaller area. A protected tree, in addition to carob trees and olive trees, cannot be cut down or moved without a permit.

Streams and Springs Authorities Law: This law authorizes the Minister of the Environment to establish authorities for the management of specific streams or springs. Among a long and varied list of duties, a stream or spring authority is responsible for the protection of the biological diversity of the stream or spring. Two stream authorities have been established in accordance with this law--the Yarkon River Authority and the Kishon River Authority.

Prevention of Marine Pollution by Oil Ordinance, Prevention of Marine Pollution (Dumping of Waste) Law, and Prevention of Marine Pollution from Land Based Sources Law: These three marine pollution prevention laws prohibit the pollution of the marine environment by oil, by dumping, and by discharge of pollutants from land based sources. Within the framework of these laws, the marine environment is inclusive of its biological diversity.

Water Law: The law prohibits the pollution--or any act that is liable to cause pollution--of freshwater. In addition, the law defines "pollution" as the harming of the biological diversity of freshwater habitats

Plant Protection Law: The law authorizes the Minister of Agriculture to take measures to prevent or eliminate plant-threatening pests.

Hazardous Substances Law: The law provides the Ministry of the Environment with authority for "cradle to grave" management of hazardous substances by requiring a permit for any premise dealing with hazardous substances.

Fishing Ordinance: This 1937 ordinance requires a permit for fishing and authorizes the Minister of Agriculture to set conditions regarding a wide range of subjects.

The Planning and Building Law: This law sets the legal framework for all development and land use in Israel, and serves as the basis for environmental policy in Israel. All development is subject to the approval of statutory planning boards.

Planning and Building Regulations (Environmental Impact Statements): These regulations under the Planning and Building Law mandate the preparation of an environmental impact statement when the planning authority considers that significant environmental impacts may occur as a result of a plan or project or when a ministerial representative on the national or district planning level requires such a

statement. These regulations can be utilized as the major tool in protecting biological diversity in the development and land use process. Any proposed project which is liable to affect Israel's biological diversity may be subject to the preparation of an environmental impact statement which will be prepared in accordance with specific guidelines prepared by the Ministry of the Environment. The project's approval will be dependent on the conclusions of the environmental impact statement, which may recommend that due to its harmful effect on biodiversity the project should not be approved at all, or that the plan be subjected to certain conditions.

2.2. Environmental Planning and Biodiversity Conservation

For the past two and a half decades, Israel has utilized the land use planning system as an effective framework for implementing environmental policy. At the top level of national planning is the National Planning and Building Board (National Board), chaired by the director general of the Ministry of the Interior, and composed of representatives of government ministries, local government, and public and non-governmental organizations, including nature protection bodies. The National Board provides a broad and extensive forum for deliberation by all concerned bodies. Discussion at this level allows for the mobilization of professional input and expertise representing many disciplines.

One of the primary responsibilities of the National Board is to enact national outline schemes which are prepared for issues of national planning significance or for land uses that serve national interests. Several national plans are targeted at protecting specific natural resources considered to be of high value as part of the national natural and cultural heritage, such as plans for nature reserves and national parks, natural and planted forests, and memorial and historic sites. Other plans address particularly sensitive areas warranting special attention by the national planning authority such as plans for the Mediterranean coastal area, Sea of Galilee (Lake Kinneret) shores and the Gulf of Eilat.

The country's commitment to protect natural values finds its foremost expression in the first comprehensive plan which was prepared in the 1950s. This early plan designates some of the most important nature reserves, such as those on Mount Meron and the Carmel range; it also makes oblique reference to the large desert reserves. The plan, which has statutory standing, was strengthened by the enaction of the National Parks and Nature Reserves Law. Passage of this legislation in 1963 spurred, in turn, the preparation of a national masterplan for the preservation of sites which are of special natural, landscape and historic value.

2.2.1. National Masterplans Related to Biodiversity

National Masterplan for National Parks, Nature Reserves and Landscape Reserves: This masterplan, approved in 1981, is a legally binding national plan setting aside specific areas as national parks or nature reserves. The purpose of this plan is to designate areas for nature conservation, protect areas of high scenic value

from unsound physical development, and protect areas with high recreation and tourism potential. The scheme constitutes an initial safeguard and is backed by another legal procedure--the declaration of areas as nature reserves or national parks through the Nature Reserves Law. Over one-quarter of the country's land area is designated for these purposes in this masterplan. About 80 percent of the areas designated for nature reserves under this plan have already been declared as such.

National Masterplan for the Mediterranean Coast: The major goal of this masterplan is to protect coastal resources. It provides for sustainable development of Israel's coastline which attempts to balance demands for development with protection of its rich biological diversity. The plan designates large areas of the coast as nature reserves, national parks and coastal reserves and limits building of any kind within a 100 meter range of the coast. To help provide a comprehensive long-term guide to planning policy beyond these guidelines, a more detailed document for the resource management of the Mediterranean coastline for tourist and recreation activities has also been prepared. The plan bases development policies on principles of suitability and sensitivity of coastal resources. Suitability for tourist and recreation development was assessed on the basis of geological, vegetation and landscape surveys; the allocation of the level of intensity of development for each site along the Mediterranean coastline was checked in relation to resource sensitivity.

National Masterplan for the Kinneret Watershed and Beaches: The major goal of this plan is also environmental--the protection of the Sea of Galilee as a long-term drinking water reservoir. It is basically a resource protection and management plan. It defines land uses along the lake's shores and guides development activities in the catchment basin in order to safeguard the quality of the lake waters.

National Masterplan for Forests and Afforestation: This legally binding national plan (in force since 1996) grants certain areas legal status as forested areas, and thus protects them from development. The main purpose of this scheme is to protect existing "man-made" and natural forests and to designate areas for future afforestation to supply various services, especially ecological and recreation services. The plan designates over 162,000 hectares for forest development and conservation--18 percent of the entire area of the country north of Beersheba. Afforestation is proposed for sites throughout the country in accordance with existing conditions in each area, the regeneration potential of the natural vegetation in a specific ecosystem and geobotanic location, the restoration potential of existing forests, and requirements for new forests to meet growing recreation and tourism needs.

National Masterplan for Immigrant Absorption: This short-term masterplan, approved by the government in January 1993, was prepared in order to help the government coordinate planning efforts by all sectors of government in absorbing the hundreds of thousands of immigrants which poured into Israel in the early 1990s. The plan is noteworthy for its integration of environmental management and resource protection measures. An environmental guidelines map accompanies the plan as a statutory document. Based on an evaluation of the sensitivity of areas to development, the map denotes areas in which building should not be permitted, namely areas of high natural and landscape value designated for protection and areas exposed to environmental deterioration.

Israel 2020: A Long-Range Masterplan for Israel: The call for the preparation of a long-range masterplan was given to the Israeli government by the nation's leading planners, architects and engineers in 1989. The project has witnessed the preparation of comprehensive strategic documents which are expected to form a framework for national plans until the year 2020. One of the main conclusions of the plan is that the challenge of coming years will be the conservation of Israel's scarce land resources in light of the expected growth of the country's population from 5.5 million today to 8 million in 2020 and the concomitant trebling of its built-up area. Recommendations include concentrated and dense development in existing population centers, green buffers, open spaces and the preservation of heritage and nature values.

Legal protection of farmland--although not through a national masterplan--is another powerful tool enabling control of open space at national level. A national masterplan for all open spaces is expected to be the next stage in the use of masterplans as tools in environmental policy implementation. In 1996, the National Board for Planning and Building adopted the suggestion of the Council for the Protection of Landscape and Land Resources and ordered the preparation of a policy paper on open space preservation. The paper, which will be based on the results of professional surveys and on the evaluation of open space landscapes in each of the country's regions, should provide the basis for a national planning policy on open space protection.

In general, national and regional plans prepared since 1990 have included new features in terms of the environmental issues addressed and the tools for addressing those issues. The table below describes some innovations which were first introduced into masterplans during the 1990s. Prominent among these is the recognition that open spaces may function as a network with many functions and the perception of the positive externalities of farmlands as open spaces, and their protection on this basis.

In addition, there has been a shift from a reactive approach to a proactive approach in environmental planning. While previously the goal of most environmental planning efforts was to mitigate deleterious effects of various projects, the environmental goals of the plans noted in the table are increasingly to improve resource protection (primarily open space and water resources) and promote sustainable development.

Innovations in Environmental Planning as Adopted in National Masterplans

INNOVATION	**PLANS IN WHICH INTRODUCED**
Coastal zone management	National Masterplan for the Mediterranean
Intensity of development	National Masterplan for the Mediterranean
Environmental buffer zones	National Masterplan for Quarries
Open space management • multi-tier functional designation • protection of farmland • positive externalities of open spaces	National Masterplan for Immigration Absorption; Northern and Central District (Regional) Plans; National Masterplan for Afforestation; National Masterplan for Tourism; Israel 2020 Strategic Plan

(Source: *The Israeli Road Toward Sustainability: Incremental Transformation Of Environmental Planning* by Eran Feitelson, The Hebrew University of Jerusalem, 1996).
Israel's national masterplans and the Planning and Building Law are particularly relevant for the preparation and development of the national biodiversity strategy. Together with the environmental impact statement regulations, they serve as major tools in regulating land use that could be harmful to biodiversity. Therefore, Israel's planning laws constitute the basis of a preventive policy whose goal is to anticipate and prevent all future land use and development activities that threaten to harm Israel's biodiversity. In addition, damage to biodiversity is already considered a crime under a long list of Israeli laws, and perpetrators may be prosecuted through the enforcement of these laws. One prominent example of the preventive aspect of such laws is the Water Law which determines that any act *liable* to harm the biological diversity of any body of water is a crime. Today, the Ministry of the Environment examines all its criminal prosecution cases involving water pollution in order to verify whether the act of polluting the water also involves damage to legally protected species.

Clearly, Israel already has the necessary legal framework to protect its biodiversity, and therefore, a national strategy plan for biological diversity may be implemented through the enforcement of these laws.

3. ISRAEL'S BIOTIC ASSETS

3.1. Origins of Biodiversity in Israel

Historic, climatic, geological and geographical factors contribute to the high rate of species diversity in Israel when compared to other regions of Mediterranean climate and European neighboring countries.

Israel's rough topography, its lithological diversity and climatic heterogeneity have given rise to a wide variety of life zones, habitats, and accordingly to a multitude of vegetation units. Tectonic events which started in the Early Tertiary have brought about not only a topographic but also lithologic diversity , which in turn resulted in a multitude of soil varieties and in a macro- and microclimatical differentiation caused through rain shadowing, sloping and diversification of exposures. In addition, volcanic eruptions that appeared in the Upper Tertiary and Pleistocene mainly in the northern part of the country, resulted in a heavy basaltic cover that overlays the sedimentary rocks throughout the north-eastern part of the country where it is associated with volcanic cones.

Another great geological event in the topography of the crust was the establishment of the Jordan-Dead Sea depression, which is part of the great Rift Valley, extending from S. Anatolia to Zambia. The Dead Sea and its surroundings as well as the Arava Valley and the Jordan Valley are the most outstanding features, not only because of being partly situated about 400 m below sea level, but also because of their tropical climate, which is well reflected in their ecology and vegetation.

The country is generally divided into three longitudinal belts: the Coastal plain, the Mountain Ridge and the Rift Valley. Because of their longitudinal axis, both their climate, soils and vegetation change gradually or abruptly from north to south. Accordingly, they have since ancient times been divided latitudinally in well discernible districts, each displaying ecological features of its own.

The country may be divided bioclimatically into a subhumid zone with an annual rainfall of between 1000-400 mm, a semiarid zone in which the annual rainfall ranges between 400 and 200 mm and an arid zone with 200-25 mm of rain. This subdivision coincides roughly with the phytogeographical division of the country.

Israel's geographic location at the junction of three continents coupled with the climatic changes throughout the history of this region have been largely responsible for this country's high diversity of species. The Pleistocene era with its strong climatic changes caused by glacial and interglacial periods left many relics of African invasions through the rift valley to the Dead Sea region, and from the cold north to the high mountains in the northern part of Israel. Israel is also a main migration route for palearctic birds and the only terrestrial meeting point for organisms from Europe, Asia and Africa. It serves as a terrestrial bridge connecting the temperate zone in the north with arid desert areas and further south with the rainy and hot forests of Africa and Asia.

3.2. Biogeographical Zones

Israel is situated at the meeting point of three phytogeographical regions--Mediterranean, Irano-Turanian and Saharo-Arabian. Within its small land area, two different and even opposing climate regimes are found--Mediterranean in the north and desert in the south. The central part of Israel is a transition area between these two biogeographical regions where desert biota is replaced gradually by Mediterranean biota. A "tongue" of the Irano-Turanian biogeographical region penetrates Israel from the east.

Species widely distributed over the entire Mediterranean climate region reach their southern limit of distribution in Israel; Saharan or Asian desert species reach their northern limits of distribution in this country; while Irano-Turanian species reach their western limit here. The wealth of Israel's biological diversity is expressed in some 2,780 plant species, 7 amphibian, 97 reptile, 511 bird and 116 mammal species.

Based on the above, it is possible to classify the different organisms according to their distributional components:

1. *The endemic component* is comprised of some of the species of flora and fauna that have remained in this country and its vicinity from prehistoric times when climatic conditions were different than those prevailing today. Present geographical conditions are not conducive to an increase in this endemic, residual component since Israel constitutes a bridge between continents and is open to invasion from three directions.
2. *The northern (Mediterranean) component* is especially significant in Israel's world of flora and fauna and encompasses species which abound in Israel's Mediterranean coastline. These species may have invaded this area from the north at a relatively late period, when present climatic conditions began to stabilize in this region, along with the development of the evergreen scrubland.
3. *The steppe (Irano-Turanian) component* originated in the heights northeast of Israel.
4. *The desert (Saharo-Arabian) component* is prevalent in the Negev from which point it reaches northward in two arms: along the strip of coastal sand dunes and into the Dead Sea and Jordan Valley.
5. *The equatorial (Sudanese) component* includes a number of species which originated in the forests and savannahs of Africa.

The composition of the species in the different regions of the country changes in relation to the local conditions: In the northern part of the country, the Galilee, and the Golan Heights, the northern component is dominant accompanied by the steppe component. In the south of the country, in the Negev and Arava, the desert component prevails accompanied by the equatorial component. Between the Galilee and the Negev a wide intermediate region stretches.

3.3. Diversity of Species in Israel

There are about 51,000 living species in Israel. About 47,000 (92 percent) species are known, or thought to be known, and another 4,000 (8 percent) are species which are assumed to be found or identified in the future. Most of the taxa listed in the table on the following page were roughly estimated, based on several sources, except for the moss, lichens, ferns, plants, molluscs and vertebrates. Heywood and Watson (1995) list some 1,750,000 living described species, based on several sources, as the total global biodiversity. By this account, Israel's biodiversity (including viruses) comprises about 3 percent of the global biodiversity. This rich biodiversity is largely attributed to the two species-rich seas around Israel.

The information in the following table is based on numerous sources from which general numbers have been estimated. This is the first time in which the information in its entirety is being presented in table form, and it represents the first attempt in Israel to estimate the numbers of all of the country's living species based on the findings of several individual reports and surveys undertaken by numerous investigators (see Selected Bibliography).

The table is primarily arranged according to the classification of living organisms presented in *Global Biodiversity Assessment* by Heywood and Watson (1995), but with a few changes. The following should be noted when reviewing the table:

1. The prokaryotes are divided into Archea and Eubacteria, but without specific kingdom level. Another 3,000 species of viruses, assumed to be found in Israel, may also be added to this species list.
2. Little is known about many Protoctista phylums. Some, like the Formanifera phylum, may be estimated to be represented by about 400 species in the Red Sea and about 300 species in the Mediterranean, including deep sea water species.
3. The algae taxa include about 500 macro-algae species mainly in the Mediterranean. While the micro-algae number is not yet clear, it may elevate the total number even higher.
4. The 2,780 wild plant species include exotic species as well. About 500 of these species are found in wetlands and moist habitats, including marine habitats.
5. The number of insect species in the table (45 percent of all species) is lower than the global percentage due to two factors: the presence of two species-rich seas around Israel and the fact that most of the global insect fauna is in the tropics, while Israel is depauperated because it is situated in a largely arid region.
6. The number of bird species (511) includes 204 breeding species. There are several vagrant species and their numbers may be assumed to be on the rise.
7. There are 106 terrestrial mammal species and an estimated ten more marine mammal species (based on personal observation).
8. The numbers presented for the different groups also include recent extinct species. These include, *inter alia*, three inland water fish, one amphibian, three reptile, and several mammal species.

9.

Living Species in Israel

Taxon	Known Species		Species Assumed to be Found in the Future	
	species	total	species	total
Kingdom Prokaryota				
Archea	100			
Eubacteria	5,000			
Kingdom Protoctista	1,800		900	
Algae	2,000		100	
Kingdom Fungi	800			
TOTAL LOWER KINGDOMS		**9,700**		**1,000**
Kingdom Plantae				
Bryophyta	260		30	
Lichens	235		?	
Pteridophyta (ferns) - wild	25		?	
Pteridophyta (ferns) -cultivated	70		?	
Spermatophyta - wild	2,780		110	
Spermatophyta - cultivated	2,750		?	
TOTAL PLANTAE		**6,120**		**140**
Kingdom Animalia				
Porifera (sponges)	160		10-20	
Cnidaria (cnidarians)	870		30-50	
Ctenophora (comb-jellies)	25		?	
Worms (flat, round & annelids)	1,280		100	
Inland & terrestrial molluscs	(229)			
Mediterranean molluscs	(850)			
Red Sea molluscs	(1,120)			
Mollusca total	2,200		30-50	
Bryozoa (bryozoans)	65		?	
Arthropoda (except Insecta)	3,400		500	
Insecta (only)	20,500		2,000	
Echninodermata (echinoderms)	160		?	
TOTAL INVERTEBRATES		**28,660**		**2,720**
Tunicata (sea-squirts)	100			
Hemichordata (hemichordates)	30			
Fish-freshwater (wild)	(36)			
Fish-freshwater (cultivated)	(12)			
Fish-Mediterranean	(410)			
Fish-Red Sea	(1,270)			
Pisces (fish) total	1,728		150-200	
Amphibia (amphibians)	7			
Reptilia (reptiles)	97		1-3	
Aves (birds)	511			
Mammalia (mammals)	116		1-2	
TOTAL VERTEBRATES		**2,589**		**255**
TOTAL SPECIES		**47,069**		**4,115**

Source: Reuven Ortal, Nature Reserves Authority, 1997

3.4. Biodiversity of Flora in Israel

The flora of Israel comprises 2,780 wild plants including exotic species. A recent analysis for 2,412 species found in Israel (*sensu stricto*) reveals that they belong to 700 genera and 126 families. Of these, 1,558 species are concentrated in the Mediterranean zone and 600 in the desert. Only 6 percent of the plants are endemic. These can be classified into two groups according to abundance--common and widespread species vs. rare species. Forty-three percent of the endemic species of Israel are common both on a macro geographical scale and on a local geographical scale; 27.5 percent of the endemic species have rare occurrences in Israel; and 25.6 percent are very rare--found in less than ten sites in Israel.

Taxonomically Israel's flora does not differ from that of neighboring countries except for the following:

1. There is a striking number of families represented by a single genus and very many genera comprising a single species. Most of these families and genera reach their terminal limit of distribution in Israel where phytogeographical zones meet in a rather small area, but one which is nevertheless sufficient to accommodate marginal representatives of each individual region.
2. Because of its position, the Mediterranean area terminates towards east and south with a broad belt of timbales, dwarf-shrub or herbaceous vegetation which is exceedingly rich in species and harbors most of the country's endemics.
3. In this transition belt most of the annuals, and a high number of geophytes, are centered.

In this flora, some genera are outstanding for their high number of species. These include, among others, *Astragalus* - 50 species, *Trifolium* - 55, Silene - 35, *Allium* - 38, *Euphorbia* - 31, *Centaurea* - 26, *Medicago* - 23, *Salvia* - 24. The largest families are Asteraceae (96 genera and about 280 species), Poaceae (90 genera and 210 species), Fabaceae (65 general and 280 species), Apiaceae (53 general and 102 species), Alliaceae (23 general and over 100 species).

3.4.1. Phytogeographical Diversity

The flora of Israel has been extensively studied for centuries by various visitors who have recorded the country's natural history in their diaries since the sixteenth century. These first accounts were supplemented by floristic explorations of this country in subsequent centuries. More recently, Israeli botanists and investigators have made significant contributions to the country's taxonomic research in this area.

The flora of Israel is generally divided into seven groups on the basis of the following general distribution:

1. Mediterranean species, which are distributed around the Mediterranean Sea.
2. Irano-Turanian species, which also inhabit Asian steppes of the Syrian desert, Iran, Anatolia and the Gobi desert.

3. Saharo-Arabian species, which also grow in the Sahara, Sinai and Arabian deserts.
4. Sudano-Zambesian species, typical to the subtropical savannas of Africa.
5. Euro-Siberian species, also known in countries with a wetter and cooler climate than Israel, growing mainly in wet habitats and along the Mediterranean coasts.
6. Bi-regional, tri-regional, and multi-regional species that grow in more than one of the regions mentioned above.
7. Alien species from remote countries, propagating without human assistance. The principal countries of origin are the Americas, Australia, and South Africa.

Israel's rather small percentage of endemic species are largely concentrated on the sandy soils of the coastal plain and in the Negev highlands on smooth-faced limestone outcrops.

3.4.2. Principal Plant Communities

The plant communities that occur in a particular location are influenced by their phytogeographical position, climatic factors, lithology, soil, and human activities. Following is a listing of Israel's principal plant communities according to one of the investigators:

1. Maquis and forests:

The principal woodlands are found in the mountains of Judea, Carmel and Galilee. In most of the area, cultivated plants have replaced the wild trees. Trees that have been domesticated from the wild flora of Israel, such as olives and almonds, today cover large parts of the previous woodland areas. Areas of suppressed maquis support herbaceous vegetation that has higher nutritional value than the evergreen trees and shrubs.

After cultivated ground is abandoned, the area is colonized by low herbaceous lignified plants, lasting dozens of years. This vegetation formation of Mediterranean semi-shrubs covers vast areas and is locally known as "batha". In the last century, a large proportion of these batha areas has been reforested by the State of Israel. *Pinus halepensis* (Aleppo pine) which grows naturally all over this unit was the principal planted forest tree.

In areas only slightly influenced by human intervention, it is still possible to study the relationship between vegetation and edaphic factors. Trees that survived at the margin of cultivated land or sacred trees assist in identifying the woodland boundaries.

2. *Quercus calliprinos* woodland on basalt:

Maquis dominated by *Quercus calliprinos* (common oak) develops on basalt and other volcanic substrata in the Golan Heights at an elevation of more than 500 m above sea level. There are very few lignified semi-shrub, shrub, or tree companions to the dominant oak. Judging from 100 year old maps, the woodland range has substantially decreased in recent times. Evergreen forests and maquis are the most common and most characteristic of the Mediterranean region.

3.* Montane forest of *Mt. Hermon:

At elevations of 1300-1800 m there are remnants of trees and shrubs that withstand low temperatures and high intensity, speed and perseverance of wind. As in other Mediterranean countries, montane forests are composed of many winter-deciduous trees.

4. Park forest of *Quercus ithaburensis:*

Park forest is a vegetation formation of trees, the canopies of which do not totally cover the area. Such a formation is found in drier and warmer areas than the *Quercus calliprinos* (common oak) woodland--in elevations of 0-500m. *Quercus ithaburensis* is a Mediterranean tree but belongs to a section of the genus that originated in the Irano-Turanian region. There is ample evidence that *Q. ithaburensis* woodlands prevailed in the coastal area of Israel until the last century, but these woodlands have largely been converted into olive groves in most of the central section of the coastal plain.

5. Park forest of *Ceratonia siliqua* (carob) and Pistacia lentiscus (terebinth):

Ceratonia-Pistacia lentiscus park forest develops on all the limestone hills at the foot of the central mountain range of the Mediterranean zone of Israel. This plant community is more drought and heat resistant than that of *Quercus calliprinos*, and develops at elevations of 0-300 m. above sea level.

6. *Ziziphus lotus* with herbaceous vegetation:

The southeastern hilly area of the Galilee looks like a park forest without trees. Instead, scattered shrubs of *Ziziphus lotus* (lotus jujube) may be found over large areas of the typical Mediterranean grasses.

7. Savannoid Mediterranean vegetation:

Spiny trees of Sudanian origin, mainly the quasi-tropical *Ziziphus spina-christi* (wild jujube) and in a few places *Acacia albida*, grow in areas that seem to be too warm and dry to support Mediterranean trees. These trees are accompanied by Mediterranean herbaceous vegetation.

8. Semi-steppe batha:

The vegetation boundary of the Mediterranean territory towards the desert, where mean annual rainfall is 250-350 mm, is represented by batha of semi-shrubs with no trees. In addition to Mediterranean species there are various plants that grow in neighboring desert areas as well. Many species which live in primary habitats here grow in synanthropic habitats in the center of the Mediterranean area.

9. *Tragacanth* vegetation of Mount Hermon:

Snow covers much of the area of Mt. Hermon 1900 m above sea level for at least 3-5 months a year. The dominant vegetation formation is composed of spiny, rounded, dense and small shrubs often known as "cushion-plants." Plants here must survive the hardships of two seasons, snow cover and low temperatures in winter, and 4-5 months of drought in summer in those areas with no snow accumulation.

10. Steppe vegetation:

Semi-shrubs grow over most of the slopes and hills in areas with 80-250 mm mean annual rainfall. This vegetation formation is often referred to as steppe.

11. Steppes with trees of *Pistacia atlantica:*

Most of this landscape unit is covered by *Artemisia sieberi* steppes. Trees are found on rocky terrain above an elevation of 800 m. *Pistacia atlantica* (Atlantic terebinth), an Irano-Turanian tree, is the most common tree species.

12. Desert vegetation:

There is a gradual transition between steppe vegetation, in areas with more than 80 mm mean annual rainfall, and desert vegetation in drier areas. Many Saharo-Arabian species prevail on slopes with 70-90 mm mean annual rainfall. Within this

area, edaphic conditions and microtopography are the most important factors affecting the moisture regime and thus the distribution of plant communities.

13. Sand vegetation:
Each of the three main sandy areas in Israel is situated in a different climatic zone. The origin of their sand is also different and supports different kinds of vegetation.

14. Oases with Sudanian trees:
The Arava, Dead Sea and Jordan valleys constitute the warmest zone in the country. This zone is also the base of erosion (i.e., runoff water and underground water accumulate in it). Constant supply of fresh water and high temperatures enable thermophilous trees of Sudanian origin to become established in oases. The distribution of each tree is limited by its demands for high temperatures or resistance to low ones, and by its tolerance of soil salinity. Several desert springs support the salinity-resistant date palm. There is growing evidence that naturally growing date palms could have been the progenitors of the cultivated varieties.

15. Desert savannoid vegetation:
The amount of mean annual rainfall gradually increases in the rift valley from 30 mm near Eilat to more than 150 mm north of Jericho. This quantity enables the growth of desert plants in most of the area. Sudanian trees, the roots of which penetrate through the upper layers in wadis, may take advantage of the high water table in this area of poor rainfall. Thus, some areas of the rift valley look like East African savannas, but with Saharo-Arabian companions and with no perennial grasses.

16. *Haloxylon persicum* on sands:
Deep sands in the Arava valley are covered by a sparse woodland of *Haloxylon persicum*--trees that are 2-4 m in height.

17. Swamps and reed thickets:
Waterlogged soils on river banks support dense vegetation with low species diversity.

18. Wet salines:
Salines where salty water moistens the soil throughout the year occur along the Jordan, Dead Sea and Arava valleys and near the Mediterranean sea at Acre.

19. Synanthropic vegetation:
The vegetation in the areas that are intensively managed by humans can be easily differentiated from that of the intact areas, or areas of small interference. The history of human activity in the Levant is long, and some investigators have characterized present times as the Neo-Segetal era.

It should be noted that other investigators and botanists have divided Israel's principal plant communities into somewhat different categories.

3.4.3. Human Impact on the Biodiversity of Flora

As stated, four major features, separately and in combination, have shaped the floral biodiversity of Israel: its location and topography, its lithology and soil formation, its climate and human impact on the region. The latter has been so powerful that it has changed some vegetal landscapes significantly for the following reasons:

1. Humans have roamed this area for over half a million years during which time they introduced major changes in the composition and dominance of the local vegetation, merely by collecting plants for their diet and for other uses.
2. The period that elapsed since the invention of agriculture was sufficient to remove the original vegetation from every arable spot.
3. Humans and their domesticated animals impacted non-arable land through continuous cutting, grazing and burning. The present appearance of the arboreal vegetation in the form of shrubbery may well be the result of human intervention. This primarily anthropogeneous form has become genetically fixed through natural selection bestowing the plant with a property of high survival value. This is demonstrated by the fact that side by side with the shrubbery form of the evergreen oak, an arboreal form of the same species is also found.
4. Many species still known at the beginning of the present century have disappeared and scores are on the verge of extinction. The expansion of agriculture endangers valuable parts of natural vegetation.
5. Human traces are clearly marked in the country's "holy trees." Since ancient times, humans frequently chose to bury men of distinction in woods or under single, aged and majestic trees. The deification of trees is manifest in the fact that the Hebrew names of two of the country's dominant trees, the oak and the terebinth, stem from the same root as the Hebrew name for God. "Holy trees" serve botanists as reliable indicators of former vegetation which has long since vanished.
6. This region has supplied the progenitors of over a score of cultivated species, including cereals, pulses and fruit trees.
7. The hundreds of wild useful plants scattered throughout the country are remains of a wide variety of edible plants that have supplied the vegetable diet in the long presegetal era. Though heavily decimated, some are still collected by villagers and brought to market.
8. Various plants have been translocated and exotic species have been introduced into the country.

3.5. Origins of Biodiversity of Fauna in Israel

As in the case of flora, Israel's fauna is extremely varied due to the fact that Israel is the meeting point of three climatic and vegetation regions. However, unlike its flora, which has been well studied and surveyed, Israel's fauna is not as extensively known.

Animal life, like that of plants, is largely determined by geographic conditions. Therefore, Israel's zoogeographic regions resemble phytogeographic zones in their extent and borders. However, due to the ability of animals to move from one zone to the next in reaction to changing conditions, Israel's zoogeographic borders are more blurred and transient than its phytogeographic regions. This is especially true of recent decades when animal habitats have frequently been changed by man's activity. Thus, on the one hand, many species of waterfowl which were accustomed to nest or rest in the Hula Valley have disappeared since the swamps were drained while, on the other hand, new fish ponds have attracted populations of fish-hunting birds. The opening of the Suez Canal allowed tropical Red Sea fish to reach the Mediterranean

and a great number of species have subsequently acclimatized to the lower temperatures and salinity of their new surroundings.

The history of fauna in this country is a long one, tracing back to the Eocene when the sea retreated from extensive regions previously covered for over millions of years. The Pleistocene epoch was especially dynamic and decisive from the viewpoint of the development of the country's fauna mainly as a result of the influx of animals from various regions. In this period, fauna which are now characteristic of East African savannas predominated in the country, including warthog, hippopotamus, rhinoceros, and striped hyena, as well as various species of gazelle. In later periods, animals penetrated to the country from Western and Central Asia, including the wild horse, the wild ass, gazelles, wolves and badgers. Climatic changes during the Middle and Upper Pleistocene and up to the Neolithic Period brought fresh changes in the composition of the local fauna. No significant further changes were noted since then, but many species were exterminated through hunting and destruction of forests.

There are 229 recognized species of inland aquatic and terrestrial molluscs in Israel with 20 exotic species and 15 species which have become extinct--largely through drainage of swamps and wetlands, stream diversion and pollution of coastal rivers. The marine fauna on the coasts of Israel appears to have been less depleted during human history than land animals. On the Mediterranean coast, the composition of fauna is determined by the relatively high salinity of the sea. Water temperature, salinity and other factors in this sea give rise to an Atlantic type of fauna, with the addition of some tropical species. The tropical Red Sea fauna on the Eilat Coast stands out by its wealth of forms and colors while freshwater fauna is represented mainly in the Sea of Galilee. Israel's marine fauna is represented by about 850 mollusc species and 410 fish species in the Mediterranean Sea and 1,120 mollusc species and 1,270 fish species in the Gulf of Eilat.

Because invertebrates were less decimated by human activity than were the higher classes, they are the best example of the country's position as a meeting ground for creatures of extremely divergent geographic origin. In addition to countrywide species, many are restricted to limited areas such as those which abound in the Hula Valley, the valley around the Sea of Galilee and the northern parts of the Coastal plain.

Amphibians, whose existence depends on the presence of permanent water bodies, naturally decline in number from the coast inland and from north to south with the increasing aridity in these two directions. Swamp drainage in Israel has greatly reduced the number of local amphibians and is responsible for the extinction of one species. Reptiles, belonging to the three orders of tortoises, lizards and snakes, are widely represented in Israel. The local species include several which are almost extinct in other parts of the world.

There are 511 species of birds in the country. This large number is attributed to the fact that Israel is on the migration route from Europe and West Asia to Africa and back, that a multiplicity of habitats abound in this country, and that this is a crossroad of three continents, climatic regions and biogeographical units. Of the large number of bird species, 204 are breeding species. Others include winter visitors, passing

migrants which remain for a few days or weeks, and occasional visitors. The distribution of birds has undergone decisive changes in recent decades with the disappearance or reduction in various species of raptors, on the one hand, and the increase in other birds which are attracted by newly planted forests, sown fields or human habitations.

The variety of terrestrial mammals--106 species-- is relatively large for the small area of the country, but the number of individuals has greatly decreased. This is particularly true of the present century due to hunting in first part of the century and, more recently, habitat destruction and poisoning.

3.5.1. Human Impact on the Biodiversity of Fauna

Although additional surveys and studies are required to fill gaps in knowledge concerning the status of Israel's fauna, the country's foremost zoologists believe that almost one-third of Israel's vertebrates have suffered either extinction or a reduction in their populations in this century alone due to human activity--whether hunting, agricultural practices, urban and industrial development, or poisoning. While some of these changes were inevitable (e.g., veterinary supervision and increased irrigation), others were preventable such as the controversial draining of Lake Hula in the 1950s which destroyed a unique wetlands ecosystem.

Hunting was the main cause for the extinction of several species until the mid-20th century. Of all the herbivores, for example, only the adaptable wild boar, with its high reproductive potential, was never endangered since it was protected by the religious beliefs of a mainly Islamic population.

In the second half of this century, the destruction of habitats through housing and development projects, road construction, urbanization, environmental pollution and the large-scale use of pesticides and poisons in the agricultural sector has been responsible for the disappearance of large numbers of species. Since the beginning of the present century, the area west of the Jordan River has undergone major changes, with a tenfold increase in population and a similar increase in standard of living. Furthermore, changes in agricultural methods, such as more irrigated areas and large-scale use of pesticides, have had a pronounced effect on wildlife. Today, the greatest danger to Israel's wildlife lies in the continued cultivation and urbanization of the country's already limited open space landscapes, a process which threatens to destroy even more natural habitats and species.

Local fauna was especially affected by the extensive use of chemicals in agriculture. The most dramatic incident of poisoning occurred in the early 1950s when an intensive poison campaign, targeted at rodents, seriously affected 37 out of the 39 species of raptors which were known in Israel prior to the use of pesticides. Species which were common breeders, such as the griffon vulture, Egyptian vulture, kestrel and lanner falcon, became very rare breeders while less frequent or rare breeders such as the lappet-faced vulture, bearded vulture, spotted eagle and others became either extinct or their populations decreased drastically. Today, some species have made a come-back, the most successful being the kestrel. Others are being reintroduced through captive breeding programs.

Carnivores are yet another group which suffered from poisoning in Israel. In the 1960s, a widespread anti-jackal poisoning campaign was launched in order to protect agriculture from damages caused by jackals. The poisoning campaign affected not only the jackal but several mammal predators as well. In addition, it upset the delicate predator/prey balance, ultimately leading to an increase in the rodent population and greater damage to agricultural crops.

Today, awareness of the impact of such measures on animals and on the balance of nature coupled with increased law enforcement have led to new initiatives targeted at reducing the conflicts between wildlife and humans.

Another factor affecting biodiversity is environmental pollution, especially sewage. The discharge of raw or partially treated sewage mainly affects the breeding places of amphibians. As an arid country, Israel has only six amphibian species; a seventh, newly described, became extinct as a result of habitat destruction soon after it was discovered. Most of the species were reasonably well established and widely distributed in the past. Five species bred mainly in winter rainpools, created by rain water, that dammed up in depressions in the ground. However, the flow of sewage into these depressions has polluted some breeding sites.

Many reptiles have a restricted distribution in certain habitats so that development threatens their survival. For example, the lizard, *Acanthodactylus schreiberi*, lives in the coastal plain on sand-loam soils which are developed for agriculture and settlements. Since no nature reserves exist to preserve this habitat, this lizard is threatened by extinction. Similarly, a related species, *Acanthodactylus pardalis*, lives on loess soils in the Negev that have been converted into grain fields. As a result, this formerly common lizard now survives on small, uncultivated pockets where its continued existence is uncertain. Another lizard, *Ophisops elegans*, formerly one of the most common, was once able to live in grain fields all over the country due to the fact that traditional shallow ploughing did not harm its eggs that are deposited in the soil. Today's modern, deep ploughing destroys the clutches and consequently, this lizard has become quite rare.

In the Mediterranean region, where about 105 declared nature reserves are dispersed in a total area of 250 km^2, the main problem facing nature conservation is habitat fragmentation. While most of the wildlife of Israel still lives and is protected outside nature reserves, the decrease in open areas may well make nature reserves the last stronghold for many species. However, the small size of most reserves (63 percent are smaller than 1 km^2 and 25 percent are smaller than 10 km^2) makes them vulnerable to impacts from their surroundings, thus placing the future of the flora, fauna and ecosystems in the reserves at risk.

3.6. Biodiversity of Genetic Resources in Israel

Israel's location in the Middle East heartland of the genetic diversity of many major agricultural crops, coupled with its remarkable geographical and climatic diversity, have helped create a particularly rich collection of habitats and corresponding local

varieties. In fact, Israel is considered to be one of the world's richest areas in progenitors and relatives of domesticated species. In light of spreading urbanization, habitat destruction, intensive farming and the almost universal use of elite cultivars by farmers, the preservation of Israel's wild genetic riches is an imperative. Therefore, the protection of these precious genetic resources has been accorded priority on the national level.

Israel has one of the largest and most accessible collections of wild wheat, barley, oats, and legumes in the world, as well as a wealth of wild fruits and other important crops such as *Alliums.* Many contain genes which can improve protein content, disease resistance, insect resistance, salinity and drought tolerance, and other traits. From the time Aaron Aaronsohn, the discoverer of wild emmer wheat in the Galilee in 1909, was invited to participate in the research efforts of the U.S. Department of Agriculture (USDA), Israel has played an important role in the international activity on genetic preservation. More recently, Israeli researchers have found genes responsible for the high protein content of some Israeli wild wheat. Using a collection of wheat varieties differing by only a single chromosome, they were able to sexually transfer such genes to commercial wheat varieties, in a highly specific and controlled manner.

Israeli wild wheats have long been known to harbor genes conferring resistance to yellow stripe rust. These are now widely used by commercial wheat breeders. Israeli wild barleys harbor several genes conferring resistance to powdery mildew, leaf rust and several other diseases. Israeli wild oats harbor genes conferring resistance to crown rust, and many commercial U.S. oat varieties now incorporate this gene. Israeli wild thistles have been used in developing seed-propagated artichokes. Local colocynth varieties with mildew resistance have been found and tested in watermelon-breeding programs.

Today, Israel is an active participant in the International Plant Genetic Resources Institute (IPGRI) network. Every second year, IPGRI sends 20 of its Third World fellows to Israel for training in the *in situ* preservation of wild genetic resources.

4. OBJECTIVES OF ISRAEL'S BIODIVERSITY STRATEGY

4.1. National Vision

The declining rate of the three main biodiversity components--ecological systems, species and genes--is one of the main threats to the environment throughout the globe. The trend, in many cases, is the result of human activity.

The obligation to conserve precious natural assets is inherent in a significant number of human civilizations. In the Jewish heritage, this obligation expresses itself in the stories of the Creation and of Noah's Ark and in numerous religious commandments.

Israel's national biodiversity strategy is based on a national vision in which society appreciates and respects all life forms and sustainably uses natural resources while preserving and conserving the country's rich biological diversity for the benefit of future generations. This national vision is based on a number of principles:

- All forms of life have inherent value;
- The survival of humankind is dependent on the conservation of biological diversity and therefore humankind is obligated to preserve biodiversity and to sustainably utilize natural resources;
- The ecological approach is central to achieving the conservation of biodiversity;
- Development must be ecologically and economically sustainable;
- Biodiversity is best preserved in nature;
- Traditional expertise and knowledge must be preserved;
- Actions must be based on best available information, but they must also accord with the precautionary principle;
- Actions must be based on global cooperation in sharing information related to cost/benefit assessment.

4.2. Goals and Objectives

In order to fulfill this national vision, Israel has formulated several objectives aimed at protecting, assessing, utilizing and benefiting from biodiversity and its components. These general goals include:

- Increasing efforts to preserve biological diversity and sustainable use of biological resources especially in such sectors as agriculture, forestry, and pasture;
- Initiating an ecological approach to management which is based on an understanding of ecosystem functioning, biological inventory, reliable data, integrated planning and monitoring systems;
- Increasing public participation in planning, developing and implementing biological diversity policies in accordance with the provisions of the Biodiversity Convention;
- Striving to achieve an optimal balance between regulatory action, on the one hand, and education, on the other, in order to promote responsible public behavior;

- Contributing to the international effort to preserve biological diversity.

4.3. Targets

Israel hopes to meet its goals through the implementation of a number of targets:

- Developing and implementing a comprehensive plan for preserving biodiversity and for sustainable use of its components;
- Establishing a network of protected areas for the preservation of ecosystems, species and genetic resources which are capable of functioning ecologically and which are related to other open spaces such as agricultural fields;
- Rehabilitating damaged ecosystems in order to promote biodiversity;
- Coordinating the implementation of the plan among all stakeholders including governmental and non-governmental bodies, the private sector, community groups and other target populations;
- Utilizing legislation, rules and procedures, budgetary allocations and other regulatory measures to establish methodologies for conservation of biological diversity and for sustainable use of resources;
- Advancing public awareness concerning the advantages of biodiversity conservation and sustainable development;
- Promoting knowledge and expertise through formal and non-formal education, ongoing research, and increased institutional capabilities.
- Harmonizing national action with international and regional conventions, activities and plans;
- Implementing the precautionary approach through measures intended to forecast, prevent and combat the causes for reduction or loss of biodiversity at source;
- Integrating traditional knowledge on the conservation of biodiversity.

Israel's strategy relates both to habitats and to key species such as endangered species, endemic species, species of international importance and Red Book species. Indicators for implementation will be designated for both habitats and species. Every effort will be made to identify organizational frameworks capable of implementing the program and to strengthen the role of non-governmental organizations. In addition, new or amended legislation will be developed in order to strengthen natural resource conservation, to accord protection from exotic species and to prohibit commerce in indigenous species. High priority will be accorded to integrating the principles of biodiversity in educational programs on all levels.

On the technical level, initiatives will be launched to incorporate ecosystems which are not currently represented in the national network of protected areas, marine reserves and population inventories and surveys. Recommendations for conserving and using different biotic resources will be formulated, and plans for research and management of isolated populations for the purpose of their preservation will be drafted.

On the research front, it will be necessary to strengthen taxonomic and systematic research and to monitor global impacts and ozone depletion. An economic assessment of indigenous genetic resources, genetic engineering and use of popular knowledge of these resources is planned as well.

4.4. Central Components of the National Strategy

- Declaration of at least 10 percent of each ecosystem as a nature reserve;
- Preservation of 20 percent of all open spaces as scrubland, half of which will be natural scrubland;
- Establishment of regulatory and other controls on the use of biological resources;
- Implementation of an environmental impact assessment system to control pollutants which threaten to damage ecosystems;
- Protection of the diversity of domesticated races;
- Monitoring and establishment of a data base to assess the status of species and ecosystems and to establish priorities for conservation;
- Incorporation of such considerations as natural resource conservation and ecological functioning of ecosystems in development decisions;
- Promotion of regional and international cooperation.

4.5. Criteria for Setting Priorities for Ecosystem Conservation

An essential part of any national strategy for the conservation of biodiversity is the setting of priorities for action. In Israel, the following criteria have been set for selecting ecosystems for preservation:

- wealth of biodiversity;
- high level of endemism;
- representative value;
- undisturbed status;
- presence of important species;
- critical ecological value (path of migration, nesting, food, hydrological significance to the ecosystem.)

The following criteria have been set for selecting species for preservation:

- genetic importance;
- ecological importance;
- economic and social importance;
- level of risk and damage.

5. TOWARDS A BIODIVERSITY STRATEGY IN ISRAEL

In order to conserve biodiversity, activities must be initiated in a number of realms. Of top priority is the continued development of the network of nature reserves in Israel and the preservation of essential habitats. Had Israel's protected areas been large enough, it is possible that the country's nature reserves would have been sufficient to preserve species diversity, the second component of biodiversity. However, since Israel is a small country and the areas left for nature protection are small and fragmented, additional steps must be undertaken to preserve the diversity of species.

In many cases, the need to protect specific species is clearcut and in such cases reserves are indeed declared for the protection of specific species. However, in order to determine for which species such conservation activities are required, it is first necessary to assess the diversity of species in Israel. In order to meet this challenge, the Nature Reserves Authority is currently preparing a comprehensive plan for preserving nature in Israel's open spaces. A central criterion in the assessment process is the potential of the area to protect biodiversity. Thus, the plan will also constitute an important step in preserving the diversity of ecosystems.

5.1. Assessment of Species Diversity

Israel is currently preparing a national plan for nature conservation aimed at protecting biodiversity within the framework of a national plan for allocating "open landscapes." The first step toward reaching this objective is to develop a national biodiversity digital database on the species level. The biodiversity database will be used to assess biodiversity and classify areas by their importance for biodiversity conservation. The second step will be multivariate correlation of the biological and abiotic data and numerical classification of areas according to ecosystems.

The national biodiversity database will contain data from many sources now scattered among several bodies including digitized field observations of the NRA, herbarium and museum records, and non-governmental databases. This information, arranged on a GIS system, will cover a wide range of taxonomic groups at many temporal and spatial scales. This will allow analysis at many levels, from populations to landscapes, and from seasonal to long-term patterns. At this time, it is not expected that the database will include data on genetic diversity.

5.1.1. Methods

At present, information on the distribution and abundance of species in Israel is scattered among a few museums, universities, the Society for the Protection of Nature in Israel (Israel's leading environmental NGO) and the NRA. The databases of the NRA and of the Israel Plant Information Center of the Hebrew University of Jerusalem (Rotem) contain an abundance of specific data on the diversity of plant species in Israel. Both Rotem and the NRA are now working on listing and mapping endangered species in Israel (Red Book). In order to facilitate the assessment of plant

biodiversity in Israel, ongoing projects must be completed and existing data processed and collated.

Priorities for data accumulation will be given to taxa whose members can serve as umbrella species. Umbrella species have been defined by Heywood as ”species whose occupancy areas (plants) or home range (animals) are large enough and whose habitat requirements are wide enough that, if they are given a sufficiently large area for their protection, will bring other species under that protection.” In developing Israel’s database, first priority will be given to collecting and compiling the plant data. Plant species that cover more area than others are likely to serve as umbrella species, thus affecting entire ecosystems. In the animal world, since mammals are many times more susceptible to extinction risks than other species, they can serve as “indicator species.” Priorities for other data will be set in accordance with the availability of data.

At present, a computerized database on wildlife diversity in Israel does not exist. However, a significant quantity of material from which data can be derived is available. It is therefore necessary to review the professional literature, to survey existing biological collections, to assess in which areas and in which systematic groups there is a scarcity of knowledge, to prepare action plans to close the gaps, to determine where such data is no longer relevant because of irreversible development process, and to check the reliability of results by comparing the data with the results of field surveys in selected sites. Efforts have begun to seek funding for this project, but to date the required funds have not yet been secured.

5.1.2. Mapping

It is currently envisaged that mapping will be a fundamental component of Israel’s biodiversity strategy because it provides an estimate of the past and present distribution and abundance of many species found in Israel.

Various types of analysis will be undertaken to determine areas of high species diversity, for each taxon separately and any combination of taxa. Comparing distribution and abundance of species from the past and their current distribution will point to the species and areas that are most threatened by human development. Other types of analysis will be used to correlate species distribution with abiotic factors and disturbance factors such as grazing and fire. This analysis can be used to define ecosystems in terms of both species assemblages and their abiotic features which will help identify ecosystems not well presented in the existing nature reserves. It will also help predict and explain “hot spots” in biodiversity in one or more taxonomic groups. Finally, correlation of high diversity with particular species assemblages and/or environmental factors will help to correct management procedures, to construct management models to optimize biodiversity and to make predictions about the impact of environmental conditions on diversity.

After filling in the gaps in data and validating the results of the analysis, the maps will be overlaid on a land use map and on a map of existing nature reserves in Israel. The combination with the current land use map will supply a quick estimate for the degree of habitat degradation for different species and the degradation of entire ecosystems.

The combination with the nature reserves map will point to ecosystems, species assemblages and diversity "hot spots" that are not well protected today and will direct the conservation efforts of the government.

5.1.3. Toward a Biological Diversity Plan

While it is clear today that the current nature reserves will most likely continue to serve as the cores for biodiversity conservation in the future, it is expected that the assessment of species diversity in Israel will enable areas to be evaluated according to the index that estimates their value for conservation. It is expected that five categories of areas will be defined:

1. Areas that are urbanized which will not be targeted for conservation.
2. Clusters with high biodiversity values which will be designated as nature reserves.
3. Areas with lower biodiversity values which are situated in the vicinity of clusters of high biodiversity which will serve as buffer zones.
4. Areas with high biodiversity values that do not form clusters will be included as natural habitats within local and community planning zones, as a first priority. If not possible, other measures such as translocation of resident populations to nature reserves, botanical and zoological gardens, will be considered.
5. Areas with low biodiversity value will be accorded low conservation priority.

Since the results of such an assessment will not indicate corridors between natural habitats, they will have to be overlaid on the results of the "open landscape" project where the ecological potential of areas for conservation was evaluated based, *inter alia*, on their size and their ability to function as corridors.

Special importance will be given to the buffer zones. Many activities such as tourism, picnic areas, extensive agriculture and pasture, will be directed to these areas, while directing local communities in using these opportunities to make their living.

The results of the assessment will primarily help to develop a national database of ecological information, on which national planning for nature conservation, biodiversity protection and sustainable use of natural assets may be based. This database can be used as a decision support resource for land conservation and development planners in Israel and in the region. Pooling the relevant information in a single location will greatly facilitate its ease of access for conservation planning and will aid in coordinating future plans.

6. CONSERVATION STRATEGY FOR INLAND ECOSYSTEMS

While research on floral and faunal species in Israel and on the country's plant genetic resources is relatively comprehensive, Israel's ecosystems have not been the subject of comprehensive research until recently. Moreover, the country's ecosystems have not been defined and divided in accordance with a standardized classification. Nevertheless, concern for Israel's natural legacy has resulted in numerous programs and initiatives to protect Israel's ecosystems and habitats.

6.1. Nature Reserves

In a small country, with a high rate of industrialization and urbanization, nature reserves help secure the biodiversity of the natural environment. Israeli law defines a nature reserve as an area containing unique and characteristic animal, plant and mineral forms which must be protected from any undesirable changes in their appearance, biological composition or evolution. Israel's reserves vary in size, character and use. Some encompass less than one square kilometer while others span thousands of hectares; most are open to the public and some offer special visitor services. Together, they represent the entire spectrum of Israel's ecosystems, including Mediterranean forests, marine landscapes, sand dunes, freshwater landscapes, desert and crater landscapes and oases.

To date, 155 nature reserves, spanning an area of some 3.5 thousand hectares, have been declared and 17 more have been approved for declaration. With the declaration of another 202 reserves, now in various stages of planning toward declaration, the total area of the reserves will reach 6.1 thousand hectares.

While none of Israel's reserves is large enough to preserve entire ecological systems which encompass a variety of habitats, efforts have and are being made to move in this direction through the declaration of biosphere reserves. Thus, one of Israel's most important regions--Mt. Carmel--was declared a biosphere reserve in April 1996 within the framework of the Man and Biosphere Program of UNESCO. A biosphere reserve is defined as an area in which nature conservation and development are managed sustainably in cooperation with users of the area. This is achieved by dividing the reserve into several zones: a core with strict conservation regulations; a buffer where active conservation management practices, outdoor leisure, educational activities and scientific research take place; and a transition zone where infrastructures for tourism, education and scientific research are located and where the human population is concentrated. Other areas considered to be appropriate for declaration as biosphere reserves include Mt. Meron in the north and the area encompassing the slopes of the Judean Hills in the transition zone between the Mediterranean and desert biomes. The latter, unique to Israel, is not represented in any biosphere reserves and has diverse genetic resources which are very important in case of global climate changes.

It should be noted that national parks, while not directly related to biological diversity, also play a role in preserving open spaces in Israel. National parks are defined in

Israeli law as areas of natural, scenic, historic, archeological or architectural value which are protected and developed for recreational purposes. These protected areas serve an important function in helping to protect the natural landscape from rapidly-encroaching urbanization.

6.1.1. Case Study: Mt. Carmel

In September 1989, a wild fire burned more than 300 hectares of pine (*Pinus halepensis*) forest on Mt. Carmel, one of Israel's most important protected regions. Public concern motivated the authorities to appoint professional committees to assess rehabilitation options and fire policies. The committees subsequently reevaluated the goals and practices of nature conservation and management in protected areas in a much broader context than just fire prevention. The recognition of the dynamic nature of ecosystems, the low predictability of their behavior, and the role of fire as a disturbance agent that promotes biodiversity, contributed to recommendation of minimal intervention, allowing self-regeneration.

Further, the committee commissioned an interdisciplinary research program to provide insights for planning the region as a biosphere reserve. The participatory mechanisms involved all stakeholders in decisions concerning establishment and management of the biosphere reserve for the purpose of sustainable development and conservation. An integral part of the program was based on a joint German-Israeli project to plan the Carmel as a biosphere reserve for purposes of nature protection, management, development, and research and monitoring using a Geological Information System computer package for data compilation and analysis.

Studies have revealed that the Carmel comprises four main ecosystems, represented by four tree species: *Quercus calliprinos, Ceratonia siliqua, Quercus ithaburensis and Pinus halepensis.* These systems are represented in the three core zones chosen for protection. The other nature resources are management dependent, so that the buffer zones are very important, both in terms of biodiversity conservation and core protection.

The characteristics of Mt. Carmel are compatible with the aims of biosphere reserves. The area--nearly 50,000 hectares encompassing the mountainous area of the Carmel, the coastal plain and the seashore--boasts geological and geomorphological diversity, contrasting landscapes, rich biodiversity, a mixture of agricultural practices, a wealth of prehistoric, historic and archeological sites, and diverse human activities and settlements. Furthermore, Mt. Carmel is situated within a regional and biotic transition zone: the Mediterranean scrubland extends to its north; the arid zone to its south. It is anticipated, therefore, that this biosphere reserve will conserve the biota of transition zones, as part of an international concerted effort to manage the global biosphere by reducing the scope of adverse ecological impacts due to global warming.

6.2. Open Space Landscapes

Largely in order to overcome the problem of habitat fragmentation in Israel, the Nature Reserves Authority and the Jewish National Fund have cooperated on a so-called "Open Landscapes Plan" for Israel. Geographical and lithological data,

collected by the Jewish National Fund, and botanic data, collected by the Nature Reserves Authority, is currently being compiled, evaluated and mapped on the Geographical Information System at the Nature Reserves Authority. The result will be an ecosystem assessment of the remaining open natural landscapes in Israel which will include an evaluation of each area based on such criteria as unique or rare elements, biodiversity in terms of species and communities, and potential for sustainability based on size and connectivity to other areas. The first part of the project (which encompasses the area from Beersheba to Nazareth) has been completed and is described below. The Negev section has also been completed. The third part (encompassing northern Israel--the Jezreel Valley, Upper and Lower Galilee and the Jordan Valley) is currently in preparation.

Preparation of an open space assessment of the Negev is especially important in light of the constant pressures on this region from various directions, including pressures for the allocation of training grounds in this sparsely populated region. The assessment method used for the Negev differs from that used for the assessment of open spaces in the central part of Israel. Since data on some ecosystems in the Negev is relatively scarce, a methodology using "umbrella species" was adopted. For the purpose of this assessment, the *Capra ibex nubiana* was selected as the "umbrella species" for the rocky and cliff areas while the *Gazella dorcas* was selected for the valleys and plains.

The lithological part of the open space project has also been recently completed. The underlying principle of this research project was that preservation of diverse environmental conditions, as expressed in the combination of exposed rock types and climatic conditions, is a prerequisite for the preservation of a wide diversity of ecosystems. Therefore, diversity of lithologic/climatic conditions will have a direct impact on diversity of vegetation. The purpose of the research project was twofold: to indicate those areas characterized by rare lithological features which require special protection and to indicate types of rock which are not represented in nature reserves for the purpose of pinpointing those regions in which such types may still be preserved.

6.2.1. Case Study: An Assessment of Open Spaces in Central Israel--The Biological Aspect

6.2.1.1. Assessment Methodology

When selecting the optimal method for assessing Israel's open natural spaces for purposes of nature conservation, the NRA decided to base its assessment on the contribution of open spaces to plant protection. Since plants comprise most of the biomass of all terrestrial ecosystems, their central role as primary producers makes them prime candidates on which to focus for nature conservation purposes. The ecological criteria which guided the assessment of Israel's open spaces included preservation of unique or rare species and ecosystems at risk of extinction, areas of high biodiversity, and large and dense areas having the potential to function naturally over time. Keystone species were not identified.

6.2.1.2. Rarity

Humankind's responsibility to protect rare and endangered species, communities and ecosystems rests on both moral and utilitarian grounds. On the one hand, it is incumbent upon humankind to prevent the further disappearance of species and ecosystems since human intervention is largely responsible for the decline and disappearance of species. On the other hand, it is assumed that the conservation of rare communities and ecosystems will help preserve rare species as well. Furthermore, rare species frequently serve as bioindicators for the health and stability of the ecosystem as a whole.

Rare ecosystems, by definition, require special protection. However, because such ecosystems--and especially those damaged by human activity--do not rank high when compared to other geographical areas in terms of biodiversity level, they cannot be assessed according to the same criteria used for more common ecosystems. In Israel, the sand and kurkar ecosystem of the coastal strip--which is globally unique--constitutes the most endangered ecosystem. Continued human intervention, largely in the form of construction and quarrying, threatens its very survival. The rarity of this ecosystem, combined with the fact that it supports a relatively large number of endemic species and a wide variety of fauna (e.g., rodents, reptiles and anthropods), is responsible for the decision to grant Israel's sand and kurkar regions top priority, without further analysis.

6.2.1.3. Biodiversity

The second ecological criterion used to assess Israel's open spaces is their importance for biodiversity conservation. While methods for measuring and assessing genetic diversity have been developed in recent years, an assessment of Israel's genetic biodiversity is not expected in the near future. Therefore, the assessment of biodiversity in Israel's open spaces was based solely on the diversity of species and plant communities, on the assumption that plant community diversity is an indicator of ecosystem diversity.

6.2.1.4. Functionality

The third criterion used to assess open spaces was the preservation of areas likely to sustain functioning ecosystems for a long time and areas which are vital for the protection of other adjacent regions. The accumulated experience of some 50 years of nature conservation throughout the world supports the assumption that biodiversity is better preserved in large rather than in small areas, in connected rather than in fragmented areas. While the importance of regions as corridors for distribution has not been conclusively determined, most scientists have called for the preservation of as many wide corridors as possible as conduits for animals and plants in a fragmented landscape.

To comply with the third criterion, the NRA is striving to direct its conservation efforts to large areas, to areas that are connected to other areas with corridors that

allow distribution of plants and animals, and to areas that are surrounded by a buffer zone.

6.2.1.5. Methods and Results

For the purpose of data collection, the country was divided into three main regions--north, central and south--according to their geographic and botanic proximity. Data collection was based on field surveys, and to a lesser extent on the existing botanic literature and on aerial photographs. Areas with natural vegetation were divided into polygons--generally not less than 10,000 square meters in area--according to plant communities. Geographically adjacent polygons with similar botanic composition were then combined into 26 analysis regions. Each region was ranked in comparison to the other regions according to the criteria described above, namely rarity, biodiversity and functionality. Rarity was assessed in terms of the number of species and plant communities expected to disappear if appropriate conservation activities are not taken. Biodiversity was assessed in terms of an inventory of species and communities. Functionality was assessed in terms of the chances of the region to support ecosystems over time as determined by such factors as size of the area, its importance as a potential corridor for plants and animals, and the relation between the area and its periphery. The three criteria were then weighted in a simple algorithm to yield a final score ranging between 0 and 100. (See map on the following page).

In total, 5,650 square kilometers were surveyed, of which 4,004 square kilometers were agricultural areas, 483 square kilometers were forested areas planted by the Jewish National Fund and 903 square kilometers were natural vegetation areas. The rest of the area comprised built up regions, water reservoirs and a coastal strip bare of vegetation. Of the total natural area, only 242 square kilometers have been allocated for conservation of which 119 square kilometers are currently undergoing preliminary statutory processes and it is unclear whether they will be declared nature reserves.

Based on the above assessment, the following regions ranked highest: Beit Guvrin, Adulam, and Lahav (all of which constitute a unique corridor between the desert and the Mediterranean ecosystems) and Mt. Hurshan (in the region of Ramat Menashe between Mt. Carmel in the north and Samaria in the south). The Jerusalem area was among the areas which ranked lower, but this region should be preserved for its special landscapes, including planted forests, and for its rich multitude of recreational and historical sites.

6.2.1.6. Discussion of Results

The assessment of Israel's open spaces for national planning purposes should take into account the different functions of open landscapes--from nature conservation, afforestation, recreation, agriculture and preservation of cultural and historic sites to the designation of land reserves for building and industry. However, when formulating national priorities for the allocation of open spaces, planners should recognize the fact

that the conversion of open spaces into built areas is an irreversible process: a "natural" area once transformed into a built area can never again be recreated. At the same time, it should be remembered that while cultivated and agricultural areas are assumed to be better suited to nature conservation than built or industrial areas--because they serve as distribution corridors for flora and fauna and as shelters for rare species and sink populations--they too carry risks to nature conservation, especially in terms of pesticides, land treatment and pests. Finally, when reviewing the results of the NRA assessment, it should be remembered that the study did not relate to several important aspects of nature conservation, such as the preservation of fauna, small but essential ecosystems such as endangered wetland habitats, rare species within very small areas, nesting sites, or unique geological phenomena. These and other aspects of nature conservation require source treatment on the appropriate level.

Bearing in mind these reservations, the NRA study is expected to make an important contribution to the conservation of biodiversity in Israel within the overall context of open space preservation. Based on the study, the following recommendations were made with regard to Israel's most important regions from the point of view of nature conservation:

- Special attention should be paid to Israel's sand and kurkar areas because of their rarity value. Since Israel's sand reserves for quarrying purposes are already limited, sand import for building purposes should be encouraged and sand quarrying should be significantly reduced. Concurrently, steps should be taken to preserve Israel's sand areas through the declaration of sand reserves and parks.
- Special attention should be granted to the continuum of natural open space between the northern Negev and the Jerusalem corridor which constitutes a unique transition zone between desert and Mediterranean ecosystems. This continuous area, measuring only 60 kilometers in length, is globally unique in that it serves as a meeting point for Saharo-Arabian, Mediterranean and Irano-Turanian biota. It is recommended that a biosphere reserve be established in this area which will include areas for nature protection, planted forests, national parks, agriculture and areas for building and industry in the environs of existing settlements.
- The Ramat Menashe and Alonim regions deserve special protection both in terms of their inherent value and in terms of their function as the sole bridge connecting the Carmel and Samaria in the south and the Carmel and the Galilee in the north. Disruption of the Carmel from these two areas may result in genetic stress to small Carmel populations, loss of regeneration capacity in case of the outbreak of disease, and loss of biodiversity.
- Nature conservation in Samaria is especially important since this region is the only natural corridor connecting between Mediterranean communities in the Judean Mountains and those in the Carmel and the Galilee. Furthermore, the slopes of Samaria east of Rosh Ha'Ayin serve as the last remaining natural "green lung" for residents of the Tel Aviv-Dan metropolitan area.
- The Besor-Gerar region in the Negev should be granted high priority for conservation because of its botanic diversity and uniqueness.

These recommendations are expected to guide not only the NRA's priorities for the declaration of nature reserves in the future but to direct present development initiatives toward less sensitive areas from the point of view of nature conservation for the mutual benefit of both humans and the natural environment which sustains them.

6.2.2. The Role of NGOs in Protecting Open Space Landscapes

While the open space assessment project currently being implemented by the NRA has a direct impact on the conservation of biodiversity in Israel, all of the country's green bodies have waged a major campaign on behalf of preserving Israel's open spaces in the face of development pressures. Various steps have been taken in recent years to help secure the biodiversity and the natural landscapes of Israel: an interdisciplinary "think tank" was organized by the Society for the Protection of Nature in Israel in 1991, a Public Council for the Protection of Land and Landscape Resources was set up in 1994, and a proposal for a national policy which integrates development with landscape preservation was drafted in 1996. A major component of this national policy proposal is classification of open space landscapes into units according to criteria which relate to the characteristics and functions of each landscape unit including: ecological function, cultural and historic importance, rarity, regeneration capacity, landscape and aesthetic function and potential for leisure and recreation activities. On the basis of these criteria, the level of development which each area can sustain, without damaging its unique value and characteristic image, may be determined. Based on the carrying capacity for development of each area, guidelines for planning and land use will be defined for each category of preservation/development.

An important element in the development of such an open space policy for Israel was the establishment of the Open Landscape Institute of the Society for the Protection of Nature in Israel. The Institute was set up for the express purpose of collecting data on open spaces, analyzing and assessing their importance and providing professional background material to enable sustainable development in Israel. The process of survey, analysis and assessment of open spaces defines the landscape units, maps and describes the characteristics of each unit, assesses their importance and provides the tools to preserve their unique character. The results are expressed in background maps for planning and in databases. The material is made available to planners, developers and environmentalists, guides land designations and promotes sustainable development which integrates preservation and development of open spaces.

The methodology is based on three stages:

- *Stage 1:* Collection and classification of findings: Collection of data is currently based on existing data and on field surveys of the specific area. Information has been collected on the natural, landscape and heritage values, together with data on the range of the open area in the region and its environment. Thus expression is given to additional functions of open space such as green lungs between settlements, open spaces for recreation and leisure, and aquifer infiltration areas.
- *Stage 2*: Evaluation of various resources: Evaluation of the data collected is undertaken in each of the fields of information, and the unit of comparative reference is derived from the geographic region in which the survey was undertaken. The extent of the open area is evaluated in a broad context, through its relation to the functioning of the general totality of the open areas.
- *Stage 3*: Integration of data and evaluation: The data and the evaluations in the various fields of information are integrated into summarizing maps, which can serve as background for existing or proposed plans.

Currently, 32 surveys which span the area of the entire country are being conducted by the Survey Unit. The findings of the surveys are being entered into the Geographic Information System of the SPNI. The principal findings are summarized in booklets that contain a general introduction, a series of maps (at a scale of 1: 50,000) and explanatory notes. Full details of the surveys relating to vegetation and landscape, including documentation of sites and photographs, are included in the appendices. Members of the administration of the Institute include the SPNI, the Jewish National Fund, the National Parks Authority and the Institute for the Conservation of Nature at Tel Aviv University.

6.2.2.1. Case Study: Survey and Evaluation of Natural Resources and Landscape in the Lachish Region

The Lachish area, an endangered and environmentally critical region which is located between the Mediterranean and desert habitats of the country, was the first in which the SPNI implemented the GIS system in evaluating natural landscape resources for land use planning. The process resulted in the production of ten maps of which map number ten formed the basis for a recommendation on a conservation and planning policy which should be taken into consideration when evaluating natural resource sensitivities in the region. In this map, grade 1 is the most sensitive and grade 7 is the least sensitive (see the map on the following page).

The verbal description in the survey and evaluation of the Lachish region relates to the special features of the site and notes that the area is a transition point between flora which is characteristic of the Mediterranean scrubland and flora characteristic of the desert. Following is a summary of the principal findings as expressed in the Lachish booklet:

The Lachish region is an area of unusually high value, both in terms of the landscape that opens before the hiker against the background of the steep slopes of the adjoining hills and of the variety of vegetation, ranging from cultivated Mediterranean plant life to traditional flora that spread northward to the cliffs. The striking colors of the vegetation change throughout the year. The meanderings of the Lachish River, along with the sheer chalk slopes of the Adorayim Stream, form a rich and varied landscape. The area has a wide abundance of archeological sites, including Tel Lachish. Most of the area is a continuous open area situated at a short and convenient distance from most of Israel's residents.

Since the entire region is of high value, areas that should remain open landscapes, despite current plans for development, were classified into four categories as follows:

- *Greatest Sensitivity - Very High Natural and Landscape Values - Natural Vegetation and Pasture:* In this area it is possible to develop a hiking infrastructure which will enable a broader sector of the public to enjoy the scenery, vegetation and historical sites.
- *Very High Sensitivity - High Landscape Value -Natural Vegetation and Crops:* This region can absorb centers for leisure activity and camping which can also serve hikers in the valuable and sensitive region. Its visual sensitivity dictates continuation of farming in the existing patterns.

- *High Sensitivity - Importance for the Expanse of Open Landscape - Intensive Agriculture and Forest:* The present form of farming may be preserved and a camping center established in the central forest area.
- *Medium Sensitivity - High Visual Absorption Capacity - Intensive Agriculture and Forest:* These areas which are situated in the heart of the existing infrastructure are also appropriate for development of more intensive vacation centers that can include camping facilities.

In addition to these categories, separate categories were established for two other areas which were not accorded high conservation value, as follows:

- *Rural Zone - Rural Building and Intensive Agriculture - Continuation of Rural Development.*
- *Urban Zone - Low Value - Unlimited Development.*

6.3. Mediterranean Coast

Israel's Mediterranean coastline stretches some 195 kilometers from north to south. The major ecological feature of the Mediterranean coast of Israel is that it constitutes the northernmost sector of the Nile littoral cell, which extends from the coastal zone of the Nile Delta to the end of Haifa Bay at Acre. This cell is composed of quartz Nilotic sand which is transported along the coasts of Egypt, Sinai and Israel until Haifa Bay. The net yearly sand transport within the surf zone decreases from about one million cubic meters at the Nile Delta to about 250 thousand cubic meters at Ashkelon and to zero somewhere between Hadera and Haifa. Beyond the surf zone, the sediment transport is estimated to be about one order of magnitude larger at the Nile Delta, decreasing to about 500 thousand cubic meters at Ashkelon and about 100 thousand cubic meters off Haifa.

About 70 percent of Israel's population lives within 15 kilometers of the Mediterranean coastline and the country's major economic and commercial activity is concentrated here. Other activities which affect the coastal environment are the industry, refining and commerce that take place in the ports of Haifa, Ashdod and Ashkelon and power generating facilities along the coast which use Mediterranean waters for cooling.

As previously noted, the NRA's open space assessment accords top priority to protecting the sand and kurkar ecosystem of the coastal strip, which is both globally unique and endangered. Continued human intervention, largely in the form of construction and quarrying, threatens its very survival as well as the survival of a wide variety of species in this area.

In 1970, the National Planning and Building Board recognized that Israel's coastline should be treated as resources of national value and called for the preparation of national plans for all its sea and lake shores. The main objectives of the National Masterplan for the Mediterranean Coast, which was approved in 1983, were to prevent development which had no need for a coastal location, to protect large sections of the coastline as nature reserves, national parks and coastal reserves and to

allocate coastal areas for tourism and recreation activities. The masterplan includes a highly effective clause prohibiting development within 100 meters of the coastline.

To help provide a comprehensive long-term guide to planning policy beyond the guidelines in the approved masterplan, a more detailed document for the resource management of the coastline for tourist and recreation activities was prepared by the Ministry of the Environment. Each site designated for tourist and recreation use was allocated a level of intensity of development, initially proposed by the planners on the basis of surveys, geological and ecological guidelines and local site conditions.

There are four types of nature reserves along the Mediterranean coast of Israel: marine reserves, coastal reserves, islet reserves and protected natural asset belts. The 20 coastal reserves, with an area of about 3,500 hectares (16 of which have been proposed and four declared), are important for the preservation of both the aquatic and the littoral environments since they prevent shoreside development.

In November 1996, Israel embarked on yet another initiative in the area of coastal land management within the framework of the Coastal Areas Management Programme (CAMP) of the Mediterranean Action Plan (MAP). This program was first initiated in 1989 in order to implement the concept of integrated coastal area management in selected locations. The United Nations Conference on Environment and Development (1992 Earth Summit) gave further impetus to this new approach by recommending that all coastal states adopt the integrated coastal management process in order to meet three increasingly important types of coastal needs: sustainable development and use of coastal resources; protection of marine and coastal ecosystems and biodiversity; and response to climate change.

The CAMP-Israel agreement is oriented to the creation and promotion of the process of integrated planning and management through six interrelated activities, as follows:

- First National Strategy for Sustainable Development;
- Assessment and control of pollution;
- Management of coastal resources and hazards;
- Economic instruments;
- Remote sensing;
- Coastal area management.

The program has two main objectives which are also expected to facilitate the preparation and implementation of Israel's biodiversity strategy:

- To encourage policy makers of economic development sectors to take responsibility for the environmental impacts of their decisions and to incorporate environmental considerations in their decision making processes (e.g., sustainable development, economic instruments);
- To provide the professional basis for policy making on issues not sufficiently covered in current coastal zone management (e.g., pollution control, sand reservoir, cliff stability).

6.4. The Negev: Israel's Desert

Israel, with an area which totals only 24,000 square kilometers, is 90 percent dryland. Although the land area is so small, all four types of global drylands--hyperarid, arid, semiarid and dry sub-humid--occur within Israel.

The Negev desert, which comprises over half of the country's land area, is inhabited by only 7 percent of the population. Yet this arid expanse once extended further north than it does today. Strategies implemented since 1948 have succeeded in pushing the edge of the desert southward, and actually reversing the process of desertification. Thus, although most of Israel is dryland, it is barely affected by desertification.

Israel has accomplished this by substantial investment in scientific research--in soil, climate, agriculture, forestry and ecological sciences. Achievements in basic science were then translated into technological advances and applied in the field, thus bringing about sustainable development of the Israel drylands and the prevention of their desertification

The Jewish National Fund (JNF), which has been instrumental in afforesting the land of Israel since its establishment in 1901, initiated a new project in 1986 for planting single trees or clusters of trees in areas where climatic conditions do not permit woodlands or shrubs to grow without substantial human intervention. This project, known as savannization, aims at preventing desertification and increasing productivity and biodiversity without resource enrichment. The assumption of the savannization project is that biological production and diversity in semiarid regions are related to the patchiness of the landscape. Entire watersheds are managed as whole units encompassing runoff-contributing areas (cyanobacteria, unicellular algae, lichens and mosses) and runoff-collecting patches (clumps of annual plants and shrubs). By manipulating the patchiness at various sites in the Negev and by using water harvesting techniques, some of which were first employed two thousand years ago by the Nabatean inhabitants of the area, rainfall and runoff are redirected, and relatively highly-productive patches are created within the desert landscape. The major features of the savannization concept are the digging of pits in which runoff accumulates and the planting of trees in these pits. Israeli scientists have found that the mere disturbance of the landscape, through the construction of pits and mounds, has tripled the species diversity of annuals and increased total plant productivity tenfold.

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Israel's nature reserves also play a role in combating desertification, since they provide ecosystem services for agricultural areas by contributing to the recharging of aquifers, later used to irrigate dryland agriculture. These nature reserves are also used for recreation and tourist activities, thus providing alternative livelihoods for the inhabitants of the drylands--livelihoods that do not exert pressure on the sensitive soil resources of the drylands.

6.4.1. The Value of the Semiarid Region as a Repository of Biogenetic Resources

It has been suggested that the prospective loss of biodiversity due to global warming may be mitigated by an exploitation of the genetic diversity of species living in the semiarid ecosystems of Israel. This assumption is based on growing evidence that geographically peripheral populations of a species live under low environmental stability, have high within-species diversity, high evolutionary potential and high resistance to environmental changes in comparison with populations of the same species that inhabit core areas of their geographical distribution. Therefore, some climate change scenarios predict the extinction of core populations of drought-resistant species due to their low genetic diversity and the persistance of peripheral populations which are then expected to be used to rehabilitate the core areas of distribution of their species.

Within Israel, the semiarid region is the one richest with peripheral populations. Thus, for example, in a survey of Israeli bird species which quantified the degree of peripherality of the 204 Israeli breeding bird species, on a scale of zero to one, the following was found: of the 124 species which have the highest value of the peripherality index, 100 have Israel as their southern periphery, and 17 and 7 have Israel as their northern and eastern periphery, respectively.

The semiarid belts sandwiched between the arid and the dry subhumid belts, constitute climatic transition areas in which species, both arid and dry subhumid ones, reach their distributional peripheries. On the one hand, these regions are most prone to desertification. On the other hand, they harbor biodiversity that may be significant for future mitigation of the detrimental effects of climate change elsewhere. Therefore, it has been suggested that the natural habitats of Israel's semiarid belt should be protected, both from desertification and from agricultural development, so that they can serve as repositories of unique within-species biodiversity, with evolutionary potential for rehabilitation purposes. The conservation of habitats in the semiarid regions may then also constitute a climate change mitigation strategy.

6.5. Woodlands and Afforestation

Most of Israel is dryland, yet in the historical past, its sub-humid parts were covered by scrublands and dry woodlands which protected the soil and its fertility. Whereas in the distant past, these woodlands covered 30 percent of Israel, when the State was established in 1948, only less than one percent remained forested. Israel has developed forestry and forest rehabilitation methods for drylands. As a result, nearly 50 years after its establishment, it increased the forested area from less than 1 percent to nearly 10 percent of its territory. By utilizing methods and practices of run-off harvesting, Israel succeeded in the afforestation of regions with 200 mm of rain a year, with trees that normally grow only where rainfall is more than 350 mm.

Today, natural woodland covers about 225,000 hectares in Israel. Most of this is protected in nature reserves and national parks. About half of Israeli woodland is Mediterranean scrub vegetation, with only a small proportion (40,000 hectares) fully grown natural woodland. Israel's natural forests consist of Jerusalem pine (*Pinus halepensis*), common on the Carmel mountain range; Tabor oak (*Quercus ithaburensis*), common on the Coastal plain, the hill regions of Samaria and Lower

Galilee; oak and terebinth of which the dominant species are the common oak (*Quercus calliprinos*) and the Palestine terebinth, which are most abundant in the hill regions; and carob and pistachio, which are common on the coastal sands and foothills up to a height of 400 meters. In the Negev and Arava Valley, tamarisk, acacia and zizyphus may still be found. All these species are protected *in situ* in different ecogeographic zones in nature reserves spread throughout the country. There is no need for *ex situ* conservation. However, in some cases, there is need for improved implementation of the *in situ* conservation. This largely relates to forest species under threat, such as *Pinus halepensis* which is under threat by the pine bast scale *Matsucoccus josephi.*

The JNF has been instrumental in reclaiming, developing and afforesting the land of Israel since the beginning of the century. To date, the JNF has planted over 200 million trees, creating 280 forests over an area spanning 90,000 hectares--in addition to caring for 40,000 additional hectares of natural woodlands. Much of the JNF's work today is concentrated in its afforestation branch, which is responsible for tending saplings in nurseries, planting new trees, thinning and tending forest growth, preventing fire, protecting woodlands against pests and diseases, and forest recreation.

The JNF's early plantings were composed of predominantly pine and cypress in the north, and eucalyptus in the south. In later years, damage from pests and arboreal diseases led to a new policy of species diversification. This policy was reinforced by the desire to cultivate tree species which were once part of the natural landscape of biblical Israel, such as various kinds of oak. While two-third of JNF's afforestation efforts once focused on the Jerusalem pine, today's forests feature a wider variety of species: oaks and carobs, terebinths and cypresses, eucalyptus, Judas trees, acacias, olive, almond and many more.

Although diseases, pests and pollution cause damage to forests in Israel, the most serious destruction is caused by fires. In recent years, efforts have focused on the development of an effective fire-prevention and fire-fighting system.

The success of afforestation in Israel cannot be overemphasized. Forests contribute to soil conservation, prevent soil erosion, act as a barrier against dust, noise and air pollution, create shade and comfortable mini-climates for recreation, halt desertification on the border of arid zones and contribute ecologically and globally to reducing the greenhouse effect. Each year, about 2000 more hectares, some 3 million trees, are planted.

6.5.1. Case Study: Holy Trees Project

A new project to record all sites in which sacred or holy trees are found was begun in 1997 by ROTEM. A holy tree is a tree or small group of trees adjacent to prayer or holy burial sites. These trees or groups of trees are usually very large and old and are often connected to the graves of sheikhs. It is estimated that there are approximately 1,000 holy trees in Israel. The sites containing these trees are currently being surveyed and information on more than 400 such sites has already been computerized. The information includes the name of the tree, its dimensions, location, type of cultural site, status of the ground, condition of the tree, environmental conditions,

current use of the site, the associated story concerning the holiness of the site, and a photograph of the site and its trees. The protection of these sites is important for the cultural heritage of Israel, for environmental protection and for ecological and historical research.

In a related endeavor, the JNF and the Agricultural Research Organization have been working on the establishment of a Galilee Biblical Fruit Trees National Park to preserve old Israeli horticultural landraces while educating the public as to their importance. They have already selected 75 fig, 40 grape, 35 pomegranate and other local fruit varieties for preservation in this unique 8 hectare park and genetic preserve.

7. CONSERVATION STRATEGY FOR AQUATIC ECOSYSTEMS

Due to the fact that Israel is inherently poor in water bodies and that many of its aquatic ecosystems have either totally been replaced by terrestrial ones or have been dried up, special attention is now being focused on the conservation and sustainable use of the country's aquatic ecosystems.

7.1. Eilat's Coral Reef

Since the founding of the State of Israel in 1948, the coral reefs of Eilat have been viewed as a national treasure. In 1956, the first warden, working on behalf of the Society for the Protection of Nature in Israel, was appointed to protect the coral reefs in Eilat under the Fishery Ordinance which declared some corals, sponges and shellfish as "protected fishes." In 1959, most of the commercial venture of collecting corals and other species was stopped.

The reef ecosystem of the northern Gulf of Aqaba is one of the northernmost and one of the most diverse in the world (34°N). The major component of this fringing coral reef are the scleractinian (reef building) corals which continuously secrete calcium carbonates thereby creating highly diverse structures. The reefs of this region exhibit exceptionally high biodiversity with 1,270 species of fish, hundreds of species of coral, and 1,120 species of molluscs out of a total of 2,000 which have been recorded in the Red Sea. The rich fauna of the region attracts frequent visits from large vertebrates such as whale sharks (*Rincodon typus*), dugongs (*Dugong dugon*) and dolphins (six species have been observed). The beach area constitutes a nesting site for hawksbill sea-turtles (*Eretmochelys imbricata).*

As a general rule, the higher the complexity of a coral habitat, the more diverse the fish community it will shelter. Since the Red Sea coral reefs are extremely complex with countless nooks, crannies, crevices and caves in a myriad of shapes and sizes, a highly diverse selection of retreats for each and every fish species that seeks shelter is available. The coral reef allows coexistence between hundreds of species of fish. The recorded ichthyofauna of the Red Sea comprise 1,270 species belonging to 157 families. A few families are represented by a high number of species whereas more than 90 families are represented by only 1-3 species. The rate of endemism among Red Sea fishes is also high. At least 171 species (13 percent of the total), belonging to 48 families, are endemic to the Red Sea.

A monitoring program of the algal communities in the Gulf of Eilat has been initiated in order to evaluate the risk of deterioration of the reef ecosystem. Continuous measurements have revealed seasonal fluctuations and community changes in the benthic macroalgal vegetation of the coral reef area. Algal monitoring is also expected to serve as a tool to identify pollution effects.

The marine habitats of the Red Sea are important not only for the coral reefs and other forms of marine life they contain, but also for continental fauna that use it as an

important staging habitat. Thus, Eilat is the major bottleneck flyway for 280 species of birds, which include representatives from most avian families. They pass through this area in autumn when migrating south to winter in Africa, and in spring when migrating north to their breeding grounds across Europe and Asia. Many of the waterfowl and pelagic species use the calm waters off-shore to feed and to rest, prior to continuing their journeys. Without these resources, some of the long-distance avian migrants, which comprise part of the breeding populations of Europe and Asia, would not survive.

The Gulf of Aqaba is separated from the main body of the Red Sea by a narrow, shallow passage (Straits of Tiran). This feature causes a low rate of exchange between water in the Gulf and the Sea proper. The rate of evaporation in the Gulf of Aqaba is very high leading to high concentrations of dissolved salts. This special combination of conditions makes the Gulf especially vulnerable to the effects of pollution. Low rates of exchange, combined with high rates of evaporation, mean that introduced pollutants can affect the Gulf for long periods of time. Because the corals are dependent upon clear, nutrient-poor water, sewage and industrial effluent can severely affect their survival and growth.

The entire reef acts as a system that is constantly being built up by the living coral polyps, and is continuously being degraded by natural factors such as erosion from storms and degradation by coral eating organisms. These two processes have continued together for millions of years, offsetting and balancing each other. The relatively recent introduction of the human factor has tipped the scale in favor of the degradation side of the equation, leading ultimately to a net loss in coral reef mass in recent decades.

7.1.1. Case Study: Conservation and Sustainable Use of the Eilat Coral Reef

Israel's Red Sea coastline and the coral reef are among the country's most valuable natural assets. Their protection from the often conflicting demands of urbanization, recreation and tourism are of utmost importance. To protect this unique and sensitive area, two marine nature reserves and two coastal reserves have been declared. They extend over 4 km on the marine side and 3.6 km along the Israeli coast respectively. These reserves are subject to the same restrictions on activities as all nature reserves in Israel. For example, entrance to fenced areas is permitted only to paying visitors, and collection or damage to natural assets is prohibited. In order to provide legal protection to the coral reef ecosystem, many coral reef species were included in the list of Protected Natural Assets set out in the Nature Reserves Law. The entire phylum Mollusca (including non-local species) is also protected by Israeli law.

In light of the sensitivity of this ecosystem, major efforts are invested in patrol, inspection and enforcement. The criminal files for the years 1990-1995 from the enforcement programs of the marine and coastal reserves in Eilat can be classified into five categories:

1. Collection of natural assets such as coral, molluscs and/or other protected invertebrate organisms (alive or dead);

2. Fishing from boat, shore or with spear-gun of any protected fish species, or fishing in the nature reserve.
3. Boating which crosses the restriction line of buoys which protect the fore-reef side and the people who swim along the reef.
4. Disorderly behavior such as littering, or crossing the small buoys line which is used to designate the paths from the back-reef to the fore-reef, or other prohibited activities in the nature reserve.
5. Illegal entrance into the fenced nature reserve area from the coastal or marine side (scuba divers) during the closed hours, or without paying the entrance fee.

About 500,000 people (half of them tourists) and about 30,000 cars (95 percent Israelis) enter Israel through the Taba border station annually. About 450-500 kg of protected nature assets are confiscated at the border crossing station annually as they are brought without official documents into Israel.

Alongside legal action, public awareness plays an important part in protecting the coral reef ecosystem. Thus, a Gulf Watch Forum was set up at the initiative of the Eilat Field Study Center of the Society for the Protection of Nature in Israel in 1996 to promote the conservation of the coral reef. Members of the forum include the Eilat Field Study Center, the Eilat District of the Nature Reserves Authority, the Eilat Environmental Unit, the Ministry of the Environment's Marine Pollution Control and Response Center, the Eilat Division of the Israel Diving Federation, the Eilat branch of Israel Oceanographic and Limnological Research, the Interuniversity Institute, the International Bird Watching Center, the Dolphin Reef, the Underwater Observatory, the Arava Research Institute and the local Eilat weekly. The forum was established in order to coordinate informal efforts to save the Gulf and to promote public awareness activities.

Following is a short description of some of the bodies which are directly involved in the conservation and sustainable use of the coral reef ecosystem at Eilat:

- **Marine Pollution and Response Center (Ministry of Environment):** Concern for the potential of damage to the fragile Gulf ecosystem from an oil spill is high because of the close proximity of the highly sensitive coral reef which is situated to the south of the Eilat oil terminal. Since the prevailing winds and currents are predominantly from the north, the coral reef is at high risk. Eilat's capacity for marine pollution control was dramatically improved with the inauguration in 1991 of a newly-expanded pollution control and response center. The center is manned 24 hours a day by professional marine pollution inspectors. The Gulf of Aqaba's pollution control capabilities were expanded as part of the Gulf of Aqaba Oil Spill Contingency Plan, a unique project within the framework of the Middle East multilateral peace talks. In view of the sensitivity and importance of the area, Israel, Jordan and Egypt have agreed to cooperate in combating pollution in the Gulf of Aqaba. In case of an oil spill, all three parties will place pollution control equipment at each other's disposal.
- **The National Center for Mariculture (IOLR, Ministry of Infrastructure):** This institute, a branch of Israel Oceanographic and Limnological Research (IOLR), is located on the northern beach of Eilat. Its main efforts are invested in

developing commercial mariculture of marine fishes. Several experiments are focusing on the use of molluscs for water purification.

- **The Interuniversity Institute:** The institute was first erected on the shore of the Gulf of Eilat in 1968 by the Hebrew University of Jerusalem. Today, the laboratory is an internationally important center for advanced marine research in a wide variety of disciplines, shared by all the universities in Israel.
- **Eilat Field Study Center (Society for the Protection of Nature in Israel):** The Field Study Center includes a staff of 15 expert field guides. It is active in promoting public awareness and is involved in public campaigns for environmental and nature conservation. A new computer center (the Computer Center for Environment and Nature Studies) was recently established.
- **International Birdwatching Center, Eilat:** The International Birdwatching Center is a non-governmental organization whose Board of Directors is comprised of representatives of the Municipality of Eilat, SPNI, NRA, JNF, Ministry of Tourism and Ben-Gurion University of the Negev. The Center was established in 1984 and has the only long-term bird ringing program, migratory raptor ringing and soaring bird survey in the Middle East. The staff recycled the local landfill in order to create a Bird Sanctuary in an attempt to give the migratory bird populations an alternative habitat to that lost to human purposes.
- **International Coral Reef Initiative for the Gulf of Aqaba:** This successful regional forum, initiated by the United States, has accelerated efforts to protect the Gulf of Aqaba's unique coral reef. A comprehensive Israeli National Report was presented on the occasion of the Red Sea Regional Meeting which was held in Aqaba in September 1997.
- **EcoPeace:** This organization was founded in December 1994 as a regional environmental consortium of Jordanian, Egyptian, Israeli and Palestinian environmental non-governmental organizations. This organization has focused special efforts on developing public awareness and education and fostering environmentally sound development of this sensitive region.

Recently, the Nature Reserves Authority and the Aqaba Regional Authority (ARA) of Jordan received a three-year grant from the USAID, Middle East Regional Cooperation Fund for the conservation of the Gulf of Aqaba. The project, "Research, Monitoring and Management Program for the Binational Red Sea Marine Peace Park" will promote the management of the four kilometer long coral reef of Israel and the seven kilometer long coral reef of Jordan as the northernmost reefs of the world. The project will be based in the sea, the coral reefs and along the coastlines of both countries and will be conducted with the support of scientists of the Marine Science Station of Jordan and the Interuniversity Institute of Israel under the joint conservation administration of the NRA and ARA. Coordination of the project will be undertaken by scientists from the National Oceanic and Atmospheric Administration of the U.S. Department of Commerce.

7.2. Wetlands

Israel, which signed the Convention on Wetlands of International Importance in 1993 and ratified it in May 1996, has accumulated extensive experience in the conservation

and rehabilitation of wetlands in addition to its accomplishments in such fields as inventories, surveys and conservation of waterfowl and aquatic flora and fauna. Ratification of the Convention is facilitating conservation and management efforts in such areas as river rehabilitation, protection of the Sea of Galilee, rehabilitation of the Hula wetlands and conservation of coastal wetlands. In line with its obligations under the Convention, Israel has designated two wetland sites for inclusion in the Ramsar List, namely the Hula Nature Reserve and the En Afeq Nature Reserve.

One of the most pressing environmental problems in Israel has been the exploitation of water resources, the reclamation of swamps and the diversion of rivers. Most major wetlands of Israel have been drained totally (coastal wetlands) or partially (Hula wetland), whereas others, especially around the Dead Sea, though small in size, are still relatively intact. The case of the Hula Reserve is especially significant in reviewing the history of Israel's wetlands.

7.2.1. Case Study: The Hula Reserve

The Hula Valley lies in the northern Jordan Valley which runs along Israel's eastern perimeter. In the Quaternary, a basalt spill from the direction of the Golan Heights blocked the Jordan Valley from the south. Water from the springs and streams drained into the closed valley and formed Lake Hula. The excess water carved a gully in the basalt barrier and flowed south.

The resulting lake and swamps, which covered more than 6,000 hectares, were drained in the 1950s to reduce the risk of malaria and to make the land suitable for agricultural cultivation. Until recently, the only remnant of the former site is a 300-hectare nature reserve, Israel's first nature reserve, which was set aside in 1964 for preservation as a result of conservation efforts by a dedicated group of nature lovers and scientists, later to form the SPNI. Their campaign helped preserve some of the indigenous vegetation, animal and bird life at this unique meeting point of tropical and temperate climate zones.

While drainage of the swamp succeeded in ridding the area of the malaria-infested swamps and reclaiming the land for farming purposes, numerous unanticipated consequences of the project soon became evident. The valley's indigenous flora and fauna disappeared, the waterfowl population declined, oxidation of the peatlands led to spontaneous underground fires and the land began to subside. Habitats changed, plant associations suffered, numerous animals moved from the Hula to more secure homes and many birds stopped nesting in the reserve or no longer visited during migration season. According to Israeli scientists, some of the Hula's endemic species have disappeared altogether, including such species as the frog *Discoglossus nigriventer*, the fish *Acanthobrama hulensis*, and two dragonflies.

In an effort to overcome the problems, the NRA introduced a long-range plan to restore the Hula Nature Reserve in 1971. A small-scale model of the lake and the swamps was reconstructed; some of the habitats were recreated; water quality levels were carefully monitored in order to improve water quality for the benefit of plants and animals which cannot tolerate low-quality water; and small pools were dug and a network of viaducts set up to monitor the open-water areas. In addition, a meadow

was cleared, to be protected by the grazing of water buffalo, and paths and an observation tower were constructed for public use. When the renovations were completed in 1978, the reserve was opened to visitors.

Today the reserve is an important protected area for flora and fauna and provides ample food and a refuge and rest site for a wide number and variety of waterfowl. Over the years, many species of birds returned to the Hula Valley and once again stop there during migration. Birds, such as the marbled teal and the black-winged stilt, have resumed nesting in the area, ducks stop at the reserve on their long trip from Europe to Africa, hundreds of cormorants can be seen in winter, and on spring and autumn mornings the sky is covered with pelicans leaving their roosting place in the reserve to continue their migration. Moorhen and heron, indigenous bank vegetation, papyrus thickets which reach their world northernmost distribution in the Hula, terrapins and catfish--all flourish in the rehabilitated environment.

More recently, in 1992, it was decided that a part of the larger Hula area (outside of the nature reserve) should be restored to its original wetland state. The Hula Rehabilitation Program was planned by Tahal (the national water planning company of Israel) and implemented by the Jewish National Fund which carried out the draining about 40 years ago. The soil works were completed in the late autumn of 1993 and the area was reflooded in April 1994. Jordan River waters were once again allowed to flow into a reconstructed part of the drained area at the heart of the Hula as part of the first stage of the rehabilitation project. The reflooding and restoration project extends over 800 hectares and includes a 100-hectare lake at the center of what will be a combination of wetlands and tourist area. Environmentalists see the reflooding as a chance to recreate the original ecosystem, enabling many species to repopulate the Hula, while allowing others to be reintroduced once the former water system has been recreated. The entire restoration program is meant to implement the principle of sustainable use which sees the management of wetlands as part of a complex system which transforms wetlands into assets rather than obstacles to sustainable development.

As an integral part of the Hula wetland rehabilitation, a three year, multi-disciplinary research program was initiated in 1994. The program is divided into five main fields of research: soil, eco-tourism development, agriculture, water and recreational development. Soil research focuses on problems of peat-soil fertility and manganese treatment. Eco-tourism includes surveys of shade trees and grass for open areas, introduction of large herbivores (water buffalo) and recolonisation by birds, mainly waterfowl. Agricultural research aims to find the optimal crops and cultivating methods for peat soils, including different vegetable species and “organic agriculture.” Water research includes detailed hydrological and geochemical surveys, chemical, microbial, zoo- and phytoplankton monitoring programs and special systems for the recolonisation and monitoring of the former vegetation, invertebrate and fish fauna. Recreation research concentrates on the special development needs in wetlands.

The Hula wetland rehabilitation represents an important test case for reflooding areas in an arid region. It appears to be successful given the rate of recolonisation of native fauna and flora. On the other hand, the rehabilitation has taken place too late for some aquatic species which were globally eliminated and have not recovered.

7.3. Mediterranean Marine Ecosystems

The Mediterranean coast of Israel extends some 195 km from Ziqim in the south to Rosh HaNiqra in the north. Morphologically, it is divided into two coastal regions, south and north, separated by the Carmel-Yagur fault near Haifa.

Vermetid reefs are unique phenomena that occur in the Mediterranean, only on the eastern coasts. These reefs are small-rimmed intertidal structures which developed in the subtropical marine water of the southern Levant and the Atlantic (Bermuda) coasts at about the same latitude. They are also known as "serpulid reefs", although in both areas they are mainly built by molluscs: *Dendropoma spp.* in both places and *Vermetus triquetrus* only in the Levant. These reefs are globally rare phenomena. They can exist only where soft and erodable coastal rocks rise at an appropriate rate relative to the marine erosion. The rim of *D. petraeum* is about 10 cm high, creating an interface shallow lagoon where dense algal meadows develop with diverse and rich intertidal fauna.

The Mediterranean coast of Israel includes 14 proposed marine nature reserves with a total length of about 35.5 km and another 20 declared and proposed coastal reserves extending about 44 km, mostly in parallel sections. There are also two marine protected belts along the shore, between Rosh HaNiqra and Akhziv (north of Acre) and between Atlit and Dor (south of Haifa) where all fish, molluscs and most marine invertebrates are fully protected under separate bylaws. Marine protected belts are generally included in the proposed marine nature reserves. Ten national parks also dot the Israeli Mediterranean coastline.

About 30 islets with a total area of more than 0.1 hectares may be found between Tel Aviv and the northern border of Israel. Most are within 200 m of the beach, and only the northern islets are further offshore. Most of the islets are included in proposed marine reserves and five islets are already declared as nature reserves. None of the islets are inhabited or subject to any human usage. Marine birds nest on some islets and about 2,000 cormorants (*Phalancrocorax carbo*) winter on the northern islets.

The primary aims of the marine management policy are to protect the unique phenomenon of the vermetid reefs, and the low-diversity native flora and fauna species of the eastern Mediterranean, which include high numbers of Indo-Pacific immigrants through the Suez Canal. Some 410 fish species including 55 (13.5 percent) Indo-Pacific species and 850 mollusc species are recorded along the Mediterranean Sea.

7.4. Saline Wetlands (salinas and their surroundings)

There are five salinas in Israel, four of which cover 360 hectares and are operated for salt production by a private company. They are located at Atlit on the Mediterranean coast; Qalya at the north end of the Dead Sea, and at Evrona and Eilat on the Red Sea coast. The fifth salina is managed as evaporation ponds for potash production and is

located at Sedom on the southern part of the Dead Sea, extending over 14,500 hectares.

The NRA has published a report on the status of salterns in Israel. The report relates to flora such as vegetation and algae and to faunistic components such as bacteria, insects, molluscs, fish and vertebrates including amphibians, reptiles, mammals and aves. A few of the salt marshes were almost completely destroyed before any research was conducted on the composition and zonation of the vegetation. Others, such as the Atlit and Eilat salinas are expected to be drained in the next five years in order to develop their area for tourism. The Evrona salina will be enlarged by about 200 hectares, but it is not yet clear to what extent it can substitute for Eilat as a rich site.

Located near the northern tip of the Red Sea, the Eilat sabkha serves as an example of the fate of Israel's salterns. The depression on the Israeli side extends over an area 4 km long and about 3 km wide, covering an area of about 1,200 hectares. Its southern part is covered by the tourist city of Eilat and the salt ponds. The major part is cultivated by a nearby kibbutz. Less than 2 percent of its area forms a Bird Sanctuary Nature Reserve (23.7 hectares). The sanctuary is a rehabilitated garbage dump site and serves as a resting site for about 280 migratory bird species which pass over Eilat on their route to Africa, along the Levantine flyway. The salina located close to the city of Eilat extended over 90 hectares.

The last natural remnant of the Eilat sabkha (not included in the nature reserve) was destroyed in 1997. This 4 hectare of Seablite forest (about 2-3 meters in height), a remnant of the previous 1,200 hectares, was abandoned. The site was used by over 70 passerine migratory species.

7.5. Rivers

With the exception of the upper Jordan River and its tributaries, the prognosis for Israel's rivers has long been gloomy. Whether as a result of industrial discharge, municipal sewage, overpumping or general abuse--rivers have either dried up or become sewage conduits.

For years, the NRA, the Ministry of the Environment, and the Water Commission have monitored Israel's ailing streams, collecting data on water quality, identifying sources of pollution, and compiling information on flow rates, water sources, and flora and fauna. Concomitantly, efforts and resources were invested in sewage treatment, effluent reuse in agriculture and groundwater recharge. Where possible, cleanups were initiated and riverbanks developed for recreational purposes, especially in the congested central region of the country.

These and other individual efforts culminated in the establishment of the National River Administration in November 1993. Initiated by the Ministry of the Environment, the Administration serves as a coordinating body among the numerous agencies which deal with rivers in Israel and oversees the restoration of the country's rivers and the preservation and renovation of natural and historic sites along riversides. It includes representatives from the Interior, Tourism (Israel Government

Tourist Corporation), National Infrastructures (Water Commission), and Environment Ministries, the Jewish National Fund (JNF), the NRA, the National Parks Authority, the National Water and Sewage Administration, the Society for the Protection of Nature in Israel and the Nature Conservation Institute of Tel Aviv University.

The Administration is dedicated to fulfilling the following aims:

- rehabilitation of the country's rivers through cleanups and restoration of water quantity and quality;
- preservation and rehabilitation of landscapes, ecosystems, and fauna and flora in the rivers and their watershed basins;
- development of rivers on the basis of existing and potential nature and landscape values for purposes of recreation, tourism, education and research;
- promotion of the ability of rivers to serve as drainage channels for flood prevention.

In order to attain these goals, the Administration has committed itself to:

- formulate an integrated national policy for the protection, cultivation and development of Israel's rivers, taking into account both consumer needs and the unique features of each river;
- prepare a national master plan for river rehabilitation;
- classify Israel's rivers according to a scale of priorities for rehabilitation;
- encourage the establishment of regional river authorities and river administrations for Israel's major rivers, and transfer responsibility for river rehabilitation and management to these bodies;
- encourage, guide and aid local and municipal bodies and other entrepreneurs to undertake measures which can help achieve the Administration's goals;
- collect and compile data in order to establish a database on natural resources, sites and landscapes in rivers;
- formulate and supervise the implementation of professional criteria for river rehabilitation;
- catalyze the planning and implementation of river rehabilitation projects and the development of landscape parks and riverside trails in accordance with set criteria and priorities;
- increase public awareness and participation in river rehabilitation and landscape protection.

Over the past three years, the Administration has formulated a model for river rehabilitation and established criteria for setting priorities for river rehabilitation (e.g., magnitude of the nuisance, potential for tourism and recreation, natural and landscape resources, land and water availability, feasibility, availability of funding). In addition, ecological and environmental surveys have been initiated or completed for most of the rivers earmarked for priority action. Within the framework of these surveys, data are collected on water and pollution sources along the river (including plans for solving pollution problems), hydrology (including plans for the regulation and stabilization of river banks), water quality (physio-chemical monitoring and hydrobiology), land, flora and fauna (including mapping of protected or rare species and unique ecosystems), historical and archeological sites, landscape sites, walking paths, land uses and environmental nuisances (such as quarries, waste sites). The data are then

summarized and mapped to serve as a basis for assessing the rehabilitation potential of the river.

The landscape surveys and evaluations provide planners with the necessary background information to ensure that development will not destroy the ecosystem, wildlife and landscape features of the river. The integration of such considerations as the sensitivity and vulnerability of rivers or sections of rivers to development is expected to help secure biodiversity and to preserve visual resources. In areas in which unique natural resources may be irreversibly damaged by development, conservation or minimal development are proposed. In less sensitive spots, more intensive development may be possible. In addition to such essential considerations as water quality and quantity, the planning process endeavors to make the river more prominent in the landscape, to designate areas for recreation and tourism, and to establish walking paths alongside the rivers, replete with signposts to direct hikers to significant or picturesque sites along the way. Once completed, the masterplan for rehabilitation of the river and its corridor is presented to the relevant planning commission for statutory approval.

The goal of the Administration is to entrust actual restoration work to local stakeholders while serving as a catalyst, coordinator and professional guide. Therefore, major efforts are invested in setting up regional river administrations, parallel in their aims and composition to the National Administration, but with a local focus. The regional administration is comprised of representatives of local authorities, drainage authorities, relevant regional organizations, representatives of national bodies (such as the NRA, JNF, National Parks Authority), and representatives of the National Administration.

Conservation and sustainable use of Israel's wetlands will be further advanced as a result of a three-year grant (1997-1999) to the Ministry of the Environment by the European Union for the joint financing of two nature conservation and biodiversity related projects in the framework of LIFE II programs. The projects to be financed include:

- *The restoration and conservation of fauna and flora in the re-flooded Hula Wetland Habitat*: This involves the reintroduction to the area of lost animals and plant species such as the native water buffalo, the protection of species and sites from intrusive plants and harmful rodents, the creation of special habitats and monitoring of the ecosystem.
- *Restoration of rivers in Israel's coastal plain*: This project is intended to help the Ministry of the Environment prepare a comprehensive national masterplan for the restoration of six rivers in Israel's coastal plain. This will include a survey of all major sources of pollution, surveys of the ecology and natural and cultural resources of lands adjacent to rivers, guidelines for water quantities and qualities needed for restoration of streams, and river-specific masterplans.

Specifically, the project will involve the following:

- Preparation of a comprehensive list of pollution sources, including characterization of both volume and pollutants and coordination of enforcement efforts by various arms of the Ministry of the Environment. A computerized list of

pollution sources, their characteristics and the current and updated status of enforcement and improvements will be prepared as part of this effort.

- Preparation of detailed surveys of ecological sensitivities and natural values of six rivers in Israel. This will be carried out by external consultants in accordance with guidelines prepared by a multidisciplinary steering committee representing the NRA, the Antiquities Authority, the Ministry of the Environment and academic experts.
- Preparation of detailed estimations of water qualities and quantities required for rehabilitation of the six rivers included in the project. This will be carried out by teams of external consultants consisting of hydrologists, ecologists and economists. This will form the basis for requests for water allocations from the Water Commission in accordance with the provisions of the Water Law.
- A masterplan for preservation and controlled development of areas adjacent to the six rivers which will be prepared by teams of landscape architects and town planners. Their work will be supervised by the National River Administration in close cooperation with the Ministry of the Interior which is in charge of the district planning and building commissions. This will serve as a basis for local plans which will regulate building and development carried out in the vicinity of rivers in order to achieve their preservation and rehabilitation.

The project will be accompanied by educational activities. Two conferences on stream rehabilitation in Israel will be organized: one aimed at the professional public and one targeted at the general public.

7.5.1. Case Study: The Alexander River

The Alexander River, one of the longest rivers in central Israel, is another example of river rehabilitation in progress. Flowing in the southern part of the Alexander River National Park, the 30-kilometer river is only an hour's drive from most of the country's residents. The wide open spaces still left alongside the river, in the midst of the densely populated central region of Israel, offer an unparalleled opportunity for recreation, leisure and nature protection activities.

Some 25 different pollutants, including organic and industrial effluents, have been discharged into the river for the past 40 years. The continuous onslaught of pollutants has adversely affected water quality, destroyed the natural landscape and played havoc with the unique ecosystem. A 1973 survey of river vegetation and of the impact of pollution on the distribution and composition of species revealed that of 81 different species of vegetation which once flourished along the Alexander River and its tributaries, 18 had disappeared; another nine species have disappeared since the 1970s.

While a number of rehabilitation initiatives were undertaken in recent years by numerous organizations, an integrated and comprehensive rehabilitation program was only launched in 1995, with the establishment of a fifteen-member regional administration and a planning team. As a result of effective coordination and cooperation, real progress has already been achieved including the completion of an eco-environmental survey and the first stage of a comprehensive masterplan. Recommendations relate to conservation and development options along the river, to

monitoring requirements, and to the establishment of micro reserves along the riverside which will serve as shelters for fauna and flora especially during times of intensive tourism. Special attention is granted to the Nile soft-shell turtle (*Trionyx triunguis*) and to the preservation of its breeding sites along the river. With the exception of the Alexander River, this protected rare species has all but disappeared from Israel's coastlines as a result of deteriorating water quality and water scarcity.
The success of the rehabilitation scheme for the Alexander River, as for most of the rivers slated for priority treatment, will be dependent on the success of sewage treatment in the area. Today, low-quality effluents are discharged into the river, either directly or as a result of mechanical failures in the existing sewage treatment plant. The construction of a new treatment plant for the city of Netanya should bring about significant improvement as should the construction of effluent treatment and disposal facilities in a number of industrial plants in the Emek Hefer region.

7.5.2. Case Study: The Taninim River ("Crocodile River")

Among Israel's coastal rivers, only the Taninim River has managed to survive. Despite the destruction of wetlands and the subsequent extinction of many of the flora and fauna species which once characterized it, this river has managed to support unique aquatic fauna and flora which include both rare and endemic species. Moreover, this river ecosystem is one of the few which has been accorded national importance since nature reserves were declared in its vicinity. The ecosystem also has national importance as a source for the repopulation of flora and fauna in coastal rivers which are currently undergoing rehabilitation.

Several long-range surveys and studies were conducted in the Taninim River. One recently published study reviews the changes in the mollusc fauna of this ecosystem over a period of 120 years. It emerges that even this last "unpolluted" coastal stream has also suffered from modern developments in the area. Although two species could be recorded as new for the river, *Mienisiella gaillardoti* and *Unio terminalis delicatus*, at least ten species seem to have disappeared. The lost species were all typical freshwater representatives confined in their distribution to the upper part of the river. That tract is now either disconnected from the middle and lower part, or has turned into an ephemeral stream carrying water only during the rainy period. In addition, the mollusc fauna of the middle and lower sections of the river is becoming more pressured by agrochemical and industrial pollution.

In yet another study, botanical surveys conducted in this region since the beginning of the 20th century are reviewed. Some 203 species which are typical of riverine and wetland habitats were identified, of which 56 were designated as rare species. Though the botanical data were not collected systematically throughout the years, the emerging picture portrays the loss of about 55 percent of typical riverine and wetland plant species, disappearance of many other naturally occurring plant species and invasion of species typical of disturbed habitats and species accompanying human development.

7.6. Sea of Galilee (Lake Kinneret)

Of Israel's two lakes, one (the Dead Sea) is globally unique in its apparent lifelessness and the other (Sea of Galilee or Lake Kinneret) serves as an operational open water reservoir for Israel. The Sea of Galilee is an ecosystem intensively managed to serve as the major operational reservoir supplying water of drinking quality to most parts of Israel. Research and monitoring for that purpose is provided by the Yigal Alon Kinneret Limnology Laboratory, part of Israel Oceanographic and Limnological Research.

The Sea of Galilee lies approximately 209 meters below mean sea level in the northern part of the Great Afro-Syrian Rift. It measures 22 kilometers from north to south and 14 kms from east to west, has a surface area of about 170 square kms, a mean depth of 24 meters and a maximum depth of 43 meters. When full, the lake has a total water volume of four billion cubic meters.

Most of the water (and pollution) flowing into the lake is brought by the Jordan River which drains 1,560 square kms of the northern watershed, covering the Upper Galilee, the Golan Heights, and some areas of Syria and southern Lebanon. Large parts of this region are heavily cultivated, and include the highly organic soils of the Hula Valley which were drained in the mid-1950s. The western and eastern catchment areas (1,200 square kms), contribute only about 20 percent of the water input. In addition to serving as Israel's major national reservoir (supplying 25 to 30 percent of Israel's annual water requirements) and as an increasingly important center for tourism and recreation, the lake also supports a commercial fishery with an annual catch of 1,500-2,000 tons.

7.6.1. Conservation and Sustainable Use of the Sea of Galilee

While scientific curiosity concerning the lake has been considerable over many centuries, only after 1960, with the decision to use the Sea of Galilee as the principal reservoir of the National Water Carrier system, was an effort made to encourage systematic studies of the lake. The Mekorot Water Company, which is responsible for most of the water supply in Israel, began to monitor water samples from the lake and its catchment area while Tahal (a semi-public company charged with the development of new water sources) undertook to study the hydrology of the saline inputs.

In 1968, the Kinneret Limnological Laboratory was established and four years later, partially stimulated by the initial research at the laboratory, public pressure resulted in the formation of the Kinneret Commission. This body, which functions under the aegis of the office of the Israel Water Commissioner, is responsible for formulating and implementing overall management policies, as well as for regulating and monitoring development in and around the lake and its catchment area with the aim of minimizing environmental pressures on the ecosystem and maintaining water quality. The Kinneret Limnological Laboratory has a staff of about forty scientists, technicians and support personnel and serves as the principal scientific advisory to the Water Commissioner and the Kinneret Commission on all matters concerning water quality in the lake.

Most historical accounts praise the quality of the lake's waters even though it appears that large amounts of algae have probably developed annually in the late winter and

spring for several hundred years. But, even if the Sea of Galilee has long been blessed with good-quality water, environmental changes within the last 60 years have led to increasing ecological stress upon the system. These include significant population increase around the lake and increased tourism and recreation. Thus, large parts of the natural shoreline and shallow coast (littoral) have been destroyed as a result of shore development. The littoral, although accounting for only 5-10 percent of the total lake area, has a uniquely important role in the metabolism of the Sea of Galilee ecosystem. The shallow waters are the only sites where most of the fish can breed and spawn. The rocks and boulders of the littoral are necessary for the attachment of fish eggs and for the successful development of the larvae and fingerlings. Limnologists now recognize that maintaining healthy native fish populations is generally a positive factor in preserving water quality. The St. Peter's fish, which is the most valuable fish in the lake, both from an ecological and an economic point of view, has a limited number of breeding and nursery sites in the littoral and is particularly susceptible to the destruction of this habitat.

Many factors determine water quality including the amounts and kinds of algae, particles and organic matter in the water; levels of pathogenic micro-organisms (bacteria, viruses, protozoa); and concentrations of harmful compounds such as pesticides, herbicides, heavy metals, etc. In addition to these factors, salinity is an important consideration for water quality.

Despite the widespread environmental changes noted above, long-term monitoring indicates that the quality of the lake water has not deteriorated significantly over the past 25 years. In some respects there has even been a definite improvement. For example, the levels of pathogenic organisms have markedly decreased over the past 15 years and concentrations of pesticides are now within permissible limits as a result of an intense effort to treat and control sewage sources and to limit and regulate crop spraying in the lake's catchment area. In the catchment area, a concerted attempt was made to lower the amounts of nutrients entering the lake by changing agricultural and irrigation practices, by cutting back the total area of commercial fish ponds and by introducing new management techniques. Sewage treatment plants were improved and a new drainage network which recycles much of the more polluted water within the watershed region was constructed. Around the lake, public and private beaches and recreation areas have been equipped with appropriate sanitary facilities. Pollution and sewage from settlements and fishponds near the shores are now treated and diverted from the lake. The *Bateicha,* a unique area of lagoons and wetlands in the northeastern corner of the lake, which is of special importance as a breeding and nursery site for St. Peter's fish, has been declared a protected region. Although much has been done to minimize the flow of pollution into the lake, this effort must be maintained and expanded, given the continuous environmental pressure on the ecosystem.

Nevertheless, despite the generally benign situation, there have also been changes in the lake which are less encouraging. For example, in mid-September 1994, a hitherto rare blue-green alga, *Alphanizomenon ovalisporum*, developed in the lake, reaching high amounts during the first weeks of October before disappearing in early November. Although no immediate harmful effects to water supply were noted, the fact that this alga belongs to a species which is known to cause deterioration of water

quality has caused scientists to view the phenomenon with concern. This episode emphasizes the fact that the time and manner of response of ecosystems like the Sea of Galilee to environmental changes is still unpredictable and therefore the increasing environmental pressures from human development on the lake cannot be viewed with complacency or ignored with impunity.

Perhaps the most prominent of the long-term negative changes which have been observed, is an ongoing, continuous decline in the amounts of zooplankton. These are tiny invertebrates, usually between a tenth to a half-millimeter in length, many of which feed on algae and thus help to keep it in check. Since the early 1970s, the early annual average of zooplankton in the lake has dropped by 50-60 percent, probably because of overpredation by the so-called "Kinneret sardine" or lavnun (*Microgrex terrasanctae).* The numbers of this endemic, small fish, which only resembles the true sardine in its size, have increased significantly in the lake since the early 1970s. The lavnun comprises the bulk (55 to 60 percent) of the commercial fishing catch but has only a low market value. By contrast, the St. Peter's fish has a high market value and plays a beneficial role in the ecosystem by feeding on algae. Therefore management recommendations are to encourage the removal of the lavnun and, at the same time, to promote the growth of St. Peter's fish. Pond-grown St. Peter's fish fingerlings are stocked in the lake each year in order to bolster the natural population.

Changes expected in the Sea of Galilee in the coming years, whether increased tourism or allocation of lake waters to the Hashemite Kingdom of Jordan as part of the peace process, might well affect the ecology of the lake. Therefore, much thought will have to be given to the future management of the Sea of Galilee as a sustainable source of high quality water. To achieve this goal, the concerted monitoring and research effort which has proved effective in the past will need to be maintained and intensified.

8. CONSERVATION STRATEGY FOR SPECIES OF FLORA

8.1. Database on Israel's Flora

The Rotem Israel Plant Information Center, a joint project of the Hebrew University of Jerusalem and the Society for the Protection of Nature in Israel, was established in 1979 as a Center for Documentation, Research and Education of the Flowers of Israel. The purpose of the project is to construct and maintain the ecological database of the flora of Israel. The Israel Wild Plant Database (EcoIsrael) now comprises over 430,000 records on the distribution and phenology of the country's native plants and includes information on all of Israel's identified wild floral species. The information on each species includes fields that summarize distribution and phenology as well as information from the literature on ecological parameters such as habitat, morphology and sex type.

8.2. Red Data Book of Plants

In 1990, the NRA commissioned from the Hebrew University of Jerusalem, with the aid of Rotem, a field survey of rare and endangered plant species of Israel. A major task was to find objective criteria to define the rare as well as the vulnerable threatened wild plants. Rotem has already started to monitor 791 species (about a third of Israel's flora) which have been classified as rare (197 species), potentially rare (161), very rare (389), very very rare (209), and extinct (32). The "potentially rare species list" also includes any suggested plant species that is known to be found in ten or less geographical sites. For each of the twenty-four geographical districts of Israel, a "potentially rare species list" was prepared. All of the Herbarium sheets of each potentially rare species at the Hebrew University were entered into the Israeli Plant Database.

Beginning in 1991, Rotem began conducting a detailed quantitative field survey in several regions of northern Israel to monitor the rare plants. Results of the field surveys have revealed that some of the recorded rare plants in the flora may no longer be classified as rare according to the quantitative definition of rarity while others have been added to the category of rare and threatened plants in northern Israel. The first part of Israel's Red Book, which focuses on the northern part of Israel and includes comprehensive information on biodiversity "hot spots" in this region, will be published in 1998.

The rare plant database is now being transferred to an ARC/INFO - GIS framework. Thus, "hot spots" of regions with high diversity of rare and endangered species can be located and the relationship between distribution of rare plants and their ecological characteristics can be analyzed.

8.3. Control of Alien Plant Species

Invasion by alien species is recognized as one of the major factors limiting biological diversity today. Therefore, Israel has included the control of aggressive alien colonizers and the prevention of the introduction of potentially aggressive species in its biodiversity conservation program.

According to recent scientific data, there are over 120 adventive wild plant species in Israel. About 30 have already become widespread and have penetrated into natural habitats, causing changes in the composition of plant communities and habitats. Another 20 are known as invasive species from other countries and are therefore expected to cause similar problems in the future. Since the colonization of an alien species is usually preceded by a lag period of 10-30 years, short-term pilot studies are usually insufficient to predict the "behavior" of a new alien species.

Current legislation in Israel doesn't provide for the prevention of ecologically hazardous species introduction nor for the control of invading species. Plant import is virtually free with the exception of plant species included in the CITES Convention which require the approval of the NRA and some poisonous or narcotic species which are prohibited by the Ministry of Health.

The Introduction Commission of the Ministry of Agriculture coordinates agricultural and horticultural introductions all over the country--mostly in order to improve acclimation of new species. However, it can also help to control new introductions and to prevent unwanted ones. Attempts are now being made to create a complete database on introduced species used in Israel, including full information on their systematic status, origin, introduction history, and properties.

The NRA is currently undertaking the following steps:

- Survey of alien species in nature reserves and implementation of management procedures which will lead to their elimination from reserves and from their surroundings.
- Steps to discourage the use of alien tree species in afforestation projects in open areas.
- Accumulation of information on potentially invasive plants all over the world including control methods.
- Advancement of proper use of native species in habitat restoration.

8.4. Wildflower Protection Campaign

As previously noted, the flora of Israel has about 2,780 species of higher plants, among them a few hundred plants whose flowers were once heedlessly picked. By the early 1960s, some of these species were on the verge of extinction. This was especially true of bulb and other geophytes of the families Iridaceae, Liliaceae, Amaryllidaceae, Orchidaceae, Ranunculaceae, and Primulaceae. Efforts to protect endangered wildflowers centered on legislation and public education. The Society for the Protection of Nature in Israel in cooperation with the NRA actively lobbied for

nature protection legislation, and in particular, for the declaration on protected natural assets.

Picking wildflowers used to be a popular pastime in Israel: some species of *Anemone, Narcissus, Cyclamen, Lupinus* and others were sold commercially. To reverse this trend, the SPNI and the NRA prepared a list of protected wildflowers, designed to include a minimal number of entities but with maximum clearness. Thus of the 30 Orchidaceae in Israel, only ten were endangered, but since most people are not familiar with the specific differences, the entire family was declared protected. A similar case was that of the genus Iris (20 species, 12 endangered).

There were four prohibitions: Don't pick; don't uproot; don't buy ; don't sell. After the legislative process was completed, a large-scale public campaign was launched in 1965 by the SPNI. It was mostly based on education, but was assisted by the authority of the law. The week around Arbor Day, usually falling in February, was declared in 1965 "Nature Protection Week." For the next few years, the week was dedicated to the subject of wildflowers and their protection. Placards, brochures and other materials were published. Volunteers explained the law to hikers. Special activities were launched in schools and kindergartens.

The power of the law was rarely used. Only a few violators were brought to court. The campaign has definitely saved Israel's wildflowers. In retrospect, after more than three decades, it has been widely acclaimed as the most successful nature protection campaign ever launched in Israel.

9. CONSERVATION STRATEGY FOR SPECIES OF FAUNA

In 1987, the NRA published the names and status of all vertebrates in Israel in accordance with IUCN categories. In 1994, the names of Israel's inland aquatic and terrestrial molluscs, including categories of threatened species, were published as well. These publications are part of an ongoing project to identify the status of all of Israel's plant and animal species in order, *inter alia*, to compile a comprehensive "Red List" for Israel.

9.1. Reintroduction of Fauna

Relative to its geographical size, Israel is rich in biodiversity of fauna. Thus, for example, in Europe which is 300 times larger than Israel, about 140 terrestrial mammals may be found as opposed to 106 mammals known to exist in Israel until the beginning of the present century. Several species of vertebrates, mostly mammals, disappeared from Israel at the beginning of this century. The introduction of firearms to the Middle East by the end of the 19th century and the tradition of hunting were followed by the disappearance of four ungulates (roe deer, fallow deer, Arabian oryx and Syrian onager), three carnivores (Syrian bear, cheetah, the northern subspecies of the leopard), the ostrich and the Nile crocodile.

As nature and wildlife protection gained new prominence, major efforts were made to rehabilitate and reintroduce some of these species to nature. One of the methods used was reintroduction-- the process of returning wild animals to natural areas in which they have existed in the past, and from which they have disappeared due to human activity (such as hunting).

In the 1960s, the NRA set out to reintroduce populations of animals present in historical times, as supported by biblical reference, but no longer found within modern Israel. Two breeding cores, Hai-Bar Carmel (1975) in the north of Israel and Hai-Bar Yotvata (1964) in the south of Israel, were established to breed animals suitable for release; the former for Mediterranean species, the latter for desert species. The founder animals for each species came from all over the world both from zoos and from the wild. Five species have been chosen: ostrich, roe deer, Asiatic wild ass, Persian fallow deer and white oryx (also known as Arabian oryx). Of these, all except the roe deer are globally endangered.

Worldwide reintroductions have become an important component of conservation programs for threatened and endangered mammals. Procedures for reintroduction were drafted by the International Union for the Conservation of Nature in 1987 in order to enhance the probability of success. Four stages are included: feasibility, preparation, release, and post-release monitoring. In all cases, the breeding core must be large enough to support the removal of a herd for reintroduction and must have good reproductive success to enable future boost releases. Prior to release, animals are transported to habituation enclosures at the release site, kept in the enclosure for a given time period and released after being marked and radio-collared and receiving

appropriate veterinary care. Israel's reintroduction procedures closely follow these recommendations. Successful reintroductions into the wild have already been implemented for the Asiatic wild ass (since 1982, nearly 100 individuals have been released in the Makhtesh Ramon area of the Negev desert), the fallow deer (the first release took place in 1996 in the Nahal Kziv area of the Western Galilee), and most recently, the white oryx.

The case of the white oryx serves as an interesting example of the reintroduction process in progress. The white oryx, frequently mistranslated as the unicorn, once inhabited more than 3 million square kilometers of Middle East desert, but due to hunting, not a single white oryx was known to survive in nature by 1973. Fortunately, when the white oryxes' impending extinction became evident, naturalists collected several of them from nature and zoos and created a "World Herd." They were carefully protected, bred, and ultimately provided calves to restore the species to its rightful habitats. Today, white oryx reintroduction projects are under way in Jordan, Saudi Arabia, Oman and Israel.

Israel's herd of white oryx is located in the Hai-Bar Reserve in Yotvata, a 12 square kilometer fenced reserve in the Arava valley, about 30 kilometers north of Eilat. It was started from a nucleus of eight animals from the San Diego Zoo in 1978 where the captive herd of oryx was created in the 1960s. Today, Israel's herd of 90 animals can support reintroduction, and a program using habituation enclosures is being implemented. In March 1997, 21 of these magnificent animals were released into the wild, equipped with radio-collaring equipment and, in the case of one female oryx, with a satellite transmitter.

9.2. Action Plan for Raptors

Early travelers to this region--most notably Henry Baker Tristram whose published work *Fauna and Flora of Palestine* (1884) earned him the title "father of the nature study of Palestine"--reported on the large number of raptors which existed in Israel, especially griffon vultures and black kites. Today, the existing populations of breeding raptors are only a fraction of their former populations. Compared to the dozens of pairs of griffon vultures which bred in the Galilee and on Mt. Carmel before the widespread use of agricultural poisons began, none are known to nest today. The situation is similar with respect to the lappet-faced vulture, the largest of Israel's birds. While 25 pairs of lappet-faced vultures were reported in the Negev in the 1940s, none breed there today.

The causes for the drastic decline in raptor populations in the latter half of the 20th century are attributed to hunting, poisoning, inadequate food supplies and reduction of open spaces and nesting sites. The introduction of veterinary care which prohibits, *inter alia*, the disposal of carcasses into the environment, coupled with changes in the Bedouin lifestyle (which have minimized or eliminated the number of carcasses left in the field), have drastically reduced the food supplies necessary for the survival of several raptor species. In order to facilitate the survival of these endangered raptor populations, a series of feeding stations were set up in Israel where carcasses are supplied.

Major work on captive breeding and reintroduction of raptors into the wild began in earnest in 1980. In one program, based at Tel Aviv University's Zoological Gardens, efforts concentrated on the lappet-faced vulture. Seven years after the first chick was taken from its nest in the Arava in 1981 and brought to the zoological garden in Tel Aviv University, the first hatching anywhere of an egg laid in captivity by Negev lappet-faced vultures took place. Concomitantly several other reintroduction schemes were started, most notably in Ramat Hanadiv south of Mt. Carmel near Haifa. This program includes such raptors as the griffon vulture, of which 30 individuals have already been released, and lanner falcons, of which 40 individuals have been successfully released. Other projects now being undertaken include the rehabilitation and reintroduction of the white-tailed sea eagle in the Hula Valley as well as similar programs for the Egyptian vulture, lesser kestrel and other raptors.

Following is a brief survey of the current status of some of Israel's raptors by categories:

- *Extinct*: white-tailed eagle, spotted eagle, Verreaux's eagle, Cinereous vulture, peregrine, marsh harrier, lappet faced vulture, bearded vulture and black kite. A comparison of the status of raptors in Israel today and in 1983 reveals that three new species were added to the list over the past 12 years, namely the lappet faced vulture, bearded vulture and black kite. While the last two known pairs of white-tailed eagle disappeared in 1957, a reintroduction program initiated in 1992 in the Hula Reserve has met with success--with 11 individuals released thus far. A reintroduction program is also being implemented for the lappet-faced vulture in Tel Aviv University and in the Hai-Bar in the Carmel and Yotveta.
- *Endangered species* (for which 10 or less nesting pairs are known): Bonelli's eagle and the eastern buzzard.
- *Vulnerable or rare populations*: This category includes small populations or populations which now constitute less than one third their previous size. The category includes the Griffon vulture, Egyptian vulture, Lanner falcon, golden eagle, and lesser kestrel.
- *Species which are not under immediate threat of extinction***:** shaheen, kestrel, hobby, sooty falcon, short-toed eagle, long-legged buzzard and sparrowhawk.

The action plan currently being implemented in Israel includes four components: management measures such as protection of habitats as nesting sites; surveys and research; captive breeding for the purpose of bolstering endangered species and vulnerable populations; and captive breeding for the purpose of reintroducing extinct species. Within the framework of the program, high priority is being accorded to feeding stations. In the north of the country, this is being carried out by the NRA, the SPNI and the Israel Electric Corporation. In the south, a major Israeli manufacturer, Israel Chemicals, is cooperating with the country's nature protection bodies in funding feeding stations in this area, especially for the purpose of reintroducing the lappet-faced vulture.

Surveys constitute another major component of the action plan. A comprehensive survey aimed at discovering all raptor nesting sites in Israel, whereby a different section of the country will be targeted for surveying each year, has been initiated. In addition, regional wardens of the NRA will survey nesting conditions in known nesting sites. The sites will be carefully mapped in an effort to promote monitoring

and risk management. One practical result is expected to lead to the prohibition of Air Force flights near sensitive nesting areas.

Other management measures include a project, in cooperation with the Israel Electric Corporation, to locate problematic areas which threaten raptors with electrocution and to protect them. Other initiatives may seek to restrict rappelling in areas known to include nesting sites.

For each species, different management approaches have been designated. Thus, for example, in a joint project of one of Israel's regional councils, the NRA and the SPNI, nesting boxes were placed on the rooftops of a region which was characterized by shingled rooftops in which lesser kestrels nested in the past. It is hoped that the rooftop nesting boxes will once again attract these raptors to the region.

9.2.1. Case Study: Conservation of the Imperial and Spotted Eagles

The Hula Nature Reserve in the north of Israel has been designated as a "Wetland of International Importance" by the Ramsar Convention. The Hula Valley, including the nature reserve and the recently reflooded area, is one of the most important migrating and wintering sites in the region for more than 200 species of birds including five endangered species according to BirdLife International and the IUCN List. Twenty-one species of raptors winter in this region.

Recently, the Convention approved a financial grant to the Israel Ornithological Center of the SPNI for a research project on two of the endangered raptor species that winter in the Hula Valley: the Imperial Eagle (*Aquila heliaca*) and the Spotted Eagle (*Aquila clanga*). The main objective of the project is to promote the conservation of these two species. This will be done by investigating the ecological requirements of the species as well as the effects of pesticides, intensive agriculture and tourism on the wintering populations. Land surveys will be conducted to define the habitats used by the two eagle species. Radio telemetry transmitters will be used to track the movements of the eagles within the Hula wetlands and the surrounding areas. Pellet contents will be studied in order to define the food requirements of the species. Blood samples of six birds of each species will be taken and analyzed in order to monitor the presence of pesticides in the eagles' bodies.

An educational program will constitute an integral part of the project. As part of the program, students will track the eagles marked with transmitters as part of personal projects and will identify pellet content and correlate the data with surveys conducted on local fauna. The students will present the projects to the local community, thereby increasing public awareness of conservation efforts in the Hula Valley. All relevant stakeholders--including local farmers and decision makers--will thus be involved in the project. In the future, a management plan will be developed in cooperation with local authorities, landowners and developers to improve the conservation of the two species and to help preserve this unique wetland habitat.

9.3. Conservation Policy for Invertebrates

In Israel, as in the rest of the world, an important challenge of nature conservation is to protect invertebrates as a whole, especially in light of the fact that several inland species have already become extinct. In Israel, several species of invertebrates are declared protected species within the framework of the Nature Reserves Law within declared and proposed nature reserves. Outside nature reserves, taxa declared as protected natural assets are protected throughout Israel or in a specific part of it. This list now includes a small number of taxa of invertebrates, mostly marine fauna. Only two groups of invertebrates which include inland species have been declared natural assets: all molluscs in Israel and one crustacean group.

The list of protected natural assets is updated from time to time and published as required. In 1987, the NRA appointed an expert committee to prepare a list of the groups of insects designated for declaration as protected natural assets. A recommended new list of taxa was presented in 1991 and included, as a starting point, the group of Lepidoptera: Ropalocera.

It is estimated that invertebrates in Israel include over 30,000 species as opposed to 150-200 thousand species in Europe. While the number of vertebrates in Israel is well known, the number of invertebrates can only been estimated. There is no comprehensive assessment of invertebrates threatened by extinction, with the exception of specific groups related to inland water habitats. A recent publication presents an updated list of inland and inland water molluscs in Israel which includes 229 species (including 29 exotic species). Of these, 156 are inland species and 73 are terrestrial water species. In Israel's previous list of 200 species, 97 species (48.5 percent) were defined as threatened, and 15 (17.5 percent) as extinct, most of which are inland water species which were originally found in the coastal rivers, swamps of the coastal plain and the Hula Valley and swamps.

Invertebrates are endangered by such threats as habitat destruction, environmental pollution, exploitation, and introduction of alien species. Israel's strategy for protecting these endangered species aims at combating all these threats. Specifically, it is believed that the protection of insects is mainly a function of preserving the ecosystems which sustain them, mainly within the bounds of nature reserves. In the case of the relatively small groups of insects which are subject to commercial exploitation which threatens their existence, proposals have been made for prohibiting commercial trade in protected insects, prohibiting the collection of threatened species for commercial purposes, limiting the collection of insects in nature reserves to scientific needs only, and updating the list of restricted species.

Implementation of the program for insect preservation requires additional research within the bounds of nature reserves in order to better understand both the inventory and the life cycles of insects within these reserves.

The following recommendations were forwarded by the Nature Reserves Authority for the conservation of invertebrates in Israel:

1. Preparation of lists of species belonging to selected invertebrate groups along with their risk level in accordance with IUCN categories.
2. Conservation and declaration of nature reserves in habitats which are at high risk level including inland water habitats, coastal sands, mountains and coastal cliffs (including coral reefs) in the Gulf of Eilat and the Mediterranean Sea.
3. Rehabilitation and restoration of extinct habitats (e.g., reflooding the Hula).
4. Formulation of a management plan for protecting associations of invertebrates in nature reserves.
5. Updating the lists of invertebrate species designated for declaration as protected natural assets.
6. Encouraging amateurs in different frameworks to take part in follow-up, reporting, registration and computerization of data on invertebrate distribution.

9.4. Action Plan for Monitoring and Conserving Insectivorous Bats

Only one species of fruit bat (*Rousettus aegyptiacus*) exists in Israel, and its population is on the increase. Therefore, Israel's action plan relates to insectivorous bats of which 32 species have been identified in Israel (about a third of all the mammal species in Israel). An additional species was recently identified on Mt. Hermon.

While information on bat populations in Israel is limited, evidence suggests that most of the insectivorous bat populations is on the decline, especially in the Mediterranean habitats and less so in the desert. All species of insectivorous bats in Israel are defined as protected natural assets and, as such, are protected by law since 1955. Any damage or intentional disturbance to these species is illegal.

The main factors which have led to the destruction or extinction of bats in Israel include:

- *Poisoning:* Large colonies of insectivorous bats in Israel were exterminated through the use of Lindane gassing--illegal since 1988-- in caves in a campaign to exterminate fruit bats in the late 1950s.
- *Insecticides in agriculture*: Bats are especially sensitive to poisoning and mainly to insecticides containing organochlorines. The use of insecticides in agriculture not only harms bats directly, but decreases the abundance of food available to them.
- *Disturbance of caves*: Disturbance of caves used by bats as hibernating sites or roosts may cause them to move to less suitable sites and thus reduce their chances for survival and breeding. Disturbance during hibernation may cause arousal and energy loss.
- *Habitat loss*: During the last few decades there has been a constant loss of habitats available for bats as roosts and feeding sites due to construction and development, fire, logging, loss of natural livestock ranging sites, planting forests

of young pine trees and large open mono culture fields, drainage of swamps and loss and contamination of wetlands.
- *Natural causes*: Causes such as climatic effects, effects of diseases, parasites and predation on bats have not been investigated in Israel.

Since current information on the status of bat populations in Israel is limited, it is imperative to monitor the status of their populations and the long-term changes in their population sizes, as well as the distribution and habitat requirements of each species within the framework of a bat conservation strategy. The methods which may be used for monitoring bat populations include:
- Cave surveys in autumn and spring and colony counts in summer to help identify caves that are used as day roosts during these seasons, identify the species in each area and obtain crude estimates of population sizes.
- Surveys of caves and other underground sites in winter in order to discover which caves are used as hibernacula and to try to estimate the size of hibernating colonies.
- Surveys of feeding sites in summer in order to identify species in each area using bat detectors and mist-netting in known feeding sites (mainly above water bodies). A national survey of feeding sites in Israel should also be initiated in order to provide a measure for comparison, to provide crude estimations of long term changes in bat population sizes in Israel, and to identify their use of feeding sites. All known roost sites will be mapped along with land uses and habitat types.
- Detailed surveys in sites of high bat activity and location of flight paths.
- Detailed surveys in forests, woodlands and maquis habitats in order to estimate the use of these sites for feeding and roosting.
- Collection of data on the use of buildings as roosts in order to increase data on species and roost distribution in Israel and to increase public awareness about bat conservation.
- Bat boxes may be used as an additional means of monitoring bat presence.

As part of the action plan, the following management measures for the conservation of insectivorous bats have been formulated:
- Pesticide control and law enforcement.
- Control of visitors in caves, grilling of cave entrances, limiting disturbance and limiting permits for capturing bats.
- Preserving bats and their roosts in houses and other buildings.
- Preserving other roosts and hibernacula and constructing artificial roosts.
- Preserving wetland habitats.
- Preserving other feeding habitats such as woodlands and forests.
- Preserving flight paths between roosts and feeding sites.
- Raising bats in captivity.
- Regional cooperation in the Middle East.

Yet another essential element in the conservation plan is research. The first priority is to identify all bat species in Israel, to recognize the type and frequency of their ultrasound, and to estimate the population size and distribution of each species. The roosts, hibernation sites, feeding sites and flight paths of each species should be identified and characterized, as well as seasonal food composition and its availability

and quality in the different habitats. Movement and migration patterns of colonies should also be followed. Finally, life history parameters, population dynamics, and relative importance of causes of death and extinction should be studied.
The conservation strategy should be accompanied by education, public relations and special courses, including bat enthusiast groups.

The action plan for monitoring, management and conservation of bats in Israel depends on the allocation of adequate manpower and resources and on raising external funds for acquiring the necessary equipment. Therefore, implementation of the plan will start with monitoring and conservation actions that have been accorded first priority and can be conducted with the manpower and resources already available to the NRA. Priority will be given to the Mediterranean habitats in both monitoring and management and conservation activities.

9.5. Conservation of Amphibians

Six amphibian species exist in Israel today: two urodeles and four anurans. A seventh species is now considered to be extinct. *Discoglossus nigriventer* was known to exist in one site (Hula Valley) and has not been reported since 1955. All six species breed in rainpools and small ponds and are distributed in the Mediterranean region of Israel.

Israel's Mediterranean region (about 12,500 sq. km) boasted some 1,200-1,500 rainpools (or vernal pools) in the past which were largely maintained by villagers and shepherds. Until the early 1950s, the rainpools played an important role as water supply sources for animal watering in the fields and human use in villages. These villages, most of which had no central water drinking system, had to rely on springs and the storage of rainwater in cisterns and pools.

The wide development of cultivated lands, water supply systems and urbanization caused a major decline in the number of rainpools in the Mediterranean region of Israel. About a hundred rainpools are left today, of which a few dozen have been declared as small nature reserves. However, these rainpools suffer from pollution as their drainage basin is subjected to cultivation or urbanization.

The earliest recorded data from a rainpool in Israel dates back to 1859 in Mammila, located close to the Old City walls of Jerusalem. Other rainpools were described in the latter half of the 19th century and early 20th century. Publications on amphibian distribution in Israel in the last fifty years deal mainly with the shrinkage limits of these species in Israel. There is no doubt today that all the amphibians in Israel, although declared protected natural assets by law, are on the verge of extinction as a result of habitat degradation and deterioration. Three species which reach their southernmost global distribution in Israel, are more prone to extinction: the *Salamandra* in the mountains of the Galilee and the Carmel; the *Triturus* in the mountains of the Galilee, Carmel and Judean Hills and along the coastal plain and the *Pelobates syriacus* in the Golan, Galilee and coastal plain.

In order to promote amphibian and reptile protection, the NRA published a special booklet in 1995. The publication identified the main threats to amphibian life in Israel

as the common habit of rearing pets from nature, the construction of roads which delineate their habitats, poisoning by pesticides and predation by feral animals. By far, the main threat is the degradation of the wetlands in Israel in an area within two climatic regions: the arid and the Mediterranean. In order to maintain these habitats, artificial rainpools must be created in protected sites.

In 1994, the NRA initiated a 5-year plan to create 60 artificial rainpools in nature reserves throughout Israel. The program was launched in order to maintain these important wetland habitats and to curb their disappearance from the Mediterranean landscapes of Israel. The project has been carried out by the NRA Development Department and the Northern and Central Districts of the NRA, under the scientific monitoring of the Aquatic Ecology Department. About 10 artificial rainpools are created every year. Today, there are about 30 rainpools in the Central Galilee, Western Galilee, Carmel, Ramot Menashe and the Judean Hills.

In 1996, a preliminary survey in the Mt. Carmel area was initiated and in 1997, two parallel surveys followed in this same area and in the Golan Heights, Hula Valley and Galilee areas in order to monitor the recent distribution of the amphibians and the results of creating artificial rainpools in reserves in order to maintain the invertebrates and amphibian species. The surveys are expected to continue in 1998 along with the creation of new rainpools. Results have already led to efforts to declare a new nature reserve for the type-locality of *Pelobates syriacus*.

10. CONSERVATION STRATEGY FOR GENETIC RESOURCES

10.1. The Israel Genebank

Israel's exceptionally rich plant genetic resources and advanced scientific and biotechnological expertise combine to create unique opportunities for genetic preservation, characterization, utilization and commercialization. In fact, Israel was one of the first countries to respond to growing awareness in the 1970s of the need to preserve genetic diversity. The Israel Genebank for Agricultural Crops (IGB) was established in 1979 by Israel's National Council for Research and Development (now the Ministry of Science) and the Ministry of Agriculture as a central focus for Israel's highly decentralized plant genetic resource efforts. Today, these two governmental bodies, along with scientists from academic institutes and Israel's seed industry, are working together on the formulation of a policy on the preservation and sustainable use of Israel's genetic resources.

The principal responsibilities of the IGB are: to maintain active and passive germplasm collections, herbaria, gene parks and genetic reserves; to facilitate national and international exchange of plant material; to maintain a database and information network; to promote national and international cooperation and coordination; to organize and participate in workshops, conferences and training activities; to disseminate information; and to guide research on genebank activities such as dynamic *in situ* conservation methods.

The IGB supports four distinct strategies for genetic preservation:

- *ex situ* conservation whereby seeds are kept in genebanks for 10 to 20 years at low temperatures (around -20° C) and periodically checked for viability and mutations;
- field plots and botanical gardens for plants which aren't suited for cold storage such as bulbs and roots;
- gene parks where fruit trees are grown for preservation;
- *in situ* conservation, in which wild species and relatives of domesticated crops are preserved in their natural habitat.

The IGB headquarters office, its base collection, its database and its computer facilities are located at the Volcani Center of the Agricultural Research Organization at Bet Dagan. The base collection holds over 20,000 accessions of indigenous varieties and land races as well as material from other Mediterranean countries, with over 1,500 new accessions added annually. The IGB collection has its own refrigeration, equipment, laboratory, quarantine facilities and grow-out fields. Most of the research on plant genetic resources is carried out in Israel's seven major universities and institutes of higher learning as well as in the Agricultural Research Organization, in regional research stations and in public and private companies. Following is a partial list of the organizations which currently take an active part in the IGB network:

- The National Clonal Repository which maintains plants, trees and rootstocks in vegetative storage at the Mattityahu Experimental Station;

- The National Herbarium of the Hebrew University of Jerusalem, dating back to the university's founding in the early 1920s, is the only collection of its size in the eastern Mediterranean. Two-thirds of its 500,000 specimens were collected in the Mediterranean and Middle East regions.
- The *Allium* Gene Bank at the Faculty of Agriculture of the Hebrew University is an internationally renowned collection of vegetatively-propagated, short-day-adapted *Allium* species.
- Tel Aviv University's Institute for Cereal Crop Improvement is the largest of the many major and minor private collections in the network and includes 20,000 (mostly wild) accessions of Israeli cereals and 2,000 worldwide accessions.
- Haifa University's Institute of Evolution's *in-situ* and *ex-situ* genebanks focus on the genetic resources of wild cereals (barley and oats).
- The Weizmann Institute of Science maintains a significant *ex-situ* collection of *Triticum* species.
- Ben-Gurion University's Center for Desert Research at Sde Boqer has a sizable collection of arid-land plants, which are resistant to salinity and drought.

10.2. *In-Situ* Conservation

Israel has long been aware of the need for comprehensive *in situ* conservation as evidenced by its national park and nature reserve system and its nature conservation policies and legislation which date back to the 1960s. In addition, the IGB coordinates and cosponsors, with the Israel Ministry of Science and the Ministry of Agriculture, a wide variety of *in situ* conservation studies. Most importantly, it has pioneered the concept of dynamic gene preservation--preserving genes in wild interacting populations rather than by the static preservation of seeds. The plants continue to crossbreed, forming new combinations, but the genes themselves are preserved, as long as the overall system stays in a roughly steady-state equilibrium. Israel's landmark studies on dynamic *in situ* conservation in wild wheat populations have drawn considerable international attention.

Many species of wild progenitors of cultivated plants still exist in Israel and can be used to make cultivated plants resistant to new diseases and adapted to changes in the agricultural environment. It is estimated that some 30 species of wild progenitors of food plants have survived in natural habitats in the Mediterranean part of Israel. Although they occupy fairly limited areas, most maintain high levels of genetic diversity. The wild plants in their natural habitats are continually exposed to the changing environment and their genetic constitution is incessantly molded by the forces of natural selection.

For over a decade, a multidisciplinary team of Israeli scientists, with support from the U.S. Department of Agriculture and the Ministry of Science, have been studying the genetic diversity and population dynamics of wild emmer wheat on a hilly slope near Ammiad in the Eastern Galilee. Each year, samples of wheat seeds are collected every 3-4 meters along four transects. These are grown in experimental plots and tested for biochemical markers, disease resistance and other gene-related traits. Differences are carefully noted and correlated with the highly-localized soil, water, topographic and

ecological conditions at each collection site. Results have shown that the wild wheat genes are not spread randomly across the terrain. Groups of genes exist as stable clusters or complexes associated with specific geographical features, such as north-facing slopes. These results will help guide future Israeli and international efforts in the realm of dynamic gene preservation.

10.3. Landraces and Old Cultivars

Israel's commercial agricultural sector is totally Western in its reliance on recent high-performance hybrids and intensive year-round cultivation. This and spreading urbanization (habitat erosion) threaten many old landraces, some of which (particularly domesticated fruit trees such as olives and dates) date back many centuries, if not to Biblical times.

Landraces and old fruit tree cultivars still remain in some small traditional Arab villages and among the Bedouin in the Northern Negev. Many field expeditions, especially in the early decades of the State, have systematically collected landrace varieties and local information. These historical collections are preserved and monitored. The Israel Genebank is now checking its collections of Bedouin wheat, small grains, chickpeas, lentils, faba beans and other legumes from the Judean Desert for continued viability.

Israeli agricultural scientists are well aware that local varieties can help improve modern imported varieties, by increasing their adaptability to Israel's particular climate, soils, plant diseases and pests. A case in point is the small local Hashabi apple. Many generations of selection pressure have given it considerable resistance to Israeli soil diseases, pest, etc. This makes the Hashabi a useful rootstock for many local and imported apple varieties. Twenty years of controlled selection at the Agricultural Research Organization have created superior Hashabis with increased vigor, yields, fruit size and quality. Similarly, a 100,000-seedling breeding program for grapes has combined local and imported genes to produce six patented new hybrids.

Other examples include landrace varieties of temperate fruit trees, adapted to Israel's mild winters, which can provide useful genetic input into commercial varieties. Under an innovative multi-landuse plan, combining genetic preservation with tourism, the Agricultural Research Organization is establishing a Galilee Biblical Fruit Trees National Park to preserve such landrace varieties, while educating the public as to their importance.

The Ministry of Science, in cooperation with the Ministry of Agriculture and other organizations, is making special efforts to preserve the genetic treasures Israel has inherited. Israel's experiments with *in-situ* conservation are especially appropriate for developing countries since, on the one hand, specific conditions such as refrigeration and dryness are not required and, on the other hand, some of the risks of *ex-situ* conservation, such as adverse effects on vitality and mutations, are avoided. Israel has reiterated its long-standing commitment to sharing its expertise in plant genetic resource research, preservation and utilization with all other countries. Only through

such all-encompassing cooperation can it maximize the benefits of its unique genetic heritage to all humankind.

10.4. Biotechnology and the Sustainable Use of Genetic Resources

In view of the rapid progress and promise held by biotechnology and its potential for the promotion of a science-based industry in Israel, efforts to develop a national policy on biotechnological research in Israel were initiated in the early 1980s when the National Council for Research and Development, in cooperation with the Chief Scientist's Office at the Ministry of Industry and Trade, initiated a survey of biotechnological research in Israel. The conclusions and recommendations led to the designation of biotechnology as a field of national priority in 1989. In 1991, a National Biotechnology Committee was established to implement the national biotechnology program. This steering committee, composed of representatives from government, universities and industry, advises the relevant government ministries--specifically Science, Agriculture, and Industry on priorities and guidelines.

In Israel, biotechnology has developed steadily over the last 20 years, gaining in status among high-tech industries. Several priority areas of biotechnology were designated for development in Israel over the next decade: pharmaceuticals, diagnostics, environmental biotechnology, research technologies, gene therapy and agricultural biotechnology.

Israel is already one of the world leaders in research into such subjects as hybrid seed development, peptide technology, aquaculture and biopesticides. Its outstanding achievements in the biotechnology agricultural sector include propagating new seeds, extending the shelf life of fruits and vegetables, improving yields and enhancing disease resistance. The second outstanding sector in Israeli biotechnology is medicine where medications have been developed which assist in the diagnosis of diseases, in both man and animals.

In 1996, a National Center for Plant Genome was set up by the Ministry of Science in order to give the scientific and industrial community in Israel access to activities in the realm of mapping, cloning and utilization of crop genes with biotechnological importance. At this stage, infrastructure is set up chiefly around the tomato crop, but the Center is currently considering broadening its infrastructure to other plant genomes, especially wheat, for which Israel has unique strains. Israel's universities carry out a number of projects in this area including genetic transformation of wheat, constitutive and tissue-specific promoters, resistance to herbicides and to transient drought, etc.

The Israeli Wheat Biotechnology Center, based in Tel Aviv University and the Weizmann Institute of Science, is working on the development of high-value, elite seed for the agro-industry. It seeks to provide state-of-the-art molecular and genetic tools to be implemented in wheat and other cereals. The utilization of newly developed, stable, short-statured Israeli wheat mutants, with high-yielding potential and high combining ability is a biotechnological tool of immediate application in international wheat breeding.

As previously stated, Israeli scientists have been actively involved in genetic engineering research since the 1980s and recent years have witnessed dozens of experiments in the area of transgenic plant research. The genes which have been inserted into plants and organisms using genetic engineering methods represent a wide range of markers and features: resistance to disease, insects and insecticides; resistance to stress (drought, salinity); and various crop features such as changes in the composition and production of different materials. This research activity is now leading to the first field experiments.

In light of these development, the Chief Scientist of the Ministry of Agriculture appointed a committee in 1988 to study issues related to the supervision of experiments involving transgenic plants. Based on the recommendations of the committee, a National Committee for Transgenic Plants (NCTP) was appointed in 1991 whose function is to approve experiments in transgenic plants in Israel and imported transgenic material. Members of the committee include researchers in genetic engineering from academic institutes, government bodies--Ministry of Agriculture, Science and the Environment--and representatives of private bodies. The committee operates under the Plant Protection Law of 1956 and is based on the experience and composition of similar committees in the USA, Europe and Australia. Concomitantly, institutional safety committees have been established in universities and research institutes throughout the country which work in coordination with the main committee. In addition, draft regulations on transgenic plant experiments or the import of transgenic material which are based on procedures which are already mandatory under the Plant Protection Law have also been prepared.

11. MONITORING AND EVALUATION

11.1 Geographical Information Systems

The development of Geographical Information Systems (GIS) in recent years has led to important breakthroughs in the organization and analysis of geographic data for ecological purposes. A GIS is a computer mapping/database system which enables the user to present physical, statistical or thematic data (derived from maps, aerial or satellite photographs, field surveys and digital information) in their geographical context. Automated cartography is used in resource management to identify areas of environmental sensitivity and areas of conflict.

The Ministry of the Environment's Planning Division has been using the GIS as a planning tool since 1988 and has developed a GIS which contains over 20 layers of information for the country, the average scale being 1:50,000 meters.

The first GIS project undertaken by the ministry was the Mediterranean coast database, which originally produced the maps included in the National Masterplan for the Mediterranean Coast. The coastal area is divided into 18 designated sections/maps, each of which includes the following layers of information: land use features; areas including archeological, vegetation, and natural landscape sites; and communication lines (e.g., roads, railroads). The Mediterranean coast database is now being expanded to include information on monitoring sites and beach access.

The second database covers the entire country. It includes information, based on national masterplans, on areas exposed to airport noise, quarries, roads, and solid waste sites as well as areas of aquifer sensitivity. This information is of special importance for use by the planning authorities to identify areas where potential development may be subject to environmental degradation.

The third database deals with open spaces. It delineates national parks, nature reserves and landscape reserves which are included in national and regional masterplans; areas of special landscape value which were identified in a survey of open space landscapes; and areas proposed for afforestation in the afforestation masterplan. This database will provide a basis for open space policy and decision making.

In recent years, the GIS has been used extensively by many other divisions in the Ministry of the Environment including the divisions of solid waste, hazardous substances, marine and coastal pollution, water quality and pest control. Thus, for example, maps showing the accumulation of pollutants along the course of the Alexander and Na'aman rivers were produced. In addition, a database of drinking water wells was developed with information compiled from the Hydrological Service and the National Water Authority. The location of wells was analyzed vis a vis aquifer-sensitive areas to create a map of wells with different buffer zones

More recently, cooperation with other government bodies using the GIS has been enhanced for purposes of data exchange and joint projects. Such cooperative ties

encompass the Hydrological Service, NRA, Israel Lands Administration, JNF and SPNI. Furthermore, the GIS unit has contributed information and analysis to the planning teams which produced the masterplan on immigrant absorption and the long-range masterplan for Israel (Israel 2020). As biodiversity information becomes more complete, it is expected that this data too will become an integral part of the GIS.

Finally, to determine the feasibility of using satellite imagery as a source of data for land use and environmental pollution, two remote sensing projects using image processing of satellite imagery were contracted by the Ministry of the Environment. One project, in the Dan metropolitan area, used Landsat TM satellite images to classify land use in the Greater Tel Aviv area, from Ashdod in the south to Herzliya in the north. Eight classifications of land uses were mapped: built areas, uncultivated areas, sand dunes, vegetation (3 types), water bodies and building-starts. The project used images from two different years (1987 and 1993) to identify changes over time with regard to green areas, new neighborhoods, expansion of roads, infrastructure work, etc.

In a second project, the Geography Department of Bar Ilan University classified land uses in the Haifa-Carmel area using SPOT satellite images. The project used images from different seasons to classify agricultural, residential, industrial, quarrying, and other land use types. The main goal of the project was to develop methods of remote sensing for the purpose of mapping land uses in different conditions in Israel. The Carmel area was chosen as the area of research due to the variety of components it incorporates, and since it represents a wide range of coastal landscapes which are characteristic of large parts of the country.

While in the past major focus was placed on the use of air photography, today efforts are concentrated on satellite imagery over larger areas. While this method provides a lesser level of resolution, it provides essential digital information which can be utilized immediately. The NRA, for example, is investing major efforts in using satellite images as a tool in nature conservation. Remote sensing images are proving useful both for the classification of vegetation and for monitoring changes and trends in vegetation both inside and outside of nature reserves.

11.2. Remote Sensing Support for Analysis of Coasts

Another new project, recently launched in Israel and Europe, promises to advance coastal management along Israel's sensitive Mediterranean coastline and to serve as a case study for other coastal zones. The RESSAC project, acronym for Remote Sensing Support for Analysis of Coasts, was officially launched in Israel in March 1997 within the framework of the European Commission Programme on Environment and Climate 1994-1998. Although remote sensing projects have been implemented before, RESSAC is deemed to be one of the most ambitious projects yet and the first in Israel to utilize funds provided by the European Commission.

The project itself was first conceived by the Regional Activity Centre for Environmental Remote Sensing (RAC/ERS), within the framework of UNEP's

Mediterranean Action Plan (MAP), in coordination with the Israel Ministry of Environment.

11.2.1. Data Integration and Contribution to Decision Making

Israel is now according high priority to the development of databases as essential tools for the integrated management of natural resources, in particular coastal and marine resources. Such databases reduce uncertainty and provide decision makers with ways of identifying relevant coastal issues, reviewing the impacts of alternative actions and providing information on present and expected costs and benefits.

An essential component of data management for integrated coastal management is the compilation of the data on physical/natural resources and economic information. In this context, the GIS has emerged as one of the basic tools for data integration as well as for the analysis and management of land resources. Nevertheless, the implementation of an "image-based" GIS is still new and such an implementation depends not only on the further development of the technology but also on an increased understanding of how such systems will be used and may be integrated into information support systems, including spatial decision support systems.

In the framework of the RESSAC project, the GIS unit in the Ministry of the Environment's Planning Department will play an essential and active role. The system will help the Ministry of the Environment to identify some key indicators of existing instability conditions in the test area, to define the level of vulnerability and degradation of coastal resources and to provide new integrated tools for monitoring the evolution of a specific phenomenon. A special effort will be made to set up procedures to allow the integration of data derived from the different remote sensing platforms and *in-situ* ones to provide combined information. Such combination of data will allow the gathering of information on the environmental conditions in the area under examination--sea-state, exceptional events, bathymetry, sediment pattern, sand inventory, coastline changes. The RESSAC project will attempt to define the vulnerability of the selected coastal area by using the combined information produced by the integration between remotely sensed information and *in-situ* data. The production of such a map should be very useful for the proper planning and management of the coastline in the selected area and should represent a new tool which the Ministry of the Environment can apply to the planning of other coastal areas. Another output expected from such a demonstration is the definition of a proper monitoring plan of the selected area which could combine satellite and *in-situ* measurements.

12. BIODIVERSITY AND ISRAEL'S SUSTAINABLE DEVELOPMENT POLICY

Basic to Israel's environmental management program is a policy founded upon cooperation and integration between environmental protection and economic development. Given the rapid rate of development, the focus of environmental policy has always been on preventive measures, largely through the incorporation of environmental considerations into major development projects. This policy was first formulated in the 1970s, when Israel's environmental administration was first created, but it has gathered momentum and force over the years.

However, while environmental management is well established in Israel, it has until recently been too often regarded as the domain of the environmental "lobby". Moreover, long-range planning documents have largely focused on physical land use policies with little attention to the integration of economic and regulatory instruments which are important elements in any sustainable development policy. The formulation and implementation of a sustainable development strategy in Israel will require the full participation of policy makers and stakeholders in all sectors.

12.1. Background

The process of formulating a sustainable development strategy for Israel was influenced by an amalgam of international, regional and national factors. Internationally, the shift toward sustainable development which has been gaining ground since the momentous 1992 Earth Summit has impacted Israel as well. Regionally, similar shifts in perception have taken place, including the Mediterranean Action Plan (MAP), which has formulated its own Agenda MED 21 and has integrated the goals of sustainable development in its Phase II. In Israel, several factors have combined to usher in a new era of sustainable development--growing environmental awareness, a committed environmental administration, and greater integration of environmental aspects in local, regional and national planning.

Moreover, several recent Israeli studies have set the scene for anticipating future developments, particularly the recently completed non-statutory masterplan for the 21st century--Israel 2020. The environmental team of Israel 2020 reviewed the environmental issues likely to influence long-term development policy and proposed a number of approaches for building a sustainable development strategy. These approaches have been compiled in a preliminary policy paper which has been widely disseminated by the Ministry of the Environment as a first step toward introducing the concept of sustainable development into government discussions. Israel will use this preliminary policy paper, along with similar studies, as stepping stones on the road toward formulating and implementing a sustainable development strategy and a sustainable biodiversity strategy for this country.

12.2. Toward Development of the Strategy

Today, as a direct result of the recently signed UNEP/MAP Coastal Areas Management Programme for Israel (CAMP), a new path is being forged. Although Israel's national strategy for sustainable development will use previous planning studies and discussions as its base documentation, experiences gained in other countries will play an essential role. Specifically, the European Union directive, "Towards Sustainability," and the experience of the Netherlands in formulating National Environmental Policy Plans, will provide important guidelines. Israel has found the Dutch approach, which is largely based on stakeholder participation, target setting, consensus building and public support, to be an excellent example of the practical application of sustainable development concepts. Indeed, the support, participation, and guidance of the Mediterranean Action Plan and of the Netherlands' Ministry of Environment, Housing and Spatial Planning have been crucial in the initiation of Israel's program for a national sustainable development strategy. Their continued encouragement and assistance will continue to be crucial elements in the future success of the program as well.

The program itself includes the following elements:

- Opening seminar on approaches to preparing a strategy for sustainable development in November 1996;
- Organization of seven target groups (industry, energy, transport, tourism, agriculture, urban sector, biodiversity) composed of a wide range of stakeholders including national government, local government, the private sector, academics and NGOs;
- Appointment of Israeli experts to act as facilitators for each of the target groups;
- Intermediate seminar to review progress in January 1998;
- Formulation of conclusions and recommendations for a national strategy for sustainable development in Israel.

12.3. Practical Steps Along the Way

Throughout 1997, several of the target groups have met in an effort to prepare a sustainable development strategy for each sector using the consensus building approach. Discussions are conducted within a round table framework with the participation of all stakeholders (i.e., 15-20 representatives of central and local government, NGOs, academics, and private enterprise in each target group). The discussions are administered by a facilitator--an Israeli expert assisted by experts invited through MAP who have experience in formulating strategies for sustainable development. The report of each group will then be distributed for wider public comment, and the policy document finalized by the facilitator. The draft strategy will be presented to the directors general of Israel's government ministries for adoption and referral to the government for approval.

A facilitator for the biodiversity target group has already been appointed and the group is preparing for its meetings. It is expected that the following issues will be initially raised:

- Maintenance and enhancement of biodiversity;
- Open space strategy in relation to open space functions;
- Development strategy in relation to open space sensitivity.

12.4. Basis for a National Biodiversity Strategy in Israel

Several of the components of Israel's national biodiversity strategy are already in place--legal framework, participation in international conventions and initiatives, surveys and research, and concrete programs for the conservation and sustainable use of ecosystems, species and genetic resources. The subject has been accorded greater priority in recent years with the growing awareness that land scarcity, coupled with unprecedented population and economic growth, threaten to deplete Israel's natural resources and open space landscapes. According to Israel 2020, the country's masterplan for the 21st century, the main challenge of coming years will be to preserve these scarce land resources especially in the area north of Beersheba, where some 92 percent of the population currently resides. Experts believe that the disappearance of large tracts of Israel's open spaces--and the biodiversity within them--may still be halted, but only if action is taken today to promote a policy of sustainable land development which integrates development needs with open space and biodiversity conservation. As it continues to plan and to act on behalf of the conservation and sustainable use of its biodiversity, Israel is now investing additional efforts in drafting and implementing an integrated and comprehensive biodiversity conservation strategy which will promote better coordination among all stakeholders.

According to Israeli law, the national biodiversity strategy can only receive binding legal status once it undergoes several steps: the plan must be brought before the government for approval, the government must issue a formal decision calling for the drafting of a National Masterplan for the Conservation and Sustainable Use of Biological Diversity or, as is more likely, for the integration of such a plan into a national plan for sustainable development. Following final government approval and official publication, the resultant national masterplan would be legally binding.

Once such a national masterplan becomes law, all future planning and development would be subject to its provisions. All statutory regional and local planning boards would be obligated to examine plans brought before them for approval in terms of their impact on the biological diversity of a given area. Approval would be contingent on compliance of the plan with the masterplan's provisions.

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