Forest Management Policy of Israel
Guidelines for Planning and Management

קרן קימת לישראל
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Guidelines for Planning and Management

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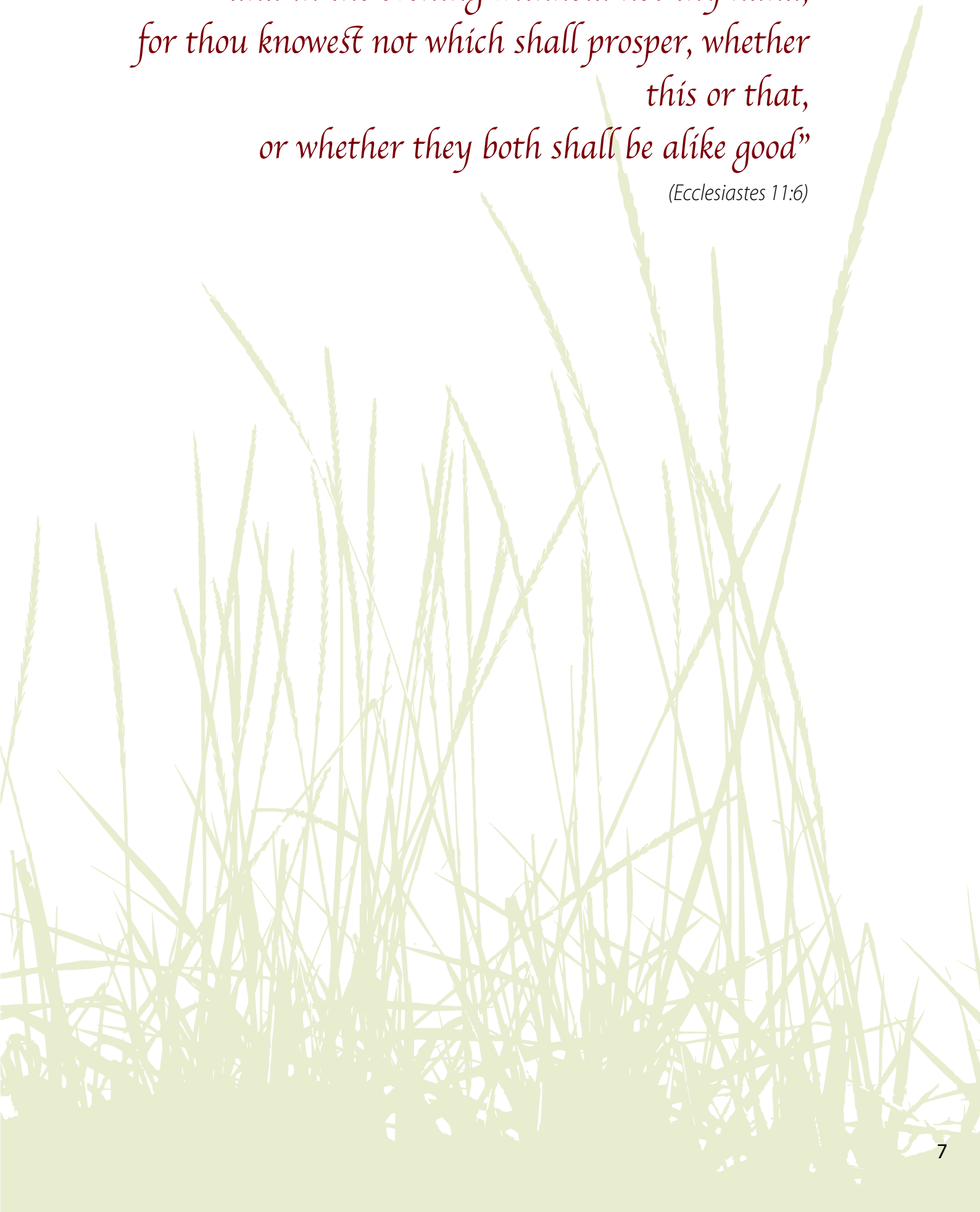
"In the morning sow thy seed,
and in the evening withhold not thy hand;
for thou knowest not which shall prosper, whether
this or that,
or whether they both shall be alike good"

(Ecclesiastes 11:6)



Preface by the Director of the KKL-JNF Forestry Division upon the publication of the English edition

It has been nearly a decade since "Forest Management Policy in Israel "was initially published, and now the time has arrived to publish an English edition. Today, in late 2023, we can look back with satisfaction and appreciate the fundamental role of this document. The policy was meticulously constructed, drawing upon the wealth of experience of KKL-JNF foresters, in collaboration with leading researchers in Israeli academia. It encapsulates a vast reservoir of practical knowledge that has been amassed throughout the maturation of Israeli forests, tracing the significant transformations from the inception of the forestry activities to the early years of the 21st century. Its composition was a time-intensive endeavor, akin to transcribing an oral tradition into written form. The process of weaving this extensive knowledge into a coherent and methodical document demanded profound, meticulous deliberation.

Indeed, the document before you carries tremendous significance for all of us. It is a comprehensive work, structured for readability. It begins by defining the essence of a forest and outlining the goals for forests in Israel. Subsequently, it lays the cornerstone for sustainable forest management, serving as the foundation for planning processes and forest management interfaces. It provides us with a holistic understanding of the forest, its functions, and the desired interfaces within it.

Notably, Forest Management Policy in Israel adopts a long-term perspective, with its primary innovation lying in the concept of goal-oriented forest management. This is manifested through the designation of forestry areas and a deliberate focus on achieving the desired vegetation types during the forestry planning process.

Furthermore, Forest Management Policy in Israel has served as the basis for crafting detailed policy documents across various critical management fields. In the past decade, significant strides have been made to adopt the language and principles of sustainable forestry, resulting in the creation of several vital documents, including:

- A model for developing long-term ecological forest master plans, with twenty plans formulated across the three forest regions in Israel.
- The management of protected species in the forests.
- policy and guidelines for the thinning of coniferous forests.

- development and implementation of a new methodology for forest surveys.
- Policy and guidelines for the establishment and renewal of forests.
- Policy and guidelines for treating unwanted plant species.
- Measures for wildfire prevention.
- forest management strategies to address the challenges posed by climate change.

In conclusion, Forest Management Policy in Israel is a dynamic document actively utilized by all foresters, being continually integrated into our practices and expanded to encompass additional topics.

I extend many thanks and appreciation to all the individuals who contributed to the translation, editing, proofreading, and design of this edition.

Gilad Ostrovsky

Chief Forester and Director of the Forestry Division

December 2023

SUMMARY

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In light of the directives contained within NOP 22 - National Forest Plan 22 for Forests and Afforestation – the KKL-JNF (Israel's forestry service) decided to write an updated policy document on forest management in Israel. This document was prepared with deep respect and appreciation for Israel's afforestation enterprise over the years – an enterprise marked by its pioneering spirit and achievements as well as its uniqueness; a program conceived under difficult conditions paralleling those that the emerging State of Israel faced since its inception. Israel's afforestation program has given the public a valuable asset. With this in mind, the new forest management policy (FMP) recognizes the need to implement changes in current approaches to and concepts of forest management and design according to the latest developments in forestry, ecological, social and economic sciences. This FMP provides a binding professional basis for managing Israel's forests in a goal-oriented, sustainable fashion. This document defines and outlines the forestry goals in Israel, the various forest types found here, and the planning and management principles to be employed in them.

Forestry goals

The primary goal of forestry in Israel is to provide a variety of ecosystem services to its citizens, recognizing that human existence and wellbeing depend on biological diversity and the services provided by ecological systems. Secondary goals contained within this statement are as follows:

1. Provision of recreational and outdoor activity services
2. Landscape design and diversification
3. Provision of supporting and regulatory services (i.e., carbon sequestration, primary productivity)
4. Supporting Israel's unique biological diversity
5. Provision of soil and water conservation services (preventing soil erosion, increasing water infiltration)
6. Provision of a variety of economic benefits to society (wood products, pasture, tourism)
7. Protection of open landscapes
8. Protection of Israel's native tree species and reintroduction of native trees to the landscape
9. Protection and restoration of natural heritage landscapes
10. Ecological restoration of damaged sites and ecosystems
11. Creation of buffer zones around communities to mitigate the effects of environmental hazards such as noise, air pollution, visual blemishes to the landscape, and to protect against wildfires
12. Strengthening the public's identification with the forest and nature, and educating for forest conservation

Principles of Forest Management in Israel

Forest planning, management and program implementation will be undertaken according to the following ten principles:

1. **Goal-oriented, Adaptive Management:** planning and execution of management operations according to a pre-determined set of management goals
2. **Multiple-use:** managing the forest to attain a diverse set of ecological, social and economic goals
3. **Habitat Suitability:** determining forest management goals, forest structure and species composition as a function of the specific habitat conditions and location within surrounding landscapes and ecosystems
4. **Natural Processes:** relying on local species and natural processes as much as possible
5. **Rational Intervention**: attaining management goals through the lowest possible level of intervention
6. **Vitality, Tolerance and Stability:** shaping and managing forests to become vital, healthy systems able to withstand stresses and unexpected hazards
7. **Diversity, Complexity and Patchiness:** preserving and encouraging a variety of landscape

types, habitats, vegetation types, species and genotypes

8. **Continuity:** managing the forest as an interconnected landscape element within its surroundings over time and maintaining continuous vegetative cover
9. **Protection and Stewardship of Natural Heritage Assets:** designating these forestlands for the preservation and enhancement of heritage and landscapes assets of high cultural value
10. **Environmental Protection:** minimizing the environmental impacts of forest establishment and management activities as much as possible

Forest Planning and Management

Long-term planning is an essential process for the attainment of forestry goals through sustainable forest management. This planning process is based on the division of forestlands into units according to their designated land use (land-use unit). In each unit the desired vegetation type is defined according to its land-use designation, existing vegetation type, projected vegetation dynamics and specific habitat and environmental conditions. Forest planning and management will be fully coordinated with approved statutory plans at the national level (especially NOP 22), regional level, local level (detailed forest plans) and any other relevant plans. The degree of detail in the forest land-use and management plan will be more comprehensive than that which exists in the statutory plans, this level being necessary for adequate management of the forests according to the limitations defined by the statutory plans.

Primary forest land-use designations

Multiple-use Forest: These forestlands are designated to preserve continuous open landscapes, express the landscape diversity of Israel, and provide a broad range of ecosystem services. The majority of Israel's forestlands will be thus characterized. Management of these lands will be of an extensive nature, based primarily on natural regeneration, succession, and adaptation. The multiple-use forests will be multi-aged, structurally complex and patchy, and will maintain a variety of vegetation types.

1. **Recreation:** These forestlands are designated for recreational activities and outdoor experiences.
2. **Heritage Assets and Unique Landscape formation:** These forestlands are designated for the preservation and enhancement of heritage and landscapes assets of high cultural value.

Mature stand of Aleppo pine in Balfour Forest near Migdal HaEmek.

3. **Fuelbreaks:** These forestlands are managed to prevent and/or curb the spread of forest fires across the landscape.
4. **Natural Assets and Unique Habitat Types:** These forestlands are designated for the preservation and enhancement of natural assets of high ecological importance such as unique or endangered habitats, communities or species.
5. **Community Forest:** These forestlands are located next to an existing community and primarily used by its local populace.
6. **Research:** These forestlands are designated for research purposes to advance forest management techniques.

Four types of forest management plans have been designated to optimize the management process. Each type varies according to its resolution and time scale:

1. **Forest Plan:** deals with an individual forest or group of adjacent forests, according to NOP 22 guidelines. The forest plan defines the chief management goals of the general forestland. The plan subdivides the landscape unit into smaller parcels; each one is further classified for its designated land use and desired vegetation type. This plan is valid for 25 years.
2. **Multi-year Work Plan:** presents a long-term work program to attain the goals contained within the forest plan. This plan is valid for 10 years.
3. **Annual Work Plan:** presents comprehensive working plans based on those detailed in the multi-year work plan. The plan pertains only to those areas assigned for treatment in the designated year.
4. **Detailed Operational Plan:** describes the operation of management tools in each specific area designated for treatment in the annual work plan.

5.

Implementation of Management Tools

Numerous management tools are available for attaining the desired objectives and goals of a forest, as outlined in the forest planning process. The main goal of forest management operations is to direct natural processes occurring within the forest ecosystem towards the realization of planning objectives. In general, the majority of the management activities will be applied to planted forests requiring intervention in order to achieve the desired goals and vegetation structure. Other vegetation types within the forestlands which are not planted (woodland, shrubland, dwarf shrubland, etc.) will be managed at a lower level of intervention, with the main goals of protecting them and directing their utilization so as not to degrade their integrity. Similarly, the management of planted forests strives to create a sustainable forest ecosystem that will require less intensive, more self-sustaining forms of management over time.

This section presents the principal set of tools available to the forester, including planting, thinning and pruning, agro-technical techniques including mowing, plowing and weed control, and other management techniques such as grazing and prescribed burning. Each tool is described in detail its own subsection as follows:

1. **Objectives:** a list of objectives that can be achieved by implementing the specific tool
2. **Considerations:** a list of conditions and limitations to take into account before implementing the specific tool
3. **Principles:** a list of guiding principles to use when implementing the specific tool
4. **Planning:** a list of topics to take into account when preparing a work plan

The Implementation Process

Implementing the FMP is a complex venture requiring a long-term commitment of effort and resources. The process will proceed by stages and will include training sessions for those directly involved in its implementation, alongside the development and assimilation of essential tools, such as the use of templates for the design of planning and monitoring activities, as well as assigning detailed management instructions for specific goals. The FMP will be periodically updated according to advances in knowledge and data generated by monitoring and research programs. The implementation process is vital for providing professional and integrated support to management personnel.

INTRODUCTION

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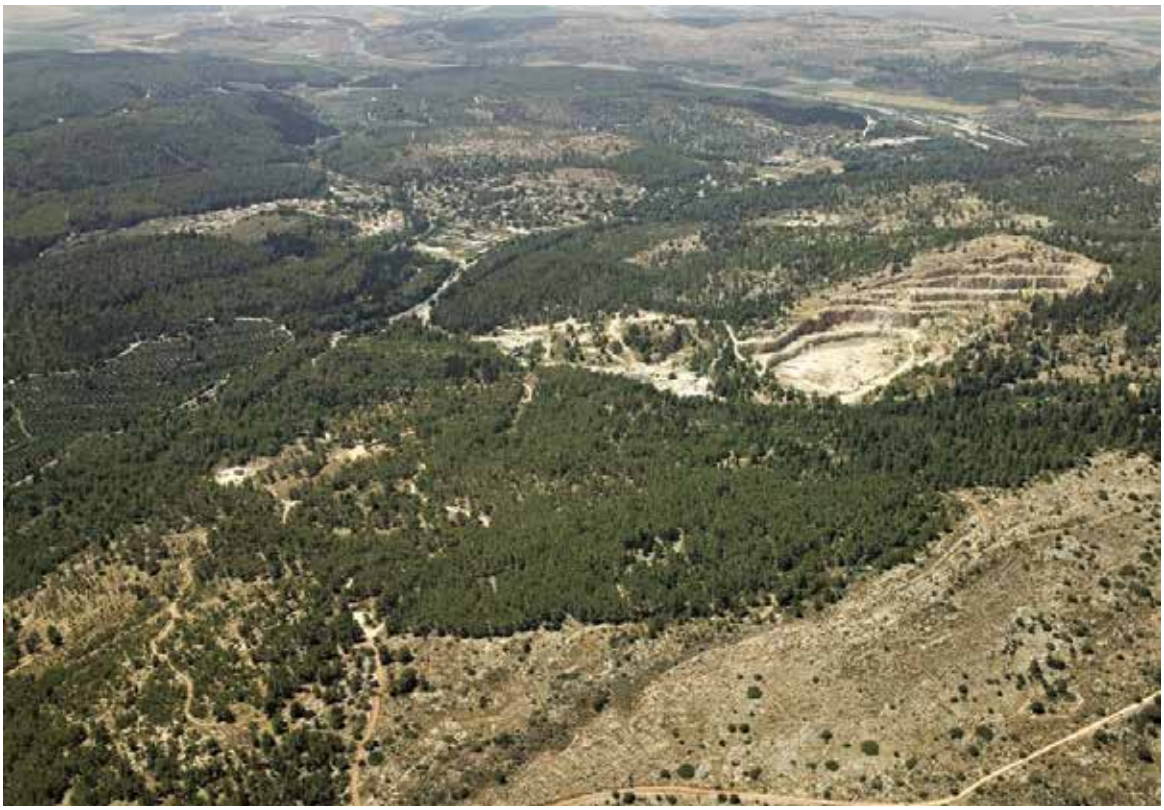
In light of the guidelines established in the National Forest Plan for Forests and Afforestation in Israel (NOP 22), Israel's national forestry service (KKL-JNF) has decided to formulate an updated policy for forestry management in Israel.

The Forestry Management Policy of Israel (FMP) paper is intended to set a professional benchmark for goal-oriented, sustainable management of Israel's forests. It defines the objectives of afforestation in Israel, the types of forests, and the principles for planning and managing them.

The policy paper also specifies the management tools available to forest managers and outlines their operating principles. At a later stage, detailed documents specifying operational guidelines for the various fields of forestry will be prepared.

This FMP paper is presented to the public as part of the KKL-JNF policy of transparency and open public discourse.



Forested landscape in the Judean Mountains. Martyrs Forest near Mesilat Tsiyon.

Preface

Since its establishment, KKL-JNF has been involved in rehabilitating Israel's landscapes and restoring its forests, after thousands of years of over-exploitation and degradation of the land's valuable natural resources. Afforestation activity, conducted under difficult conditions, restored the tree cover to previously eroded rocky hills in Israel's Mediterranean regions. Pioneer forest planting contributed to soil stabilization and enrichment and encouraged regeneration of natural vegetation. The afforestation enterprise also expanded the vegetation cover to desert transition zones in southern Israel by means of soil and water conservation methods, thus contributing to the promotion of human settlement, the creation of recreational opportunities, and the rehabilitation of degraded habitats. Afforestation has played a major role in preserving open landscapes throughout the country.

The approval of the NOP 22 in 1995 extended the authority of KKL-JNF to a wider range of landscapes, beyond planted forests, such that KKL-JNF now manages some 160,000 hectares (further on in the document we use the local area unit "dunam", one dunam is equal to 0.1 hectar) of land At the same time, during the first decade of the 21st century, extensive modifications were made to the KKL-JNF afforestation policy. In 2006, the KKL-JNF board of directors approved policy papers on sustainable development. These documents define the principles of sustainable forest management: conserving and supporting ecosystem services provided by forests, involving local communities and the public to make forests fully accessible, providing social services, promoting economic forest yields (e.g., tourism and livestock grazing), and preserving the size and quality of forests for future generations. These policy papers are the starting point for formulating Forest Management Policy of Israel (FMP) to provide specific, pertinent responses for managing sustainable forests to achieve the goals of afforestation.

The FMP was written with deep respect and admiration for the unique pioneering afforestation enterprise in Israel, conducted under difficult conditions while the young State of Israel was emerging and developing. The afforestation enterprise provided the public in Israel with a great, valuable resource. Nevertheless, the new policy recognizes the need for modifications in the manner of forest management and design, to bring it in line with the latest developments in

Judean Mountains landscape before afforestation. British aerial photograph from the Nahal Refa'im area in 1945. Most of the area is lacking woody vegetation.

Judean Mountains landscape today. Aerial photograph from 2012. Planted coniferous forests and native woodland cover most of the area.

the fields of forestry, ecology, social sciences, and economics. These changes are expressed in the establishment of forestry and management goals and in the planning and management principles of forests based on these goals. During the first decade of the 21st century we witnessed phenomena that brought the task of forest management to unprecedented levels of complexity. Development pressure and human activity in open landscapes in general, and in forests in particular, are constantly intensifying. KKL-JNF is fighting an ongoing battle to respond to the growing use of forestland, a major resource for leisure and recreation that is open to all elements of Israeli society. Moreover, we are aware of global climate change processes

associated with unique phenomena, such as consecutive drought years and extreme weather conditions. Accompanying these phenomena are dangers such as large-scale wildfires, floods, ecosystem degradation, tree mortality due to drought, and outbreaks of pests and diseases. These threats, together with international environmental commitments, call for suitable preparation and adaptation of forest management to the ecological, social, and economic challenges facing us as emissaries of the State of Israel and the public.

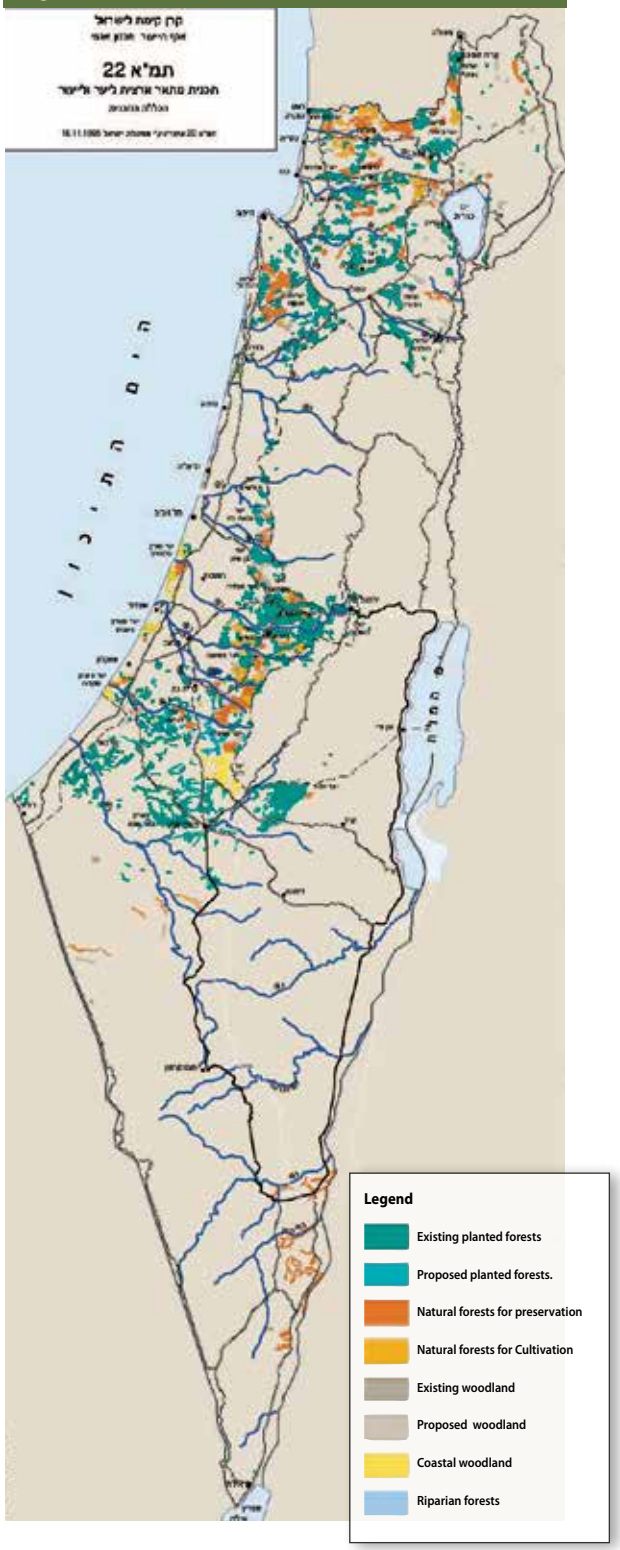
This policy paper – Forest Management Policy in Israel – is the first step in the process. It formulates policy and specifies the management principles for the core activity of forest management. In the future, we will publish chapters with detailed guidelines in various fields of forest management: fire prevention, grazing, forest health, management of non-forest habitats, soil conservation, protection of natural assets, public activity in forests, and more. Adopting the FMP will go hand-in-hand with interpretation, assimilation, monitoring, and follow-up, all of which will work to ensure its implementation, reach proper conclusions, and facilitate future updates. The FMP is intended to be updated from time to time according to newly acquired knowledge and the results of monitoring and research in the forest.

Those who came before us have left us a valuable natural resource for the environment and society in Israel. It is our responsibility to preserve it, care for it, and pass it on to future generations.

Figure 1:

Map of NOP 22, the National Outline Plan for Forests and Afforestation

Forestlands in Israel and their designations according to the NOP



Defining the Term 'Forest'

Forests are complex ecosystems comprising diverse biotic and abiotic components. Trees are a major component in forests, along with a variety of

Multiple-use forestland management. Provision of recreation services together with support for Israel's unique biodiversity.
A cluster of flowering anemones at Adulam Park in the Judean Lowlands.

plants and other organisms. Forests are a renewable natural resource that provides diverse benefits and services to human beings and to the environment.

In terms of forest management, 'forests' can be viewed in two ways: as areas to be managed and as vegetation formations.

Forests as managed areas: forests as management units are defined in the forest plans (NOP 22 and others) or are areas that were transferred to KKL-JNF management for afforestation and/or for preserving nature and landscapes. These areas will be termed "forestlands" in the FMP. Forestlands are areas that include diverse vegetation formations, but whose main components are conifer forests and native woodlands.

Forests as vegetation formations: we have adopted the definition used by the United Nations Food and Agriculture Organization for forests – an area of at least 0.5 hectares, with trees higher than 5 meters and a canopy cover of at least 10%, or trees capable of reaching these dimensions in the future, by new plantings or natural regeneration.

Objectives of Afforestation and Forest Management in Israel

We understand a forest to act as a unique ecosystem and a natural resource. It should therefore be managed as a complete ecological system, with attention paid to its various biotic and abiotic components.

The goals of afforestation and forest management are a result of weighting various factors, e.g., the geographic area covered by the forest, the land-use designations in the surrounding areas, the historical and current site conditions, and the nature of the local population and its perspective of the forest as an ecosystem and resource. Due to the dynamic nature of these factors the goals and objectives of forest management in Israel have changed over the years. After many years in which afforestation activity focused on developing and establishing forests in different regions of the country, KKL-JNF now considers managing existing forest resources to be a major national challenge that requires a focus on ecological and social objectives according to the principles of sustainable development.

The greater goal of afforestation in Israel is to supply diverse ecosystem services to the inhabitants of the country, acknowledging that the existence and

welfare of humans depends on biodiversity and the services ecosystems provide.

In the context of this greater goal, the following specific objectives have been defined:

1. Provision of services related to outdoor activities and recreation in nature
2. Landscape design and diversification
3. Provision of diverse supporting and regulating services (carbon sequestration, primary productivity)
4. Supporting Israel's unique biodiversity
5. Soil and water conservation (preventing soil erosion, improving water infiltration)
6. Provision of various economic benefits to the community (pasture, wood products, tourism)
7. Protecting open landscapes
8. Protecting native tree species and reintroducing tree species to nature
9. Conservation and restoration of natural heritage landscapes
10. Ecological rehabilitation of degraded habitats
11. Creating buffer zones to prevent noise and air pollution, conceal scenic degradation, and prevent wildfire spread
12. Strengthening the connection between people, nature, and forests and educating for forest conservation

This list of goals is based on the National Forest Plan for Forests and Afforestation in Israel (NOP 22) approved by the Israeli government in 1995, and on the policy paper formulated within its framework, as well as the KKL-JNF policy paper on sustainable development and management that was approved by the KKL-JNF board of directors in 2006.

The process of planning and managing forests is based on the goals of afforestation and forest management. We realize that it is not feasible to achieve the entire list of goals in every area, and that different landscape units are to be managed according to different priorities as specified below, while striving to obtain optimal implementation of these goals throughout the managed forestlands.

Sustainable Forest Management

Sustainable Development

Sustainable development is development that meets the needs of the present without preventing future generations from meeting their needs. In this spirit, KKL-JNF has decided to implement the following four principles:

1. **The Ecological Principle** – KKL-JNF works to preserve and improve the capacity of natural systems to provide ecosystem services; KKL-JNF will prevent their destructive exploitation and work to rehabilitate degraded ecosystems.
2. **The Socio-cultural Principle** – KKL-JNF views natural systems as a public socio-cultural resource and will work to conserve, restore, and nurture them for the public benefit.
3. **The Economic Principle** – KKL-JNF strives to foster economic opportunities for the benefit of the public and local communities through a deliberate strategy of using the 'interest' and not the 'capital' of natural systems.
4. **The Inter-generational Principle** – KKL-JNF works to conserve Israel's soil and natural resources for this generation and for future generations.

Sustainable Forest Management

Sustainable forest management refers to forest management and use of forest resources in a manner that conserves and nurtures biodiversity, productivity, the potential for natural regeneration and the vitality of the forest, as well as the potential of the forest to fulfill diverse ecological, economic, and social functions without harming other ecosystems.

Forestry, environmental, and social organizations throughout the world have developed criteria for sustainable forest management that consistently stress the following seven topics:

1. Forest health and vitality
2. Biological diversity
3. Social and economic benefits
4. Carbon sequestration and climate regulation
5. Forest productivity
6. Soil and water resources
7. Legal, institutional, and economic frameworks for managing and protecting forests

Sustainable forest management operates according to these criteria and strives to implement them in the best possible manner.

SustainableSustainable Forest Management in Israel

Ten management principles for sustainable forest management in Israel were formulated based on the criteria for sustainable forest management listed above. The support systems required for their success as well as the emphases for their implementation in forestry work are also noted. The term 'forest' in this section is used in the context of all forestlands.

These are the ten guidelines for sustainable forest management in Israel:

1. **Goal-oriented adaptive management**: planning and implementing forest management according to a pre-determined goal or set of goals; complementing management activity with monitoring that evaluates its long-term success and adapts future plans and management strategies accordingly.
2. **Multiple-use:** managing forests to achieve diverse ecological, social, and economic goals.
3. **Habitat suitability:** determining the objectives of the forest and adapting its structure, species composition, and management strategy according to the conditions of the specific habitat and its surrounding ecosystems.
4. **Natural processes:** maximizing the emphasis on native species and natural processes of regeneration, succession, and adaptation; focusing on forest management guided by these natural processes according to pre-determined goals.
5. **Rational intervention:** striving to achieve the defined forest goals through the lowest

Preserving heritage assets. Ancient agriculture – a shomera (a traditional agricultural watchtower) in a coniferous forest in the Judean Mountains.

Spatial continuity of open spaces. A combination of planted forest areas, native woodland and agriculture in Adulam Park.

Diversity and complexity. Diverse vegetation that develops in a mature pine forest.

Patchiness. Landscape with different vegetation formations. Nahal HaShofet in Ramat Menashe.

possible level of intervention in the field and bearing in mind the limitations of implementation.

6. **Vitality, resilience, and stability**: designing the forest and its management strategy while striving to create a vital healthy system, resilient to damage and stress, that can recuperate and return to full function after any type of disturbance (e.g., drought, fire).
7. **Diversity, complexity, and patchiness**: preserving and maintaining diverse landscapes, habitats, vegetation formations, species, and genotypes in the forest. In areas with existing forest formations, striving to attain tree species diversity (multiple-species forest) with a broad age spectrum (multi-age) and a complex vegetation structure (multi-layered).
8. **Continuity**: managing the forest as a continuous system in time and space that sustains continuous vegetation cover; gradual generational replacement in the forest that is based as much as possible on natural processes with the goal of avoiding 'end of rotation' situations (as defined by classical forestry).
9. **Conservation and stewardship of natural and heritage assets**: planning and managing forests focusing specifically on conservation of biological (major species and habitats), landscape (specific landscape formations), and cultural (historical and heritage areas) assets in the field.
10. **Environmental protection**: minimizing environmental impacts of forest establishment and management.

Associated Systems that Support Sustainable Forest Management

Sustainable forest management also requires the development of support systems to create a social, economic, and professional envelope for forest management:

1. **Legal system:** laws and regulations that define forests and the authority to manage and protect them.
2. **Education:** educational programs to strengthen the affinity of the public to the forests and improve their understanding of forests and recognition of their importance.

Landscape mosaic. Coniferous forest and an adjacent shrubland and herbaceous area. Shahariya Forest near Kiryat Gat.

Natural regeneration. Natural regeneration of brutia pine on Mt. Horshan.

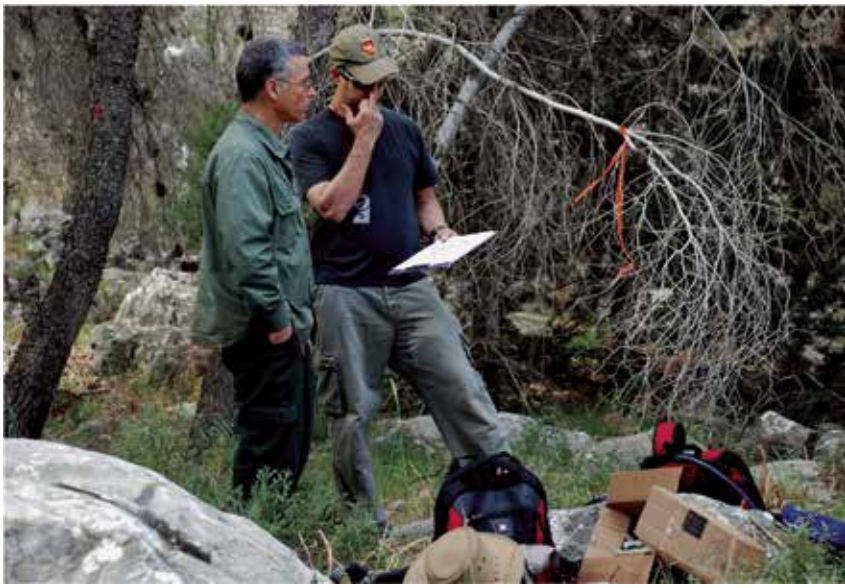
Native species. Open woodland of Tabor oak and Atlantic pistacia in the Alonim Junction area, Lower Galilee.

3. **Research and monitoring:** research and monitoring programs to study forests and encourage forest management.

Implementing Forest Management

The implementation of sustainable forest management is still in its early stages throughout the world and in Israel in particular. In addition to the list of criteria and principles of sustainable forest management specified above, the following steps could help promote forest sustainability:

1. **Creating a diverse landscape mosaic**: nurturing diverse vegetation formations in the forest while using tools such as thinning and grazing to convert forests characterized by uniform conifer coverage over large areas to forests with a patchy landscape that includes areas with variable tree density. These would include areas with no conifers or no trees at all, in which vegetation formations such as native woodland, shrubland and dwarf-shrubland are free to develop.
2. **Opening up the forest**: opening up forests by thinning trees – particularly coniferous forests – provides suitable growing space for forest trees and allows the understories to manifest themselves, promoting the growth of diverse plant species of broadleaf trees, shrubs, and herbaceous vegetation. This prevents the formation of overly dense conifer stands, whether due to planting or natural regeneration, which are characterized by low diversity, sensitivity to drought and disease, and susceptibility to wildfires.
3. **Natural regeneration**: regeneration of forest plots based on natural processes as much as possible; implementation of management strategies tailored to encourage natural regeneration, its protection, and its regulation.
4. **Native species:** optimal use of native species and ecotypes characteristic of the specific habitat, by first and foremost nurturing existing local populations, and by using native species and seed sources from adjacent areas with similar environmental conditions, particularly for the establishment of new forests.
5. **Natural assets with conservation value:** taking steps to locate and map important natural assets, such as rare species and habitats in the forest and its surroundings, while routinely considering the consequences of forest management on these values and taking active steps to nurture and conserve them, such as protecting sensitive habitats as well as passage routes, shelters, and food sources for animals. All this should be done while striving to learn the biology of the species inhabiting the forest and supported by it, such as birds nesting in the forest and mammals finding shelter in it, as well as other groups of species and their behaviors, and developing forest management strategies tailored to them.
6. **Forests as ecosystems**: managing the forest as an inclusive ecosystem with all its com-



Uncertainty. A scientist and forester discuss anticipated trends in forest development and their management significance. LTER (Long-Term Environmental Research station in Martyrs Forest near Mesilat Tsiyon.

Interface of different vegetation types and land designations. The effect of a planted forest on the adjacent shrubland used for grazing. Shahariya Forest near Kiryat Gat.

ponents, including ongoing monitoring of a range of indicators to improve our understanding of the forest ecosystem as a whole. These indicators include habitat characteristics in different areas (e.g., soil properties) and ecosystem functioning at various spatial scales (e.g., primary productivity, species diversity, landscape diversity).

7. **Interface**: being aware of neighboring areas that are affected by the forest when determining its structure, composition, and management strategy. This includes emphasizing areas in which important natural assets may be affected by forest management.
8. **Uncertainty**: accepting uncertainty as an integral element in forest management, while guiding management and determining the desired situation at a reasonable scale – rather than aspiring for total control and an exact definition of the desired condition which could lead to unnecessary intervention.
9. **Controlling human activity in the forest:** concentrating intensive human activity in forests, e.g., picnics, camping, and motorized recreation, in designated areas with appropriate, well-developed infrastructure (forest structure, roads, installations, signage, etc.) and allocating the remaining forest areas for nurturing nature and non-intensive human activity such as walking, hiking and more.
10. **Involving various stakeholders**: involving stakeholders from various fields in the forest planning and management process, with a transparent and open approach to public discourse.

FOREST PLANNING AND DESIGN

Forest Planning and Design

Sustainable forest management and attainment of afforestation goals requires a long-term structured process. In this chapter we will present the planning process for forestlands and the components of their management program. The planning process is based on classifying forestlands by their uses ('land-use units'). The desired vegetation formation is then defined for each unit ('target forest') according to its land-use designation, the existing vegetation formation, and the characteristics of the habitat and its surroundings. To competently address the uncertainty factor and prevent unnecessary intervention, a range of vegetation formations suited to the desired use should be defined when determining the desired vegetation formation. To attain the land-use designation and the target forest, management programs are formulated for different periods of time and at different levels of detail.

Forestland planning and management is answerable to legal statutory plans, including NOP 22, district plans, detailed forest plans, and more. Defining land use and the target forest in the planning process provides greater detail than is found in forest plans or detailed plans. This allows appropriate management of the land while ensuring adherence to existing definitions in statutory plans. For example, areas defined as "natural forest for conservation" in forest plans may include diverse vegetation formations such as woodland, conifer forests, or batha (shrubland). The area managers must determine the desired vegetation formations by considering the site conditions and existing vegetation formations, and then work to foster and preserve them according to the statutory definitions. In areas designated "natural forest for preservation" diverse management tools may be applied, e.g., grazing to preserve diverse, open vegetation formations, or thinning dense pine stands and so on.

Different Vegetation formations and land designations in forestlands. Adulam Park in the Judean Lowlands.

Forest Land-use Designations

As a rule, all forest areas will be managed according to the afforestation and forest management goals and the principles of sustainable forest management specified in the previous chapters. Nevertheless, the desire to respond to development needs and the increased use of open landscapes, together with the obligation to protect and maintain natural resources, demands a combined management strategy that allocates different land units to different purposes.

Forests will be divided into land units, each of which will have a principal designation (land-use units). Below is the list of principal forest land-use designations in Israel:

1. **Multiple-use forest**: the multiple-use forest is intended to express the landscape diversity of Israel as shaped by environmental conditions and anthropogenic effects. These areas comprise most of the forestlands in Israel. Multiple-use forests are intended to preserve the continuity of open landscapes and to provide a variety of ecosystem services. They are managed non-intensively, relying primarily on natural processes of regeneration, succession, and adaptation, and are characterized by a patchy, multi-age, multi-layer structure with diverse vegetation formations.
2. **Recreation and tourism**: areas designated for recreational and leisure activities in nature such as picnic areas, hiking trails, areas of interest, and information centers. These areas will be defined spatially as point, polygonal, or linear features on the map.
3. **Heritage and unique landscape formations**: areas intended for preserving and maintaining significant heritage and landscape assets. These may include structures, sites, or scenic formations that represent a specific period or culture. The forest structure and management will be adapted accordingly in such areas.
4. **Firebreaks**: areas intended to prevent the spread of wildfires. These mostly longitudinal polygons can potentially cross a variety of forest formations. Occasionally this land-use designation may overlap with other designations in the same landscape unit.

Land designated for tourism and recreation. Recreation area in the Swiss Forest Scenic Lookout in the Tiberias area.

Land designated for Heritage assets and unique landscape formations. Ancient collection pool for spring water. Martyrs Forest in the Judean Mountains.

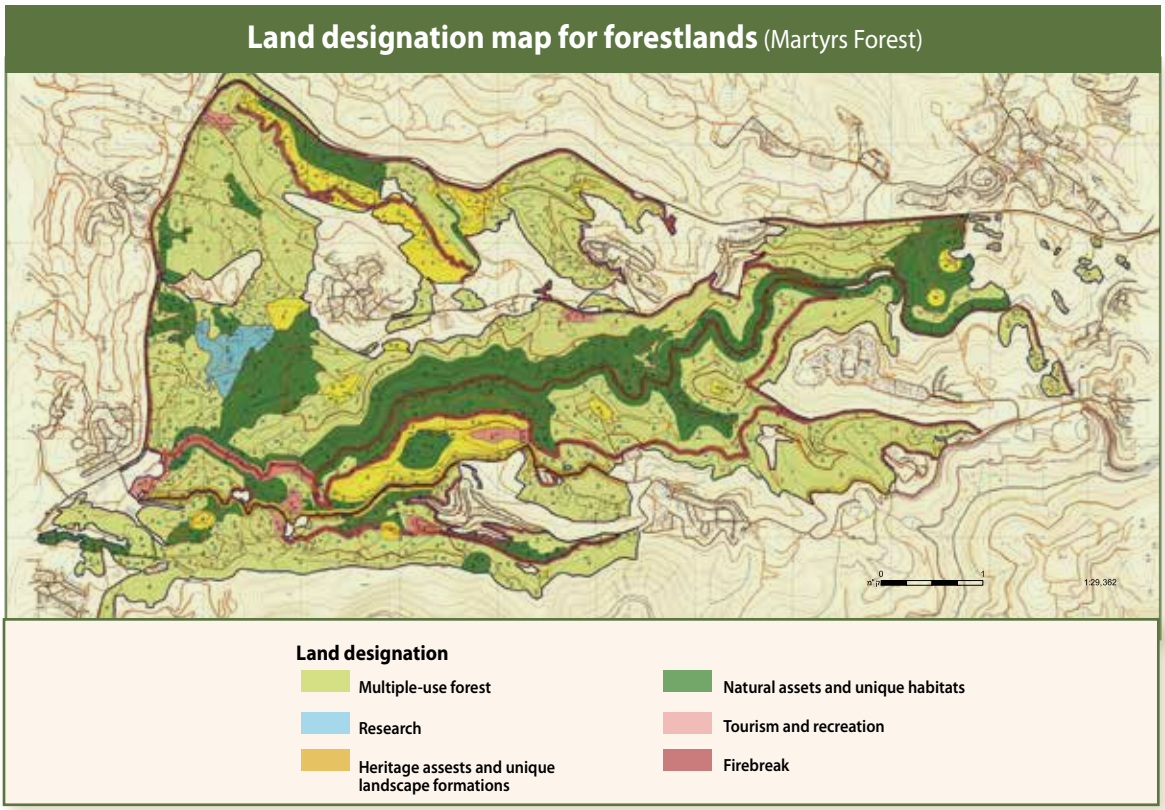
Land designated for research. Grazing effects on forest vegetation. Brutia pine on Mt. Horshan.

5. **Natural assets and unique habitats**: areas intended for protection and/or maintenance of a specific natural asset of special importance, such as a specific habitat, community, or species. Management of such areas will be determined specifically according to the natural asset intended for protection and maintenance.
6. **Community forests**: areas adjacent to residential areas that are used mainly by the local community for recreation, health, and nurturing their connection to the outdoors. These areas should be especially accessible to built-up areas and their management should be suited to activities involving the public – a range of facilities and advanced fire prevention methods.
7. **Research**: areas designated for research to advance and improve forest management.

Land designated for a community forest. Terrace restoration in an orchard by the Mevaseret Tsiyon community.

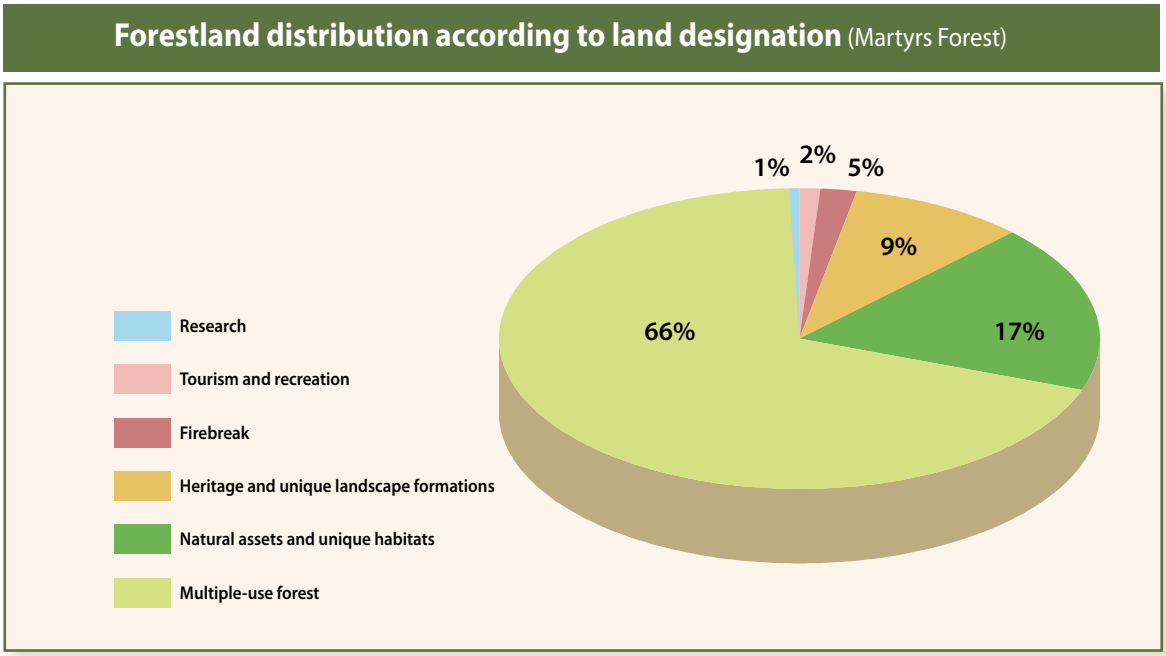
Land designated for natural assets and unique habitats. Sun's-eye tulip in a rocky Mediterranean habitat. Martyrs Forest in the Judean Mountains.

Figure 2:



Example of a land designation map from the Martyrs Forest master plan in the Judean Mountains. Land designations are determined according to various planning considerations and form the basis for the management plan.

Figure 3:



Example from the Martyrs Forest master plan.

Principal Vegetation Formations in Israel's Forestlands

A number of vegetation formations have been defined to create a common language for planning and managing open landscapes, including forestlands. The classification of 'forestland vegetation formations' is subject to the 'national vegetation mapping standard' and adapted to the needs of area management. The vegetation formations in forestlands are described in Table 1. The classification of vegetation formations is based on the percentage cover of the different vegetation components (as specified in Table 1).

Table 1: Existing vegetation formations in Israel's forestlands

	Vegetation formation in forestlands	General vegetation formation according to the national vegetation mapping standard	Definition
1.	Coniferous forest	Tall forest, trees higher than 6 m	At least 10% tree canopy cover. At least 70% of the canopy cover comprises conifers (mainly pine and cypress trees)
2.	Mixed forest		Combination of conifers and native woodland with at least 10% tree canopy cover. The canopy cover ratio between the conifer and broadleaf components differs from the definition of coniferous or native woodland forest, i.e., the relative cover of each component is below 70%.
3.	Native woodland	Woodland, the tree cover comprises trees of 2–6 m in height)	At least 10% canopy. At least 70% of the canopy cover is native woodland tree species (e.g., broadleaved species: *Quercus calliprinos, Pistacia palaestina, Laurus nobilis and Arbutus andrachne*).
4.	Shrubland	Shrubland	Less than 10% tree canopy cover and more than 10% cover of shrubs 1–2 m hight.
5.	Dwarf-shrubland (batha)	Dwarf-shrubland (batha)	Less than 10% tree or shrub cover and more than 10% cover of dwarf shrubs up to 1 m high.
6.	herbaceous	herbaceous	Less than 10% woody cover and more than 10% perennial and annual herbaceous cover.
7.	Open woodland	Shrubland, Dwarf-shrubland or herbaceous with trees; canopy cover does not exceed 10% (open forest)	Tree canopy cover of 2–10%. Characterized by well-developed trees (up to 5 trees per dunam (0.1 hectare) spaced far apart. Between the trees are herbaceous vegetation and shrubs. Typical tree species: *Quercus ithaburensis, Pistacia atlantica, Ceratonia siliqua, Acacia sp. in Negev wadis and so on*.
8.	Runoff harvest forest	Tall forest or forest/ woodland (depending on tree height)	Forests growing in arid areas whose composition and structure are based on runoff water harvest – *shikhim* (contour bench terrace systems), terraces and microcatchments. Common trees: *Acacia*, *Tamarix*, *Ceratonia siliqua*, *Acacia sp* and more.
9.	Eucalyptus forest	Tall forest	At least 10% tree canopy cover comprising a minimum of 50% *Eucalyptus* species.
10.	Orchards and groves	Forest/woodland	Areas planted with various fruit trees, with more than 10% tree canopy cover. Common trees: *Olea europaea*, *Amygdalus communis, Ficus carica and Ceratonia siliqu*a.
11.	Riparian zone forest	Tall forest or forest/ woodland	Areas along streams and dry streambeds.

Coniferous forest comprising Aleppo pine and cypress. Ramat Menashe.

Mixed forest coniferous and oak. Bar'am Forest.

Native woodland dominated by Palestine oak in Adulam Park.

Shrubland alongside herbaceous vegetation in Adulam Park.

Shrubland dominated by prickly burnet in the Shahariya Forest.

Stream banks. Streambed stabilization in the Western Negev.

Open woodland of Quercus ithaburensis near Kibbutz Regavim.

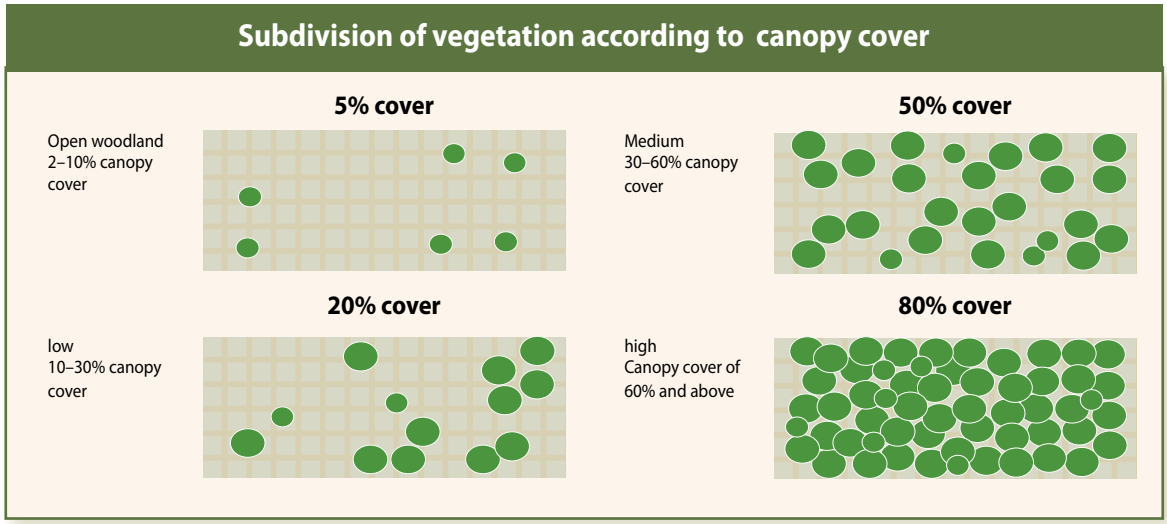
Runoff harvesting by damming streambeds.

Eucalyptus forest in Wadi Ara.

Fig orchard at the Sataf site.

Each of the vegetation formations is subdivided according to the percentage of canopy cover (See Figure 4, Table 2).

Figure 4



The figure illustrates different degrees of vertically projected canopy covers – the basis for subdivision of vegetation formations. This division follows the national mapping standard.

Table 2: The relationship between canopy cover percentage and tree density

Canopy cover (%)			Distance between canopies (m)			Distance between trunks (m)	No. of trees per dunam
Large tree Canopy diameter 9 m	Medium tree Canopy diameter 6 m	Small tree Canopy diameter 3 m	Large tree Canopy diameter 9 m	Medium tree Canopy diameter 6 m	Small tree Canopy diameter 3 m		
32%	14%	4%	5	8	11	14	5
64%	28%	7%	1	4	7	10	10
>85%	57%	14%	0	1	4	7	20
>85%	85%	21%	0	0	3	6	30
>85%	>85%	28%	0	0	2	5	40
>85%	>85%	35%	0	0	1.5	4.5	50
>85%	>85%	42%	0	0	1	4	60
>85%	>85%	57%	0	0	0.5	3.5	80

Table 2 describes the relationship between tree density and canopy cover percentage and other forest structure indicators. The table enables calculation of mean distance between trunks, mean distance between canopies, and canopy cover percentage according to the number of trees per dunam and canopy size. Note: the calculations assume a circular canopy projection and uniform tree distribution. A mean distance of 0 meters between canopies signifies canopy overlap. In this situation, canopy cover is at least 85% and there is no direct relationship between the number of trees per dunam and the canopy cover percentage.

Forestland Planning Process

Planning Components

Optimal management of forestlands requires preparation of four plans that differ in spatial scale and refer to different periods of time. Below is a list of the types of plans, ranked in order from the broadest, most general spatial and temporal scale to the narrowest, most detailed one. The major features of each type of plan area summarized in Table 3.

1. A **forest plan** focuses on an area of a single forest or several forests, as defined by NOP 22. The forest plan defines the major goals of the entire area from the list of goals of forest management in Israel. The plan divides the area into subunits, each of which is assigned a desired use and a desired vegetation formation ('target forest'). The plan is valid for 25 years.
2. A **long-term management plan** is based on the forest plan and focuses on the region covered by it. It defines the management procedures – their scope and implementation priorities – to be undertaken for proper execution of the forest plan. The plan is valid for 10 years.
3. An **annual work plan** is based on the long-term plan and focuses solely on the areas proposed for treatment in the designated work year. It is more detailed than the long-term plan.
4. A **detailed operational plan** is based on the annual work plan and specifies how management methods are implemented in each area proposed for treatment.

Table 3: types of plans used for forest management

Type of plan	Planning range (years)	Administrative unit	Plan products	Responsibility	Control and evaluation
Forest master plan	25	A single forest or a number of forests	Defining the major goals for the entire area and dividing it into units, according to its land-use designation and the target forest	District	KKL-JNF Land Development Authority / Directorate, Forestry Division, external stakeholders
Long-term	10	All the forest areas included in the Forest plan	Required actions, volume of work, timetables, priorities, and budget	Region	District, Forestry Division, external stakeholders
Annual work plan	1	Plot / stand	Planned actions, work scope, quantities, and budget	Region	District, Forestry Division, Forest Commissioner, external stakeholders
Detailed operational plan	months	Stand	Defining management methods and their implementation, the scope of implementation, limitations	Forester	Region, external stakeholders

Forest Plan

Forestlands in Israel will be divided into land units that include a single forest or a number of adjacent forests (as defined in NOP 22). A Forest plan will be prepared for each of these units.

The Area of the Forest Plan

The Forest plan area is a continuous, relatively large area that includes a single forest or several forests and comprises a unit with a distinct identity and characteristics. The Forest plan will apply to the area managed by KKL-JNF (the 'planning area') and relate to external areas that affect it (the 'reference area': settlements, nature reserves, national parks, infrastructure, etc.)

The Goal of the Forest Plan

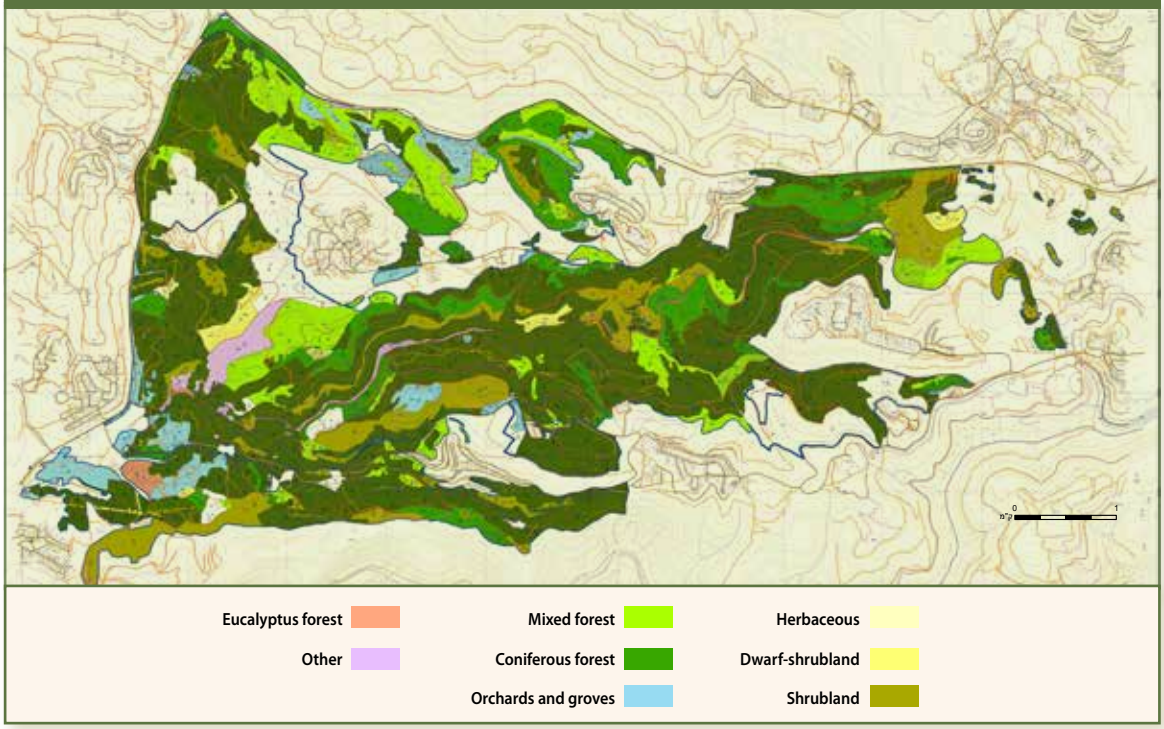
The goal of the Forest plan is to define the main objectives for the entire area, according to the goals of forestry in Israel, and to divide the area into land-use units and desired vegetation and scenic formations (target forests) while taking into consideration existing planning components in the area (settlements, infrastructure, nature reserves and national parks, agriculture, etc.).

The Process of Preparing the Forest Plan

1. The boundaries of the plan: defining the boundaries of the plan and the principal objectives of the entire area (from the list of forest management goals).
2. Existing state: defining the existing state of the various land units, including location, statutory state, physical features, fauna and flora data, habitats, unique natural assets, landscape assets and archaeology, uses and demands, threats to the area, the ability to develop and maintain, etc. The definition of the existing state will be determined by general forest surveys, more detailed individual surveys, and other existing data.
3. Land use: dividing the area into subunits according to their uses from the list of land uses for forestlands; designated units can be in the form of a point (specific site), a polygon (a wider area) or a line (see the section on the process for determining forestland uses).
4. Desired vegetation formation (the 'target forest'): the target forest will be determined based on its land-use designation and other data that should be considered (see the sec-

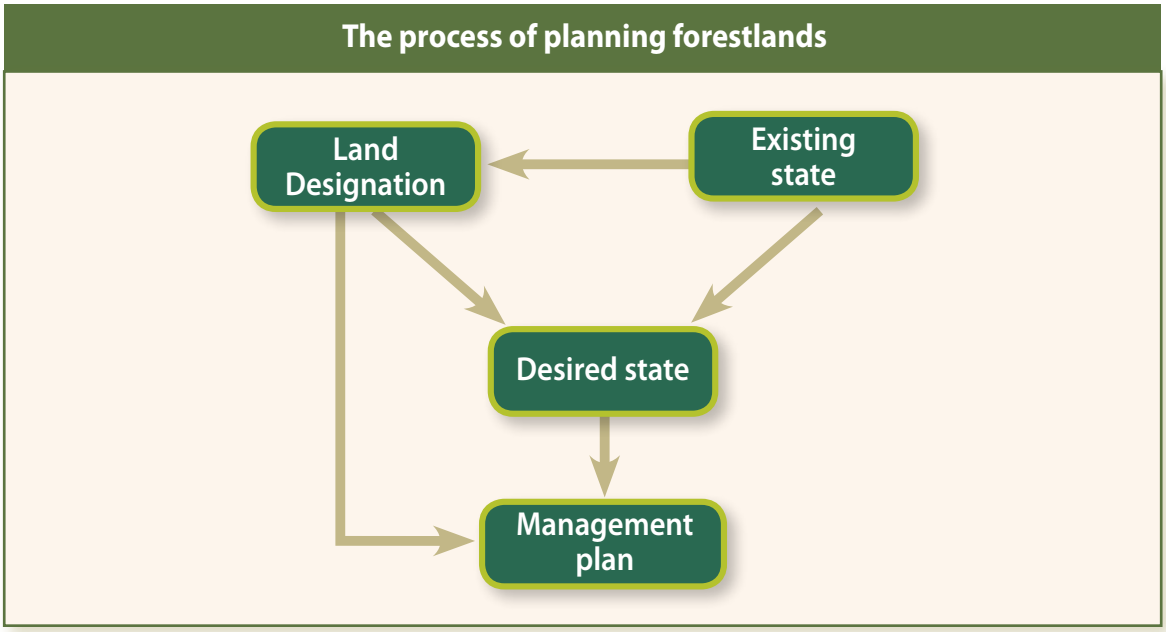
Figure 5

Map of forest vegetation formations – current state (Martyrs Forest)



Example from the Martyrs Forest master plan. The vegetation formation is determined according to plant species composition and percentage cover.

Figure 6



The land designation is determined according to the existing state and other planning considerations. The desired state is determined by the existing state and the land designation. The management plan is derived from the desired state of the site and its designation.

tion on the process for determining the target forest); several target forest types may be determined for a single designated unit. Nevertheless, only one target forest may be defined for a given area of land.

5. Reevaluation: Towards the end of the plan period (25 years), the plan should be reevaluated and updated.

Determining the Land-use Designation of Forestlands

1. As a rule, the default forest land-use designation is 'multiple-use forestland'; the designation will be determined as such unless defined otherwise. It is estimated that this type of forest area comprises the majority of forestland in Israel.
2. The designation of forest areas will be based on many different variables. The chief factors are forest location, statutory status, physical data, flora and fauna data, habitats, unique natural assets, landscape and archaeology, uses and demands, threats to the area, and the potential for development and proper maintenance of the area.
3. Determining the designation is contingent on valid statutory plans. When determining the designation of a given area there should be no significant conflict with the principles of sustainable forests in Israel. For example, a forest area designated for tourism and recreation that contains a habitat of unique conservation value conflicts with the principle of preserving and fostering natural and heritage assets and the principle of environmental protection.
4. Efforts will be made to allow expression of the full range of possible designations in the area covered by a Forest plan, without neglecting the environmental characteristics.
5. Every area has a principal designation that will dictate how it is managed, although a given area may have several secondary designations as well.

Determining the Desired Vegetation Formation (Target Forest)

The desired vegetation formation will be determined for every land unit for a period of 25 years, the amount of time for which the Forest plan is valid.

The following considerations will be taken into account when determining the target forest for a given area:

1. Statutory classifications according to NOP 22 and detailed forest plans
2. The land-use designation of the area in the Forest plan

3. The designation of the existing vegetation formation
4. Environmental and scenic considerations
5. Anticipated vegetation dynamics (expected vegetation development trends if left to develop without human intervention)
6. The operational limitations of the management procedures
7. The degree of intervention required to achieve the various alternatives for the target forest

Principles for defining the target forest:

1. The target forest definition is bound by the management principles of sustainable forests in Israel. In other words, when determining the target forest for a given area one must ensure that it does not significantly conflict with these principles.
2. When evaluating target forest alternatives for a given area, preference will be given to the alternative that requires the lowest possible level of intervention.
3. We will strive to obtain the most diverse possible vegetation formations for the managed area, including formations that are not forest. We will take care to preserve and maintain vegetation formations and communities that have conservation value.
4. In areas with uncertain vegetation development trends or without the need to plan for precise determination of the desired vegetation formation, a practical range of desired vegetation formations may be determined. For example, in existing coniferous forest areas with well-developed native woodland, a range between coniferous forest with medium coverage and mixed forest may be considered.

Forest Plan Products

1. A list of area goals chosen from the accepted forest management goals in Israel, ranked by importance and relevance for each unit
2. Collation of background data and the principles underlying the plan
3. A map dividing the area according to land use
4. A map dividing the area according to target forest formation
5. General management guidelines for implementing the plan
6. Plans for specific topics: visitor management, fire prevention, roads, forest entrances, etc.

Responsibility and Supervision of the Forest Plan

1. The relevant KKL-JNF district will prepare the plan for the specific forest together with the required professional staff.
2. The plan will be presented to the KKL-JNF Land Development Authority management for evaluation and approval.
3. Once the plan is approved it will be presented to the stakeholders.

Long-term Management Plan

1. **The goal** – to implement the Forest plan and other needs that arise in the field.
2. **The area of the plan applies to** – all of the forestlands included in the Forest plan.
3. **The process of preparing the plan** – the management actions and the scope of the necessary work will be derived from the current state of the forest and the land-use designation of the area and the target forest. When preparing the plan, it is imperative to evaluate its true potential for proper implementation (contingent on budget and other operational

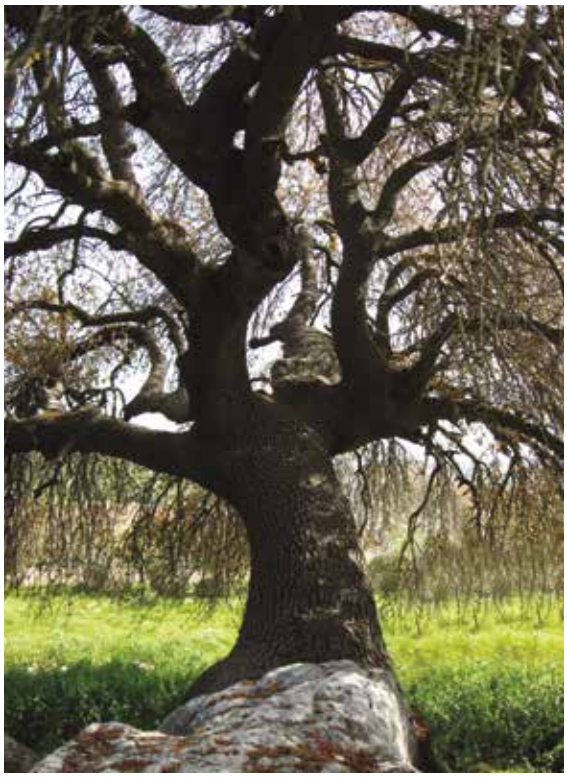
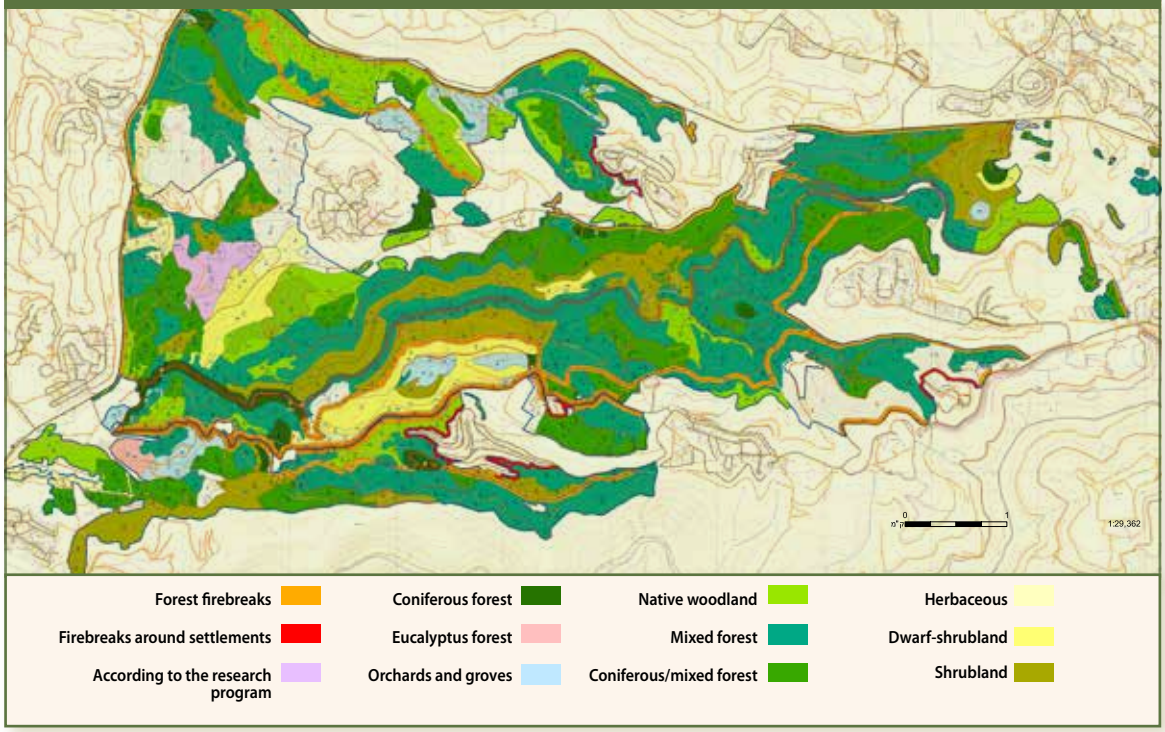


Figure 7

Map of forest vegetation formations – desired state (Martyrs Forest)



Example from the Martyrs Forest master plan. The vegetation formation is determined according to plant species composition and percentage cover.

constraints) as a basis for determining the operational priorities. The plan will be valid for a period of ten years. Towards the end of this period a new plan will be prepared, adapted to the changes that transpired during this time and to the outcomes of the previous plan (see the monitoring process and the forestry manual).

4. **Products** – a. Table of actions for implementation, scope of work, timetables, and priorities; b. Diagram of the planned work areas; c. List of required resources.
5. **Responsibility and supervision** – the management of the region (forestry unit) will prepare the plan, which will be evaluated by the district. After the plan is approved, it will be presented to external stakeholders.

Annual Work Plan

An annual work plan based on the long-term management plan will be prepared yearly. It will present a more detailed, precise account of the components of the long-term management plan. The annual work plan will also focus on recurring seasonal management procedures such as treatment of unwanted vegetation, pest control, and soil cultivation. The planned operational scope will be derived from the guidelines of the long-term management plan and from assessed operational capability. Operational capability is contingent on budget, contractor availability, statutory approval, and other factors. The annual work plan will be specified at the level of individual stands, and the operational scope will be specified at the level of individual actions. The annual work plan will be evaluated by the ten principles of sustainable forest management in Israel.

Detailed Operational Plans

Detailed operational plans should be prepared for every area proposed for treatment. Each plan will specify management tools together with their goals and manners of implementation, and will outline the approval process required for implementing the program. The goal of the detailed operational plan is to serve as a type of tender specification. The plan will focus on the following:

1. Defining the area proposed for treatment and dividing it into subunits according to the nature of the treatment

2. Determining the appropriate season for the treatment and the amount of time needed for implementation
3. Quantitative instructions for each type of treatment (intensity of thinning, planting density, etc.)
4. Methods and tools to be used
5. Natural and heritage assets for preservation
6. Safety, risks, and hazards
7. Required coordination and permits
8. Required budget

The final product of the plan is a map that divides the area according to the type and character of treatments and includes specific instructions according to the list above.

FOREST MANAGEMENT

Forest Management

Diverse management tools are available to assist in managing the forestlands according to their goals and land-use designations, and to achieve the desired target forest determined by the planning process. The objective of this chapter is to describe the management tools accessible to foresters and to formulate guidelines for their proper implementation.

Management activity in forests is intended to steer the spontaneous processes that arise in nature towards distinct goals. Nevertheless, any type of management intervention has the potential to disturb a given habitat; therefore, care and judgement should be used in planning and implementing such activity. As a rule, management efforts are mostly directed at planted forests that require management interventions to achieve their objectives and to attain the desired vegetation formation. In open areas of forestland which are not planted forests (native woodland, shrubland, dwarf-shrubland, etc.), there tends to be less need for intervention, and management focuses on protecting these habitats and managing their use (recreation, grazing and so on) to prevent damage and deterioration. We emphasize that we always strive to create a sustainable system in planted forests as well, such that the need for management interventions to maintain the existence of the forest and its ability to reach its designated goals will decrease over time.

Management Tools

This section describes the primary management tools available to foresters. These include characteristic forestry procedures such as planting, thinning, and pruning, various agro-technical tools such as mowing, plowing, and spraying, and other important tools such as grazing and prescribed burning. As a rule, any implementation of a management tool in the forest must adhere to the ten principles of sustainable forest management. A specific section will be dedicated to each of these management tools, elaborating on the following:

1. Goals: a list of goals that can be attained with the specific management tool
2. Considerations: a list of conditions and restrictions that should be accounted for when planning and implementing the management tool
3. Principles: guiding principles for implementing the management tool
4. Plan: a list of topics to be considered when preparing a plan to implement the management tool

Due to the great significance and importance of thinning and planting among forestry activities, the sections on those tools focus more specifically on procedures than do other sections.

Treatment of logs from thinning. Martyrs Forest near Mesilat Tsiyon.

FOREST THINNING

Thinning is the main tool utilized by foresters to shape forests and encourage their development according to their land-use designations. In this period of global warming, thinning is the major tool used to expand the living space available to trees and improve forest resilience under conditions of continuous aridity. Thinning is usually performed in coniferous forests or in the conifer component of mixed forests. Nevertheless, selective thinning is also important in dense native woodlands to create living space for regenerating trees and increase plant diversity. Thinning also has environmental consequences that must be considered.

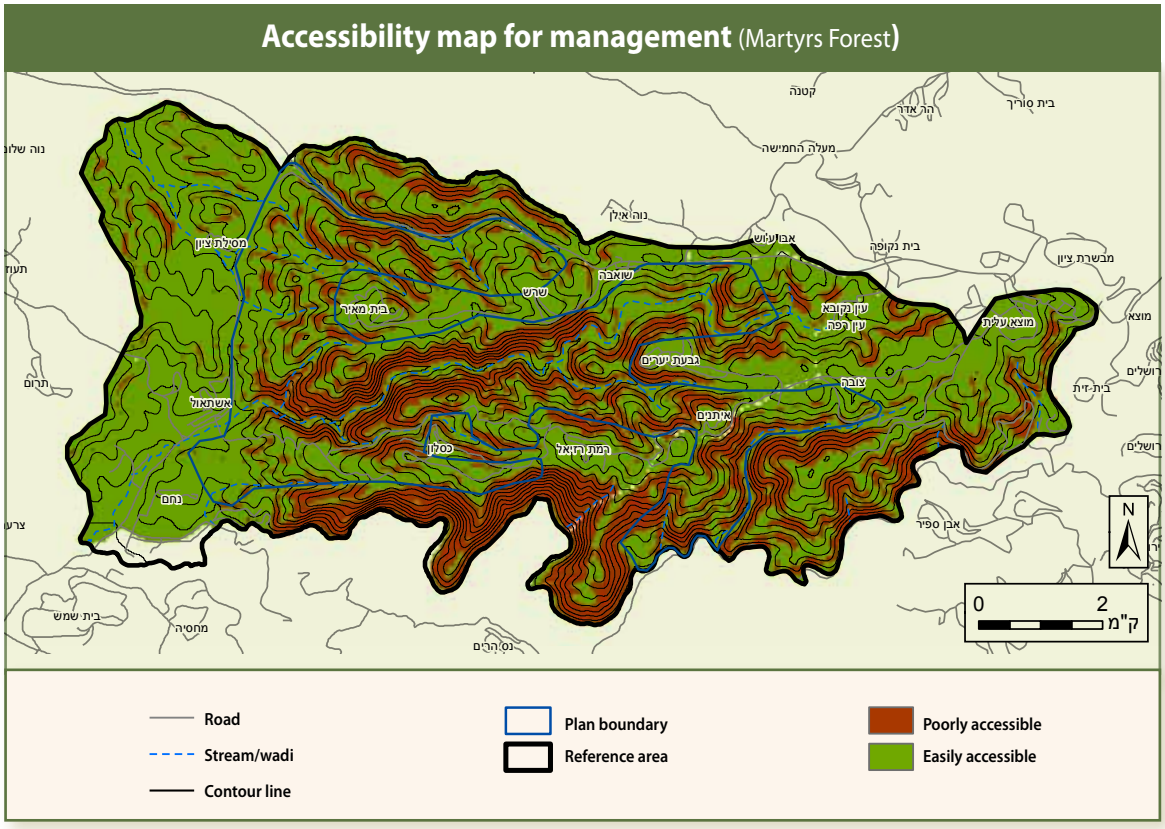
Objectives of Forest Thinning

1. Shaping forest structure (density, height, patchiness)
2. Determining forest species composition and encouraging growth of the desired vegetation formation
3. Providing the necessary living space and resources for suitable development of forest trees, focusing on adjusting tree density to water availability in the habitat and considering warming processes and anticipated climate change
4. Encouraging understory growth and increasing forest species diversity
5. Providing the opportunity for natural forest regeneration
6. Reducing fire hazard
7. Diversifying forest structure
8. Protecting and fostering specific natural assets in the forest
9. Preserving the health of forest trees and preventing pest and disease infestation

Considerations when Determining Thinning Methods, Character, and Intensity

1. The land-use designation of the area and the target forest formation
2. The goal of the thinning
3. Conditions of the habitat, in particular, its water economy

Figure 8



Example from the Martyrs Forest master plan. The forest areas are classified according to the degree of access for performing forestry management procedures. The degree of access is determined by topography, distance from roads and other physical features such as lithology, terraces, etc.

4. The existing tree density and composition
5. The health and expected lifespan of the existing trees
6. Accessibility and difficulties in performing thinning
7. Human activity in the forest
8. Protection of natural and heritage assets at the area

Thinning Plan

A detailed plan should be prepared for the area intended for thinning, according to the following specifications:

1. The size of the area to be treated
2. Thinning intensity (according to the distance between the trees, their density or their cover)
3. Timing of thinning
4. The desired species composition after thinning
5. The methods and tools for dealing with the cut material (see relevant section)
6. The amount of timber removed and the amount remaining
7. Consideration of protected natural and heritage assets
8. Necessary coordination and permits

thinning principles in different forest formations

As a rule, thinning in all forest formations will be performed according to the vegetation formation determined for the target forest. Therefore, the thinning program in existing forests will be determined according to the target forest, i.e., directed at achieving the desired species composition and cover percentage.

Coniferous Forests

Four states can be defined for conifer forests:

1. **Young forests**: tree populations up to 10 years old, originating from planting or natural regeneration. At this stage, the main objectives of thinning are shaping the structure of the future forest, determining the species composition, and nurturing the forest trees. Compared to mature forests, thinning activity in young forests is relatively easy and involves less resources and minimal disturbance to the area.

High-intensity thinning in a multiple-use forest subject to a low-intensity treatment regime. Adulam Park in the Judean Lowlands.

Thinning to encourage regeneration. Development of an uneven-aged forest subsequent to high-intensity thinning in an Aleppo pine forest near Kibbutz Harel.

2. **Maturing and mature forests**: the objectives of thinning in maturing forests (10–30 years old) and mature forests (over 30 years old) are to shape the structure of the forest, nurture the forest trees, and encourage understory growth. Thinning at these stages is more difficult than in young forests and involves significantly more disturbance of the area.
3. **Multi-aged forests**: forests that comprise trees of different ages. The objectives for thinning in these forests are identical to those noted in sections 1 and 2. It is possible to thin every age class separately in this type of forest.
4. **Renewing forests**: this type of thinning will be implemented in stands of trees nearing the end of their lifespans (according to their age and health) to encourage natural regeneration of

forest trees. Outstanding trees are to be left at a density of 5–10 trees per dunam (dunam=0.1 hectar) to serve as parent trees for seeds.

Recommended Ranges of Forest Density and Thinning Frequency in Coniferous Forests

Thinning programs should bear in mind the following factors:

1. **Land use designation** – the formulation of a thinning program according to land-use designation distinguishes between three possibilities: 1) forests for recreation or community use, subject to high-intensity treatment regimes; 2) multiple-use forests, subject to moderate intensity regimes in accessible areas and low-intensity regimes in difficult areas; and 3)other designations - i.e., buffer, scenic and heritage areas, protected natural assets, special habitats, and research sites – subject to thinning according to the specific local plan.
2. **Accessibility level** – the level of accessibility, and consequently the treatment intensity, as explained above, will be determined by slope, rockiness, terracing, distance from roads and other relevant factors.
3. **Habitat and water regime** – the maximum density of a mature forest depends on the habitat carrying capacity, particularly the quality of the water regime. The quality of the water regime is primarily determined by the amount of rain, but is also significantly affected by other factors, the most important of which are rock type, soil type and depth, slope, and topographic aspect.
4. Forestlands in Israel can be divided into habitats by mean average precipitation in each region:

   a. Mediterranean habitats – above 500 mm annual rainfall

   b. Arid Mediterranean habitats – 350–500 mm annual rainfall

c. Semi-arid habitats – 250–350 mm annual rainfall

When adapting the thinning regime to a specific forest the additional factors noted can be considered, in addition to the amount of rainfall.

For thinning to be most effective, it should be performed during the young and maturing forest stages (up to 30 years old). Table 4 presents thinning regimes up to 30 years old. Delays in thinning at these stages can have negative, sometimes irreparable, effects on the future of the forest

Table 4: Thinning table for coniferous forests with "high" canopy cover

Thinning number and forest age	Habitat	Number of remaining trees per dunam (dunam=0.1 hectar)		
		High intensity	Moderate intensity	Low intensity
Thinning 1 up to 10 years old	Mediterranean	70	45	30
	Arid Mediterranean	60	40	25
	Semi-arid	50	35	20
Thinning 2 High intensity up to 20 years old, moderate intensity up 30 years old	Mediterranean	45	30	
	Arid Mediterranean	40	25	
	Semi-arid	35	20	
Thinning 3 up to 30 years old	Mediterranean	30		
	Arid Mediterranean	25		
	Semi-arid	20		

Maximal recommended tree density according to habitat type, forest age, and intensity of treatment regime. Recommended densities are maximal densities for coniferous forests designated as having "high" canopy cover level. If the target canopy cover level of the forest is low or medium, the desired density will be correspondingly lower. The intensity of thinning regimes is determined by the land-use designation and accessibility of the area. Maximal density at a given age is determined according to the habitat type with an emphasis on the water regime.

Other Emphases

- Low-intensity treatments are intended to fulfill two goals: reducing the degree of intervention in the ecosystem (according to the principle of rational intervention) and helping to cope with the difficulty of intensive treatment in the entire forest area.
- When forests undergo intensive thinning, as recommended for moderate and low-intensity treatments, there are two causes for concern:

a. Thinning stress – appears mainly in maturing forests (15–30 years old) as a result of intensive thinning (removal of more than 30% of the timber volume or 50%–60% of the trees). Therefore, we will strive to conduct heavy thinning in young forests (less than 10 years old), as experience has shown that forests at this age are relatively less sensitive to thinning stress.

b. Massive natural regeneration of pine seedlings – intense opening up of forests can occasionally trigger germination and establishment of pine seedlings in the thinned area. In such cases, young seedlings can receive direct treatment during the years following germination. Treatment of young seedlings (up to 5 years old) is simple, inexpensive, and carries relatively minor environmental consequences compared to repeated thinning in mature forests.

Thinning in Mature Coniferous Forests (Over 30 Years Old)

1. When forests are thinned appropriately up to 30 years old, additional effective thinning at older ages may be applied, as needed.
2. In Israeli forests, many mature forest stands are overly dense. In dense forests with relatively good condition, we recommend thinning according to the thinning 3 regime (Table 4). This thinning regime will account for the limitations of accepted thinning practices, i.e., no more than 30% of the timber volume (5–60% of the trees) in the forest will be removed. If the target forest has not been designated to consist solely of conifers the forester may exceed this limitation.
3. In relatively degenerated mature forests the next thinning should be for the purpose of forest renewal.
4. Thinning for promoting natural regeneration should consider the condition of the forest. The forest should be thinned to 5–10 trees per dunam (20% canopy cover). Only outstanding trees that will serve as parent trees for the seed bank will be left standing. In extreme cases, when the general condition of the trees in the forest is especially poor, clearcutting may be considered.

Thinning In Multi-Aged Forests (Over 30 Years Old)

In multi-aged forests in which several age classes exist, the appropriate density will be determined for each age class separately (according to Table 4) and thinning will be performed accordingly in each class.

Considerations for Determining Thinning Times in Coniferous Forests

1. Young forests will be treated when tree size does not necessitate removal of cut material or allows it to be easily removed.
2. Thinning in maturing and mature forests should be performed during summer–autumn (before the rains). If thinning must be done in winter, when the ground is wet, the introduction of heavy machinery should be kept to a minimum.
3. Thinning for forest renewing – to be performed during spring to ensure that the seed source for natural regeneration is primarily the parent trees left in the area.

Mixed Forest Stands

When the target forest is a mixed forest, thinning should focus on the coniferous element and preference should be given to native broadleaved species. Thinning of conifers in mixed forests will be performed according to the following guidelines:

1. Any broadleaved individual taller than 2 meters will be considered a tree.
2. To facilitate creation of a mixed forest, the growth of broadleaved individuals or patches (several adjacent individuals) will be encouraged by opening up their available living space by thinning the pines in their vicinity.
3. Thinning of conifer concentrations with no broadleaved species is to be performed according to Table 4.

Removing cut trees by skidding during thinning. Aleppo pine forest in Adulam Park in the Judean Lowlands.

4. Trunk thinning and canopy raising can also be implemented on broadleaved trees in order to open up the forest and shape it according to different objectives.

Native Woodland

In areas managed as native woodland, the coniferous component will be thinned so that its relative cover will not exceed 30% (according to woodland definitions).

The major tool for shaping woodland, when necessary, is trunk thinning and canopy raising (see sections on pruning).

CLEARCUTTING

Clearcutting is complete, or nearly complete (above 80%) removal of the woody cover over an extensive area – several tens of dunams (dunam=0.1 hectar) or more. Cutting down all or most of the trees in a smaller area can be considered, in some cases, simply part of thinning the forest. Clearcutting of a forest stand is to be performed only when absolutely necessary, which may be due to tree deterioration, disease, or death (e.g., after a forest fire), or when it is essential to change the species composition or genetic composition of the trees. As long as a forest is vital and functional its life should be extended for as long as possible. Our objective is to avoid clearcutting by gradually renewing the forest. Clearcutting may have negative environmental and scenic consequences due to skidding cut trees, removing vegetation cover, and exposing the soil over extensive areas.

PRUNING

Pruning refers to the removal of side branches or the thinning of branches and trunks in multi-trunked trees.

Objectives of Pruning

1. Raising the forest canopy and opening it up for passage of people and animals
2. Shaping trees, particularly by creating a central trunk in woodland trees
3. Reducing the risk of canopy wildfires by separating the tree crown from the lower vegetation
4. Removal of branches that pose safety hazards. This is particularly important in areas with intensive anthropogenic activity and for species susceptible to falling branches such as river red gum *Eucalyptus camaldulensis*.

Pruning to shape trees and raise the canopy in an olive tree grove in Sataf Forest, the Judean Mountains.

Considerations when Pruning

1. Land-use designation of the area
2. Desired vegetation formation and tree species
3. Forest age
4. Operational capabilities, including the treatment of pruned branches

Pruning Principles

1. Pruning is particularly relevant for areas managed for recreation, community forests, and firebreaks. In these forests pruning should be implemented up to a height of 3 meters above the ground (high pruning).
2. Planted forests 5–15 years old should be pruned to a height of 1 meter (crown lifting), to contribute to tree development and reduce damage from ground fires.
3. Pruning in native woodland is intended to encourage trees to develop upwards and to shape them with a central trunk. Pruning should be repeated every few years or be combined with high-pressure grazing to achieve this result.
4. Pruning in orchards and fruit tree groves is an essential management tool for shaping trees. One objective of this pruning is to enable mechanical treatments in the grove.
5. Pruning in young forests subject to high-pressure grazing should be delayed up to the stage in which the trees have reached dimensions that will ensure their resilience to grazing.

Pruning Program

The plan for an area designated for pruning should include the following:

1. Pruning height
2. Species to be pruned
3. Treatment of pruned branches

MOWING

Mowing is the action of cutting understory vegetation to ground height. This can be done with a hoe, a mechanical scythe, or a mower attached to a tractor. Mowing is considered a highly selective activity with few environmental consequences, yet it is expensive compared to grazing, spraying, and prescribed burning.

Objectives of Mowing

1. Reducing combustible material in the forest
2. Maintaining firebreaks
3. Opening up the understory vegetation

4. Reducing competition with weeds and facilitating natural regeneration of trees and desirable species

Considerations When Mowing

1. Lithological and topographic conditions
2. Site sensitivity and potential damage to the soil, fauna, and flora due to the introduction of mechanical equipment and implementation of mowing.
3. The characteristics of the flora and the degree of selectivity required for its treatment
4. Alternative weed treatments

Mowing Principles

1. Mowing will be used when grazing cannot be used on the site – when herds are unavailable or the site is not suitable for grazing, e.g., in recreation areas.
2. Mowing will be used when there is a need for selective vegetation treatment, e.g., in planting sites or natural regeneration sites.
3. Mowing is an environmentally friendly alternative to the application of pesticides.
4. When the site is accessible and not too rocky or steep, a mower attached to a tractor is most cost-effective
5. The best time for mowing is in the stage before seed production, when the vegetation is green and young.
6. In some cases, repeated mowing will be necessary to attain the goal.

TILLING AND PLOWING

Tilling and plowing are mainly used in fruit tree groves and orchards, firebreaks, at the edge of forests and in water harvesting systems in arid areas.

Objectives of Tilling and Plowing

1. Reducing competition between trees and weeds for water and mineral resources in the soil
2. Creating weed-free sites that will serve as firebreaks in the forest and along its edges
3. Increasing runoff percolation and creating areas to absorb runoff water to facilitate tree growth within water harvesting systems.
4. Improving soil conditions (aeration, reducing mechanical resistance) to encourage establishment of plantings
5. In certain cases – encouraging natural regeneration of forest trees

Tilling the soil in a fig orchard. Shayarot Ridge, Martyrs Forest.

Considerations When Tilling and Plowing

1. Lithological and topographic conditions
2. Soil type and humidity
3. Site sensitivity and potential damage to the soil, fauna, and flora due to the introduction of mechanical equipment and plowing
4. Type of tractor and plow

Principles of Tilling and Plowing

1. If the site is too dry or too wet, tilling and plowing should be avoided to prevent soil compaction and damage to soil structure.
2. If the site contains important populations of geophytes or rare plants, tilling and plowing should be avoided.
3. If the site is rocky or has steep slopes, tilling and plowing should be avoided.
4. The type and size of the tractor and plow should be suited to the site conditions and the objectives of the treatment.
5. The season for tilling and plowing should correspond to the treatment goals.

GRAZING

Many forestlands in Israel provide grazing services to livestock, including cattle, sheep, and goats. Grazing is a central tool for forest management and also provides economic benefits for communities adjacent to the forest. Grazing has a significant effect on vegetation and is considered a preferred tool for shaping vegetation and encouraging biodiversity. Nevertheless, improper use of this tool can lead to damage of habitats and vegetation. The forest manager should tailor the grazing regime to the objectives of the area and the habitat conditions.

Objectives of Grazing

1. Reducing combustible material in the forest
2. Maintaining firebreaks
3. Opening up the forest understory
4. Raising the canopy, shaping the tree structure, and encouraging vertical growth (particularly in native woodland)
5. Increasing biodiversity (species and landscape diversity)

Goat grazing in open native woodland. Adulam Park in the Judean Lowlands.

The effect of cattle grazing on the understory vegetation. Research plot in a Pinus brutia forest on Mt. Horshan.

Individual sapling protection in a cattle-grazing site.

6. Providing the community with a source of income

Considerations When Introducing and Managing Grazing

1. Land-use designation of the area
2. Objective of grazing (from the perspective of the area manager)
3. Amount of fodder and carrying capacity
4. Necessary infrastructure for sustaining grazing
5. Possible disturbance to management and visitor infrastructure
6. Possible damage to young trees or natural regeneration
7. Existing and desired vegetation formation
8. Type of livestock
9. Possible damage to water sources, soil, habitats, and certain species

Principles for Managing Grazing in Forestlands

1. The goal of grazing: grazing pressure (grazing intensity relative to production capacity) should correspond to the goal of grazing from the perspective of the area manager. Thus, maintaining a firebreak requires sustained, continuous high-pressure grazing. On the other hand, preserving and fostering biodiversity requires relatively moderate grazing pressure during limited periods of time.
2. The amount of fodder and carrying capacity: the carrying capacity of a unit of pasture is derived from several variables, including the type of grazing animal, the vegetation character, the grazing management, and the objectives of the herd owner and the landowner. One valid definition of the carrying capacity of a forest area is the maximum number of animals per unit area per unit time (e.g., number of grazing days per year per dunam) that will use the grassy and woody pasture without adversely affecting the forest objectives and the continuation of grazing. When planning grazing in forestlands, the carrying capacity of each land unit should be considered and the grazing regime determined accordingly.
3. Necessary infrastructure: when planning grazing, the necessary infrastructure – including permanent fencing, portable fencing, water and fodder points, enclosures and mobile housing for herders, gates and passageways – should be taken into consideration.
4. Protecting young trees: grazing should be limited during periods of forest establishment or renewal. Alternatively, it is possible to provide individual fences as protection for young trees.
5. The type of livestock: in Israel there are three main types: sheep, goats, and cattle. The type of livestock affects several variables, including necessary infrastructure (the need for fencing), determining carrying capacity (according to the type of vegetation), the effect on visitors and visitor infrastructure, the impact on the vegetation, the impact on soil and water, and damage to agricultural terraces and ancient buildings. For example, cattle, unlike sheep and goats, require fencing, are more troublesome with visitors and visitor infrastructure, and cause more damage to terraces and buildings. Goats, unlike cattle and sheep, characteristically prefer woody rather than herbaceous vegetation.
6. Dividing the grazing load over time and space: grazing should be mobilized so that it will be spread appropriately over the rangeland. This calls for attention to scenic, diversity, and patchiness considerations that facilitate creation of a non-homogenous distribution of vegetation across the area. We will strive to ensure that the grazing area has appropriate periods without grazing (in both seasonal timing and duration) to encourage natural regeneration of local vegetation. Within every given forest there should be areas defined as ungrazed land (about 15%–20%).
7. Timing of grazing: when determining timing of grazing (seasonal beginning and end) the following factors should be considered: minimal forage accumulation (the threshold value for introducing grazing), natural vegetation regeneration, flowering and seed dispersal times, and analysis of the plant species that should be encouraged or suppressed.
8. Continuous versus rotational grazing: Continuous grazing, in which the herd remains in a permanent enclosure, is often close to a residential area. This type of grazing is characterized by a circular grazing space (around the enclosure area) and permanent, developed

infrastructure that allows for dairy herds to be maintained and reduces the need for infrastructure in open areas. Conversely, under rotational grazing the herd remains in a given area for a limited time and moves from one land unit to another when the grazing paddock is moved. Rotational grazing is characterized by better control of grazing timing and pressure, enables longitudinal grazing areas (suitable for firebreaks), is usually suitable for goat and sheep herds raised for meat, and requires some degree of infrastructure in open areas. As a rule, rotational grazing allows more flexibility and is better adapted to the needs of the land manager.

The Grazing Program

Every land unit will have a plan that includes the following:

1. type of animal
2. Grazing intensity (number of animals per unit area per unit time)
3. Timing of seasonal entrance and departure
4. Rotation between land units
5. Necessary infrastructure
6. Protection of trees
7. Consideration of natural and heritage assets for conservation
8. Necessary coordination and permits

PLANTING

In the past, planting was the major focus of forestry work in Israel. Given that after many years of planting, the availability of unforested areas designated for planting has decreased, and the first generation planted forests have been transitioning to second generation ones, which are to be based predominantly on natural regeneration, a decrease in planting activity is anticipated. Forest plantings will be subject to the definitions of land-use designation in the area and desired vegetation formation when natural processes are not expected to lead to the desired outcome within a reasonable period of time. Planting is a significant intervention with both environmental consequences and high costs, and therefore should only be used under appropriate circumstances and in a manner suited to each individual situation.

Planting sleeves and cover sheets in broadleaved plantations in Nahal Refa'im, Judean Mountains.

Exposed landscape in Nahal Tsuba before forests were planted. Surface photograph, 1970.

Nahal Tsuba in 2013. A continuum of coniferous forests.

Objectives of Planting

1. Establishing forests in areas in which there are no forest trees nor potential for spontaneous, natural development of a forest
2. Establishing forestlands of special character for specific goals, e.g., orchards or areas designated for recreation and visitor reception
3. Forest renewal following disease, fire, or any other cause of massive mortality, when natural regeneration is insufficient or does not produce the desired forest formation
4. Reintroducing tree species to nature and enriching the forest with desired species and genotypes
5. Diversifying coniferous forests and converting them into mixed forests
6. Ecological rehabilitation of damaged habitats and conservation of soils and streambeds
7. Restoring heritage landscapes
8. Improving rangelands
9. Preserving protected trees by transplanting them to forestlands

Planting Considerations

1. Land-use designation of the area
2. Environmental conditions and the characteristics of the soil and natural vegetation
3. Natural and heritage assets in the area considered for planting
4. Tree species intended for planting
5. Presence of grazing in the planting site
6. Planting season

Planting principles

Adapting the Planting Method to the Land-use Designation of the Area

The planting method should suit the land-use designation of the area and the target forest formation. For example, heavy investment per sapling is justified in areas designated for recreation or orchard plantings as well as areas subject to grazing, by preparing the site for planting, using irrigation and large saplings, protecting the trees individually, and more. In contrast, in areas designated for scenic plantings or coniferous

forests (pine or cypress), the investment per sapling tends to be lower.

Planting Density

Planting density depends on a number of factors, such as the land-use designation of the area, habitat conditions, the desired forest formation and tree density in the mature forest (target density), and the degree of investment required and feasibility of sapling establishment.

The degree of investment will likely determine the degree of success, i.e., the number of saplings that will establish themselves and develop into trees compared to the total number planted. Three levels of investment may be defined by means of this principle:

1. Low investment – one third of the planted seedlings are expected to develop into full-grown trees and comprise the mature forest. This involves high-density planting at relatively low investment per sapling. In addition to the relatively low investment per sapling, the advantage of this method is that it allows better classification of successful trees and suitable niches over time.
2. Moderate investment – half of the planted trees are expected to develop into mature trees.
3. High investment – all of the planted trees are expected to develop into mature trees. This involves low-density planting (close to the target density) at high investment. The advantage of this approach is that it ensures greater tree establishment rates, faster growth, and a reduction in damage from grazing and climate abnormalities.

The degree of investment when planting is expressed in the way the area is prepared for planting (plowing, digging pits, etc.), in the size of saplings (small – container volume 180–300 cc, medium – 0.5–5 liters, large – 10–60 liters or transplanted trees), tree irrigation, and treatments such as planting sleeves, hoeing and weed control (Table 5). In mixed forest planting, which combines conifer and broadleaved species, trees can be treated according to the degree of investment tailored to each species, e.g., low investment in conifers alongside higher investment in broadleaved species.

Planting broadleaved species, with high investment. Large planting holes, large saplings and woodchips cover

Sapling size. Saplings of various sizes. Eshtaol Plant Nursery.

Table 5: Planting characteristics according to the planned level of investment

Investment level	Seedling size	Land preparation	Irrigation	Additional treatments
Low	Small	Manual or mechanical pit excavation	None	Tilling and weed control up to 3 years
Moderate	Small to medium	Plowing and/ or mechanical pit excavation	Supplementary irrigation up to 2 years after planting	Tilling and weed control up to 5 years; planting sleeves
High	medium to large	Excavating large planting pits; Infrastructure for runoff harvesting	Continuous irrigation the whole Dry season up to 5 years after planting	Tilling/hoeing and weed control up to 10 years; planting sleeves or net protection against grazing

Table 5 proposes characteristic examples of planting component combinations. Different combinations are possible in accordance with various factors. For example, in runoff harvest forests it is customary to combine high investment in site preparation (runoff-harvest infrastructure) with the use of small seedlings.

Planting Density in Different Forest Formations

The intended tree density for the mature forest (target density) will be determined by the desired forest formation. The ratio between the target density and the planting density will be determined by the degree of planned investment. Table 6 specifies the recommended planting densities for different forest formations according to the degree of investment, based on accepted mature forest densities for various formations. Different target densities may be defined in accordance with specific planning considerations, such as the size of mature trees and the degree of their development according to habitat conditions, the proportion of desired canopy cover in mature forests, etc.

Table 6. Planting density according to the planned level of investment, for mature forests with "high" canopy cover

Forest formation	Planned density in mature forest	Low investment (trees/ha)	Medium investment (trees/ha)	High investment (trees/ha)
Conifer	30	140–180	60	30
Native woodland	40	-	80	40
Mixed forest	40	-	80	40
Eucalyptus	40	-	80	40
Orchard	40	-	-	40
Runoff harvest	20	-	-	20

Recommended ranges of planting density (trees per dunam) in different forest formations and according to the level of the planned investment. The detailed densities In the table correspond to a target forest with a "high" canopy cover

Spatial Seedling Distribution when Planting Mixed Forests

In such situations, considerations regarding treatment effectiveness and suitability to local habitat conditions suggest that the optimal spatial seedling distribution is a patchy pattern, i.e., planting groups of one species or a number of species with similar ecological requirements and treatments. Landscape design, ecological (habitat-related) principles, and forestry practices will be taken into account when determining patch sizes. Landscape and forestry-related considerations may allow a mixture of species to be distributed throughout the planting area, though not without management and ecological limitations. For

example, a random distribution of broadleaved species in a area of planted coniferous trees makes it difficult to provide complementary treatments required by broadleaved species, although it may contribute to protecting the saplings from grazing.

Timing of Planting

Planting at the right time significantly increases the probability of sapling establishment. Experience has shown that early planting in autumn, supplemented by irrigation, significantly improves the probability of establishment. If supplementary irrigation is not possible, planting should be carried out as early as possible in the wet season, when the soil reaches field capacity or close to it. Soil temperature is another consideration when determining the planting time and supplementary irrigation regime. Some species, such as the twisted acacia *Acacia raddiana*, cannot be planted in winter when the soil temperature drops below a given threshold.

Tree Species for Planting

Selection of the tree species to be planted is a fundamental consideration in forest planning. A diverse array of tree species is at our disposal, variating in adaptation to environmental conditions and integration with different landscapes. Some of them grow naturally in Israel, i.e., native species, while others have been introduced for various purposes.

Major native species used for forestry in Israel include Aleppo pine *(Pinus halepensis)*, Palestine oak *(Quercus calliprinos)*, Tabor oak *(Quercus ithaburensis)*, Boissier oak *(Quercus boissieri)*, terebinth *(Pistacia palaestina)*, Atlantic pistacia *(Pistacia atlantica)*, carob *(Ceratonia siliqua)*, jujube *(Ziziphus jujuba)*, red thorn *(Vachellia gerrardii)* and twisted acacia *(Acacia raddiana)*.

Major introduced species include brutia pine *(Pinus brutia)*, Canary Island pine *(Pinus canariensis)*, stone pine *(Pinus pinea)*, Arizona cypress *(Cupressus arizonica)*, river red gum *(Eucalyptus camaldulensis)* and coral gum *(Eucalyptus torquata)*.

The criteria for selecting tree species for planting are as follows:

1. Habitat suitability – as a rule, species planted for afforestation should be suited to the habitat. These species will develop in the planted area without much intervention, blend into the landscape, and not intrude as a foreign element that could adversely affect the habitat and the ecosystem. When defining the character of the habitat it is important to consider annual precipitation, lithology and soil, altitude and temperature regime, and the composition of the natural vegetation.
2. Native species – to achieve optimal adaptation to the habitat, efforts should be made to plant local (native) species and ecotypes and to ensure appropriate seed sources (provenances) for creating the seedlings.
3. Introduced species – as a rule, introduced trees should be used when the species has a clear advantage over native species with regards to the management objectives of the forest. Introduced species will usually be used for the following purposes:

a. Diversifying the forest and creating unique landscape formations, such as cedar groves.
b. Improving forest performance in terms of growth rate, degree of cover, and resistance to dry conditions, e.g., using eucalyptus species to create shade groves in the Negev.

Introduced species will be used cautiously, considering the following limitations:

a. Refraining from planting only invasive species.
b. Refraining from planting species susceptible of becoming foreign elements that could adversely affect the local habitat or the ecosystem surrounding the forest area.

Practices at the Planting Site

1. When the site is prepared for planting, efforts should be made to keep habitat disturbance to a minimum.
2. Soil erosion should be prevented by using preparation methods suited to the type of soil, lithology, and topography.
3. Harm to existing infrastructure, e.g., terraces, should be avoided; instead, effort should be made to rehabilitate them whenever possible.
4. Natural drainage routes should not be damaged and work should be done to stabilize stream channel heads and road drainage.
5. Damage to native vegetation should be reduced to a minimum at the planting site. If there is a need to treat competing vegetation, treatment should be focused in the close vicinity of the seedlings.

6. Use of chemical pesticides is to be minimized by focused spraying and using alternative pest control methods, such as mulching.
7. Site preparation for planting should include structures for collecting runoff and preserving water.

Management Methods and Tools for Planting

Seedling establishment is a key issue in forestry work. Establishment signifies that the seedling has developed to a stage that no longer requires significant intervention to ensure its survival. Experience in Israel has shown that coniferous forests become established relatively easily, but broadleaved forests frequently encounter difficulties and require intensive efforts to ensure seedling establishment. Below is a list of methods to be used in plantings:

1. Excavating planting pits to ensure stable planting, initial root development, and capture and infiltration of water. The planting pits may be created at various sizes and by different methods (mechanical or manual). The type and size of the pit should be suited to the habitat, planting density, seedling dimensions, and tree species.
2. The quality of the seedlings is critical. Quality control should focus on three main factors: 1) the quality of the root mass (stable or crumbly); 2) the crown structure (ratio of trunk diameter to height); 3) the state of the foliage (health and vitality of leaves).
3. The soil should be plowed or tilled to improve water infiltration, aerate the rhizosphere, and remove competing vegetation. Disturbing factors, e.g., plowing, can have environmental consequences and should therefore be performed carefully and only after preliminary evaluation, and then too – in a restricted manner, e.g., plowing in rows.
4. Competing vegetation should be treated by mulching the soil using sheets, woodchips, or other means, or by tilling, hoeing, mowing, or spraying. Whenever possible these actions should be performed only in the vicinity of the seedlings, i.e., specific treatment.
5. Broadleaved saplings should be protected in planting sleeves.
6. Grazing animals should not be permitted at the area for a few years, until sufficient development of the saplings allows for such activity.

Transplanting mature trees. Using a truck crane to transport and plant a translocated tree in a forest.

7. Supplementary irrigation may be applied in the dry season to ensure sapling survival in the early years. Supplementary irrigation is relevant mainly in autumn and spring. Experience has shown that in summer, after the long dry period, supplementary irrigation is quite ineffective.
8. Full irrigation, i.e., irrigation that keeps soil humidity constant for a number of years, can improve the survival and seedling development of certain, less drought-resistant species, such as cedars and fruit trees, and occasionally woodland trees as well.

Transplanting Mature Trees to Forest Areas

Transplanting mature trees is a costly activity intended first and foremost to save protected trees from development activity by transferring them to a protected area. Due to the size and rapid development of the transplanted trees, these trees are best suited for planting in pastureland and for rehabilitating and establishing recreation areas. Transplanting mature trees is an ongoing process that requires special techniques at all stages – while uprooting and transferring them to the planting site, while preparing the site for planting, and while caring for the planted trees in subsequent years. These activities may also have serious environmental consequences that must be considered.

Planting Program

A plan, which includes the following information, will be prepared for every planting site:

1. The manner of site preparation
2. Species composition and spatial distribution
3. Seedling size and type
4. Planting time
5. Planting distances
6. Use of planting sleeves and mulching
7. Treatments at the planting site until the forest is established: irrigation, tilling, hoeing and weed control
8. Consideration of natural and heritage assets for preservation
9. Necessary coordination and permits

Use of Chemicals

Chemicals are applied, via spraying or other means, to fight hazards such as pests and weeds. It is important to minimize the use of chemicals that harm people and the environment, and to give preference to alternative methods such as mowing, mulching, tilling, grazing and biological or integrated pest control.

Objectives of Chemical Control

1. Weed control along roadsides, firebreaks, and planting sites
2. Invasive species control
3. Pest control, e.g., the pine processionary *Thaumetopoea pityocampa* – a pest that causes an unpleasant reaction in humans

The Principles of Chemical Pest Control

1. Evaluating environmentally preferable alternatives
2. Using types and doses of products suited to the necessary goal and environmental conditions
3. Favoring environmentally friendly products
4. Avoiding long-term repeated use on the same land unit
5. Application specific to time and space, focused spraying in target areas, and avoidance of spraying in the vicinity of sensitive areas
6. Maximum consideration of natural vegetation and animals that could be potentially harmed by chemicals

NON-INTERVENTION

Non-intervention is considered an absolutely valid management decision. Areas of land and periods of time in which no management interventions will be conducted are to be defined as such in the framework of a management plan. As a rule, there is no need for intervention in forest areas whose state and developmental trend are in line with the objectives of the area and the target forest.

Objectives of Defining Areas Managed by Non-Intervention

1. Data collection and analysis, e.g., monitoring post-fire vegetation renewal as a basis for decision making
2. Leaving untreated control areas for comparison with treated areas (adaptive management)
3. Protecting natural and heritage assets
4. Evaluating inexpensive management tools

PRESCRIBED BURNING

The implementation of intentional, planned, low-intensity fires in the forest understory is not a technique used in Israel. There is a lack of experience in this field, and there are legal restrictions on implementing this tool. Nevertheless, prescribed burning is used extensively around the world and is in fact suited to the conditions in Israel. It is recommended to develop the operational methods of this management tool in Israel.

Objectives of Prescribed Burning

1. Reducing the amount of combustible material to lower the risk of wildfires
2. Weed suppression to encourage natural forest regeneration
3. Increasing plant diversity in the forest

FOREST ROADS

Forest roads are the main means of access to forests. They are necessary for managing forest maintenance activity, preventing and fighting

Public road in a forest. Nahal HaShofet in Ramat Menashe.

wildfires, and providing entrance to the public and forest users – visitors, travelers, shepherds, etc.

Objectives of the Road System

1. To provide access to the public and serve as hiking routes
2. To provide access to users such as shepherds, beekeepers and more
3. To provide access for forest maintenance
4. To support prevention and extinguishing of wildfires

Considerations When Developing and Managing the Road System

1. The objective of the road: when planning, developing, and maintaining a road, its goal, target population, infrastructure and environmental conditions should be considered. The following factors will determine the road classification:

   a. Visitor roads – intended for the general public, safe and accessible to 2x4 vehicles most of the year; will also be used to achieve other objectives of the road system.

   b. Main forest road – used for forest maintenance, preventing and extinguishing wildfires, and more (e.g., shepherds); accessible to vehicles appropriate for these purposes (SUVs, firetrucks, etc.).

   c. Secondary forest road – intended only for forest maintenance, accessible to 4x4 vehicles; this type of road can be closed at the discretion of the area manager.

2. Avoiding damage to soil and water resources: forest roads may cause damage to soil and water resources in the forest. Roads modify features of the land surface, thus increasing the surface runoff volumetric flow rate. If road planning and management are faulty, this change in the runoff flow regime could cause severe environmental damage to the forest area, as well as to the roads themselves.

Principles of Road System Planning and Management

Minimizing damage to soil and water resources: this is a major principle in planning forest roads or selecting suitable alternatives for the road route. First and foremost, we must plan the runoff flow and road drainage. Other aspects to be considered include: ensuring that transverse and longitudinal slopes along the road are as moderate as possible; maximizing the distance of the road route from watercourses and minimizing crossing points to ensure minimal impact; avoiding damage to ancient agricultural terraces on the slope and the

channel.

- No damage to unique habitats and archaeological sites.
- The selected route should cross on stable foundations, through areas with rapid rehabilitation potential.
- The number of forest roads should be minimized and unnecessary forest roads should not be developed.
- Maintenance activity should be conducted by necessity and not as a matter of routine; stabilization with vegetation should be preferred in channels and on excavated slopes.
- Events that could block channels and drainage pipes should be taken into consideration, particularly after activities such as cutting and skidding trees or laying infrastructure lines.
- There is a need to consider possible damage to roads by unregulated creation of trails for off-road motorcycles and bicycles, fallen trees due to snow or wildfire damage, or heavy rains and extreme runoff incidents.
- The forest road system may be integrated into the forest to rehabilitate erosion damage that was present before the forest was established; in existing forests, it is often necessary to rehabilitate road systems developed improperly in the past. This is an important component in preventing damage and rehabilitating existing forests.

Road Plan

Every forest should have a road plan that includes the following:

1. Classification of existing roads
2. Addition of missing roads or elimination of existing roads
3. Necessary maintenance and rehabilitation work
4. Signage

Monitoring, Documentation and Mapping of Forestlands

Monitoring, documentation, and mapping are essential support tools for decision making in planning and ongoing forest management. Adaptive management cannot be implemented without these three tools.

Monitoring

Monitoring is the ongoing evaluation of the state of the forest according to consistent, defined, quantitative and qualitative indicators that allow comparison and detection of trends.

Objectives of Monitoring

1. Description and mapping: tracking the distribution and characteristics of forestlands to create updated descriptions and maps.

Diverse multi-layer forest. A primary layer of open planted coniferous forest and understory layers of woodland trees, shrubs and herbaceous vegetation.

2. State of the forest: updated evaluation of the state of the forest, its composition, and its resources, while defining the vegetation formation, habitat characteristics, projected vegetation dynamics and existence of natural assets of conservation value at each area, for the purposes of planning and decision making regarding forest management.
3. Forest damage and hazards: gathering information for relatively quick treatment of damage and hazards in the forest.
4. Forest maintenance: gathering the required information for implementing specific management procedures. Areas targeted for treatment will be surveyed.
5. Forest treatment results: monitoring the results of treatments conducted in the forests and evaluating the degree of success and the need for additional treatments, according to the objective of the treatment and the forest land-use designation. The nature and frequency of the surveys will be determined by the specific requirements and goals of the treatment.
6. Long-term forest processes: long-term monitoring of forest dynamics, identification of major trends in the forest and factors or processes threatening the forest; studying and accumulating information regarding the long-term effects of management activity in the forest.
7. Updating the Forest plan: evaluating the degree to which the Forest plan defined for the forest has been implemented and updating it accordingly.

The Monitoring System Layout

The monitoring system layout includes various types of surveys designed to evaluate the state of the forest according to the specified objectives.

1. **Forest state survey**: a simple, rapid survey with a uniform protocol, covering all of the forest areas regularly – approximately once every 10 years. The survey defines dominant indicators of the composition, structure, and state of the different forest layers: the forest overstory (above 6 meters), the intermediate layer (2–6 meters) and the understory. The forest state survey is also intended to determine the need for treatments according to the objectives determined for the forest.

Long-term research in the forest. Aerial photo of various thinning intensities within the framework of long-term ecological research (LTER) in Martyrs Forest.

2. **Pre-treatment survey**: a detailed survey conducted only in areas selected for treatment. This survey comprises a list of specific surveys according to the different treatments – pre-thinning survey, pre-planting survey, etc.
3. **Treatment monitoring survey**: a survey system comprising different surveys for the purpose of monitoring the areas treated, evaluating the results, and adapting management accordingly. These surveys are performed at times determined by the area manager.
4. **Damage and hazard survey**: these surveys will be conducted immediately (within weeks-months) according to the needs of area managers and based on information from the field that indicates significant events requiring rapid response, e.g., severe pest infestation, climate damage, etc. The purpose of these surveys is to estimate the scope of the damage and to help plan future treatments.
5. **Post-disturbance survey**: these surveys will be conducted within several years of a major disturbance (wildfire, climate damage) to assess the trends in vegetation development, which will form the basis for a long-term management plan. These surveys will be conducted within time periods sufficient for detection of a specific trend.

6. **Long-term monitoring**: a broad network of permanent monitoring plots used for tracking long-term changes in the forest. The survey will focus on indicators describing the vegetation dynamics and ecosystem functioning. Every year a given number of plots will be assessed, such that each plot is evaluated approximately once every 10 years.
7. **Remote sensing**: aerial photos and satellite imaging used for routine monitoring and broad-scale mapping of events such as wildfires, phenomena such as large-scale death, and processes such as the spread or retreat of forests.
8. **Long-term research**: a limited number of long-term research sites are used for comprehensive research geared towards targeted questions.

Monitoring Principles

1. **Targeted monitoring**: The size of the area and the extent of monitoring detail will be determined by objectives defined in advance – from the national level (e.g., the size of the forested area), via the forest level (e.g., the distribution of vegetation formations in the forest) to the level of the land unit to be treated (e.g., the state of the trees and the results of management activity).
2. **Criteria and indicators**: criteria will be selected for the state or process being monitored. The relevant monitoring indicators will be defined according to these criteria.
3. **Uniformity and simplicity**: uniform protocols and simple, reliable, informative indicators will be used, facilitating easy, inexpensive replication.
4. **Compatibility**: the various surveys will complement each other and will be compatible with respect to concepts, definitions, measurement methods, and data analysis.
5. **Availability**: the monitoring data will be entered into a central database and will be available in real time at the level of the region and the district for immediate implementation in ongoing management.

The Monitoring Plan

The monitoring plan will include the following:

1. Definition of the area to be monitored
2. Objective of the monitoring
3. Biotic and abiotic parameters for monitoring (indicators)
4. Measurement methods and required equipment
5. Sampling intensity and surveying frequency

Documentation ("Forest History")

Every land unit of forestland will be subject to routine recording of all management activity or event affecting the state of the forest, e.g., wildfires, significant mortality or pest infestation. Documentation will be GIS-based and will be kept indefinitely. The following data will be recorded for every management activity or event:

1. The type of activity or event
2. The area (location and boundaries)
3. The date
4. Quantitative data relevant to the type of treatment or event, e.g., intensity of thinning or mortality rate

MAPPING

The forest mapping system will focus on four main information layers:

1. **Existing state**: a map displaying the current state of the forest, focusing on the spatial distribution of the vegetation and forest characteristics
2. **Forest land-use designations**: a map dividing the forestlands according to their land-use designations in the Forest plan
3. **Target forest**: a map describing the spatial distribution of vegetation formations and target forest characteristics as described in the Forest plan
4. **Long-term management plan**: a map describing the distribution of planned management activities

Mapping Units

1. The units on the map of forest land-use designations may be points, lines, or polygons, as appropriate, and independent of vegetation units.
2. The mapping units to be used to map the existing situation, target forest, and work plan are defined below:

a. **Forest**: as determined by NOP22 or other plans; its dimensions remain constant and

Cyclamens blooming in a 50-year-old stand of Aleppo pine in the Shahariya Forest.

cover areas of thousands to tens of thousands of dunams (dunam=0.1 hectar).

b. **Plot**: as determined by the division into land units, topography, and other physical factors such as settlements and roads. The dimensions of the plot remain constant and cover areas of hundreds to thousands of dunams.

c. **Stand**: as determined by vegetation data (as specified below). The dimensions of a stand vary in time according to criteria (as specified below) and cover areas of a few to hundreds of dunams. The division of an area into stands according to the existing state does not necessarily correspond to the division according to the target forest.

Rules for Defining a Forest Stand According to the Existing State

The forest stand is a defined area with a relatively uniform vegetation formation. The division of the area into stands will be based on characterization of the vegetation formations according to the following criteria:

1. **Species composition**: the list of major species and their relative abundances in the primary forest layer (the tallest layer in the forest).
2. **Age, size, and state of trees**: the degree of development of the trees in the primary layer, or other important tree characteristics such as age, size, etc.
3. **Structure**: the structure of the primary forest layer – mainly density, canopy cover, and spatial patterns (patchiness).
4. **Secondary forest layer**: the composition and degree of development of the species in the forest layer beneath the primary forest layer.
5. **Special cases**: in some cases, the definition of the stand will be based on the existence of a specific species or habitat that has unique value, independent of the previous criteria.

Variation in the Division of the Area into Stands

The division of the area into stands is not fixed and should be updated according to changes occurring in the forest. Stand boundaries will be modified when there is a significant change in the primary forest layer, whether due to an event such as a wildfire or large-scale mortality or due to deliberate management actions such as cutting and planting. The boundaries of a stand may be changed if at least 10 dunams (dunam=0.1 hectar) of the stand are modified. Stand boundaries may be updated at any point in time due to a specific event, or regularly, every 10 years, contingent on the forest state surveys.

Maps for Forester Use

The following types of maps are required for ongoing forest management:

1. A map of the current state of the forest
2. A combined map of land-use designations for the area and the target forest
3. A long-term management plan

Forest Management in Accordance with Land-use Designations

The Forest plan divides forestlands into designated units. This section specifies the management principles for different forest land use designations.

Management Principles for Areas Designated as Multiple-use Forests

Forestlands in Israel comprise mainly multiple-use forests. These forests are intended to express Israel's landscape diversity just as it has been shaped by both man and environment, and to provide diverse ecosystem services. Of all the diverse principles for sustainable forest management we will emphasize rational intervention, due to our aspiration to minimize the need for intervention in the future as well. Optimal management is based on natural processes: natural regeneration, succession, and adaptation. This focus is not derived from economic perspectives, but rather from the perspective of sustainable management. Other important principles include diversity, complexity, patchiness and forest continuity in space and time, i.e., a mixed-aged forest with gradual generational replacement.

Management Tools in Multiple-use Forests

Thinning

1. The main objectives of thinning in multiple-use forests are preserving the health and vitality of the forest trees, encouraging natural regeneration in the understory, diversifying species of trees and other forest vegetation, and creating a multilayered, spatially heterogeneous forest.
2. Thinning will be implemented at low frequencies and relatively high intensities (low to medium treatment intensity).
3. Thinning will focus on the coniferous component of the forest.
4. Some of the cut material may be left in the forest area. As a rule, slim pruned branches will not be collected after thinning.
5. Desired species that are less commonly found in the forest should be left in the forest during thinning with the aim of enhancing forest biodiversity.
6. Thinning intensity may be diversified, including clearcutting in patches to form gaps, with the aim of creating spatial heterogeneity.

Grazing

1. Grazing is the main management tool in multiple-use forests. The main objectives of grazing in multiple-use forests are raising the canopy and opening the understory, reducing combustible material in the understory, and increasing diversity and spatial variability in the forest. Nevertheless, grazing may adversely affect natural regeneration in the forest.
2. Excessive grazing pressures should be avoided as they can lead to the destruction of understory vegetation.
3. Varied grazing regimes are to be implemented throughout the forest, including areas left ungrazed, with the aim of creating spatial heterogeneity.
4. To encourage natural regeneration in the forest, grazing should be ceased or significantly reduced for 5–10 years. This can be done by excluding grazing in some parts of the forest, e.g., by large exclosures; these areas closed to grazing in the forest will be rotated every 5–10 years.

Planting and Seeding

Planting or seeding in multiple-use forests will be implemented in the following situations:

1. To establish trees in areas with no forest and no natural tree regeneration; this is the case when establishing a forest (afforestation) and it should be done according to specific objectives.
2. To enhance tree species diversity in the forest and create seed sources that will form the basis for future natural regeneration; this will be done when certain tree species are absent

Planting broadleaved species with high investment to restore a forest recreation area for intensive use. Contini Recreation Area, Martyrs Forest, Judean Mountains.

from their natural habitat due to damage or a shortage of seed sources.

3. To enrich the forest with improved genotypes expressing characteristics such as drought resistance and pest resistance. This will only be done when existing seed sources in the field are of insufficient quality and the foresters have access to seed sources with distinct advantages.

Prescribed Burning

Fire as a management tool tends to be suitable mainly for the management of multiple-use forests due to its low cost and minor environmental effects relative to other management tools. As stated above, the implementation of this tool should be further developed in Israel.

Additional Management Tools

Multiple-use-forest management strives to minimize the use of management tools such as plowing and tilling, weed control, and pruning. These tools will be used when there is a need for treating a severely damaged forest, removing an invasive species, rehabilitating a damaged habitat, or preventing soil erosion.

Management Principles in Areas Designated for Recreation and Hiking

Two types of forest areas are designated for recreation and hiking:

1. **Intensive recreation**: areas that include recreation areas and other facilities for recreational activity. This definition includes areas designated as future recreation areas together with the area surrounding them up to a radius of 100 meters.
2. **Non-intensive recreation**: this includes hiking and bicycle trails, scenic roads, and lookouts.

Intensive Recreation Forests

As a rule, forests for intensive recreation require .a high degree of intervention

The Desired Forest Structure

1. A high proportion of canopy cover, exceeding 60%, to create extensive shade and a comfortable microclimate.
2. A tall canopy (achieved by pruning) and open understory that facilitate movement, offer a comfortable stay for visitors, and enable good ventilation (air movement)
3. A sparse understory to facilitate movement and prevent fires
4. 'Windows' overlooking the open landscape

Mowing with a mechanized scythe in irrigated agriculture terraces at Sataf Spring, Judean Mountains.

Management Tools and their Implementation in Forests with Intensive Recreation

Thinning

1. The main goals of thinning in recreational forests are to preserve tree health and maintain high canopy cover and a long-term, open understory.
2. Relatively frequent thinning at low intensities (high intensity thinning as defined in Table 4).
3. Thinning will be implemented in a manner that ensures only minimal damage to infrastructure and visitor activity in the area.
4. The cut material, including thin pruned branches and wood chips, will be completely removed.
5. Trees should be cut at ground level to prevent leaving behind stumps that remain as obstacles.
6. A forest being thinned for renewal cannot be used for recreation until it is once again deemed suitable.

Pruning

1. Trees in recreational forests are to be subject to high pruning (2–4 meters).
2. All pruned material should be removed from the forest.

Planting

1. Planting is an important tool for rapid renewal and establishment of recreation areas subject to continuous, intensive human activity.
2. Planting is a tool for renewing and establishing recreation areas that lack the potential for spontaneous growth of suitable tree species.
3. Planting in recreational areas requires visitor activity in the area to be suspended for a number of years. It is recommended that this is done gradually and only in part of the recreational area (emphasizing the importance of preliminary planning).
4. To reduce establishment time and increase the establishment probability of certain species, large saplings should be chosen for planting (nursery size 7–9) and watered with an irrigation system (highest level treatment as defined in Table 5).

Grazing

1. Grazing should be used to preserve high open canopies, mainly in recreational native woodland areas.
2. Grazing is potentially an effective tool for controlling the forest understory yet it can interfere with visitor activity, especially in the case of cattle grazing.
3. The infrastructure required for grazing, particularly fencing, may also conflict with visitor activity.

Spraying and mowing

These tools are used to treat the understory to prevent fires and facilitate ease of movement throughout the forest. They are an alternative to grazing, and must be repeated every few years, as needed.

Control of forest pests

In recreational areas it is particularly important to treat the pine processionary (*Thaumetopoea*

Forest heritage sites. The Gazelle Memorial honoring the fighters in Israel's War of Independence, near Ma'ale HaHamisha.

Landscape and heritage. Characteristic terrace landscape in the Judean Mountains. Olive tree grove at Sataf.

pityocampa), as it poses a threat to visitors.

Tilling and plowing

These tools may be useful in treating recreational areas suffering from soil compaction. This topic .requires further study

Extensive Recreation Forests

Extensive recreation activity is suited to all existing types of forests. Forestry treatment in areas of extensive recreation focuses on the following:

1. Safety
2. Allowing movement through the forest (on roads or trails)
3. Reducing fire hazards
4. Creating potential scenic lookouts

Management Principles for Areas Designated for Heritage and Unique Landscape Formations

Heritage assets are assets of historical or cultural importance. They can be structures, areas or landscape formations that represent a given period or culture.

Some characteristic examples of heritage assets include archeological or historical structures, springs, ancient agriculture sites, and trees or groves of historical landscape significance.

In areas that have been designated for preservation and maintenance of a specific heritage asset, the forest structure and management activity will be adapted to the character and state of the asset designated for preservation and maintenance, as well as to planning considerations such as location, anticipated visitor activity, threats, etc.

Considerations:

1. Preserving, maintaining, and revealing significant remains in the area
2. Shaping the landscape according to the relevant period
3. Suitable presentation of the asset to the public
4. Maintaining the unique landscape formation, revealing it, and highlighting it in the surrounding landscape.

Below are two examples:

1. Terraces and ancient agricultural sites as heritage assets: striving to preserve and restore terraces and sustain vegetation formations such as orchards or other tree cover at low heights and densities that emphasize the terrace landscape and do not harm it.
2. Military heritage sites: striving to preserve remains such as trenches and bunkers together with the landscape that existed during the relevant historical period.

Management Principles for Areas Designated for Natural Assets and Unique Habitats

Natural assets for preservation include species, plant communities, and habitats, as well as landscape formations that are unique and significant to biodiversity. Defining designations of natural assets for preservation and maintenance may be done for areas in which these natural assets exist, in addition to supporting wildlife passages, water and food sources, and shelter areas requiring specific management. Examples of natural assets for preservation and maintenance include endangered species, flagship species, wetlands, etc.

Areas that are natural assets for preservation will be determined on the basis of existing information and future surveys.

In areas designated for preservation and maintenance of natural assets, the structure of the vegetation and management activity will be suited to the character and state of the asset, as well as to planning considerations, such as location, anticipated visitor activity, threats, etc.

Administration Principles in Areas Designated for Natural Assets and Unique Habitats

1. Gathering specific information regarding the natural asset for preparing a management program
2. Adapting management based on a broad biological and ecological understanding of the asset for preservation, while considering the diverse surrounding supporting factors, e.g., traffic routes, food sources, etc.
3. Mapping the major threats to the assets and addressing them (threat-focused management)
4. Considering the effects of adjacent areas and of their management practices on the natural assets.
5. Suitable presentation of the asset to the public

Unique Forest Management Issues

This section will focus on several situations and processes in the forest that require specific attention.

Coping with Aridity and Drought and Preparing for Climate Change

Most of Israel's forests were planted in areas with limited water sources that cannot easily sustain tall, developed forests. Moreover, due to the development and maturation of forests planted in the past, and following a series of drought years in the first decade of the 21st century, the forests are experiencing increasing tree mortality. This situation requires adaptation of the forest structure and management to water limitations.

Forest tree mortality due to drought. Dehydration of stone pines after a series of drought years at Ramat Hanadiv Park near Zikhron Yaakov in 2011.

Principles of Designing and Managing Forests in a Water-limited Environment

1. Forest density and structure should be adapted to the carrying capacity of the area with regards to water. A more arid habitat allows for a lower level of desired canopy cover (see Table 4).
2. Tree species and ecotypes in forests should be suited to the habitat conditions, particularly water limitation (resistance to drought). When deciding which trees to leave in the forest during thinning, preference should be given to drought-resistant ones.
3. Actions to reduce water loss (mulching, preventing runoff) and to harvest runoff will be implemented.
4. The increased risk of wildfires due to the desiccation and death of trees will be taken into consideration.

Natural regeneration from seed. Aleppo pines after the Mt. Carmel wildfire in 2010.

POST-FIRE FOREST MANAGEMENT

Forest development and climate change have led to an increase in the intensity and severity of wildfires in Israel. Post-fire forest renewal differs from the establishment of new forests and from natural regeneration in forests that have not experienced wildfires.

Forest wildfires open a 'window of opportunity' to shape and diversify forest structure when followed by reliance on natural succession processes. However, this process also has potential risks, particularly in cases of repeated wildfires in the same land unit or in cases of accelerated soil erosion. Treatment of forests following wildfire must also be performed according to a plan and tailored to the goals determined for the area.

Regeneration from buds at the base of a Quercus calliprinos after the Mt. Carmel wildfire in 2010.

Key Characteristics of Post-fire Forestlands

1. Massive regeneration of pines, particularly Aleppo and brutia pines, in the first two years post-fire
2. Regeneration of broadleaved species from stumps and roots
3. Risk of soil erosion and landslides
4. Risk of significant establishment and proliferation of ruderal and invasive species
5. Large amounts of burnt woody material, left standing and scattered on the ground

A coniferous forest that burned in the Second Lebanon War in 2006. Biriya region, Upper Galilee.

Management Considerations in Post-fire Forests

1. The guiding principle is the emphasis on natural regeneration processes, and management will focus on directing these processes.
2. Immediate post-fire management should focus on removing safety hazards and reducing the risk of soil erosion, if necessary.
3. Removing burnt material from the area will be done according to safety considerations (e.g., the danger of another wildfire), scenic and esthetic considerations, soil conservation, protection of natural assets, accessibility, and operational capacity. Priority of burnt material for removal should be given in the case of a safety hazard or high risk of repeated fire; this is determined by location, environmental conditions, and the amount of dry (burnt) material. Areas with limited accessibility will receive low priority. At least some remnants of burnt material should remain in the area, or should only be removed with the utmost care, e.g., manual removal of pruned material or leaving it on site, out of considerations for soil conservation and preservation of natural and heritage assets.
4. Once the decision is made to remove the burnt material, it should only be removed after the first post-fire winter, to minimize soil erosion. This activity should be avoided in the winter when the soil is wet. To reduce safety hazards from tree collapse and to minimize damage to regenerating vegetation, removal of burnt material should be completed within 4 years since the fire.
5. Planting will be performed when the natural regeneration is insufficient to achieve the required outcome according to the land-use designation of the area and the target forest. As a rule, it is advisable to wait at least five years before planting. Planting immediately after a fire will be performed only to fulfil specific needs.
6. If necessary, pines will be thinned within 2–7 years post-fire, or at an average tree height of 0.2–1.5 meters. If the intention is to create a coniferous forest, thinning will be implemented according to the recommended density up to age 10. In mixed forests, thinning will be more extensive, according to a patchy pattern (see principles of thinning in mixed forests). Additional thinning will be conducted according to the development of existing trees and the degree of natural regeneration in the area. When thinning young pines care should be taken to cut saplings low, around the root crown, or to pull the seedling out by the root.
7. Complete removal of pines from the area will be done at age 3–4 by low cuts in the root crown area of the trees or by pulling them out by the root. To obtain an area free of pines the process must be repeated once every several years, according to the degree of natural regeneration in the area.
8. Wildfires provide an opportunity to address soil erosion damage and restore terraces and ancient agricultural infrastructure. They also create opportunities for modifying the forest composition and structure according to its objectives.

A forest in the Neve Ilan area that regenerated after the Sha'ar HaGai wildfire (1995) and was subject to pine seedling thinning in 2012.

Natural Aleppo pine regeneration without fire in a planted forest in the area of Kibbutz Gil'ad, Ramat Menashe.

Aleppo pine forest created by spontaneous establishment of pines in an unplanted area. The forest was photographed three years after seedling thinning. Sataf Forest, Judean Mountains.

Renewing Coniferous Forests Based on Natural Regeneration (without fire)

Forest renewal is a planned process of establishing young trees in a currently or previously forested area. Natural regeneration is a spontaneous process (with no planting or seeding) of young tree establishment. Intentional renewal of forests can be based on natural regeneration processes. This approach is now a central tenet in sustainable forest management as it provides several important advantages:

1. Encouraging processes of selection and adaptation of the forest to its habitat
2. Reducing intervention and site disturbance
3. Lowering costs
4. Maintaining continuous cover and creating a patchy, age-diverse and landscape-diverse forest structure with a natural appearance

Controlled forest renewal should begin in a coniferous forest that is expected to complete its rotation within the next 20 years. When approaching coniferous forest renewal, it may be designed as a coniferous forest or a mixed conifer-broadleaved forest. According to current knowledge the conifer species that can be renewed through natural regeneration are:

1. **Aleppo pine** *(Pinus halepensis)*: renews itself successfully in habitats with a mean annual precipitation of 400 mm and above. Extensive natural regeneration can be expected on light rendzina soils that developed over soft or marly chalk. On terra rossa soils that develop over hard limestone and dolomite, natural regeneration tends to occur more moderately.
2. **brutia pine** *(Pinus brutia)*: regenerates successfully in relatively good habitats, on soft rock, in areas with a mean annual precipitation of 500 mm and above. Mt. Horshan and Biriya Forest are such cases. This topic requires further study.
3. **Cypress** *(Cupressus sempervirens)*: regenerates moderately well on soft rock, in areas with a mean annual precipitation of 500 mm and above. Ramat Menashe and Mt. Carmel are examples of such areas. This topic requires further study.

Steps to Renew Forests Based on Natural Regeneration

The following steps should be taken to renew forests based on natural regeneration:

1. Performing preliminary surveys to determine the potential for natural regeneration of conifers and broadleaved species at varying levels of shade.
2. Defining the target forest (coniferous or mixed forest).
3. Thinning the conifers on site and leaving only selected trees (parent trees for seeds) whose canopy cover accumulates to 10–20%. To

allow seed-eaters sufficient time to remove seeds from cut trees, the thinning should be performed in spring or early summer. Superior trees that continue to provide seeds for natural regeneration will be selected primarily by their vitality and health – proof of their suitability to the habitat. The criteria for health and vitality are foliage state (color, density), crown size and structure, and trunk appearance and thickness. Additional accepted considerations for selecting parent trees are straight, upright trunks, a balanced crown structure that ensures resistance to wind, and few cones.

4. Grazing must be withheld from the area or reduced significantly for a period of 5–10 years.
5. The degree of natural regeneration should be monitored and steps should be taken to encourage natural regeneration, if necessary, mainly by treating competing herbaceous vegetation. This topic requires further study.
6. Initial thinning of the regenerating layer should be implemented within the first 10 years after opening up the forest, according to the principles specified in the section on thinning. This can be done in areas where the natural regeneration pattern is patchy.
7. It is important to conduct repeat thinning in accordance with the development of the forest and the extent of natural regeneration in the area.

Treatment of Woody Material Accumulated During Thinning and Pruning

During pruning, thinning and other management activities, woody material – trunks and branches – accumulates on the forest floor. This section focuses on how to deal with these materials.

Options for Dealing with Woody Material

There are three options for dealing with woody material:

1. Leaving the material in the field without treatment
2. Treating the material in the field by one of three methods:

a. Piling it in heaps or in lines
b. Burning it on site

Shredding the material and spreading it throughout the forest

3. Removing the material from the forest. With respect to log removal, two options are available:

a. Mechanically dragging the whole log (skidding)
b. Sawing the wood and removing it manually

Considerations when Dealing with Woody Material

As a rule, ongoing removal of woody material from forests leads to a decline in the system's resources. Moreover, the act of removal in itself, particularly skidding trees, can damage vegetation, roads, terraces, and ancient facilities. Nevertheless, leaving woody material in the forest can increase the risk of wildfires, and even encourage infestation by pests, particularly bark beetles. Another consideration is that the rate of woody material disintegration under natural environmental conditions in Israel is very slow and continues for years (this topic requires further study).

Two things should be considered before deciding how to treat woody material – the type and amount of wood and the ability to remove the woody material from the area.

Removal of cut woody material with a small articulated loader from a coniferous forest after thinning. Aminadav Forest, Judean Mountains.

Chipping woody material with a giant chipper while thinning a coniferous forest.

The Type and Amount of Woody Material

It is accepted practice to leave the woody material in the forest when it amounts to less than 1 ton per dunam (0.1 hectare) . When the amount exceeds this, a decision should be made based on the estimated risk of wildfires and pest infestation. These risks depend on factors such as which tree species grow in the forest, the thickness of the woody material, and the state and density of the forest. All of this should be considered in relation to the removal capabilities.

The Ability to Remove the Woody Material

The ability to remove woody material from the area is affected by many factors:

1. The distance from a road or a skid trail
2. The slope of the incline
3. The existence of terraces in the area
4. The existence of infrastructure such as roads and power lines
5. The degree of rockiness
6. The existence of natural and heritage assets that must be preserved
7. The size of the logs to be removed

The Principles of Treating Woody Material

1. Removal of woody material from the forest should focus on the coarse material, i.e., trunks and thick branches.
2. Log skidding should be done along permanent skid trails to reduce damage to the soil and the vegetation and should be performed during the summer. Log skidding during winter is permissible only when the ground is dry. Skidding trees on wet earth causes long-term damage to the soil texture. Skid trails should be placed, if possible, parallel to contour lines to prevent formation of soil erosion tracks.
3. In sensitive areas, e.g., terraced areas and steep slopes, logs should be cut into pieces and removed from the area manually.
4. Some of the woody material may be retained in the forest by chipping and re-scattering it throughout the area. This should be done only with respect to maneuverability throughout the area and bearing in mind the damage that may be caused to soil and vegetation due to the introduction of mechanical equipment. Spreading thick layers of wood chips should be avoided.
5. The long-term forest treatment program (frequency and intensity of future thinning) should consider the consequences of removing woody material from the forest.
6. The detailed thinning operational plan should specify the method of woody material removal.

Runoff-harvest Forests

Runoff-harvest forests are planted in arid areas with a mean annual precipitation below 250 mm. In these conditions trees become established and develop as a result of runoff from extensive areas ("donating areas") that concentrates in a small area near the trees. Runoff-harvest forests in Israel are found mainly south of the Yatir-Lahav-Rahat line and north of the Hatserim-Be'er Sheva-Nevatim line.

Runoff-harvest forests provide a number of services:

1. They restrict and prevent soil erosion processes and decrease flood damage
2. They reduce water loss from the system and increase primary productivity
3. They provide shade for people and animals
4. They increase fodder production
5. They provide a base for recreational activity in desert areas
6. They develop the environment around residential areas
7. They restore ancient settlements and agriculture within the framework of heritage preservation

Establishing and maintaining forests in arid areas requires a continuous, high level of intervention compared to forests in the more humid Mediterranean region. This reality has environmental consequences that should be considered when approaching the various benefits specified.

Runoff-harvest Methods

There are two main methods of harvesting runoff:

1. **Contour bench terrace systems and furrows**: in this method runoff is collected from inclines with a slope of up to 30%, by soil embankments running parallel to topographical contour lines. This method is limited to areas with a mean annual precipitation above 200 mm.
2. **Dams**: runoff is collected in streambeds or their vicinity by earth or stone dams. When the runoff donor catchment is relatively large, this method may also be suitable for areas with a mean annual precipitation below 200 mm (see the principles of ancient agriculture in the Negev). Experience has shown that in areas with a mean annual precipitation exceeding 200 mm there is at least one assured runoff event every year. In areas where the level of precipitation is below this value, there may be years – occasionally a number of consecutive years – with no runoff events at all. It is important to plant particularly drought-resistant species in these areas.

Principles of Establishing and Managing Runoff-harvest Forests

1. Planning runoff-harvest forests should be based on the anticipated amount of runoff on the slope and in the streambed, in accordance with the amount of rainfall and the physical properties of the land, such as topography, rockiness, and soil characteristics.
2. The species of trees and the runoff-harvest system should be suited to the size of the donor area and the desired amount of runoff, to ensure the plantings survive during drought years.
3. The collection structure must be designed to withstand extreme rain and flood events. This is done primarily by building spillways to drain surplus runoff.
4. The planting density in runoff-harvest forests is 10–20 trees per dunam (0.1 hectare) . The trees should be planted in areas that receive runoff, i.e., streambeds, valleys or slopes whose slope does not exceed 30%. Steep inclines, areas with sodium-rich soil, and rock surfaces tend to serve as runoff donor areas and are not used for planting.

Runoff harvesting along a wadi in the Northern Negev.

Runoff harvesting in a local catchment in the Negev.

5. Runoff-collection areas in streambeds and at the foot of hills that enjoy improved soil quality and humidity conditions are suited to planting a wide variety of forest and orchard trees. Planting sites located on ridges and slopes should be planted with species that are more drought resistant and acclimated to arid climates, such as acacia and tamarisk species (among others).
6. To ensure successful establishment and good development of young saplings it is recommended to provide them with supplementary irrigation in the dry season during their first three years, in accordance with the amount and timing of rain and runoff events. Competing vegetation should be treated by mulching the soil near the sapling, as well as mowing and spraying.
7. The saplings should be protected from grazing for a number of years, consistent with the development of the trees. Grazing in these newly planted areas should be prevented until appropriate. Planting sleeves provide reasonable protection against sheep grazing, yet are not sufficient for preventing damage from cattle, goat, or camel grazing.

Coping with Invasive Plant Species

Invasive plants are those plants alien to the local habitat whose presence is a result of anthropogenic activity. They are considered invasive when they spread rapidly (over 100 meters in 50 years) and establish themselves extensively in new areas.

Invasive species may lead to tangible changes in ecosystems, excluding local species and causing financial damage. Sustainable management of open landscapes should strive to minimize the establishment and spread of invasive species. Nevertheless, the environmental consequences of actions intended to deal with invasive species, such as chemical pesticide spraying and so on, should be taken into account.

There are three elements in dealing with invasive species:

1. Avoiding the introduction of invasive species to Israel: in our context, this means avoiding planting alien invasive species in forests.
2. Preventing establishment and proliferation in forestlands: minimizing disturbances (e.g., certain types of soil cultivation) that encourage establishment and spread of invasive ruderal species.
3. Eradicating invasive species that have penetrated forestlands: taking steps such as spraying, uprooting, etc. to eliminate invasive species.

Visitor Management in the Forest

A prime objective of forests in Israel is to provide recreation, hiking, and leisure opportunities in the outdoors. Extensive forestlands border on settlements and are the basis for many public activities. Israel is a densely populated country and there is great demand for open landscapes for recreation. KKL-JNF considers it extremely important to develop recreational facilities in open areas, and insists that these services be provided free of charge.

'Visitor management' means intelligent planning and management of the visitor activity in the forest and the necessary supporting infrastructure. This management aims to provide optimal, sustainable recreational services.

The Goals of Visitor Management

The main goal of visitor management is adapting and balancing public demand while maintaining the sustainability of the forest. This should be expressed in the following manner:

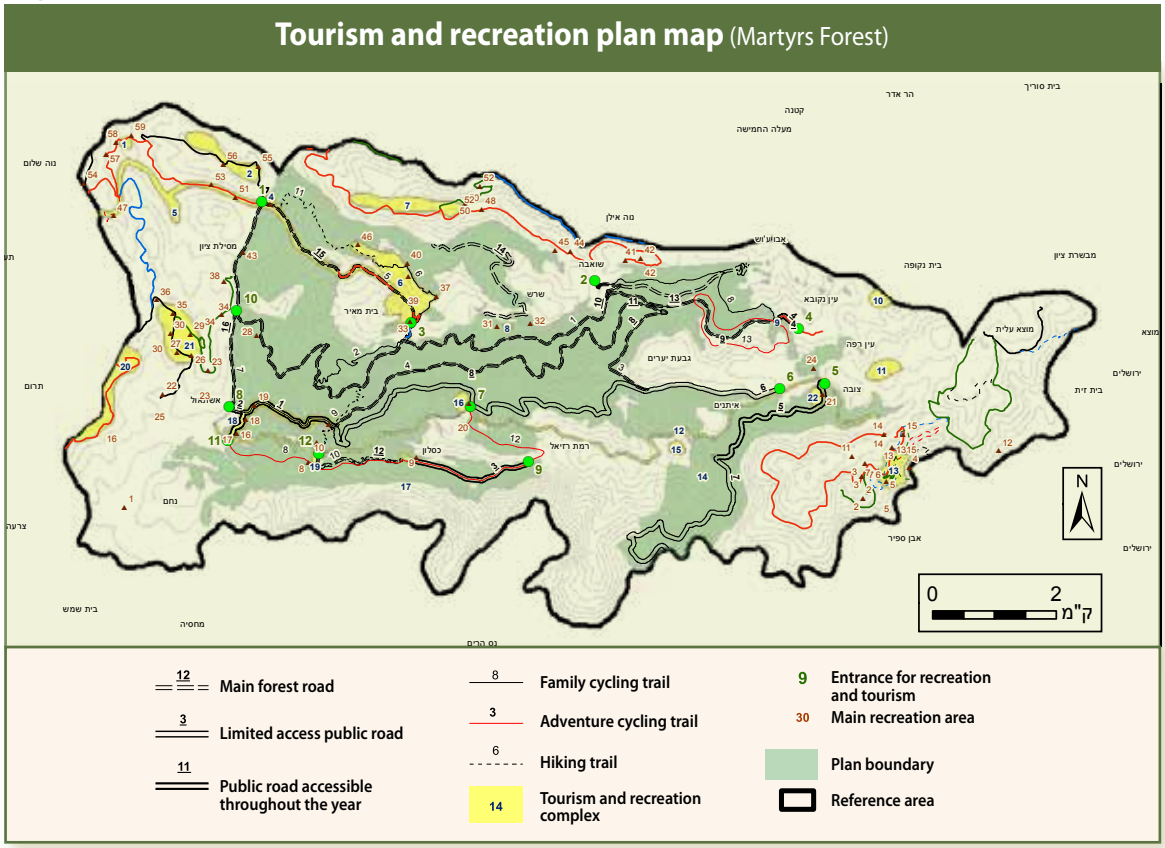
1. Regulating visitor activity in time and space, while adjusting it to the demand that changes over time
2. Tailoring the type of activity to the different forest areas
3. Accommodating for the infrastructure required in the forest
4. Educating the public and increasing its affinity for the forest and the outdoors

Considerations for Visitor Management in the Forest

1. **Forest location**: defining the target population and the type and intensity of activity according to its location in the forest
2. **Target population**: defining the types and extent of activities and infrastructure required according to the target population
3. **Public involvement**: connecting with communities and the forest user population through the forest planning and development process to attract visitors
4. **Natural, scenic and heritage assets**: defining the natural, scenic, and heritage assets in the area; ensuring their preservation and maintenance while simultaneously opening them to the public
5. **Preserving open landscapes**: encouraging visitor activity and improving the association of the public with open landscapes under threat of over-development
6. **Stakeholders**: coordinating development and public activity with stakeholders, e.g., local government, the Israel Nature and Parks Au-

Single-track bicycle trail in Adulam Park, the Judean Lowlands.

Figure 9



Example from the Martyrs Forest master plan. The map shows the plan for recreational infrastructure, including forest entrances, roads, recreation areas and sites of interest.

thority, and the Israel Antiquities Authority

7. **Entrepreneurship opportunities**: identifying the need for services and activities that could be supplied to the public by business entrepreneurs, such as restaurants and bicycle renting services
8. **Safety**
9. **Maintenance and operating restrictions**

Principles of Visitor Management in the Forest

1. Concentrating intensive visitor activity in specific sites and in limited areas and assigning most of the forest area to non-intensive activity or no organized activity.
2. Positioning large visitor reception areas, such as information centers, restaurants and memorial sites, adjacent to existing infrastructure such as roads, settlements and parking lots.
3. Developing visitor infrastructure based on the extent of existing or projected demand, bearing in mind the carrying capacity of visitor reception areas and the sustainability of the forest surrounding them.
4. Using methods and materials friendly to the environment and to human health for visitor infrastructure, e.g., non-toxic paint, materials that do not disintegrate and disperse in the environment, and closed containers for trash collection.
5. Integrating business initiatives to supply needs that have been defined, and which KKL-JNF cannot provide by itself. The goal is to provide the public with services and not to generate revenue for KKL-JNF.

Signage and information. Directional sign in Sataf Forest, Judean Mountains.

Visitor Management Plan

The visitor management plan will be a part of the forest plan. A more detailed plan will also be needed, particularly with respect to routine operation and safety in visitor activity areas. The plan should include the following elements:

1. **Defining the target population** according to the type of activity (cycling, picnicking, etc.), settlement or region, community, and sector (students, youth); if the target population resides in the settlement adjacent to the forest a specific site may be defined as a community or municipal forest.
2. Defining anticipated **scope of use**
3. A **road system** for vehicles and trails for pedestrians and bicycles, all open to the public in the forest
4. An **array of entrances** to the forest
5. A **signage and information system**: entrance, directional, informational and instructional signs, informative brochures and maps, and information available on the internet
6. **Defining sites and special places** in the forest, such as scenic lookouts, flowering sites, and natural springs, and determining their required development – access roads, installations and so on
7. Defining areas that will serve as **recreational areas** for intensive visitor reception and determining the development they require
8. An **accessibility** plan and consideration of special needs populations
9. Integrating **commercial entrepreneurship** to increase the diversity of visitor services, e.g., food, rental equipment, and guiding
10. A plan for **monitoring visitors** to track the extent, types and trends of use, in order to update the plan
11. An **operating system** with details of the routine actions required to receive and serve visitors, e.g., trash collection and removal, monitoring and maintenance of facilities and infrastructure, educational instruction, activities and information stations; specifying the required frequency for each action and the means required for it
12. A **safety file** that includes a survey of existing or potential safety hazards in the areas of visitor activity, details of necessary steps to treat them, and a plan for maintaining the safety system

Protecting Forests from Wildfires

Protecting forests from wildfires involves reducing the number of wildfires and the extent of the burnt areas, and in particular, minimizing the damage caused by wildfires to forests, property, .and human lives

To achieve this goal a number of steps are to be :taken before a wildfire breaks out

1. Analyzing the degree of fire risk and preparing a comprehensive plan to protect the forest from fire
2. Creating firebreaks to allow safe, effective fire extinguishing
3. Establishing firefighting infrastructures such as roads and water-refill stations
4. Performing forestry treatments to reduce the risk of wildfires throughout the forest area
5. Preliminary planning of firefighting steps based on the degree of risk and possible scenarios

Firebreaks

Firebreaks are areas designated to slow down the progress of the fire front and the fire intensity to allow safe and effective action by firefighting forces. This goal will be achieved by reducing the amount of combustible material in the firebreak and creating a horizontal and vertical break in the continuity of these materials.

We stress that firebreaks are designed to facilitate the work of the firefighters and not to stop the fire on their own.

Principles of Developing Firebreaks

The following two factors affect the rate of progress of a fire, in addition to weather conditions:

1. The incline of the slope – the steeper the slope, the stronger the fire will be.
2. The combustible material – the taller or more flammable the trees, or the greater the tree or shrub cover, the more intense the fire that will develop.

The schematic parameters of the firebreak width listed below will be adapted to the parameters of the specific area, i.e., in areas with steeper slopes and tall and continuous combustible material, the

Firebreak around the Mevaseret Tsiyon community.

dimensions of the firebreak should be larger, and in the opposite case, the firebreak should be smaller.

Types of Firebreaks

1. Firebreak surrounding a residential area: prevents the spread of fire from the forest into the settlement, and to a certain extent, in the opposite direction (from the settlement into the open landscapes)
2. Firebreak in the forest: divides the forest area into units and creates buffers between them to help prevent the fires from spreading from one unit to another

Structure of a Firebreak at the Point Where the Forest and Settlement Meet

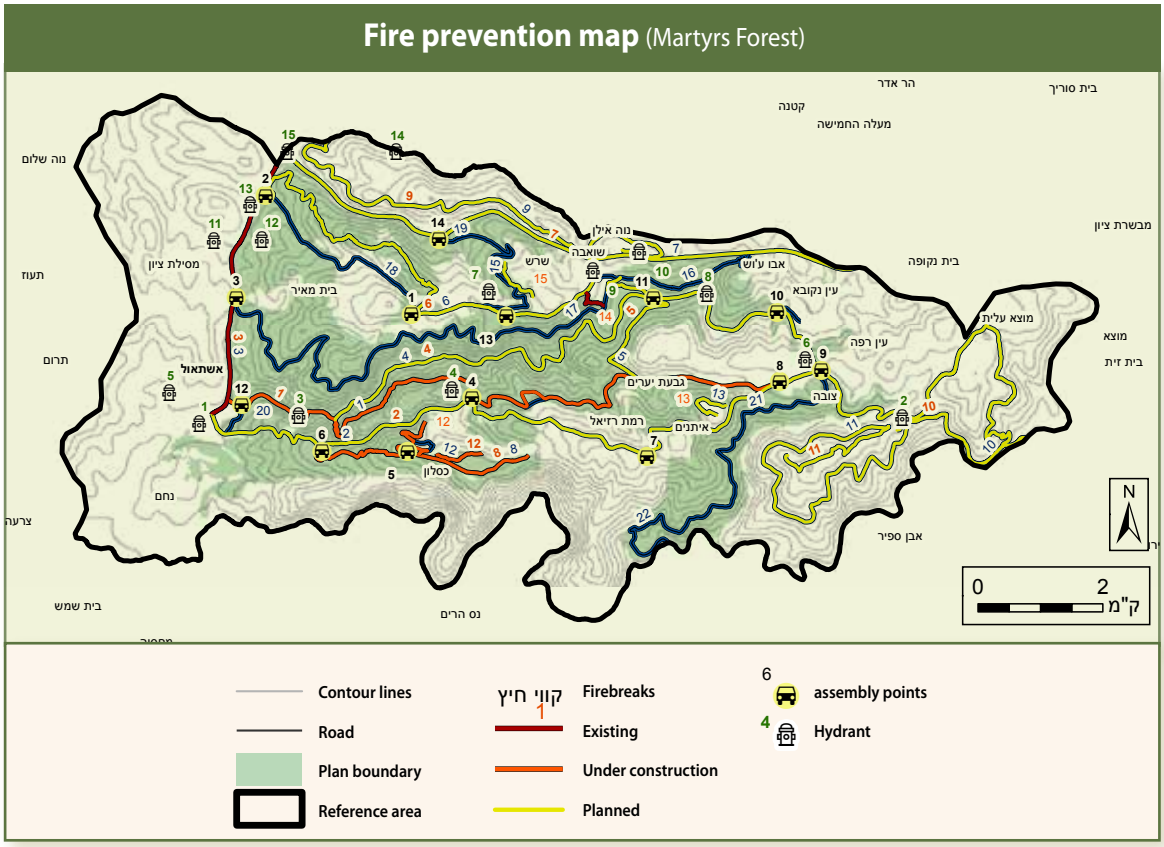
Firebreaks comprise two strips:

1. The first strip is 15–25 meters from the line of buildings towards the forest; it contains very sparse trees and shrubs (canopy distance of at least 10 meters) and the trees are pruned high. This strip includes a road adjacent to the line of houses and fire hydrants set on the side of the road at regular distances of 100 meters. It is possible to add giant sprinklers to the firebreak and apply preventive fire retardants in early summer.
2. The second strip continues from the first strip and is at least 50 meters wide; it includes sparse forest or woodland, with a canopy cover of 20–30%. The distance between crowns is 3–6 meters, depending on the species and the height of the tree. High pruning is required for trees and shrubs. This type of strip may be created in orchard formations as well.

In the Forest

1. Optimal location: on ridgelines, along wide roads with exits in both directions.
2. In the center of the firebreak there should be a road that is 4–6 meters wide.

Figure 10



Example from the Martyrs Forest master plan. The map shows the plan for firefighting infrastructure, including firebreaks, hydrants, roads, and gathering points for firefighting crews.

3. On both sides of the road there should be a strip 10–20 meters wide, clear of trees and shrubs ('clean strip'). The required width of the clean strip depends on the tree height and slope angle; the taller the trees and the steeper the slope – the wider the clean strip must be.
4. Adjacent to the clean strip, 35–50 meters on either side, there should be a strip of low-density forest, with a canopy cover of 20–30% and high pruning with no shrubs in the understory or contact between the tree crowns. This type of strip may be created in orchard formations as well.
5. Water-refill stations are to be placed near or on the firebreak.

Maintaining Firebreaks

The primary objective of routine firebreak maintenance is to prevent regeneration of trees and shrubs. The development of herbaceous vegetation should also be prevented as much as possible. Grazing, mowing, tilling, prescribed burning, spraying, and tree-cutting may be used for maintaining firebreaks. Firebreak maintenance will be performed according to the development of the vegetation. Grazing is the preferred method as it is the most effective and has the least significant environmental consequences.

Plan for Protecting Forests from Wildfires

To protect the forest from wildfires, a plan that includes measures to prevent fires and plans for fighting fires that eventually break out must be prepared. The first step is a fire risk analysis that serves as the basis for the entire plan. This analysis should include the following data:

1. The type and spatial distribution of the combustible material
2. The fire history
3. The potential damage to settlements, facilities inside and outside the forest, local habitats, etc.
4. The climate regime with a focus on extreme events

Ground firefighting with water from a firetruck. Mt. Carmel wildfire, 2010.

Aerial firefighting with seawater. Mt. Carmel wildfire, 2010.

5. The fire protection plan will include the following:

1. The entire reference area covered by the Forest plan, rather than the planned area alone, as fires are not limited to defined administrative areas.
2. Firebreaks
3. Roads and access ways to the area for maneuverability of firefighting forces
4. Water-refill stations
5. High-risk forest areas that should be prioritized for treatment
6. Preliminary planning of firefighting actions tailored to a number of different scenarios and degrees of risk