Viewpoint: A Brief Review of Afforestation Efforts in Israel

John Stemple

he establishment of the State of Israel and its land administration policies have generated political, ethnic, and religious controversies ever since the United Nations voted for the partition of Palestine on 29 November 1947. By 1961 the Jewish National Fund (JNF), also known as Keren Kayemeth Leisrael (KKL), had been designated by the Israeli government as the solely accredited agency for soil amelioration, land development, and afforestation. With Israel's fiftieth anniversary only weeks away, afforestation efforts continue utilizing five decades of accumulated experience.

Natural historians contend that Israel contained a wide variety of native trees in centuries past. In fact it is generally acknowledged (Azaria 1969) that in ancient times, "Woodland covered almost all the country. . .". Indeed it would seem that the land in general contained considerable flora.

Based upon the Hebrew Bible, and allowing for variations in the translations of its ancient writings, it would appear that many tree species were indigenous to modern Israel. Tree references (Walker 1979) from the biblical texts include: Acacia seyal (acacia); Amygdalus communis (almond); Buxus longifolia (box); Cedrus libani (Cedar of Lebanon); Cinnamomum cassia (cassia); Cupressus sempervirens (Italian cypress); Elaeagnus angustifolia (oil); Ficus carica (fig); Ficus sycomorus (sycamore); Juniperus excelsa (Grecian juniper); Juniperus oxycedrus (cedar); Myrtus communis (myrtle); Olea europaea (olive); Phoenix dactylifera (palm); Pinus halepensis (aleppo or Jerusalem pine); Pistacia terebinthus (terebinth); Pistacia vera (pistachio); Platanus orientalis (oriental plane tree); Populus alba (poplar); Populus euphratica (aspen); Prunus armeniaca (apricot); Pterocarpus santalinus (almug); Quercus aegilops (valonia oak);

Quercus ilex (holly oak); *Salix alba* (willow); and *Tamarix articulata* (tamarisk).

Much of the modern State of Israel was home to two Israelite kingdoms in biblical days, but the northern Kingdom of Israel was taken by Assyria in 722 B.C.E. and the southern Kingdom of Judah by Babylonia later on. Thus Roman and Byzantine (586 B.C.E.-614 C.E.), Persian (614-629), Byzantine (629-638), Moslem Arab (638-1099), Crusader (1099 - 1291),Moslem Arab (1291-1517), Ottoman (1517-1917), and British (1917-1948) "annexers" successively (Dosick 1995) administered the region.

The tree elements of "Palestine" (the designation adopted by Roman leaders) were mismanaged and neglected during the Diaspora. They were occasionally wantonly requisitioned for war and building material. Herds of grazing animals roamed the denuded areas and hampered the natural regeneration of foliage. Water erosion also took its toll. The eventual result was that the land (Azaria 1969), "reached its lowest ebb during the second half of the nineteenth century...in terms of its natural setting...".

During the latter 1800s settlers and visitors alike were astonished by the bleakness of the land. As a case in point, one day in September of 1867, a traveler named Mark Twain commented in his personal journal (McKeithan 1958) that, "Of all the lands on earth for dismal scenery, I think Palestine must be prince. The hills are barren...".

In the twentieth century rangeland degradation would continue. World War I was, in a sense, the coup de grace for the remaining large tree elements. As one author put it, the removal (Dregne 1983) of "trees and shrubs...in World War I was but the last instance of the deforestation that

began with the destructive felling of the Cedars of Lebanon, Syria, and Jordan 3,000 years ago."

Only a few decades later, during the Israeli 1948-1949 War of Independence, trees were indiscriminately burned. During this conflict it was estimated (Morris 1961) that 50,000 trees growing in the Balfour Forest of Ginegar and near the kibbutz of Shamir were burned by advancing troops. Another 115,000 saplings died during this conflict due to neglect while their Israeli caretakers were diverted by the necessity of defending the reestablished State.

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Most of Israel's remaining native tree elements (Tucker 1995) are located in areas of the Judean, Samarian, and Galilee Hills, and near Haifa. Maguis and other smaller woodland elements containing the following species can be found in various areas of the country: Acacia albida (acacia); Zizyphus spina-christi (Christ-thorn); Pinus halepensis; Quercus ithaburensis (Mount Tabor oak); Styrax officionalis (styrax); Quercus calliprinos (Kermes oak); Pistacia palaestina (Palestine terebinth); Laurus nobitis (bay tree); Cercis siliquastrum (Judas tree); Ceratonia siliqua (carob); Pistacia lentiscus (lentisc); Artbutus andrachne (Eastern Strawberry); Pistachia atlantica (Atlantic terebinth); Pyrus syriaca (Syrian pear); Prunus ursina (wild cherry); Acer obtusifolium (maple); and Platanus orientalis.

The absence of trees was not only obvious, but also severely felt by the residents. Even prior to Statehood it was recognized that the presence of trees would help to: raise the level of



Jewish National Fund (JNF) planting site in the vicinity of Golani, Israel.

underground water; create new soil; reinvigorate the earth; anchor shifting sand dunes; cover the hills with foliage and timber; protect young crops from fierce desert winds; provide cover and camouflage for the precursors to the Israel Defense Forces; provide forestry and timber employment; and make the bleak landscape productive, fruitful, and aesthetically pleasing.

The reintroduction of trees to the land was undertaken by residents, settlers, and immigrants. Eucalyptus trees, imported from Australia, were planted to drain areas where malaria infested swamps existed. According to the Jewish National Fund (JNF) its first forest was planted in 1908 at Ben Shemen, located between the city of Jerusalem and what would become the city of Tel Aviv. Some 12,000 olive trees were planted.

Trees were often planted between December and February, the period of heaviest rainfall. Due to Israel's climate the necessities of selecting species (Tucker 1995) which could survive the prolonged dry season between April to October was of paramount importance. An additional requirement was for a species which would survive in the shallow, high-pH soils of the limestone hills. *Pinus halepensis* was attractive because it is drought resistant and has a shallow root system. This species was planted extensively in mountainous zones.

Other early plantings included cypress, tamarisk, acacia, and carob trees. Tamarisks were planted in the depressions and salty swamps. Even in the desert the JNF went to work planting trees. In addition to early plantings of acacias and tamarisks in northern Negev gullies and wadis, and palms near Eilat and Yotvata, pinewood forests were eventually established.

In forest areas as of 1970 (Tucker 1995) approximately 89% of new planting was coniferous and 82% consisted of *Pinus halepensis, Cupressus sempervirens* and *Pinus brutia* (Calabrian pine). As late as 1995 *Pinus halepensis* accounted for at least 36% of the total forest species planted.

Nine Jewish National Fund (JNF) tree nurseries were established in different regions of the country between the period 1949–1960, so many of the saplings were propagated domestically. By 1960 nurseries, such as the one located at Gilat, had raised nearly 1,000,000 saplings for replanting annually.

Figures related to national tree establishment programs indicate an impressive growth rate over the years. Prior to 1920 contributors enabled 15,000 trees in six areas, covering 19 ha of land, to be planted. By 1948 the totals had soared to 5,280,000 trees at 72 different sites, encompassing nearly 2,368 ha. By the year 1960, the total plantings had reached 48,000,000 trees covering more than 18,569 ha. In 1968 the trees-planted total rose to 95,000,000. By the end of 1994 over 205,000,000 trees had been planted. By 1995 80,000 ha of planted forest and 40,000 ha of natural woodland had been established, and the JNF was planting almost 2,835 ha of new forests and utilizing nearly 3,000,000 saplings annually. Total forest coverage in 1995 was estimated at approximately 5%. As a former JNF official (Dr. Samuel I. Cohen, Executive Vice President for the JNF of America) related in a speech delivered at the USDA Winter Leadership Conference in Arlington, Virginia, on 26 January 1995, Israel will be the only country in the world that will have more trees at the end of the twentieth century than it contained at the beginning.

Experience and knowledge has enabled the JNF to achieve a planting survival rate of over 90%. The density of plantings averages from 160 trees per acre in arid zones to 600 trees per acre in hilly areas.

The JNF currently manages over 150 forests. Forests are maintained even in the Negev, where about 32 kilometers north of Beersheba the Lahov and Yatir forests green the arid landscape. These sites possibly represent the southernmost pinewood forests in the northern hemisphere.

The number of species being planted has been significantly increased since the early days, partially as a result of the spread of diseases through the primarily monocultural forests established decades ago. Another influence for the expansion of species is the move towards multi-purpose forestry. Trees are now needed for ecological reasons, recreational uses, and timber-related industries.

More than 80 species of trees are currently being planted. Native species such as *Quercus calliprinos*, *Quercus ithaburensis*, *Pistachia atlantica*, *Pistachia palaestina*, *Ceratonia siliqua*, Cercis siliquastrum, Olea europaea, and Arbutus andrachne are being introduced in greater numbers. Also conifers such as Pinus pinea (Stone pine), Pinus pinaster (Maritime pine), Pinus radiata (Monterey pine), Cedrus atlantica (Atlantic cedar), Cedrus deodar (deodorar cedar), and Cedrus libani have been recently introduced or reintroduced to the land.

The afforestation of Israel progressed via experience (trial and error) and experimentation, and despite natural disasters. A major goal of early afforestation was simply to plant trees across the barren land in an effort to make Israel's landscape alive and productive. Masses of trees were planted with a somewhat naive hope for their survival. Thus, while trees were considered critical to Israel in the fight against desert and wilderness, species mixes and forest management were not always comprehensively planned.

The need to more thoughtfully evaluate planting sites was becoming apparent to the Jewish National Fund (JNF) by 1950. Natural factors, which had been overlooked or underestimated in the haste to implement a large-scale afforestation program, contributed to this need for careful planning.

The JNF devised methods of planting, clearing weeds and underbrush, pruning, thinning, and trimming. Silvopastoral management methods were eventually undertaken to prevent "fuel loading" in forests as a fire reduction effort, and silvicultural intervention was implemented to enable proper tree development.

The result of the lessons learned was a concerted effort to take into account soil depth and texture, topography, force of rainwater runoff, and the average temperature and precipitation at planting sites. Furthermore the density of the plantings, the suitability of species, and site maintenance were all brought into play in determining plantings at any specific location.

Current site problems are illustrated by maintenance experiences of mixedspecies forests (Ginsberg 1995) such as Biranit, Meron, Sifsufa, and Sasa. In some areas it was found that the residual roots and stumps of several The Forestry Department realized that with comprehensive planning problems such as disease, fire, and stunted growth could possibly be minimized and made more manageable.

species, including Quercus calliprinos and Pistacia palestina, continued to grow even after the sites had been cleared and prepared for pine plantings. It was discovered that the residual oaks which grew in the open usually matured into shrub-like trees of less than 4 meters of attained height and intense intervention was required to shape them into single or double stemmed trees. Meanwhile, the oaks growing under a pine over-story sought light from the openings and grew taller (6 to 7 meters) and straighter, and with less side branching, with minimal intervention.

Since forests planted in the 1950s and 1960s are now attaining a normal rotation age, Keren Kayemeth Leisrael (KKL) forestry planners are sometimes able to revise their forest plans. Through natural lifespan processes they are provided an opportunity to redesign mature forests to include expanded species mixes and to provide for efficient multipurpose forest growth and maintenance.

However, forest rotation due to maturity is not the only opportunity JNF has been given to modify forests. Another scenario of forest redevelopment can be seen in the example of Baram Forest (Ginsberg 1995), which is located in Galilee. Baram itself encompasses approximately 1,000 ha. It was an even-aged forest of largely monocultural block plantings.

Pinus halepensis, the most plentiful species, Pinus brutia, and Cupressus sempervirens accounted for 85% of the forested area. Beginning in 1970 additional non-native conifers and native broadleafs such as Pinus pinea, Pinus radiata, Pinus canariensis (Canary Island pine), Cupressus arizonica (Arizona Roughed Barked cypress), Cupressus macrocarpa (Monterey cypress), Cedrus libani, Cedrus atlantica (Blue Atlas cedar), Cedrus deodora, and local varieties of Quercus, Pistacia, Cercis, Styrax, Arbutus (heath), Ceratonia, Laurus, and Crataegus (hawthorn) were introduced to expand the species mix.

Prior to 1992 fire damage and infestations of Israeli pine blast scale (*Matsucoccus josephii*) were the forest's only real problems. Then several atypically heavy snowfalls significantly damaged the forest. Nearly, 100,000 *Pinus halepensis* trees, representing 95% of the forest species and 35% of the total forest inventory, were destroyed.

Rather than being dismayed officials realized that this natural disaster provided the Keren Kayemeth Leisrael (KKL) with an opportunity to not only replace trees, but also make the forest more resilient. The Forestry Department realized that with comprehensive planning, problems such as disease, fire, and stunted growth could possibly be minimized and made more manageable.

In essence the revised Baram plan was an attempt to make the forest even more successful and durable by changing the structure of the forest from large, even-aged, monocultural blocks to smaller, even-aged, multi-species blocks of trees. Decisions as to what the forest's trees would be utilized for became a preliminary focus. The result was that certain areas were designated for commercial usage and others reserved for recreational purposes.

The areas of Baram having the most potential for commercial forestry were designated as "productive". Productive stands were designed to include two to four conifer species only. Planting densities in productive stands were adjusted to 1,600 trees per hectare, with a spacing of 2.5 by 2.5 meters.

"Nonproductive," or recreational sections, were to have as many as 12 conifer and broadleaf species. The plan called for 1,100 trees per hectare, with spacing of 3 by 3 meters. On steeper sites 600 trees per hectare were planned, with a planting spacing of 4 by 4 meters.

Since hot, dry summers are a con-



into effect in Israel itself. Over the decades since Israel's reestablishment, foreign dignitaries and officials have rolled up their sleeves and inserted a sapling into Israeli soil. Those whose names are not as recognizable have planted a far greater number of trees. These individuals are the true VIPs, or "Very Important People". According to the JNF the period between 1993-1995 saw nearly 100,000 visitors planting saplings at seven centers through the country. Photo A shows a Jewish National Fund (JNF) tree-planting site located in the Golani vicinity. Photo B shows an American "VIP" planting a sapling, which she purchased on-site from JNF stocks for \$10.00 (U.S.), during a visit this past May to Israel.

Conclusions

Susan Vesely-Gale plants a tree in Israel.

cern in the Baram area excavators with hydraulic hammers opened holes 50 to 60 centimeters deep into the bedrock to allow oak and pistachio seedling roots to grow downward rapidly and access deep-soil moisture. Planting tubes were used to boost the initial growth rates. In the first year of tube utilization the growth rate of the "tubed" seedlings was at least twice that of the other unsettled seedlings.

More than a century ago Mark Twain (McKeithan 1958) declared, "What Palestine wants is paint. It will never be a beautiful country until it is painted." As an outreach service to the friends of Israel, and the ecologically concerned around the world, the Jewish National Fund (JNF) operates tree sponsorship programs. Individuals who would like to donate money for tree plantings may often do so through their regional JNF office. Trees may be designated for planting as memorials or in honor of an individual who is personally significant in some way to the donor.

Referring to the land Twain also suggested (McKeithan 1958) that, "Each detachment of pilgrims ought to give it a coat. . .". As if in response to his suggestion, a "Plant a Tree With Your Own Hands" program was put

There is little doubt that Israel has demonstrated to the world the potentialities of afforestation. As then U.S. Senator Al Gore noted (p. 324) in his book, "the reclamation of the desert and degraded lands in Israel is one of the great ecological success stories, reversing centuries of land abuse ... ". Anyone visiting the country and who is aware of the land's natural history cannot but be cognizant of the fact that Israel and the Jewish National Fund (as Michael Aschenbrand, Director of Administration for the JNF of America. related in a speech delivered at the USDA Winter Leadership Conference in Arlington, Virginia, on 26 January 1995), "have restored an ecological balance to a land that was desolate."

Perhaps significantly for the world, Israel's effort can serve as a model (Gore 1992) for what could be accomplished all over the world. JNF forestry experts continue to experiment with new types of trees, cultivation methods, and new woodland protections against pests and the spread of tree diseases. For these reasons Israel's accumulated afforestation knowledge is shared with other countries through membership and participation in the International Arid Lands Consortium.

It would seem that the State of Israel has borrowed the spirit of Mark Twain's

travel journal entry. Israel is literally painting its landscape, and the "pigment" utilized has been trees. It is ironic to note that contemporary Israelis are only repeating what their ancestors had done and recorded centuries before, for the Scripture verse of Leviticus 19:23 strongly infers that their predecessors planted trees throughout the land: "you shall come into the land, and shall have planted all manner of trees..." (The Jerusalem Bible translation). Thus with each tree planted the "painting" of Israel continues.

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The author holds a Master of Arts Degree in Community Leadership. He recently visited a Jewish National Fund (JNF) afforestation site while in Israel.

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