Management of nature reserves for conservation of wild relatives and the significance of marginal populations

Uriel N. Safriel, Yehoshua Anikster & Miriam Valdman

Abstract

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Wild emmer wheat (*Triticum turgidum* var. *dicoccoides*) in Israel is used as an example of how the various roles of research and conservation and management practice may be determined in the conservation and management of wild relatives of cultivated plants. An account is given of the government-commissioned Ammiad project for the 'Dynamic conservation of the Wild Wheat in Israel', its prospects and the lessons that can be drawn from it.

Research vs. conservation and management

A major obstacle for the conservation and management of wild relatives of cultivated plants is the lack of clarity with respect to the timing for phasing out research and initiating conservation and management practices. It seems that both scientists and conservation managers tend to defer as much as possible this point in time; the scientists are interested in their studies and are eager to continue doing their job, whereas managers are overburdened with other duties, and the dynamic conservation of wild progenítors is not high on their priority list. This situation is well illustrated by the case of the wild emmer wheat in Israel.

Wild wheat in Israel

The wild tetraploid wheat *Triticum turgidum* var *dicoccoides* ($2n = 4x = 28$; genome AABB) is the progenitor of most cultivated tetra- and hexaploid wheats. It has a patchy distribution throughout the Fertile Crescent of the Middle East. The species does not receive special protection measures in Israel – those stands that happen to occur within nature reserves (ca 300 reserves in Israel, totalling ca 20% of the land, all under the responsibility of a government agency, the Nature Reserves Authority), are provided the same protection measures as the rest of the reserve's species, be they oak trees or gazelles. However, in 1984 the Israeli Ministry of Science and Technology commissioned a multidisciplinary scientific project named 'Dynamic Conservation of the Wild Wheat in Israel'. Six research institutes and about ten senior scientists were involved, throughout the 5 years of the project.

The Ammiad Project

The scientists selected the site of Ammiad, a mountainous rocky pastureland belonging to a farming settlement, the Kibbutz of Ammiad. This is not a conservation area, and given the legislation, social and political realities of Israel, it is not likely to become one. It has been chosen mainly by virtue of its significant habitat heterogeneity, and the fact that it is within the core area of distribution of the wild wheat in Israel. The study site was very small, but intensively used: within 0.1 km^2 four transects totalling 800 m were established, and in them ca 250 points were selected for detailed study. The site was first screened for its habitat heterogeneity by ecological classification and characterization of its sub- or micro-habitats. Then, the scientists studied the wheat plants by their habitats and explored (1) the spatial and temporal population dynamics; (2) the phenotypic variability; (3) the phenotypic plasticity (survey and experimentation); (4) sensitivity to pathogens (survey and experimentation); (5) the genetic variability of allozymes, and of High Molecular Weight endosperm glutenins.

Repercussions of the Ammiad Project

Following the last year of the project the Israeli Ministry of Science organized a concluding workshop. In the concluding discussion the then Chief Scientist of the Israeli Nature Reserves Authority requested from the scientists guidelines for a management plan for the wild wheat, for implementation by the Nature Reserves Authority. The researchers pointed out that since the study had been conducted at Ammiad, which is not a nature reserve, the elaboration of a management plan for the wheat in nature reserves, will require a study in these reserves. The researchers of Ammiad Project were not ready to propose a management plan for Ammiad as an exercise in application of basic science for conservation. Instead, a smaller group of the original Ammiad Project group, proposed to carry out a two-years basic research project in two nature reserves. This proposal was approved and financed, this time jointly, by the Nature Reserves Authority and the Ministry of Science and Technology. By the end of this project, a joint meeting of the research group and their two sponsors was held in early 1993. The scientists asked for more research time and funds, and the sponsors did not attempt to formulate a conservation and management program at that point in time, but approved additional two years of research, to terminate in 1994. Thus, as of 1984 and until 1994 research was, and is being carried out, with no tangible effect on conservation practices, and the wild wheat of Israel continue to evolve, we hope 'dynamically' for better or for worse, and to struggle for its existence, with no help from conservationists or scientists.

A conservationist's interpretation of the scientists'reports

Given past experiences and the state of affairs described above, it is not unlikely that research continues and conservation does not start. It is therefore necessary to propose a conservation and management plan now, using the current state of knowledge, irrespective of whether it is sufficient or not. Fortunately, the Ammiad Project was duly published in a comprehensive volume of the Israel Journal of Botany (Vol. 40. Nos. 5-6, 1991, Guest Editors Auguste Horovitz and Moshe Feldman). Playing a manager, the senior author of this contribution draws the following lessons from the screening of the published scientific reports of the Ammiad Project:

Ecology

(1) Wheat inhabits a diversity of microhabitats, which are discernible by microtopographical variability (Noy-Meir & al. 1991a); (2) density variations in both space and time are affected by rainfall, rockiness and grazing; (3) at a 1 m scale, extinctions and colonizations may reach 30% and 57%, respectively (Noy-Meir & al. 1991b).

Genetics

The genetic structure of the population reflects the three ecological attributes just described: (1) Isoenzyme variability is habitat-related and is richest in the most heterogeneous microhabitat (Nevo & al. 1991); (2) in the four loci of the High Molecular Weight glutenins, there were habitat-related frequencies (ranging 7-11 alleles and 4-11 genotypes per habitat), though the spatial directionality of this variation was very different from that of the isoenzymes (Felsenburg & al. 1991); and (3) there is a high spatial structuring of phenotypic variability and plasticity. A key statement made by the scientists here is that preservation of the largest possible number of phenotypes guarantees conservation of greatest genetic diversity (Anikster & al. 1991).

Objective and methodologies of a conservation and management plan

The above interpretation suffices for laying the foundation of an infrastructure of a dynamic conservation and management plan for wild wheat in Israel. The first step is to define the objectives of this plan, and then design methodologies that are likely to meet these objectives. The objectives are those of 'classic' conservation and of 'dynamic' conservation. 'Classic' conservation has two objectives:

(a) prevention of loss of rare alleles and rare genotypes. The proposed methodology is to prevent extinction of local populations, assuming that at present extinction of local populations is likely to result also in the elimination of rare alleles and genotypes from the population. The means of reducing chances of extinction are those of 'classic' conservation biology, namely attempting to conserve large patches and to reduce the distances between them.

(b) Maintenance of the currently known and existing genetic diversity. This can be achieved by conservation of a large spectrum of suitable habitat types. The objective of

dynamic conservation is the *promotion of the operation of agents of natural selection.* This can be achieved by inducing relevant 'natural' environmental changes, by the execution of cycles of fire (or felling) to induce secondary succession and of grazing (or mowing) to induce variation in grazing pressure.

A framework program for dynamic conservation and management

Based on the conservationist's interpretations of current scientific knowledge, and given the above objectives and matching methodologies, the following is outlines for a project aimed at a rapid initiation of a persistent dynamic conservation and management programme for wild wheat in Israel. This project consists of six phases, to be carried out within one year, at the end of which the conservation and management plan can start to be implemented.

Phase 1. Designation of existing reserves: use of existing data to overlay current distribution of wild wheat in Israel, and the distribution of existing reserves (using Geographical Information System), and after identifying reserves with wheat, execute field verification.

Phase 2. Survey of the designated reserves: use of existing data and attempt habitat classification, by mainly topographical, rock and soil types information. By use of information from Phase 1, it will be possible to identify all sites within a designated reserve which are suitable for wild wheat. Field verification will identify the inhabited and non-inhabited such sites.

Phase 3. Site selection within the designated reserves: a three-dimensional matrix will be followed, as far as feasible

Patch sizes:	10, 100, 1000 m^2
Distances between patches:	50, 500, 5000 m
Number of habitats in a patch:	one, two, three

In this way each reserve will have several patches, or 'sub-reserves' dedicated to the conservation of wild wheat. The effectiveness of the conservation programme will increase if these patches also include some other species that are wild relatives of cultivated plants.

Phase 4. Creation of a benchmark data base: (a) Characterization of each of the patches, by soil type and an integrated index of microtopography; (b) determination of the frequency of one, easily but reliably measureable, qualitative phenotypic trait. Since this should be done persistently every year by the manager (and not by the scientist), the emphasis is on simplicity, and low amount of resource and time investment. A more elaborate sampling routine is scientifically (and also from the conservation aspect) more meaningful; however, it is not likely to be carried out persistently, and is therefore totally meaningless, in the conservation context.

Phase 5. Formulation of a patch-related management plan: (a) each patch type will 'move' through an 8 year cycle with respect to fire (or mowing) that will initiate succession that will last 8 years until the next fire; and with respect to grazing by livestock (or wildlife), with two years of low-intensity, four years of medium- intensity, and two years of high-intensity grazing. (b) all phases of grazing and succession should co-occur in the reserve, temporally. These two measures guarantee that the climate of any given year will have the opportunity to affect the different management phases, yet each patch type will not be stable from one year to the next, even when the climate happens to be stable.

Phase 6. Preparation of a Public-Relation (PR) programme. This is the most critical phase. If by the end of the year of the project, such a programme is not ready, conservation may not follow this project, or, if it follows, it is unlikely to persist. Conservation bodies currently need a tangible incentive for being engaged in dynamic conservation. It is a lot of effort, directed at items which may be regarded as insignificant, as compared with working on other more attractive life forms. The PR programme has the objectives of increasing awareness and interest not only in the public, but also among the managers and conservationists themselves, as well as among politicians and the scientific community. The PR programme is the tool for generating commitment by the managers, and is the sole mechanism that can guarantee and maintain long-term persistence, without which dynamic conservation is pointless and meaningless.

And where does research come in?

The major asset of this plan is that it does not rise or fall with research. The design can be looked at as a huge-scale scientific experiment, performed by conservationists, and ready for analysis by scientists. Some aspects of this design are likely to achieve the goals, others may be ineffective, and some may be even deleterious.

But overall, the bottom line should be positive.

Yet, it is up to the scientists to challenge this programme, to find where it is bound to fail, to ascertain that it indeed failed, and to propose something better, based on robust knowledge.

The prospects of the programme

The above-outlined programme can be executed within one year, at a cost of ca $50000. After ten years of research, may be it is timely to devote one additional year for setting the stage of a conservation plan, and then start to implement it.

The proposed project can be followed immediately by an initiation of a long-term conservation and management programme, that can be carried out at a much lower cost, absorbed by the ordinary budget of the conservation authorities.

It is a local programme, but it will conserve dynamically a species of a global significance.

Though the cost is relatively low, it is likely that there is not sufficient incentive, locally, to raise these funds. Outside support, given also the current political atmosphere in the Middle East, may provide the necessary push and the required incentive.

Priorities - marginality and global climate change

It is likely that in the first stage the wild wheat will be found in more than a few reserves, and priority choice will have to be made. In this respect, it is instructive to examine some results from the two reserves project, by Anikster, Horovitz, Feldman, Felsenburg and Agami (report to Nature Reserves Authority and Ministry of Science and Technology 1991-1992, 1992-1993), summarized in the following table:

		Reserve A	Reserve B
Biogeographical distribution of wild wheat		core	margin
Population dispersion		dense	sparse
		large	patchy
Number of glutenin genotypes		5	8
Number of glutenin alleles		7	10
Genotypic variance			
	within patches	large	small
	between patches	small	large

Thus, the marginal population is more diverse. Should climate change prevail, marginal populations of wild wheat are likely to persist better and withstand the changes, due to their greater genetic variation (Holt 1990).

Priority for dynamic conservation should be therefore given to the marginal rather than to core areas of distribution of wild wheat.

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Addresses of the authors:
Dr. U. N. Safriel, Department of Evolution, Ecology & Systematics, the Hebrew University of Jerusalem, Jerusalem 91904, Israel.
Dr. Y. Anikster, Department of Botany and Institute of Cereal Crops Improvement, Tel Aviv University, Tel Aviv 969978, Israel.
M. Valdman, Ministry of Science and Technology, Jerusalem, Israel.