



Global Re-introduction Perspectives: 2010

Additional case-studies from around the globe
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IUCN/SSC Re-introduction Specialist Group (RSG)





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Reinforcement of the populations of critically endangered endemic fern *Diellia pallida*, Kaua'i, Hawaiian Islands, U.S.A

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Introduction

Diellia pallida (Aspleniaceae) is the endemic fern to the island of Kaua'i. It is a species of the lowland diverse mesic forest or Diospyros/Metrosideros mesic forest communities on the northern slopes of the western ridges of Koke'e Mountains. The natural population of *D. pallida* consisted of 13 mature individuals on three sites, only eight of these were reproducing (Agurauja, 2004). *Diellia pallida* is federally listed as Endangered (U. S Fish & Wildlife Service Species List, 25th February 1994). Corresponding to the IUCN criteria (IUCN, 2001) this species belongs to the category of globally critically endangered plant species (Agurauja & Wood, 2002). Due to very small number of existing individuals, their very narrow distributions, obligatory out crossing and slow recruitment, *D. pallida* is a subject to increased likelihood of extinction through any stochastic extinction event. The major threats to extant local populations of *D. pallida* are habitat degradation by animals (substrate erosion caused by trampling of goats, pigs, mule deer, red jungle fowl) and direct disturbance (trampling, uprooting and browsing). Trampling and erosion are the major factors of high mortality in gametophyte generation and sporeling stage, what in long term may lead to the depletion of natural spore bank.

Goals:

- Goal 1: Protection of all extant individuals as the main spore source for the habitat.
- Goal 2: Establishment of experimental population patches within known historical distribution area.
- Goal 3: Establishment of new natural generations, population recruitment.
- Goal 4: Species survival on the landscape within its natural communities; self-sustaining persistence of the populations and their normal evolutionary process.



The endemic fern *Diellia pallida*



***Diellia pallida* habitat in Mahanaloa Valley in Kokee Mountains on the island of Kauai**

- **Goal 5:** The model method for the conservation of critically endangered fern species of same growth form and life cycle specificities, in the tropics and elsewhere, where the habitat conditions allow the recovery/restoration of the species.

Success Indicators

- **Indicator 1:** Survival of out planted individuals, increased number of mature spore producing individuals in the site.
- **Indicator 2:** Establishment of new generation.
- **Indicator 3:** Colonization

and establishment in new empty patches of suitable habitat, extended distribution.

Project Summary

The conservation oriented research of *Diellia pallida* was started with the condition assessment of extant individuals and populations (Agurauja, 2001). As emergency, the cages were put on last mature individuals protecting thus the last spore source against browsing by feral animals. The cages also helped to stabilize the soil around the plants. Few rhizomes, uprooted by feral pigs and goats, were planted into the neighboring fenced ex-closure. With these activities, detailed observations and documentation of the changes in population structure, the research was continued (Agurauja, 2005). Protection of mature individuals and coincident more favorable weather conditions during 2003-2006, resulted in a drastic increase of gametophytes and sporelings of *D. pallida* in two local populations, demonstrating that habitat conditions are still suitable for germination and establishment of younger stages. The analyses of population regeneration still showed very low survival of younger developmental stages. Regardless that hundreds of sporelings developed during the winters of more favorable years, less than percentage of these survived till next winter, mainly because of the trampling, wash out and erosion.

In 2006, the preparations for propagation and reinforcement experiment were started in collaboration with National Tropical Botanical Garden (NTBG). The encouraging factors were: the high natural germination in the habitat; *D. pallida* was tolerant to the replanting; empty patches of suitable habitat in the historical distribution area; some fenced ex-closures with suitable microhabitat conditions within historical distribution area. As the trampling and erosion were documented as main factor for the death of the individuals in younger stages, it was also decided to learn rescue the eroded sporelings and boost them up as emergency

method for increasing the number of individuals. The main idea of recovery experiment was to reinforce the natural population by increasing the number of individuals and spore source of the habitat; to test if gradual imitation of natural population recruitment would influence the efficiency of population reinforcement efforts; and to test if establishment of experimental populations within fenced enclosures would affect the dispersal of the species via colonization of new patches of suitable habitat within the whole historical distribution area.

Two parallel but complementary lines of research were conducted: 1) propagation efforts in the laboratory and nursery conditions; and 2) reinforcement experiment and observations of natural and experimental populations in the field. The propagation trials were started with the sowing of single individual spores (N. Sugii, Lyon Arboretum). It was learned then that *Diellia* gametophytes may perennialize and live three to four or more years, and that they may be obligatory out-crossers. The germination tests with the mix of spores originating from different individuals resulted in first sporelings and showed also that *Diellia* ferns are very slow in their younger life stages. It took a year from the sowing to the emergence of the first sporeling of *D. pallida*. The stock *ex situ* conservation collection was created and divided between the propagation nursery in Lawai'i (NTBG) and the restoration area of Limahuli Garden (NTBG). Considering the patchy distribution and availability of safe and protected sites, seven experimental population patches were established in 2007. According to the recovery criteria for the Kauai Plant Cluster (USFW 1995) and available micro-sites, 30 individuals were planted into each. Simultaneous surveys of population dynamics of natural and experimental populations were started. Since the survival has been highest in two sites, indicating that habitat conditions must be still suitable for *D. pallida* in there. Based on the analyses of the survival rates and microhabitat conditions of this first out planting, the optimum number of individuals will be worked out for the plantings during several consecutive years.

Major difficulties faced

- The uncontrolled disturbance by introduced game and feral animals in the habitat.
- The uncontrolled erosion in the habitat, scarcity of safe sites.
- The uncontrolled insect damage and fungal disease.
- Stressed mature individuals staying sterile, extreme population fluctuations during longer dry periods.
- Difficult to propagate the species, obligatory out-crosser.
- The native forest community losing its structure: increased smothering effect of the leaf litter, less ground vegetation, drier soil.
- Only very small patches of the native forest community were protected by fences, most of natural germination areas were located outside of fenced areas.
- The current and historical distribution area is divided between several landowners.



Soil sampling for soil spore bank tests in the natural habitat

Major lessons learned

- The population monitoring showed that population dynamic followed the local climate pattern of the cycle of wetter and drier years, where the germination and establishment of new individuals was successful during the period of more favorable conditions and could completely fail during the drier period. The best timing for more successful population reinforcement activities would be during the winter months of wetter years.
- For more successful reinforcement and population

recovery additional research of micro habitat conditions is needed, as the choosing the appropriate microhabitat site is crucial for the survival of the fern individuals.

- The boosting of disturbed individuals of *Diellia pallida* and propagation in ex situ conditions should be short-term and in toughening conditions for future planting into natural habitat, decreasing thus the after planting environmental stress and increasing the potential survival of the individuals in the site.
- The individuals of fern species *Diellia pallida* need after-care and site management during their first year in the site.
- The single out planting into the habitat equals to a single occasional natural distribution event. It may take very long time until structured self-sustaining population evolves naturally, particularly in relatively hard conditions of mesic forest on steep slopes, and probability for this event to happen is as big as that of extinction. It was learned that the out planting should be gradual during several consecutive years or by the cycles, imitating thus the natural colonization, population growth and establishment of structured self-sustaining population.

Success of project

Highly Successful	Successful	Partially Successful	Failure
		√	

Reason(s) for success/failure:

- The appropriate habitat conditions still exist and support the establishment of new individuals, if protected against introduced animals.
- The methods and plan for further bigger population reinforcement within the whole distribution area on the landscape have been worked out and tested.

The initial results show that the recovery of the fern species *Diellia pallida* is possible. Since, the study of ecology, population monitoring, and restoration tests have been conducted within the framework of scientific research project initiated by the researcher. For further success in landscape level recovery of the species, the institutional collaboration for the protection of the sites, propagation of the plants, population reinforcement, conservation management activities and population monitoring, needs to be build up.

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