Vegetation reinforcement in a new and anthropised park: The case of Inwadar National Park, Malta

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INTRODUCTION

Inwadar National Park (INP) is a recently-established protected area in Malta, designated as a Special Area of Conservation (SAC).

Established: 2019
Area: 0.95 km^2
Location: south-eastern coast of Malta
Land cover: predominantly rural
Phytocoenoses: fragmented, mainly coastal scrubland on which a ruderal flora is superimposed. Secondary ecological succession in abandoned agricultural areas.
Principal challenge: restoration of a 'natural' geobotanical climax vegetation in an anthropised area.

Aims:

- Analysis of the present phytocoenoses and edaphic conditions in INP.
- Reinforcement of some existing natural plant populations.
- Proposal of plausible strategies for targeted reinforcement of characteristic vegetation as part of a broader restoration strategy.

METHOD

Step 1: Assessment of land uses in INP

a. Human impact evaluation through categorisation of land uses and direct observation.
b. Construction of a detailed orthomosaic photo by means of UAV imagery captured with a a DJI Mavic 2 Pro drone in 2022.
c. Analysis of orthomosaic to produce a land cover map of INP (**Figure 1**).

Step 2: Assessment of edaphic conditions:

a. Analysis of physical and chemical properties of topsoil including granulometry, water retention, electrical conductivity, pH, nitrate content, phosphate content, and organic matter content. Samples were collected from 15 points in INP in an approximate grid pattern.
b. Analysis of any relationships between the soil characteristics and (i) proximity to the sea, and (ii) land use (**Figure 2**).

Step 3: Targeted reinforcement and monitoring:

a. Selection of species for targeted reinforcement by assessing the coastal vegetation and comparing Ecological Indicator Values.
b. Collection of cuttings and seeds from wild specimens in late 2021 and culturing them in the laboratory for fourteen months through artificial asexual propagation and in vitro seed germination techniques.
c. Transplantation of approximately 60 cultured plants into the wild, mainly of *Limbarda crithmoides*, *Suaeda vera* and *Jacobaea maritima.* These were relocated into edaphically-appropriate 'intervention areas' in INP (**Figure 3A**) in January 2023.
d. Assessment of the general and photosynthetic 'performance' of cultured plants after transplantation into the wild. Their 'state of health' was based on objective visual assessments and chlorophyll concentration measurement of leaves, recorded at regular intervals (**Figure 3B and C**).

RESULTS

Step 1: Assessment of land uses in INP

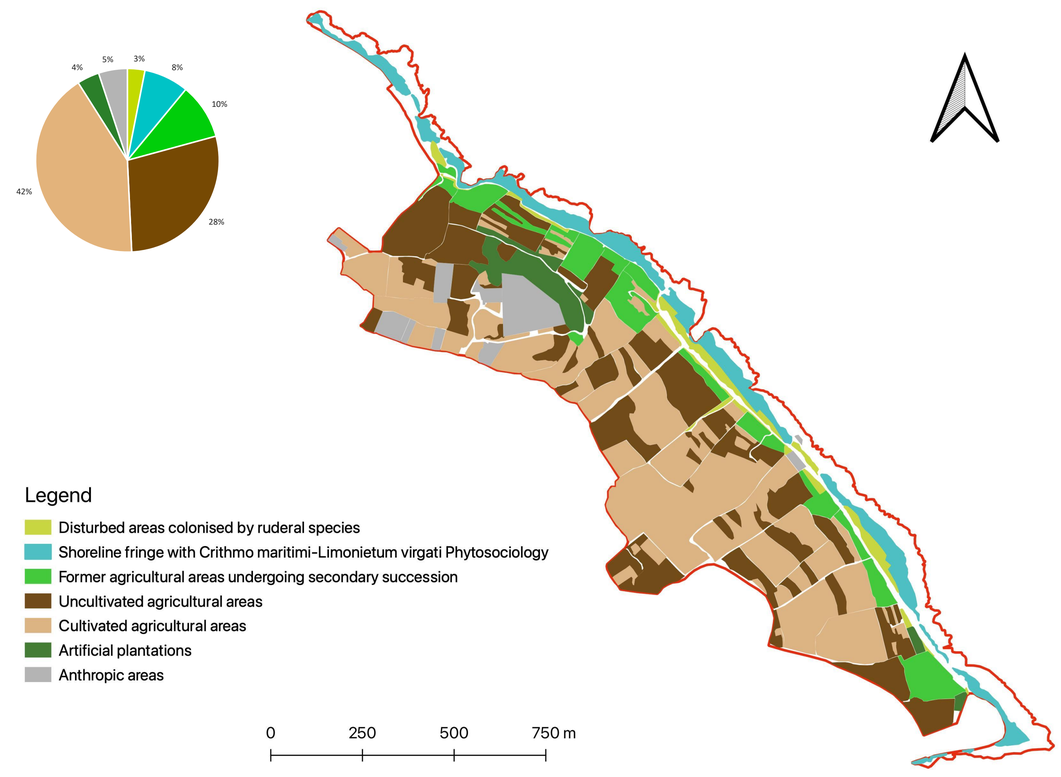

Figure 1: Land cover map of INP.

Major human impact in INP is habitat modification, including soil importation, clearing vegetation, land terracing, and planting of synanthropic species.

Figure 2 indicates a clear gradient of land cover perpendicular to the shoreline:

- A **coastal platform** that has maintained its natural cover
- A narrow strip of **ruderal cover** along the margins of the dirt path
- **Abandoned agricultural areas** undergoing secondary succession
- **Agricultural land** mostly under active cultivation, with a few patches of uncultivated agricultural land.

Step 2: Assessment of edaphic conditions

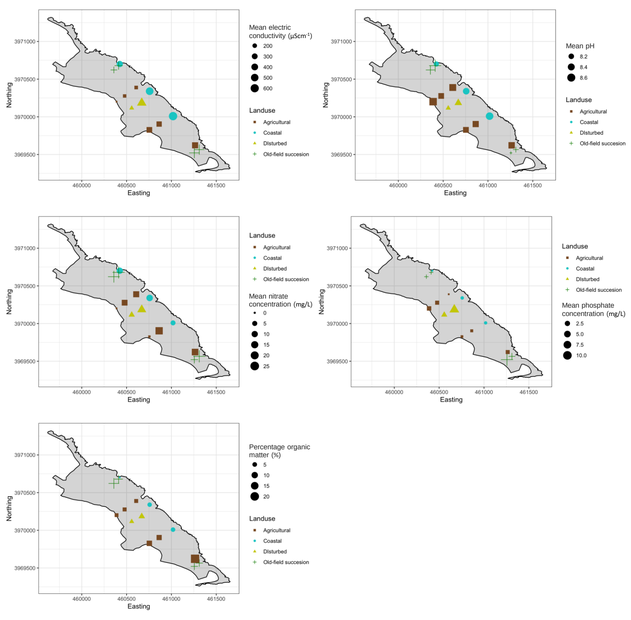

Figure 2: Plots of the mean values of parameters measured for the topsoil in INP (electrical conductivity, pH, nitrate concentration, phosphate concentration, and percentage organic matter), in relation to land-use category and distance from shoreline.

Variation patterns of soil parameters were not monotonic, with the exception of electrical conductivity and nitrate content, where both decreased with increasing distance from the shoreline.

Throughout INP, the **soil texture** was mostly consistent with a 'fine sand' on the Wentworth scale.

Step 3: Targeted reinforcement & monitoring

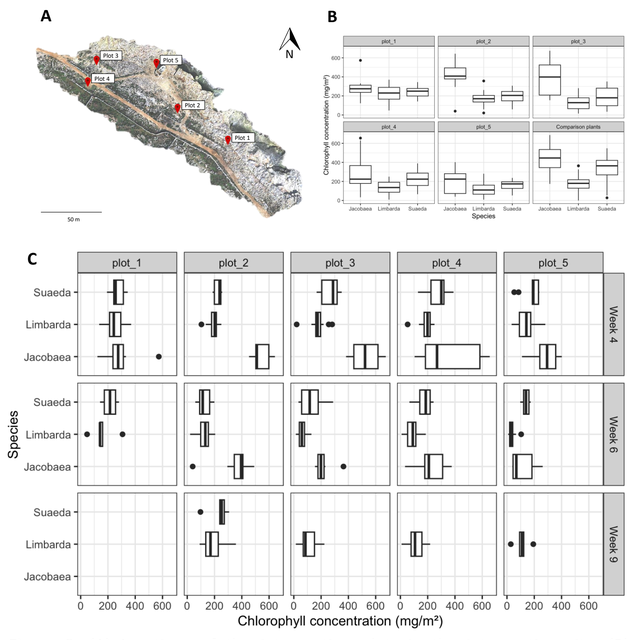

Figure 3: (A) Locations of the intervention plots in the intervention site, (B) Chlorophyll concentration (mg/m^2) in the leaves of the target species in each experimental plot after 4 weeks from planting, and in the leaves of the "Comparison plants" growing in situ, (C) Chlorophyll concentration (mg/m^2) in the leaves of the target species in each experimental plot after 4 weeks, 6 weeks and 9 weeks.

Mortality of the introduced plants was approximately 80% after nine weeks post-introduction. This was attributed to environmental stress, although a spike in mortality was also recorded after a major storm that was followed by a long dry period. Lowest mortality was noted in *Limbarda crithmoides*.

CONCLUSIONS AND RECOMMENDATIONS

#1. Sparsely Vegetated Coastal Fringe

Targeted reinforcement: UNNECESSARY

Natural re-colonisation of characteristic species would be sufficient to fill gaps in the habitat.

Moreover, due to high natural plant mortality rates in this sector, restoration efforts would be more fruitful if employed in other sectors of INP.

#2. Areas undergoing secondary succession

Targeted reinforcement: UNNECESSARY

Areas should be left to develop naturally.

Reinforcement here would require the clearing of plants to create gaps for the introduction of target species, creating sinks for fast-growing opportunistic species, who would then compete with the target species introduced.

#3. Heavily disturbed areas

Targeted reinforcement: FEASIBLE

Recreating the natural ecological zonation of vegetation.

These disturbed margins are close enough to the shore to give halophytes a selective advantage and their introduction in this area would serve to extend the inland spread of the coastal community, creating the characteristic coastal phytocoenoses.

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