**Management protocol**

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| Sector/ TOPIC: Flora  Components: Plant (Terrestrial Invasive Species) | | |
| *TITLE OF THE PROTOCOL: Invasive Plants Management Plan in TCNR* | | |
| tARGET AREA: TCNR (SCIENTIFIC ZONE) and Abbasieh (Nature Reserve zone) | | |
| frequency: Yearly | | |
| **MONITORING RATIONALE (System Component)** | | One of the increasing threat for the ecosystems, in particular the dunes along the coastal areas, is the biological invasion. The Non-native plant species, when become invasive, can outcompete and replace native vegetation. Their aggressive growth can alter the composition and structure of these fragile ecosystems, affecting wildlife habitats and disrupting the natural balance (Kozhoridze et al 2022).  *Heterotheca subaxillaris*, known by the common name camphorweed, is a member of the Asteraceae family. Its classification indicates it as an annual plant, although it can occasionally exhibit biennial or perennial characteristics (Halvorson and Guertin 2003). It engages in competition with indigenous vegetation, vying for essential resources like water, nutrients, and sunlight. Its flower heads typically remain closed for about ten days, during which time the fruits reach maturity. Seed maturation and dispersion typically take place in autumn. This plant yields two kinds of seeds: the initial type originates from the disc floret and can germinate promptly under both light and dark conditions. The second seed type arises from ray florets, necessitating a one-year period of dormancy before germination, which occurs in well-lit conditions. As *Heterotheca subaxillaris* matures, it may potentially exhibit the capacity for rootstock resprouting. These characteristics, among others, render this species highly invasive, posing a significant threat to native and endangered species, including *Astragalus berytheus*, endemic for Tyre (Bou et al., 2016).  The Camphorweed's native place of origin can be traced to the southern regions of the United State (USDA, 2016) . In 1975, an initial introduction of this plant took place in the Middle East, specifically south of the Lebanese border, with the aim of stabilizing mobile sand dunes. Between the end of October 2008 and the beginning of the following year, a limited number of camphorweed plants were first spotted in Lebanon, near TCNR (Tohmé and Tohmé 2009).  Invasive terrestrial plants have established themselves in various parts of the Tyre coastal area, including the terrestrial parts of the protected areas Abbasieh (Nature Reserve) and Hema Al Mansouri (Figure 1).  Figure 1    Ongoing research is being conducted in Abbasieh and is projected to conclude by the end of summer, under the supervision of the Southern Green Association. However, research on Hema Al Mansouri has not started yet. Acknowledging the significant role played by MPA networks and analogous coastal areas in promoting sustainability goals through comprehensive coastal management, we can consolidate these endeavors in collaboration with Abbasieh Nature Reserve. |
| **MONITORING GOAL** | | The primary goal of this management strategy is twofold: first, it strives to conserve native biodiversity by preventing invasive plants from overtaking and replace indigenous plant species. By eliminating invasive plants within a specific area, the aim is to prevent their dissemination to surrounding areas.  Moreover, the attempts to control and eliminate invasive plants open doors for scientific exploration. This involves in-depth examinations of how invasive species impact native flora, fauna, and ecosystems, while also evaluating the efficiency of eradication approaches. Additionally, these efforts create educational prospects, especially for school student (particularly, this pertains to those individuals who will be actively involved or take part.), to understand relevant impacts of invasive species on the ecosystem.  In conclusion, collaborative efforts and harmonization between the two marine protected areas will assist us in organizing actions, sharing expertise, promoting the conservation of a diverse range of marine species and habitats, and exchanging vital data crucial for informed decision-making. |
| **LABORATORY ANALYSIS NEEDS** | | \_ |
| **DATA ANALYSIS AND INTERPRETATION PROTOCOLS** | | Data will be entered into the ISP system by TCNR, with responsibility shared between the Project Manager and the Technical team. The table will contain the following metrics: locality, year, month, day, coordinates, area (square meter), and biomass. Data insertion will occur on a daily basis throughout the duration of this project.  The cause-effect analysis for this protocol analysed the potential impacts of invasive species on the endemic plants. To explore better the relations between these two plants’ categories and collect information aimed to explore and quantify this dynamic, it is essential to monitor the endemic plants presence and distribution both before and after the eradication process. The outcome of this data will spread and communicate on the website of TCNR, Green Southerners, and with publish informative and scientific articles. |
| DSS System Diagram & INDICATORS | | |
| **DIAGRAM ELEMENT:**  **[Plant Species (Id=1029)]**     |  |  |  |  |  | | --- | --- | --- | --- | --- | | Indicators attached to component: [Invasive species (Id=32)] -> Terrestrial Species (Id=33) | | | | | | **Name** | **Description** | **Data Source** | **Update Frequency** | **Notes** | | Presence of *Heterotheca subaxillaris* | Estimation about the extension in surface of removed plants |  | Annual | Removed every year by hand | | Terrestrial Invasive Species | Field survey for plant species (invasive and endemic species). | Field survey has done by Lebanese university student under supervision of TCNR project Manager on August 2023 | Annual | Scheduled to remove by hands |  |  |  |  |  |  | | --- | --- | --- | --- | --- | | Indicators attached to component: [Endemic species (Id=30)] -> Terrestrial Species (Id=31) | | | | | | **Name** | **Description** | **DataSource** | **UpdateFrequency** | **Notes** | | Presence of Astragalus beritheus | Presence and distribution of the species |  | In the past years, occasional surveys. |  | | Cover of A. beritheus | Surface (sq m) |  | Occasional |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | | Indicators attached to component: [Rare/Threatened species (Id=27)] -> Terrestrial Species (Id=28) | | | | | | **Name** | **Description** | **DataSource** | **UpdateFrequency** | **Notes** | | Presence of Salsola kali | Over explotation for export |  | Occasional |  | | Cover of Salsola kali |  |  |  |  | | | |
| Data Collection Procedure | | |
| Staff | TCNR team and Volunteer (Five students from Lebanese University), NGO’s (Fekr w Insan, ADR, AMWAJ), Tyre II Official School, DSC Lebanon, Al Afaaq Institute of Imam Sadr Foundation.  The exact staff count remains uncertain as the contact process has commenced but is still ongoing. However, it is anticipated to reach approximately 100 individuals. | |
| Equipment | Gloves, Root puller, Pruning Shears, Hand Pruners, Bags, Rakes, Disinfectant for shoes. | |
| Protocol | The individuals involved in this protocol will receive training through a workshop organized by TCNR prior to field engagement. The training will cover essential topics, including how to step carefully to safeguard delicate species, identification of invasive species for removal, proper extraction techniques, and appropriate procedures for collecting and storing the removed plants in designated bags (figure 2).  The expected number of respondents could reach max 100 people; the all zone will require a duration of five days. It's important to note that all plants collected in each zone will be burned after the extraction process is completed, noting that the location of burning in each zones should be in the open areas (locations devoid of animal and plant species).  We strongly recommend disinfecting the soles of your footwear using a spray bottle filled with an appropriate disinfectant before entering or exiting any location. You can use methylated spirits (70-100%), diluted bleach (25%), or F10 solution. Simply spray the disinfectant and wait for one minute before moving forward to prevent recontamination of your footwear    Figure 2 illustrates the approach for eradicating invasive plant species  Training  Gathering on the field  Use the disinfectant for the shoes  Eradication of invasive species  Collecting plants using bags  Burning in open area  The Invasive Plants Management Protocol at TCNR is scheduled for implementation either during the upcoming spring season or in the midst of winter, strategically chosen to take advantage of moist soil conditions that facilitate the efficient removal of these invasive plants, emphasizing root extraction. This protocol is designed to be applicable not only to the management of *Heterotheca Subaxillaries* also to address various types of invasive plant species encountered within the reserve.  The success of this management approach hinges on collaboration and active participation from multiple stakeholders, including NGOs, dedicated volunteers, and the TCNR team. By engaging this collective effort, we aim to tackle invasive species comprehensively, protect the integrity of the natural ecosystem, and ensure the long-term preservation of the TCNR's unique biodiversity. | |
| Quotations | Hand Pruners: 68$ (approximately 50 piece)  Gardeners gloves: 25$ (approximately 50 piece)  Pruning Shears: 40$ (approximately 50 piece)  Root Puller: 45$ (approximately 50 piece)  Bags: 5$ (approximately 70 piece)  Rakes: 6$ (approximately 70 piece)  Disinfectant for shoes: 6$ (approximately piece 70) | |
| **References:**  Bou, M., Kharrat, D., Farhat, P., Dakik, N., Kahale, R., and Potash, L.2016. Invasion and management of Heterotheca subaxillaris in Tyre Coast Nature Reserve, Lebanon. January 2017. <https://doi.org/10.13140/RG.2.2.21409.40808>  Daehyun Ki., Jung-Yun L., Jongcheol S. and Insang S. 2019. Recolonization of native and invasive plants after large-scale clearance of a temperate coastal dunefield. Applied Geography, Volume 109. ISSN 0143-6228.  Halvorson, W. L. 2003. Verification of plant specimens from Sonoran Desert parks. Report  to the Desert Southwest Cooperative Ecosystems Studies Unit, University of Arizona, Tucson, AZ.  Kozhoridze, G.; Dor, E.B.; Sternberg, M. 2022. Assessing the Dynamics of Plant Species Invasion in Eastern-Mediterranean Coastal Dunes Using Cellular Automata Modelling and Satellite Time-Series Analyses. Remote Sens: 14, 1014: 20 pp. https://doi.org/10.3390/ rs14041014  Stenberg M. 2016. From America to the Holy Land: disentangling plant traits of the invasive Heterotheca subaxillaris (Lam.) Britton & Rusby. Plant Ecol (2016) 217:1307–1314. DOI 10.1007/s11258-016-0656-z  Suarez and Estelrich 2018. Heterotheca subaxillaris. en: Malezas e invasoras de la Argentina. Tomo III Historia y Biología. Ed.: Fernandez, Leguizamon y Acciaresi: 435 – 448.  Tohmé, G. et Tohmé, H.2009. Espèces nouvelles du Liban et redescription d’espèces endémiques. Lebanese Science Journal, 10;125–130 | | |