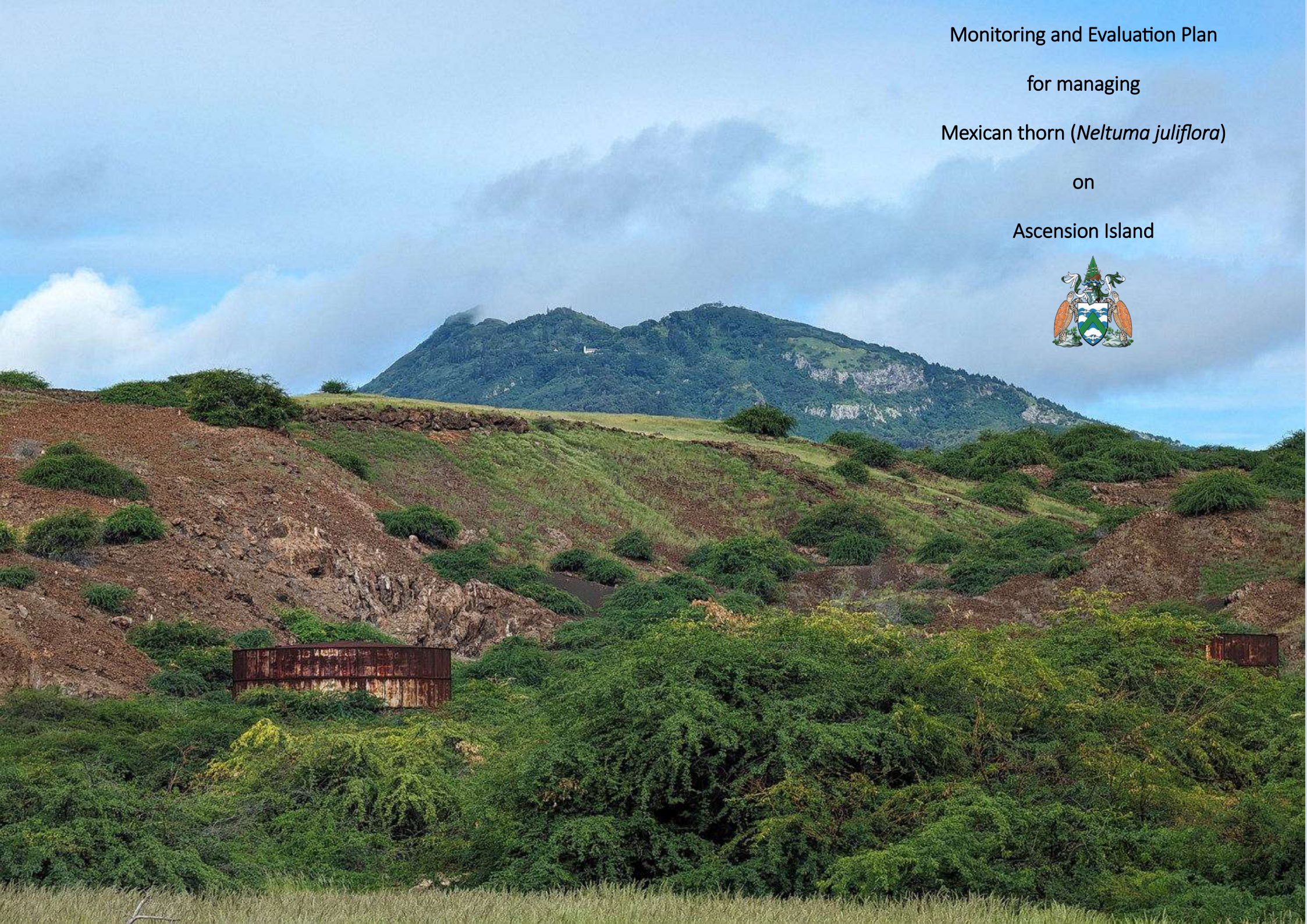

Monitoring and Evaluation Plan

for managing

Mexican thorn (*Neltuma juliflora*)

on

Ascension Island

Contents

Executive Summary 3

Introduction 4—5

Project Summary 5

Purpose of this plan 6

- Problem Statement 6
- Goals 6
- Objectives 6
- Applicable Legislation 7—8

Management Units for Ascension Island 9—11

- Species present 12
- Management Units 13

Recommended methods 14—24

Recommended herbicides 25—26

Monitoring activities 27—30

Drone flights 31—33

Action Plans for the Nature Reserves 34—35

- Monitoring threats to the Beach Nature Reserves 35—36
- Monitoring threats to the Waterside Fairs Nature Reserves 37—38
- Monitoring threats to the Letterbox, Boatswain Bird Island Sanctuary and South Coast Nature Reserve 39
- Monitoring activities relating to the biocontrol agent, *Evippe* sp. #1 40—42
- Monitoring activities within other assigned Manageable Units 43—47

Roles and Responsibilities 48—49

References 50

Annexures 51—62

Executive Summary

Ascension Island, a UK Overseas Territory in the South Atlantic Ocean, faces a severe ecological challenge from the invasive Mexican thorn (*Neltuma juliflora*). Introduced in the 1960s to mitigate soil erosion during the development of the Two Boats settlement, this species has rapidly spread across the island, forming dense stands that threaten both local wildlife and infrastructure. With its resilience to drought and lack of natural predators, Mexican thorn has become the island's most harmful invasive species, affecting critical nesting sites for green turtles (*Chelonia mydas*) and seabirds such as the sooty tern (*Onychoprion fuscatus*). It also provides shelter for pests like rats and mice, which in turn threaten native flora like the Ascension Spurge (*Euphorbia origanoides*) through increased grazing pressures.

In response to this ecological threat, the Ascension Island Government Conservation and Fisheries Directorate (AIGCFD), with funding from the Darwin Plus Initiative, implemented the DPLUS134: Repelling the invader: turning the tide on Ascension's Mexican thorn Project.

This Monitoring and Evaluation (M&E) plan provides a framework for tracking the project's progress. It outlines performance indicators, data collection methods, and timelines to assess key outcomes, including:

- Reduction of Mexican thorn in critical areas
- Restoration of native habitats and species recovery
- Evaluation of control methods for future use
- Capacity-building efforts for long-term management
- Protection of infrastructure from encroachment

The plan ensures continuous improvement in controlling Mexican thorn, restoring ecological balance, and building resilience against invasive species on Ascension Island.

Introduction

Mexican thorn is the most damaging invasive species on Ascension Island. The Mexican Thorn Control Project is taking a strategic and integrated approach to controlling Mexican thorn on Ascension including rigorous assessment of further biocontrol and improved chemical and mechanical treatment. The project will ensure local capacity is built to deliver those most appropriate and cost-effective for Ascension. The outcome will be a step change in our ability to control Mexican thorn and result in a long-term contraction of its range and restoration of habitats.

What is Monitoring and Evaluation?

Monitoring and evaluation involve repeated field surveys to track progress or success and determine the efficacy of the methods used to control invasive plants such as Mexican thorn.

The following factors are monitored to track the project implementation progress:

- How effective are the methods being used to control invasive plants?
- Does the level of invasive alien plant infestations decrease in areas where control projects are being implemented?
- Is there any recovery of endemic or native vegetation seen in cleared areas?
- How much herbicide is being used for clearance efforts? What type of herbicide (active ingredients) are used?

If the survey results indicate that the targeted invasive alien plants (IAPs) have not been effectively controlled then the specific control methods that were used must be investigated to determine what caused the ineffectiveness of the methods used. Once the specific problem has been identified, it must be rectified.

It is important to record species, densities, and age classes of IAPs before and after each control effort to determine whether infestations are decreasing or increasing. These field surveys can be used to determine to what extent endemic or native vegetation has recovered in a treatment area. Clearing methodology and treatment intervals must be adapted accordingly if necessary.

Accurate records must be kept of all herbicides used during these control efforts to track usage and efficacy over time. Not only will this data assist with compiling accurate budgets, but it will show trends in quantities for different infestation levels and species over time which will increase the success rate of the intervention.

Project Summary

Title	DPLUS134 - Repelling the invader: turning the tide on Ascension's Mexican thorn
Territory(ies)	Ascension Island
Lead Partner	Ascension Island
Start/end dates	01/09/2021 – 31/03/2024
Project partners	CABI, Invader Plant Specialists® Pty Ltd, Centre for Biological Control (Rhodes University)
Darwin Plus grant value	£ 184, 191

Purpose of this plan

Problem Statement

The purpose of this Monitoring and Evaluation Plan is to demonstrate where management actions used to control Mexican thorn on Ascension are successfully meeting the invasive plant management objectives and to quickly detect and modify ineffective actions. Monitoring can play an essential role in managing invasive plants as it provides nonbiased information to make well-informed management decisions.

Goals

The goal of AIGCFD is to protect Ascension Island's native flora and fauna by developing an integrated management plan that will assist natural area land managers and the general public in effectively managing Mexican thorn on Ascension Island.

Objectives

- To provide information about the taxonomy, ecology, distribution, and environmental impacts of Mexican thorn on Ascension Island.
- To provide up-to-date information on control methods for Mexican thorn on Ascension Island.

In terms of M&E, the project aims to:

- Detect new invasions (if present) in time to prevent and control further spread.
- Determine the status and temporal trends in population sizes or density and the extent and locations of invasive species over time.
- Determine the effects of invasive plant species on endemic and/or native fauna and flora, and ecosystem processes.
- Detect the effects of invasive species on habitats.
- Determine the success of management measures.
- Detect effects of best management practices on habitats.

Complete eradication of Mexican thorn may no longer be possible due to the extent of the infestation; however, the threat could be minimised through implementing monitoring and control interventions. Mechanical and chemical control efforts are deployed as direct and immediate action against Mexican thorn, while the release of the biocontrol agent, *Evippe sp.* #1 will provide a long-term control technique to help keep Mexican thorn numbers in check (White, 2009).

The desired state for all Manageable Units of Ascension Island is to prevent adult trees from setting seeds and ultimately prevent the recruitment and establishment of seedlings in these Management Units. The seed bank will remain active for several years, so regular monitoring will be necessary to control regrowth and seedling growth.

Applicable Legislation

The control of Mexican thorn is identified as a high priority in Ascension's National Biodiversity Strategy and Action Plan (BSAP). It poses a significant threat to Ascension populations of endangered green turtles, nesting seabirds, and the endemic and critically endangered Ascension Island spurge. The BSAP seeks to identify long-term, sustainable means of controlling high-priority invasive non-natives including Mexican thorn, where they are available.

Ascension, with the UK Government, is committed under Article 8 of the Convention on Biological Diversity (CBD) to control alien species that threaten ecosystems, habitats, or species.

The following threats are also identified within the Ascension Mexican thorn Species Action Plan:

- Harbouring non-native pests.
- Competition with native or endemic plants and invertebrates.
- Rapid spread alters landscape characteristics.
- Obscuring the volcanic nature of the island.
- Increased difficulty in maintaining infrastructure.
- Significant costs involved with removal and control efforts.
- Increased fire risk.

Figure 1: Mexican thorn form display different growth forms on Ascension.

Name	Details	Description
International Agreements and Strategies	Convention on Biological Diversity (CBD)	Extended to Ascension and provides the overarching context for biodiversity protection on the island. It ensures: • The conservation of biological diversity. • The sustainable use of the components of biological diversity. • The fair and equitable sharing of the benefits arising from the use of genetic resources. The CBD Post-2020 Global Biodiversity Framework sets out 23 targets covering the main areas of biodiversity protection.
	UK Overseas Territories Biodiversity Strategy	Encourages well-managed area-based protection.
	Ascension Environmental Charter (2001)	Fulfils Ascension's obligation to protect habitats and species.
Ascension Protected Areas Legislation	National Protected Areas Ordinance, 2003	It provides the Governor with powers to designate nature reserves 'primarily for the purpose of maintaining a proper balance in the natural ecology of the area'. It also limits the type of development that can be permitted within a nature reserve and allows the restriction of activities that could be harmful to a nature reserve. The Ordinance also provides powers to introduce regulations to protect nature reserves and to appoint Reserve Wardens to enforce these regulations.
Other relevant Ascension Legislation	Wildlife Protection Ordinance, 2013	AN ORDINANCE to protect and preserve the wildlife and habitat of Ascension. It is an offense to wilfully take, kill, trade, or molest any of the 40 species listed in the Ordinance.
	Biosecurity Ordinance, 2020	AN ORDINANCE to control the entry into, introduction, or establishment within Ascension of invasive species, pests, and diseases of animals and plants and their products, and to make ancillary and related provisions. It places restrictions on imports and provides control measures and powers to inspect and treat or destroy contaminated cargo from vessels and aircraft arriving on Ascension with the aim of reducing the likelihood of introducing new non-native species to the island. Legislation cannot address the threat of existing non-native species (Waterside Fairs MP compressed, 2023).
	Mexican thorn Species Action Plan (SAP)	It outlines the conservation actions necessary to minimize the impacts of Mexican thorn and to improve habitat conditions within the island's current resources and capacity.

Management Units for Ascension Island

The island is divided into seven (7) Manageable Units. This will assist in effectively controlling all IAPs present within these distinct boundaries. Each Manageable Unit has a certain purpose and will have its own set of objectives and goals to achieve within a pre-determined timeframe. All IAPs present per unit are listed in order of priority for clearance in Table 2. The Map of Manageable Units on Ascension is attached as Annexure 1 of this document.

Table 1: Manageable Units on Ascension Island

Manageable Units	Description	Who is responsible?	Details
AI001	Nature Reserves and Green Mountain National Park (including buffer zones)	AIGCFD	Management efforts should start within our Nature Reserves which is aimed at protecting our green turtle and seabird populations.
AI002	Outliers		Prioritise walk-throughs at least once a year. Clear possible Mexican thorn growing beyond their current range at: • NASA road • Portuguese Trail • (Oates's) Cricket Valley • Hummock Point Valley • Beyond Echo Canyon • Middleton's trail
AI003	Infrastructure maintenance	AIG, MITIE, Yang Enterprises Inc., Babcock, Encompass, Sure, and MET Office	Each stakeholder will keep their work areas clear of Mexican thorn and prevent encroachment on infrastructure. The following infrastructure needs regular maintenance and management: • Road safety • Water pipelines • Electricity stations • Buildings • Water treatment areas • Fuel station • Military installations • Earth station • Seismographic monitoring sites
AI004	Road safety	AIG OPS Department, Yang Enterprises Inc., and Mitie	AIG Operations Department, Yang Enterprises Inc., and Mitie remove vegetation along road verges for road safety and improved visibility.

Manageable Units	Description	Who is responsible?	Details
AI005	Geological features	**None	Sites that need intervention to remove or prevent Mexican thorn invasion include: • South Gannet lava flow to the southeast • Devil's Ashpit • Devil's Cauldron • Sister's Peak and lava flow to the north • Lava lakes • Devil's Riding School • St Mary's Grotto • Command Cave • Bird Cave • Broken Tooth and Hollow Tooth
AI006	Historical heritage	**None	Historical sites across the island need interventions to control the spread of Mexican thorn. • Hydroponics area in Donkey Plain • Heritage forts • Scouts Beach hut and campsite • Golf course behind Georgetown and One Boat golf course • 'God be thanked' water tank and pipeline • Dampier's Drip • Ahmadiyya Mosque • The Lizard • Firing ranges (along North East road and close to wind turbines)
AI007	Inaccessible areas	** None	Visit these sites to determine whether the moth has spread here after its release. Monitor the establishment of the *Evippe* moth as well as the health status of the culture and the trees after one month of release. Implement drone monitoring by taking images of the landscapes across Ascension before the release of the moth and comparing them to images taken at three-monthly intervals after its release and establishment on the island. Record drone height and use pre-determined set coordinates.

** The management of these sites is not achievable within the current capacity and resources of AIGCFD. All land on Ascension is owned by the Government, therefore responsibility for control of alien invasive species generally falls with Government agencies. Some occupiers of Government land may have a vested interest in controlling invasive plants to protect their assets (Belton, 2008).

Species present

The IAP species present within these Management Units are recorded in Table 2. It is important to note that the M&E Plan only lists species co-existing with Mexican thorn in their shared environment. The IAP species list will be updated regularly to include any new infestations once detected within these Management Units.

Table 2: Extent and distribution of IAPs

Species name	Common name	Risk of invasion	Prioritisation
Argemone mexicana	Mexican poppy	Low	Low
Casuarina equisetifolia	Australian pine tree	Medium	High
Lantana camara	Black lantana	Medium	Medium
Nicotiana glauca	Tree tobacco	High	High
Opuntia elatior	Red-flower prickly pear	Low	Medium
Psidium guajava	Guava	High	High
Neltuma juliflora	Mexican thorn (Mesquite)	High	High
Schinus terebinthifolius	Wild mango	Low	High
Tecoma stans	Yellow boy	High	Medium

Management Units

Table 3: IAPs present within each Management Unit

Species per Management Unit									
Management Unit	Mexican pop-py	Australian pine tree	Black lantana	Tree tobacco	Red-flower prickly pear	Guava	Mexican thorn	Wild mango	Yellow boy
AI001									
Beach NRs									
Wideawake Fairs NRs									
Letterbox NR and Boatswain Bird Island Sanctuary									
Hummock Point NR									
South Coast NR									
Green Mountain NP									
AI002									
Outliers									
AI003									
Infrastructure maintenance									
AI004									
Road Safety									
AI005									
Geological features									
AI006									
Historical features									
AI007									
Inaccessible areas									

Recommended methods

Following the trials completed by the Mexican Thorn Control Project, the subsequent methods are recommended to control Mexican thorn on Ascension. The inaccessible nature of most of the sites usually limits the use of hand tools to secateurs, loppers, silky saws, and reciprocating saws. Chainsaws are only used in extreme cases and help is obtained from the certified Park Warden team if necessary.

Cut stump application

This method is still considered to be the most effective and delivers more consistent results. Most trees have long thorny tendrils which form a protective barrier to cut through before the stump can be reached. Loppers and secateurs are useful to remove the thinner thorny branches before getting to the junction of branches at the stump. Silky saws and reciprocating saws are used to cut through thicker branches and stumps. With extremely thick branches and stumps, assistance is needed from the Park Warden team or appropriately qualified staff to chainsaw these trees down to a stump of at least ankle height. Due to the growth habit of these trees on Ascension, the use of hand tools is still required to gain access to the stump.

Ensure that the stump is cut to at least ankle height with a saw, lopper, or chainsaw (depending on the size of the tree). Apply a registered herbicide directly to the cut surface and around the base of the stem as soon as possible after cutting (within one hour of cutting), either with a handheld sprayer with a cone nozzle set to the correct spray width or by paintbrush.

(a)  (b)  (c)  (d) 

Figure 2: (a) Thorny tendrils are removed with loppers to gain access to the main stump. (b) The reciprocating saw cuts the stump down to at least ankle height. (c) Herbicides are applied to all the cut surfaces and around the base of the stump. (d) Chainsaws are used to remove large trees © C. Visser

Foliar application

This method is recommended for use in areas where it would be too labour-intensive to gain access to the tree stump by cutting away all the dense foliage. Take weather conditions such as wind speed, direction, and temperature into consideration before application. Ensure the knapsack and lance are clean and dry. Spray all the leaves of the trees to the point at which the herbicide starts to run off the leaves.

Figure 3: A registered herbicide is applied through a pressurised knapsack and sprayed on the leaves © C. Visser

Basal stem treatment

This method is recommended, but it is important to consider weather conditions such as wind (speed and direction) and temperature as this can cause spray drift and prevent the herbicide from working effectively. Ensure that the knapsack and lance are clean and clear of any trace amounts of bleach or water as this will dilute the RTU herbicide and prevent it from working effectively.

Figure 4: The registered herbicide is sprayed on the base of the stem down to the root crown © C. Visser

Uprooting

This should preferably only be considered and done where the whole root system of the tree can be removed. If some roots break off in the removal process, it must be treated with a registered herbicide. This is also only recommended where the plants are small enough to be successfully pulled out with the roots intact. The application of mattocks may also provide the necessary leverage.

Figure 5: Seedlings can be uprooted by hand © C.Visser.

Mechanical control by using heavy machinery

The bulldozing of road verges and any other operational needs can continue with the addition of a registered herbicide during their operations. Unfortunately, trees are not always removed intact and some roots break off in the process, leaving them open to regrow. Some exposed roots are treated with Garlon® Ultra herbicide, but the consistency of application is difficult to determine. It is therefore important that any exposed or broken-off roots must be treated with a registered herbicide. Any regrowth from these clearance efforts must be treated with foliar application as soon as regrowth is visible.

Some sites may require the use of hand tools, especially where delicate and sensitive equipment is used – Encompass uses loppers and silky saws to open up water pipelines for annual check-ups which cannot be reached by JCBs, while Babcock (CSO) opts to weed seedlings by hand from their sites.

Figure 6: Machinery such as JCBs are used to remove Mexican thorn from road verges © L. Shearer

Handling Biomass

Cut material from mechanical or chemical clearance efforts should be dragged away from the original cut stump and leaf litter. This is important to allow for easy inspection of seedlings possibly growing in the existing seed bank and to monitor possible regrowth on the cut stump. Cut branches can be stockpiled into stacks approximately 2m high and 3m wide nearby. This will allow easy access to sites, especially in areas where dense Mexican thorn tree stands are present.

The cut material is left to dry out and decompose *in situ* to not disturb surrounding vegetation. These stockpiles can provide shelter for sooty tern chicks similar to living trees, but without providing the resources used by invasive fauna such as rats, mice, and myna birds. The community of Ascension can collect cut material to use as firewood or timber. During clearance efforts, the seedpods are removed from all the cut branches and collected in bin bags. These bags are taken to the dump to burn at the end of the work day. AIG Operations Department usually transports all cut material by truck from their work sites to the dump as well to be burned.

Figure 7: Stockpiles of dried Mexican thorn vegetation on the beach at North East Bay Nature Reserve.

Biological control through the release of *Evippe* sp. #1

On Ascension Island, biological control, as part of an Integrated Control Plan, represents the only viable option for naturally limiting the spread of Mexican thorn and has already been successful in slowing its advances through the introduction of the bruchid beetles in the past. Therefore, AIGCFD has released *Evippe* sp. #1 moth to help control the Mexican thorn (*Neltuma juliflora*), a highly invasive non-native tree. Under Section 40 of the Biosecurity Ordinance, 2020, the release of a biocontrol agent on Ascension has been authorised by the Governor on the recommendation of the Chief Biosecurity Officer.

Figure 8 (a) & (b): *Evippe sp.#* 1 in the quarantine facility in South Africa © CBC

AIGCFD and our partners CABI put together a comprehensive risk assessment for the introduction of the *Evippe* moth (*Lepidoptera: Gelechiidae*). This risk assessment evaluates the effects this biocontrol agent will have on the island once introduced. A batch of circa 500 - 1000 caterpillars and pupae hidden in *Neltuma* leaf-ties has been shipped from CABI in April 2024 to Ascension for release. The project completed four separate releases of *Evippe sp*. #1 at sites in Donkey Plain and St Mary's Grotto between April and September 2024.

Research from Australia and South Africa suggests that *Evippe sp.* #1 has the ability to maintain high densities, resulting in greatly reduced growth rates and seed production of *Neltuma* species. The most also causes defoliation of the plant over time and weakens it, making it more manageable by herbicides (Maczey and Tanner, 2013).

The release of the *Evippe* moth will benefit all organisations who have to undertake repeated control efforts to clear it from roads, buildings, pipelines, and installations. It will also prevent the damaging encroachment of Mexican thorn into globally important turtle and seabird nesting sites.

The aim of the *Evippe* release is to establish a self-sustaining population of the moth on Ascension that will suppress the growth and vigour of Mexican thorn and form part of an integrated control plan alongside mechanical and chemical methods. The presence of the moth should result in lower regrowth and regeneration of Mexican thorn following other treatments, enabling more effective and efficient clearance over the long term. The *Evippe* release will not result in the eradication of Mexican thorn from Ascension, but rather the control of the population.

How fast will it spread after its release?

Natural spread

The dispersal rate on Ascension will probably be rapid. *Evippe sp*. #1 is a small flying insect that can easily be carried by wind. In Australia, rates of increase were greatest at sites with warm winters and hot summers, possibly allowing a greater number of generations per year (van Klinken et al., 2009). The species is also an excellent disperser. It spread 1.3 to 3.6 km/year following release, and in one case spread ca. 115 km from a release site within three years (van Klinken et al., 2003), and over 1,300 km between isolated mesquite populations, presumably by wind (van Klinken et al., 2009). See Annexure 2 for a map of how the moth will spread across the island within two years of its release.

Based on the published rates of spread from Australia, it is predicted that *Evippe sp. #1* should reach all parts of Ascension within two years of its release. The natural spread of *Evippe* sp. #1 is likely to be restricted to areas where its target host *Neltuma* occurs.

Artificial spread

Based on the experience gained in Australia and South Africa, it is recommended to directly release any imported *Evippe* sp. #1 into a small number of suitable naturalised *Neltuma* stands. A small culture will be maintained in controlled conditions to allow for any unexpected events around the primary release and to allow for introductions to be made in other areas at later dates if seen as beneficial.

Cut branches of *N. juliflora* hosting *Evippe* sp. #1 leaf ties have been transported in contained boxes directly from the UK quarantine facility to Ascension. These branches were then placed into polystyrene boxes with holes cut for moth emergence and at the base of the box to allow water egress. These boxes were placed directly into healthy *N. juliflora* trees, ideally with sufficient shade to stop the box from overheating and with exclusionary measures against rats. Additional small releases were made inside mesh sleeves along *N. juliflora* branches to allow for monitoring of moth emergence, which may otherwise be hard to detect.

The control of non-native ants and rats at the release sites is important and would aid establishment.

(a)  (b)  (c) 

Figure 9: (a) Rearing *Evippe* in controlled conditions at the CABI facility in the UK, (b) *Evippe* release at SKA in South Africa by ARC; (c) A Styrofoam box is fastened to the tree which allows the adult moths to emerge safely and protected from heat and predators © CABI

(a)  (b)  (c) 

Figure 10: (a) First release of *Evippe* on Ascension in April 2024, (b) preparation of a release in a styrofoam box, (c) Preparation of a release in a sleeve ©Mel Morgan

Recommended herbicides

The project proposes that the following herbicides be used for all control of Mexican thorn on Ascension. Contact details of suppliers are attached as Annexure 1. The MSDS and labels of these herbicides can be obtained from the Integrated Mexican thorn Control Plan (2024).

Table 4: List of herbicides

Herbicide	Description
Turbodor® 29 mpa (L4920)	It is a ready-to-use, low-volume, systemic herbicide for the selective control of problem plants as listed in conservation, grass pastures, forestry, and industrial areas. An increase in insect activity (borer beetles and termites) as well as saprophyte growth which is directed specifically at the treated areas, are recorded. The net effect is the promotion and acceleration of natural biological decay of the treated plants and a knock-on benefit of stimulating the local ecosystems.
Methods of application	Cut stump treatment (at least ankle height), basal stem application for which treatment should take place from knee height down to soil level. Low-volume foliar application for mostly cacti species.
Active ingredients	Triclopyr (Pyridyloxy Compound) (Acid equivalent) 29g/l (As butoxy ethyl ester) 40g/
Mixing ratio	Ready to use, no mixing required.
Sendero™ 336 SL (L10569)	It is a water-soluble concentrate herbicide for the selective control of woody plant species. This is the new standard in Mesquite control. This herbicide does not harm grasses and many desirable brush species. Controlling mesquite with Sendero™ 336 SL results in increased grass production and improved wildlife habitat.
Methods of application	Foliar application through a pressurised knapsack sprayer and suitable cone nozzle.
Active ingredients	Aminopyralid (acid equivalent) 60 g/L (as potassium salt), Clopyralid (acid equivalent) 276 g/L (pyridine compound)
Mixing ratios	For a knapsack with a 16L capacity: Full knapsack sprayer: 128ml of Sendero 80ml of H&R crop oil 15L, 792ml of water Half knapsack sprayer: 64ml of Sendero 40 ml of H&R crop oil 7L, 896ml of water

Monitoring activities

Nature Reserves and Green Mountain National Park are identified as AI001. Monitoring and Evaluation can be defined as a continuous management function that assesses if progress is made in achieving expected results, spots possible hold-ups in implementation, and highlights whether there are unintended effects, either positive or negative, from a project and its activities. The monitoring outcome is also intended to adaptively guide management decision-making. The goal of these activities is to improve outputs, outcomes, and impacts. The recording of new species or newly invaded areas should be immediately adopted into the Control Plan.

The objectives of monitoring Mexican thorn control are to determine the change in number, size, maturity, and density of infestations and to assess the presence and extent of any re-growth from treated plants or recruitment from seed. This can be achieved by monitoring a representative sample of sites before and after control (Belton, 2008).

For AIGCFD, monitoring is essential to ensure that management actions are completed and that they are making a positive contribution towards protecting the natural features of the Nature Reserves and achieving the Management Plan objectives. These monitoring actions will be reviewed annually by AIGCFD and are linked to the Management Plan objectives. Monitoring activities will largely be delivered by the AIGCFD, though volunteers and external partners will also be involved.

Monitoring the Mexican thorn population on Ascension

Monitoring of invasive species such as Mexican thorn is important as it provides an initial starting point for the Control Plan, as well as allowing for Adaptive Management.

The first step of monitoring comprises before and after photos of areas where clearance efforts have taken place. Fixed-point photography is useful as visual change over time can be monitored easily. This will allow the tracking of clearance progress and may help to calculate regrowth which can inform future follow-up interventions if seedlings or regrowth is recorded. Through this method, the efficacy of current clearance methods and herbicide usage can be accessed. This involves repeated field surveys to track progress or success and to determine the efficacy of control methods implemented.

Monitoring for Early Detection

Early detection monitoring is implemented before unwanted species have arrived in an area. In this case, this will apply to Management Unit 002 – Outliers, as we want to prevent Mexican thorn from moving into areas where no trees have been recorded before and to prevent a seed bank from establishing. It is important to prevent trees from moving into these sometimes difficult-to-reach areas.

This is considered to be the most effective form of monitoring because rapid eradication takes place as soon as Mexican thorn seedlings or saplings are recorded; therefore, future control efforts are minimal.

- These activities are aimed at finding seedlings or saplings when they first appear within areas such as NASA road, Portuguese Trail, Cricket Valley, Hummock Point Valley, Echo Canyon, Middleton's trail, or, other sites where Mexican thorn has not spread to yet.
- Walk-throughs of these sites should take place at least every six months.
- The number of seedlings, location, clearance methods, and/or herbicides used should be recorded.
- GPS coordinates of treated plants should also be recorded.

Monitoring for the Effect of Management Actions on Mexican thorn

The Mexican thorn Control Project trialled new methods which needed to be assessed for efficacy through regular monitoring actions. Regular walk-throughs took place where methods were trialled. The number of trees, treatment methods, and herbicides used were recorded. GPS coordinates were also recorded at each site. Signs of death (the browning or yellowing of leaves in the case of basal stem and foliar application) were recorded and how long it took to show these signs.

Through this form of monitoring, the Project could determine which methods would be the most cost-and labour effective methods to implement on Ascension. Refer to Section 12 to find out what control methods and herbicides are recommended for implementation.

Monitoring implementation progress

- The effectiveness of control methods being used to control invasive alien plants.
- Whether control actions result in decreasing levels of invasive alien plant infestations or not.
- The level of indigenous vegetation recovery in areas that have been cleared of invasive alien plants.
- Herbicide volumes being used for each control project being implemented.

Measuring IAPs parameters

- Abundance metrics: numbers, density, cover, frequency of occurrence.
- Condition metrics: measures of vigour, performance, fecundity.
- Structure metrics: size or age class information.

Record keeping

Accurate records must be kept of all herbicides used during the implementation of control projects to track usage over time. By analysing the herbicide usage data over time, trends in quantities for different infestation levels and species can be determined which will increase the success rate of control projects where the herbicide is used. The data will also assist in compiling accurate project budgets.

Monitoring requirements

- Photographic records must be kept of areas to be cleared prior to work starting and at regular intervals during initial clearing activities. Similarly, photographic records should be kept of the area immediately before and after follow-up clearing activities.
- Simple records must be kept of daily operations, for example, area or location cleared, labour units and the amount of herbicide used.
- It is important that, if monitoring results in the detection of invasive alien plants, this leads to immediate action.

Monitoring for the Status and Trends of Mexican thorn

Mexican thorn is present across most of the island landscape. Terrain and weather conditions do not deter or prevent trees from moving into different areas. There is a persistent seedbank present which requires constant monitoring and the removal of seedlings or saplings. The trees on Ascension display staggered seeding patterns across the island which is common in environments with relatively stable climates.

The trees on Ascension also display different growth forms across the island. Some form distinctive and relatively straight stems which would be easy to cut down with a chainsaw or reciprocating saw. Other mature specimens do not gain much height but form very wide, dense, and low thickets which are more difficult to treat. This form is more common in the poorer quality, rockier, and windswept habitats close to the coastline.

Ascension received more rainfall this year, so most Mexican thorn trees are lush and green. It forms dense and impenetrable stands across the landscape.

Monitoring the biocontrol agent, Evippe sp. #1 itself, and the effect on the Mexican thorn population (tree health)

Monitoring to confirm the establishment of *Evippe* sp. #1 should be conducted at least once a month after the release and once a year thereafter. Most of the beneficial impacts such as the dieback of Mexican thorn may not be detectable for several years.

Monitoring establishment and efficacy

Monitoring should focus on the documentation of larval activity, namely defoliation and the presence of leaf-ties. Their presence and density can be evidenced by simply taking a series of photographs. It is then easy to complement these with photographs of caterpillars and pupae after opening a number of leaf-ties. The presence of adult moths will be more difficult to demonstrate but this is not necessary.

The extent of establishment and spread can easily be documented through a selection of monitoring points covering the majority of Mexican thorn stands before the start of the monitoring. At each monitoring point, photographs should not only be taken of individual branches but also of whole trees or stands and should repeatedly be taken from the same place throughout the monitoring programme so that changes in tree health and cover can be documented.

Environmental impact

To assess the environmental impact, it is proposed to use earth observation satellite imagery and drone photography, to establish baselines before the release of the IBCA and measure cover by Mexican thorn over subsequent years. This should be complemented by an assessment of potentially increasing cover by other non-native woody plant species. Before and after photos of the release sites and surrounding areas will be taken with the drone for monitoring the success of the moths' establishment on Ascension, but also the health of the trees and how they respond to the continuous defoliation facilitated by the biocontrol agent.

Figure 11: Setting up polystyrene boxes to release the *Evippe* moth.

Figure 12: Preparing moths for transport to release sites.

Drone flights

The AIGCFD is using drone technology to monitor the natural spread of Mexican thorn across the island, as well as the impact the moth will have on its survival. The drone step-by-step instructions as well as the logbook are attached as Annexure 4.

Table 5: Drone information

Item	Description
Drone model	DJI MAVIC 3M
Software for programming and flying the drone	DJI Pilot
Software used for creating the orthophotos	OpenDroneMap (https://github.com/OpenDroneMap/ODM)
Camera details	
The Mavic 3M has four 5MP multispectral cameras. Its built-in camera array combines Green, Red, Red Edge, and Near Infrared sensors. • Near Infrared: 860 nm ± 26 nm • Red: 650 nm ± 16 nm • Red Edge: 730 nm ± 16 nm • Green: 560nm ± 16 nm These sensors support the NDVI, GNDVI, and NDRE vegetation indexes to provide farmers with vital information. • NDVI: Makes it possible to detect plants under stress, differentiate between crops, and determine at which stage they are in their growing cycle. • NDRE: Provides insights on chlorophyll content in leaves. • GNDVI: Useful for estimating photosynthetic activity, as well as water and nitrogen content in the plant canopy.	

The items marked with an asterisk (*) are related to the camera and set automatically so it cannot guarantee that it's the same for all pictures. However, this can be set manually to guarantee consistency.

How to run the software for creating orthophotos:

Command for running the software (run on the terminal on a Ubuntu machine): sudo docker run -ti --rm -v /home/marcos/data/drone_mapping/datasets:/datasets --gpus all opendronemap/odm:gpu --project-path /datasets evippe_test_150ft_merge_2 --feature-quality 'ultra' --pc-quality 'ultra' --orthophoto-resolution 0.5.

Table 6: Drone flight plans for Nature Reserve and *Evippe* release monitoring

Site name	GSD	Distance (kft)	Estimated time	Photos	Area (km^2)
Long Beach Nature Reserve	2.15cm/pixel	59.93	1h 7m 0s	1398	0.40
North East Bay Nature Reserve	3.28cm/pixel	57.75	1h 4m 56s	673	0.76
Grotto Evippe	0.82cm/pixel	15.63	17m 44s	734	55783.5
Grotto-2-Evippe	0.82cm/pixel	9.24	10m 46s	446	22179.3
Donkey-Plain-Evippe	0.82cm/pixel	28.01	31m 47s	1316	0.10

Action Plans for the Nature Reserves

Action Plans for the Nature Reserves on Ascension.

For AIGCFD, monitoring is essential to ensure that management actions are completed and that they are making a positive contribution towards protecting the natural features of the Nature Reserves and achieving the Management Plan objectives. These monitoring actions will be reviewed annually by AIGCFD and are linked to the Management Plan objectives. Monitoring activities will largely be delivered by the AIGCFD, though volunteers and external partners will also be involved. The following monitoring actions are recorded per Nature Reserves as set out in their Management Plans. It is also referred to as Manageable Unit AI001.

Monitoring threats to the Beach Nature Reserve

- Long Beach Nature Reserve
- North East Coast Nature Reserve
- South West Bay Nature Reserve
- Hummock Point Nature Reserve

Actions	SMART Indicators	Priority	2023				2024				2025				2026				2027			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Non-native shrub removal	Use appropriate control methods. Focus on beach habitat and buffer zones. Maintenance checks at 6-month intervals.	High	Nature Reserves cleared												Buffer zones cleared							
				■		■		■		■		■		■		■		■		■		■
Clearance of annual weeds from beach habitat	Remove weeds on beaches at 6-month intervals. Community engagement Annual Beach Clean-up (Q3 – shown in blue).	High		■	■	■		■	■	■		■	■	■		■	■	■		■	■	■

MONITORING																						
Actions	SMART Indicators	Frequency	2023				2024				2025				2026				2027			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Monitoring sites for regrowth or seedlings.	Drone imagery of Nature Reserves Drone imagery of 100m buffer zone. Record the number, location, and species present. Walkover surveys (Pan Am)	Annually																				

Monitoring Threats to the Waterside Fairs Nature Reserves

- Mars Bay Nature Reserve
- Waterside Fairs Nature Reserve

Actions	SMART Indicators	Priority	2023				2024				2025				2026				2027			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Non-native shrub removal	Remove all Mexican thorn, Nicotiana, and other invasive plants from Waterside Fairs NR.	High													No invasive species in Waterside Fairs NR by Year 5.							
	Remove all Mexican thorn within the 200 m buffer zone around Mars Bay boundary.	Low					No Mexican thorn within Mars Bay NR 200 m buffer by Year 5.															
	Remove all Mexican thorn, Nicotiana and other invasive plants in a 200 m buffer zone around Waterside Fairs NR boundary.	Low													No invasive plant species within Mars Bay NR 200m buffer by Year 5.							

MONITORING																						
Actions	SMART Indicators	Frequency	2023				2024				2025				2026				2027			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Monitor Mars Bay NR for new Mexican thorn recruits. Check previously marked trees for regrowth. Where necessary, cut and treat with herbicide.	Drone imagery of Nature Reserves Drone imagery of 100m buffer zone. Record number, location, and species present. Walkover surveys	Every quarter																				
Trial and establish best -practice methods to control Mexican thorn	Refer to the Mexican thorn control Datasheet. Walkover surveys Record the number, location, method, and herbicide used.	Ongoing DPLUS Projects: DPLUS134 DPLR1024	Complete Integrated Control Plan which includes best-practice methods.			Release plan on Ascension																
Risk assess potential biocontrol agents for Mexican thorn and other invasive species.	Complete host-range testing in the UK. Complete Public Consultations on Ascension. Build and prepare culture facility on Ascension.			Complete RA and send to FERA/ DEFRA for review.		Biocontrol agents released																

Monitoring Threats to Letterbox, Boatswain Bird Island Sanctuary and South Coast Nature Reserve

Actions	SMART Indicators	Priority	2023				2024				2025				2026				2027			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Non-native shrub removal	Remove Waltheria and swamp flat-sedge within 200 m boundary of Ascension spurge areas.	Medium																				
	Clearance of guava from White Horse Hill by Year 5.	Medium													Plateau of White Horse Hill free of invasive guava.							
MONITORING																						
Actions	SMART Indicators	Frequency	2023				2024				2025				2026				2027			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Monitor and remove new recruits of plants within the watershed above Razor Edge.	Drone imagery of watershed above Razor Edge. Record number, location, species present, and herbicide used. Walkover surveys	Twice annually																				
Monitor and remove new recruits encroaching onto Wig Hill from the western edge towards the Ascension spurge sites on Little White Hill and Little White Horse Hill.	Drone imagery of the area around Wig Hill, Little White Hill, and Little White Horse Hill. Walkover surveys Record number, location, species present, and herbicide used.	Every quarter																				

Monitoring activities relating to the biocontrol agent, *Evippe* sp. #1

MONITORING																						
Actions	SMART Indicators	Frequency	2023				2024				2025				2026				2027			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Establishment	Documentation of larval activity (defoliation and presence of leaf-ties). Photographs to determine the presence and density of moths. Open a number of leaf-ties to check if caterpillars and pupae are present. Observations of the presence of adult moths.	Once a month after release Once a year thereafter																				
Tree health and cover	Fixed-point photographs of individual branches as well as whole trees or stands.	Once a month																				
	Drone imagery	Every six months																				

MONITORING																						
Actions	SMART Indicators	Frequency	2023				2024				2025				2026				2027			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Efficacy – moth emergence	Small releases made inside mesh sleeves along Mexican thorn branches.	Once a month during initial releases if needed (could risk excess moth mortality).																				
	Sticky traps to assess emergence and dispersal.	Once a month after initial releases.																				
	Assess leaf-mining and tying.	Once every six months thereafter.																				
Environmental impact	Earth observation satellite imagery or drone imagery to establish a baseline prior to releases. Assessment of potentially increasing cover by other non-native woody plant species.	Once before the initial releases of IBCA. Every six months.																				
	Before and after photos of release sites and surrounding areas.	Once before the initial releases of IBCA. Every six months.																				

Monitoring activities within other assigned Manageable Units

Monitoring is an essential management function that governs decision-making and allows for Adaptive management within organisations. All land on Ascension is owned by the Government, therefore responsibility for control of alien invasive species generally falls with Government agencies. The management of Manageable Units AI005 to AI007 is not achievable within the current capacity and resources of AIG.

MONITORING																				
Manageable Units	SMART Indicators	Frequency	2023				2024				2025				2026				2027			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
AI002 - Outliers	Clear Mexican thorn growing beyond their current range. Walkover surveys.	Every six months																				
AI003 – Infrastructure maintenance	Remove Mexican thorn threatening infrastructure or interfering with daily operations. Record the number of trees treated and herbicides used.	Remove trees as needed. Record information when clearance takes place.																				

MONITORING																						
Manageable Units	SMART Indicators	Frequency	2023				2024				2025				2026				2027			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
AI004 – Road safety	Remove Mexican thorn and other vegetation from road verges as needed. Treat exposed roots and cut stumps with a registered herbicide. Follow-up with foliar application when regrowth occurs. Record the number of trees treated and herbicides used.	Remove trees as needed. Record information when clearance takes place. Implement walkover surveys every 6 months (combined with clearance activities when possible)																				

MONITORING																					
Manageable Units	SMART Indicators	Frequency	2023				2024				2025				2026				2027			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
AI005 – Geological features	Rank sites according to priority – address sites where intervention needs to happen first. Drone imagery to monitor change in the landscape over time. Record number of trees treated and herbicides used.	Walkover surveys once a year. Drone surveys once a year. Record information when clearance takes place.																				
AI006 – Historical heritage	Rank sites according to priority – address sites where intervention needs to happen first. Drone imagery to monitor change in the landscape over time. Record the number of trees treated and herbicides used.	Walkover surveys once a year. Drone surveys once a year. Record information when clearance takes place.																				

MONITORING																					
Manageable Units	SMART Indicators	Frequency	2023				2024				2025				2026				2027			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
AI007 – Inaccessible areas	Drone imagery to monitor change in the landscape over time. Record the number of trees treated and herbicides used.	Walkover surveys once a year. Drone surveys once a year. Record information when clearance takes place.																				

Roles and Responsibilities

Role	Responsibilities
AIGCFD	The Directorate will take responsibility for overall project management, delivery, and public engagement of the project. The Project Leader has extensive project management experience and AIG has a financial and procurement team who will assist with project budgeting and ordering.
CABI	With a long history of implementing biological control programmes globally (including the release of the seed-eating beetles on Ascension, CABI is well placed to carry out the required work on Mexican thorn and to undertake both laboratory and greenhouse evaluation, as well as field trials, to determine the host specificity and efficacy of control agents. CABI can conduct the necessary research on *Evippe*, including cultivation, additional host plant testing and release, as well as post-release monitoring of establishment by delivering the following: • Carry out the collection of *Evippe* sp. #1 from successful release sites in South Africa and transport, under license, these to the specialist quarantine facility for further assessment and cultivation in Egham, UK. • Conduct any remaining host specificity studies on key non-target species using our high-level containment infrastructure in the UK. • Application to the appropriate bodies for the eventual release of *Evippe* sp. if appropriate and subsequent monitoring. • The production of an in-depth report on the feasibility of *Evippe* sp. as a natural control agent for *Neltuma juliflora* and the success of establishment after release on Ascension. (Maczey and Tanner 2013)
Centre of Biological Control (Rhodes University)	• Written information and or website links to access information on *Evippe* moth. • Photographs of the *Evippe* moth itself, impact at release sites and culture facilities. • Stakeholder engagement information – are farmers or local communities supportive of biocontrol; do they show interest or hesitation in *Evippe* being released on their farms? Are there any interviews or questionnaires available to access?
Invader Plant Specialists® Pty Ltd	• Consultation and initial inputs on the Integrated Mexican thorn Control Plan and Monitoring and Evaluation Plan. • Recommendations on herbicides to test or use in the Mexican thorn Project.

References

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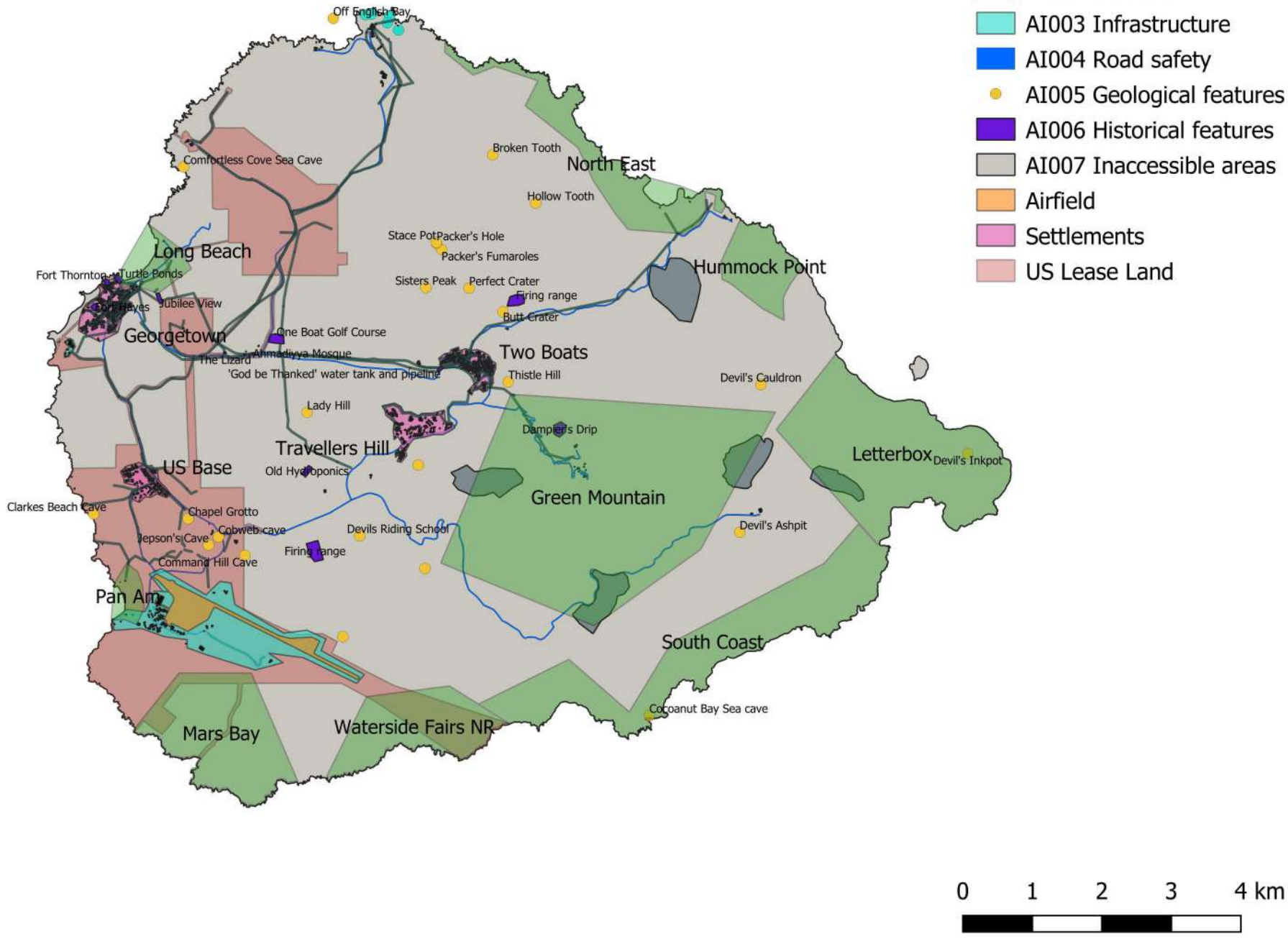
Photo credits:

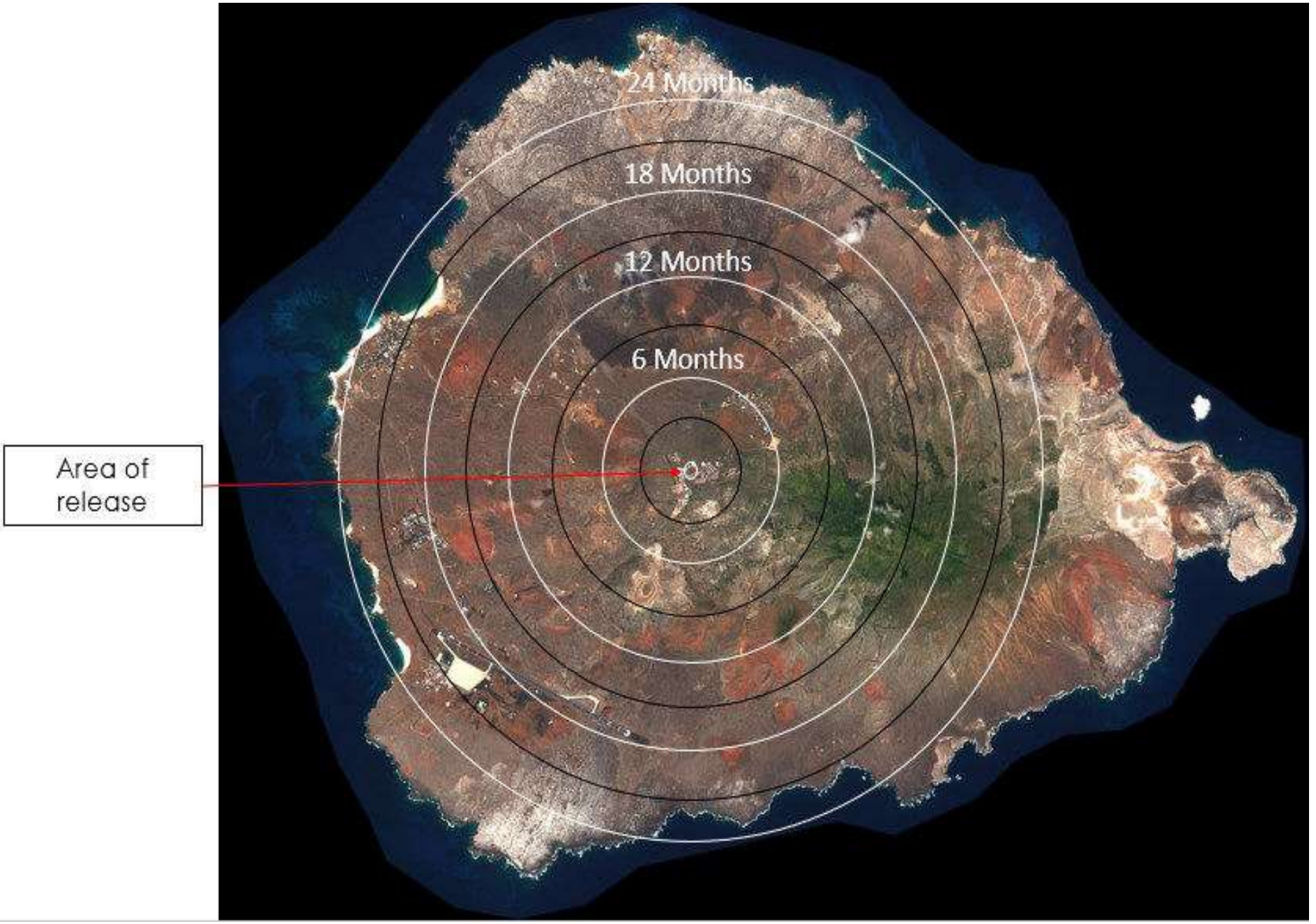
P.1: Corin Pratt; P.3: AIGCFD; P.4: AIGCFD; P.7: Chrisna Visser; P.9: AIGCFD; P.14: AIGCFD; P. 15: Chrisna Visser; P.16: Chrisna Visser; P.17: Chrisna Visser; P.18: Chrisna Visser; P.19: Laura Shearer; P.20: AIGCFD; P.21: Blair Cowie & Fritz Heystek; P.23: CABI; P.24: Mel Morgan; P.25 Chrisna Visser; P.27: Toby Hunt; P.30: Chrisna Visser; P.31: AIGCFD; P.34:AIGCFD; P.40: Mel Morgan; P.43: AIGCFD; P.48: AIGCFD; P.51 Phil Lambdon; P.52: Rebecca Nightingale; P. 56: AIGCFD; P.62: AIGCFD

Annexures

Annexure 1 – Map of Manageable Unit on Ascension



Annexure 2: Spread of *Evippe sp. #1* on Ascension.



Annexure 3 – Contact details of external role players and herbicide suppliers

Company name	Contact person	Contact information	
CABI	Norbert Maczey (Senior Ecologist/Entomologist)	n.maczey@cabi.org	
	Corin Pratt (Research Scientist - Invasive Species Management)	C.Pratt@cabi.org	
Centre of Biological Control (CBC), Rhodes University	Martin Hill (Director: Centre for Biological Control (CBC))	m.hill@ru.ac.za	
	Philip Ivey (Researcher)	p.ivey@ru.ac.za	
Invader Plant Specialists (Pty) Ltd	Dr Graham Harding	harding@pixie.co.za	
	David Harding	david@invaderplantspecialists.co.za	
Herbicide suppliers			Products
Ecoguard Biosciences (Pty) Ltd 22 Eiland Street, Eiland Park, Paarl, 7646	Abie Theron (Regional Technical Sales Manager)	paarl.sales@ecoguard.co.za	Turbodor® 29 mpa
	Lisa Garcia (Office Administrator)	admin.paarl@ecoguard.co.za	
InteliGro	Derek Nicholson (Crop Solution Specialist (CSS)	DerekN@inteligro.co.za	Sendero™ 336 SL
	Chantelle Juretic (East London Depot)	eastlondon@inteligro.co.za	
	Chantelle Adoons (East London Depot)	EastLondonAdmin@inteligro.co.za	

Annexure 4: Drone Step-by-step instructions

Drone checklist

- SD card in the drone (128 GB – blue)
- SD cards in the IR camera (if using – 2 x 64 GB – gold)
- Remote control (charged)
- Drone batteries (8 – stored in Project Office)
- Props (4)
- Landing platform

Safe take-off and landing

Setting up the drone for flight, ensure:

- Batteries are locked in place and fully charged
- Arms are fully locked
- Blades are locked in place properly
- SD cards in the remote and drone
- A suitable take-off and landing zone is present: This needs to be away from cars, machinery and people, and it needs to be as level as possible.
- You are behind (orientation-wise) the drone for take-off and landing: This ensures that left and right aren't reversed on the controller if you need to make a quick landing.

To turn on any DJI equipment, push and then push and hold the power button: this goes for the drone and controller. The screen will turn on automatically when the controller is switched on, providing the screen is properly connected to the remote controller.

Pre-Flight Checklist	
Item	Action/Check
Weather and Wind Speed Check	Check weather and wind speed is still with acceptable limits
Logs	Update pilot logs
Crew and Public	Ensure all crew and public are in correct positions and that public people in the area are aware of operations
Clearance	Does this flight operation have clearance? Park Warden, Director, Police, whoever is appropriate for the flight
Foreign Object Debris	Landing/take-off zone clear of debris
Power Up	Shout “Taking Off” and start motors
Take off	Take a final look around, check with mandatory observer that they agree it is safe to fly. Take off to approx. 2m height
Control Test	Test Yaw and cyclic controls (small movements)
Function Test	Aircraft should hold position and altitude
Flight Battery Check	Check battery status and satellites being tracked
Operation	Confirm with team that flight plan is still good to go ahead

Landing Checklist	
Item	Action/Check
Landing Area	No crew within 5m of the landing area
Foreign Object Debris	Clear landing site of debris
Public	Public need to be at least 30m from landing point
Camera	Ensure camera is pointing forwards and level (automatic with RTH is active)
Orientation	Orientate aircraft pointing away from landing position
Reverse	Reverse aircraft into landing position (be wary of dirty-air phenomenon*)
Call	Call ‘Clear’ or ‘Landing’
Descent	Descend slowing into landing position
Disarm	Disarm motors (turn drone off before controller. Remember push then push and hold)
Batteries	Allow batteries to fully cool before charging. Consider fridge storage when not in use. However, they would need to reach room temperature before flight use.

Templates

Accurate records of all herbicides used must be kept as this will allow for the identification of the best product that can deliver the desired results. These monitoring actions can be reviewed annually and linked to budget allocations. Keeping photographic records can help monitor the change of the landscape over time.

The attached templates will help keep records on what herbicides are used daily as well as when the drone was used for flights to ensure regular checks and maintenance are carried out.

Herbicide usage sheet

Date	Site name	Product used	Species treated	Clearing methods	Applicator name

Drone Log book

Flight Log

Mission Flight											
Date	Drone	Operator	Flight no.	Take off time	Landing time	Total flight time	Location	Reason for flight	Incidents	Battery used	Props used

Battery Log

Battery	ID	Mission Flights	Flight time	Damage		
				Physical	Swelling	Comments

Maintenance Log

Date	Operator	Maintenance details	Comments

Incident Log

Date	Time	Operator	Type	Description	Cause	Damage	Comments	After Actions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