parco nazionale dell'alta murgia

# DETERMINAZIONE DIRIGENZIALE

| N. 203/2014 | del 25/06/2014 |
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| OGGETTO | PROGETTO LIFE ALTA MURGIA — LIFE 12 BIO/1TI000213 - "CONTROL AND ERADICATION OF THE INVASIVE EXOTIC PLANT SPECIES AILANTHUS ALTISSIMA IN THE ALTA MURGIA NATIONAL PARK" APPROVAZIONE ACTION PLANT |
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Si attesta la regolarità contabile del presente provvedimento e la relativa disponibilità finanziaria sul Bilancio di riferimento.

La spesa prevista con il presente atto trova copertura finanziaria sul Cap. _____ - UPB _____ del Bilancio di Previsione 2014.

Il Responsabile del Servizio Finanziario

dott.ssa Maria Rosaria Savino

1) Con la presente disposizione si procede alla liquidazione della somma di

€ _____ UPB_____Cap. _____Esercizio 2014

in base all'impegno contabile n. _____dell'anno _____

assunto con ❑ deliberazione ❑ determinazione n. _____ del _____

2) Con la presente disposizione si procede alla liquidazione della somma di

€ _____ UPB _____ Cap. _____ Esercizio 2014

in base all'impegno contabile n. _____ dell'anno _____

assunto con ❑ deliberazione ❑ determinazione n. _____ del _____

parco nazionale dell'alta murgia

## IL DIRETTORE F.F.

**VISTA** la Deliberazione Presidenziale n. 14/2012 del 24/09/2012 con la quale si è preso atto che il progetto denominato "Control and eradication of the invasive exotic plant species Ailanthus altissima in the Alta Murgia National Park", proposto dall'istituto di Scienze delle produzioni alimentari (ISPA) del Consiglio Nazionale delle Ricerche (CNR) di Bari, prevede lo studio di sistemi di controllo ed eradicazione di specie vegetali aliene, ed è finalizzato alla conservazione degli habitat e delle specie presenti all'interno dell'area protetta, riducendo l'invadenza di una specie esotica particolarmente invadente e competitiva;

**CONSIDERATO** che con la succitata Deliberazione Presidenziale è stato approvato il progetto in questione ed è stato assegnato al Direttore f. f. dell'Ente l'incarico, una volta approvato e finanziato il progetto da parte della Commissione Europea, di formalizzare il rapporto con il suddetto ISPA, e, una volta verificata la pertinenza e la capienza dei capitoli del bilancio, di procedere all'adozione dei necessari atti contabili per la realizzazione del progetto di che trattasi;

**VISTO** che in data 21/11/2013 è stato sottoscritto tra questo Ente ed il soggetto capofila il Partnership agreement per la disciplina dei rapporti tra i due Enti;

**VISTA** la nota prot. n. 0004062 del 11/06/2014 pervenuta dal Consiglio Nazionale delle Ricerche — Istituto di Scienze delle Produzioni Alimentari (CNR ISPA - soggetto capofila) con la quale è stata richiesta l'approvazione dell'*Eradication Action Plan,* che costituisce il piano operativo del progetto e descrive in dettaglio le tecniche da utilizzare per la gestione dell'ailanto;

**VISTO** che per procedere nell'attuazione del progetto è necessario approvare il Piano di Azione suddetto verificando che le azione da porre in essere siano in sintonia con la normativa vigente;

**CONSIDERATO** che il progetto prevede l'eradicazione dell'ailanto da tutto il territorio del Parco nazionale dell'Alta Murgia mediante l'utilizzo di fitofarmaci con tecniche a basso impatto ambientale di somministrazione controllata e circoscritta dei prodotti;

**VISTO** che ai sensi dell'art. 4 c.1, lett f) dell'allegato A al DPR 10/03/2004 in zona 1 del Parco è vietato l'utilizzo di fitofarmaci e pesticidi;

**VISTA** la nota prot. 0004782PNM del 10/03/2014 del Ministero dell'Ambiente e della Tutela del territorio e del mare con cui è stato concesso il nulla osta all'adozione da parte dell'Ente Parco di un provvedimento motivato di deroga che consenta l'utilizzo di prodotti fitosanitari per l'attuazione del progetto di eradicazione della specie esotica *Ailanthus altissima* anche in zona 1 del Parco.

Tutto ciò premesso, quale espletata istruttoria ,

## DETERMINA

Le premesse costituiscono parte integrante del presente provvedimento.

**Di approvare** l'*Eradication Action Plan,* che costituisce il piano operativo del progetto e descrive in dettaglio le tecniche da utilizzare per la gestione dell'ailanto, allegato alla presente determinazione per costituirne parte integrante.

**Di riservarsi** di adottare il provvedimento di deroga all'uso di fitofarmaci in zona 1 a seguito della consegna da parte del capofila del progetto, Istituto di Scienze delle produzioni alimentari (ISPA) del Consiglio Nazionale delle Ricerche (CNR) di Bari, della mappatura completa delle aree in cui è stata censita la specie da eradicare e della trasmissione di tutte le autorizzazioni propedeutiche al rilascio dell'autorizzazione finale di questo Ente per attuare il progetto come previsto ai sensi dell'art. 10 dell'allegato A al DPR 10/03/2004.

**Di dichiarare** immediatamente esecutivo il presente provvedimento.

**Il RUP** _____
Dott.ssa Chiara Mattia

**Il Direttore f.f.** _____
Fabio Modesti

parco nazionale dell'alta murgia

Il presente provvedimento sarà pubblicato all'Albo pretorio dell'Ente ed all'Albo Pretorio on-line dal 25/06/2014 e per 15 giorni consecutivi, fino al 10/07/2014

Gravina, 25/06/2014

L'incaricato

Registrato impegno di spesa n. ____ al capitolo _____ del bilancio di previsione anno _____ gestione residui/competenza.

Gravina, _____

L'incaricato

Emesso mandato di pagamento n. ____ in data _____ sul capitolo _____ del bilancio di previsione anno _____ gestione residui/competenza.

Gravina, _____

L'incaricato

Action A3

# ERADICATION ACTION PLAN

## Progetto

**Controllo ed eradicazione della specie vegetale esotica invasiva**

***Ailanthus altissima* nel Parco Nazionale dell'Alta Murgia**

**LIFE12 BIO/IT/000213**

# Action A3 - ERADICATION ACTION PLAN

The eradication action plan consists in the description of the complete eco-friendly control strategy, including the intervention criterions and protocol, taking under active consideration the characteristics of the target species and threatened habitat. This document provides all technical details about the treatment techniques, the herbicide used, tools and equipment needed.

## INDEX

**Introduction**

Low attention is given to the negative impacts of Ailanthus invasion and no control is currently done for this threatening and highly competitive species.

*Ailanthus altissima* poses a significant threat to biodiversity from local to EU scale, and this threat is likely to increase in the future unless robust action is taken at all levels to control the introduction and establishment of this species and to eradicate populations already introduced.

The degradation of the ecosystems represents the loss of "natural capital", therefore the costs of inaction are potentially immense. Furthermore, restoring degraded ecosystems is much more costly than looking after the natural original systems and the control of IAS is the best example. The economic damages caused by *Ailanthus* and the costs of controlling and eliminating it amount to billions of euro per year, far greater than the costs of preventing its introduction.

Management of *A. altissima* is not well established yet, so this project is aimed at stopping its uncontrolled spread in the Alta Murgia National Park, eradicating it through innovative techniques of management, and by increasing public awareness about the management needs.

**Target species: ecology and characteristics**

*Ailanthus altissima* (tree of haven) is a woody invasive alien species (IAS). It has been transported across ecological barriers becoming established in natural or semi-natural ecosystems or habitats outside their native range. Its introduction was, and can still be deliberate, to satisfy human needs, or accidental (often as a result of the increased globalization of human activities).

IAS can influence and threaten native biological diversity. Their spread can cause enormous damages to natural and semi-natural ecosystems, livelihoods and human health. They are considered the second most important threat to biodiversity after habitat loss and are key direct pressure causing ecosystem degradation. Trends in invasive alien species is a "European Biodiversity Indicator". Due to a lack of information and awareness, the issue of invasive species and their effects is often underestimated and adequate prevention and mitigation measures are lacking. Reducing the impact of IAS on EU biodiversity through their control and eradication is one of the six main targets set in "The EU Biodiversity Strategy to 2020" by the European Commission. IAS cause some € 12.5 billion worth of damage each year in the EU in terms of health care and animal health costs, crop yield and fish stock losses, damage to infrastructure, river navigability, protected species and so forth. Indirect drivers such as the fact that biodiversity's economic value is not reflected in decision making are also taking a heavy toll on biodiversity.

As elsewhere in the world, the number of IAS in Europe has grown substantially in recent years. Although the challenges posed by IAS are common to many Member States, there is currently no dedicated, comprehensive EU policy to address them.

The exotic *Ailanthus altissima* is one of the most harmful and widespread woody invasive species in Europe (www. europe-aliens.org). It reaches the heart of protected areas and spreads across the natural environment rapidly and spontaneously (without direct intervention by humans), producing reproductive offspring in very large number and at considerable distances, having the potential to spread over a considerable area. In just two years it can form a several feet high tree. It has a considerable vigor. The invasive capacity of this species is explained by its ability to reproduce equally well both by seed and asexually. The samara is the dried fruit with membranous wings; it is transported over long distances by wind and water. One plant can produce up to 300,000 samaras per year. Ailanthus spreads also by an extended and vigorous root system, generating numerous suckers and progeny plants. The invasiveness of this species is due to multiple propagation mechanisms: a) samaras allow rapid colonization of new areas, in which plants begin to spread by vegetative means, causing the rapid consolidation of the species; b) young seedlings grow very quickly forming highly dense stands displacing and out-competing native species by heavily shading them in the growing season and/or reducing their growth thus causing serious direct and indirect damages to ecosystems, producing severe ecological, environmental and economic effects.
The species is able to adapt to any type of soil and water regime, from stony and sterile soils to rich alluvial bottoms, tolerates prolonged drought, saline and acid soils, nutrient deficiency and air pollution.
Once established, it is very hard to eradicate. Its management is very difficult because of its fast growth and mechanical treatments are ineffective due to root-suckers and resprouting shoots.

***Ailanthus altissima* in the Alta Murgia National Park**

In the last years the species is quickly spreading and multiplying in Alta Murgia National Park (South Italy, Puglia Region) causing serious direct and indirect damages to ecosystems, replacing and altering communities that have a greater conservation value, producing severe ecological, environmental and economic effects and causing natural habitats loss and degradation. Many plants and infested areas grow in vulnerable natural habitats, on rocky soils, along the roads crossing the Park and at forest edges. In the whole Park infested areas are scattered in distant places.
There is no exact record about the starting date of the infestation but, considering the size of some trees, it can be presumed that it started at least 50-60 years ago because some people living in villages or in the countryside introduced some plants for ornamental purposes or to quickly shadow, not worrying about their invasive potential. Then plants spread by seed dispersal.
There are certainly thousands of trees in the Park, most of which are present as very dense groups or areas rather than "single" plants, due to their reproductive features. Its presence is scattered within the Park, being mainly concentrated along roadsides, dry stone walls, inside and around *jazzi* (sheep

folders) and ruins, also present close to wells and pools and in stony and dry areas. Thus, the infestation covers more or less the whole Park area, but the "real" infested area could be a small percentage compared to the total surface. Currently it is no more voluntarily introduced by farmers in the private areas of the Park.

The Park is mostly characterized by dry grasslands, pseudo-steppe and wide open spaces with low vegetation, whose tendency is to be easily invaded by Ailanthus and to evolve towards woodland. Some priority habitats host precious floristic species such as orchids, which would be heavily shaded in the growing season, discouraged to establish and would tend to disappear. As grasslands are a semi-natural vegetation, only active and on-going management could prevents its reversion to woodland and would ensure the conservation of the wild flora and fauna species of these environments. *A. altissima* can seriously harm the ecological balance of the Park.

**Alta Murgia National Park: characteristics and habitats**

The "Alta Murgia National Park" (SCI and SPA Murgia Alta IT9120007 in Natura 2000 network) is one of the most extended among national and continental parks. It extends over 68077 hectares in the Mediterranean Biogeographic Area. Around 50% (36,000 hectares) of the total Park area is agriculture land, privately owned, with cereals, vegetables, orchards, vineyards, olive groves, etc. The other part is covered by forests and pastures. In this part, around 11,000 hectares are covered by forests and the remaining part by pastures. Pastures are all private, whereas around 5,000 hectares of forests are public and 6,000 are private. Thus, all considered, around 10% of the Park is public and 90% is private.

The Park is a wide plateau among the most important geological carsic areas of Italy, mostly characterized by calcareous soils and with remarkable geological phenomena such as rocky crests, dolines, sinkholes, caves, scarps, depressions, etc. It is one of the largest sub-steppe areas of Italy housing one of the largest population of priority bird species *Falco naumanni** (lesser kestrel) in Europe and in the world. The Park has a high biodiversity degree: there were surveyed about 1500 plant species, representing 25% of the total species present throughout Italy.

The area is characterized by the presence of unique highly diverse ecosystems. The most important habitat types in this site, priority under the 92/43/EEC Habitat Directive, are:

- 6210*: Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (*important orchid sites),
- 6220*: Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea,
- 62A0: Eastern sub-mediterranean dry grasslands (*Scorzoneratalia villosae*).

These dry grasslands contain several clearly different vegetation types and provide the ideal habitat for many threatened or rare bird species, including many which are listed in Annex I of the Birds

Directive. Birds of prey as *Falco biarmicus* (lanner falcon), *Pernis apivorus* (honey buzzard), *Circaetus gallicus* (short-toed eagle) and *Circus pygargus* (Montagu's harrier) use the grasslands as hunting and trophic areas during the breeding season and it is therefore important to assure the presence of the animal on which they feed. All these raptors require large, open areas for hunting with suitable taller vegetation for roost sites. Many passerine species, listed and not in the Directive, including *Lullula arborea* (woodlark) and *Lanius collurio* (red-backed shrike) use this environment for nesting and roosting (LIFE04NAT/IT/000173) and have slipped into an unfavourable conservation status due to changes in agricultural practices during the latest decades.

In the Park the perennial action of nature is linked to the thousand years agricultural and pastoral activities of man. The area was exposed to a tremendously accelerated process of habitat loss and fragmentation by a number of combined pressures. Among these, the Common Agricultural Policy (CAP) drove transformation of natural grassland pastures into agricultural (cereal crops) areas through stones removal. Loss, fragmentation and deterioration of the habitat through changes in agriculture has a direct impact on plant and bird species. Lack of management due to agricultural abandonment or changes in land use, urbanisation, irrational grazing, intensification of farming, resulted in lower number of plant and invertebrates species. A reduced availability of this important winter food source leads to a widespread and ongoing decrease in the EU range of many bird species, such as the red-backed shrike, honey buzzard, short-toed eagle and Montagu's harrier.

The conservation status of these grasslands is in some area degraded due to stones removal that completely destroy them.

The 6210* habitat type, visibly rich in species (flowering plants, insects, raptors) which were once widespread in Europe, are now a scarce and threatened habitat, which has been pushed back into isolated residual areas in the past decades (LIFE 2002/NAT/D/8461). The 6220* habitat type is fragmented and strictly influenced by excessive grazing leading to a reduction of the species number. When environment conditions are favourable and in absence of disturbance, 6220* habitat can be invaded by perennial woody species that tend to displace the herbaceous vegetation. So one of the worst pressure to these habitat types is due to the invasive alien species *Ailanthus altissima*: grassland habitats undergo a progressive qualitative and quantitative regression, evolving towards woodland.

Other habitat types in this site are:

- 91AA* Eastern white oak woods
- 8240* Limestone pavements,
- 8210 Calcareous rocky slopes with chasmophytic vegatation,
- 8310 Caves not open to the public,
- 9250 Quercs trojana woods

- 3170* Mediterranean temporary ponds: this habitat type has a great importance from a biological diversity point of view but has a very fragile equilibrium;
- 3150 Natural euthrophic lakes with Magnopotamon or Hydrocharition-type vegetation

The diffusion of nitrophilic and very competitive woody species such as Ailanthus would be critical and harmful to all this habitats and mostly to 8240*, 8210 and 3170*.

In the AMNP many species are protected under the Habitat Directive 92/43/EC. Among these there are many animal species included in Annex II (7 mammalians, 4 reptiles and amphibians, 4 invertebrates) and one plant species (Priority species Stipa austroitalica*). Moreover, there are 6 animal species listed in Annex IV.

In the Park there are 34 Wild Bird Species included in Annex I of the Birds Directive 2009/147/EC, some of which are included in the list of priority bird species considered "Priority for funding under LIFE" as agreed by the Ornis Committee. Moreover, there are 21 regularly occurring migratory bird species, not included in Annex I of the Birds Directive.

**Criteria of intervention**

Interventions on *A. altissima* aim at the reduction of degradation key pressure caused by the unfavourable impact of IAS.

Intervention criteria on *A. altissima* must respect the main objectives of the project which are:

- halt the loss of EU biodiversity and strengthen its conservation in AMNP, fulfilling the EU biodiversity strategy to 2020,
- safeguard and improve the conservation status of EU most important natural habitats and wild species of AMNP, protected under the EC Habitat and Wild Birds Directives,
- sustain the biological functionality of natural ecosystems reducing the vulnerability against actual or expected climate change effects,
- provide an innovative, eco-friendly and sustainable chemical strategy to eradicate and control *A. altissima* able to increase efficacy and minimize herbicide use, implementing the Directive on the Sustainable use of pesticides,
- enhance environmental and human health protection from risks and impacts posed by exposure to chemicals in Natura 2000 sites.

The whole infested area within the Park and all the infested sites will be detected during the mapping phase. All the "Concrete conservation actions" will be carried out by CNR-ISPA and ARIF technicians with the collaboration of PARCO. Technical personnel who will accomplish treatments will have been trained thanks to specific training.

The techniques to be used are: endotreatment, injection, cut stumps and spaced cuts with sponge. They are described in the successive sections of the document.

The treatments will be carried out in the wide Park area over the 4 years of the project.
There will be "first interventions" on flora ever treated and "maintenance actions", when further treatments are necessary. In general, the control of invasive vegetation would be facilitate if carried out continuously.

Halt dissemination

First of all it is important to stop the species dissemination thus reducing the incidence of new infestations. Otherwise, while treatments occur, new plants will emerge thus frustrating the efforts. For this purpose, big female plants with flowers or samaras will be treated first (Action C1 – Halt dissemination). Indeed female trees produce thousands flowers/samaras that, when ripe, are dispersed far away from the plant by wind and water. Female plants will be detected and chosen from the maps acquired from action A1 - Ailanthus mapping in the Park.
The use of glyphosate applied by the stem treatment techniques (see above) would allow the complete desiccation of flowers or immature samaras as first and immediate consequence of the treatment two/five days after application also for very big plants.
Cut stumps with glyphosate application (see above) would also lead to total elimination of the tree. Dead plants will be removed during action C5 – Trunks recovery and disposal.

Treat natural areas

Another criterion to manage interventions is based on a habitat vulnerability approach. Natural areas will be treated before non-natural ones (Action C2 - Plant management in the most vulnerable natural areas) and priority habitats and vulnerable sites will have precedence over others, thus guaranteeing their restoration. Where Ailanthus is wildly growing, threatening biodiversity and altering ecosystems, it is fundamental to stop its spread and eradicate all plants which can be source of new infestation. And this is even more important in the most vulnerable habitats that need to be treated first (grasslands, pseudo-steppe, limestone pavements, calcareous rocky slopes).
Thanks to the mapping phase, information about the location of the infested areas will be obtained. This will allow prioritization of intervention, quickly detecting the most vulnerable ecologically threatened natural areas, needing urgent control.
This action will be carried out in all the natural areas of AMNP (30500 hectares) scattered all through the Park surface (68077 hectares). Most of the natural area (around 80%) is privately owned. The remaining publicly owned land (20%) includes some relatively small forest areas (e.g. Mercadante forest, around 1000 ha).
The site of treatment will be chosen according to the habitat vulnerability and priority under the EC Habitat and Wild Birds Directives. Treatments will be carried out every year from the beginning of the vegetative phase in April to the end of September.

Treat non-natural areas

The eradication of the invasive vegetation should be continuous and complete. In previous on-the-spot investigations many infested areas have been found along roadsides of both main and secondary streets crossing the Park, in private farms, houses, abandoned old farmhouse and ruins. In particular, streets are pre-established corridors that favor samaras spread also very far through cars and tracks passage. So, as well as in the protected natural areas, invaders have to be eradicated also in such public and private areas which are usually strictly connected to the most important habitats of the Park as grasslands and pseudo-steppe (Action C3 - Plant management in other public and private areas).

This action will be carried out over a 37,600 hectares surface distributed all through the Park surface, all privately owned. There are around 400 landowners/farmers in the Park. Most of them have agricultural lands and they all will be contacted.

Thanks to the mapping phase, information about the location of the infested areas also in private areas will be obtained. These areas are scattered in distant places, so interventions must be carefully planned according to the location. An important aspect to be considered is the arrangement of interventions with the farm/land owners involved. Some farmers will be contacted thanks to the questionnaire from Action A2-Questionnaire to landowners and farmers, and some will be tracked down after the mapping phase.

Treat resprouts

Ailanthus is a resprouting species. Even after treatments that cause the plant death, a part of the root or the root collar can be still alive and generate new sprouts. Leaving resprouting trees alive would mean incomplete control, so treatments to halt resprouting plants will be carried after the appearance of resprouts (Action C6 - Strengthening control treatments). The re-sprouting rate depends mainly on the plant size. According to our previous experience, we could expect that 1/10 to 1/5 of the larger plants could resprout, whereas for the smaller plants the rate could be the lowest one. We expect to treat twice or even three times as it is almost never possible to obtain a complete control of invasive and aggressive pests with just a single intervention.

These strengthening control treatments will be realized within the project area everywhere necessary and at least one year after the end of actions C1, C2 and C3 performance.

**Sustainable control methods**

*A. altissima* control will be achieved by means of an innovative eco-friendly and sustainable strategy, based on low volume localized and pinpointed stem application techniques combining the use of mechanical and chemical methods. These means allow maximum efficacy, minimal herbicide use, minimal risks of exposure to, and dispersal of herbicides, in compliance with the "Directive on

the Sustainable Use of Pesticides" and involve in most cases the use of common and easy to use equipment and tools.

As explained above, tree of heaven is hard to remove. Its management is very difficult because of fast growth and mechanical treatments are ineffective. The most common control methods are manual, mechanical and chemical ones. Hand pulling can be carried out only on very young seedlings before the root system has developed (Figure 1). Mechanical removal (cut) is the mainly used technique in public areas, but costly and ineffective due to root suckers and resprouting shoots in greater density. Moreover, if applied in natural areas, the passage of large mechanical equipment in natural areas would create many damages to the native vegetation and in some habitats, such as slopes and rocky areas, would even be impossible. Girdling the cambial tissue on the stem induces heavy root sprouting. Chemical spray control would be the most effective and cheap treatment for this species, but it is poorly eco-friendly because of the release of large amounts of herbicides in the environment making it particularly dangerous for sensitive areas such as parks and Natura 2000 sites. In fact, spraying herbicides has negative consequences including drift of the droplets that harm or kill non-target plants and affect animals and humans. On large trees the problem is much more serious.

In the scientific literature there are many publications showing that the combined use of mechanical and chemical treatments seems to be the best option.

An innovative approach is the use of stem herbicide applications suitable to directly introduce the herbicide into trunks and increase effectiveness and able to kill tree of heaven applying very low volumes of product, thus reducing the risks and impacts of pesticide use on environment and human health. The sustainable control methods used in this project are:

- endotreatment (endotherapy),
- injection,
- cut stumps,
- spaced cuts with sponge.

Endotherapy

Currently used for protecting ornamental trees from fungi and insects, is here innovatively used as a treatment for direct control of woody weeds (*endotreatment*). The technique is accomplished by making 3 cm-deep drill holes at the base of the trunks and by injecting a water soluble systemic herbicide that will be translocated up and downwards through the lymphatic vessels. Endotherapy is accomplished by specific pressurized "endotreatment systems" provided with injecting needles (see below).

The development of this method applied to the elimination of undesired plants allows to improve the localization of the product, the accuracy of the dosage and the distribution of the product in all parts of the tree, thus considerably reducing the volumes of herbicide used, the dispersal of products in the environment, the washing action of rainfall, pollution, effects on non-target species, risk of toxicity to humans, animals and useful insects, and improving efficacy (which reduces the number of treatments), operator safety and selectivity.

Injection

Injection consists of making downward drill holes in the trunk and then applying in it 2 ml of herbicide by pipettes or by a syringe (Figure 2).

Cut stumps

Cut stumps means that the systemic herbicide is applied by a squeeze bottle directly onto the cambial region of the cut surface, soon after the plant is cut (Figure 3).

Spaced cuts with sponge

This technique consists of making a downward 3x3 cm-cut in the bark and placing a little piece of flat sponge in it (Figure 4). The sponge will be soon imbued with the herbicide. The use of a little sponge in the spaced cuts keeps the tissues wet for long and avoid herbicide drip and evaporation.

In the case of endotreatment, injection and spaced cuts the plant die standing on and is to be cut later on.

All the proposed techniques have already been tested in previous studies, are effective and easy to be applied. They can be carried out using very simple tools (such as pipettes or sponge) or a more complex but easy-to-use instrument (such as the home-made "endotreatment system" – Figure 5). All the sustainable control methods used implicate maximum localization and a considerable reduction of the employed volumes of the product thus being safe for man and environment and usable for ailanthus control in natural areas. These techniques have not been applied before or elsewhere on a large scale. Compared to traditional control methods these techniques have many important advantages such as low drift, no off-target effects, selectivity and minimal need of equipment.

Prior the project these innovative stem herbicide application techniques were set up and tested with the aim of minimize herbicide volumes. Standard application methods were modified and herbicides application rates minimized. All three application techniques resulted very effective for tree of heaven control, leading to plants desiccation and death and to middle/long term effect.

The choice of the treatment to be applied will be done depending on the degree of the total infestation detected in the Park area, and then time by time, depending by the single infested spot (habitat type and size, plant density and number), the characteristics of the around area (e.g. presence of walls, buildings, wells, or open spaces), the plant size and height, etc. For example, in

case of very larger plants, cut stump must be avoided not to generate root sprouts, while endotreatment could be much more effective. On the contrary, in very dense areas with small or medium size plants, cut stumps could be the best option to make interventions quicker.

For very large plants or in case of resprouts, repeated treatments are foreseen to carry out after the appearance of regrowth.

Those observations and all the treatment techniques will be explained to the operators in details during the training phase.

**Tools and equipment needed**

Tools and equipment needed are the following:

<u>for cut stumps:</u>

- a chainsaw to cut big trunks,
- hand saw or pruning shears for small plants,
- squeeze bottles to apply herbicide,

<u>for injection:</u>

- a drill to make the holes in the trunks,
- pipettes or syringes to apply herbicide,

<u>for spaced cuts with sponge:</u>

- knives to cut the bark,
- flat sponge,
- pipettes or syringes to apply herbicide.

<u>for endotreatment</u>:

- specific endotherapy systems must be used.

The best available for sale are BITE (Blade for Infusion in Trees - Figure 6) and ArboProf professional (Figure 7). These systems will be purchased and used.

BITE and ArboProf systems are portable instrument for endotreatments. The instruments are very effective for very large undesirable tree and environmentally safe, avoiding herbicide dispersal.

ArboProf is based on an adjustable low pressure system in which the contained herbicide solution is put under pressure and led into trunks by injection needles.

Personal protection devices such as clothes, boots, gloves, eye protection, etc. will be used.

**Choice of the herbicide**

To select the proper herbicide effective against ailanthus, the following characteristics have been taken into account:

- target species: the herbicides must be effective against perennial (possibly woody) plants; in general, for natural areas it is best to select compounds that are specific and effective against the target species. Conversely, if you use a broad-spectrum herbicide, drift, leaching and runoff should be avoided. That is possible by employing localized application methods (the sustainable methods here used) that minimize the herbicide dispersal into the environment.
- activity: as the target species generates shoots from the crown and from the roots, the selected herbicide needed to be systemic and capable of moving inside the plant through the vascular system, reaching areas far from the point of application, hopefully the roots;
- toxicity: the selected product must not be toxic to animals and other organisms and the overall impact on the environment must be as small as possible.
- registration: the selected product has to be registered for use in non-crop areas;
- formulation: liquid concentrate are best to be applied in holes, sponges, cuts or vascular system.

**Herbicide (Glyphosate) characteristics**

The active ingredient Glyphosate (chemical formula: N-phosphonomethyl-glycine) has already been successfully tested. It is a non-selective post-emergence water-soluble systemic herbicide for control of annual and perennial weeds and woody plants (vines, shrubs and trees) in non-crop areas including natural areas.

Glyphosate is one of the most widely used herbicides. Monsanto's patent for glyphosate expired in 2000, and other companies are already selling glyphosate formulations under an assortment of trade names. The major application for glyphosate products is agriculture, but it is also used to control unwanted weeds in non-cultivated areas.

Glyphosate is transported in both the xylem and phloem of treated plans. It works by inhibiting the synthesis of aromatic amino acids tyrosine, tryptophan, and phenylalanine necessary for protein formation. Such metabolic pathway is essential for the plant's growth, but does not exist in animals. That makes glyphosate a very effective broad-spectrum herbicide and contributes to its non-toxicity to birds, mammals, and fish.

Glyphosate is strongly adsorbed to soil particles, which prevents it from leaching or from being taken-up from the soil by non-target plants. Glyphosate is non-volatile when applied and it is soon degraded primarily by microbial metabolism. In plants, glyphosate is slowly metabolized.

The broad-spectrum herbicidal activity is evident when glyphosate is applied by conventional sprayers to foliage, as there is no penetration of woody stems or bark. Selective application to particular species and the need to minimize drift of such an effective phytotoxin led to the development of the novel applications and techniques here used (cut stump, injection, spaced cut with sponge and endotreatment).

The first symptoms of the herbicide usually occur 7-14 days after treatment with yellowing and reddening to desiccation of vegetation; completely dried plants is reached within a few months.
The perennial weeds are most susceptible to glyphosate during flowering, while trees and shrubs are more sensitive in the summer-autumn period.
Roundup 450 Plus (liquid soluble concentrate - Monsanto) will be used pure or diluted with water according to the plant size and to the application technique used. Care should be taken and protective clothing worn to prevent accidental contact of these formulations on skin or eyes.

**Treatment protocol**

Treatment priority

Among the infested areas surveyed, key action sites will be identified and prioritised according to:
- habitat vulnerability approach,
- presence of big female plants with flowers or samaras.

Herbicide used

Glyphosate will be used:
- pure for cut stumps, injection and hack and sponge,
- diluted 1:2 for endotherapy.

Control techniques:

- Cut stump:
    - Cut the plant 40 cm above the soil level using a chainsaw or a pruning saw.
    - Treat the whole stump surface soon after the cut with the herbicide solution applied with a laboratory squeeze bottle avoiding runoff.
    - Apply 2 to 30 ml of herbicide solution according to the tree size (see above).
- Hack and sponge:
    - Make spaced downward cuts in the bark.
    - Place a little 2x2 cm flat sponge in the fresh cut.
    - Imbue each sponge with 2 ml of the herbicide by a lab pipette or a syringe.
    - For trunk diameter up to 4 cm, one bark cut with sponge will be made and 2 ml of herbicide applied per tree. Every increase of 2 cm in the diameter size will require one more spaced cut with sponge and 2 ml more of herbicide solution to be applied. For example, for a 4–6 cm diameter trunk two bark cuts are necessary, while for a 10-12 cm diameter trunk 5 bark cuts are required, with 4 ml and 10 ml of herbicide respectively.
- Injection:
    - Realize big drill holes in the trunk with a downward angle of 45°.
    - Inject the herbicide into the holes by a lab pipette or a syringe.

- For tree diameters till 4 cm one drill hole and 2 ml of herbicide solution will be applied. For 4-6 cm diameters two drill holes and 4 ml of herbicide solution will be applied. For trees with 6-9 cm of diameter three drill holes will be carried out and 2 ml per hole applied. For bigger plant the techniques is not recommended because too laborious.

- Endotreatment (endotherapy) with Arboprof (only for very large trees):
  - Make 4 mm drill holes in the trunk.
  - Insert the brass injection needles of the endotherapy system into the holes.
  - Open the Arboprof valves to introduce the herbicide solution, under pressure or not, directly into the lymphatic vessels.
  - The number of holes and the amount of herbicide solution supplied will be chosen according to the size of the plant and to the presence of samaras.
- Endotreatment (endotherapy) with BITE (only in case of big plants):
  - Insert the blade into the trunk.
  - Inject the herbicide solution.

Doses:

The number of cuts or holes to be realized per plant and the amount of pure herbicide/herbicide solution applied to each plant vary depending on the treatment technique and according to the diameter of the plant. They are listed in the following Table 1:

| Treatment technique | Trunk diameter (cm) | Drill holes (n) | Bark cuts (n) | Hericide solution per hole or bark cut (ml) | Total herbicide solution per tree (ml) |
|---|---|---|---|---|---|
| Cut stump | 1 – 40 | / | / | / | 2 – 50* |
| Hack and sponge | < 4 | / | 1 | 2 | 2 |
| | 4 - 6 | / | 2 | 2 | 4 |
| | 6 - 8 | / | 3 | 2 | 6 |
| | 8 -10 | / | 4 | 2 | 8 |
| | 10 - 12 | / | 5 | 2 | 10 |
| Injection | < 3,5 | 1 | / | 2 | 2 |
| | 3,5 - 6 | 2 | / | 2 | 4 |
| | 6 - 9 | 3 | / | 2 | 6 |

* variable according to the diameter.

**Table 1. Treatment techniques, tree size, herbicide applications and amount, to control tree of heaven.**

Treatment period

Treatment will be carried out from late spring to early autumn. Late summer or autumn treatments are the most effective to kill suckers and roots, as the downward lymphatic flow is maximum.

Treatment efficacy

The treated plants will be observed every 15 - 20 days after the treatment.

For plants treated by injection, endotreatment or spaced cut, speed and seriousness of phytotoxicity symptoms (leaf yellowing or browning, leaf fall, necrotic branch or stem, trunk splitting, plant death) will be regularly recorded after the treatments. The occurrence of possible resprouts will also be recorded. On plants which have undergone cut stump, the occurrence of latent buds, resprouts/regrowth and root suckers will be observed.

Every year the observation period will last from the late spring until the beginning of the leaf fall.

Plants will be considered died if no sprouts or new vegetation are observed during the growing season following that of the treatment.

**Trunks disposal**

The control techniques and the eradication plan foresee that all plants are cut before treatment in the case of cut stump, and after treatment in the case of spaced cuts, endotreatment and injection. In the first case, plants cut before treatments can be still alive, so they have to be removed from the soil, cut in pieces, and dried to avoid resprouts. In the second case, plants cut after the treatments should be died, but they have to be cut and removed anyway.

Ailanthus has heat-producing properties similar to birch, white oak, and other woody species.

Plants, in pieces or in trunks, must be disposed. There are different ways to dispose the wood produced:

- to store it locally in the form of logs and use it, directly by the land owners or by other local people, for charcoal and firewood for supplementary house heating,
- to cut up all branches and chip it up making woodchips.

Woodchips are made by a portable shredder machine. They can be used as an organic mulch to strew possibly on the soils close to the treated areas: as the chips decompose they improve the soil structure, permeability, bioactivity, and nutrient availability. Woodchips will also be utilized directly as a biomass solid fuel for heating in buildings or in energy plants for generating electric power from renewable energy. The newer heating fuel systems use either woodchips or wood pellets. Woodchips are less expensive than wood pellets and theoretically more energy efficient than pellets, because less energy is required for manufacturing, processing, and transporting. Woodchip as an energy source is a clean alternative to carbon emissions produced by fossil fuels and does not have waste disposal issues, since wood ash can be used directly as a mineral-rich plant fertilizer.

In the distributed questionnaire, landowners and farmers (action A2) are informed about the wood availability and asked if they are interested in keeping the wood coming from their properties for

domestic use or if they prefer the wood to be removed. Local people will be informed and allowed, in the case of wood availability, to come and pick it up with a personal vehicle. If necessary, logs can be accumulated in temporary storage areas, and then taken directly by the local population for personal use.

Herbicide degradation would occur sufficiently fast to have no non-target effects, regardless the type of treatments.

Also the educative approach acquired by wood availability to be used as house heating or energy source should be kept into account. For example, farmers or local population can be sensitized on ailanthus and invasive species control and at the same time informed that their control lead to firewood availability.

Trunks recovery will occur during actions C1, C2, C3, C4 all through the Park area (68077 hectares). Trunks storage and disposal will occur in different sites and will be managed in progress.

**Figure 1. Very young ailanthus seedlings that can be removed by hand pulling.**

**Figure 2. Drill holes made in trunks to practice injection treatment technique.**

**Figure 3. Cut stumps treatment technique**

**Figure 4. Spaced cuts with sponges.**

**Figure 5. Homemade endotreatment system.**

**Figure 6. Blade for infusion in trees - BITE system.**

**Figure 7. Arboprof professional endotherapy system.**