

**Guide to measures for reducing  
damage caused by  
wild mammals  
in rural areas,  
urban areas and infrastructures**



**Diputació  
Barcelona**

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#DibaOberta

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**Authors**

Carme Rosell, Berta Pericas, Joana Colomer and Ferran Navàs, MINUARTIA

**With the support of**

Ministry of Agriculture, Livestock, Fisheries and Food (Forest Ecosystems and Environmental Management Department), Government of Catalonia

Territory and Sustainability Area, Barcelona Provincial Council

**Contributors**

Barcelona City Council (Animals Rights Department)

Rangers' Office, Government of Catalonia

Faunatek

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# Presentation

Damage caused by wild fauna is an emerging conflict that is generating serious losses for crop and livestock farmers. It also represents a threat to the correct operation of transport infrastructures (particularly roads and airports) and causes problems in areas such as urban green areas maintenance and reforestation. In urban areas, and particularly in the Barcelona metropolitan area, the growing presence of wild boar (*Sus scrofa*) that have lost their fear of humans is damaging urban infrastructures and has even become a risk to people. In fact, it is this species that causes the greatest amount of damage and which most of the measures set out in this document are aimed at.

One of the main factors that is aggravating this conflict is the expansion of a number of species of fauna that have no predators or that see humanised areas as safe zones where hunting is prohibited and where food can be easily found. The fact that some people wish to approach these wild animals and feed them is another factor that is worsening the conflicts, as this attitude is encouraging such fauna to become progressively habituated to humans and to lose their wild instincts.

Alongside this growing conflict, there has also been a rapid increase in the products and techniques designed to prevent or reduce damage caused by fauna. Some of these have been proven to be effective if used suitably, while others have yet to be assessed for effectiveness or have been proven ineffective or counter-productive.

Within this context, Barcelona Provincial Council, in collaboration with the Catalan Ministry of Agriculture, Livestock, Fisheries and Food, has commissioned this guide, which describes the measures that can be taken to reduce the damage caused by wild mammals, and in particular by wild boar, which cause conflicts arising from their presence in urban areas, sports facilities and infrastructures, as well as in rural settings, on agricultural and grazing land and in reforestation.

Given the flood of interest surrounding the topic at hand, we found it necessary to translate this text into both Spanish and English. The text will be available in open access on the following websites:

[https://www1.diba.cat/llibreria/1stDetail\\_Publicacions.asp?Opener=Libreria&ID=61831](https://www1.diba.cat/llibreria/1stDetail_Publicacions.asp?Opener=Libreria&ID=61831)  
<https://parcs.diba.cat/web/conservacio-de-la-biodiversitat/cacera>

**Jordi Padrós Selma**  
Natural Area Services Coordinator

# 1. Objectives

The **objective** of this Guide is to provide up-to-date information on tried and tested measures, detailing the cases in which they should be used and giving basic instructions for implementation, as well as any applicable regulatory considerations. The information has been set out in a series of files containing the relevant details on each measure, which can be regularly updated to include information on innovative measures or specific cases of use that may serve as appropriate examples.

This document is mainly **addressed to** local council technicians responsible for the management of urban areas, and in particular urban green areas, as well as those who manage natural protected areas. It may also be of use to the managers of sports facilities and companies in the area of gardening and habitat restoration, as well as agricultural and livestock farms.

The information provided on the files describes the possibilities and conditions for applying each measure so that the most suitable one can be chosen in each case. Many of these measures must be implemented by professionals and, in some cases, require a high degree of expertise as well as permits. It should be mentioned that aspects related to the management of hunting activities, which affect the control of animal populations and may contribute towards reducing damage, are not included within the scope of this Guide.

Finally, it must be highlighted that the Guide has been structured in such a way that it can be easily adapted for online consultation. The creation of a website containing all the information set out in the Guide, where the content can be regularly updated, is considered to be a key step both in terms of making the information easy to access and consult, and of introducing the regular updates that will undoubtedly be required, as this is a field that is constantly evolving, with dynamic innovation and frequent new products.

## 2. Methodology

The following tasks were undertaken to draw up this Guide.

- Review of bibliographical information and the results of effectiveness trials

Firstly, a review was carried out of both published and unpublished documents compiled by the authors of the Guide, who have been working in the area of damage control for more than two decades. The effectiveness trials carried out by the authors themselves or other professionals with whom they work were also taken into consideration. It must be borne in mind that this is an area in which a lot of information that is generated is not published in scientific journals or easily accessible documents. In particular, many of the trials relating to products which prove to be ineffective do not go on to be published. The review also takes into account updated information on measures that are still in the experimental stage.

- Consultation with distributors, users and specialised technicians

The next stage involved consultations with distributors, users and technicians responsible for applying different types of measure, both within councils and other organisations. The resulting information served to complete the descriptions of the conditions for implementing each measure, as well as providing references that are included by way of examples. In this regard, Barcelona City Council has made a valuable contribution thanks to its extensive experience in the management of wild boar in urban areas.

- Consultation with other actors involved in the implementation of measures

The information regarding regulations and permits required for the implementation of measures includes data provided by the Catalan Ministry of Agriculture, Livestock, Fisheries and Food, and specifically the Department for Hunting and Inland Fishing Activities. Furthermore, manuals including measures that can be applied on transport infrastructures have been identified. Two main references providing descriptions of measures to reduce the risk of animal-vehicle collisions (fencing, wildlife passages, etc.) are given, the contents of which are listed in Annex.

- Creation of files describing the measures

All the information compiled has been organised into files for easy consultation of each specific measure. Each file includes information on:

- Objectives and areas of application.
- Effects of the measure (exclusion, repulsion, capture, habitat management or communication).
- Duration of the effects (temporary or permanent).
- Basic technical features and other aspects to bear in mind when implementing the measure.
- Applicable legislation and permits required for implementation.
- Diagrams and photographs to help explain the features of each measure.



### 3. Main conflicts caused by wild boar and other wild mammals

The conflicts dealt with in this Guide are mainly caused by four species of wild ungulates: wild boar and deer, specifically roe deer (*Capreolus capreolus*), fallow deer (*Dama dama*) and red deer (*Cervus elaphus*).

The most significant conflicts caused by wild boar and other wild ungulates are:

- Damage to crops, pastures and other agricultural assets

Rural areas are the ones that suffer the most from damage caused by animals, and particularly by wild boar. There are no global statistics available on the number of incidents, but the problem can be seen to have grown significantly if we look at the number of capture or hunting permit requests made on the grounds of damages each year in Catalonia. During the time between 2003-2015, a total of 24,874 exceptional permits were granted on the grounds of damages, 48% of which were related to problems caused by wild boar (DARPA, 2016), and of these, 93% of all the permits were granted for damages caused by ungulates. Over this 12-year period, there has been a nine-fold increase in the number of permits for damages caused by fauna, with almost 7,000 permits issued in 2015.

A wide range of crop species are affected by wild boar. In addition to corn—the crop that has traditionally been most affected—we can now add a large number of other crops, most importantly grapes, fruit species such as apples, peaches and almonds, and others including rapeseed and horticultural crops. In all cases, the damages affect the fields temporarily, mainly when the crops ripen and become most attractive to wild boar. However, damage is also reported during the sowing season due to the consumption of freshly sown seeds.

Another type of damage that is reported is that caused to irrigation systems, especially during dry periods, when wild boar unearth and damage irrigation systems to obtain water.

Grazing land is affected due to rooting by wild boar to dig up food (invertebrates, roots and rhizomes). The damage may extend to significant depths and widths, which may result in difficulties moving machinery or reduce the value of the grazing land.

- Damage to forest areas and plantations undergoing ecological restoration

Revegetation may be affected by both wild boar and other ungulates. Wild boar mainly affect plants that have been brought from greenhouses, as it has been observed that they attract them due to their rich nutrient content. Revegetated areas associated with public works, habitat restoration or forestry plantations are frequently attacked by wild boar, which dig up the shoots, often consuming part of the root and causing other harm to the plants. These attacks are heightened when new vegetation is watered during dry periods, as the water and rich nutrients make a very attractive combination for this species.

In the case of deer, another type of damage is observed. This mainly affects young trees and may be caused by browsing or due to deer rubbing their antlers on the tree bark. In the first case, the damage is the result of the animals eating buds and leaves, and in the case of roe deer this mainly affects the apical parts. Rubbing is caused by male deer during the period when the velvet coating on the growing antlers dries out. During this period, the animals search for trees, normally with a small diameter, on which they repeatedly rub their antlers, damaging the trees' bark and even occasionally causing them to die. Protection against this type of damage caused by deer will be included in further versions of this Guide.

- Damage to biodiversity in natural areas

In natural areas, damage is reported being caused by wild boar to different elements of the natural environment. Damage to certain species of wild flora, such as orchids, whose buds are actively sought after by wild boar, is a useful example. This impact has been observed in places where conservation projects are carried out, such as the Delta del Llobregat Natural Areas, but also in the Montseny, in Sant Llorenç del Munt and in parts of the Alt Empordà area. Other problems that have been detected are the predation of eggs and ground-nesting bird chicks, which particularly affects birds in wetland areas such as the Llobregat delta and the marshes of the Empordà area. Predation of Herman's tortoise (*Testudo hermanni*) eggs has also been documented in Albera and European crayfish (*Astacus fluviatilis*) in Montseny, among others. An over-abundance of wild boar clearly represents a threat to the conservation of biodiversity, which is why many natural area management plans consider the species as a threat factor and include measures for controlling wild boar and the damage they cause.

- Road accidents caused by ungulates

Every year, around 1,000 accidents due to wild ungulates are reported on Catalonia's network of inter-urban roads (data from 2010-2014), most of which are caused by wild boar, and with an average of around 60 resulting in victims. The number of accidents has doubled since 2007, the first year for which comparative data exist. This conflict has been dealt with in a specific study on road accidents involving animals in Catalonia (Ministry of Territory and Sustainability, 2016) which identifies accident hotspots and proposes accident reduction measures.

- Conflicts involving other transportation infrastructures

Wild boar entering airports, despite there being a perimeter fence, is a significant risk factor that is occurring ever more frequently, resulting in the need for special capture operations. Small airfields are also affected by wild boar, in this case due to extensive rooting on the areas where the light and ultralight aircraft circulate, with the resulting problems that this causes.

Cases of wild ungulates being run over on railways are reported occasionally, including on the high-speed line, even though it has a perimeter fence and wildlife crossings have been built. When a perimeter fence is not buried, wild boar can easily access the track. There are no known cases of such collisions with ungulates causing train delays or affecting the track's operation logistics, but they do require specific maintenance measures. Moreover, carcasses attract birds and other species of carrion-eaters, the mortality rates of which are increased as a result.

- Conflicts due to the entry of wild boar into urban areas

There has been a notable increase in the presence of wild boar in Catalan peri-urban areas, and even inside towns and cities, as is also occurring in many other cities in Europe and around the world. The Barcelona metropolitan area, and in particular the urbanised areas adjacent to the Collserola park, suffer intensely from the problems generated by these animals when they come into the city in search of food from waste containers and litter bins, food from feral cat colonies or food offered to them directly by people. These wild boar become habituated to humans, they lose their fear and are extremely adept at moving around and finding refuge in areas that have been significantly transformed by human activity. One of the most significant conflicts they cause is the risk to people—there have already been some attacks—but they also cause damage to grass, garden irrigation systems and street furniture. This is a complex case in which, as well as taking measures aimed at protecting those elements liable to damage by wild boar, a change of habits is required to stop people from aggravating the conflict by providing the animals with food. These aspects are the focus of several of the measures described in this Guide.



The wild boar causes the highest number of conflicts in all types of area, including agricultural fields and pastures, gardens and sports facilities, as well as affecting infrastructures and biodiversity conservation in natural areas.

Source: *Minuartia*

## 4. Selection of measures aimed at reducing damage

### 4.1. Types of measure

The measures described in this Guide have been classified **according to their effects**, as follows:

- Exclusion: This involves the installation of systems that prevent wild boar and other species of mammal from entering exclusion areas. This type of measure includes perimeter fences.
- Repulsion: Systems aimed at deterring animals from entering specific areas to prevent them from causing damage. Examples of this type of measure are acoustic devices and odour repellents.
- Removal: Measures aimed at capturing animals that cause conflicts, normally when they are present in urban areas or in places where they may have become trapped, such as elements of infrastructure.
- Communication: This involves providing information and encouraging a change of habits in people, who may then help to reduce conflicts caused by wild boar and other wild fauna.
- Habitat management: Measures to modify vegetation maintenance or to adapt other elements such as waste containers and street furniture, with the aim of preventing wild boar from being attracted or being able to access food.

The measures have also been classified **according to the main type of area to which they apply**:

- Urban areas: Towns, cities and other built areas.
- Agroforestry areas: Fields of crops and other agricultural or grazing land and areas undergoing reforestation or habitat restoration.
- Infrastructures: This mainly includes roads, railways, aerodromes and airports, although other types of infrastructure such as water and waste treatment facilities may also be considered.
- Other: This includes a range of areas such as sports facilities (e.g. football pitches and golf courses).

Finally, a third type of classification has been used **based on the duration of the effects**:

- Permanent: Those that continue to be effective in the long term if proper maintenance is provided.

- Temporary: Those that cease to be effective after a certain period of time or that are only implemented in certain periods or places where damage is registered.

The file for each measure specifies the type of effect, the area of implementation and the duration, as per the above classification.

## 4.2. Suitable measures for each type of damage

The following table lists the measures included in the Guide and their main features, as well as the species to which they may apply.

File no.	Measure	Location	Target species	Type of measure	Effect
1	Perimeter fences	Urban Agroforestry Infrastructures	Wild boar Other ungulates and other species of fauna	Exclusion	Permanent
2	Reinforcement of existing fences	Urban Agroforestry Infrastructures	Wild boar Other ungulates and mammal species	Exclusion	Permanent
3	Electric fences	Agroforestry Infrastructures	Wild boar Other ungulates	Exclusion Repulsion	Permanent or temporary
4	Odour repellents	Urban Agroforestry Infrastructures	Wild boar Other ungulates	Repulsion	Temporary
5	Acoustic devices	Agroforestry Infrastructures	Wild boar Other ungulates and species of fauna	Repulsion	Temporary
6	Trapping	Urban Agroforestry Infrastructures	Wild boar	Removal	Permanent
7	Darting	Urban Infrastructures	Wild boar Other ungulates and species of fauna	Removal	Permanent
8	Management of vegetation and green areas	Urban Infrastructures	Wild boar	Habitat management	Permanent
9	Adaptation of street furniture	Urban Agroforestry	Wild boar	Habitat management	Permanent
10	Adaptation of cat feeding areas	Urban	Wild boar	Habitat management	Permanent
11	Regulations and public awareness raising	Urban	Wild boar	Communication	Permanent or temporary

The following is a list of the main measures applicable to reduce the different types of damage described in section 3.

- Damage to crops, grazing land and other agricultural assets
  - Perimeter fences (file 1).
  - Reinforcement of existing fences (file 2).
  - Electric fences (file 3).
  - Odour repellents (file 4).
  - Acoustic devices (file 5).
- Damages to forest areas and plantations undergoing ecological restoration
  - Perimeter fences (file 1).
  - Reinforcement of existing fences (file 2).
  - Electric fences (file 3).
  - Odour repellents (file 4).
  - Acoustic devices (file 5).
- Damage to biodiversity in natural areas
  - Perimeter fences (file 1).
  - Reinforcement of existing fences (file 2).
  - Electric fences (file 3).
  - Odour repellents (file 4).
  - Acoustic devices (file 5).
  - Trapping (file 6).
- Traffic accidents caused by ungulates
  - Perimeter fences (file 1).
  - Reinforcement of existing fences (file 2).
  - Odour repellents (file 4).
  - Acoustic devices (file 5).
  - Specific measures (see Annex).
- Other conflicts involving infrastructures
  - Perimeter fences (file 1).
  - Reinforcement of existing fences (file 2).
  - Electric fences (file 3).
  - Odour repellents (file 4).
  - Acoustic devices (file 5).
  - Trapping (file 6).
  - Darting (file 7).
  - Management of vegetation and green areas (file 8).

- Conflicts due to the presence of wild boar in urban areas
  - Perimeter fences (file 1).
  - Reinforcement of existing fences (file 2).
  - Odour repellents (file 4).
  - Trapping (file 6).
  - Darting (file 7).
  - Management of vegetation and green areas (file 8).
  - Adaptation of street furniture (file 9).
  - Adaptation of cat feeding areas (file 10).
  - Regulations and public awareness raising (file 11).

## 5. Measures

This section includes the following files:

1. Perimeter fences
2. Reinforcement of existing fences
3. Electric fences
4. Odour repellents
5. Acoustic devices
6. Trapping
7. Darting
8. Management of vegetation and urban green areas
9. Adaptation of bins and waste containers
10. Adaptation of cat feeding areas
11. Regulations and public awareness raising



PERIMETER FENCES				File 1
Location	Target species	Type of measure		Effect
Urban	Wild boar	Exclusion	Repulsion	Temporary
Agroforestry	Other ungulates	Removal	Communication	Permanent
Infrastructures	Other species of fauna	Habitat management		

### Objective and applications

Measure aimed at protecting specific spaces from possible damage by wild boar and other ungulates through the use of a perimeter fence that prevents these animals from entering the enclosed area.

Applicable to all types of area that require permanent protection against damage by wild boar:

- Rural areas (farms, grazing land, reforested areas, facilities in rural areas, etc.).
- Urban areas (parks, gardens and other green areas).
- Infrastructures (roads, railways, airports, waste management or other facilities). It also applies to sports facilities (golf courses, football pitches or other spaces).

### Description

Perimeter fence that acts as a physical barrier to stop wild boar and other ungulates from entering specific areas.

The mesh type and height of the fence must be carefully chosen as they are critical factors determining fencing effectiveness. It is also essential that the fence be buried to a depth of 20 cm or firmly anchored to the ground to prevent wild boar from lifting it up and passing underneath.

A wide range of materials and designs may be used depending on the conditions and the use of the land being protected.

Existing perimeter fences can be adapted to prevent the entry of wild boar by adding different types of reinforcement at the bottom (see datafile 2).

### Technical features

- The most recommendable type of fence consists of metal wire mesh tensed between posts and buried to a depth of 20 cm (figure 1.1).
- The most preferable option is galvanised knotted rectangular mesh with progressive density, the so-called 'game fencing' or 'ursus fencing' (figure 1.2). There must be a fixed distance of 15 cm between vertical wires and a progressive distance of 5-10 cm at the bottom and 15-20 cm at the top between horizontal wires.
- The use of chain-link fencing is not advisable as wild boar have been known to bend it to open up holes which they can pass through.
- The height of the fence and the distance between posts will depend on the target species of animal (table 1.1). A height of 1.80 m above ground level, with posts every 4 m, is a suitable solution to keep out wild boar and roe deer, the two most widely distributed species in Catalonia and the rest of Europe.

If the area to be protected is also home to red deer, the height needs to be increased to 2.2 metres, either using mesh or by adding two taught galvanised steel wires to the top. The fence becomes more effective if the tops of the posts between these wires are inclined outwards at an angle of 45°, as this makes it harder for deer to jump over.

**Table 1.1. Recommended perimeter fence dimensions according to the target species**

Target species	Wild boar	Roe deer/Fallow deer	Red deer
Minimum fence height above ground	1.6 m (plus 20 cm underground)	1.60-1.80 m	2.20 m
Separation of fence posts	2-4 m	4-6 m	4-6 m

- The fence posts need to keep the mesh tightly tensed and therefore need to be strongly anchored to the ground. In sections with changes in the slope of the ground, a post must be placed obliquely to the horizontal mesh wires.
- The fence posts can be made of wood or metal, preferably galvanised or with other coatings to prevent rust. Round wooden posts blend in better with the surroundings in fences in forested areas, natural areas or other places where a low visual impact is required, as well as favouring the use of local timber. Metal posts are particularly useful when a greater height is required with an outwardly inclined top part for fitting wires.
- On land with soft soil, there is the possibility of installing the fences above low walls made of concrete, stone or other materials that are characteristic of the local surroundings. In this case, special care must be taken when fixing the fence to the wall; it can either be sunk into the concrete or anchored using a tension cable or a rigid rod at the bottom (figure 2.6, file 2).
- Dry stone walls (figure 1.3), in areas where these are traditional features, may be used as an alternative to mesh fencing; although it must be ensured that the necessary height can be obtained according to the target species (table 1.1).
- To prevent wild boar from entering gardens, parks or small urban green areas, fences can be installed consisting of vertical posts made of wood or other materials (figure 1.4), anchored to a foundation wall to guarantee stability. A distance of 5 cm between each post will prevent access by wild boar and a good overall visual impact will be achieved.

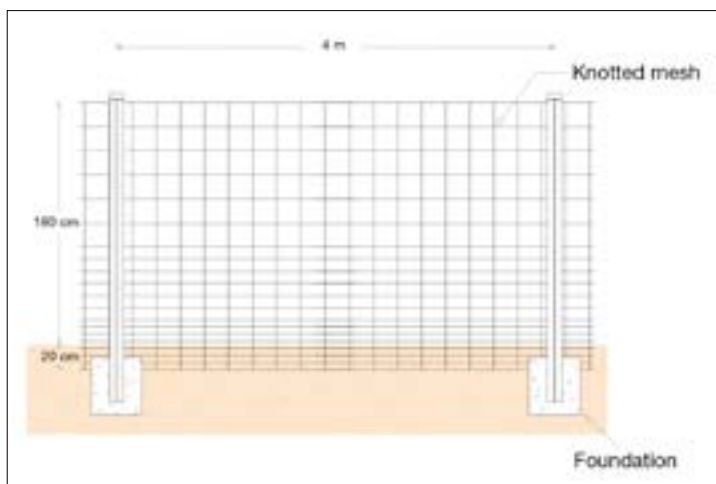


Figure 1.1. Diagram of a perimeter fence suitable for wild boar and roe deer.

Source: *Minuartia*



Figure 1.2. Fence made of knotted mesh with progressive density and wooden posts, suitable for rural settings. The mesh must also be buried in the soil to a depth of at least 20 cm.

Source: Minuartia



Figure 1.3. Stone wall suitable for blocking access of fauna, topped with a mesh fence to prevent access to people.

Source: Carme Rosell



Figure 1.4. Urban green space enclosed with vertical wooden posts, 5 cm apart, which prevent access to wild boar.

Source: Robert Rosell

### Protection at intersections with paths

- At the intersections between fences and access paths, wild boar and other ungulates can be kept out by installing cattle grids. These consist of a ditch with a depth of approximately 30 cm, covered by metal bars (figure 1.5). The width of the ditch will need to vary depending on the target species, with a minimum recommended width of 2 meters to prevent deer from jumping over. The sides of the cattle grid must be touching the perimeter fence, with no gap in between. To help any small animals that fall into the ditch to climb out, ramps must be built at the sides with a slope of less than 45° and a rough surface.
- Another alternative is to install gates across the access paths, always fitted perfectly into the fence, with no space beneath the gates which the animals might crawl under. It is advisable to install a concrete base under the gate.

### Prevention of access along drainage tunnels

- Irrigation drainage tunnels or other drainage systems are vulnerable points that may provide access to wild boar. They need to be protected by means of vertical bars with the correct thickness and spacing for each situation (figure 1.6).



Figure 1.5. Cattle grid to prevent ungulates crossing intersections of fencing with paths.

Source: *Minuartia*



Figure 1.6. Protection of a drainage culvert to prevent wild boar from accessing an area enclosed by a perimeter fence.

Source: *Minuartia*

### Exclusion fencing for small species of fauna

The above-mentioned perimeter fence for preventing access to ungulates allows other, smaller species of wild fauna to cross freely, thus ensuring ecological connectivity. However, in some cases it may be necessary to exclude invasive wild species (e.g. the American mink, *Neovison vison*) or autochthonous species that can cause damage, such as the rabbit (*Oryctolagus cuniculus*).

Small fauna can be kept out by installing a 2 x 2 cm electro-welded wire mesh reinforcement stapled to the outside of the knotted wire mesh. In addition, it is advisable that the top 5 cm be bent outwards at a 45° angle to impede access by certain climbing species such as the American mink (figures 1.7 and 1.8). The necessary height will vary depending on the species that needs to be kept out, but 1 m above ground level is high enough in most cases.

Rabbits are particularly difficult to contain because of their ability to burrow deep tunnels. In this case, specially designed solutions are required that adapt to the specific type of terrain and the size of the area to be protected. One solution that is complicated to implement but which has proved to be effective is to bury an L-shaped section of electro-welded wire mesh: 20 cm going down vertically as an extension of the fence, and at least 30 cm running outwards and covered with earth.

Some distributors provide fences made of flexible opaque material that are specifically designed for small animals, allowing them to leave enclosed terrains (the inner side is rough, allowing the animals to climb up) but not to enter (the outer-facing side is completely smooth).



Figure 1.7. Knotted mesh fence to prevent access to wild boar and other ungulates, reinforced with an electro-welded mesh to block American mink from a high conservation value wetland area.

Source: Ferran Navàs



Figure 1.8. Fence combining electro-welded mesh for small fauna (lower part) with knotted mesh for ungulates (upper part).

Source: Minuartia

## Maintenance

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- The first few months after a fence is installed, animals (and particularly wild boar) often make repeated attempts to cross the fence at certain points, causing possible damage. However, if damage is repaired quickly, the attempts decrease over time.
- Over the course of the first year, it is advisable to perform inspections of the fence every three months, after which they can be performed annually.
- Appropriate fencing may last for over 10 years, depending on the quality of the materials and other factors such as the type of terrain or the local climate.
- The growth of trees and bushes adjacent to the fence must be avoided to prevent damage to the structure from branches.

## Regulations and permits

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- The installation of fences may be subject to regulations, both in urban areas and on non-developable land. Regulations may place limits on both the possibilities of installing fences as well as their characteristics and their distance from paths, height, material, etc.
- When they are intended for natural protected areas, the municipal regulations or other specific regulations need to be checked.
- Some examples in Catalonia are:
  - Special Plan for the Protection of the Natural Environment and Landscape of the Montseny Park: <http://www.agroteritori.org/ficha.php?doc=345&cid=2>
  - Modification of the Special Plan for the Protection of the Natural Environment and Landscape of Sant Llorenç del Munt i l'Obac: <https://parcs.diba.cat/documents/215256/5240117/p04d090.pdf>
  - Bylaw on the Occupation of Land using Fences on Non-developable Land in the Serralada Litoral Park [https://parcs.diba.cat/c/document\\_library/get\\_file?uuid=40a29eeb-16dd-479a-bf96-6a519901402d&groupId=189633](https://parcs.diba.cat/c/document_library/get_file?uuid=40a29eeb-16dd-479a-bf96-6a519901402d&groupId=189633)
- There are grants available for the installation of fences around commercial forestry areas, agricultural and animal farms and other areas. For example, these include the grants offered by Barcelona Provincial Council: <https://parcs.diba.cat/documents/8751007/160205557/Convocatoria+i+bases++2018++CAT.pdf/1c665fb5-8196-4244-9284-13bc02ad9301>

REINFORCEMENT OF EXISTING FENCES				File 2
Location	Target species	Type of measure		Effect
Urban	Wild boar	Exclusion	Repulsion	Temporary
Agroforestry	Other ungulates	Removal	Communication	Permanent
Infrastructures	Other species of fauna	Habitat management		

### Objective and applications

The aim of this measure is to strengthen the protection of areas that have a damaged or inadequate perimeter fence, by reinforcing either damaged sections or the entire fence, to prevent wild boar and other ungulates from entering by raising the mesh or by other means.

Applicable to all types of area that require permanent protection against damage by wild boar:

- Rural areas (farms, grazing land, reforested areas, facilities in rural areas, etc.).
- Urban areas (parks, gardens and other green areas).
- Infrastructures (including roads, railways, airports and water waste management facilities). It also applies to sports facilities (golf courses, football pitches, etc.).

### Description

This consists of installing rigid mesh, ground stakes or other systems at the base of an existing fence or on sections that have suffered damage.

Such reinforcement makes it possible to protect vulnerable points where the fence has been damaged or improve fences that have been installed incorrectly or with unsuitable characteristics. It applies particularly to fences where the base has not been buried or where chain-link fencing has been bent open by wild boar.

### Technical features

#### Electro-welded wire mesh reinforcement

- Installation, on the outside part of an existing fence, of a rigid electro-welded mesh measuring from 40 to 90 cm high (depending on the condition of the fence and the location of the points damaged by animals attempting to breach it) and 5 mm thick wires. There must be a distance of 5 cm between vertical wires and 30 cm between horizontal wires; these are the dimensions for ensuring wild boar are unable to stick their snouts between the wires, which would enable them to pull on the mesh and tear it out (figures 2.1, 2.2 and 2.3).
- The first horizontal wire at the bottom of the reinforcement must be cut away to leave a row of vertical spikes that can be stuck into the ground to a depth of 20-25 cm (figure 2.3). This system is an easy way of burying the lower part of the reinforcement mesh and can be used in relatively soft ground without the need for digging trenches. Once it has been sunk into the ground, the electro-welded mesh must be stapled to both the posts and the existing mesh.
- This system is particularly suitable for repairing chain-link fencing that has been stretched open by wild boar (figure 2.4).

#### Reinforcement to anchor the mesh using ground stakes

- In knotted wire mesh fences where the bottom has not been buried, it can be anchored to the ground using pegs to prevent it being lifted up by wild boar. However, it must be ensured that wild boar are unable to pull out the pegs. A certain type of peg is available that consist of a tube containing sev-

eral flexible bars. When they are hammered into the ground, the hammering action pushes the bars out of the tube and they anchor firmly into the earth (figure 2.5). These pegs include a plate with a hole through which the pegs are placed and a part which attaches to the mesh.

#### Reinforcement for anchoring fencing to low concrete walls

- Fences installed on low concrete walls with gaps between the bottom of the mesh and the wall can be reinforced by installing a durable metal wire or, better still, a rigid metal bar anchored to the wall (figure 2.6) to which the bottom of the mesh can be attached. This system can also be used for fences installed on very hard ground. Reinforcement using this type of taught wire at the bottom of the fence is not suitable for soft ground as wild boar may be able to pass underneath.

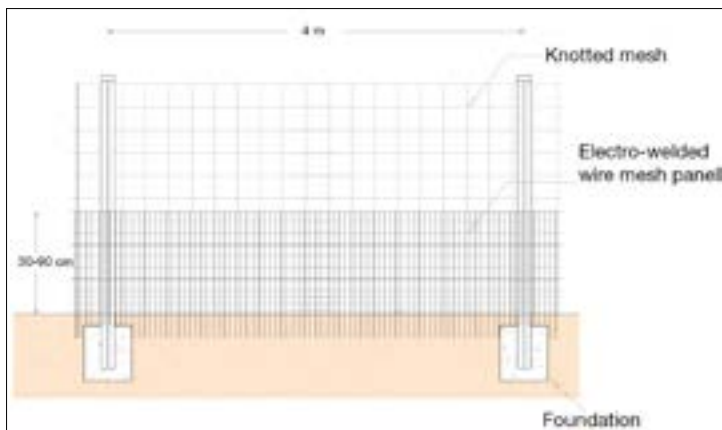


Figure 2.1. Diagram of a fence reinforced with electro-welded mesh.

Source: Minuartia



Figure 2.2. Reinforcement of chain-link fencing with electro-welded mesh installed along the bottom section.

Source: Minuartia





Figure 2.3. The horizontal wire at the base of the reinforcement mesh must be cut away to help stick the mesh into the ground.

Source: Minuartia



Figure 2.4. Repair of damage to chain-link fencing reinforced with electro-welded wire mesh suitable for wild boar.

Source: Minuartia



Figure 2.5. Peg for anchoring the mesh to the ground.

Source: Minuartia



Figure 2.6. Mesh anchored to a low wall using a horizontal metal bar to prevent animals from raising it and getting through. The chain-link fencing could still be pulled open by wild boar, however.

Source: *Minuartia*

### Maintenance

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- For the first few months after installation, it is advisable to inspect the damaged areas on a monthly basis to check the effectiveness of the reinforcements. Subsequently, the inspections may be performed annually.
- Appropriate fencing may last for over 10 years, depending on the quality of the materials and other factors such as the type of terrain or the local climate.
- The growth of trees and bushes adjacent to the fence must be avoided to prevent damage to the structure from branches.

<b>ELECTRIC FENCES</b>				<b>File 3</b>
<b>Location</b>	<b>Target species</b>	<b>Type of measure</b>		<b>Effect</b>
Urban	<b>Wild boar</b>	<b>Exclusion</b>	<b>Repulsion</b>	<b>Temporary</b>
<b>Agroforestry</b>	<b>Other ungulates</b>	Removal	Communication	<b>Permanent</b>
<b>Infrastructures</b>	Other species of fauna	Habitat management		

### Objective and applications

The aim of this measure is to protect specific areas from possible damage by wild boar and other ungulates by means of an electric perimeter fence that prevents these animals from entering the enclosed area.

They are particularly suitable for:

- Farms, grazing land and reforested areas.
- Small infrastructures (e.g. aerodromes).
- Natural areas where protection is required for a specific element that is particularly attractive to wild boar.

It can be installed as a permanent fence or activated on a temporary basis, connecting it to the power supply only when protection is required (for example during periods when a certain crop is available). Mobile electric fences can also be used that can be moved to points requiring temporary protection.

### Description

Electric fences consist of a power supply system, conductive wires or tapes, stakes, insulation and earthing system (figure 3.1). When an animal touches one of the conductive wires, it receives an electric shock that dissuades it from making further attempts to enter the sector protected by the fence.

If the wire is high enough and the system has the right voltage, it is very effective at preventing damage caused by wild boar and other ungulates.

### Technical features

- The number of wires and the height at which they need to be installed will vary depending on the target species (figures 3.1 and 3.2):
  - Wild boar: A minimum of two wires installed at 25 cm and 50 cm above ground level.
  - Roe deer: A third wire must be installed at a height of 100 cm.
  - Red deer and fallow deer: A third wire must be installed at a height of 120 cm.
- Instead of wires, white conductive tape can be used to make the fence more visible (figure 3.3). This system helps to prevent people from receiving accidental electric shocks as well as making the fence more visible to animals. However, it has a greater visual impact than fences with conductive wires.
- The conductive wires or tape should preferably be attached to wooden stakes (prioritising the use of local timber) and must never be attached to tree trunks. Stakes must be spaced at 10-12 m on flat terrain, or closer together on uneven ground. The wires must be kept at a constant height from the ground. If the lowest wire runs at a height of above 25 cm due to uneven ground level, wild boar may be able to pass underneath.
- The wires must be attached to the stakes using an insulating system that prevents short circuiting, which would render the fence ineffective.

- The power supply system may use direct current or solar-charged batteries (figure 3.4). For wild boar and deer, a minimum energy of 4 to 8 joules is required, powered by a solar battery of at least 12 volts or by a direct power supply, if available.
- When the fence crosses paths or small roads, a handle made of insulating material must be installed for each wire.
- The perimeter to be protected should ideally be a maximum of 1 km long. If it is longer, it will need to be divided into sectors with separate power supply systems.
- It is advisable to signpost the fence to prevent people present in the area from accidentally touching the wires.



Figure 3.1. Diagram of an electric fence suitable for wild boar and roe deer.

Source: *Minuartia*



Figure 3.2. Location of electric wires to block wild boar (the lower two wires) and roe deer (the tape at the top).

Source: *Minuartia*



Figure 3.3. Electric fence for wild boar with conductive tape to make it visible to people.

Source: *Minuartia*



Figure 3.4. Power supply system with batteries and solar panels.

Font: *Minuartia*

## Maintenance

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- During the first few days after installation, the fence should be inspected every one or two days until the animals become used to it and avoid contact.
- It is important that the system be kept completely free from vegetation, as contact between the conductive wires and grass or bushes will reduce its effectiveness. It will therefore be necessary to schedule regular cutting and clearing or slow down the growth of vegetation by covering the ground with sand or gravel. The use of herbicides that could affect the biodiversity is not advisable.

## Regulations and permits

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- Electric fences must be duly approved, and their use may be regulated in some places so municipal regulations should always be followed. In natural protected areas, other specific regulations may also apply (see file 1).

<b>ODOUR REPELLENTS</b>				<b>File 4</b>
<b>Location</b>	<b>Target species</b>	<b>Type of measure</b>		<b>Effect</b>
<b>Urban</b>	<b>Wild boar</b>	Exclusion	<b>Repulsion</b>	<b>Temporary</b>
<b>Agroforestry</b>	<b>Other ungulates</b>	Removal	Communication	Permanent
<b>Infrastructures</b>	Other species of fauna	Habitat management		

### Objective and applications

It is possible to reduce the damage caused by wild boar and other ungulates by applying products with scents that are unpleasant to these animals and that dissuade them, at least temporarily, from entering a certain area.

They are particularly suitable for providing short-term protection (normally of a few weeks) for:

- Farms, grazing land and reforested areas.
- Gardens and other green urban areas (e.g. lawns and flower beds).
- Natural areas where protection is required for a specific element that is particularly attractive to wild boar.
- Specific sections of linear transport infrastructures crossed by animals during certain short periods of the year.

Odour repellents are only effective on a temporary basis: they lose their effectiveness over a period of weeks, both due to the volatility of some of the substances and also because repeated, consecutive applications of the product may cause the animal to become habituated, meaning the animals become used to it and no longer react.

### Description

Method based on the application of volatile chemicals around the perimeter of areas requiring protection which have a scent that repels wild boar, deer or other species. They are normally specific for a certain species.

They do not cause any harm to the animals, but simply provide an unpleasant stimulus that they may associate with the presence of predators or other effects, thus dissuading them from entering the protected area. They must not be confused with products that take effect when ingested (normally emetics) which do cause the animals to suffer digestive disorders.

These products are available in a wide range of types, and it is necessary to choose those that are guaranteed to be effective based on product evaluation. Although their effects are only temporary, they may be useful in preventing damage during critical periods when a certain area contains resources that are highly attractive to wild boar or deer.

One specific type of dissuasive product creates an 'olfactory barrier'. It uses a substance that is meant to cause alarm (but not repel) wild boar and other ungulates, who then move with greater caution as a result, thereby avoiding potential accidents on certain sections of the road. These products are not suitable for crop protection, but can be implemented temporary in transport infrastructures (see Annex).

### Technical features

There are several ways to apply these products, and the instructions supplied by the manufacturer should be followed in each case. A range of products are available with different methods of applica-

tion and compositions. Only those with positive evaluations regarding their effectiveness should be used. The main types are as follows, classified by method of application:

#### **Powdered products**

- These products are normally sold in drums, diluted with water (e.g. in a proportion of 1 l of product to 50 l of water) and applied using a tractor tanker, in the case of large surfaces (figure 4.1), or using a backpack for smaller areas.
- Protection is achieved by applying the diluted solution along a perimeter strip of between 4 to 6 m wide. In the case of products for human consumption, it will be necessary to check how long the effects last. In areas dedicated to organic crop or animal farming, the regulatory authority must be consulted to check whether the use of these products is allowed.
- The odour will linger in the area where it is applied for a certain period of time which will vary depending on the weather conditions, dose applied and other factors. Protection is normally achieved for a period of several weeks, after which there may be renewed damage.

#### **Spray products**

- Substances sold in small containers and applied as a spray to plates provided by the manufacturer consisting of pieces of absorbent felt stuck to thin sheets of metal (figure 4.2). They may also be applied to other porous surfaces that retain liquid.
- The plates are hung either from stakes installed for this purpose or from low tree or bush branches, if the area to be protected is surrounded by this type of vegetation. It is important to hang them from places exposed to air currents so that the scent spreads out more effectively.
- The entire perimeter to be protected must be dotted with plates approximately every 10 m (or less, depending on how attractive the resource to be protected is) and at a height of roughly 50 cm above ground level.
- When the product evaporates and the effect wears off (which can be seen due to the appearance of damage) the repellent needs to be reapplied. One type of product that has proven to be effective consists of packs with two containers of products with slightly different compositions. These are applied alternately, so that the animals take longer to become habituated.

#### **Products applied over synthetic resins to protect the perimeter of infrastructures (see Annex)**

- This is also called an olfactory barrier, even though it does not prevent the animal from passing, but merely makes it move with increased awareness and caution.
- The product is applied first of all as a synthetic resin foam which solidifies on contact with air and clings firmly to the stakes or other supports.
- Subsequently, the product is reapplied by injecting it into the resin.
- The stakes are placed close to the edges of road sections where accidents repeatedly occur due to wild boar or deer. The distances between the stakes should be no greater than 5 m. It is advisable to install a second row approximately 10 m away from the first, even if they need to be located on private land.
- As with all other odour repellents, the effect of the product is temporary.



Figure 4.1. Application of an odour repellent in a field by means of spraying.

Source: Minuartia



Figure 4.2. Odour repellent placed at the edge of a field on plates with absorbent felt.

Source: Minuartia

### Maintenance

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- The products should be reapplied after a certain period of time (normally a few weeks) which will vary depending on the product and the local conditions.
- It is not advisable to continue applying them over a period of several months, as the animals will become habituated and they will become completely ineffective.



ACOUSTIC DEVICES				File 5
Location	Target species	Type of measure		Effect
Urban	Wild boar	Exclusion	Repulsion	Temporary
Agroforestry	Other ungulates	Removal	Communication	Permanent
Infrastructures	Other species of fauna	Habitat management		

### Objective and applications

Devices aimed at preventing damage caused by wild boar and other ungulates by emitting sounds (or ultrasound with a frequency above the audible range for humans) which alarm the animals and deter them from entering the areas where they are installed.

Applicable for repelling fauna from:

- Farms.
- Transport infrastructures: Mainly airports, roads and railways.

The effectiveness of many of the available devices has not been widely tested and in some cases they are still under evaluation. Devices that emit sounds at regular intervals are not effective, as the animals become habituated and do not react to the sounds. However, positive results are obtained when varied sounds are used, or when the devices are activated by the presence of the animals or by cars or trains when located near linear transport infrastructures.

The use of sounds within the audible range for humans may cause a nuisance if the devices are installed in residential areas or close to buildings, and this is a factor which limits their use.

### Description

These are devices that emit sounds aimed at scaring wild boar or other animals to deter them from areas that require protection. They are frequently used to keep away birds, for example in airports, although some models have been designed to deter wild boar and other ungulates.

### Technical features

- There is a wide range of devices from different manufacturers and for different target species.
- Sound cannons are one of the most common types of device. They emit a short, loud sound (similar to a small explosion) at regular intervals (figure 5.1). Animals become used to the sound quite quickly, rendering them ineffective, and for this reason their use is not recommended.
- The devices that use recordings can emit a wide variety of sounds. Some of them emit warning or distress cries of the target species to deter the animals, while others emit sounds of dogs barking or people moving or shouting (figure 5.2). In all cases, the animals also become used to these sounds if they are emitted at regular intervals and they cease to be effective within a short period of time, as shown in trials with deer in captivity. However, they can be effective if activated only when the target species is detected.
- There are currently innovative acoustic devices that are activated using animal presence detectors, which are either movement sensors or thermographic cameras (figure 5.3). The latter can be programmed to identify the shape or size of animals in order to emit the relevant warning cries. These devices are more effective due to the fact that the sound is not emitted at regular intervals, but only when the animal approaches the protected area.
- Another innovative version of this type of acoustic deterrent are electronic devices that emit ultrasound out of the audible range for humans—or almost out of range—but which can be clearly detected by

wild boar and deer. These are small, free-standing devices powered by solar panels that are installed on posts approximately 50 cm high and which can combine sound emission with small flashes of varying colours of light emitted at different intervals (figure 5.4). The combination of sound and light can be programmed and changed periodically to delay habituation and the resulting loss of effectiveness of the system. When used on roads, they can also be activated using sensors that detect approaching vehicles or headlights. These devices have been tested in some countries and have proved effective, although they require frequent maintenance to ensure they are working correctly.



Figure 5.1. Sound cannons to scare animals. They are not very effective; wild boar become habituated to them very rapidly.

Source: *Minuartia*



Figure 5.2. Devices activated by the detection of target species that emit recorded sounds (which vary depending on the species).

Source: *Minuartia*

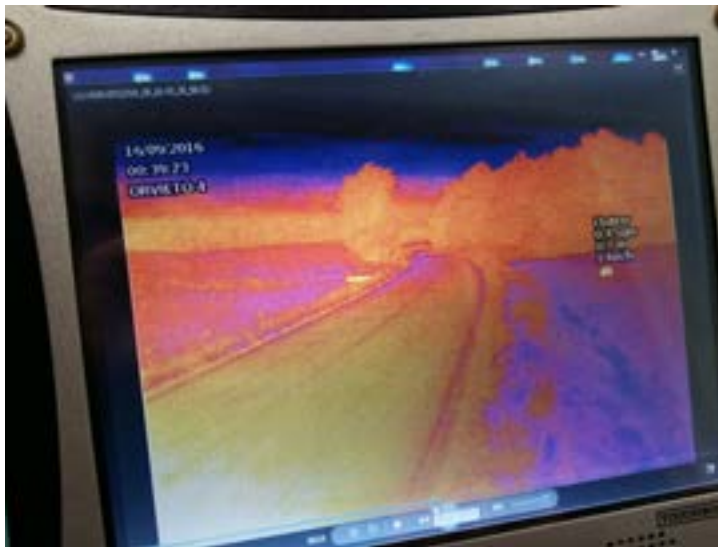


Figure 5.3. Thermographic fauna detection camera that activates warning sounds.

Source: Minuartia



Figure 5.4. Electric devices to be mounted on posts which emit variable sounds and flashes of light.

Source: Minuartia

## Maintenance

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- In all cases, these devices require a high level of maintenance; the type of maintenance depends on the system, from cleaning sensors and sound emitters to periodic checks of correct operation. If they use animal detection systems (whether movement sensors, thermographic cameras or others), it must be ensured that the field of detection is kept free of obstacles, meaning regular clearing of vegetation may be required.

## Regulations and permits

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- The use of sound cannons or other acoustic devices may be subject to regulatory controls, and their use may be regulated in some places so municipal regulations should always be followed. In natural protected areas, other specific regulations may also apply (see file 1).
- Some examples of regulations in Catalonia are:
  - Bylaw on devices that simulate firearm detonations (scare cannons) in Planes d'Hostoles: <https://ssl4.ddgi.cat/bopV1/pdf/2013/120/201312007185.pdf>

TRAPPING				File 6
Location	Target species	Type of measure		Effect
Urban	Wild boar	Exclusion	Repulsion	Temporary
Agroforestry	Other ungulates	Removal	Communication	Permanent
Infrastructures	Other species of fauna	Habitat management		

### Objective and applications

Used to selectively capture conflictive wild boar and remove them from the area when they pose a risk to people or cause damage to urban spaces or to other species of wild flora and fauna in natural areas. This file only refers to wild boar, as the types of trap described are specific to this animal.

When the presence of wild boar that have become habituated to urban areas is detected, this measure must be applied quickly to prevent them passing on this behaviour to their young, which would result in the problem increasing rapidly and exponentially.

Applicable for removing fauna from:

- Urban and peri-urban areas.
- Natural protected areas.
- Occasional conflicts in infrastructures, for example in airports or other enclosed areas that wild boar manage to enter despite the presence of protection systems (perimeter fence or other measures).

### Description

There are a range of trapping systems available, including cage traps, corral traps and hanging nets. This file only describes cage and corral traps, which are systems with tried and tested effectiveness that allow the captured animals to be easily and suitably handled.

In both cases, bait is used to lure the wild boar into the traps, capture them and remove the conflictive individuals from the places where they are creating problems.

Trapping is normally required for individuals that have become habituated to humans in urbanised areas and cannot be returned to the wild, for which reason it is recommended that the captured animals be euthanised using ethical methods. It is not advisable to return these animals to the wild for two reasons: Firstly, because even if they are released at a considerable distance from the point of capture, they often return to the place where they have caused conflicts, and secondly because in many areas of Catalonia there is currently an over-abundance of wild boar, and it is an animal with no natural predators that is causing damage of many types.

### Technical features

- Before setting up traps, the most suitable areas must be identified. These must be sheltered places where the captured animals will be protected from vandalism or attack. Both cage traps and corrals can be dismantled and reinstalled wherever necessary. The traps must be suitably signposted to warn people of their purpose and the risks.
- The type of trap must also be selected according to the situation and local conditions. There are a wide variety of possible sizes, materials, activation systems, door mechanisms, etc., and only those that have been proven fully effective should be used. Cage traps are particularly suitable for capturing young individuals and corral traps for matriarchal groups (females together with their young). To capture adult males, it is best to use other systems (see file 7), as these individuals are less likely to enter these traps.

- The measure must be implemented during the period in which conflicts appear and when the probability of catching the animals is highest.
- The bait used to attract the animals must be plant-based (corn, apples or similar), and under no circumstances should food scraps or animal remains be used. Just enough bait should be used, placed in a way that makes it inaccessible to other animals: under stones or using other systems that can only be moved by wild boar, in dispensers suitable for this species, etc. This will prevent the food from being obtained by other species of wild fauna, a situation which must be avoided as it can lead to the habituation of wild animals to humans and loss of their wild state.
- To prevent captured animals from being confined in the trap for longer than necessary, systems can be installed to detect the animals and close the door, at the same time as sending a mobile alert to the team responsible for handling the animals. If this type of system is not used, the traps need to be checked on a suitable basis: an inspection first thing in the morning and once in the afternoon, or at the times the animals are known to normally visit the area, should be sufficient. It must be born in mind that in natural settings, wild boar have a mainly crepuscular and nocturnal activity pattern, while in urban areas they are also active during the day.
- It may be easier to remove the animals from the traps using sedatives (see file 7) or immobilisation boxes (figure 6.4), separation boxes (figure 6.5) or other mechanical techniques, which must always guarantee the well-being of the animals.
- As previously mentioned, it is not advisable to return these animals to the wild, and doing so can only be justified for the purpose of conducting studies. If the animals are freed, they must be individually marked in order to check whether they return to their original area or continue to cause conflicts in other places
- It is advisable to exploit the data obtained from captured animals to the full for scientific and management purposes. With this in mind, it is essential to note the basic data for each individual (sex, age, weight, composition of its group, if known, etc.). It is also advisable to obtain biometric data and analyse their reproductive condition and health.



Figure 6.1. Cage trap for capturing wild boar.

Source: *Minuartia*



Figure 6.2. Immobilisation box for removal and transportation of captured animals.

Source: *Minuartia*



Figure 6.3. Corral trap for capturing wild boar.

Source: *Rangers' Office, the Government of Catalonia*



Figure 6.4. Separation box for individual removal and handling of the animals captured in a corral trap.

Source: *Rangers' Office, the Government of Catalonia*

## Maintenance

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- A significant amount of investment is required in terms of logistics, materials and human resources. Once they have been activated, the devices must either be checked on a frequent basis or systems must be installed that provide alerts when the trap door closes, to help to ensure the animals are trapped for the shortest possible time.

## Regulations and permits

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- Animal capture is subject to different regulations and requires a permit from the Catalan Ministry of Agriculture, Livestock, Fisheries and Food (DARPA) as well as fulfilment of the conditions required for exceptional authorisation of traps, which include aspects such as the type of bait to be used and the frequency with which they must be checked.

Two types of permit may be obtained:

- Permit for the capture of wild fauna specimens for scientific, management or educational purposes. These permits can be requested online at:  
<http://territori.gencat.cat/ca/tramits/tramits-temes/Autoritzacio-per-a-la-captura-dexemplars-de-la-fauna-salvatge-per-motius-cientifics-de-gestio-o-educatius>
- Exceptional permits for capture due to damage. These permits can be requested online at:  
[https://web.gencat.cat/ca/tramits/tramits-temes/9380\\_Autoritzacions-excepcionals-de-ca-ca-per-danys](https://web.gencat.cat/ca/tramits/tramits-temes/9380_Autoritzacions-excepcionals-de-ca-ca-per-danys)

<b>DARTING</b>				<b>File 7</b>
<b>Location</b>	<b>Target species</b>	<b>Type of measure</b>		<b>Effect</b>
<b>Urban</b>	<b>Wild boar</b>	Exclusion	Repulsion	Temporary
Agroforestry	<b>Other ungulates</b>	<b>Removal</b>	Communication	<b>Permanent</b>
<b>Infrastructures</b>	<b>Other species of fauna</b>	Habitat management		

### Objective and applications

Used to selectively capture particularly conflictive animals and remove them from the area when they pose a risk to people or cause damage to urban spaces or other species of wild flora and fauna in natural areas. This technique applies to the capture of wild boar but also of any other species of mammal, adapting the product and dosage to be used.

Applicable for removing fauna from:

- All types of space, but mainly urban areas and infrastructures where animals have become enclosed and are disorientated, or in other situations where an animal needs to be immobilised as quickly as possible.

This system may only be used by professionals with specific authorisations (both to carry out the operation and to use a dart gun) who have the required training and skills to perform the darting with veterinary support.

### Description

It consists of administering products that anaesthetise the animals and which can be administered from a distance using a blow gun, air gun or rifle (figures 7.1, 7.2 and 7.3). These weapons are used to shoot darts containing the product that is then injected into the animal as the dart hits.

### Technical features

The products and dosage required, which must be prescribed by a vet, will vary depending on the species and the required effect. The most suitable weapon must be chosen in accordance with the expected darting distance.

- A blow gun (figure 7.1) consists of a long, thin tube through which a dart is blown onto the animal. Blow guns can have different sizes, materials and ranges. They are most commonly used over short distances of 2-5 m, making them particularly suitable for animals habituated to humans or that have become trapped in a confined space.
- Rifles and guns that propel projectiles using compressed air (figure 7.2) are injection weapons classified as class-7 by the Spanish Regulation on Firearms (approved by Royal Decree 137/1993 of 29 January), capable of shooting projectiles to a considerable distance. Their use is regulated by the aforementioned regulation. Their range varies depending on the model. Air guns are normally used for distances of under 50 metres, even though they can cover longer distances. Rifles have a longer range of up to 100 metres, although they tend to be used for shorter distances.
- As well as the arms themselves and the material for administering the anaesthetic product (darts, needles, CO<sub>2</sub> cartridges, etc.) (figure 7.3), the professionals who use this technique must be equipped with all the necessary personal protective equipment and material for subsequently handling the animal.
- Anaesthetic products must always be administered in a way that is safe for the animal, using a very fast-acting product so that the animal is unable to escape and collapse somewhere else, causing a problematic situation. Furthermore, all the material must be available for subsequently handling the animal (figure 7.4).





Figure 7.1. Blow gun for injecting darts from a short distance.

Source: [www.trofeoca.com](http://www.trofeoca.com)



Figure 7.2. Air guns and rifles can inject darts over wide distances.

Source: Rangers' Office, the Government of Catalonia



Figure 7.3. The products and auxiliary materials to be used must be determined by specialist personnel with the support of veterinarians.

Source: *Vets&Wildlife*



Figure 7.4. The use of anesthetic products requires specific material and conditions and allows animals to be removed with the minimum amount of distress.

Source: DIBA, UAB

### Regulations and permits

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- The acquisition, possession and use of air guns and rifles for administering anesthesia is regulated by:
  - Royal decree 137/1993 of 29 January, which approves the Spanish Regulation on Firearms (Official Spanish State Gazette no. 55/1993).
- Authorisation must be requested for the capture of animals (see file 8).

<b>MANAGEMENT OF VEGETATION AND URBAN GREEN AREAS</b>				<b>File 8</b>
<b>Location</b>	<b>Target species</b>	<b>Type of measure</b>		<b>Effect</b>
<b>Urban</b>	<b>Wild boar</b>	Exclusion	Repulsion	Temporary
Agroforestry	Other ungulates	Removal	Communication	<b>Permanent</b>
<b>Infrastructures</b>	Other species of fauna	<b>Habitat management</b>		

### Objective and applications

The aim is to prevent wild boar from being attracted to green areas in towns, cities and infrastructures by adapting the flora and management of these spaces.

Applicable to habitat management in:

- Gardens, parks and other green areas, especially in places adjacent to natural areas or connected to ecological corridors along dry river beds, streams or spaces with natural vegetation that protrude into urban areas.
- Green areas associated with any type of infrastructure.

### Description

It consists of applying measures to design and maintain green areas to reduce the amount of shelter and food they offer to wild boar. Specifically, this measure's aim is to:

- Reduce irrigation, as damp soils, particularly if they contain organic matter, are home to a rich community of invertebrates (earth worms, insect larvae, etc.) which wild boar actively seek out. They can detect them even when buried under the earth, and they capture them by turning over the soil, resulting in the characteristic rooting behaviour of this species which can ruin large areas of lawn or affect the verges alongside roads or other green areas.
- Avoid planting species of bulbous plant (e.g. lilies and orchids) or fruit-bearing plants (apple trees, plum trees, etc.) which provide foods that are very attractive to wild boar.
- Avoid creating areas of thick bushy vegetation that can be used by wild boar for shelter and rest. This species does not dig dens, rather it farrows and rests (normally during the day) of small hollows, sometimes covered sparsely with vegetation and normally located in areas protected by dense vegetation.

This file describes habitat management systems that help to make green areas less hospitable to wild boar so that they progressively stop using them, therefore offering a medium-to-long-term solution.

If immediate measures are needed to reduce damage to lawns or other urban green spaces, a temporary exclusion or repulsion system can be used complementarily, including odour repellent devices, electric fences or other measures (see files 3 and 4).

### Technical features

- The use of xeriscaping is an option that makes urban green spaces less attractive to wild boar and avoids the need for damp soil in gardens and grassy areas. It consists of designing gardens and green areas with plants that require little irrigation, and is particularly suitable for coastal areas and regions

with a low rainfall. This best practice, as well as avoiding the attraction of wild boar, makes it possible to reduce water consumption and allows better adaptation to climate change.

- Minimising irrigation reduces the spread of earth worms, insect larvae and other animals that live in damp soil or rotting wood and that are highly attractive to wild boar. It is therefore necessary to prevent rotting wood from piling up in gardens within areas that are vulnerable to wild boar.
- Replacing lawns that require large amounts of water with dry fields dominated by wild grasses characteristic of Mediterranean areas, makes these areas less attractive to wild boar and benefits biodiversity as flowering grasses can attract pollinators and other fauna.
- Another option to avoid attracting wild boar is to replace lawns with tall autochthonous bushes that only produce small seeds, such as thyme, lavender or other aromatic Labiatae that are also beneficial to pollinating insects.
- In all cases, it is advisable to avoid planting bulbous plants and particularly orchids, as it has been established that they are highly attractive to wild boar, especially during periods of the year when the bulbs hold more nutrients. Wild boar are also known to be particularly attracted to other plants with large roots or rhizomes, such as some species of fern.
- To reduce the amount of places offering possible shelter, it is advisable to cut back thick vegetation in green areas, particularly reed beds and briar patches, but also areas with other communities of flora around the trunks of large trees and bushes, where the plants and foliage should be cleared up to a height of 60-100 cm. This will prevent such areas from offering cover for wild boar where they can build their nests.
- Areas of dense vegetation located in wildlife corridors that connect green spaces in urban areas with local woods or scrubland can act as passageways for wild boar and encourage their entry into urban areas, and in places with a high level of conflict due to the presence of wild boar, suitable management of vegetation may also be required in these areas. However, any such work must be planned carefully so as not to have a detrimental effect on other elements of biodiversity.
- Cutting and clearing work must be planned taking into account expert opinions on which plants need to be conserved and which can be cut back or pruned more extensively.
- Another system for keeping vegetation under control is the pasture of grasslands with flocks of sheep.



Figure 8.1. Garden designed using xeriscaping.

Source: *Minuartia*



Figure 8.2. Urban green space with cleared dry fields.

Source: Google Earth

## Maintenance

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- Xeriscaping practices will reduce irrigation and other maintenance costs.
- Cutting and clearing should preferably be carried out at the end of the winter or during the spring, the main farrowing periods when wild boar females habituated to humans may search for bushy areas to give birth and forage for food in urban areas.
- Maintenance records for urban green spaces should ideally include incidents caused by wild boar, the time of year when they occur, the species planted in the area, irrigation frequency, etc. An analysis of these incidents together with a suitable expert assessment may make it possible to identify the factors that are attracting wild boar to these areas, while at the same time determining the characteristics of those spaces that have not suffered any damage, so that, in the medium term, the conditions of urban green spaces can be adapted to make them less attractive to wild boar.

## Regulations and permits

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- Local regulations must be checked regarding aspects such as the design and management of green spaces, the use of water for irrigation, and pasturing.
- It is necessary to take into consideration catalogues or special plans that include natural features, protected gardens subject to specific conditions and regulations regarding groves declared to be of particular value.
- Regulations on forest fire prevention must also be taken into account, as it is possible to apply measures that reduce the risk of forest fires starting and spreading while at the same time making it difficult for wild boar to become established on the outskirts of urban areas.
- Some examples of regulations in Catalonia are:
  - Law 5/2003 of 22 April on measures for the prevention of forest fires on housing estates, in urban centres, buildings and facilities located within forested areas:  
[http://portaljuridic.gencat.cat/ca/pjur\\_ocults/pjur\\_resultats\\_fitxa/?documentId=303933&action=fitxa](http://portaljuridic.gencat.cat/ca/pjur_ocults/pjur_resultats_fitxa/?documentId=303933&action=fitxa)
  - Decree 123/2005 of 14 June on measures for the prevention of forest fires on housing estates not directly connected to urban conglomerations:  
[http://portaljuridic.gencat.cat/ca/pjur\\_ocults/pjur\\_resultats\\_fitxa/?action=fitxa&mode=single&documentId=384053&language=ca\\_ES](http://portaljuridic.gencat.cat/ca/pjur_ocults/pjur_resultats_fitxa/?action=fitxa&mode=single&documentId=384053&language=ca_ES)

ADAPTATION OF BINS AND WASTE CONTAINERS				File 9
Location	Target species	Type of measure		Effect
Urban	Wild boar	Exclusion	Repulsion	Temporary
Agroforestry	Other ungulates	Removal	Communication	Permanent
Infrastructures	Other species of fauna	Habitat management		

### Objective and applications

Reduce the possibility of wild boar obtaining food in urban areas.

They are particularly suitable for:

- Urban areas: Waste containers (mainly organic and general waste) and bins.
- Small villages or scattered houses in natural areas with waste containers at the side of paths and roads.

### Description

This consists of adapting waste containers and bins in areas that suffer conflicts due to the presence of wild boar, with the aim of preventing these animals from tipping them over and gaining access to the waste. Wild boar are highly adept at using their front legs to tip over large waste containers. They are an omnivorous animal that consumes all types of food, including food waste from containers.

Contact between humans and wild fauna leads to the risk of disease transmission (zoonoses). Furthermore, when people come across groups of wild boar feeding from containers, they may be at risk of being charged at and injured. The adaptation of waste containers should therefore be considered as a measure which prevents wild boar from becoming habituated to urban settings while also reducing the possible risk to people.

### Technical features

- Wild boar can be prevented from tipping over containers by protecting the containers with wooden or metal screens, at least along the sides and back (figure 9.1), or by using bars or cables to hold them in place (figure 9.2). Some waste management companies install specific anti-tipping systems (figures 9.2 and 9.3.), such as those consisting of a U-shaped platform attached to the ground and joined to the bottom of the container by means of a height-adjustable bar. This system firmly anchors the container to the platform and prevents it from being tipped over.
- There must be information and awareness-raising measures aimed at local residents to discourage them from leaving bags of rubbish outside the containers .
- As regards bins, swinging bins must be avoided in areas suffering conflicts from the presence of wild boar as these animals can easily learn to push them so the rubbish spills onto the ground.



Figure 9.1. Containers with a partially screened perimeter to prevent wild boar from tipping them over.

Source: [www.vacarisses.cat](http://www.vacarisses.cat)



Figure 9.2. System of bars placed around containers to prevent them from being tipped.

Source: Google Earth

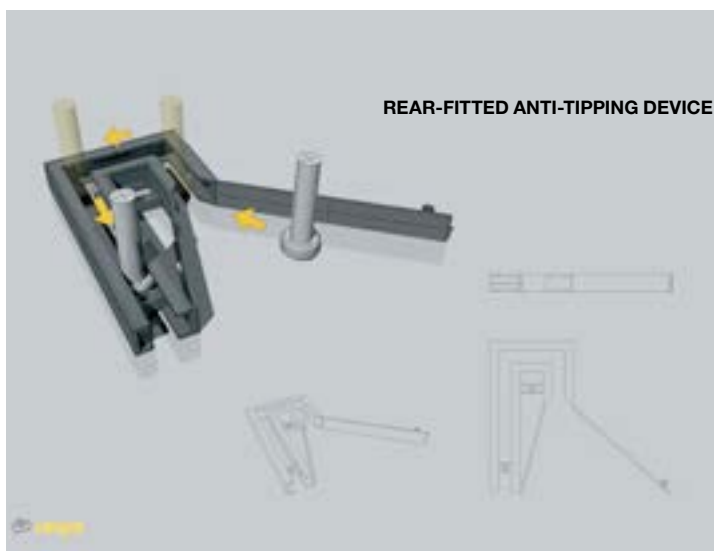


Figure 9.3. Diagram of the anti-tipping system used on containers located in areas of Barcelona that suffer conflicts due to the presence of wild boar.

Source: Barcelona City Council – CESPA, S.A.



Figure 9.4. System for attaching the container to the anti-tipping platform.

Source: *Barcelona City Council – CESPÀ, S.A.*

### **Maintenance**

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- The use of systems to prevent damage to containers caused by wild boar reduces the need for maintenance of the spaces where these containers are located. However, periodic maintenance of these protective systems is required to ensure they are working properly.



ADAPTATION OF CAT FEEDING AREAS				File 10
Location	Target species	Type of measure		Effect
Urban	Wild boar	Exclusion	Repulsion	Temporary
Agroforestry	Other ungulates	Removal	Communication	Permanent
Infrastructures	Other species of fauna	Habitat management		

### Objective and applications

Reduce the possibility of wild boar being able to access food left out for feral cat colonies, which has been identified as one of the elements that attracts wild boar to urban areas.

Applicable to:

- Urban areas, specifically places with controlled cat colonies for which food is left out.

### Description

Installation of adapted cat feeding devices which prevent wild boar from accessing the food.

Feral cat colonies are frequently found in many towns and cities. Many of them are controlled and measures are applied for the animals' well-being, such as the installation of sand pits, feeding areas and drinking troughs. Measures are also applied to manage the cats themselves, including veterinary treatments and sterilisation. Wild boar have come to view controlled cat colonies as a place where they can obtain food, a fact which also contributes towards their habituation to humanised settings as they associate the smell of the cats and of the people that look after them with the possibility of obtaining food. The consumption of highly nutritious foods such as animal feed has another negative consequence: it can boost wild boar's reproductive capacity, thus aggravating the problem of wild boar overpopulation found in many places. This is due to the fact that sows that consume animal feed can reach optimum physical conditions and farrow a high number of piglets per litter.

### Technical features

The possible solutions to this problem include the following:

- The installation of adapted feeding areas, such as those used in certain areas of Barcelona (figures 10.1 and 10.2) is a very effective solution. They consist of a concrete box containing trays for food and water with a lid held closed with a padlock or other system, which allows for easy maintenance. Cats are able to enter the box via openings with a diameter of 15 cm at the bottom on two of the sides. Wild boar, on the other hand, are unable to access the food as they cannot fit through the holes. It must be ensured that the feed is placed far enough inside the box so that the wild boar cannot reach it by sticking their snouts through the holes, and also that the wild boar are unable to tip over the boxes to access the feed. For this reason, the boxes should ideally be anchored to the ground.
- By installing the feeding areas in boxes or other devices placed at a height of 1.2 m or more above ground level, the cats are able to access them by jumping or climbing, while the food is kept out of reach of wild boar. It must also be ensured that wild boar are unable to pull the boxes down or tip them over, bearing in mind that they can stand on their hind legs to reach the food.
- An alternative solution to prevent wild boar from accessing cat colonies may be to enclose the colony in a wild boar-proof fence (see file 1 for the different options) or reinforce the existing fence (see file 2).



Figure 10.1. Lidded box where water and animal feed can be placed out of the reach of wild boar.

Source: Barcelona City Council



Figure 10.2. Cat feeding boxes adapted to prevent access by wild boar must be anchored to the ground or have other anti-tipping systems.

Source: Barcelona City Council

## Maintenance

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- Regular maintenance is needed. For a few days after the system is installed, it must be checked that it is working correctly and that the wild boar are unable to tip the feeding areas over or reach the food by other means.

## Regulations and permits

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- It is necessary to check any local municipal regulations regarding the characteristics of controlled feral cat colonies and the provision of food to wild animals (see file 11).

REGULATIONS AND PUBLIC AWARENESS RAISING				File 11
Location	Target species	Type of measure		Effect
Urban	Wild boar	Exclusion	Repulsion	Temporary
Agroforestry	Other ungulates	Removal	Communication	Permanent
Infrastructures	Other species of fauna	Habitat management		

### Objective and applications

Draw up regulations and raise public awareness in order to discourage people from giving food or making food easily accessible to wild boar. This behaviour is highly detrimental to wild boar and is the main reason they become habituated to humanised settings, increasing the conflicts and risks to people associated with this species.

They are particularly suitable for:

- Urban and other residential areas that suffer conflicts due to the presence of wild boar.

### Description

The measure consists of drafting and approving regulations to control the practices that contribute towards the habituation of wild boar to humanised settings, and to raise public awareness in order to avoid bad practices that attract wild boar to these areas and potentially increase conflicts, such as:

- The risk of attacks on people and domestic animals.
- Damage to green areas (e.g. lawns and irrigation systems).
- Damage to street furniture (mainly waste containers and bins).
- Increased risk of traffic accidents.
- Increased risk of disease transmission (zoonoses).

The measures to be taken fall under the competence of local councils and must be adapted to each specific situation. Many councils have already implemented a range of different measures, some of which are described below for reference.

- Approval of regulations to control and penalise bad practices towards wild animals, and in particular wild boar. A number of municipalities in Catalonia have issued municipal bylaws regarding this matter. To give an example, the following is a section of the Barcelona City Council Bylaw on the Protection, Possession and Sale of Animals of 15 September 2014:
  - “Article 33. Wild boar and wild animals on roads and in public spaces
    1. It is prohibited to give food of any type and in any manner, without the necessary government permit, to wild boar or any other wild animal present on roads or in public spaces or that have accessed private property, including public and private forestry areas, within the Barcelona municipal area.
    2. It is prohibited to approach wild boar or any other wild animal in any situation that may involve danger to people.”
  - “Article 59. Non-compliance [...]
    4. Minor offences include: [...]
      - g) Giving food of any type and in any manner, without the necessary government permit, to wild

boar or any other wild animal present on roads or in public spaces or that have accessed private property.

h) Approaching wild boar or any other wild animal in any situation that may involve danger to people.”

Papiol Council, in its Bylaw on Coexistence with Wild Boar or Any Other Mammals in a Wild State, of 18 June 2014, also specifies the same offences and classes them as minor, serious or very serious, with fines of up to 900 euros.

- As well as municipal regulations, the resolutions of the Government of Catalonia that establish the species for which hunting is permitted, hunting seasons and special hunting prohibitions in Catalonia also regulate food for wild boar. Specifically, Resolution ARP/663/2018 of 4 April establishes that, apart from exceptional cases in which a specific permit has been granted:
  - “Article 14.13. Under no circumstances may food be provided or made available to wild boar.”
- Signposting of areas affected by the presence of wild boar that specifies the ban on giving them food and the danger of approaching them. In particularly conflictive areas, signs must be put up with information on the characteristics of wild boar, its behaviour and the harm caused when we habituate it to contact with humans.
- Information and awareness-raising campaigns using the most appropriate means in each case: information booklets, educational activities in schools, neighbourhood associations or other groups, diffusion through the media and social networks, etc. Ideally, information should be provided regarding the following aspects:
  - The habits of wild boar that live in natural areas and the changes caused by habituation to humans. Identification of negative consequences of wild boar becoming accustomed to easily obtaining food from urban areas. Among these, it is important to highlight the fact that wild boar lose their ability to find food in the wild and that they may approach roads, with the resulting risk of traffic accidents and death of the animal. People should also be informed that, once they have become accustomed to humans, wild boar cannot return to a wild condition and will most probably have to be euthanised. Therefore, by giving them food, we are distancing the wild animals from their natural habitat and may be condemning them to be put down.
  - The fact that wild boar are able to survive in natural areas and find food, even during periods of drought. Some people believe that wild boar come into the cities because they cannot find food in the wild, and they must be informed that this is not the case.
  - Risks of enhancing the transmission of diseases between wild boar and humans (zoonoses) in areas where food or rubbish is left in reach of wild boar.
  - Risks posed by wild boar to humans due to the possibility of charging and the serious injuries they may cause with their tusks. People must be informed that this type of attack becomes more likely if they approach a female accompanied by her litter, or when wild boar find themselves threatened or cornered with no way to escape, for example by a barking dog.
  - The problems caused by the current over-abundance of wild boar in Catalonia, and the need to avoid any practice that may increase their fertility. With this goal in mind, people should refrain from providing any food to wild boar, and belly pigs should not be released into natural areas, as they cross-breed with wild boar and therefore increase their litter sizes.
  - Increase in aggressiveness of wild boar that have lost their fear of humans and approach people to try to grab bags or obtain food in other ways.
  - At waste collection points, people should be informed of the need to tightly close their rubbish bags and leave them inside the waste containers so that they are not made accessible to wild boar (also see file 8).
  - In picnic and barbecue areas, people must be informed of the need to take their rubbish away with them and leave it in tightly closed containers, and also that they should avoid leaving bags of food on the ground where they may be accessible to wild boar. They should also be informed that if they see a wild boar, they should not offer it any food or approach it and attempt to touch it, due to the risk of being bitten or charged at and seriously injured by the animal’s tusks.

- Recommendation to enclose allotments and gardens so they cannot be accessed by wild boar (see files 1 to 3), or to use repellents in the case of temporary, short-term conflicts (see file 4).



Figure 11.1. Example of documents created to raise public awareness and avoid bad practices that attract wild boar to urban areas.

Source: Sant Cugat City Council



Figure 11.2. Warning sign on the dangers caused by wild boar and good practices for avoiding them in the Collserola park.

Source: Minuartia

## Maintenance

- As well as maintaining the information wild boards and signposting, the frequency of the awareness-raising measures must be defined to coincide with the periods that see the highest levels of conflict, and they must be adapted to each situation.

## Regulations and permits

- Catalan regulations define the responsibilities of local councils regarding the management of wild animals in urban areas. Specifically, in:

- Legislative Decree 2/2008 of 15 April, approving the consolidated text of the Animal Protection Act.

Article 16 of said Decree establishes that “local councils are responsible for rounding up and controlling [...] wild animals in urban areas”.

[http://portaljuridic.gencat.cat/ca/pjur\\_ocults/pjur\\_resultats\\_fitxa/?action=fitxa&documentId=492668](http://portaljuridic.gencat.cat/ca/pjur_ocults/pjur_resultats_fitxa/?action=fitxa&documentId=492668)

- Regulations regarding food for wild boar are also contained in the annual resolutions of the Catalan Ministry of Agriculture, Livestock, Fisheries and Food on game management, for example:
  - Resolution ARP/663/2018 of 4 April establishing the species subject to wild game exploitation, hunting seasons and special hunting prohibitions for the period 2018-2019 for the whole of Catalonia (Resolution of 4 April, published in Official State Gazette no. 85 of 7 April).  
<http://www.boe.es/boe/dias/2018/04/07/pdfs/BOE-A-2018-4782.pdf>  
  
Article 14.13 of this resolution establishes that “under no circumstances may food be provided or made available to wild boar.”
- Many local councils have their own regulations on food and other practices related to wild animals. Some examples in Catalonia are:
  - Bylaw on the Protection, Possession and Sale of Animals of 15 September 2014. Barcelona City Council.  
<https://bop.diba.cat/scripts/ftpisa.aspx?fnew?bop2014&09/022014022793.pdf&1>
  - Bylaw on Coexistence with Wild Boar or Any Other Wild Mammals in a Wild State of 30 June 2014. Papiol Council.  
[http://dogc.gencat.cat/ca/pdogc\\_canals\\_interns/pdogc\\_resultats\\_fitxa/?documentId=665743&language=ca\\_ES&action=fitxa](http://dogc.gencat.cat/ca/pdogc_canals_interns/pdogc_resultats_fitxa/?documentId=665743&language=ca_ES&action=fitxa)  
Sant Feliu de Llobregat Council has the same bylaw.

## 6. Other measures and future trends

### 6.1. Inadvisable methods for deterring wild boar

In relation to wild boar, apart from the measures included in this Guide, there are many other systems which are used to deter these animals, especially in rural areas, to prevent them from entering farmland. Some of the measures which are not advisable, at least on a wide-spread basis, are described below.

- **Repellent granules**

These products, which take effect when ingested, have not been included in this Guide due to the lack of information regarding their possible effects on other species of wild fauna. Furthermore, no studies have been conducted to assess their effectiveness.

These products come in the form of pellets or granules—similar to animal feed—and the manufacturers recommend they be spread around the edge of fields or other areas of land that need to be protected against wild boar damage. These products are marketed on the premise that, after being eaten, they have a taste which is unpleasant to wild boar or they cause them to experience digestive disorders, leading the animals to modify their behaviour and temporarily (supposedly for a period of a few months) avoid the areas where the product has been used. Manufacturers also recommend that the product be spread over strips of ground several metres wide and that it be reapplied every few days, which may result in a significant amount of the product (dozens of kilos) being introduced into the natural environment.

- **Spreading of human hairs, chemicals or other products**

One traditional method used in some mountain areas is to spread human hairs (collected from hairdressers), perfumes or other household products that wild boar might take as a sign of human presence, to alert and deter them. This method will only work to keep wild boar away for a few days, or possibly may have no effect at all, especially in peri-urban areas where wild boar are already habituated to humans. As such it is not advisable to use these methods, which may furthermore involve introducing products with possible adverse effects into the environment.

- **Use of dogs**

In some rural areas, trained dogs are used to guard fields at night and ward off any wild boar that approach.

This measure can only cover rather limited areas. Furthermore, in areas where wild boar have lost their fear of humans and domestic animals, wild boar may act highly aggressively, attacking and injuring the dogs.

## 6.2. Future trends

At the present time, many of the new products in the experimental phase are based on the use of technology that combines different systems for the detection of fauna, data transmission and remotely controlled repulsion systems. The aim is to activate measures to deter the animals, but only when they approach areas that require protection.

A significant amount of research and experimentation is being conducted regarding new systems, with novel, innovative techniques constantly appearing, for which reason the body of knowledge on damage prevention must be kept up-to-date. However, expert opinions based on evaluating the effectiveness of products must also be gathered, as manufacturers often market their products as offering new and effective solutions, when in fact the results of product trials prove otherwise.

Techniques for the prevention of damage by fauna is therefore an emerging field in which, by combining technology and knowledge regarding the eco-ethology of the species involved, new solutions are sure to be found in the future.



## 7. Reference documents

ALT PIRINEU NATURAL PARK. *Protecció de prats contra danys de senglar al Parc Natural de l'Alt Pirineu. Consells per instal·lar tancats elèctrics* [Protection of fields against damage by wild boar in the Alt Pirineu Natural Park. Recommendations for installing electric fences]. Alt Pirineu Natural Park, Ministry of Environment and Housing, 2005. Unpublished document, 4 pp.

BARCELONA CITY COUNCIL. *Bones pràctiques de jardineria a Barcelona: conservar i millorar la biodiversitat* [Good gardening practices in Barcelona: Conserving and improving biodiversity]. Urban Ecology Area Barcelona City Council, 2016. 155 pp.

BARCELONA PROVINCIAL COUNCIL. *Programa per a l'establiment de colònies controlades de gats en àmbits urbans* [Programme for the establishment of controlled cat colonies in urban areas]. Public Health and Consumption Department. Barcelona Provincial Council, 2010. 7 pp.

IUELL, B., BEKKER, G.J., CUPERUS, R., DUFEK, J., FRY, G., HICKS, C., HLAVÁČ, V., KELLER, V., B., ROSELL, C., SANGWINE, T., TØRSLØV, N., WANDALL, B. LE MAIRE, (Eds.). *Wildlife and Traffic: A European Handbook for Identifying Conflicts and Designing Solutions*. 2003. KNNV Publishers.

MINISTRY OF AGRICULTURE, FOOD AND ENVIRONMENT. *Technical prescriptions for wildlife crossing and fence design*. Second edition, revised and expanded. From the collection 'Documents for the reduction of habitat fragmentation caused by transport infrastructure', number 1, 2016. 123 pp. Madrid.

MINISTRY OF AGRICULTURE, LIVESTOCK, FISHERIES AND FOOD. *Pla de prevenció dels danys i els riscos originats per la fauna cinegètica* [Plan for the prevention of damages and risks caused by wild game], 2016. 56 pp.

MINISTRY OF ENVIRONMENT AND HOUSING. *Pla de gestió per a la reducció dels danys causats per fauna als conreus de les zones de seguretat del Baix Llobregat* [Management plan for reducing damage caused by fauna to crops in non-hunting areas of Baix Llobregat], 2016. 108 pp.

MINISTRY OF ENVIRONMENT AND HOUSING. *Pla de control del senglar (Sus scrofa) a Collserola. Situació actual i avaluació d'alternatives d'actuació* [Plan for the control of wild boar (*Sus scrofa*) in the Collserola park. Current situation and assessment of alternative measures]. Government of Catalonia. Ministry of Environment and Housing, 2005. 77 pp.

MINISTRY OF TERRITORY AND SUSTAINABILITY. *Estudi de l'accidentalitat provocada per animals en llibertat a la xarxa de carreteres de la Generalitat de Catalunya* [Study on the accident rate

caused by free-roaming animals on the network of roads of the Government of Catalonia], 2016. 86 pp.

**Websites with information on urban wild boar**

BARCELONA CITY COUNCIL. «Senglars» [Wild boar] <<http://ajuntament.barcelona.cat/benestaranimal/ca/senglars>>

COLLSEROLA PARK. «Atenció als senglars» [Be aware of wild boar] <<https://www.parcnaturalcollserola.cat/atencio-als-senglars/>>

SANT CUGAT CITY COUNCIL. «Senglars» [Wild boar] <<https://www.santcugat.cat/web/senglars>>

## Annex. Measures to be applied in transport infrastructures

Two manuals are recommended for detailed information about how to reduce animal-vehicle collisions and fauna mortality in roads and railways. The most relevant measures described in the documents are listed below.

### 1. *Technical prescriptions for wildlife crossing and fence design*

MINISTRY OF AGRICULTURE, FOOD AND ENVIRONMENT. *Technical prescriptions for wildlife crossing and fence design*. Second edition, revised and expanded. From the collection 'Documents for the reduction of habitat fragmentation caused by transport infrastructure', number 1, 2016. 123 pp. Madrid.

Available online: <[https://minuartia.com/wp-content/uploads/2018/05/technical\\_prescriptions\\_wildlife\\_crossing.pdf](https://minuartia.com/wp-content/uploads/2018/05/technical_prescriptions_wildlife_crossing.pdf)>

#### Measures described in the document

- Wildlife crossings

File 1: Ecoducts

File 2: Wildlife overpasses

File 3: Multi-use overpasses

File 4: Canopy bridges

File 5: Modified viaducts

File 6: Large mammal underpasses

File 7: Multi-use underpasses

File 8: Underpasses for small vertebrates

File 9: Modified culvert for terrestrial animals

File 10: Modified culvert for fish

File 11: Amphibian tunnels

File 12: Wildlife crossing entrance and surface adaptation

- Road safety improvement and wildlife mortality mitigation measures

File 13: Fences for large mammals

File 14: Fences for small vertebrates

File 15: Wildlife escape systems and prevention of entrance to fenced roads

File 16: Verges and median strip vegetation management

File 17: Wildlife warning sign reinforcement

File 18: Deterrent devices

File 19: Prevention of bird strikes with transparent screens and fences File 20: Adaptation of ditches and other elements to reduce small animal mortality

- Specific recommendations for certain species and groups

File 21: Specific recommendations for terrestrial tortoises

File 22: Specific recommendations for bats

File 23: Specific recommendations for semi-aquatic mustelids

File 24: Specific recommendations for brown bears

File 25: Specific recommendations for the Iberian lynx

## **2. *Wildlife and Traffic: A European Handbook for Identifying Conflicts and Designing Solutions***

IUELL, B., BEKKER, G.J., CUPERUS, R., DUFEK, J., FRY, G., HICKS, C., HLAVÁČ, V., KELLER, V., B., ROSELL, C., SANGWINE, T., TØRSLØV, N., WANDALL, B. LE MAIRE, (Eds.). *Wildlife and Traffic: A European Handbook for Identifying Conflicts and Designing Solutions*. 2003. KNNV Publishers.

Available online: <<https://handbookwildlifetraffic.info/viewer-book/>>

### **Measures described in the document**

- Reducing the barrier effect: overpasses
  - Wildlife overpasses and landscape bridges
  - Modified bridges over infrastructure: multi-functional overpasses
  - Tree-top overpasses
- Reducing the barrier effect: underpasses
  - Viaducts and river crossings
  - Underpasses for large and medium-sized animals
  - Modified and joint-use underpasses
  - Underpasses for small animals
  - Culverts modified for use by terrestrial animals
  - Passages for fish and other aquatic organisms
  - Amphibian tunnels
- Avoiding and reducing animal mortality
  - Fences
  - Artificial deterrents
  - Warning signs
  - Wildlife warning systems with sensors
  - Adaptation of the habitat alongside the infrastructure
  - Adaptation of infrastructure



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**Gerència de Serveis d'Espais Naturals**  
Comte d'Urgell, 187. Edifici del Relotge, 3a planta  
08036 Barcelona  
Tel. 934 022 428 · Fax 934 022 439  
[xarxaparc@diba.cat](mailto:xarxaparc@diba.cat) · [parcs.diba.cat](http://parcs.diba.cat)