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Ecological considerations to conciliate forest activities and conservation of the

MIDDLE SPOTTED WOODPECKER

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Contents

Introduction

The POCTEFA Habios project (EFA 079/12, www.habios.eu), which was carried out between 2016 and 2020, and was co-funded by the European Regional Development Fund (ERDF), met together diverse stakeholders working on the conservation of biodiversity and the sustainability of nature resources throughout the Pyrenean region. They included public administrations, as well as organizations involved in nature management, environmental research bodies, and non-governmental organizations. Habios intended to mobilise all those entities to enhance their technical capacitation, to promote the exchange of knowledge and to increase transboundary coherence of the actions carried out in forested and alpine habitats on both the Spanish and French slopes of the Pyrenees.

The Middle Spotted Woodpecker (*Dendrocoptes medius*) is one of the target species in POCTEFA Habios. This woodpecker has functional characteristics that highlight its conservation value regardless of its own patrimonial value *per se*. With a global range mostly located in Europe, the Pyrenean, Basque and Cantabrian populations of the Middle Spotted Woodpecker are placed in the south-western edge of its range, which can make those populations particularly vulnerable. It is considered a habitat specialist that depends on old-growth oak forests, or at least on forests with large deciduous trees (Pasinelli, 2003). Predominant in the past in the lowlands of temperate Europe, this type of forested landscape has been severely reduced and fragmented historically by agriculture and urbanization, among other activities.

The Middle Spotted Woodpecker is very sensitive to structural changes in its forested habitat and, together with the Lesser Spotted Woodpecker (*Dryobates minor*), has been shown to be the best indicator of species richness and abundances of other forest birds, at least in north Europe (Roberge & Angelstam, 2006). Like other woodpeckers, the Middle Spotted Woodpecker provides cavities in trees that can be used by other organisms. Although the impact of woodpeckers on structuring animal communities through cavity supplementation has not been properly and sufficiently studied in Europe (Fuller & Robles 2018), European woodpeckers may play, under certain circumstances, a key role ("*keystone species*") in the persistence of other forest organisms. This may be the case for the Bechstein's Bat (*Myotis bechsteinii*), as around 80 % of their known roosting sites in the Basque Country and Extremadura have been found in cavities excavated by woodpeckers (Napal *et al*., 2013). In addition, the Middle Spotted Woodpecker is a charismatic species that has become a flagship for the conservation of forest ecosystems (Virkkala, 2006).

Being included in Annex I of the Directive 2009/147/CE, the Middle Spotted Woodpecker must be subjected to special conservation actions in its habitat to ensure the survival and reproduction of this woodpecker throughout its range. In addition, the States of the European Union are expected to take actions for avoiding, especially within the Special Protection Areas for Birds (SPAs), any deterioration of its habitat with strong negative effects on the species and, consequently, on the aims of the Directive (article 6 of the Directive 92/43/CEE). These serious deteriorations of its habitat are likely to be linked to important negative effects on the behavioural characteristics or ecological dynamics of other sensitive avian populations co-habiting the SPAs (Álvarez, 2011).

In France, the Middle Spotted Woodpecker is included in the Decree (*Arrêté Ministériel*) of the 29th October of 2009, which establishes the species to be protected and the categories for their protection. In Spain, the transposition of these European regulations into the Spanish legislation has occurred under two laws: (i) Law 42/2007 regarding the natural patrimony and biodiversity, and (ii) Law 33/2015 that modifies the former. The Middle Spotted Woodpecker is included in the Spanish list of wild species subjected to special protection (*Listado de Especies Silvestres en Régimen de Protección Especial*, Royal Decree 139/2011), which requires the application of the actions included in the articles 54, 56 and 76 of the Law 42/2007. Among the autonomous communities within Spain, only Asturias has approved a specific plan for the conservation of its habitat (Decree 104/2002) through the categorisation of the Middle Spotted Woodpecker as "sensitive to habitat alteration" (*Sensible a la alteración del hábitat*, Decree 32/1990). In the Basque Country, this woodpecker is classified as "vulnerable" (*Vulnerable*, Decree 167/1996 and Order of the 10th of January of 2011). In Navarre, it is classified as "endangered" (*En peligro de extinción*, Foral Decree 563/1995); in Catalonia it is included in category B of the "Law for the protection of the animals" (*Ley de Protección de Animales*, Decree-law 2/2008) and is classified as "very sensitive" (*Muy sensible*,

Decree 148/1992). Finally, in Castile and León the Middle Spotted Woodpecker is listed in Instruction 02/DGMN/2005, concerning the criteria for forest management actions and the use of phytosanitary products compatible with the conservation of forest birds and bats.

According to all these regulations, it is necessary to guarantee the preservation of habitat quality and the viability of Middle Spotted Woodpecker populations in forests subjected to wood harvesting and other activities that are susceptible to modify substantially the composition, structure and functionality of the forests. It is advisable, therefore, to produce a manual or compilation of ecological criteria that help technicians, project planners and managers to guarantee the maintenance of Middle Spotted Woodpecker populations in forests subjected to silvicultural interventions and other forestry activities, both in areas occupied by the species and in areas with potential habitats that could be occupied. Even though numerous initiatives have resulted in guidebooks or compilations of suggestions aimed at minimising the impact of silvicultural activities on the general biodiversity or on specific biodiversity components (e.g., Jiménez *et al*., 2006; Camprodon, 2013; Atauri, 2020), just a few documents have included detailed recommendations for the management and conservation of the Middle Spotted Woodpecker and its habitat (see e.g., Pasinelli *et al*., 2008; Maldonado *et al*., 2009; regulations of the Office National des Forêts, 2015, for communal and public forests).

Given that a high amount of the scientific information on the ecology and conservation of the Middle Spotted Woodpecker has arisen in recent years, a document that compiles the current scientific information to inform management and conservation actions will serve as a powerful tool for forest managers, practitioners, project planners, conservationists, and other agents and stakeholders involved in activities that can influence this woodpecker and its forested habitat. The habitat requirements of the Middle Spotted Woodpecker and their conservation implications have been investigated in central Europe (e.g., Pasinelli, 2000; Kosiński, 2006) as well as in the Iberian Peninsula (e.g., Robles *et al*., 2007a; Ciudad *et al*. 2009; Robles & Ciudad, 2012). In the last decade, projects such as LIFE+ Pro-Izki (www.izkilife.com) and POCTEFA Habios have generated detailed information and knowledge on the distribution and the ecological requirements of the Middle Spotted Woodpecker, the present document being one of their outcomes. A large portion of the ecological information available on the relationships between the Middle Spotted Woodpecker and its habitat structure comes from two regions in the north of Iberia: the Izki Natural Park in Álava province, and the southern slope of the Cantabrian Mountains in León and Palencia provinces. Consequently, there will be recurrent references to both geographical areas along this document.

Biology and ecology of the Middle Spotted Woodpecker

General description

The Middle Spotted Woodpecker is a medium-sized bird (~21 cm in chord length from bill to tail, ~55 g). It differs from other woodpeckers in a combination of characters: red crown, incomplete moustache, pale black-and-white patterns in head and dorsum, and streaked flanks. It has a wide repertoire of voices, being the most distinctive vocalization a nasal 'gwääh', often repeated 4-8 times and emitted mainly, but not only, in the pair bond season from February to April. Unlike other woodpecker species, the Middle Spotted Woodpecker rarely drums (Pasinelli, 2003; Turner, 2020).

Adult male on the twigs at the top of an oak. Photo: Carlos Ciudad.

The species has been recently included in the genera *Dendrocopos*, *Leiopicus*, *Dendrocoptes* and *Dendropicos*, being probably *Dendrocoptes* the most supported by detailed molecular analyses (Fuchs *et al*., 2015). The Iberian Middle Spotted Woodpecker was initially included in a different subspecies (*lilianae*) to the nominal *medius*, but such differentiation is currently neither recognised nor validated by morphometrics and genetic studies (Kamp *et al*., 2019), although more research is necessary to clarify this issue.

Unlike other woodpeckers, the foraging behaviour of the Middle Spotted Woodpecker does not produce signs on trees that can be attributed unequivocally to this species (Pasinelli, 2003). The height of the hole entrance is slightly smaller than that of the Great Spotted Woodpecker (*Dendrocopos major*), but the high overlap in hole entrance dimensions does not allow the cavity maker to be identified clearly (Kosiński & Ksit, 2007).

The Middle Spotted Woodpecker is a habitat specialist strongly associated with old-growth deciduous forests, mainly those rich in oaks (*Quercus* spp., Pasinelli, 2003). This woodpecker is resident, monogamous, and territorial (Pasinelli, 2003). Natal dispersal movements are rather short (Ciudad et al., 2009; Robles *et al*., 2019), although some juveniles can move further than 10 km (Robles *et al*., 2019).

Distribution and populations

The range of the Middle Spotted Woodpecker is located mostly along the temperate bioclimate in the Western Palearctic (Pasinelli, 2003; Robles & Pasinelli, 2020). Its range tends to be more continuous in central and north Europe than in the south, where its distribution is more fragmented (Robles & Pasinelli, 2020). Located at the south-western edge of its range, the Pyrenean, Basque and Cantabrian populations of the Middle Spotted Woodpecker are particularly subjected to habitat fragmentation.

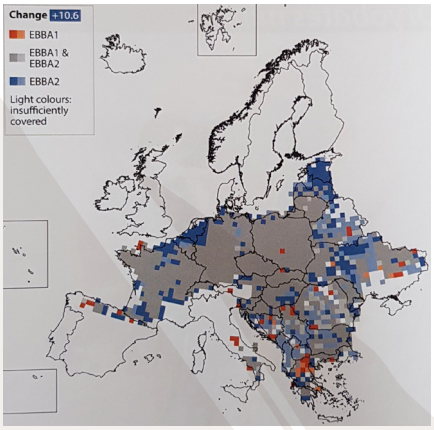
The occurrence of the Middle Spotted Woodpecker along the French Pyrenees is rather scarce. In 2017-2018, the species occurred in only 18 of 156 units of 1 km^2 inspected with species-specific methods in the French Pyrenees (LPO/BirdLife, 2019). In Iberia, the Middle Spotted Woodpecker population is unevenly distributed in the northern forests dominated by deciduous oaks, from Ancares in the west of the Cantabrian Mountains to the Arán Valley in the central Pyrenees (Onrubia *et al*., 2003). The most important core populations are located in the Cantabrian Mountains (across León, Palencia and Cantabria provinces) and in the Basque Mountains (Izki forest and its surroundings in Álava and Navarra provinces). In the Basque Country, there are three important ranges: a continuous area in south-east Álava and two smaller ranges in Montes de Vitoria and Sierra de Entzia (Fernández-García & Robles, 2020). Additionally, a few recordings of this woodpecker have shown its occasional occurrence in Guipuzkoa province (Fernández-García, 2019).

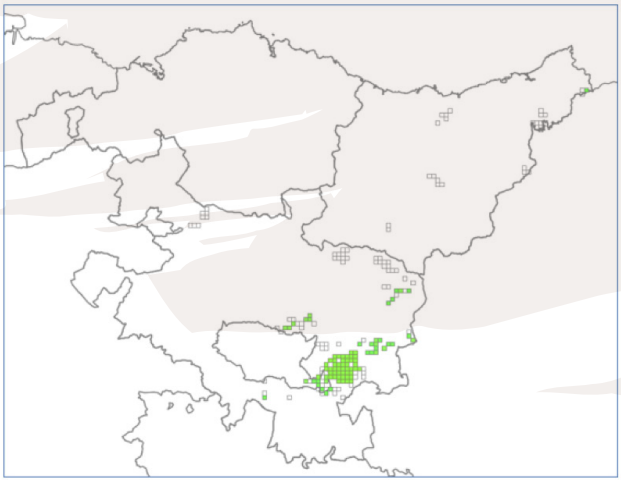
Small populations occur in other peripheral areas along the Cantabrian-Pyrenean axis, where some of them may have likely become extinct, given the lack of recent observations (e.g., Ancares and western Asturias, see Sánchez-Corominas *et al*., 2009). Conversely, other populations like the one in the Arán Valley, which are likely to be connected to the French range, may have grown considerably in the last 25 years (Romero *et al*., 2013). Population expansion from the Arán Valley may explain the recent observations of this species in the east of the Huesca province in Spain (Vergne, 2020). The main population in Navarra province, located in Bertiz (13-14 couples in 2010), was supposed not to occur in 1992 (Campión *et al*., 2012).

	Point-counts with extensive playback of vocalizations (territories/10 ha)	Territory mapping with occasional playback of vocalizations (territories/10 ha)
León (the whole province)	0,98	
León (central-east)		0,13
Cantabria province	0,29-0,78	
Arán Valley	0,22-0,63	
Izki Natural Park (in Álava province)	1,29	0,89
Montes de Vitoria (in Álava province)		0,24

Mean territory densities of the Middle Spotted Woodpecker estimated with different methods and locations in Spain. Compiled by Unanue et al. (2010) and Domínguez & Ciudad (2017).

Population densities in Spanish oak forests range from 0.12 to 1.3 territories/10 ha, showing higher estimations in studies that used point-counts with extensive use of playback of woodpecker vocalizations compared to those that used territory mapping with occasional use of playback. This suggests that the former technique tends to overestimate the abundance of territories (Robles & Olea, 2003; Robles, 2004). In Europe, different estimations have yielded populated densities from 0.01 to 3.9 territories/10 ha (Pasinelli, 2003).





Distribution of the Middle Spotted Woodpecker at three spatial levels and temporal windows: Europe, 50 x 50 km, in 1980-1995 (EBBA1) vs. 2013-2017 (EBBA2) (Robles & Pasinelli, 2020); Spain, 10 x 10 km, 1985-2002 (Onrubia et al., 2003); Basque Country, 1 x 1 km, 2012-2018 (Fernández-García, 2019; Fernández-García & Robles, 2020).

The estimation of the population size in Europe is 213,000-528,000 pairs; 1,045-1,205 of those for Spain and 40,000-80,000 for France (BirdLife International, 2015). The estimations of population sizes and trends are, however, based on incomplete and biased information, which make those calculations quite speculative. In Spain, species-specific field estimations of population sizes have been conducted in several areas: 432 territories in Liébana (Cantabria province; Fombellida *et al*., 2009), 125 in Picos de Europa National Park (central Cantabrian Mountains; Fernández & Lozano, 2009), 102-107 territories in the southern Cantabrian Mountains (820 km^2 in León and Palencia provinces; Robles & Olea 2003), 27 in Arán Valley (Romero *et al*., 2013) and 315 ± 59 territories in Izki (Álava province; Ciudad & Robles, 2013).

The continuous oak forest in Izki Natural Park sustains one of the largest populations of Middle Spotted Woodpecker in Iberia (left). The old-growth oak forests in the Arán Valley host an increasing population of the species. Photos: Jonathan Rubines and Carlos Ciudad.

Reproduction

From January-February, breeding territories are actively defended by both members of the couple through vocalizations, visual displays and prosecutions of intruders. Both sexes share the breeding duties of a single brood per year (Pasinelli, 2003). In the Cantabrian Mountains, mean clutch size was 5.1 (range= 3-7; n = 40), average fledgling number was 3.1 (range = 1-5), average weight of nestlings about to fledge was 50.6 g (range = 39.3-59.0), and mean fledging date was the 21st of June (range = 8th of June-13th of July) (Robles *et al*., 2008). In Izki, average fledging date in 2012 was the 9th of June (range = 31st of May-22nd of June) and mean fledgling number was 2.2 (range = 1-3) (Ciudad & Robles, 2013). More recent studies conducted in 2017 and 2018 confirmed the differences in the phenology between the Cantabrian and Izki populations, which typically resulted in a two weeks advance in fledging dates in Izki compared to the southern slope of the Cantabrian Mountains (unpublished data from the POCTEFA Habios project). Average fledgling numbers in both populations are lower than those reported in other populations from central Europe (4.1 ± 1,4 in four studies, as documented by Pasinelli, 2006).

Different phases of the breeding cycle of the Middle Spotted Woodpecker. From left to right: aggressive encounter between two males competing for a territory in the pre-breeding pair-bonding period, construction of a nest in the trunk of an oak parasitised by aphyllophorales fungi, monitoring the interior of a breeding cavity by a remote camera, and eggs and one hatchling inside a breeding cavity. Photos: Carlos Ciudad and Hugo Robles.

In both the Cantabrian Mountains and Izki populations, the incubation period last 10-12 days and the chicks remain 23-30 days in the nests (Robles & Ciudad, own data). After fledging, the chicks stay in the natal area and are partly fed by their parents for 2-4 weeks (Robles *et al*., 2007b; Robles & Ciudad, own data). Fledgling dependence on the parents is reduced across the days and, eventually, the juveniles become independent and disperse out of the natal area.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Establishment of the breeding territories												
Incubation (10-12 days)												
Nestling period (23-30 days)												
Independency of juveniles (15-30 days after fledging)												
Juvenile dispersal						certain	certain	cetain	possible (no data)	possible (no data)	possible (no data)	

Phenology of the Middle Spotted Woodpecker in Izki Natural Park.

Trophic ecology

The diet consists mainly of a wide variety of arthropods that are gathered from the surface and in the crevices of rough-bark deciduous trees. Because Middle Spotted Woodpeckers are less likely to excavate into the wood than other woodpeckers, the larvae of woodboring xylophagous insects do not seem to make up a relevant portion of its diet. Given that defoliating caterpillars are seasonally important prey for provisioning food to the nestlings, these woodpeckers are often seen collecting caterpillars from the foliage of the oaks in spring (Robles, 2004).

On a branch at the top of the tree canopy, a Middle Spotted Woodpecker searches for food on the leaves of an oak in spring (left). Adult male bringing a large number of caterpillars to feed the chicks (right). Photos: Carlos Ciudad.

Occasionally, Middle Spotted Woodpeckers consume plants, such as hard mast and berries in the autumn and winter (Pasinelli, 2003). Ivy (*Hedera helix*) berries can form a large part of the diet in spring, at least for provisioning the chicks in some areas of central Europe (Spühler *et al*., 2014) as well as in Izki (Arambarri & Rodríguez, 1997; unpublished data from the POCTEFA Habios project). The importance of ivy berries, however, remains unclear. The consumption of these berries has not been documented in the southern slope of the Cantabrian Mountains, where the ivy is rather scarce.

Demography, spatial ecology and social structure

The social structure of the species is characterised by the monogamy and territoriality. However, a fraction of the population is composed of *'floaters'*, which can either queue around certain territories (Robles & Ciudad, 2017) or wander across wide areas that include territories and non-territorial areas (Robles & Olea, 2003; Robles & Ciudad, 2020). Being sexually mature, floaters behave as dispersers that may buffer the extinction risk of spatially structured populations, either by replacing the breeders that disappear (Robles & Ciudad, 2017) or by (re)colonising habitat patches that balance local extinctions in fragmented landscapes (Robles & Ciudad, 2020).

Territory sizes in the breeding season are around 10 ha, but territorial woodpeckers increase their home ranges after breeding and particularly in winter, when home range overlap reaches its maximum (Pasinelli *et al*., 2001). Home ranges can be substantially larger for floaters (Pasinelli *et al*., 2001; Robles & Ciudad, 2017, 2020) and dispersing juveniles (Robles *et al*., 2019).

In both Izki and the Cantabrian Mountains, juvenile survival during the first few weeks after fledging is low (41 % in Izki in 2017-2018, 36 % in the Cantabrian Mountains in 2003-2005; Robles *et al*., 2007b, 2019). Juvenile survival is even lower when considering the natal dispersal period (25 % in Izki, 31 % in the Cantabrian Mountains; Robles *et al*., 2007b, 2019). Annual survival of adults is considerably higher compared to that of juveniles (~70-80 %; Robles *et al*., 2007b, Robles & Ciudad, own data).

Ringing and radio-tagging juvenile woodpeckers has allowed to study several demographic parameters in the populations from Izki and the southern slope of the Cantabrian Mountains. Photos: Carlos Ciudad.

The adults are mostly faithful to their breeding territory in consecutive years, but most juveniles leave their natal territory. Natal dispersal movements brought the juveniles 0.5-12 km away from their natal nest in Izki (n = 36; Robles *et al*., 2019), whereas average dispersal distance in the Cantabrian Mountains was 3.5 km (n = 43; Ciudad, 2011)

Conservation concerns

Globally, the Middle Spotted Woodpecker is included in the category "least concern" (BirdLife International, 2015), whereas it is classified as "near threatened" ("*casi amenazado*") in Spain (Onrubia *et al*., 2004). However, the poor knowledge on the species' distribution and population trends makes difficult to assess its conservation status and threats, particularly at the more local levels, where management decisions and actions for conservation are often implemented (Camprodon *et al*., 2007).

The major conservation threats for Middle Spotted Woodpecker populations are the loss, fragmentation and degradation of old-growth rough-bark deciduous forests (BirdLife International, 2015; Pasinelli & Robles, 2020). In Spain, like in other European countries, the removal of rough-bark deciduous forests for agriculture, intensive

livestock production or plantation of exotic trees is a serious threat (Onrubia *et al*., 2004; Robles & Ciudad, 2019). In addition, mining activities, commercial forestry and extreme fires result in high fragmentation and degradation of rough-bark deciduous forests, which turn into scattered small patches lacking maturity features that are essential for the Middle Spotted Woodpecker (Onrubia et al., 2004; Robles & Ciudad, 2019). In the Cantabrian Mountains, increases in the loss and fragmentation of old-growth rough-bark deciduous forests lead to reductions in the occupancy probability of those habitat patches by woodpeckers. Moreover, habitat fragmentation results in reductions in the size of local populations that make them more prone to extinction (Robles & Ciudad 2012). Regardless of habitat loss and fragmentation effects, reductions in the density of large oaks associated with degradation of the intrinsic habitat quality in the remaining patches can restrict occupancy and the (re)colonisation of habitat patches by territorial Middle Spotted Woodpeckers (Robles & Ciudad, 2012, 2020).

Some silvo-pastoral systems have traditionally maintained forest structures suitable for the Middle Spotted Woodpecker. This is the case of the Spanish *dehesas*, a type of wooded pastureland that offers grazing opportunities for livestock, and where the trees provide shelter and are pruned for additional fodder and for fuel. Consequently, this system promotes the development of large-diameter trees that are used for foraging by Middle Spotted Woodpeckers (Robles et al., 2007a). In the north of the Iberian Peninsula, a disruption in the social-economic system associated with the long-term persistence of deciduous oak *dehesas* has led to a high regeneration that results in high dense understories in abandoned *dehesas*, whose impact on Middle Spotted Woodpecker populations is unknown. Conversely, a high intensification of livestock production systems can risk the long-term persistence of these *dehesas* by precluding the replacement of decaying trees and large oaks through rejuvenation processes (Robles *et al*., 2007a; Rozas, 2009).

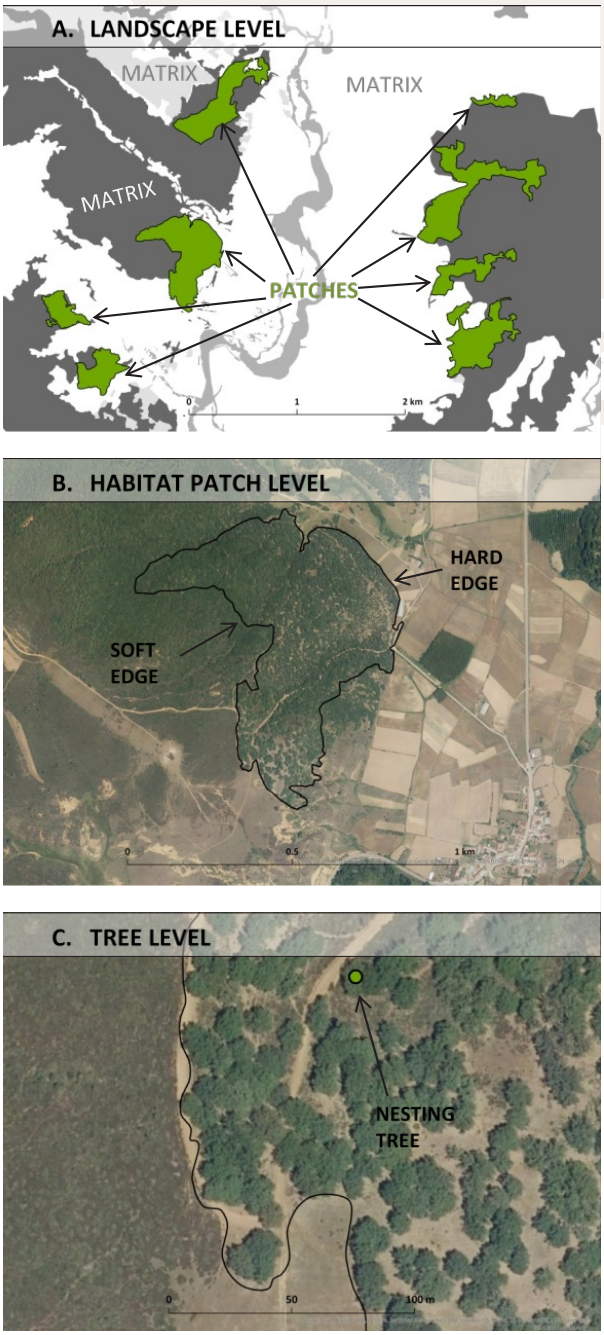
Examples of processes that may constrict the conservation of the Middle Spotted Woodpecker. From left to right and top to down: habitat loss and fragmentation due to linear infrastructures (Cantabrian Mountains in León and Palencia provinces, northern Spain), replacement of native forests by exotic plantations of conifer trees (Cantabrian Mountains, León), cuttings of deciduous trees (Izki Natural Park, Álava), high forest regeneration that results from the abandonment of traditional management (Cantabrian Mountains, León), low replacement of large trees, and livestock production that influences forest regeneration in dehesas (Cantabrian Mountains, León). Photos: Carlos Ciudad.

On the habitat of the Middle Spotted Woodpecker at multiple spatial levels

The study of the factors that influence habitat suitability requires analyses at different levels of the spatial organisation of the habitats. For the case of the Middle Spotted Woodpecker, those levels are, among others, the tree level, the habitat patch level, and the landscape level.

As for populations of many other animals, the composition and configuration of the landscapes can strongly influence Middle Spotted Woodpecker populations. Both spatial planning and forest management actions that, even if implemented at a local level, alter landscape structure and configuration, can impact population dynamics. From an ecological viewpoint, the landscape is a heterogeneous entity composed of areas covered by habitat, where a given species finds all the resources needed to survive and breed, and areas not covered by habitat (i.e., the "matrix"). Often, the original area covered by habitat is reduced and split into a number of smaller fragments named "patches", which is the second level of organisation described in this document. The critical resources (e.g., food, shelter) for the species occur within the habitat patches. As for the Middle Spotted Woodpecker, such habitat resources are found on the trees, which conform the third level of organisation.

It should be noticed that, even if the ecological term "habitat patch" do not have equivalents in the forestry terminology, a "habitat patch" has some similarities to a "forest stand" with maturity features suitable for the Middle Spotted Woodpecker. However, while not all forest stands are habitat patches, a habitat patch can consist of several forest stands that share structural attributes (see Atauri, 2020). Because the relationships between the Middle Spotted Woodpecker and habitat structure have been studied from an ecological perspective, we prefer to use the term "habitat patch" throughout this document. We hope that foresters and other agents find these ecological criteria useful and can incorporate them satisfactory into forest management practices.



Levels of spatial organisation for the assessment of the habitat of the Middle Spotted Woodpecker: (A) 'landscape level' where habitat patches (in green) are embedded in a matrix with varying permeability (dark colours indicate more permeability compared to clear colours); (B) illustration of the 'patch level' where a habitat patch has edges with different hardness; (C) in the 'tree level', some tree characteristics provide resources (food, shelter, nesting sites) for the Middle Spotted Woodpecker.

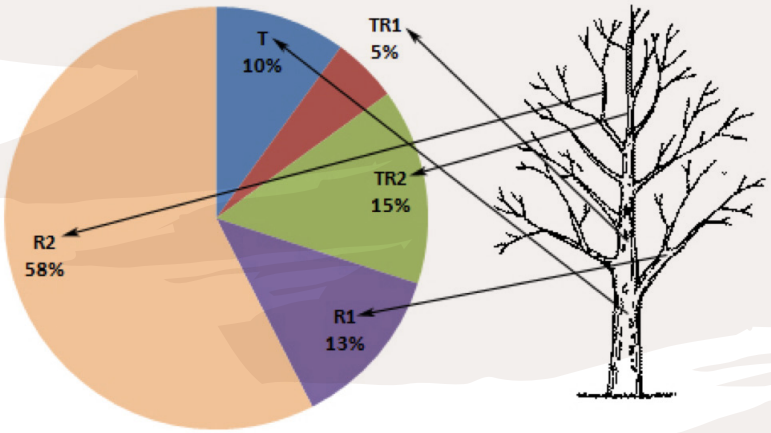
The tree level

Characteristics of important foraging trees

Middle Spotted Woodpeckers forage mainly on rough-bark deciduous trees. Overall, oaks are the most used tree species, but these woodpeckers can also forage on other deciduous trees such as beeches (*Fagus sylvatica*), poplars (*Populus* spp.), alders (*Alnus* spp.), birches (*Betula* spp.) or willows (*Salix* spp.). Regardless of the tree species, Middle Spotted Woodpeckers prefer large-diameter trees, and often forage on trees with DBH (diameter at breast height, measured at 1.3 m) values of, at least, 36 cm (Pasinelli & Hegelbach, 1997; Robles *et al*., 2007a; Ciudad & Robles, 2013).

Old large-diameter oaks contain high amounts of rough bark, fissures, crevices, holes and decay wood that provide suitable micro-habitats for multiple invertebrates, which are the staple food for the Middle Spotted Woodpecker. Photo: Carlos Ciudad.

These woodpeckers forage mostly on the living parts at the top of the canopy (Pasinelli & Hegelbach, 1997; Ciudad & Robles, 2013). However, Middle Spotted Woodpeckers increase the use of dead wood for foraging in winter and all year-round in non-oak deciduous forests such as old-growth beech and riverine forests in central Europe (Pettersson, 1983; Pasinelli, 2003; Domínguez *et al*., 2017). Thus, decayed and dead wood in either living trees or in snags can be important foraging substrates under certain environmental conditions.



Percentage of foraging observations in relation to their position on the trees during the pre-breeding period in Izki (n = 40; after Ciudad & Robles, 2013). T: on the trunk under the branches; TR1: on the main stem in the lower half of the canopy; TR2: on the main stem in the top half of the canopy; R1: on branches and twigs in the lower half of the canopy; R2: on branches and twigs in the top half of the canopy.

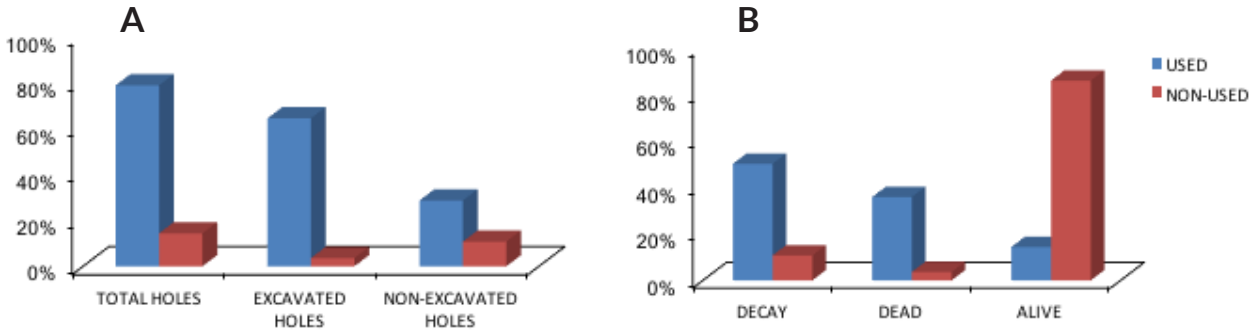
Characteristics of important foraging trees	
Species	Mainly oaks, but also other deciduous trees (beech, poplars, etc.)
Size	Preference for large-diameter trees, frequent use of trees ≥ 36 cm DBH
Condition	Preference for living trees, but high use of decayed trees and snags in winter and all year-round in forests lacking oaks.

Characteristics of potential nesting trees

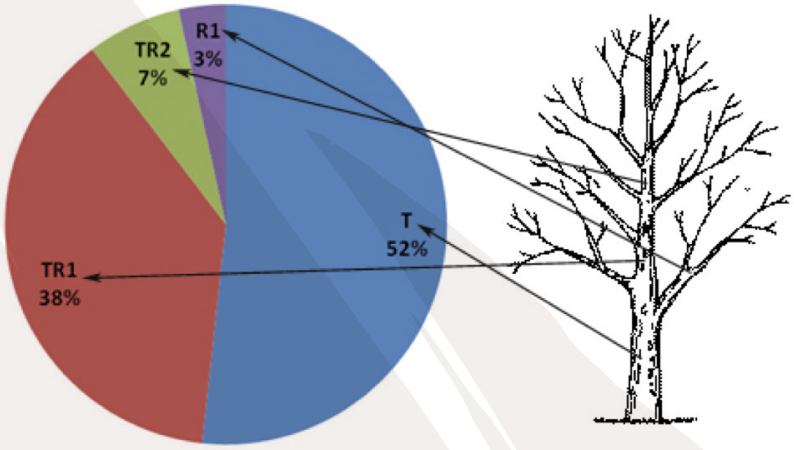
Neck and bill muscles are weaker in the Middle Spotted Woodpecker than in other comparable woodpecker species. Thus, the use of soft wood as substrate for excavation of the nesting cavity may be even more important for the Middle Spotted Woodpecker. Indeed, this woodpecker often use decayed trees, living trees with decayed soft wood, or snags (Pasinelli, 2003; Robles *et al*., 2007a; Ciudad & Robles, 2013). Tree species seems to be less relevant than tree condition (Pasinelli, 2003). Some studies found a positive selection of large-diameter trees for nesting (Kosiński & Winiecki, 2004; Pasinelli, 2007; Hebda *et al*., 2016; but see Robles *et al*., 2007a), but this result may depend on local conditions and forest structure. In any case, Middle Spotted Woodpeckers require a minimum diameter tree (~18 cm of DBH) where to build their breeding chamber (Robles, 2004). The occurrence of aphyllophorales fungi and previous holes, either excavated by woodpeckers or generated by decay, are also indicative of potential nesting trees (Robles *et al*., 2007a; Ciudad & Robles, 2013).

Middle Spotted Woodpecker nests excavated at different heights and positions in decayed oaks and snags from Izki and the Cantabrian Mountains. Photos: Carlos Ciudad.

In Izki Natural Park, all nests were excavated in oaks (n = 28; Ciudad & Robles, 2013), but in spring 2020 one nest was excavated in a beech (Izki Natural Park, own data). Middle Spotted Woodpeckers preferred decayed trees or snags with the presence of previous holes (Ciudad & Robles, 2013). Most nests were located on the trunk, at an average height of 4.5 m (range = 1.5 – 10.5 m). Birds did not select trees in relation to their diameter, but all nests were located in trees with DBH ≥ 18 cm, which may serve as a minimum value of reference to allow the placement of the breeding cavity chamber. These tree characteristics found to be important for nesting in Izki matched the values found also in the southern slope of the Cantabrian Mountains (Robles, 2004; Robles *et al*., 2007a).



Characteristics of 28 trees used for nesting and 84 non-used trees (control trees) in Izki (after Ciudad & Robles, 2013). Percentage of used and non-used trees according to their condition (A) and to the previous occurrence of holes (B).

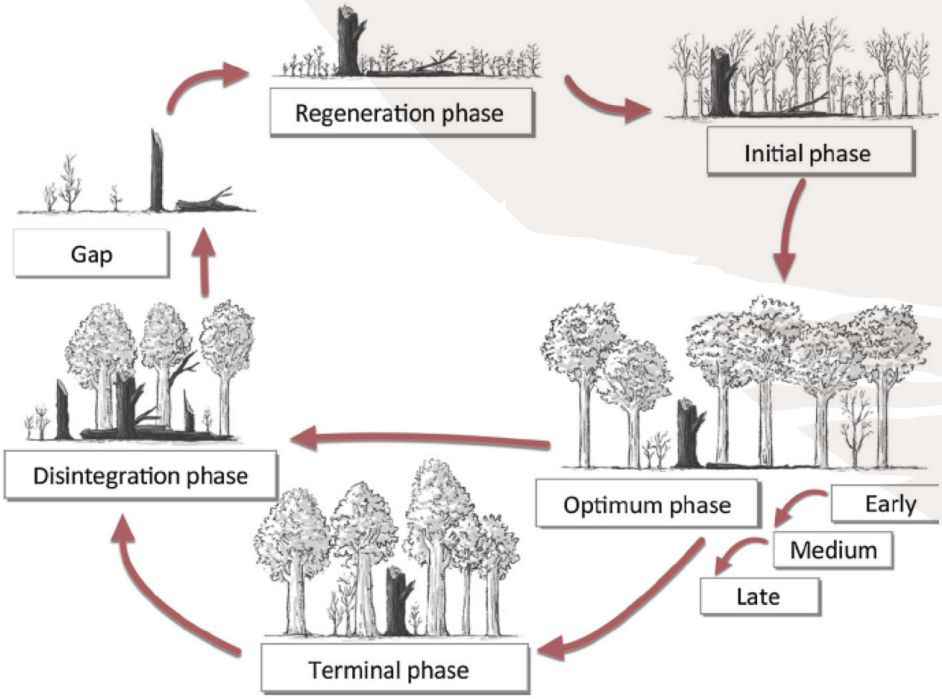


Percentage of nests in relation to their position on the trees in Izki (n = 29; after Ciudad & Robles, 2013). T: on the trunk under the branches; TR1: on the main stem in the lower half of the canopy; TR2: on the main stem in the higher half of the canopy; R1: on branches and twigs in the lower half of the canopy; R2: on branches and twigs in the higher half of the canopy.

Characteristics of potential nesting trees	
Species	Likely to be non-selective; high use of oaks because of their high availability in Izki and the Cantabrian Mountains.
Size	DBH ≥ 18 cm
Condition	Preference for decayed trees and snags
Other characteristics	Occurrence of old holes and aphyllophorales fungi

The habitat patch level

The ecological and structural characteristics of the habitat patches must be analysed by taking the silvogenetic cycle into account. In the continuous dynamic of a silvogenetic cycle, it is possible to differentiate phases. Each phase may last for decades and is characterised by successive structural changes associated with the development of each tree generation, from tree birth to their natural death and replacement by other trees. The most usual forest management system, addressed to wood harvesting, is based on cutting the trees in the initial successional phases of the forest before maturation, when trees are still in their maximum vigour. Consequently, conventional harvesting systems shorten the natural cycle by limiting the advance to mature and senescent phases (Atauri, 2020), which provide the structural features of the suitable habitat for the Middle Spotted Woodpecker. Searching for solutions that allow the maintenance of these structural features, which are relevant to biodiversity conservation, is one of the main challenges of modern forestry.



Simplification of the silvogenetic cycle, used by Begehold et al. (2015) to place the Middle Spotted Woodpecker niche in mixed beech-oak forests in Germany. This woodpecker selects positively the mature ("terminal") and senescent ("disintegration") phases, whereas it avoids the gap, regeneration and initial phases.

Species composition of the forest

As we have previously mentioned, the Middle Spotted Woodpecker is a habitat specialist associated with old-growth rough-bark deciduous forests, mainly those dominated by *Quercus* trees. In the Iberian Peninsula, this woodpecker is linked mostly to forests dominated by Pyrenean oaks (*Q. pyrenaica*), sessile oaks (*Q. petraea*), pedunculate oaks (*Q. robur*) and, to a lower extent, by Portuguese oaks (*Q. faginea*). However, Middle Spotted Woodpeckers also occupy forests composed of a mixture of oaks and other deciduous tree species, such as beeches, poplars, alders, birches and ashes (*Fraxinus* spp.). A high diversity of tree species could provide a wider variety of food resources in mixed forests compared to monospecific oak forests (Delahaye *et al*., 2010; Ciudad & Robles, 2013). Middle Spotted Woodpeckers can also occupy forests lacking oaks. This is the case of exceptionally old and extensive beech and riverine forests that occur in some areas of Germany and Poland (see the review by Pasinelli, 2003). Conversely, the forests dominated by conifers do not constitute a suitable habitat for this woodpecker.

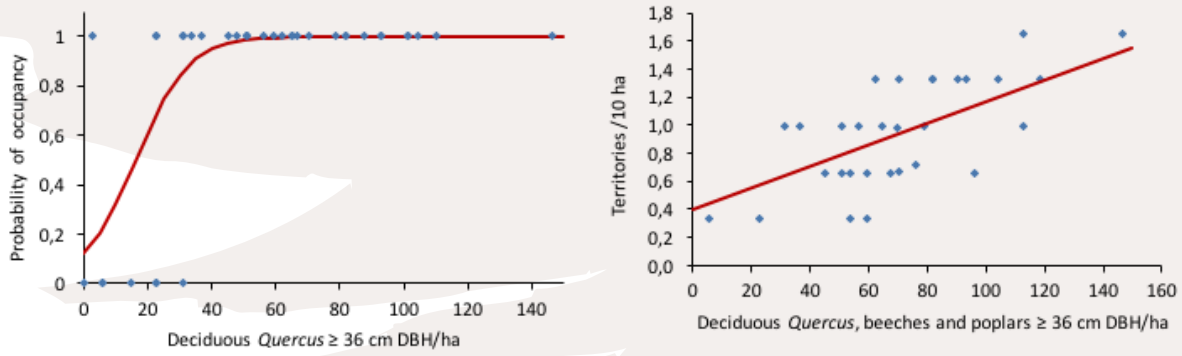
Typical habitat for the Middle Spotted Woodpecker: an extensive and, for the most part, old-growth Pyrenean oak forest in Izki Natural Park. Photo: Carlos Ciudad.

Out of the breeding territories, oak forests are also the most used habitat by floaters (Robles & Ciudad, 2020) and juveniles (Ciudad *et al*., 2009) during dispersal. However, both in Izki (Robles *et al*., 2019) and in the Cantabrian Mountains (Ciudad *et al*. 2009), juvenile dispersers sometimes use forest patches lacking deciduous oaks and dominated by other tree species, such as beeches, poplars or evergreen oaks (*Q. ilex*).

Forest structure

- **Tree density**

In the Middle Spotted Woodpecker, occupancy and territory density within the habitat patches are strongly associated with the density of old, large deciduous oaks. In Izki Natural Park, the sampled plots (~30 ha each in rather continuous forest) occupied by breeding territories contain, on average, 65 deciduous oaks ≥ 36 cm of DBH per ha (Ciudad & Robles, 2013), which is quite close to the values found in the Cantabrian Mountains (Robles *et al*., 2007a) and in other European populations (see the review by Pasinelli, 2003). Moreover, territory density is positively related to the density of all large deciduous trees in Izki (Ciudad & Robles, 2013; Robles & Ciudad, 2015). In particular, those plots with territory densities higher than the average density in 37 sampled plots, hosted at least 72 oaks, beeches and poplars with DBH ≥ 36 cm per ha. This suggests that the maintenance of high numbers of large old deciduous trees (not only oaks) in the forest stands will allow the preservation of a high-quality habitat for the Middle Spotted Woodpecker. Post-fledging juvenile woodpeckers also prefer forest stands with high densities of large oaks and other large-diameter deciduous trees (Ciudad *et al*., 2009).



The probability of occupancy and territory density of the Middle Spotted Woodpecker in relation to the density of large-diameter deciduous trees in forest plots sampled in Izki. The dots indicate the observed values for each plot, whereas the red lines show occupancy probabilities or territory densities as predicted values derived of the models performed by Ciudad & Robles (2013).

Values	Period	Study area	Reference
65 oaks ≥ 36 cm DBH/ha	Breeding (occupancy)	Izki	Ciudad & Robles, 2013
72 oaks, beeches and poplars ≥ 36 cm DBH/ha	Breeding (abundance)	Izki	Ciudad & Robles, 2013
76 trees ≥ 30 cm DBH/ha	Post-breeding	Izki	Domínguez *et al*., 2017
66 oaks ≥ 37 cm DBH/ha	Breeding	Cantabrian Mountains	Robles *et al*., 2007a
44 oaks, poplars and willows ≥ 44 cm DBH/ha	Post-fledging (juveniles)	Cantabrian Mountains	Ciudad *et al*., 2009
63 oaks ≥ 36 cm DBH/ha	Breeding	Switzerland	Pasinelli, 2000
80 oaks > 43 cm DBH/ha	Breeding	Austria	Michalek *et al*., 2001
15 oaks > 60 cm DBH/ha	Breeding	Germany	Coch, 1997
10-40 oaks > 55 cm DBH/ha	Breeding	Sweden	Pettersson, 1984

Mean densities of large-diameter deciduous trees (relevant for foraging) in habitat patches occupied by Middle Spotted Woodpeckers in different periods and locations.

The occurrence of territorial Middle Spotted Woodpeckers may also require the maintenance of a certain density of potential nesting trees (decayed or dead deciduous trees, with previous holes and/or aphyllophorales fungi). Reference values range from 26 trees/ha in Switzerland and Poland to the 53 trees/ha reported in Izki.

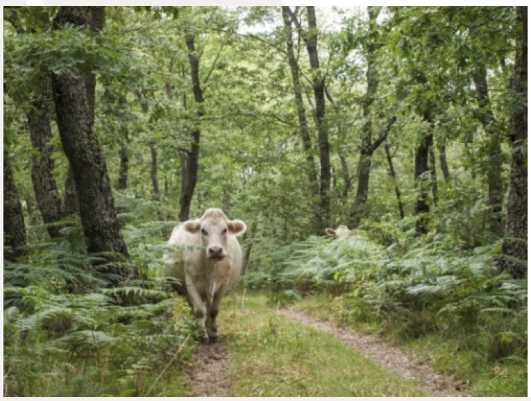
Values	Study area	Reference
53 potential nesting trees/ha	Izki	Ciudad & Robles, 2013
30 potential nesting trees/ha	Cantabrian Mountains	Robles et al., 2007a
26 potential nesting trees/ha	Switzerland	Pasinelli, 2000
26 potential nesting trees/ha	Poland	Kosiński & Winiecki, 2004

Mean densities of potential nesting trees in habitat patches from different European locations.

Middle Spotted Woodpecker habitat in Białowieża National Park (Poland) hosting high densities of large-diameter deciduous trees and of potential nesting trees. Photo: Carlos Ciudad.

- **Livestock grazing pressure**

Extensive grazing systems by sheep, goats, cattle or horses in old-growth forests and *dehesas* can be compatible with the conservation of the Middle Spotted Woodpecker (Robles *et al*., 2007a). The key issue is the preservation of high densities of important trees for foraging and nesting. A proper regulation of livestock grazing can avoid an excessive proliferation of woody vegetation in the understory that may restrict tree growth. This in turn can complement forest management actions that aim to promote the development and maintenance of old-growth forests (Núñez *et al*., 2012; Arrechea, 2015). However, high grazing pressures associated with high livestock densities, as well as with an excessive grazing by wild ungulates, can limit the rejuvenation capacity of the forest.




Cattle in the extensive oak forest from Izki (left) and sheep grazing in an oak dehesa in León province (north-western Spain). Photos: Carlos Ciudad.



Old-growth oak dehesas with high rejuvenation and dense understory vegetation due to strong reductions in the grazing pressure on old wood pastures. From left to right: pictures located in León, Navarra and Álava provinces (northern Spain). Photos: Carlos Ciudad and José María Fernández-García.

- **Dead wood**

As previously indicated, despite the fact that the Middle Spotted Woodpecker does not depend so much on dead wood for foraging as other woodpecker species, dead wood can be an important foraging substrate in certain periods and forest types. Moreover, decayed trees and snags over 18 cm of DBH are essential as potential cavity trees for nesting. Other types of dead wood created by natural dynamics, either on the ground or as snags, may have indirect benefits by enhancing food availability for the Middle Spotted Woodpecker (Pasinelli, 2000) and, more generally, as key features for the integral functioning of forest ecosystems (Harmon *et al*., 1986; Lindhe *et al*.,2004).


Interior of an old-growth oak forest with high amount of dead wood, both standing and on the ground (left), and adult female bringing food to a nest built in a snag in the Cantabrian Mountains (right). Photos: Carlos Ciudad.

- **Understory**

The Middle Spotted Woodpecker uses mostly large trees for foraging and resting, and only occasionally forages on the understory (woody or herbaceous) vegetation or on the ground. However, it can be useful to maintain an understory rich in berries, which may be important food items for the Middle Spotted Woodpecker in the autumn-winter (Pasinelli, 2003). A particular case that deserves to be studied is the high consumption of ivy berries in the breeding season in Izki (Arambarri & Rodríguez, 1997; unpublished data from the POCTEFA Habios project) and in other areas in central Europe (Spühler *et al*., 2014).

The characteristics of the understory can also influence indirectly the quality of the habitat for the Middle Spotted Woodpecker. On the one hand, a drastic reduction or simplification of the understory structure may influence the richness and diversity of other forest organisms (e.g., arthropods, xylophagous fungi). On the other hand, an excessive understory growth, which often occurs after rapid land-use changes and perturbations (e.g., pasture abandonment in *dehesas*, intensive silvicultural actions, local clearances that are not maintained, fires), can reduce habitat quality by limiting tree growth through competition or by restricting the access of woodpeckers to trees surrounded by dense vegetation (Ciudad & Robles, 2013).

The landscape level

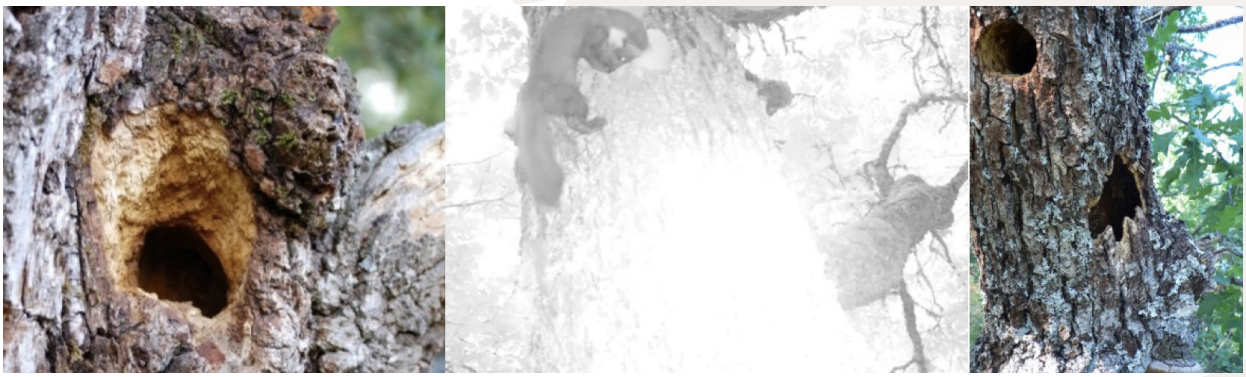
Habitat loss reduces the total amount of habitat at the landscape level. Habitat fragmentation, in addition, leads to habitat division into smaller patches or fragments, increases the edge-to-interior habitat ratio and enhances the isolation (distances) among the remaining habitat patches (Lindenmayer & Fischer, 2006).

The term "habitat" refers to the site that is occupied by individuals from a given species and that provides the resources needed for their survivorship and reproduction. In this sense, the habitat of the Middle Spotted Woodpecker matches those deciduous forests, mainly rich in oaks, that host high numbers of large-diameter trees (Pasinelli, 2003). Thus, habitat fragmentation for the Middle Spotted Woodpecker is not synonymous with forest fragmentation (see Fuller & Robles, 2018).

Loss and fragmentation of the habitat of the Middle Spotted Woodpecker (old-growth deciduous forests) due to cereal cultivation, roads and urban areas in the boundary between Álava and Navarra provinces in north Spain. Photo: Carlos Ciudad.

Habitat loss and fragmentation may have multiple negative consequences on Middle Spotted Woodpecker populations:

- Reduction of the probability of territorial occupancy in the habitat patches under high fragmentation conditions (Kossenko & Kaygorodova, 2001; Robles & Ciudad, 2012). This is due to a shortage of resources that are essential for foraging or nesting, or as shelter from predators.
- Reduction of population sizes in the patches that remain in the landscape (Fuller & Robles, 2018), which may lead to increase local extinctions through stochastic processes and the Allee effect (Swift & Hannon, 2010; Robles & Ciudad, 2017); that is, due to the fact that population declines will be more pronounced for small populations than for large ones. For the Middle Spotted Woodpecker in the Cantabrian Mountains, reductions in local population sizes associated with habitat fragmentation diminish the number of floating individuals that replace the breeders when they perish or disperse, which in turn increases the extinction risks (Robles & Ciudad, 2017).
- Reduction of population sizes in small habitat patches can also lead to a disruption of social facilitation mechanisms (Fuller & Robles, 2018). This is particularly relevant if woodpeckers use the abundance of conspecifics as an indicator of habitat quality; that is, if they decide to settle in and to mate in habitat patches with previous occurrence of a high number of other Middle Spotted Woodpeckers. The reduction in pairing success of males in small habitat patches of the Cantabrian Mountains can be explained by this hypothesis (Robles *et al*., 2007b, 2008).
- Potential reduction in food availability in small habitat patches and close to patch edges (Fuller & Robles, 2018), which may lead to reductions in breeding success and nestling mass (Burke & Nol, 1998; Lampila *et al*., 2005). Although there is no evidence of reductions in those breeding parameters associated with food availability in the Cantabrian Mountains (Robles *et al*., 2008), we cannot exclude the possibility that this occurs in other areas of the species' range, or even in the same area under different environmental conditions.
- Increase in the predation pressure due to an increase of the number or the efficiency of predators in small habitat patches and, particularly, close to edges (Fuller & Robles, 2018). Such increase of predation has been documented on the nests (Chalfoun *et al*., 2002, Lampila *et al*., 2005) as well as on post-fledging juveniles (Naef-Daenzer & Grüebler, 2016; Robles *et al*., 2007b, 2019). Even if there is no evidence of an increase of the predation pressure in small patches of the Cantabrian Mountains (Robles *et al*. 2007b, 2008), we cannot exclude this possibility in other areas of the species' range or under different circumstances.



Predation events on nests of Middle Spotted Woodpeckers recorded in the Cantabrian Mountains. From left to right: nest hole enlarged and predated by a mustelid, image of a pine marten (Martes martes) trying to predate on a nest at dusk, and nest likely predated by a Great Spotted Woodpecker that excavated the lateral wall at the height of the nest chamber. Photos: Gianluca Roncalli, Hugo Robles and Carlos Ciudad.

- Disruption of dispersal and gene flow associated with increased isolation of habitat patches (Fuller & Robles, 2018). A proper gene flow is essential for the persistence of spatially structured populations in fragmented landscapes and depend on the exchange of individuals through dispersal among the habitat patches that

conform the (meta)population. In the Cantabrian Mountains, reductions in dispersal distances of juvenile females born in isolated patches (Robles *et al*., in prep.) may lead to gene flow restrictions.

- Decrease in the (re)colonisation rate of small habitat patches (Robles & Ciudad, 2020) due to reduced amount or quality of resources, or to the low probability that small patches are found by dispersers. This is particularly relevant because the persistence of spatially structured populations (metapopulations, patchy populations) depend on a sufficient number of (re)colonisations that balance local extinctions (Robles & Ciudad, 2020).

The matrix

In fragmented landscapes, the characteristics of the matrix in which habitat patches are embedded can influence avian populations strongly (Fuller & Robles, 2018). Even if the information on the effects of the matrix on the Middle Spotted Woodpecker is scarce, some of the potential consequences for forest birds follow:

- Increases in predation rates associated with increments in the abundance or efficiency of predators in habitat patches surrounded by a non-forested matrix, such as cereal cultivations, open pastures, or scrublands (Chalfoun *et al*., 2002; Fuller & Robles, 2018).
- Reduction in resource (food, nest sites) availability in habitat patches due to abiotic or biotic changes associated with "hard" habitat edges surrounded by an open matrix (e.g., Burke & Nol, 1998; Fuller & Robles, 2018).
- Reduction of the functional connectivity associated with matrixes that show low permeability to avian movements. Such a reduction can be due to an increase in edge hardness of habitat patches, which can restrict or even impede dispersal out of the patches. This may occur in Cantabrian woodpeckers, which delay dispersal from habitat patches with hard edges, especially from those with high conspecific density (Robles *et al*., in prep.). Connectivity disruption can also be associated with a high resistance to movements in low permeable matrixes once dispersers leave habitat patches. Although there is no evidence for this to occur in the case of the Middle Spotted Woodpecker, some observations suggest that this hypothesis cannot be discarded. For example, juvenile woodpeckers in the Cantabrian Mountains avoid using conifer plantations, which can act as a low permeable matrix (Ciudad *et al*., 2009). Conversely, deciduous riverine forests are used in accordance with their availability, whereas young oak forests, even if avoided statistically, are frequently used by juveniles (Ciudad *et al*., 2009).

Forest activities compatible with the conservation of the Middle Spotted Woodpecker

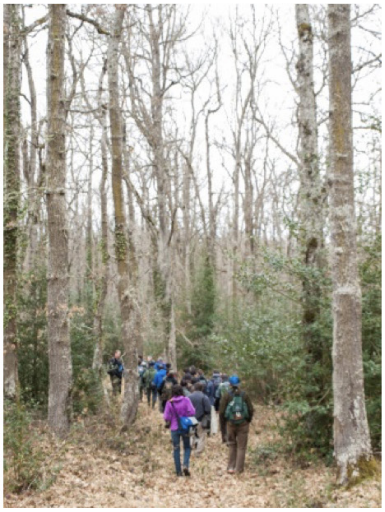
The Middle Spotted Woodpecker can be sensitive to forest exploitation. In the French forested area Forêt d'Orient (10,000 ha), territory density decreased in forest stands subjected to intensive harvesting (Fauvel *et al*., 2001). On the contrary, forestry management actions that aim to increase the proportion of trees with high diametral classes can contribute positively to the conservation of the Middle Spotted Woodpecker (Junod & Mulhauser, 2005; Pasinelli *et al*., 2008).

General planning

Middle Spotted Woodpecker conservation can benefit from a proper planning of the activities carried out in the natural environment. The design and execution of forest interventions require the irreplaceable contribution of practitioners specialised in various topics, from Ecology to Forestry. Likewise, woodpecker conservation can benefit from the cooperation between different agents and stakeholders, including governmental administrations, foresters, scientists, and NGOs devoted to conservation.

Consequently, in this section we aim to provide a general overview of the steps required to plan or project any activity within the range and habitat of the Middle Spotted Woodpecker. Whether we aim to regulate the flow of hikers, wood production for harvesting and fuel, pasture exploitation or hunting activities, or if the goal is to design a road or to improve the habitat quality for the Middle Spotted Woodpecker, some general steps would be as follows:

- Compiling the available information on the distribution, abundance, demography and behaviour of the Middle Spotted Woodpecker, not only in the area affected by the target activity, but also in the surroundings.
- On the basis of that information, to examine the characteristics of the population. It is not equivalent, in terms of impact, to propose an activity that will affect an increasing population than a declining one, an expanding population or a shrinking one, a source population or a sink, a balanced metapopulation that depends on natal dispersal or a completely isolated population lacking dispersal out of the system, etc. Likewise, it is necessary to determine, within that particular population, what is the situation of the Middle Spotted Woodpecker in the area where activities are planned.
- When there is no detailed information on population status, which is not unusual at all, it is recommended to use the knowledge provided by ecological theories on the dynamics and persistence of populations to draft hypotheses on the effects of the actions that are being planned.
- In any case, it is important to use a protocol for the species detection, as the one detailed below, to gather information about the current situation of the population.
- To assess the impacts (positive, negative or neutral) of the planned activities on the distribution, abundance, demography (reproduction, survival) and behaviour of the population at both local and landscape levels, as well as at a regional level in case it is possible and necessary.
- Finally, to assess the real effect of the activities by monitoring woodpecker populations once the activities have started to be implemented, as well as after finishing these activities. Ideally, such evaluation should be performed on a 'before-after-control-impact' framework in which the impacts of the activities are measured both in 'treated plots' and 'control plots'.



Forest activities, like hiking, wood extraction for fuel, and others, require a proper planning to make them compatible with the conservation of the Middle Spotted Woodpecker. Photos: Carlos Ciudad and Hazi Foundation.

Field protocol for the detection of the Middle Spotted Woodpecker

Unfortunately, data concerning the distribution and abundance of the Middle Spotted Woodpecker is often scarce, either because of a lack of surveys in that particular area or because information has not been updated for a long time. Thus, it is necessary to use a field protocol that allows us to detect the species within the framework of the projects or planned activities.

The detection probability of Middle Spotted Woodpeckers varies seasonally. Regardless of the season, the surveys will be conducted under the absence of precipitations and under low wind conditions to avoid reductions in the activity of woodpeckers that may influence their detection. Surveys will be done in the first hours of daylight, except for days after extremely cold nights, when it is recommendable to delay slightly the start of fieldwork (Robles & Ciudad, pers. obs.).

Because the species is often detected through auditive contacts, it is essential to become familiar to the vocalisations of the Middle Spotted Woodpecker. A description of such vocalisations can be found in Pasinelli (2003), but it is convenient to consult digital repositories (e.g., https://www.xeno-canto.org/species/Dendrocoptes-medius). Overall, surveys will be planned by taking into account the following issues (details in Robles & Ciudad, 2012):

- To design an itinerary that covers the entire plot to be surveyed at a maximum speed of 20 ha/h.
- To conduct 5-minutes point-counts every 300 m, approximately, by alternating 30 seconds of listening with 45 seconds of broadcasting conspecific vocalisations ("*keek*" and "*rattle*" calls *sensu* Pasinelli, 2003)
- To stop broadcasting vocalisations as soon as the species is detected.
- To follow individual woodpeckers and to plot their movements and interactions with conspecifics on maps elaborated *ad hoc* or by using applications in digital devices that allow recording spatial data at high accuracy.
- At the end of a given visit to a survey plot, to count and to note down the number of individuals and territories.
- It is essential to repeat the survey in the same plot by leaving 2-3 weeks between consecutive visits, with the aim of confirming or discarding the territorial settlement of individuals.
- High number of visits increase the accuracy of the estimation of territory numbers. Between three and five visits to a given plot allow a proper adjustment of estimations to the actual number of territories, as well as the identification of non-territorial floaters that may occur temporarily (Robles & Olea, 2003; Robles & Ciudad, 2017).

A proper application of this protocol requires of some experience on territory mapping of birds. Moreover, this protocol has been designed to estimate territory numbers in the period of maximum territorial activity; that is, during the pre-breeding season that ranges from January to April-May. After Middle Spotted Woodpeckers begin to lay eggs, their response to broadcasted vocalisations decreases. However, during the breeding season (April-May to June-July), these woodpeckers are still quite active vocally, particularly by emitting alarm calls after the parents or their nests are disturbed. Posteriorly, once post-fledging juveniles become independent and initiate dispersal out of the natal territory in June-July, woodpeckers become less conspicuous vocally. Finally, the lack of leaves on the trees facilitates visual detection in the autumn-winter, but woodpeckers are less vocal by then than in spring.

The surveys to detect the species must be performed mainly during the pre-breeding season. Photo: José María Fernández-García.

Calendar for the development of forest activities

The compatibility of forest activities and biodiversity conservation requires considering the seasonal variation in the potential impacts. Adult birds can be subjected to high energetic requirements and predation risks during the breeding season associated with disturbances inside and outside the nests (Francis & Barber, 2013; Strasser & Heath, 2013; Remacha *et al*., 2016). However, anthropogenic disturbances in the pre-breeding season can also affect very negatively to adult birds by reducing settlement success in a territory (Bötsch *et al*., 2017). Moreover, as it occurs in other birds, juvenile Middle Spotted Woodpeckers are particularly sensitive during the post-fledging dependence period and the posterior dispersal period (June-July), when young birds are expected to undergo high predation and starvation pressures (Robles *et al*., 2007b, 2019).

According to these issues, it is important to avoid performing intensive forest activities from March to July, which covers the pre-breeding (pair-bonding) season, the breeding season, the post-fledging dependence period and the main dispersal period in the Middle Spotted Woodpecker. For these reasons, it is strongly recommended to concentrate silvicultural management actions from August to February. Conversely, only activities with no or low impact should be conducted in the most critical March-July period.

Forest activities should be performed out of the pre-breeding and breeding seasons to avoid disturbances during territorial settlement, nest construction, egg-laying, incubation, brooding, post-fledging care and dispersal periods. Photo: Carlos Ciudad.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Period available for intensive forestry actions, such as those that modify forest structure (e.g., cuttings, clearings, construction of roads for wood extraction, etc.)												
Critical period for the Middle Spotted Woodpecker												
Period available for low intensive activities that do not modify forest structure (e.g., hiking, birding, etc.)												

Recommended calendar for the performance of forest activities in plots occupied by the Middle Spotted Woodpecker or in forest stands with potential habitat for this species.

Criteria at the tree level

Given the importance of tree structure for the Middle Spotted Woodpecker, forest activities compatible with its conservation will be those that allow preserving, or even promoting, structural features of the trees that are beneficial for foraging and nesting.

Regarding foraging trees

- To preserve deciduous oaks ≥ 36 cm of DBH (Robles *et al*., 2007a; Ciudad & Robles, 2013).
- To preserve other deciduous trees (beeches, poplars, alders, birches, maples, ashes, willows, etc.) ≥ 36 cm of DBH (Ciudad & Robles, 2013) without restricting the long-term dominance of the oak forest. Regarding the current tendency to remove beeches in oak forest stands with the aim of reducing competition between beeches and oaks (e.g., González *et al*., 2008; Lasala *et al*., 2013; Arrechea, 2015), it should be noted that cutting large-diameter beeches and other deciduous trees in oak forests can be detrimental for the habitat of the Middle Spotted Woodpecker (Delahaye *et al*., 2010; Ciudad & Robles, 2013; Robles *et al*., 2019).

- To promote the growth of mid-diameter deciduous oaks by selective cutting of surrounding stems that may compete and limit their development (Ciudad *et al*., 2009). This will favour the replacement of large old oaks that fall down and, thus, will promote the renovation of the foraging habitat for the Middle Spotted Woodpecker.
- To preserve decayed trees and snags, particularly the large-diameter ones, which may be relevant as winter foraging habitat (Pasinelli, 2003, and references therein).
- To maintain dead wood on the ground as an indirect source of food and larvae that may become available for the Middle Spotted Woodpecker after emerging, and to preserve the integral functioning of the forest (Harmon *et al*., 1986; Pasinelli, 2003; Lindhe *et al*., 2004).
- To preserve berry-producing plants (e.g., *Prunus* spp., *Hedera helix*), which may provide complementary food for the Middle Spotted Woodpecker (Pasinelli, 2003; POCTEFA Habios project, own data).

Examples of trees to be preserved in the forests because of their relevance for foraging in the Middle Spotted Woodpecker. Such trees include mainly large-diameter oaks, but also other large-diameter deciduous trees such as beeches, poplars, alders, or birches, as well as some berry-producing shrubs like ivy. Photos: Carlos Ciudad.

<u>Regarding nesting trees</u>

- To preserve deciduous trees ≥ 18 cm of DBH that are either decayed (trunk partly debarked and/or with aphyllophorales fungi) or completely dead and/or with previous holes (Robles *et al*., 2007a; POCTEFA Habios project, own data). This goal should be achieved by a proper survey of trees before forest interventions.
- Nest reuse and, particularly, the reuse of nesting trees where new cavities are excavated, is not infrequent (up to 30% of nesting trees are reused annually in the Cantabrian Mountains; Robles & Ciudad, own data). Thus, nesting trees used in previous years should be preserved.

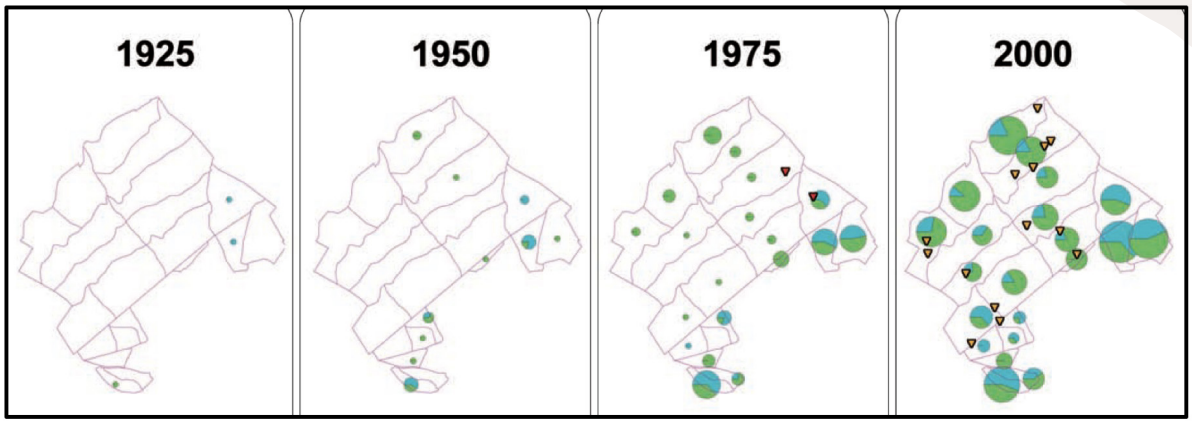
Examples of potential nesting trees for the Middle Spotted Woodpecker include decayed or dead deciduous trees, with previous holes and/or aphyllophorales fungi. Photos: Carlos Ciudad.

Criteria at the habitat patch level

Regarding tree density

In old-growth deciduous forest patches, the density of trees to be preserved should be sufficient as to provide habitat requirements for both adults in their breeding grounds and dispersers (mainly floating adults and juveniles after independence) moving through unfamiliar areas (Robles *et al*., 2007a; Ciudad *et al*., 2009; Robles & Ciudad, 2012, 2020):

- To maintain high densities of foraging trees. In Switzerland, a reference value to achieve this goal is at least 30 oaks > 36 cm of DBH per hectare, which correspond with forests of over 60-120 years (Pasinelli *et al*., 2008). As reference values for Spain, oak forests with breeding adults hosted on average 66 oaks ≥ 37 cm of DBH per hectare in the Cantabrian Mountains (Robles *et al*., 2007a), and 65 oaks ≥ 36 cm of DBH per hectare in Izki (Ciudad & Robles, 2013). Plots with territory densities over the average value reported in 37 plots in Izki hosted 81 oaks, beeches and poplars ≥ 36 cm of DBH per hectare (Ciudad & Robles, 2013).



Temporal changes in the proportion of large trees (oaks in blue and beeches in green, all trees > 55 cm of DBH) and the number of Middle Spotted Woodpecker territories (triangles) in a forest from Switzerland (Junod & Mulhauser, 2005).

- To maintain high densities of potential nesting trees. Based on the data collected for the Cantabrian population, we recommend the maintenance of at least 30 deciduous trees ≥ 18 cm of DBH, either decaying or dead, and/or with previous holes per hectare (Robles *et al*., 2007a).
- To preserve the structural heterogeneity in the habitat patches by maintaining (i) the natural diversity of accompanying tree species, (ii) a high amount of dead wood standing and on the ground, and (iii) an even distribution of tree ages that guarantee the long-term persistence of the forest structures preferred by the Middle Spotted Woodpecker (Onrubia *et al*., 2004; Robles *et al*., 2007a).

Old-growth sessile oak forests with high numbers of large oaks host high territory densities of Middle Spotted Woodpeckers in south-western Cantabria (north Spain). Photo: Carlos Ciudad.

Suboptimal forests, such as riverine and oak forests with low densities of foraging and nesting trees (i.e., young and dense stands subjected to high rejuvenation or in the initial phases of maturation), can be used by dispersing juveniles (Ciudad *et al*., 2009), and by breeding adults once the forests reach certain maturity threshold. Some recommendations to take into account in suboptimal forests follow:

- To preserve the few large and decayed trees remaining in suboptimal forests, which can function as important foraging and nesting trees for the Middle Spotted Woodpecker (see above).
- To perform selective clearances that promote the growth of the remaining trees in the forest (Ciudad *et al*., 2009; Ciudad & Robles, 2013). To achieve this goal, it is important to extract, by selective cutting, the trees smaller than 15 cm of DBH when they occur at high densities, with the aim of reducing competition and facilitating the growth of potentially larger oaks and other deciduous trees (Cañellas *et al*., 2004; Arrechea, 2015). Clearances should result in a mosaic of vegetation that acts as a refuge for mammals, birds, amphibians and reptiles sensitive to this type of forest interventions (De la Montaña *et al*., 2006).
- Pruning the twigs and small branches (diameter < 5 cm) of the trees that remain after clearances may (i) facilitate the access to trophic resources located in and on the bark of the main stems (Ciudad & Robles, 2013), (ii) contribute to cavity formation processes (Sebek *et al*., 2013; Avilés, 2019) and (iii) promote tree growth (Espelta *et al*., 2003).
- In patches with low amount of standing dead wood and low numbers of potential nesting trees, tree girdling has been proposed to generate decaying standing trees and snags that can be used by woodpeckers for excavation (e.g., Jato *et al*., 2020). However, this management action may not be useful in many forests occupied by Middle Spotted Woodpeckers, which are characterised by hosting high densities of potential cavity trees (Ciudad & Robles, 2013). Even more, killing trees through girdling could be detrimental in suboptimal forests if it compromises the growth and density of the living trees that will become suitable for foraging after the increase in their diameters over the years.
- Leaving the large-diameter remains of pruning activities scattered over the ground can increase the amount of dead wood on the ground of the forest (Ciudad & Robles, 2013).
- After selective clearances, livestock grazing at low to moderate intensity can help to reduce excessive rejuvenation in forests (Nuñez *et al*., 2012; Arrechea, 2015), which often occurs in forests subjected to high resprouting from the root or the rhizome of trees (e.g., in the Pyrenean oak forests).

Sessile oak forest in the Cantabrian Mountains (León province in north Spain) years after being subjected to selective clearance. In addition to the preservation of all large-diameter oaks, multiple young and mid-age oaks were also maintained to allow forest renovation. Photo: Carlos Ciudad.

Regarding tree understory density and structure

In both suboptimal and optimal forests for the Middle Spotted Woodpecker where a high development of the understory limits tree growth, some management actions could be carried out to reduce understory pressure. To address this issue, the following actions should be conducted only after thoughtful technical advice and always under the cautionary principle:

- Local clearances of the understory vegetation that limits growth of potential foraging and nesting trees by following the criteria described above for clearances of young trees in dense forests.
- During clearances, it is important to preserve the natural diversity of the understory, particularly of berry-producing shrubs that may provide complementary food for the Middle Spotted Woodpecker and essential food resources for other forest dwellers.
- Promoting low to moderate livestock grazing can control the excessive development of the understory due to regeneration processes after clearances. However, grazing intensity should not limit the regeneration of the forest.

Understory with high density of young oaks and scrubs in Pyrenean oak forests from the Cantabrian Mountains (left) and Izki Natural Park (right). Photos: Carlos Ciudad and Hazi Foundation.

Other considerations

- To avoid the use of phytosanitaries and biocide products in the habitat patches, which can reduce the richness and abundance of arthropods that form the staple food for the Middle Spotted Woodpecker (Onrubia *et al*., 2004; Ciudad & Robles, 2013).
- Overall, moderate to continuous forest cover with diverse degrees of tree density and canopy cover can favour many forest specialist bird species (Jato *et al*., 2020). When planning local regeneration cuttings, it is preferable to use selective cuttings that mimic the formation of natural clearings within the forest. Large areas (> 0.5 ha) subjected to complete regeneration cuttings are not adequate. The initial stages of forest development, which are not suitable for the Middle Spotted Woodpecker and other birds specialised in old-growth forests, should be distributed in a fine-grain mosaic pattern where old-growth forest stands dominate the landscape and are properly connected.

Caterpillar on the underside of an oak leaf (left) and Middle Spotted Woodpecker carrying arthropods to provision the nestlings (right). Photo: Carlos Ciudad.

Criteria at the landscape level

Increasing the amount and quality of habitat at the landscape level

Within deciduous forests, the designation of "islets" without forestry interventions to allow tree aging and senescence that are potentially interesting for the Middle Spotted Woodpecker, will contribute to increase the amount of old-growth stands in forests dominated by young trees. As reference values, these "islets" in France have been proposed in plots of at least three hectares, covering at least 3 % of each forest management unit (Biache, 2017). In Switzerland, such "islets" have been proposed to be at least 5-10 hectares to fit the spatial requirements of territorial Middle Spotted Woodpeckers (Pasinelli *et al*., 2008). The creation of "forest reserves" that favour tree aging within young forests can be a suitable approach to the "islet" concept. In Navarre, at least 5 % of the area in a given forest management unit ('*monte*') should be designed as forest reserve (Regulations of the Regional Forest Law 13/1990). In any case, it should be noticed that a total absence of forest interventions may have, under certain circumstances, negative effects when high tree rejuvenation and dense stem densities increase competition and reduce tree growth substantially. Therefore, it is recommended not to apply this system to forests subjected to extensive rejuvenation by resprouting from the root or the rhizome (e.g., young Pyrenean oak forests), as these stands require active management actions that favour the development of large tree diameters (e.g., local selective cuttings complemented by low intensive livestock grazing).

Increasing habitat patch size

Increasing the size in habitat patches (e.g., old-growth forests rich in large-diameter oaks) will result in an increase of the total amount of resources, such as food and nest sites. Because small habitat patches (< 10 ha) have a low probability of occupation by territorial and floating woodpeckers (Robles & Ciudad, 2012, 2017, 2020), an increase of patch sizes is expected to benefit both breeding and non-breeding fractions of the populations in the Middle Spotted Woodpecker. The increase of habitat patch size can be achieved by two main mechanisms:

- Planting oaks in the surroundings of habitat patch edges (Fuller & Robles, 2018) and protecting the planted trees against herbivory by livestock and wild ungulates.
- Active management of the young oak forest that forms the matrix in which old-growth forest patches (i.e., the habitat patches) are embedded. Such management actions can be addressed to reduce tree competition through local selective cuttings, which would favour the development of trees with large diameters. Subsequently, it can be useful to perform additional selective cuttings and to use low intensive livestock grazing that control the excessive rejuvenation and proliferation of dense forests dominated by young trees. As previously mentioned, such actions will be particularly efficient in oak forests (e.g., Pyrenean oak forests) subjected to high resprouting from the root or the rhizome as a consequence of severe perturbations (fires and cuttings). This, in turn, generates a high density of small-diameter stems that constrain the growth of the trees through competition (Robles et al., 2011; Robles & Ciudad, 2012).

Plantation of oaks in the surroundings of a small patch of habitat for the Middle Spotted Woodpecker in León province, northern Spain (left). Selective cuttings in young Pyrenean oak stands adjacent to old-growth forests in Izki, aimed at increasing habitat patch size and favouring the development of the remaining trees (right). Photos: José María Fernández-García.

Reducing edge hardness

Reducing edge hardness of habitat patches surrounded by a non-forested environment can help to protect some microclimatic conditions that may be associated with high availability of arthropods (Fuller & Robles, 2018). In this sense, the plantation of deciduous trees (e.g., autochthonous oaks) around the habitat edges can be beneficial for the Middle Spotted Woodpecker.

"Hard" edge originated by mining activities in an old-growth oak forest of the Cantabrian Mountains (Palencia province). The plantation of autochthonous oaks to restore mining areas could preserve critical microclimatic conditions in those hard edges. Photo: Carlos Ciudad.

Changing the matrix

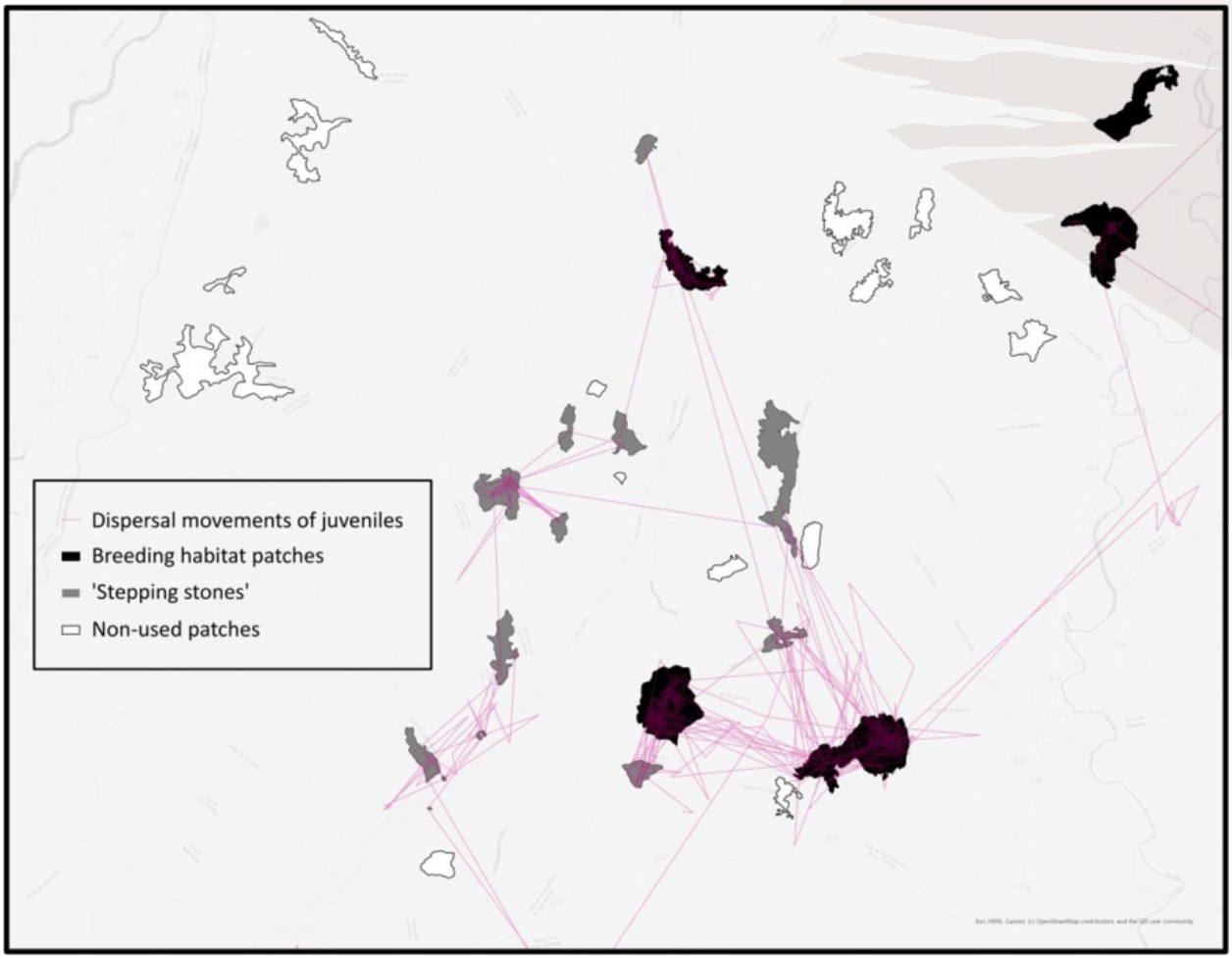
The changes in the composition and structure of the matrix should target, among other goals, the reduction of edge effects associated with enhanced predation pressures (increase in the number and efficiency of predators) and reduced availability of arthropods (Fuller & Robles, 2018). In addition, changes in the matrix can improve its permeability to animal movements, which will result in a proper functional connectivity that guarantees the persistence of spatially structured populations (Fuller & Robles, 2018). Some proposals to address these goals are set out below:

- In non-forested matrixes, it is important to promote and increase oak and riverine forests outside the breeding grounds, either as patches or as linear structures, which are frequently used by juvenile dispersers (Ciudad *et al*., 2009; Robles *et al*., 2019).
- In matrixes composed of deciduous forests (young oak and riverine forests), the actions should be addressed to favour the increase of tree diameters by low-impact selective cuttings and pruning.
- To remove, or to reduce as much as possible, conifer plantations, which can act as barriers that constrain dispersal of Middle Spotted Woodpeckers (Ciudad *et al*., 2009).

Linear structures and small patches of deciduous trees in the boundary of cultivated lands in Izki Natural Park (left), and lines of large-diameter oaks adjacent to unpaved roads that give access to cultivation fields in the Atlantic Pyrenees in France (right). This type of matrix features can provide food and facilitate the movements of dispersing woodpeckers among habitat patches. Photos: Carlos Ciudad.

Protecting the habitat patches used by dispersers

Farther away from the breeding patches occupied by territorial birds, both juveniles and floating adults often use other habitat patches as '*stepping stones*' for dispersal (Robles & Ciudad, 2020; own data). In highly-fragmented landscapes, protecting those patches can be crucial for the persistence of spatially structured populations. In the Cantabrian Mountains, the patches used by floaters as '*stepping stones*' were more likely to host breeding territories in subsequent years than the patches non-used by floaters (Robles & Ciudad, 2020).



Dispersal movements conducted by juvenile Middle Spotted Woodpeckers that were radio-tracked in the Cantabrian Mountains. Juvenile dispersers used several habitat patches as 'stepping stones' for their displacements among breeding habitat patches (Robles & Ciudad, own data).

Improving functional connectivity

Functional connectivity is essential for the persistence of spatially structured populations; that is, local populations connected by dispersal in highly fragmented environments. Basically, functional connectivity guarantees the effective exchange of genes among local populations by ensuring the interchange of individuals that will successfully breed in the destination populations. Some measures that can increase functional connectivity for the Middle Spotted Woodpecker are as follows:

• Modifying the matrix as proposed above.

• Protecting the habitat patches used as '*stepping stones*' for dispersal. Moreover, the actions oriented to increase the size of the patches not used for breeding can make those patches more attractive to dispersers (Robles & Ciudad, 2020).

• The reduction in edge hardness of the origin habitat patches may increase their permeability and, thus, facilitate the departure of the dispersers out of their natal patches (Robles *et al*., own data).

• The measures aimed at reducing the isolation between habitat patches may favour the mobility of females (i.e., the most dispersing sex) by increasing their dispersal distances (Robles *et al*., own data).

• It is highly recommended to perform connectivity analyses at both local and regional levels, which will help to identify the critical areas where permeability should be increased.

Isolated oak dehesa patch in a fragmented landscape dominated by cereal fields, heaths and extensive conifer plantations in the Cantabrian Mountains (left). Small oak patches surrounded by open pasture are used by juvenile dispersers in the Middle Spotted Woodpecker (right). Photos: Carlos Ciudad.

SUMMARY OF CRITERIA TO CONCILIATE FOREST ACTIVITIES AND WOODPECKER CONSERVATION

All information, such as territory distribution, nest locations and the distribution of potential habitat for the Middle Spotted Woodpecker, should be available to practitioners and foresters, in order to maximise the compatibility between any activity to be planned in the forests and woodpecker conservation.

The tree level

√ Preserve, as important foraging trees, all oaks and other deciduous trees ≥ 36 cm of DBH.

√ Preserve, as potential nesting trees, all deciduous trees ≥ 18 cm of DBH, decaying or dead and/or with previous holes.

√ Preserve dead wood, either standing (snags) or on the ground (logs), that has been produced by natural dynamics.

√ Preserve berry-producing plants as sources of food alternative to arthropods.

The habitat patch level

1. *In old-growth deciduous forests*

√ Maintain high densities of important foraging trees. Reference value: 65 deciduous oaks ≥ 36 cm of DBH per ha

√ Maintain high densities of important nesting trees. Reference value: 30 deciduous trees ≥ 18 cm of DBH, decaying or dead and/or with previous holes per ha.

√ Preserve the structural heterogeneity of the forest stand regarding the diversity of accompanying tree species, the preservation of dead wood and the maintenance of all tree ages.

√ Avoid using phytosanitary and biocide products in the forests.

2. *In suboptimal forests, particularly in young oak stands with some remaining features typical from old-growth forests.*

√ Preserve the few remaining trees that can be relevant for foraging and nesting.

√ In dense, young forests, it is important to reduce competition and to favour the development of large-diameter trees by (i) selective cuttings of small-diameter trees (< 15 cm) around the focal trees to be favoured; (ii) selective clearances of scrub; and (iii) pruning small branches and twigs (< 5 cm in diameter) located low on the trees (< 3 m height).

√ Promote low intensive livestock grazing with the aim of controlling the excessive proliferation of small-diameter trees and scrub in the understory. Livestock grazing should not constrain the long-term regeneration of the forest.

The landscape level

√ Increase the size of habitat patches (often old-growth oak forests), either by planting autochthonous oaks or by managing the dense small-diameter oak forest that surrounds small habitat patches. Reference value: 10 ha patches can be occupied by at least one Middle Spotted Woodpecker territory.

√ Reduce the edge hardness of habitat patches by, for example, planting autochthonous oaks in open areas adjacent to the patches.

√ Favour the presence of old deciduous trees (mainly oaks) in open matrixes. In forested matrixes composed of young deciduous forest, to promote the development of large-diameter trees by selective cuttings, clearances and pruning. Finally, to remove the area covered by conifer plantations.

√ Preserve habitat patches that, even if they are not occupied by territorial woodpeckers, can act as '*stepping stones*' for dispersal among breeding habitat patches.

Recommended calendar

√ Perform the most intensive forest interventions between August and February; that is, outside the critical period for the Middle Spotted Woodpecker, which spans March-July.

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Summary

This document, which has been published within the framework of the POCTEFA Habios project, aims to be a reference manual helping practitioners, technicians and planners to conciliate forest activities and the conservation of the Middle Spotted Woodpecker (*Dendrocoptes medius*). This bird is specialized in mature deciduous and marcescent forests that contain high numbers of large trees, especially oaks (*Quercus* spp.).

At the tree level, it is essential to preserve important trees for foraging (deciduous trees with a diameter ≥ 36 cm), as well as potential trees to excavate the nests (with a diameter ≥ 18 cm, decayed or dead and/or with previous holes). At the habitat patch level, high densities of trees for foraging (e.g. 65 oaks ≥ 36 cm/ha) and nesting (e.g. 30 potential cavity trees/ha) should be maintained, and the structural heterogeneity of the forest should be preserved to allow forest regeneration. In suboptimal habitat patches, such as dense, young oak forests with some mature features, selective thinning of small diameter (< 15 cm) stems, brush clearing, selective pruning, and low intensive grazing can enhance the growth of the remaining trees, which in turn will improve habitat quality in the medium-long term. At the landscape level, preserving large habitat patches, planting native deciduous trees in the surrounding open matrix, or managing small diameter trees in forested matrixes around small habitat patches will result in both the preservation and increase of habitat patch sizes as well as in the reduction of the hardness of patch edges and matrixes around habitat patches. Moreover, the preservation of habitat patches that, even if non suitable for breeding, are used by dispersing individuals as "stepping stones", will enhance functional connectivity for the Middle Spotted Woodpecker.

Planning the activities in forests occupied by this woodpecker or with potential habitat must consider a detailed estimation of the predictable effects on the woodpecker population. Because the critical period for the Middle Spotted Woodpecker spans from March to July, the most intensive activities (e.g., forestry interventions) should be carried out between August and February.

Resumen

El presente documento se ha desarrollado en el marco del proyecto POCTEFA Habios, con el objetivo de servir de referencia a gestores, técnicos y proyectistas, para compatibilizar las actividades forestales con la conservación del pico mediano (*Dendrocoptes medius*). Éste pájaro carpintero es un especialista de bosques caducifolios y marcescentes maduros, con gran dependencia por el arbolado de gran porte, robles (*Quercus* spp.) en particular.

A nivel de árbol, es fundamental preservar los pies importantes para la alimentación (caducifolios con diámetro ≥ 36 cm), así como los árboles potenciales para excavar el nido (con diámetro ≥ 18 cm, decadentes o muertos y/o con presencia de huecos). A nivel de parche de hábitat, se deben mantener elevadas densidades de árboles de alimentación (ej. 65 robles ≥ 36 cm/ha) y de nidificación (ej. 30 árboles potenciales/ha), así como preservar la heterogeneidad estructural del bosque. En los parches de hábitat subóptimos, como los robledales jóvenes densos con algunos elementos maduros, los clareos selectivos de pies de pequeño diámetro (< 15 cm), los desbroces de matorral, las podas y el pastoreo de mantenimiento pueden ayudar a fomentar el crecimiento en grosor de los árboles de futuro, mejorando a medio-largo plazo la calidad del hábitat. A nivel de paisaje, se recomienda preservar los parches grandes; realizar plantaciones de caducifolios autóctonos o intervenciones sobre arbolado joven para aumentar el tamaño de los parches pequeños y reducir la dureza de los bordes (i.e. el contraste entre tipos de cubierta en el perímetro de los parches); fomentar la presencia de arbolado caducifolio en la matriz (i.e. lo que no es hábitat); y preservar los parches de hábitat usados por individuos dispersantes como "*stepping stones*".

La planificación de las actividades a desarrollar en los bosques ocupados por picos medianos, o con potencialidad para serlo, debe realizarse estimando previamente las repercusiones para la población. Se considera periodo crítico el que va de marzo a julio; las actividades más intensivas, como las intervenciones selvícolas, se realizarán preferentemente entre los meses de agosto y febrero.

Résumé

Ce document a été développé dans le cadre du projet POCTEFA Habios, dans le but de servir de référence aux gestionnaires, techniciens et urbanistes, pour rendre les activités forestières compatibles avec la conservation du pic mar (*Dendrocoptes medius*). C'est un spécialiste des forêts de feuillus et d'écorces anciennes, avec une forte dépendance vis-à-vis des arbres de grandes tailles, notamment des chênes (*Quercus* spp.).

Au niveau des arbres, il est essentiel de conserver des pieds qui sont importants pour leur alimentation (arbres à feuilles caduques d'un diamètre ≥ 36 cm), ainsi que des arbres potentiels pour creuser leurs nids (d'un diamètre ≥ 18 cm, en décomposition ou morts et/ou avec la présence de trous). Au niveau de la parcelle d'habitat, des densités élevées d'arbres nourriciers (par exemple 65 chênes ≥ 36 cm/ha) et d'arbres nicheurs (par exemple 30 arbres potentiels/ha) doivent être maintenues, tout en préservant l'hétérogénéité structurelle de la forêt. Dans des zones d'habitat marginales, telles que les jeunes chênes denses avec certains éléments matures, l'amincissement sélectif des pieds de petit diamètre (< 15 cm), le débroussaillement, la taille et le pâturage d'entretien peuvent aider à promouvoir le grossissement des futurs arbres, améliorant la qualité de l'habitat à moyen et long terme. Au niveau du paysage, il est recommandé de conserver de grandes parcelles; de réaliser des plantations de feuillus indigènes ou des interventions sur de jeunes boisements pour augmenter la taille des petites parcelles et réduire la dureté des lisières (ex. le contraste entre les types de couvertures sur le périmètre); la promotion de la présence de boisements feuillus dans la matrice (c.-à-d. ce qui n'est pas un habitat); et la préservation des parcelles d'habitat utilisées par les individus dispersés tels que les «*stepping stones*».

La planification des activités à réaliser dans les forêts occupées par le pic mar, ou susceptibles de l'être, doit être réalisée préalablement en estimant les impacts sur la population. La période critique s'étend de mars à juillet; les activités les plus intensives, telles que les interventions sylvicoles, seront réalisées de préférence entre les mois d'août et février.

Laburpena

Dokumentu hau POCTEFA Habios proiektuaren barruan garatu da, kudeatzaile, teknikari eta planifikatzaileen erreferentzia gisa balio dezan, basoko jarduerak okil ertainaren (*Dendrocoptes medius*) kontserbazioarekin bateragarriak izan daitezen. Baso hostozabal eta zimelkor helduetan espezializatuta dago, zuhaitz handien, bereziki haritzen (*Quercus* spp.) mendekotasun handia duelarik.

Zuhaitz mailan ezinbestekoa da elikatzeko garrantzitsuak diran oinak zaintzea (diametroa ≥ 36 zm-ko zuhaitz hostozabalak), baita habia egiteko zuhaitzak ere (≥ 18 cm-ko diametroa dutenak, erortzear edo hilda eta/edo zuloen presentziarekin). Habitat orbanen mailan, dentsitate altuak mantendu beharko lirateke, bai elikatzeko zuhaitzetan (adibidez 65 haritz ≥ 36 zm/ha) baita habitze zuhaitzetan (adibidez 30 zuhaitz potentzial/ha), eta basoaren egituraren heterogeneotasuna mantendu baita ere. Habitat orban suboptimoetan, elementu helduak dituzten harizti gazte trinkoetan, diametro txikiko (< 15 zm) oinen mozketa selektiboak, sastraka mozketak, inausketak eta mantentze-larratzeak etorkizuneko zuhaitzen hazkuntza sustatzen lagun dezakete, epe ertainera habitataren kalitatea hobetuz. Paisaia mailan, gomendagarria da orban handiak babestea, bertako hostozabalen landaketak edo zuhaitz gazteen esku-hartzeak egitea orban txikien tamaina handitzeko eta ertzen gogortasuna murrizteko (hau da, estaldura moten arteko kontrastea perimetroan), baita hostozabalen presentzia sustatzea matrizean (hau da, habitat ez dena) eta banako sakabanatzaileek "*stepping stones*" bezala erabiltzen dituzten habitat orbanak kontserbatzea.

Okil ertainak dauden edo egon daitezkeen basoetan egin beharreko jardueren plangintza, aldez aurretik populazio horrengan izan ditzakeen eraginak aztertuz egin behar da. Garai kritikoa martxotik uztailera da; hortaz, jarduera intentsiboenak, hala nola basoko esku-hartzeak, abuztu eta otsaila bitartean burutzea lehenetsiko da.

Resum

El present document s'ha desenvolupat en el marc del projecte POCTEFA Habios, amb l'objectiu de que serveixi de referència per a gestors, tècnics i científics, per compatibilitzar les activitats forestals amb la conservació del picot garser mitjà (*Dendrocoptes medius*). Aquesta espècie és una especialista de boscos caducifolis madurs, amb gran dependència pels arbres grans, sobretot roures (*Quercus* spp.).

A nivell d'arbre, és fonamental preservar els peus més grans i vells on s'alimenta (caducifolis amb diàmetre ≥ 36 cm), així com els arbres potencials per excavar-hi el niu (amb diàmetre ≥ 18 cm, decadents o morts i/o amb presència de forats). A nivell d'hàbitat, s'han de mantenir elevades densitats d'arbres d'alimentació (ex. 65 roures ≥ 36 cm/ha) i de nidificació (ex. 30 arbres potencials/ha), així com preservar l'heterogeneïtat estructural del bosc. En els hàbitat subòptims, com les rouredes joves denses amb alguns elements madurs, les aclarides selectives de peus de petit diàmetre (< 15 cm), els desbrossaments del matollar, les podes i el pasturatge poden ajudar a fomentar el creixement diametral dels arbres, millorant a mig-llarg termini la qualitat de l'hàbitat. A nivell de paisatge, es recomana preservar els rodals grans; realitzar plantacions de caducifolis autòctons o potenciar intervencions sobre rodals d'arbrat jove per augmentar la mida i reduir l'efecte vora (i el contrast entre tipologies d'estructura i cobertura en el perímetre dels rodals); fomentar la presència de caducifolis i preservar els rodals d'hàbitat utilitzats per individus en dispersió com a "*stepping stones*".

La planificació de les activitats a realitzar en els boscos ocupats pel picot garser mitjà, o amb potencialitat per ser-ho, s'ha de fer sempre tenint en compte de no crear cap acció que pugui repercutir a l'espècie. Es considera període crític el que va de març a juliol; les activitats més intensives, com les intervencions silvícoles, es realitzaran preferentment entre els mesos d'agost i febrer.

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