

ACOUSTIC MANAGEMENT OF NATURAL PARKS: EXPERIENCE IN ARMAÑON PARK

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Summary

Natural Parks are ecosystems of high value and meet functions of biodiversity conservation, in terms of species and also their soundscape.

This paper presents the experience carried out in Armañon Park to integrate variables of noise pollution in the park management tools. The work has two objectives: to prevent biodiversity loss associated with noise interfering natural auditory signals and to enhance the presence of natural sounds as an element of interest to visit the Natural Park.

It takes into account not only the noise from outside the park, by consulting noise maps from traditional sources (road traffic, mainly), but it is specially based on the assessment of the noise associated with the uses and activities developed inside the park.

The experience carried out in Armañon Park addresses the issue from the two necessary perspectives: identification of areas under preservation against noise pollution and analysis of the acoustic impact on those areas caused by uses and activities in the park.

There is a legal framework in the Spanish legislation to define acoustic protection areas (reserve of natural sounds), areas whose sounds are considered subject to preservation for its unique value.

The ultimate goal of the project presented in the paper is to have scientifically justified tools to condition the acoustic behavior of activities (farming, ranching, hunting, recreational, etc.) carried out in the park to preserve its biodiversity.

Therefore, conclusions of the project will be integrated in the administrative tool that defines the general management plan of the Natural park, as additional requirements to the park activities.

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1. Introduction

The County Council of Biscay (hereafter CCB), is the administration responsible for the management of protected natural areas in the historical territory of Bizkaia. The CCB's protection approach for the soundscape is based on the value that the natural sounds has as a function of the natural ecosystems. The approach focuses on protecting two variables:

- To preserve the biodiversity against the noise pollution. The anthropogenic and mechanized sounds that interfere in the natural areas can affect the communication among animal species due to the disturbances that generate in the audible signals that the species make to survive (detection of predators or prey, mating and rearing).
- To allow that the natural sounds be present in the natural parks as cultural function of the ecosystems

considering the enjoyment of visitors. The natural areas have a restoring capacity (from stress) in which sounds play a key role in the framework of the integral environmental experience.

Aiming at fulfilling these objectives, the CCB integrates the abovementioned issues inside the management tools of the natural areas, specifically the "Rector Plan of Use and Management, RPUS". The RPUS establishes the conditions which apply to the different activities inside the park with the aim of preserving its natural value.

The CCB started to handle the soundscapes of natural parks with several analyses that involved an overall assessment of the impact generated by the major sources of environmental noise in the Natural parks. The analysis continued with the development of a case study in the Urkiola natural

park where an inventory of the interesting soundscapes was carried out.

At the time that these analyses were performed, a new law (Decree 213/2012) was approved in the Basque Autonomous Community (BAC) that regulates noise pollution. Regarding the natural areas, the new law set acoustic reference values for natural areas that requires a special protection against the noise (type G areas) and for reserves of natural origin sound (RSO type areas). These protection figures "type G" and "RSO", are linked to areas of nature protection where the minimum acoustic quality requirements must be fulfilled in order to ensure that the natural sounds prevail in these areas.

The work described in the present document was carried out in the "Armañon" natural park located in the west of the historical territory of Biscay, in the region of "Encartaciones". It is important to highlight the natural value of the "Pozalagua caves" located inside the Armañon Park that are the largest underground caves in Europe.

The objective of the work in Armañon was twofold. On the one hand, the identification of the "type G areas" and "RSO" was carried out. On the other hand, the activities with an acoustic relevance that take place inside the park were identified to analyze their acoustic impact in the areas. The final objective is to determine if it is necessary restrict the operation of the activities.

A detailed description of the work carried out in Armañon is presented in the following sections.

2. Methodology

The analysis carried out in the natural park of Armañon involved three main tasks. First of all the zoning map of the park was carried out in order to identify those areas sensitive of require protection against noise, and therefore that need acoustic quality requirements. Secondly, the noisy spots and activities of the park were characterized from their acoustic point of view. Finally, from the combination of both, the areas with conflicts between the acoustic quality requirements and the level of noise generated by certain activities were identified. The aim is setting restrictions for the activities and giving recommendations for the remediation and soundscape preservation.

2.1 Acoustic zonation of the Park

Based on the applicable law in the BAC, the "type g" and "RSO" are noise-sensitive areas that must be protected against noise pollution. The mentioned law sets the following definitions of these areas:

- Type g: : area that is classified as a natural one in the applicable legislation and that requires a protection against acoustic pollution.
- Reserves of natural origin sound (RSO): areas defined inside the Type g zones which sounds must be ported due to their singular cultural or natural value or due to their pureness and clarity over others.

The "type g" and "RSO" are identified in Armañon through the processing of the zoning maps of the RPUS using the Geographical Information System (GIS) and based on the following criteria:

- "Type G": A high extension of the park is classified as type G in order to define a minimum protection against noise. Without this label there would be no type of protection.
- "RSO areas": which require a more protection against noise than the "type g areas", for being the habitat of species sensitive to protect. Regarding the Armañon Park the species to protect are the necrophagous birds (*Neophron percnopterus*) and the bats (Mediterranean Horseshoe bat).

2.2 Acoustic characterization of the sound sources of the park

The acoustic characterization of the noise sources associated with the activities given inside the park has been carried out through the combination of computer works, meetings with the rangers of the park and fieldworks (visits to the park and measurements of the acoustic power of the activities).

The acoustic characterization is given from the results of the measurements of the acoustic power of the activities and depends on:

- Type of activity
- Duration of the activity
- Type of machinery and the number of operation modes
- The application surface

A series of assessment indexes are used for the acoustic characterization which are related to the targeted values of noise that the activities of the

park must fulfill in the areas sensitive to protect. The indexes are the following:

- Indexes that describe the acoustic behavior of the noise emission source: those indexes are evaluated during the acoustic measurement of activities of the park. L_{Aw} , L_{Aeq} and L_{AFmax} .
- Indexes that describe the acoustic impact of the noise emission source: the acoustic quality targets are based in these impact indexes. L_{day} , L_{Aeq30m} : (the worst 30 minutes of the activity from the noise generation point of view) and L_{Aeq1sg} that represents the worst second of the activity also from the noise generation point of view.

The noise emission sources to characterize in the Armañon Park are the following:

- ✓ Logging of "Eucalyptus" and "Pinus pinaster": this activity is performed once every 15-20 years approximately. These logging activities are under authorization of the competent institutions of the park and they usually take place in spring and summer before the nesting of the necrophagous birds.
- ✓ Logging activity: punctual forestry activity associated with the different plantations that take place in variable cycles of time.
- ✓ Mining activity: there is a mine inside the Armañon Park that extracts mineral through blasting.
- ✓ Hunting activity: this activity is under authorization of the competent institutions of the park only during certain period of the year.
- ✓ Paths across the park: there is no limitation in the access to the paths thus there is an attraction for motorcycles and quads.

- ✓ Parking and visitor activities in the area of Pozalagua caves: This is a small area that can concentrate more than 300 people in the most crowded days.

Those activities have noise restrictions where they take place in the "type g" and RSON areas.

3. Results

3.1 "Type g" and RSON areas in Armañon park

According to the methodology described in the previous section, the "type G" and RSON areas in the Armañon Park are the following:

"Type g" areas in Armañon Park:

The "type g" areas is presented in the figure 1, and involves the entire park except the reception parking of the Pozalagua caves and the corresponding access road that is out of the limit of the park.

The RSON areas in the Armañon Park are indicated in the map of the Figure 2 and involve: important areas for bats, forestry areas, interesting areas for birds, wetlands and plants community

Note that every RSON areas are also "type g" because the first ones are more restrictive.

Regarding the nesting spots of alimoche (necrophagous birds), a radio of 100 meters surrounding the nest is considered RSON area. Due to the alimoche is noise-sensitive species and it is target to protect, acoustic restrictions are applicable in the periods of mating and calving.



Figure 1: The "type g" areas in the Armañon Park (on the right) and location of the Pozalagua caves and the access road that that are out of the "type G" classification

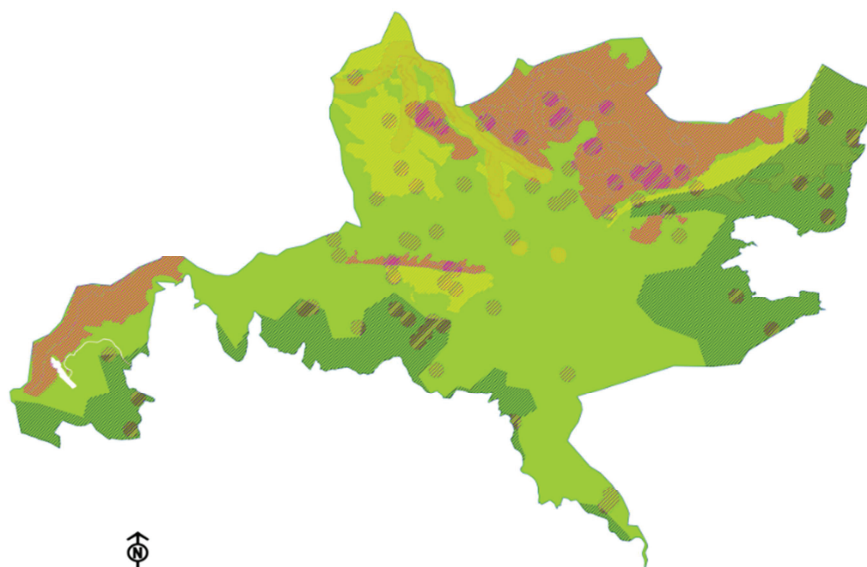


Figure 2: Location of “type g” (green areas) and RSON (rest of detailed areas) areas in the Park of Armañon.

3.2 Acoustic conditioning of the noise emission sources of the Armañon park (example of the logging of Eukaliptus)

Acoustic modeling tools similar to those used for the preparation of noise maps were the ones used in Armañon to assess the noise level of the activities in the Park. The example applied to the logging activity of Eukaliptus is described in this section that includes the measurement of noise level and the acoustic conditioning for the activity in order to prevent the impact. This activity is selected for submission because forestry is one of the activities with bigger potential to generate acoustic impact and besides it is representative of the activities given in the park that need to be developed for economic sustainability of the Park.

A- Acoustic measurement for the characterization of the operation model of the logging of Eukaliptus:

- Chainsaw: It takes ten seconds to cut a tree and it has a L_{Aw} of 108 dBA
- Processing machine: It collects the trees for removing the branches and the bark. It also cuts the trunk into pieces. The worst value of L_{Aw} is 112 dBA.
- Autoloader machine: It makes the loading and unloading of the trunks for their transportation from the logging spot to the main path. The worst value of L_{Aw} 93 dBA.

B- Modeling the logging activity

Acoustic software was used for modeling the surfaces to be logged including the noise-emission sources described in section A in their different operation modes and their area of application.

The operation is divided into days of activity considering the surface harvested in an entire day and the activity of every machine involved related to operation time of each of them.

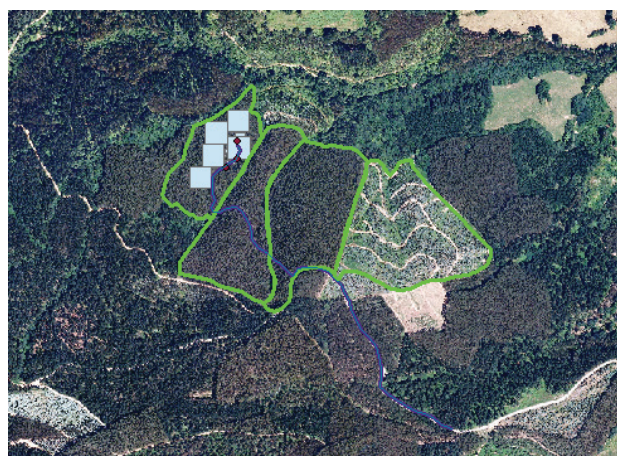


Figure 3: Area of application of the noise-emission sources (in blue) for the five days of harvested activity duration. The standard size of the logged plot is represented in green.

C- Results of the acoustic modeling

The acoustic modeling allows representing the indexes (explained in section 2.2) to verify the

potential acoustic impacts of the logging activity: L_{day} , $L_{Aeq30min}$ and $L_{Aeq1sec}$.

The results obtained for the standard logging activity are presented below:

Verification of compliance with the L_{day} .

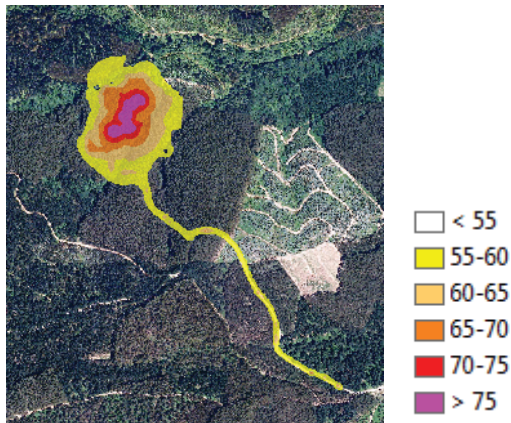


Figure 4: Logging activity- results of L_{day} , average of the period of activity (dBA)

As reflected in figure 4, the noise level outside the area of the logging is 75dBA which is generated 365 days per year. Thus, the L_{day} , average of the period of activity is 56 dBA which fulfills the noise condition in this area due to the value is lower than 60 dBA.

Verification of compliance with $L_{Aeq30minutes}$.

The blue area in figure 5 represents the surface with a value of $L_{Aeq 30 minutes}$ above 65 dBA that is the threshold set in the RSON areas for this type of activities.



Figure 5: Logging activity - results of $L_{Aeq 30min}$

According to this threshold, the logging activity should not generate a $LA_{eq 30 minutes}$ above 65dBA if the activity will take place in a RSON area. In this case, the logging activity takes place inside a RSON area therefore the threshold is not fulfilled.

Verification of compliance with $L_{Aeq1sec}$

The blue area in Figure 6 represents the surface with a value of $LA_{eq 1sg}$ above 75 dBA that is the threshold set in the RSON areas for this type of activities.

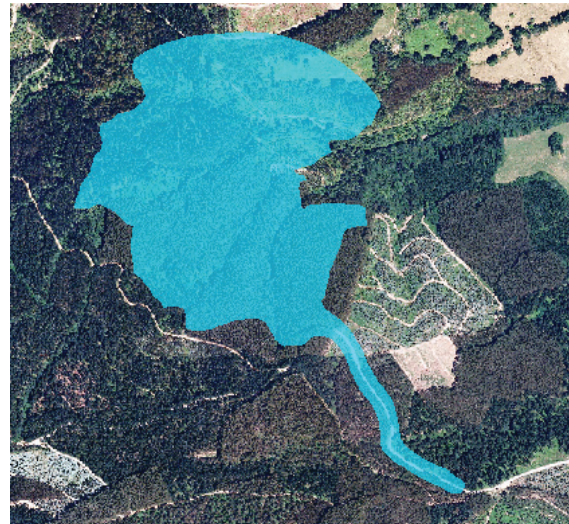


Figure 6: Logging activity - results of $L_{Aeq 1sec}$ (for the worst second of noise level of the activity)

According to this threshold, the logging activity should not generate a $LA_{eq 1sec}$ above 75dBA if the activity will take place in a RSON area. In this case, the logging activity takes place inside a RSON area therefore the threshold is not fulfilled.

The verification of compliance of those indexes can be extrapolated to the development of the activity and besides the following conclusions are obtained:

- The logging activity analyzed in the Armañon Park fulfills the level of L_{day} . According to the acoustic modeling performed in this case study it can be assumed that a logging activity similar to the one analyzed (similar in terms of operation time and machinery) could be carried out until 11 days per year without non-compliance of this parameter.
- The logging analyzed does not fulfill the $L_{Aeq 30 min}$ neither the $L_{Aeq 1sec}$. One reason of the non-compliance of these parameters is due to the activity takes places in a RSON area. When a non-compliance was detected it would be necessary to determine if the restrictions is temporal. That is, if the specie that originates the RSON zoning is sensitive to noise in that period of time. Thus, the restrictions can be temporal and the logging activities can be allowed in certain periods of the year when the sensitive species will not be affected.

- Regarding the "RSON areas" the most restrictive parameter is the $L_{Aeq1 sec}$ due to it can affect in the long distance. In this case study the maximum distance is 280 meters. The distance will depend on the acoustic characteristics of the activity and the orography of the area because has an influence in the propagation of sound.

4. Conclusions and future steps

The work performed in the Armañon Park allows identifying the acoustic impact of the typical activities that take place in Natural parks: forestry, hunting, recreate, etc. Thus, it is set operational conditions to these activities aiming at not just maintaining the economic activities of the Park but also preserving the biodiversity against noise.

The current work has provided the framework to integrate the acoustic variable within the management tools of the Park. The project provides information to the competent bodies to allow or impose restrictions to the activities. The following steps provide the framework to assess noise impact in natural parks and to identify possible restrictions and conditions if are required:

Step 1: Define if the activity will take place inside or near a RSON area

If the activity will take place inside or near (less than 300 meters) a RSON area it would be necessary to analyze the reasons for the RSON declaration: the noise-sensitive species and the period of the year for their protection.

Step 2: Assessment of the acoustic impact of the activity (if the step 1 is confirmed):

The aim is to assess the acoustic impact using modeling tools to determine if the activity fulfills the applicable acoustic limits.

Step 3: Acoustic conditioning for the exercise of the activity (applicable if the reference values are not fulfilled in step2).

The acoustic conditions can be: seasonal restrictions (schedule or period of the year), machinery restrictions (low noise-emission machines), operation conditions (number of machines operating, number of workers simultaneously) etc.

The described framework is applicable to those activities that can suffer variations of operation such as forestry and recreational which must be authorized by the competent body of the park.

Finally, the CCB is thinking about future steps of development with a twofold objective:

- Gathering more information about the noise impact in certain target species of Armañon Park such as necrophagous birds and bats.
- Applying the work and the framework of Armañon to other natural parks of the territory with the aim of reaching a compromise between the economic development of the Natural Parks and the biodiversity protection against noise.

Acknowledgement

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