HERAMBIENTE FOR BIODIVERSITY

BIODIVERSITY MONITORING AND CONSERVATION STUDIES

Winning drawing of the Herambiente 2020 Biodiversity Competition

HERAmbiente

The environmentally unsustainable path of economic growth in recent decades has inevitably triggered two major problems that today's society is facing: climate change and loss of biodiversity. Human activities have transformed ecosystems with such unprecedented speed and intensity that scientists have given a name to the new era that has begun: the Anthropocene. The intense modification of the territory has led to an inexorable loss of biodiversity, understood as the variety of genes, species and ecosystems. A turnaround to be implemented with a view to economic development that takes account of the importance of correct and sustainable spatial planning is the only solution. This establishes the importance of placing the environmental issue on the world political agenda. In its Biodiversity Strategy 2030, Europe defines biodiversity as an "*essential ally in the fight against climate change*". Within the vision of Circular Economy and the creation of shared value in which Herambiente works to "regenerate natural resources and close the circle", the Group implements a series of activities and projects that respond to the achievement of the sustainable development goals defined by the 2030 Agenda of the United Nations, which include the sustainable management of water resources, and the protection of air, soil, and biodiversity. Herambiente is committed to biomonitoring and environmental redevelopment projects in the areas affected by its facilities in order to contribute to the analysis of the environmental context of each plant site and monitor any effects on the environment and species diversity. The distribution of Herambiente productive units in many Italian regions precludes adherence in a single project. At the same time however, this ensures the development of specific projects for diversified environmental monitoring throughout the territory (*Figure 1*). This certainly amounts to a strength of Herambiente Group, which has proven capable of enacting individual projects in the immediate vicinity of sensitive areas. The Herambiente commitment also to the vital question of sustainable resource management is reinforced by collaboration with local institutions, universities and non-profit associations in the environmental field in synergy with qualified personnel and the Regional Agency for Prevention, Environment and Energy of Emilia-Romagna - ARPAE.

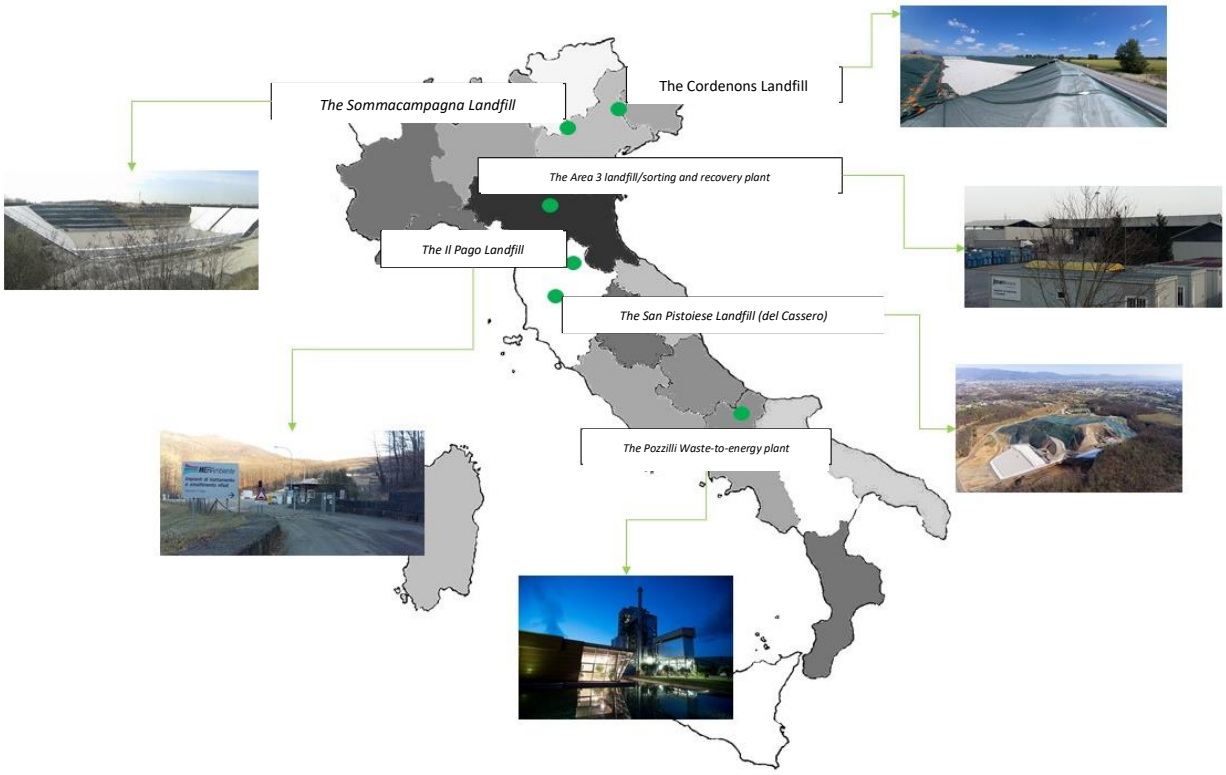

Figure 1 Herambiente productive units in which biodiversity conservation projects have been launched

Considering how crucial the creation of environmental awareness is to sustainable economic development, this report provides an update on the progress of Herambiente's environmental monitoring and redevelopment projects. The report regards six important projects in particular:

1) The environmental redevelopment project at Cordenons Landfill (Pordenone)
2) The "*Capiamo"* (Let's understand) project at the Pozzilli Waste-to-energy Plant (Isernia) to biomonitor bees and their products
3) The monitoring of biocenosis indicators to assess the environmental impact of the expansion of the Firenzuola landfill in Il Pago (Firenze)
4) The monitoring of birdlife at the Sommacampagna landfill (Verona)
5) The concession of the fenced-off area at the "Centro Fauna Selvatica il Pettirosso" (Pettirosso Wildlife Centre) near the Group's Area 3 complex in Modena
6) Biological monitoring of air quality with epiphytic lichens at the Serravalle Pistoiese and Cassero landfills (Pistoia)

These are mainly biomonitoring studies that provide a valid control instrument in assessing the effects of pollution through the use of particularly sensitive living organisms (animal, plant or fungi species) that give early warning of imbalances that are dangerous for biodiversity and human health. From a methodological point of view, biomonitoring techniques are divided into two types: bioindication techniques, in which organisms sensitive to exposure to certain pollutants are used (bioindicators) and bioaccumulation techniques, in which organisms capable of accumulating pollutants well beyond their physiological needs are used (bioaccumulators).
In addition to biomonitoring, the projects carried out also provided for redevelopment and environmental improvement actions in areas close to plant sites. The projects mentioned above and the results obtained up to the most recent monitoring are described below.

CONTENTS

1 PROJECTS

1.1 THE ENVIRONMENTAL IMPROVEMENT OF CORDENONS LANDFILL

The Cordenons landfill inaugurated in 2019 is a landfill for non-hazardous waste in the town of Vinchiaruzzo, an agricultural area in the province of Pordenone. The environmental improvement area lies within the Special Protection Zone "**Magredi di Pordenone**" and the Special Conservation Zone "**Risorgive del Vinchiaruzzo**" (*Figure 2*).

Figure 2 The environmental improvement area near Cordenons landfill (Pordenone)

This area of particular naturalistic value has largely suffered the effects of intensive agriculture, which has altered the ecological factors required for its conservation. In order to conserve and enhance the area's natural characteristics, working with the Cordenons Nature Association, Herambiente has defined a nine-year environmental improvement project (from 2020 to 2028) with the aim of restoring the original state of the area by stopping all forms of cultivation (currently affecting 58%), launching actions aimed at rebuilding the habitats of greatest naturalistic value and native flora development, and limiting the introduction of species from outside (*ex situ*) in order to improve the proliferation of species already present (*in situ*). Within the area, a path for visitors called the **Arnèr Trail** was inaugurated with indications of the points of greatest natural interest.

The areas covered by the Arnèr Trail are part of the ecological network called "Natura 2000", which guarantees the protection of European biodiversity as habitats and species of Community interest

The interventions aimed at achieving the objectives of the project are implemented in three phases. The first phase (**preparatory phase**) aims to reduce the nutrient content in the soil and the coverage for invasive species, while envisioning the conversion of land from uncultivated land to grazing land. The second phase

(**redevelopment interventions**) aims to create satisfactory conditions from a naturalistic point of view. The details of the redevelopment actions planned are as follows:

- Routine mowing of lawns
- Skimming of peat bogs
- Mowing under foliage (mowing of herbaceous vegetation in favour of arboreal vegetation)
- Scrubbing of bogs to restore the original surface to the meadow
- Selective and progressive cutting of the alien flora aimed at eliminating foreign tree species from the wooded vegetation (mainly plane trees)
- Restoration of springs dammed or altered in other ways by humans

The third phase (**restoration of the natural environment**) regards interventions in uncultivated land in order to expand coverage of cladium mariscus beds and alders after monitoring has detected reductions in invasive flora and nutrient demands. A wetland will be created in the remaining part of the remaining uncultivated land. Foresting will be implemented to promote the spontaneous advance of trees and shrubs (*Figure 3*).

Figure 3 Development of environmental improvement activities

The project aims at long-term environmental restoration; hence, the redevelopment interventions have been accompanied by a continuous and widespread monitoring activity for their correct implementation. The monitoring plan permits verification of the gap between the natural state effectively reached and the result expected, the orientation of restoration interventions based on the results of the monitoring, and the

*The methodology for monitoring involves using **bioindicators**, living organisms that inhabit the analysis area and possess certain sensitivity to the parameter investigated*

stability of the plant communities that characterize different habitats.

The progress of the work will be checked by the monitoring plan and Annual Technical Reports. The preparatory phase was completed in 2020, and five of the six interventions of the project's second phase

planned for the 2020/2022 three-year period have been launched. In this first year of activity, 8.57 hectares were redeveloped as described above against the 7 hectare area occupied by the landfill.

1.2 BIOMONITORING OF BEES AT THE POZZILLI WASTE-TO-ENERGY PLANT

Figure 4 Logo of the "Capiamo" project and Waste-to-energy plant in Pozzilli (IS)

In 2020, Herambiente launched an innovative biomonitoring project at the Pozzilli waste-to-energy plant (IS) in order to continue the analysis of the surrounding environment and any impacts exerted by the plant (*Figure 4*).

Figure 5 The bees of the "Capiamo" project

Named "Capiamo", the project aims to use bees as bio-indicators in assessing the quality of the environment. Bees have characteristics particularly suited to biomonitoring; they are highly sensitive to environmental changes caused by pollutants and therefore provide early warning of the onset of imbalances for biodiversity, the ecosystem, and human health in general, thus allowing timely planning of corrective actions. They are social insects that live in numerous colonies and are easy to breed. Their hair-covered bodies and regular storage activities (collecting nectar and pollen) allow individual colonies to make around 10,000 daily withdrawals from the air, water and soil with which they come into contact (*Figure 5*). On its daily migrations, a single bee normally covers an area of 7 km^2 and is exposed to all the chemical pollutants present in the elements in which it comes into contact. The substances that accumulate inside the hive, on the bees and their products (honey, propolis, wax, pollen and royal jelly) make it quick and easy to recover highly representative samples for analysis.

Figure 6 Bees and their products: honey and wax

The bee as a bioindicator offers much useful information in both the short and long term: honey, for example, allows us to evaluate pollution in the short term because it is the first product in which contaminants can accumulate; wax, on the other hand, allows us to evaluate the levels of pollution in the long term because due to its lipid nature it can absorb and retain non-volatile, lipophilic and persistent contaminants (*Figure 6*).

In the spring of 2020, three hives with an estimated total of 300,000 bees were installed (*Figure 7*) within the Waste-to-energy plant's perimeter in order to monitor the area constituted by the eastern side of Piana di Venafro between the Meta and the Matese Hills, where in addition to the plant chemical sector companies, private healthcare providers, abandoned construction sites, and small inhabited agricultural centres are located.

Figure 7 The hives installed

The project includes two annual sampling and analysis campaigns on the bee population of the three hives and their products, as well as medical and veterinary checks to verify their health and productivity, limit swarming phenomena, and place and remove the honeycombs. Samples collected from hives (bees, honey and wax) are subjected to chemical analysis in accredited laboratories using certified methods. The information obtained enables the knowledge and quantification of the possible effects of the impact of human activities on the environment.

The first results obtained, which will be the subject of further study, show an overall good state of environmental quality. With regard to anions (chlorides, sulphates and nitrates), their presence in the honey harvested is in line with the average values of honey of Italian origin. The substantial absence of dioxins, polychlorinated biphenyls (PCBs) and pesticides was found, whereas analyses of the polycyclic aromatic hydrocarbons (PAHs) that have the combustion of fossil fuels, waste incineration, energy production or asphalt and chemical products as their main source show an environmental condition to which several emission sources typical of the anthropization of the territory (such as traffic, industry and domestic biomass heating) contribute without any significant impact from the Waste-to-energy plant. The metals present can also be ascribed to the presence of abandoned construction sites, industries and infrastructures but also to the orographic characteristics of the territory characterized by the presence of marl and dolomite. Ultimately, the results show that the substances sought are often below the level of detection, and that there is no specific influence from the Waste-to-energy plant. The "Capiamo"

project continues with the support and collaboration of a veterinary doctor with experience in the field of monitoring, and bees, in particular.

1.3 MONITORING OF BIOCENOSIS AT THE FIRENZUOLA LANDFILL

Figure 8 landfill

The "Il Pago" landfill for non-hazardous waste is located in the municipality of Firenzuola (FI). Following the approval of the expansion landfill with the construction of a new lot, Herambiente deemed launching a project to monitor the **biocenosis** indicative of environmental changes in the area affected by such expansion appropriate *(Figure 8* landfill).

***Biocenosis**: community of species of an ecosystem that inhabits certain environment*

The species covered by the monitoring programme are **crustaceans, amphibians, and birds**. With regard to crustaceans and amphibians, the detection methods proposed comply with those indicated in the Manual of the Ministry of the Environment 141/2016. For Birds (not included in the manual above), appropriate methods standardized at national and European level have been performed.

The results collected since 2018, albeit partial, have nevertheless enabled the construction of a basic cognitive framework useful for subsequent investigations. Monitoring began in 2019 with a survey of amphibians and birds in spring and crustaceans in summer, and ended in autumn with the monitoring of amphibians. Despite the health emergency in progress in 2020, proceedings advanced in accordance with the monitoring plan's timeline. The following considerations can be made in regard to the groups studied:

CRUSTACEANS

Figure River shrimp

Surveys focused on the only species present, **river shrimp**, and the environmental conditions of watercourses potentially able to support viable shrimp populations (*Figure*). Thanks to the exploratory surveys carried out in previous years and during 2020, 6 watercourses were identified with characteristics suitable for the presence of shrimp. The data collected in 2020 confirms findings made in 2018 and 2019: the absence of the species in the watercourses immediately near the landfill and its presence in two direct tributaries of the Santerno River. It could be that the absence of the river shrimp is due to the fact that this crustacean is out of natural distribution range here more than local environmental conditions; this is supported by the study conducted simultaneously to verify the ecological characteristics of the watercourses that have shown unaltered conditions.

AMPHIBIANS

The surveys were conducted in the rainwater collection pond located within the perimeter of the landfill (*Figure 9* pond). This small pond is characterized by permanent water, absence of fish, and a fair presence of vegetation, which has allowed the proliferation of 4 species of amphibian, the presence of 2 reptiles, and various species of insects, including at least 4 species of dragonfly. These results testify to the importance of also these small environments in preserving the biodiversity of these animals. Two ponds with characteristics similar to the one inside the landfill were identified in the areas adjacent to the landfill. The species of particular interest detected here are the smooth newt *(Lissotriton vulgaris)* and the northern spectacled salamander *(Salamandrina perspicillata)*.

Figure 9 pond

The potential of the different basins for the reproduction of the species is reconfirmed, especially with regard to the endemism of the northern spectacled salamander, and therefore also the potential of the watercourses, given that this species is found in environments with good quality waters. In general, there is a certain success in terms of the presence and reproduction of the crested newt. The presence of the smooth newt, a species now well established in the ponds outside the landfill and in the landfill pond, appears significant.

BIRDS

Although community descriptor indexes and comparisons between years and areas (the IL Page landfill and the control area) indicate slight differences, they are not significant; reference must necessarily be made to the analysis of future dynamics in which the time factor is the determinant element in bringing out more ingrained differences in biocenosis.

Daytime investigations resulted in the observance of 6 species: the European honey buzzard, the short-toed snake eagle, the Montagu's harrier, the Eurasian sparrowhawk, the common buzzard, and the kestrel, all possibly nesting and some of extreme biogeographical interest, such as the short-toed snake eagle. Observations in 2020 confirmed some of the findings of previous years, and the continuation of the research will either confirm or refute the stable presence of the species both as nesting area and hunting or transit areas.

As regards nocturnal raptors, the tawny owl showed an increase in territories defended with a presence also at a station in which it had so far been absent. The common owl, on the other hand, despite several areas showing favourable characteristics, did not appear in 2020; the continuation of the research will investigate this aspect in greater depth by applying further approaches to detect the species.

1.4 MONITORING OF BIRDLIFE AT THE SOMMACAMPAGNA LANDFILL

Figure 10 landfill

Herambiente monitors the **avifauna** at the landfill located in "Siberie" in the municipality of Sommacampagna and near the Valerio Catullo airport in Verona (*Figure 10* landfill) every three months. Although the ultimate purpose of monitoring is a regular and objective assessment of the potential risk of air traffic, Herambiente also provides an up-to-date and detailed picture of the state of avifauna around the landfill. During the first quarter (July 2019 – September 2019), the presence of groups of Laridae identified as **European herring gulls** was observed at the front of the landfill area. The presence of the same species was found in the months of October and November 2019, whereas no species of bird were identified in the month of December. The same observations were made in the subsequent monitoring quarters until October 2020.

The results of daily monitoring in 2019 by Herambiente staff and the inspections carried out showed *Laridae* as the group of birds surveyed from the point of view of the potential risk of bird strike due to their medium-large size and their opportunistic eating habits. It is important to note that their presence at the Sommacampagna landfill is not significant from a quantitative point of view and it is thus believed that the methods of landfill management complied with the objective of containing the risk of bird strike phenomena during the reference period (July 2019 – October 2020) at the nearby airport structure.

1.5 CONCESSION OF AN AREA FOR THE RECOVERY OF INJURED ANIMALS TO THE PETTIROSSO WILDLIFE CENTRE

Herambiente has been cooperating since 2014 with the **Pettirosso Wildlife Centre,** to which it has reserved a fenced-off area at the Area 3 complex in Modena for the recovery of injured animals. Area 3 consists of an exhausted landfill and a plant for waste sorting, storage, processing, and recovery in the municipality of Modena in a territory mainly characterized by land for agricultural use and scattered houses with a low density of inhabitation.

The Pettirosso Wildlife Centre rescues and protects the territory's injured or struggling wildlife, supports the institutions and police forces in recovering and managing wildlife, and takes initiatives in training and information on wildlife for better coexistence and potential integration as a result. The Centre intervenes during earthquakes, floods, heavy snowfall and much more, supported by a group of highly-trained volunteers equipped for any emergency. Thousands of animals saved in this way at every hour of day and night and given a second chance at life. The facilities vaunting innovative design feature outdoor and indoor hospital areas, an infirmary equipped for X-rays, endoscopy and ultrasound diagnosis, a nursery, and many structures designed for every species of wildlife, all monitored by 24-hour cameras. The animals await release in 3 wetlands and rehabilitation and re-environmental areas.

To date, the Wildlife Recovery Centre houses **5 Eurasian lynxes** in the enclosure provided by Herambiente covering a total of 1.3 hectares. The specimens come from European species conservation projects. In 2020, 4 hives were added (which will become 8 in 2021) for the production of organic honey under the agreement with the Municipality of Modena for the recovery of bee swarms in public areas of the city for which a quarantine period will be provided before they are placed inside hives on the slopes of the plant area currently managed by the "Il Pettirosso" Centre.

1.6 BIOLOGICAL MONITORING OF AIR QUALITY WITH EPIPHYTIC LICHENS AT THE SERRAVALLE PISTOIESE LANDFILL

*Figure 11*landfill

Working with the University of Siena and the University of Pisa in 2020, Herambiente started the eighth biological monitoring of air quality with epiphytic lichens to continue the control activity on the environment surrounding the Serravalle Pistoiese landfill known as the Cassero landfill (*Figure 11landfill*). In particular, the University of Siena studied the bioaccumulation of *Flavoparmelia caperata* in stalks*,* whereas the University of Pisa focused its study on lichen biodiversity. These surveys are a follow-up to the studies carried out by

ARPAT in 1996 and 2000 and the five studies already carried out every two years from 2008 to 2018 after the approval of the project to expand the landfill as a tool to keep the area in question under control.

Surveys conducted since 1996 by ARPAT in the territory concerned using bio-indicators have enabled the assessment over time and space of any potential biological effects of the plant's management. In 2008, after 12 years of plant management, Herambiente carried out a new biomonitoring study using lichens, which integrated the stations previously monitored by ARPAT with new sampling stations located in the immediate vicinity of the plant, thus representing the new zero point in relation to the site's expansion.

Lichens *are fungi that live in symbiosis with green algae or cyanobacteria and are essentially dependent on the atmosphere for their water and nutrient intake.*

Lichens are capable of growing everywhere and accumulating substances far beyond their physiological needs. These peculiarities make lichens suitable for use as biological indicators of air pollution. The most tolerant species are used as bioaccumulators of pollutants in the atmosphere, while the most sensitive species tend to disappear in the presence of high concentrations of contaminants. Lichen biomonitoring takes the form of the production of biological data, such as biodiversity measures, physiological or genetic responses and measures of concentrations of elements in organisms. This type of study makes it possible to obtain a high density of sampling points and to integrate the results with precise measurements of chemical-physical type, thus providing a more complete interpretation of an area's air pollution.

The purpose of both lichen studies is to:

- Assess the environmental condition of the area affected by the presence of the landfill through the Biodiversity Index of epiphytic lichens
- Compare the results with the studies carried out up to 2018 to assess any changes in air quality that have occurred

The bioaccumulation study was carried out according to standardized procedures in 28 monitoring stations in which the depositions of a selection of elements (As, Cd, Cr, Cu, Fe, Ni, Pb, Zn) of environmental relevance and toxicological interest in *Flavoparmelia caperat*a lichen thallus were analysed. The collection *of Flavoparmelia caperata* was conducted in the period between mid-May and mid-June 2020 in good weather conditions and a few days after precipitation events. The results were interpreted in the light of the scale published by ISPRA - the Italian Institute for Environmental Protection and Research - in the guidelines for bioaccumulation through epiphytic lichens in Italy. A comparison of the values of each element analysed with those measured from 2008 to 2018 shows the following.
The mean levels of lead (Pb) and cadmium (Cd) have remained substantially unchanged and fall within the high natural range. The copper (Cu) data confirms the values observed in previous years that fall within the average natural range. The values of chromium (Cr), iron (Fe) and nickel (Ni) fall into the low natural range, confirming findings in the previous biomonitoring campaign. The values of zinc (Zn) and arsenic (As) undergo a decrease in their depositions from 2018 to 2020, thus falling within a high natural range. Copper (Cu) values show a slight increase in deposit from 2008 to 2020.

The lichen biodiversity study provided involved samplings from 36 total stations between June and September 2020. As in previous years, checks were conducted in the sampling stations to verify suitability for sampling and led to the exclusion and replacement of some stations with others. A standard sampling grid positioned on the trunk of the trees considered suitable was used for the detection of the Lichen Biodiversity Index (LBI). Each lichen species is counted only once for each of the meshes of the screen in which it is placed. Lichen species were identified in the field or in the laboratory whenever field identification

was uncertain. Ecological indicators were subsequently calculated because the presence and distribution of each lichen species is influenced by ecological factors that must be taken into account (substrate pH, solar radiation, aridity, and eutrophication).

The results of the lichen biodiversity study carried out in 2020 confirmed a situation of semi-naturality (LBI representing a low level of alteration) for the stations furthest from the plant, while the stations directly overlooking the plant show a condition of semi-alteration of the LBI. For the future continuation of the study however, new guidelines that also consider the uncertainties of measurement will be followed in order to provide a more reliable estimate of the level of contamination of the area under investigation.

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