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HUMANITA

D2.2.1 Report on testing and data collection

Appennino Tosco-Emiliano National Park

Version 2

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PILOT ACTIONS – TESTING PHASE

PROJECT PARTNER: PNATE, UNIPR.

LOCATION: Appennino Tosco-Emiliano National Park

PILOT SITES: Pietra di Bismantova, Alta Val Parma, Mount Cusna, Fonti di Poiano

PILOT ACTIONS: Development, implementation, and assessment of different approaches aimed at monitoring the impact of tourists on the protected areas within the Appennino Tosco-Emiliano National Park

VISITORS MONITORING

STARTING DATE

The date when field monitoring and data collection started: **01/08/2024**

METHODOLOGY DESCRIPTION

The aim of monitoring is to quantify the number of tourists who visit the area of Pietra di Bismantova, the Fonti di Poiano in the area of the Triassic Gypsum, the area of Lama Lite and the Alta Val Parma forest in particular on the path that from Lago Santo Parmense leads to the ridge. Another objective is to qualify and quantify the means by which tourists mainly visit the area (on foot, by bicycle, on horseback, by motorbike or by car) also to detect access to unauthorised areas with unauthorised methods, such as the use of bicycles and e-bikes on the top of Pietra di Bismantova, access with motorised vehicles in the area of Lama Lite Monte Cusna.

- PNATE used the equipment as follows:
- 10 camera traps, model Guard Micro 2 with the following settings:
  - Video mode
  - Video length 5 seconds
  - Video size 640 x 480 pixel
  - Work period off (activated 24/24h)
- The camera traps have been equipped with 128GB SD cards and 12V/2.9A external batteries.

Fig. 1 - Camera traps

- 11 infrared visitor counters model SMARTCHECK Microlog: CWR double infrared beam people counting devices; each device consists of a projector and a receiver device, powered by batteries, mounted on columns. It uses the interruption of a double infrared beam, therefore it can perform bidirectional counting, both incoming and outgoing, and thanks to an internal clock, it automatically resets itself at a time set for the change of day.

Fig. 2 - Infrared people counters.

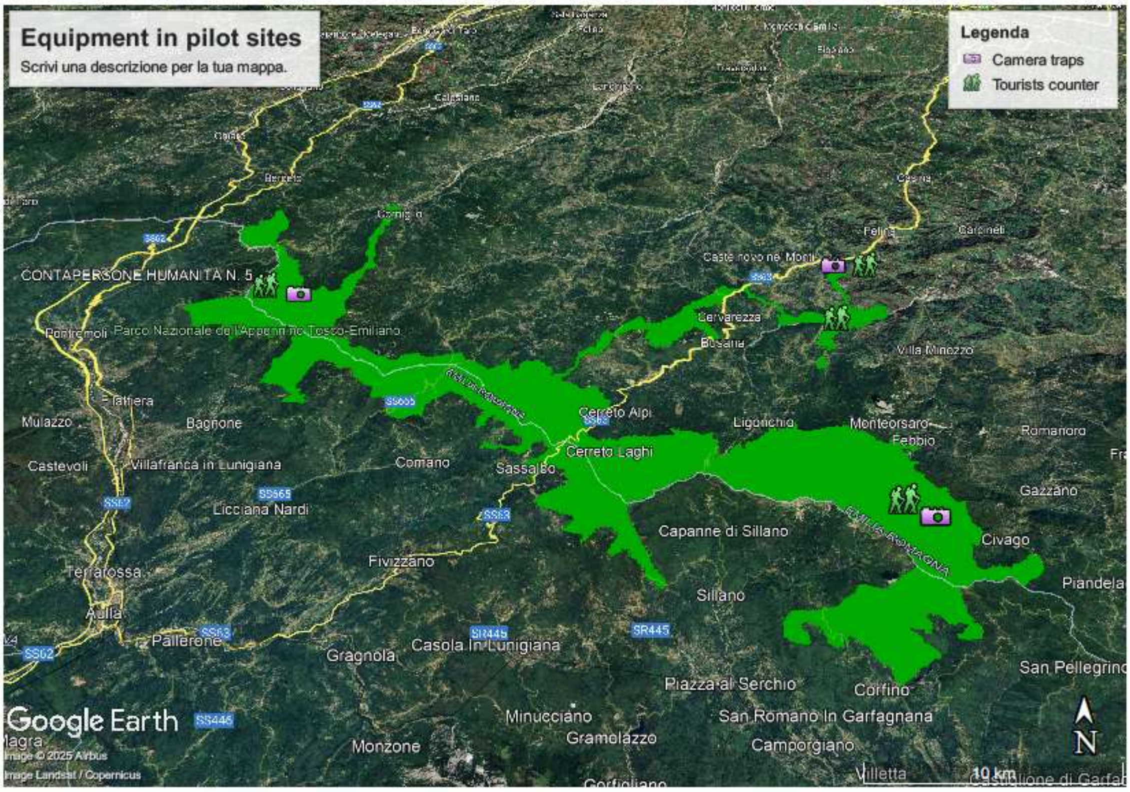


Fig. 3 - Equipment distribution in PNATE.

- **Camera traps**:

- at the Lama Lite site along trail 615, before the junction with trail 629 leading to Il Passone, mounted on trees at height to prevent vandalism and provide better visibility of the trail section;
- in the Alta Val Parma forest: near the refuge along CAI trail 723 skirting Lago Santo and after the junction with CAI trail 729 coming from the Lago Padre bog and before the 723–719 trail junctions leading to Monte Aquila and Monte Marmagna, close to the site where UNIPR monitors root erosion;
- at the Pietra di Bismantova site: along the main trail leading to the summit (697) and on the initial section of the same summit trail; between the traps there is a network of paths leading to various points of interest or forming loops frequently used by visitors;

People counters:

- at the Fonti di Poiano site: one at the main entrance and two at secondary entrances. Although only a few meters apart, these entrances are used differently by visitors depending on where they parked their cars. Note: the main entrance device malfunctioned and the data in summer 2024 were not complete;
- 1 device at the Lama Lite site, installed with a wooden pole structure and cemented along trail 615 after the junction leading to Il Passone; it was removed during the winter months to prevent snow damage and reinstalled later.
- 5 devices in the Alta Val Parma site, placed between the junction with the panoramic trail (723A) and the charcoal trail (723B), near the Lago Santo shores, and at the entrances of the State Forest. Poles installed by the company.
- 2 devices at the Pietra di Bismantova site, near the refuge along the main trail 697 leading to the summit and on the other trail leading to the summit of Bismantova. Poles installed by the company.

In all sites, poles were installed by the company to ensure stability and correct device alignment.

RESULTS AND OBSERVATIONS

In August 2024, 2356 videos by camera traps in Alta Val Parma pilot site, 790 videos in Lama Lite pilot site, 785 videos in Bismantova pilot site were collected.

At the moment, September 2025, the total number of files collected from the camera traps is **117,951**, divided as follows:

- **60,173** from the camera traps at the Alta Val Parma site
- **10,390** from the camera traps at Lama Lite
- **47,388** from the camera traps at Pietra di Bismantova

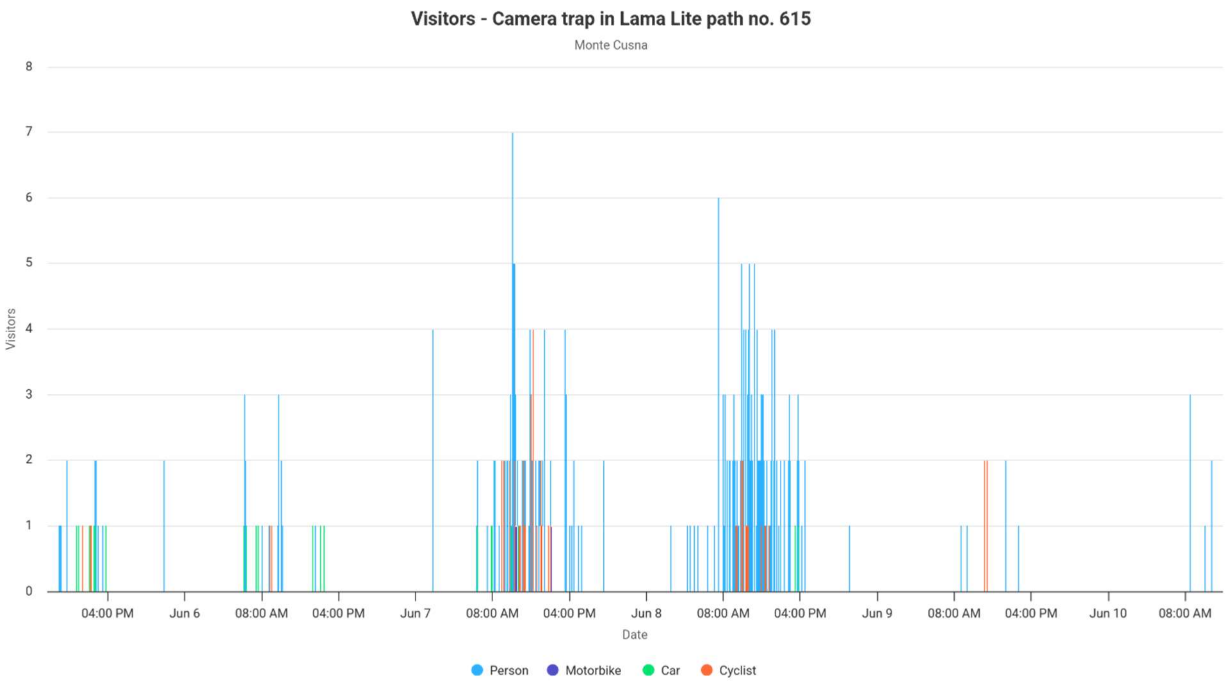


Fig. 4 - Sample data derived from analyzing camera-trap videos in the Mount Cusna pilot site.

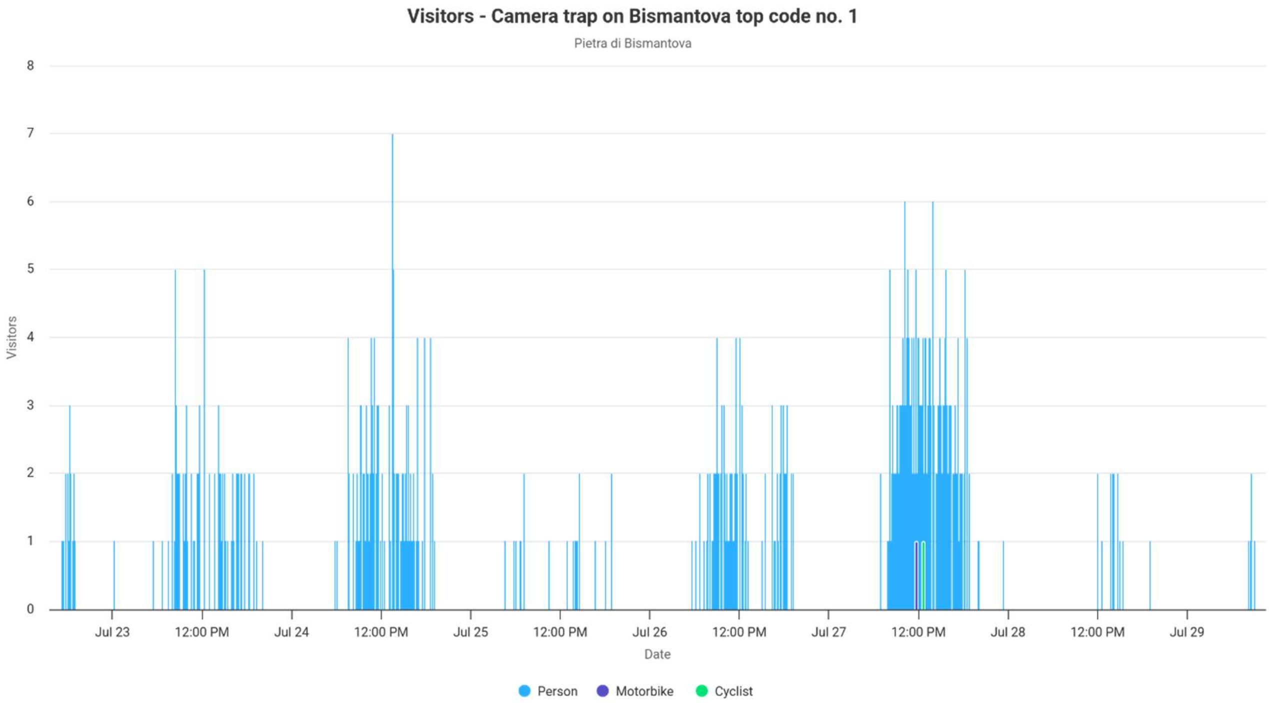
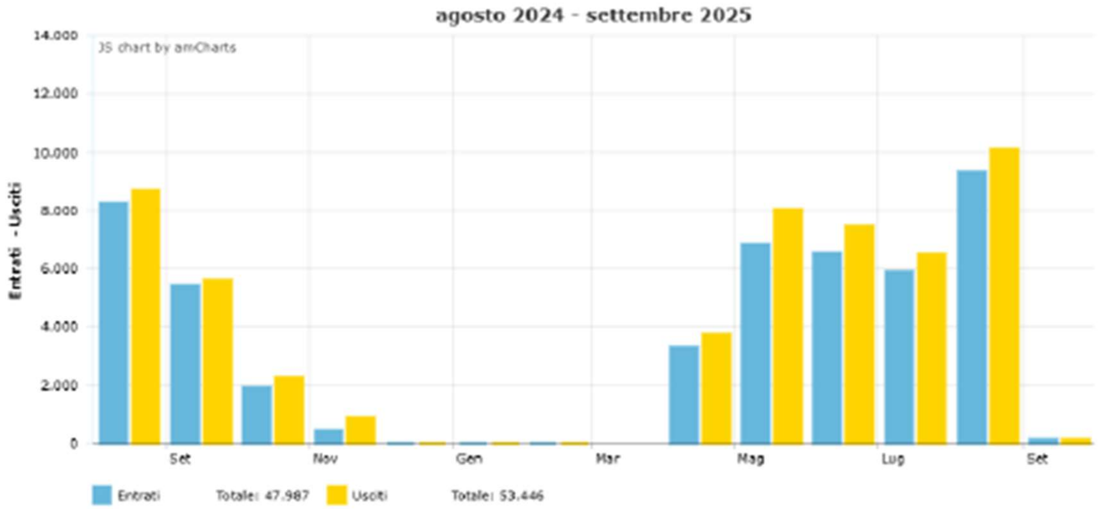


Fig. 5 Sample data derived from analyzing camera-trap videos in the Pietra di Bismantova pilot site.

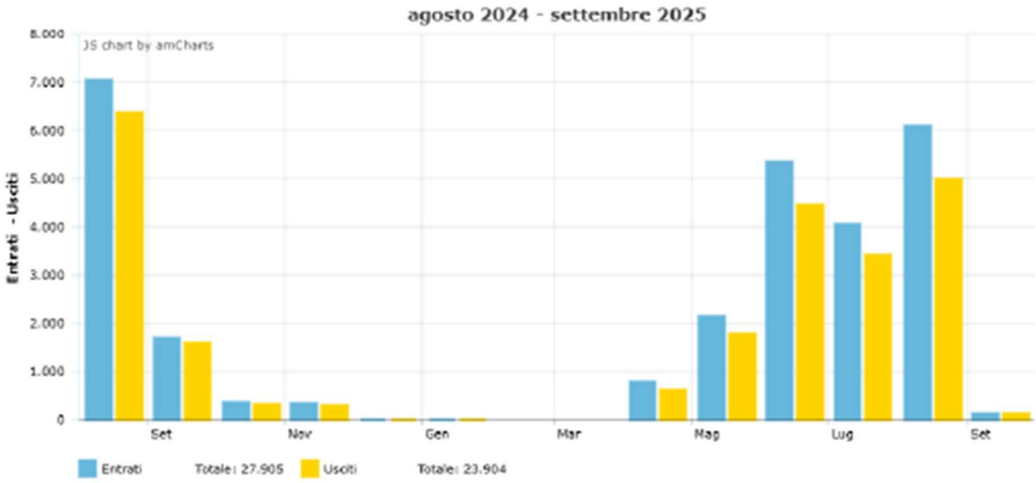
For the camera traps, video settings must be optimized to reduce battery consumption and memory use, minimizing the need for frequent site visits. Most devices are in remote areas, except for the people counters at Poiano springs. The people counters can store a very high number of data but require fairly frequent checks to verify their correct functioning since they can be damaged or manipulated by tourists.

As for the data from the people counters, the values are as follows for each site where they were installed.



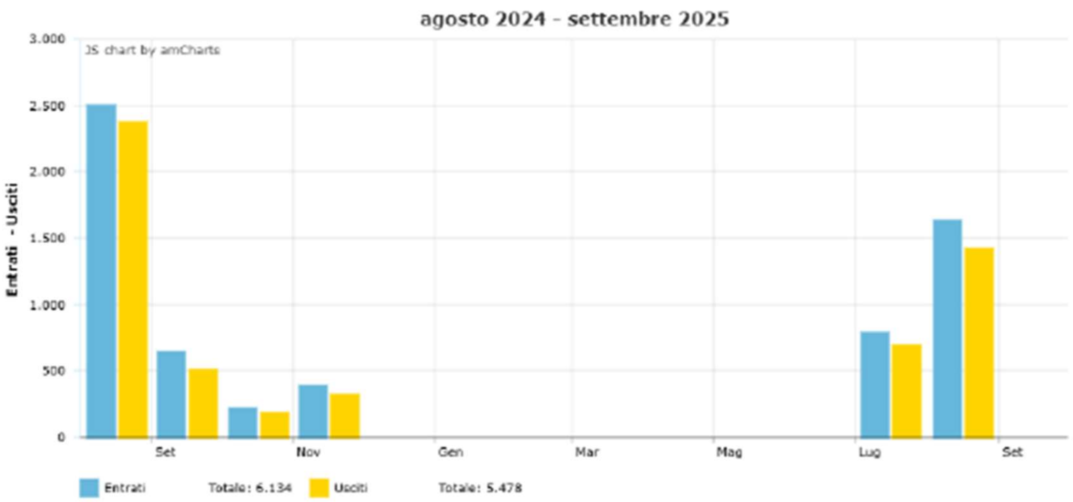
Data	Pietra Bismantova	
	Pietra Bismantova	
	Entrati	Usciti
	47.987	**53.446**
2024-agosto	8.242	8.652
2024-settembre	5.396	5.627
2024-ottobre	1.923	2.255
2024-novembre	451	870
2024-dicembre	3	6
2025-gennaio	0	6
2025-febbraio	0	1
2025-marzo	-	-
2025-aprile	3.293	3.746
2025-maggio	6.843	8.045
2025-giugno	6.521	7.481
2025-luglio	5.871	6.498
2025-agosto	9.325	10.120
2025-settembre	119	139

Fig. 6 - Data from people counters in the Pietra di Bismantova pilot site.



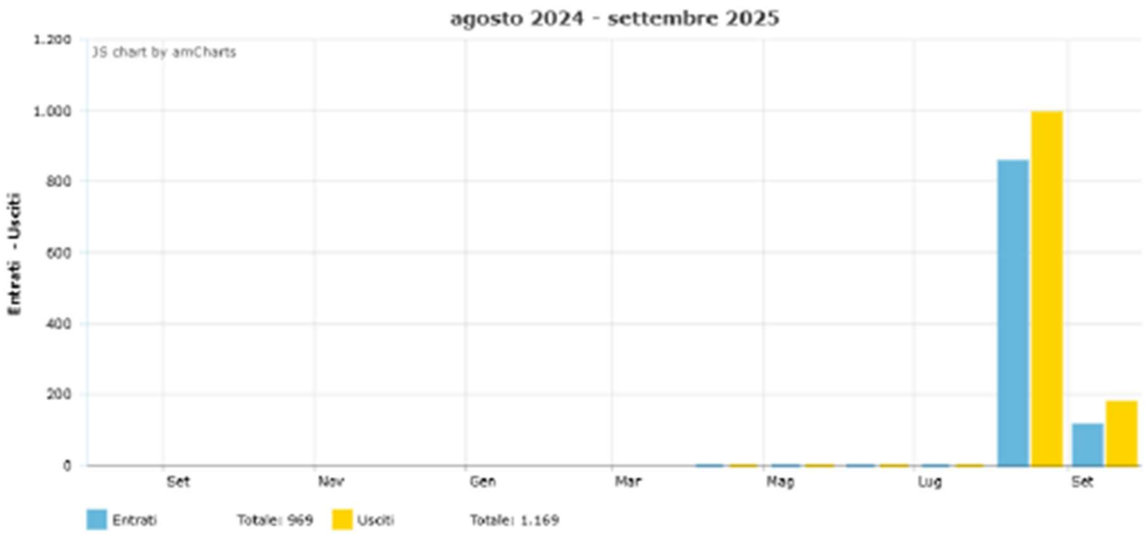
Data	Poiano varco Secondario	
	Entrati	Usciti
	27.905	23.904
2024-agosto	7.044	6.371
2024-settembre	1.682	1.581
2024-ottobre	353	313
2024-novembre	330	294
2024-dicembre	0	0
2025-gennaio	0	0
2025-febbraio	-	-
2025-marzo	-	-
2025-aprile	765	613
2025-maggio	2.137	1.783
2025-giugno	5.337	4.462
2025-luglio	4.056	3.399
2025-agosto	6.095	4.977
2025-settembre	106	111

Fig. 7 - Data from people counters in the Poiano pilot site.



Data	Lama Lite	
	Entrati	Usciti
	6.134	**5.478**
2024-agosto	2.494	2.368
2024-settembre	638	506
2024-ottobre	210	181
2024-novembre	380	312
2024-dicembre	-	-
2025-gennaio	-	-
2025-febbraio	-	-
2025-marzo	-	-
2025-aprile	-	-
2025-maggio	-	-
2025-giugno	-	-
2025-luglio	788	694
2025-agosto	1.624	1.417
2025-settembre	-	-

Fig. 8 - Data from people counters in the Mount Cusna pilot site.



Data	Parco 05	
	Entrati	Usciti
	969	1.169
2024-agosto	-	-
2024-settembre	-	-
2024-ottobre	-	-
2024-novembre	-	-
2024-dicembre	-	-
2025-gennaio	-	-
2025-febbraio	-	-
2025-marzo	-	-
2025-aprile	0	0
2025-maggio	0	0
2025-giugno	0	0
2025-luglio	0	0
2025-agosto	855	992
2025-settembre	114	177

Fig. 9 - Data from people counters in the Alta Val Parma pilot site.

As expected, visitor attendance reaches its peak on an annual scale in August and, on a weekly scale, during weekends and public holidays.

- **Main issues or limitations identified for the equipment:**

  - **People counters:**
    - *Pros*: the battery does not disconnect because it is incorporated inside the screwed-in device; they have a large long-term data storage capacity; people are probably less likely to tamper with or damage them since they do not record images and are firmly mounted on poles.

   - *Cons*: they must be installed with great precision, often requiring appropriate equipment and skills, sometimes even cement foundations. Time control and configuration are not very intuitive or immediate.
   - Specific case: the main entrance people counter at Fonti di Poiano started counting people randomly. The company suggested reversing the position of the interfacing devices. The same device was later found on the ground and recovered by the local restaurant staff. Fortunately, it was not damaged and was reinstalled in working condition.
- **Camera traps:**
   - *Cons*: very heavy data size, memory fills quickly; every time the battery cable is disconnected, the settings (date and various configurations) reset; more prone to vandalism since people easily recognize them as image recording devices and they are familiar to most visitors, who know how they work.
   - *Pros*: easy installation, do not require special poles, much more intuitive and easily controllable settings, but they reset easily if the battery is disconnected.
   - Specifically, the power cables were removed from all three sites at Lama Lite during the summer season after August 15th (Ferragosto), the period of highest visitor numbers; at Bismantova and at one of the Lago Santo camera traps, this happened earlier. This prevented counting people during the peak attendance days; fortunately, the people counters and/or alternative camera traps were functioning.

- **Main issues identified for data collection procedures on the platforms:**

  - Uploading camera trap videos is extremely problematic due to the file size and number limits, which are extremely low for this type of data collection, considering that on average around 500 videos per day are recorded at each pilot site (*this number should be double-checked*).
  - People counter data with *checkinweb* are extremely quick and easy to access.

- **Main issues identified for logistics:**

The equipment was installed mostly close to each other within each pilot site, except for Alta Val Parma, where the camera traps are located much farther away from the people counters and the pairs of acoustic sensors are several kilometers apart.

FUTURE DEVELOPMENTS

It is important to better educate and inform visitors and park's managers about the need to collect data on the use of sensitive areas.

One of the main limitations concerns the management and processing of large amounts of data: to upload data to the analysis platforms takes a lot of time, and a large storage capacity is needed. The equipment must be frequently checked, to verify the correct working and data have to be downloaded as often as possible.

We intend to extend the use of camera traps in other tourists hotspots to spread best practices improved in HUMANITA to other areas in the PNATE with high tourists pressure. We are going to improve the automatic evaluation and analysis of collected videos since they are cheaper and allow to acquire more data than infrared counters. Infrared people counters however require less maintenance and less operator intervention.

PNATE is initiating a volunteer-based project to engage and train participants in data collection using camera traps and acoustic recorders. Consequently, over the next five years, these activities will be sustained through the involvement of properly trained volunteers and enthusiasts, under the guidance of experienced technical staff.

VEGETATION MONITORING

STARTING DATE

The survey started in May 2025.

METHODOLOGY DESCRIPTION

The areas selected for the study of the effects of touristic activities on conservation status of vegetation are the pilot sites **Poiano Springs in the Triassic Gypsum** formation and the **Pietra di Bismantova**.

The first survey in the two sites also included the assessment of existing issues and, consequently, the selection of the sample areas and environments to be investigated, as well as the methodology to be applied.

The identified types were surveyed in May 2025, at the beginning of the peak visitation season, and again at the end of the season, at the end of September 2025, in order to compare the collected data and carry out the necessary evaluations.

For the Poiano Springs area, a significant amount of data was available for analysis, both from the last century and from more recent years, largely thanks to a project financed by EU LIFE Programme: "LIFE Gypsum".

In particular, the recent data on vegetation and flora, and especially the trends observed over the years of the project, provide a highly relevant baseline for evaluating the current impacts caused by heavy visitation to the area.

To assess the impact of visitor use on the vegetation component, several types of surveys were chosen to enable a comprehensive evaluation at the end of the high visitation season: two areas with herbaceous cover, each with a different degree of aridity.

For the Pietra di Bismantova area, one of the most frequented areas of the National Park and also potentially an area with the greatest impact on plant species and ecosystems, initially, it was decided to conduct a survey of the most impacted areas and use transects for the surveys, but a preliminary assessment of the sites led to a different choice. Three uniform case studies were used, and the survey generally focused on those areas where intense use had caused the greatest problems.

RESULTS AND OBSERVATIONS

POIANO SPRINGS

Survey Area N. 1 – 10 × 10 m square, center at latitude 44.390399° longitude 10.439424°

This zone presents a thicker soil layer with gravel at a depth of 1.5 m (Life Gypsum core sampling). The floristic composition reflects a more developed soil with higher moisture content.

Fig. 10 – Survey area n. 1

Situation at the end of the 2025 tourist season

The meadow area has not been significantly affected by the prolonged and intense trampling, also thanks to seasonal climatic conditions without extended periods of drought. The floristic composition appears largely unchanged; it should only be noted that in some areas there is a strong colonization by young poplar plants, which may need to be controlled through mowing.

List of vascular plant species observed in Survey area n. 1:

famiglia	taxon	for_bio	corotipo
Asteraceae	*Achillea collina (Becker ex Wirtg.) Heimerl*	H scap	SE-Europ.
Lamiaceae	*Ajuga reptans L.*	Ch rept - H rept	Eurasiat. - Europ.- Caucas.
Asteraceae	*Artemisia vulgaris L.*	H scap	Circumbor. - Eurasiat.
Asteraceae	*Bellis perennis L.*	H ros	Circumbor. - Europ. - Europ.-Caucas.
Poaceae	*Bromus hordeaceus L.*	T scap	Subcosmop.
Brassicaceae	*Capsella bursa-pastoris (L.) Medik. subsp. bursa-pastoris*	H bienn	Cosmop.
Asteraceae	*Centaurea nigrescens Willd.*	H scap	Europ.
Asteraceae	*Cirsium arvense (L.) Scop.*	G rad	Eurasiat. - Subcosmop.
Asteraceae	*Cirsium vulgare (Savi) Ten.*	H bienn	Eurasiat.
Asteraceae	*Crepis foetida L.*	H bienn - T scap	Euri-Medit.
Poaceae	*Cynodon dactylon (L.) Pers.*	G rhiz - H rept	Cosmop.
Poaceae	*Dactylis glomerata L.*	H caesp	Paleotemp.
Apiaceae	*Daucus carota L.*	H bienn - T scap	Paleotemp. - Subcosmop.
Poaceae	*Elymus repens (L.) Gould subsp. repens*	G rhiz	Circumbor.
Asteraceae	*Helminthotheca echioides (L.) Holub*	T scap	Euri-Medit. - Euri-Medit.-Orient.
Asteraceae	*Leontodon hispidus L.*	H ros	Europ.-Caucas.
Fabaceae	*Lotus corniculatus L.*	H scap	Cosmop. - Paleotemp. - Subcosmop.
Fabaceae	*Lotus tenuis Waldst. & Kit. ex Willd.*	H scap	Paleotemp.
Fabaceae	*Medicago lupulina L.*	H scap - T scap	Eurasiat. - Paleotemp.
Asteraceae	*Picris hieracioides L. subsp. hieracioides*	H bienn - T scap	Eurosiber.
Plantaginaceae	*Plantago lanceolata L.*	H ros	Cosmop. - Eurasiat.
Plantaginaceae	*Plantago media L. subsp. media*	H ros	Eurosiber.
Poaceae	*Poa annua L.*	T caesp	Cosmop.
Poaceae	*Poa pratensis L. subsp. pratensis*	H caesp	Circumbor.
Rosaceae	*Potentilla reptans L.*	H ros	Paleotemp. - Subcosmop.
Ranunculaceae	*Ranunculus acris L. subsp. acris*	H scap	Eurasiat.
Ranunculaceae	*Ranunculus bulbosus L.*	H scap	Eurasiat.
Lamiaceae	*Salvia pratensis L.*	H scap	Euri-Medit.
Caryophyllaceae	*Silene latifolia Poir.*	H bienn	Steno-Medit.
Asteraceae	*Taraxacum F.H.Wigg. sect. Taraxacum*	H ros	Circumbor. - Cosmop.
Fabaceae	*Trifolium pratense L.*	H scap	Subcosmop.
Fabaceae	*Trifolium repens L.*	Ch rept - H rept	Paleotemp. - Subcosmop.
Verbenaceae	*Verbena officinalis L.*	H scap	Cosmop. - Eurasiat. - Paleotemp.

Survey Area N. 2 – 10 × 10 m square, center at latitude 44.390425° longitude 10.440285°

This area shows greater aridity due to a thin, less developed soil layer, with gravel and sand reaching almost to the surface.

Fig. 11 – Survey area n. 2

Full list of vascular plant species observed in Survey area n. 2:

famiglia	taxon	for_bio	corotipo
Poaceae	*Anisantha sterilis (L.) Nevski*	T scap	Medit.-Turan.
Caryophyllaceae	*Arenaria serpyllifolia L. subsp. serpyllifolia*	T scap	Cosmop. - Subcosmop.
Asteraceae	*Artemisia alba Turra*	Ch suffr	S-Europ. - Steno-Medit. - Submedit.
Asteraceae	*Bellis perennis L.*	H ros	Circumbor. - Europ. - Europ.-Caucas.
Poaceae	*Bromopsis erecta (Huds.) Fourr.*	H caesp	Paleotemp.
Poaceae	*Bromus hordeaceus L.*	T scap	Subcosmop.
Boraginaceae	*Cerinthe minor L.*	H bienn - T scap	Pontica - SE-Europ.
Asteraceae	*Crepis sancta (L.) Babc. subsp. nemausensis (P. Fourn.) Babc.*	T scap	Medit.-Turan.
Brassicaceae	*Diplotaxis tenuifolia (L.) DC.*	H scap	Steno-Medit. - Subatl. - Submedit.
Geraniaceae	*Erodium cicutarium (L.) L'Hér.*	T caesp - T scap	Subcosmop.
Euphorbiaceae	*Euphorbia cyparissias L.*	H scap	Centroeurop. - Europ.
Geraniaceae	*Geranium pusillum L.*	T scap	Eurasiat.
Asteraceae	*Hieracium murorum L.*	Ch pulv - H scap	Eurasiat. - Eurosiber.
Plantaginaceae	*Kickxia spuria (L.) Dumort. subsp. spuria*	T scap	Eurasiat.
Fabaceae	*Lotus tenuis Waldst. & Kit. ex Willd.*	H scap	Paleotemp.
Fabaceae	*Medicago lupulina L.*	H scap - T scap	Eurasiat. - Paleotemp.
Caryophyllaceae	*Petrorhagia prolifera (L.) P.W. Ball & Heywood*	T scap	Euri-Medit. - Steno-Medit.
Plantaginaceae	*Plantago major L.*	H ros	Eurasiat. - Subcosmop.
Poaceae	*Poa annua L.*	T caesp	Cosmop.
Poaceae	*Poa bulbosa L.*	H caesp	Paleotemp.
Poaceae	*Poa compressa L.*	H caesp	Circumbor.
Polygalaceae	*Polygala nicaeensis W.D.J. Koch subsp. mediterranea Chodat*	H scap	Steno-Medit.
Rosaceae	*Potentilla verna L.*	H scap	Europ.
Rosaceae	*Poterium sanguisorba L.*	H scap	Paleotemp. - Subcosmop.
Caryophyllaceae	*Silene vulgaris (Moench) Garcke subsp. vulgaris*	H scap	Eurasiat. - Paleotemp. - Subcosmop.
Fabaceae	*Trifolium repens L.*	Ch rept - H rept	Paleotemp. - Subcosmop.
Verbenaceae	*Verbena officinalis L.*	H scap	Cosmop. - Eurasiat. - Paleotemp.
Plantaginaceae	*Veronica prostrata L.*	H caesp	Eurasiat.
Lamiaceae	*Ziziphora acinos (L.) Melnikov*	T scap	Euri-Medit. - Steno-Medit.

Situation at the end of the 2025 tourist season

Due to the substrate, which allows rapid water infiltration, this meadow was naturally more affected by trampling during the summer season. The floristic composition remains largely unchanged, although some species, better adapted to drought and trampling (e.g., Thymus pulegioides, Plantago lanceolata), have become more widespread compared to early spring surveys. However, in areas subject to excessive trampling, there is noticeable thinning of the grass cover, increased soil erosion (already very shallow), and gradual changes in floristic composition. Over time, these impacts could become significant.

Fig. 12 – Evidence of trampling damage in the meadow.

EVALUATION OF AREAS OF VARYING SHAPES AND SIZES, OR OF POINT LOCATIONS, WHERE EVIDENT ISSUES RELATED TO SITE USE ARE PRESENT.

Area N. 1 – latitude 44.390613° longitude 10.439438° – tree and shrub belt adjacent to the parking area (separating the parking lot from the meadow area)

Fig. 13 – Area n. 1 with issues caused by visitors in Poiano.

The entire area has undergone significant thinning of the vegetation, with pruning of the lower branches of the tree component and the clear-cutting of all shrub and herbaceous vegetation; the intervention was aimed at improving the appearance of the area for tourist use.

A true hedge had developed, including all layers of vegetation, which should clearly have been managed through careful, targeted interventions, rather than removing such a large part of the vegetation.

Beyond the landscape aspect (for example, from the meadow area and from the springs the entire parking lot and the vehicles parked there are now visible), this intervention has compromised an ecosystem that had developed over time. Several specimens of protected species (Emilia-Romagna Regional Law n. 2/1977) were also damaged.

Fig. 14 – Area n. 1 with issues caused by visitors in Poiano (*Orchis simia*, a species protected under Regional Law 2/77).

In the area affected by the intervention, one of the few remaining populations of Digitalis ferruginea was present. This population had previously been preserved through targeted vegetation management practices. Following the recent intervention, the population has been lost. Given that the remaining populations are also under severe threat, the species may soon disappear from the whole national Park.

Fig. 15 – Area with populations of *Digitalis ferruginea* in Poiano.

The intervention was carried out without following the basic principles of vegetation management. Herbaceous vegetation should never be cut below 5 cm in height in order to promote regrowth; in fact, mowing too close to the ground damages or removes the buds at the collar of hemicryptophytes, often leading to their elimination. Furthermore, the improper use of brush cutters has caused injuries to the basal parts of woody species, resulting in damage that can lead to serious structural and phytosanitary problems for the plants.

Situation at the end of the 2025 tourist season

The damage caused by an improperly conducted intervention, carried out without any assessment of its impacts, has become even more evident. It should be noted that the area, now open and close to the parking lot, has also become a site for waste dumping.

Area N. 2 – latitude 44.390293° longitude 10.440011° – bank of the artificial pond created to allow safe access to the water

Fig. 16 – Area n. 2 with issues caused by visitors in Poiano.

The bank, with a very gentle slope created to facilitate access to the water, is largely devoid of grass cover, which has disappeared due to intense trampling. On the other hand, this condition reduces the use of the banks of the outflow channel, as had been foreseen during the project phase.

The mowing of Phragmites australis along the bank prevents its expansion, but the cut material must absolutely be removed to avoid it being deposited in the water, which would create a situation of eutrophication, favoring the formation of a significant algal layer and causing the disappearance of Zannichellia palustris populations that had established themselves here.

Situation at the end of the 2025 tourist season

Heavy use of the banks, including the digging of holes, has caused the meadow to retreat and led to the displacement of Zannichellia palustris populations, which are further declining in this water body. This area, which was intended to prevent damage to the high-flow zone while allowing easier access to the water, is clearly subject to strong anthropogenic pressure during the summer months. The impacts should be monitored over time.

Fig. 17 - Area n. 2 with issues caused by visitors in the banks in Poiano.

Area No. 3 – latitude 44.390099° longitude 10.439744° - bank of the main drainage channel

Fig. 18 – Area n. 3 with issues caused by visitors in Poiano.

As expected, the ease of access to the water along the banks of the artificial lake has reduced the number of people along the outer bank of the outflow channel, allowing vegetation to colonize the highly trafficked strip.

The only area still heavily frequented and experiencing these problems is near the small bridge spanning the channel. In this area, the grass cover has naturally disappeared completely, and there are obvious signs of erosion along the bank.

Even mowing the lawn without reaching the bank discourages excessive use of this area, with obvious benefits for vegetation and erosion.

EVALUATION OF THE CURRENT POPULATION OF SOME SPECIES INDICATIVE OF THE STATE OF CONSERVATION AND EVOLUTION OF THE PRESENT HABITATS.

N° 1 species – Potamogetonaceae - *Zannichellia palustris* L.

A rooting hydrophyte in severe decline (it has disappeared in much of the Park's territory in known locations) due to the destruction and/or modification of its growing environments. Le Fonti di Poiano is one of the rare locations where this species grows at these altitudes.

Fig. 19 – *Zannichellia palustris* L. in Poiano

Zannichellia palustris was recorded at the Poiano Springs as early as 1948 by Daria Bertolani Marchetti (Vegetation of the Poiano and Primaore salt springs in the Upper Secchia Valley - Emilian Apennines). The species was initially thought to have disappeared due to a substantial change in the area's hydraulic management with the construction of an embankment and resulting lake. It was subsequently rediscovered in the interior of this area after the body of water had almost completely filled with debris and been colonized by Pragmithe australis. The removal of the embankment and the return of the original water flow allowed Zannichellia palustris to colonize the area where the mill's "gora" (stream) had once been located, and from there the species moved downstream to settle in the artificially created body of water at the mouth of the outflow canal. The reshaping of the pond, the modulation of its depth, and increased oxygenation have allowed the species to increase its population. The population is currently declining in this body of water, primarily due to heavy trampling of the banks and the first part of the flooded area, resulting from heavy traffic, especially during the summer. Continuous mowing of the Phragmites australis banks increases the risk but also prevents changes to the species' habitat.

Therefore, it is necessary to continue monitoring the situation to determine further effects on the population in the pond, while the population in the "gora" appears stable and relatively expanding.

N ° 2 species– Lythraceae - Lythrum hyssopifolia L.

An annual plant (scaphophyte) typical of our area of meadows and damp uncultivated land, which had almost disappeared in the province, it has found an ideal environment in this area after the restoration interventions linked to a specific LIFE project (LIFE Gypsum).

Fig. 20 - *Lythrum hyssopifolia* L. in Poiano

The species, previously unreported at the Fonti di Poiano, arrived a year after the completion of the LIFE Gypsum project, when it was decided not to intervene in the meadow area affected by runoff on the south side. The area, previously subject to constant mowing, was closed off from use and within a year was colonized by thrips, numerous species of Juncaceae and Cyperaceae, a significant population of Mentha pulegium, and, in the lower reaches, a significant presence of Lythrum hyssopifolia. This species is currently present in the Reggio Emilia area in only one location in Pulpiano, but will soon disappear due to a recent habitat modification project.

In the following years, the evolution of the flora in the wet meadow has been constantly monitored, and a regular succession is still observed, compensating for the loss of some species and the arrival of others. This year, for the first time, scheduled mowing will be necessary to contain the advance of Phragmites australis.

The Lythrum salicaria population has declined over time and is now relatively stable, although threatened by the advance of Phragmites australis.

The impact of influx into the area has logically diminished, but it has not yet disappeared for this species. Indeed, trampling of the damp meadow, especially in the lower part, is still observed by people entering the drainage channel, bypassing the access restriction. This situation, which has been observed in recent years, will need to be assessed during peak visitor influx periods.

Observations

The situation before the summer season in the area was good, with limited impacts. Closing the trail along the mouths due to the landslide has naturally limited further problems (people easily wandered off the trail, impacting an extremely delicate environment). The wooded area, home to the largest population of Asplenium scolopendrium (a protected species) in the Park, has also benefited significantly from the closure of the trail (in the past, people even collected its branches). Despite the ban, the trail is still used occasionally. The population of this Pteridophyte has increased in a very short time.

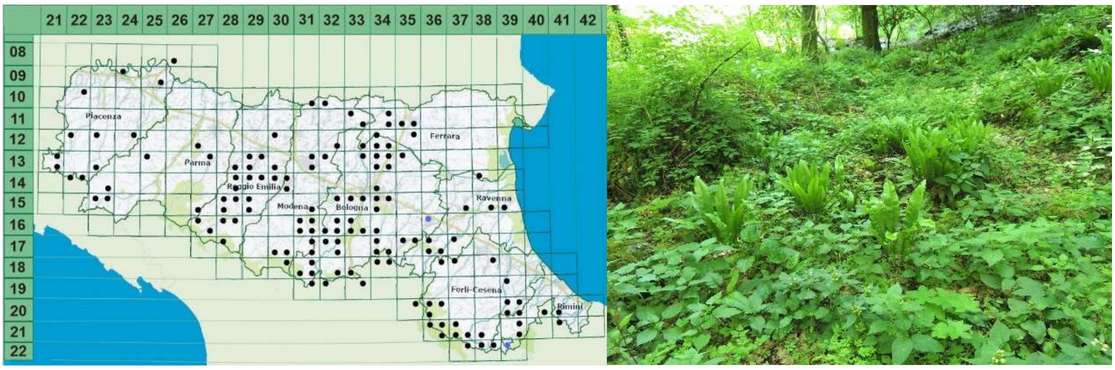


Fig. 21 – population of *Asplenium scolopendrium* in Poiano and distribution in Emilia-Romagna.

For this reason, different areas were chosen for the surveys, focusing on areas where use is currently highest and therefore also where potential impacts are greatest. Naturally, surveys and assessments will be conducted based on the current baseline once the tourist resort is completed.

PIETRA DI BISMANTOVA

Case Study n. 1 – Access Areas to Climbing Routes

There are numerous areas where climbing routes begin, or where there are paths leading to them.

Naturally, not all of them were inspected, but the focus was on those where the impact of constant traffic appears to be greatest.

One of the problems highlighted concerns the erosion and crumbling of the sandy soil. Regarding the impact on vegetation, the main problem is the constant opening of new routes or the duplication of existing ones, resulting in the elimination or continued damage of mainly herbaceous species due to constant trampling of the soil. Generally, these are undemanding species that find their ecological niche difficult in these environments, having less competition for space.

At the base of the cliffs, the impact is greatest due to the constant presence of rock, and some rock-dwelling species are also significantly affected by the constant traffic. They are almost always present in the surrounding areas, but not in these locations. The most impacted species are:

Brassicaceae - *Alyssoides utriculata* (L.) Medik. subsp. utriculata

Campanulaceae - *Campanula medium* L.

Caryophyllaceae - *Dianthus virgineus* L.

Resedaceae - *Reseda luteola* L.

Fig. 22 - Caryophyllaceae - *Dianthus virgineus*, Brassicaceae – *Alyssoides utriculata*

Fig. 23 - Resedaceae – *Reseda luteola*, Campanulaceae – *Campanula medium*

Fig. 24 – Case Study n. 1 – Access Areas to Climbing Routes in Bismantova.

Situation at the end of the 2025 tourist season

The situation remains unchanged. The only difference concerns the access routes: some trails have split or even tripled, damaging the existing vegetation. The base of the wall at the start points of climbing routes now shows minimal vegetation. As expected, the period of highest climbing activity naturally causes greater damage, especially to the species previously mentioned; however, this does not compromise their overall population

Case Study n. 2 – Summit Trails

The network of trails on the summit of Pietra di Bismantova has expanded over time with increased use.

Fig. 25 - Case Study n. 2 – Summit trails in Bismantova.

In addition to the main routes, new ones are constantly being opened, interfering with predominantly grassland environments, including those covered by Directive 92/43/EEC on the conservation of natural and semi-natural habitats and of wild flora and fauna.

Furthermore, existing paths, often subject to erosion of the thin layer of soil, are constantly being joined by alternative routes and new passages, significantly damaging the surrounding vegetation.

Fig. 26 – Alternative routes and passages in summit trails in Bismantova.

The recent mowing of the edges of some trails, again for tourism purposes, has prevented the creation of alternative routes in some sections, but in others it has resulted in a very large cut of the surrounding grassland, perhaps to allow for vehicle passage. These operations should always be carried out after all the species present in the meadow have completed their growth cycle and have dispersed, keeping the cut above 5 cm and without damaging the buds at the base and root system.

Fig. 27 – Cutting of grassland in Bismantova.

Situation at the end of the 2025 tourist season

As expected, during the summer period there is a proliferation of new trails, including temporary paths, particularly in meadow areas. Numerous new routes, as well as splits or variations of existing ones, have been observed. Many of these new trails will naturally disappear during the winter and spring seasons.

It should be emphasized that these new paths impact habitats of communiity interest. The higher the visitation of the summit plateau, the greater the impact on habitats and, consequently, on plant species.

The most affected habitat is 6210 – (*)Semi-natural dry grasslands and calcareous rocky scrub (Festuco-Brometalia) (*notable orchid bloom), a priority habitat.

Non-compliance with established trails is a common issue throughout the Apennine territory, often causing significant damage to soil and ecosystems, and in some cases, such as certain trails, resulting in the loss of unique populations of rare species. This situation is naturally difficult to control.

It is recommended that the signboard with restrictions at the summit of the Pietra should include a warning against leaving the designated trails.

Case Study n.3 – The Summit Panoramic View

The viewpoint overlooking the southeast side of the summit plateau is considered. This is undoubtedly the most popular area, even simply to enjoy the stunning panorama.

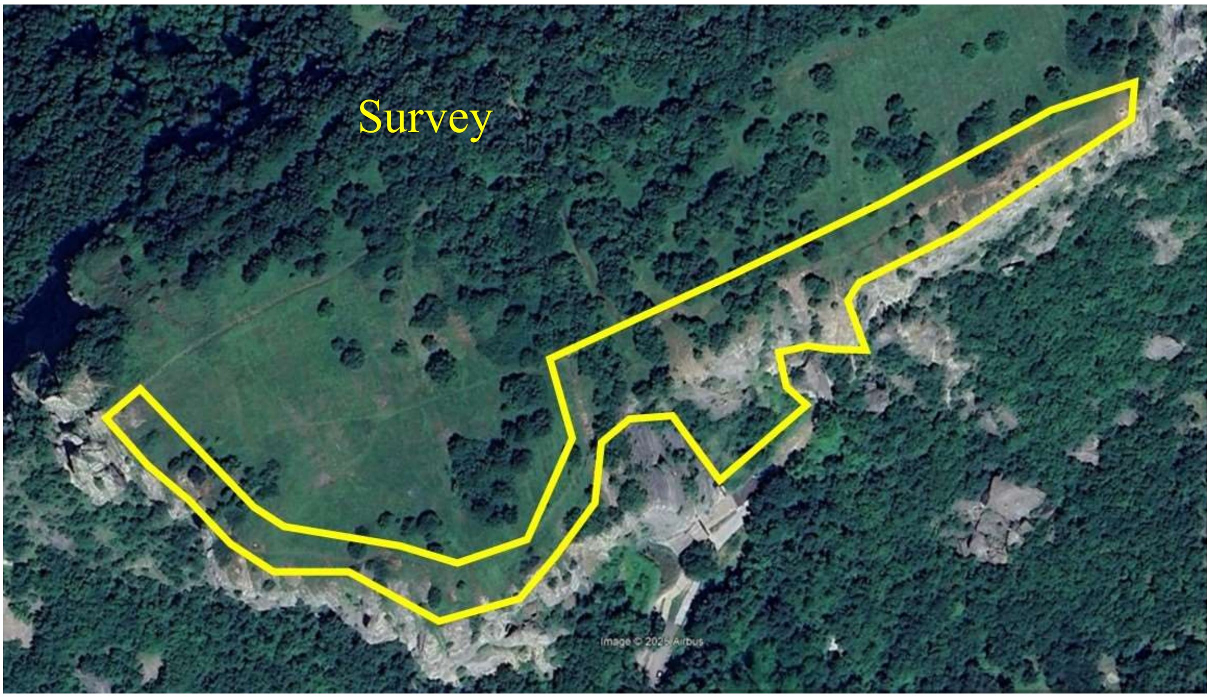


Fig. 28 – Case Study n.3 – The Summit Panoramic View surveyed in Bismantova.

The entire area has a thin layer of soil, much of it poorly evolved, resulting in a greater impact on plant life and habitats due to constant trampling.

This situation often leads to the loss of numerous specimens of various species, decreasing their populations. Furthermore, examining the data and species distribution of the Pietra di Bismantova, comparing the data contained in the local flora database over various periods, reveals that some species have disappeared or have not been recorded since 1990, the year used as a discriminant for making the assessment; these are almost exclusively species typical of this environment. It is therefore conceivable that the impact of trampling in these areas has been significant with the increase in frequentation.

Fig. 29 – Case Study n.3 – The Summit Panoramic View surveyed in Bismantova.

Situation at the end of the 2025 tourist season

The situation remains essentially unchanged compared to the beginning of the peak visitation period. The only notable issues are increased trampling and the expansion of erosion areas, problems that follow a periodic pattern depending on the number of visitors throughout the year. Littering is also a concern in this area. The plant component—vegetation, habitats, and species—remains stable, and the damaged specimens are negligible in the overall assessment. The areas experiencing the greatest impact are those at the top points of the climbing routes.

Fig. 30 – Littering and trampling at the top of the climbing routes.

Census of vascular plant species detected in the survey area:

famiglia	taxon	for_bio	corotipo
Asteraceae	*Achillea millefolium L. subsp. millefolium*	H scap	Eurosiber.
Poaceae	*Achnatherum calamagrostis (L.) P. Beauv.*	H caesp	Orof. S-Europ.
Poaceae	*Agrostis capillaris L.*	H caesp	Circumbor.
Amaryllidaceae	*Allium sphaerocephalon L. subsp. sphaerocephalon*	G bulb	Paleotemp.
Brassicaceae	*Alyssoides utriculata (L.) Medik. subsp. utriculata*	Ch suffr	Medit. - NE-Medit.
Brassicaceae	*Alyssum alyssoides (L.) L.*	T scap	Euri-Medit. - Steno-Medit.
Rosaceae	*Amelanchier ovalis Medik. subsp. ovalis*	P caesp	Medit.-Mont.
Poaceae	*Anisantha sterilis (L.) Nevski*	T scap	Medit.-Turan.
Asparagaceae	*Anthericum liliago L.*	G bulb	Europ. - Subatl. - Submedit.
Poaceae	*Anthoxanthum odoratum L.*	H caesp	Eurasiat.
Fabaceae	*Anthyllis vulneraria L.*	H bienn - H scap - T scap	Euri-Medit. - Orof. SW-Europ.
Brassicaceae	*Arabidopsis thaliana (L.) Heynh.*	T scap	Cosmop. - Paleotemp. - Subcosmop.
Brassicaceae	*Arabis sagittata (Bertol.) DC.*	H bienn - H scap	SE-Europ.
Caryophyllaceae	*Arenaria serpyllifolia L. subsp. serpyllifolia*	T scap	Cosmop. - Subcosmop.
Poaceae	*Arrhenatherum elatius (L.) P.Beauv. ex J.Presl & C.Presl*	H caesp	Paleotemp.
Asteraceae	*Artemisia alba Turra*	Ch suffr	S-Europ. - Steno-Medit. - Submedit.
Fabaceae	*Astragalus monspessulanus L. subsp. monspessulanus*	H ros	Steno-Medit.
Gentianaceae	*Blackstonia perfoliata (L.) Huds.*	T scap	Euri-Medit.
Poaceae	*Brachypodium genuense (DC.) Roem. & Schult.*	H caesp	Endem. Ital.
Poaceae	*Brachypodium pinnatum (L.) P. Beauv.*	H caesp	Eurasiat.
Poaceae	*Bromopsis erecta (Huds.) Fourr.*	H caesp	Paleotemp.
Apiaceae	*Bunium bulbocastanum L.*	G bulb	W-Europ.
Campanulaceae	*Campanula medium L.*	H bienn	NW-Medit.
Campanulaceae	*Campanula rapunculus L.*	H bienn	Eurasiat. - Paleotemp.
Asteraceae	*Centaurea triumfettii All.*	H scap	Europ.-Caucas. - Orof. S-Europ.
Valerianaceae	*Centranthus ruber (L.) DC. subsp. ruber*	Ch suffr	Steno-Medit.
Caryophyllaceae	*Cerastium arvense L. subsp. suffruticosum (L.) Ces.*	Ch suffr	Orof. S-Europ.
Caryophyllaceae	*Cerastium brachypetalum Desp. ex Pers.*	T scap	Euri-Medit. - Pontica
Asteraceae	*Cirsium arvense (L.) Scop.*	G rad	Eurasiat. - Subcosmop.
Asteraceae	*Cirsium vulgare (Savi) Ten.*	H bienn	Eurasiat.
Lamiaceae	*Clinopodium nepeta (L.) Kuntze subsp. nepeta*	Ch suffr - H scap	Medit.-Mont. - Steno-Medit.
Fabaceae	*Colutea arborescens L.*	P caesp	Euri-Medit. - Pontica - S-Europ.
Fabaceae	*Coronilla minima L. subsp. minima*	Ch suffr	Steno-Medit.-Occid.
Betulaceae	*Corylus avellana L.*	P caesp	Europ. - Europ.-Caucas.
Rosaceae	*Crataegus monogyna Jacq.*	P caesp - P scap	Eurasiat. - Paleotemp.
Poaceae	*Cynosurus cristatus L.*	H caesp	Europ.-Caucas.
Thymelaeaceae	*Daphne alpina L. subsp. alpina*	Ch frut	Orof. S-Europ.
Ranunculaceae	*Delphinium fissum Waldst. & Kit. subsp. fissum*	H scap	Orof. Eurasiat.
Caryophyllaceae	*Dianthus virgineus L.*	H scap	Submedit.
Brassicaceae	*Diplotaxis tenuifolia (L.) DC.*	H scap	Steno-Medit. - Subatl. - Submedit.
Asteraceae	*Doronicum columnae Ten.*	G rhiz	Europ.-Caucas. - Orof. S-Europ.
Brassicaceae	*Draba verna L.*	T scap	Circumbor.
Rosaceae	*Drymocallis rupestris (L.) Soják*	H scap	Circumbor.
Boraginaceae	*Echium vulgare L. subsp. vulgare*	H bienn	Europ.
Brassicaceae	*Erysimum pseudorhaeticum Polatschek*	H scap	Endem. Ital.
Poaceae	*Festuca valesiaca Schleich. ex Gaudin*	H caesp	SE-Europ. - Sudsiber.
Oleaceae	*Fraxinus ornus L. subsp. ornus*	P caesp - P scap	Eurasiat. - Euri-Medit. - Pontica
Cistaceae	*Fumana procumbens (Dunal) Gren. & Godr.*	Ch suffr	Medit.-Turan.
Rubiaceae	*Galium lucidum All. subsp. lucidum*	H scap	Euri-Medit.

famiglia	*taxon*	for_bio	corotipo
Fabaceae	*Genista tinctoria L.*	Ch suffr	Eurasiat.
Geraniaceae	*Geranium rotundifolium L.*	T scap	Paleotemp. - Subcosmop.
Plantaginaceae	*Globularia bisnagarica L.*	H scap	S-Europ.
Araliaceae	*Hedera helix L. subsp. helix*	P lian	Subatl. - Submedit.
Cistaceae	*Helianthemum apenninum (L.) Mill. subsp. apenninum*	Ch suffr	Steno-Medit. - W-Europ.
Cistaceae	*Helianthemum nummularium (L.) Mill.*	Ch suffr	Europ.-Caucas.
Asteraceae	*Helichrysum italicum (Roth) G.Don subsp. italicum*	Ch suffr	S-Europ.
Asteraceae	*Hieracium murorum L.*	Ch pulv - H scap	Eurasiat. - Eurosiber.
Asteraceae	*Hieracium tomentosum L. subsp. tomentosum*	H scap	Subendem.
Fabaceae	*Hippocrepis comosa L. subsp. comosa*	H caesp	Centroeurop. - Europ. - S-Europ.
Brassicaceae	*Hornungia petraea (L.) Rchb. subsp. petraea*	T scap	Euri-Medit. - Steno-Medit.
Hypericaceae	*Hypericum perforatum L.*	H caesp	Cosmop. - Paleotemp.
Cupressaceae	*Juniperus communis L.*	P caesp - P scap	Circumbor. - Eurasiat. - Eurosiber. - Medit.-Mont.
Fabaceae	*Laburnum alpinum (Mill.) Bercht. & J. Presl*	P caesp - P scap	Orof. S-Europ.
Asteraceae	*Lactuca perennis L.*	H scap	Euri-Medit.-Occid. - Europ.
Asteraceae	*Leucanthemum vulgare (Vaill.) Lam. subsp. vulgare*	H scap	Eurasiat. - Euri-Medit. - Eurosiber.
Linaceae	*Linum strictum L.*	T scap	Steno-Medit.
Linaceae	*Linum tenuifolium L.*	Ch suffr	Pontica - Steno-Medit. - Submedit.
Linaceae	*Linum usitatissimum L. subsp. angustifolium (Huds.) Thell.*	H bienn - H scap	Euri-Medit. - Steno-Medit. - Subatl.
Linaceae	*Linum viscosum L.*	H scap	Orof. S-Europ.
Poaceae	*Lolium perenne L.*	H caesp	Circumbor. - Eurasiat.
Asparagaceae	*Loncomelos brevistylus (Wolfn.) Dostál*	G bulb	SE-Europ. - W-Asiatica
Asparagaceae	*Loncomelos pyrenaicus (L.) Hrouda ex J. Holub*	G bulb	Euri-Medit.
Fabaceae	*Lotus corniculatus L.*	H scap	Cosmop. - Paleotemp. - Subcosmop.
Fabaceae	*Lotus tenuis Waldst. & Kit. ex Willd.*	H scap	Paleotemp.
Primulaceae	*Lysimachia arvensis (L.) U. Manns & Anderb.*	T rept	Euri-Medit.
Fabaceae	*Medicago falcata L. subsp. falcata*	H scap	Eurasiat.
Fabaceae	*Medicago lupulina L.*	H scap - T scap	Eurasiat. - Paleotemp.
Fabaceae	*Medicago polymorpha L.*	T scap	Euri-Medit. - Subcosmop.
Poaceae	*Melica ciliata L.*	H caesp	Medit.-Turan.
Poaceae	*Melica transsilvanica Schur*	H caesp	Europ. - Sudsiber.
Caryophyllaceae	*Moehringia trinervia (L.) Clairv.*	H scap - T scap	Eurasiat.
Fabaceae	*Onobrychis arenaria (Kit.) DC. subsp. arenaria*	H scap	S-Europ.-S-Siber.
Fabaceae	*Ononis natrix L. subsp. natrix*	Ch suffr - H caesp	Steno-Medit.
Fabaceae	*Ononis pusilla L. subsp. pusilla*	H scap	Euri-Medit.
Boraginaceae	*Onosma pseudoarenaria Schur subsp. helvetica Rauschert*	Ch suffr	Alpico-Appenn.
Betulaceae	*Ostrya carpinifolia Scop.*	P caesp - P scap	Pontica - S-Europ.
Urticaceae	*Parietaria judaica L.*	H scap	Euri-Medit. - Macarones.
Caryophyllaceae	*Petrorhagia prolifera (L.) P.W. Ball & Heywood*	T scap	Euri-Medit. - Steno-Medit.
Crassulaceae	*Petrosedum rupestre (L.) P.V.Heath*	Ch succ	Centroeurop. - W-Europ.
Asteraceae	*Pilosella officinarum Vaill.*	H ros	Europ.-Caucas. - Eurosiber. - Subatl.
Plantaginaceae	*Plantago sempervirens Crantz*	Ch suffr	W-Medit.
Poaceae	*Poa bulbosa L.*	H caesp	Paleotemp.
Polygalaceae	*Polygala nicaeensis W.D.J. Koch subsp. mediterranea Chodat*	H scap	Steno-Medit.
Rosaceae	*Potentilla argentea L.*	H scap	Circumbor.
Rosaceae	*Potentilla collina Wibel*	H scap	Pontica - S-Europ.
Rosaceae	*Potentilla pedata Willd. ex Hornem.*	H scap	Euri-Medit.
Rosaceae	*Potentilla verna L.*	H scap	Europ.
Rosaceae	*Poterium sanguisorba L.*	H scap	Paleotemp. - Subcosmop.
Rosaceae	*Prunus spinosa L. subsp. spinosa*	P caesp	Eurasiat. - Europ.-Caucas.

famiglia	*taxon*	for_bio	corotipo
Boraginaceae	*Pulmonaria officinalis L. subsp. officinalis*	H scap	Centroeurop. - Europ.
Rosaceae	*Pyrus communis L. subsp. pyraster (L.) Ehrh.*	P scap	Eurasiat.
Fagaceae	*Quercus pubescens Willd. subsp. pubescens*	P caesp - P scap	Pontica - S-Europ. - SE-Europ.
Resedaceae	*Reseda lutea L. subsp. lutea*	H scap - T scap	Europ. - Subcosmop.
Resedaceae	*Reseda luteola L.*	H bienn - H scap	Circumbor. - Eurasiat.
Rosaceae	*Rosa canina L.*	NP	Paleotemp.
Polygonaceae	*Rumex acetosella L.*	H scap	Eurosiber. - Subcosmop.
Lamiaceae	*Salvia verbenaca L.*	H scap	Euri-Medit. - Steno-Medit.
Caryophyllaceae	*Saponaria ocymoides L. subsp. ocymoides*	H scap	Orof. SW-Europ.
Saxifragaceae	*Saxifraga tridactylites L.*	T scap	Eurasiat. - Euri-Medit.
Crassulaceae	*Sedum acre L.*	Ch succ	Europ. - Europ.-Caucas.
Crassulaceae	*Sedum album L. subsp. album*	Ch succ	Euri-Medit. - Steno-Medit.
Crassulaceae	*Sedum sexangulare L.*	Ch succ	Centroeurop.
Crassulaceae	*Sempervivum tectorum L.*	Ch succ	Orof. S-Europ.
Poaceae	*Sesleria pichiana Foggi, Pignotti & Graz. Rossi*	H caesp	Endem. Ital.
Caryophyllaceae	*Silene italica (L.) Pers. subsp. italica*	H ros	Euri-Medit.
Caryophyllaceae	*Silene otites (L.) Wibel subsp. otites*	H ros	Eurasiat.
Caryophyllaceae	*Silene otites (L.) Wibel subsp. otites*	H ros	Eurasiat.
Rosaceae	*Sorbus aria (L.) Crantz*	P caesp - P scap	Paleotemp.
Lamiaceae	*Stachys recta L.*	H scap	N-Medit.
Lamiaceae	*Stachys thirkei K. Koch*	H scap	NE-Medit.
Lamiaceae	*Teucrium montanum L.*	Ch suffr	Orof. S-Europ. - S-Europ.
Lamiaceae	*Thymus longicaulis C.Presl subsp. longicaulis*	Ch rept	S-Europ.
Asteraceae	*Tragopogon crocifolius L. subsp. crocifolius*	H bienn - H scap	Steno-Medit.
Fabaceae	*Trifolium incarnatum L. subsp. molinerii (Hornem.) Ces.*	H bienn - T scap	Euri-Medit.
Fabaceae	*Trifolium scabrum L.*	T rept - T cap	Euri-Medit.
Poaceae	*Trisetum flavescens (L.) P.Beauv. Subsp. flavescens*	H caesp	Eurasiat.
Plantaginaceae	*Veronica prostrata L.*	H caesp	Eurasiat.
Lamiaceae	*Ziziphora acinos (L.) Melnikov*	T scap	Euri-Medit. - Steno-Medit.

ASSESSMENT OF THE CURRENT POPULATION OF SPECIES INDICATIVE OF THE CONSERVATION STATUS AND EVOLUTION OF EXISTING HABITATS.

Species n° 1 – Ranunculaceae - *Delphinium fissum Waldst.* & Kit. *subsp. fissum*

A scaphoid hemicryptophyte found in dry, more or less bushy meadows, shrublands, and thermophilous forest edges. Extremely rare and regionally localized, Pietra di Bismantova has one of its largest populations. However, over the past 20 years, it has seen a marked decline, especially in historic sites, while it appears to be spreading to other areas of the summit plateau.

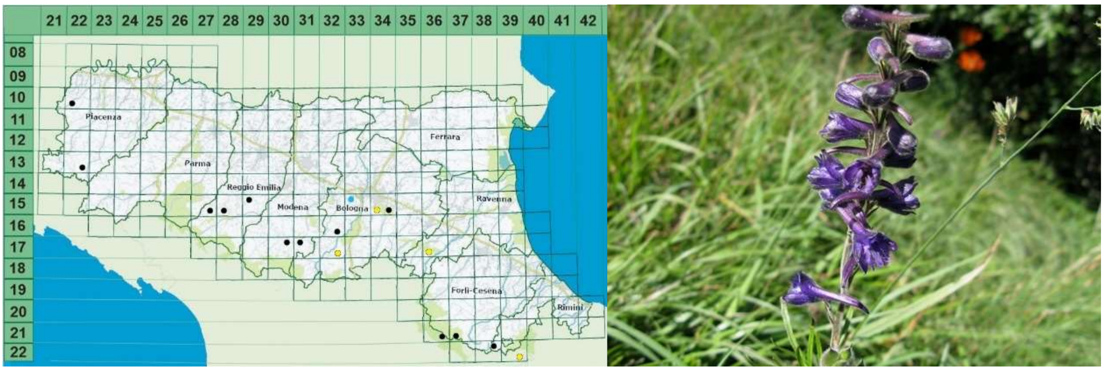


Fig. 31 – Delphinium fissum Waldst. & Kit. subsp. fissum in Bismantova.

Comparing historical data, we observe an increase in the species' population, although it has shifted from open areas, where it was abundant, to the edges of shrubs or woodlands, even into less arid and sunny environments.

The increased frequentation has certainly damaged grassland areas, especially along the edges of trails where the species was once abundant. The overall population of the present sites remains good, and perhaps also favored by a milder climate and less rainfall, the species appears to be continuing to increase.

Periodic monitoring of existing populations and, above all, the identification of any new problems is necessary.

Situation at the end of the 2025 tourist season

The situation remains unchanged, and the species has not suffered any negative impact compared to previous observations. Only in a few cases has flowering stem cutting been recorded.

Species n° 2 – Brassicaceae - Alyssoides utriculata (L.) Medik. subsp. utriculata

A subshrub-like chamaephyte found in arid meadows with varying degrees of shrubby cover, shrublands, and thermophilous forest edges. In the region, it is mainly found on ophiolitic soil. At Pietra di Bismantova, it is quite widespread, especially in the area affected by the relief at the southeastern edge of the summit plateau. In recent years, the species has tended to find refuge almost exclusively on the edge of the escarpment.

Fig. 32 – *Alyssoides utriculata* (L.) Medik. subsp. Utriculate in Bismantova.

The population appears to be in overall good condition and relatively stable, both on the summit plateau and along the cliffs and escarpments.

The only problems identified so far, even with respect to previous knowledge of distribution, concern two of the situations analyzed.

Numerous individuals have been damaged at the base of the cliff where the climbing routes begin and on the southeastern edge of the summit plateau, an area where constant trampling, even off the trails, has significantly reduced the area colonized by the species. However, the situation now appears stable; the health and size of the current population will need to be monitored over time.

Situation at the end of the 2025 tourist season

The situation remains unchanged, and the species has not suffered any negative impact compared to previous observations. Some individuals located at the start and end of climbing routes are damaged, but the overall population remains unaffected.

Observations

The current situation in the area is good; the impacts of use are evident, but for now there are no serious problems, except primarily due to the bad habit of constantly wandering off the trails at the summit.

One problem highlighted during the survey concerns an area at the end of the trail leading to the summit. Clearing, felling, and coppicing work are underway in a currently very limited area along the edge of the trail. Regardless of the reasons for the intervention, the incorrect techniques used are noteworthy. Branches have been broken and pruning has been performed incorrectly, especially on Corylus avellana trees. Even the thinning of some trees' stems was performed without any logical justification.

Fig. 33 – Vegetation management interventions in the Bismantova area.

FUTURE DEVELOPMENTS

An expert botanist will be appointed by PNATE, using its own budget, to continue monitoring the sample areas investigated during the HUMANITA project. This will allow tracking changes, including those resulting from the implementation of management measures identified in the management plans to be developed within the project and applied in the coming years in the pilot areas.

WILDLIFE MONITORING

STARTING DATE

The activity started in August 2025

METHODOLOGY DESCRIPTION

PNATE used the equipment as follows:

4 acoustic sensors model **Song Meter**, each of one consists of:

- **High-sensitivity microphones**, capable of capturing sounds across various frequency bands, including ultrasonic ranges (for bat monitoring).
- **Digital recording unit**, which stores audio on microSD memory cards.
- **Long-lasting battery**, often rechargeable or replaceable, to ensure continuous operation for weeks or even months.
- **Weather-resistant casing**, suitable for outdoor deployment.
- **Programming software**, which allows users to set recording schedules (e.g., only at dawn and dusk).

The device is pre-programmed to record at specific times or intervals. Once deployed in the field (usually mounted on a tree or post), it passively records the soundscape. The collected audio files can then be analyzed manually or using specialized bioacoustic software to identify species, count vocalizations, or assess habitat quality.

Fig. 34 – Acoustic sensors.

The acoustic sensors were configured and monitored using the dedicated smartphone application provided by the manufacturer. This app allows users to:

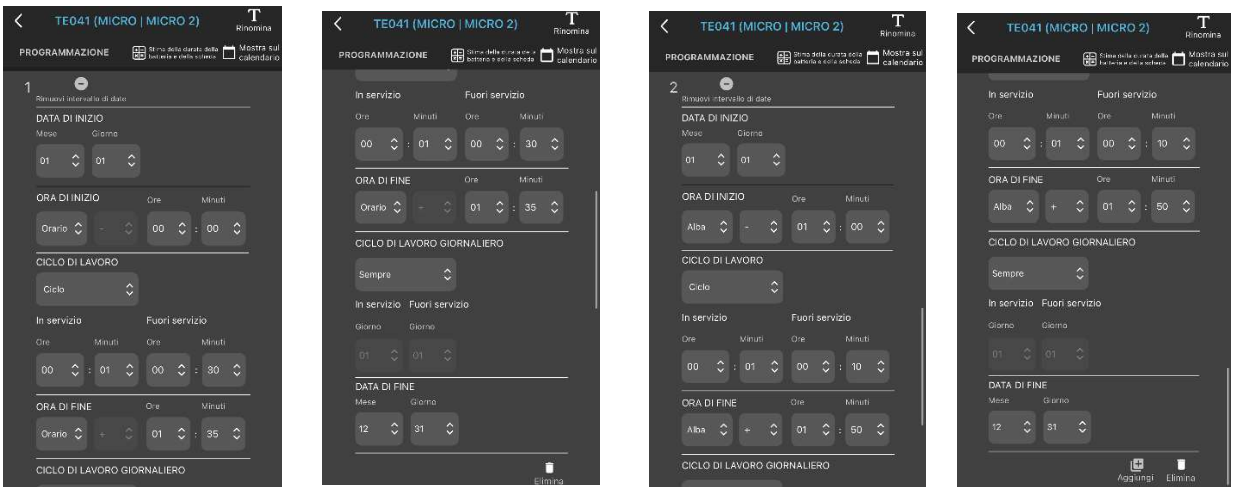
- Set recording schedules with customizable intervals and durations.
- Check device status (battery level, memory capacity, and operational status) remotely.
- Synchronize the internal clock to ensure accurate timing of recordings.
- Download configuration logs for quality control and troubleshooting.

This tool ensured precise scheduling and reliable operation throughout the monitoring period.

Fig. 35 – Acoustic sensors model.

The acoustic sensors were programmed with the following settings:

- **Nighttime recordings:**
    - One-minute recordings every 30 minutes, from midnight to 1:30 a.m., for a total of 4 recordings.
    - One-minute recordings every 10 minutes, starting one hour before sunrise and continuing until 1 hour and 50 minutes after sunrise, for a total of 16 recordings.



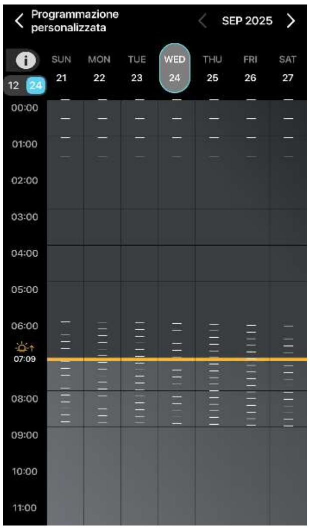


Fig. 36 – Acoustic sensors configurations.

- **Extended dawn and dusk recordings:**
  - Five-minute recordings every 15 minutes, starting one hour before sunrise and continuing until one hour after sunrise.
  - Five-minute recordings every 15 minutes, starting one hour before sunset and continuing until one hour after sunset, for a total of 12 recordings.

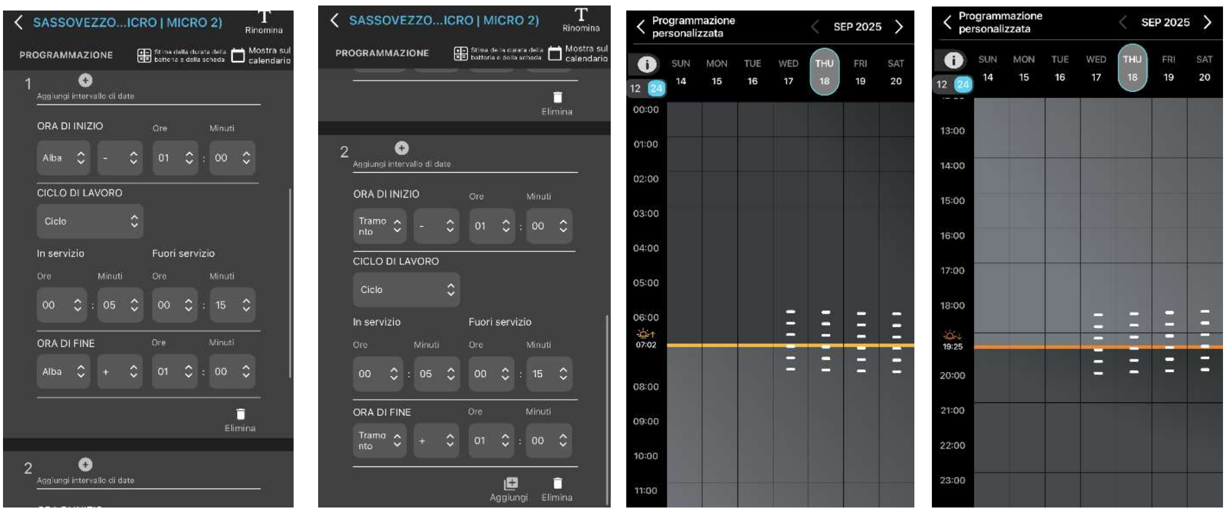


Fig. 37 – Acoustic sensors configurations.

Bioacoustic surveys aim to record, analyze, and classify bird vocalizations in order to identify the species that contribute to the soundscape. By capturing temporal and spatial patterns of avian activity, these surveys provide insights into species presence, abundance, and behavioral ecology. The method is non-invasive and allows continuous monitoring over extended periods, facilitating the assessment of habitat quality, biodiversity trends, and ecosystem dynamics. Such data are crucial for informing conservation planning, management strategies, and ecological research.

The objective for installing the acoustic sensors in PNATE within HUMANITA project was to evaluate disturbance comparing the bird species near two busy dirt roads leading to mountain refuges, by placing one sensor near the road and another deeper inside the beech forest for each road. This configuration allows us to assess the differences in anthropogenic noise and its potential impact on wildlife between high-disturbance areas (close to roads) and quieter control sites (inside the forest).

- One pair of sensors was placed along the road leading to Rifugio Lagoni (currently closed, therefore experiencing much less traffic than usual):
  - One near the road at coordinates 44.4002 10.03596, close to a single-track trail passing a few meters from a small parking area with space for three cars.
  - The corresponding sensor, intended to record birds undisturbed by road traffic, was placed off-trail at coordinates 44.40488 10.03517.
- The other pair of sensors was placed along the road leading to Rifugio Lagdei:
  - One a few meters below the dirt road, at the junction with the trail leading to Località Vezzosa (an area frequently used for barbecues, camping, environmental education, excursions, etc.) at coordinates 44.41522 10.01744.
  - The corresponding control sensor was installed deeper inside the spruce forest, off-trail, at coordinates 44.41806 10.01623

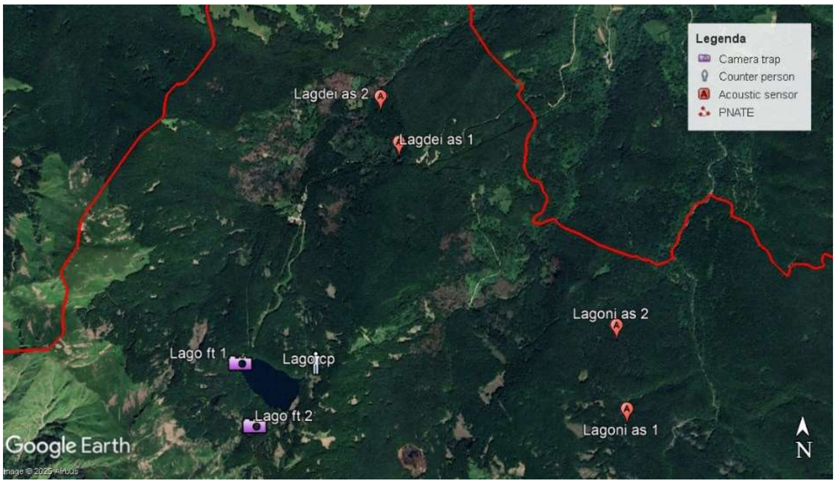


Fig. 38 – Acoustic sensors positions.

Data are recorded by devices that are periodically visited by an operator who downloads the data to SD cards. The data are transmitted to the technicians in a specific sharepoint and are analyzed by a software.

The software enables the identification of bird species from the recordings, facilitating the analysis of the avian community and the assessment of species presence and abundance.

RESULTS AND OBSERVATIONS

Device TE041: 312 acoustic files

Device TE050: 314 acoustic files

Device TE054: 314 acoustic files

Device TE055: 313 acoustic files

A total of 1,253 recordings were collected and will be processed using specialized bioacoustic analysis software (Kaleidoscope Pro Analysis Software)

- **Acoustic sensors:**
  - *Pros*: collect large amounts of data on wildlife behavior.
  - *Cons*: the configuration is slightly more complex compared to camera traps.

- **Main issues identified for data collection procedures on the platforms:**

  - Acoustic sensors: a specialist ornithologist is needed for data analysis because current software systems are not yet 100% reliable.

- **Main issues identified for logistics:**

The use of technical staff is necessary to periodically check the functioning of the devices, download the data, and replace batteries and SD cards.

FUTURE DEVELOPMENTS

This technique will continue to be employed. PNATE is initiating a volunteer-based project to engage and train participants in data collection using camera traps and acoustic recorders. Consequently, over the next five years, these activities will be sustained through the involvement of properly trained volunteers and enthusiasts, under the guidance of experienced technical staff.

EROSION MONITORING

STARTING DATE

On-site activities started between June and July 2023, depending on the pilot site.

METHODOLOGY DESCRIPTION

The main objective of this activity is to evaluate the effect of anthropic presence in terms of soil erosion, trail conditions, and trampling phenomena by exploiting different approaches and techniques depending on the investigation scale.

The first scenario focuses on a detailed analysis of selected sample small areas (few square meters), aiming to precisely measure the impact of small-scale erosion processes. In this case, the use of a tripod-mounted Terrestrial Laser Scanner (TLS) and close-range photogrammetry was investigated. Both instruments achieve high levels of precision (up to 1 mm for TLS and even higher for photogrammetry). The second approach investigates the survey of trail segments of varying lengths, including narrow paths in wooded areas. In this case, the selected techniques include spherical photogrammetry and UAV-based photogrammetry. The final scenario examines broad, open areas where it is necessary to assess the average trend of soil erosion and trampling phenomena. Here, UAV equipped with imaging sensor is employed due to its ability to cover large areas efficiently and with high accuracy.

The second approach involves the application of dendrological analyses on root samples to assess soil erosion rates along selected trails. Roots, when they come to light because of soil erosion, start growing in a different way, usually producing larger annual tree rings with narrower vessels. By counting the tree rings since this change occurred, is therefore possible to know the exact number of years that have passed up to present. The current soil surface around the emerging root has been used to estimate the local slope and the present root heights. This height is related to the amount of soil that has been eroded since root emersion. Therefore, for each of the analyzed roots it is possible to estimate an annual erosion rate.

All these techniques have been applied in different pilot sites within the Tuscan-Emilian Apennine National Park protected area:

Pietra di Bismantova

- Aerial photogrammetry performed with DJI Mavic 3E drone flying at high altitude to survey the entire top of the Pietra
- Ground-based photogrammetry performed with a standard camera on a short section of the trail leading to the top of the Pietra

Val Parma

- Aerial photogrammetry performed with DJI Mavic 3E drone flying at high altitude to survey the area below the Marmagna Saddle
- Aerial photogrammetry performed with DJI Mavic 3E drone flying at low altitude to survey the trail leading to the Marmagna Saddle
- Ground-based photogrammetry performed with a standard camera on a short section of the trail above the Lago Santo

Mount Cusna

- Aerial photogrammetry performed with DJI Mavic 3E drone flying at high altitude to survey the Lama Lite Pass trail network
- Aerial photogrammetry performed with DJI Mavic 3E drone flying at high altitude to survey the area surrounding the Bargetana Lake
- Aerial photogrammetry performed with DJI Mavic 3E drone flying at low altitude to survey the path connecting the main trail with the Bargetana Lake
- Aerial photogrammetry performed with DJI Mavic 3E drone flying at low altitude to survey the trail from the Lama Lite Pass to the ridge

- Ground-based photogrammetry performed with Insta 360 Pro2 panoramic camera on the main trail leading to Lama Lite Pass

RESULTS AND OBSERVATIONS

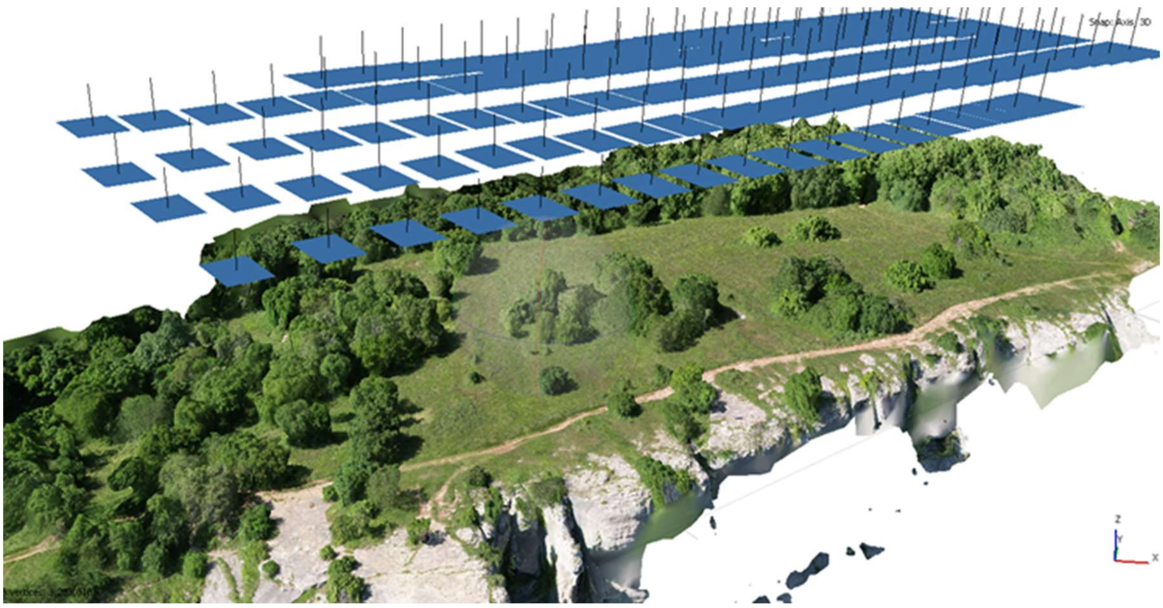
UAV-based surveys

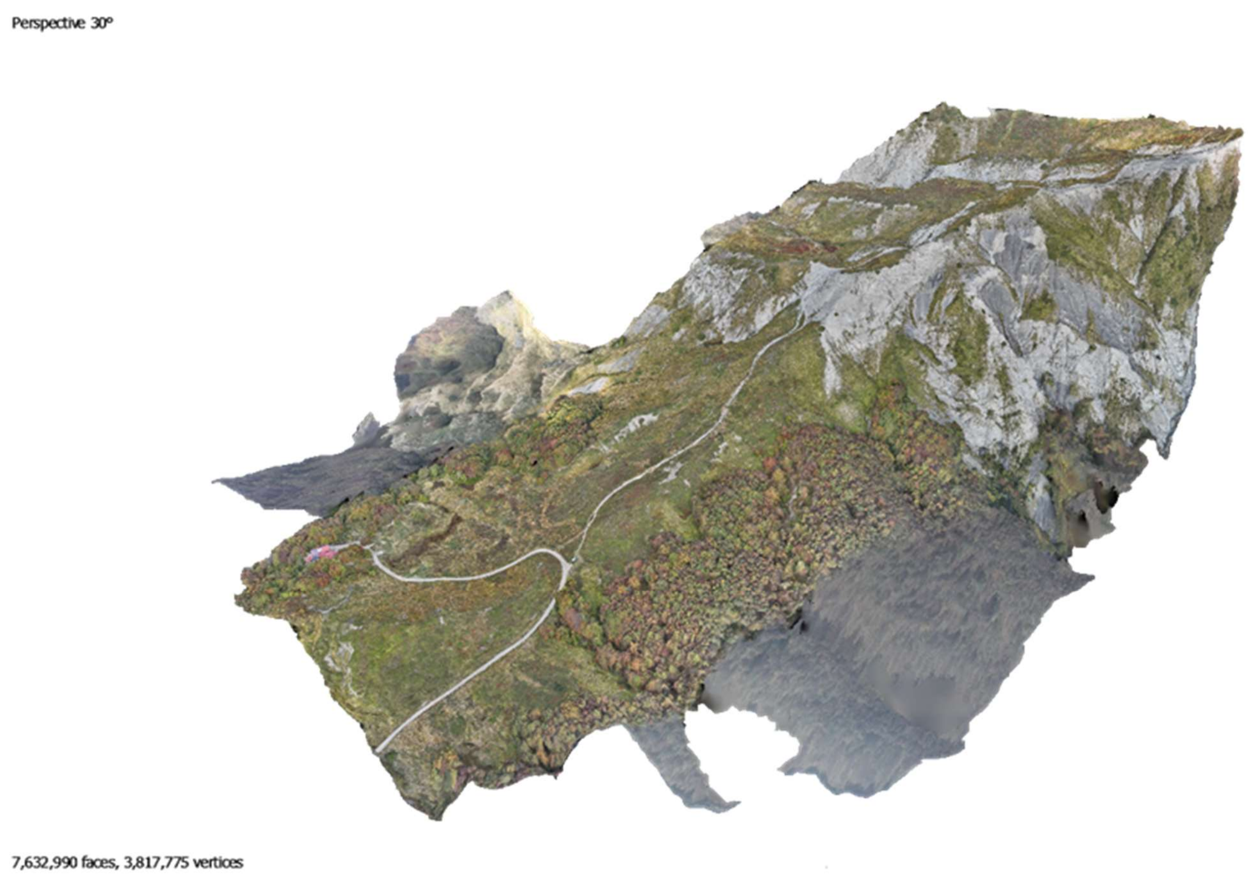
As previously stated, UAV-based photogrammetric surveys were planned for all pilot sites with two different approaches, collecting data with both areal and linear acquisitions. These activities have been performed over the entire duration of the project, before and after the summer season, in order to capture significant variations during the most crowded periods of the year. The following table summarizes the survey dates for each pilot site. Another survey campaign is planned before the end of 2025 to complete the dataset.

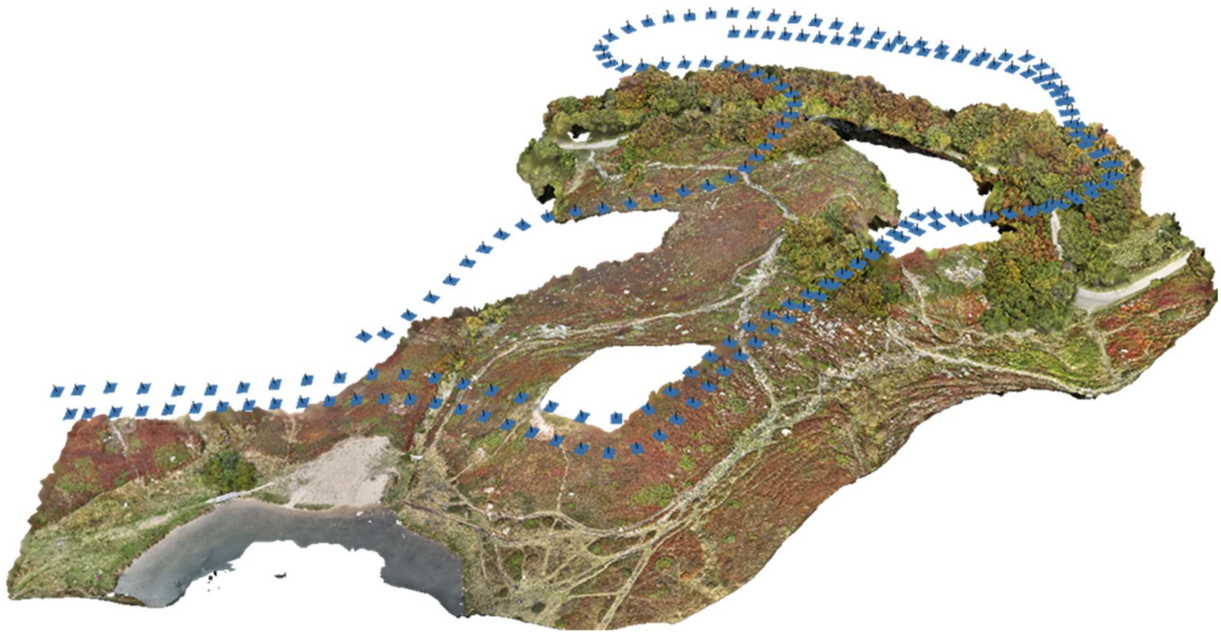
Pietra di Bismantova	Val Parma – Marmagna Saddle	Mount Cusna – Lama Lite Pass and Bargetana Lake
19/06/2023	04/07/2023	11/07/2023
19/04/2024	07/10/2023	06/10/2023
12/10/2024	04/07/2024	05/07/2024
28/05/2025	16/11/2024	11/10/2024
	26/06/2025	28/05/2025

The use of UAV-based sensors has proven highly effective for surveying extended trail sections in open areas, thanks to the possibility of planning flights at fixed altitudes with predefined photo overlap. This approach ensures both time efficiency and the comparability of repeated surveys, as flight plans can be stored and replicated. Two main configurations were applied, differing primarily in the flight altitude. High-altitude surveys (above 80 meters) provide a broad overview of the area of interest, with DSMs covering large portions of the trail network while still capturing individual paths with sufficient resolution. In contrast, low-altitude surveys (around 30 meters) are designed to follow specific trails, producing highly detailed models that facilitate precise multi-temporal comparisons.

In both cases, the adopted methodology proved reliable in practical terms and delivered valuable datasets to support comparative analyses across different monitoring periods.



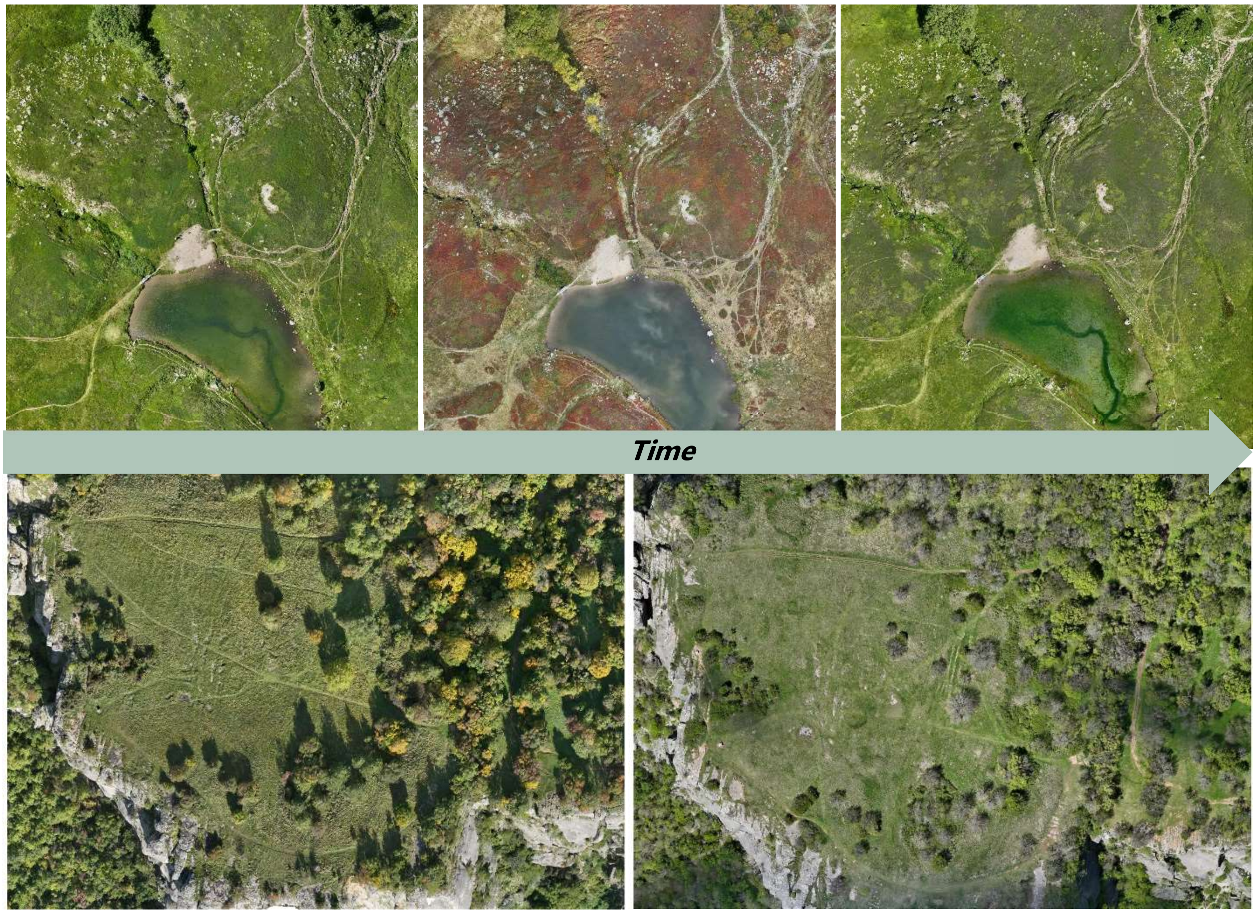




The same methodology was also tested in forested areas by manually flying the UAV beneath the canopy and along the trail. While this proved to be a feasible option for conducting surveys in such environments, several limitations emerged. First, the high density of obstacles prevents the use of pre-planned flight paths, requiring manual operation throughout the survey. Second, the very low flight altitude (around 2–3 meters) makes it necessary to proceed at extremely slow speeds to ensure sufficient photo overlap, which significantly increases the time required for data acquisition.

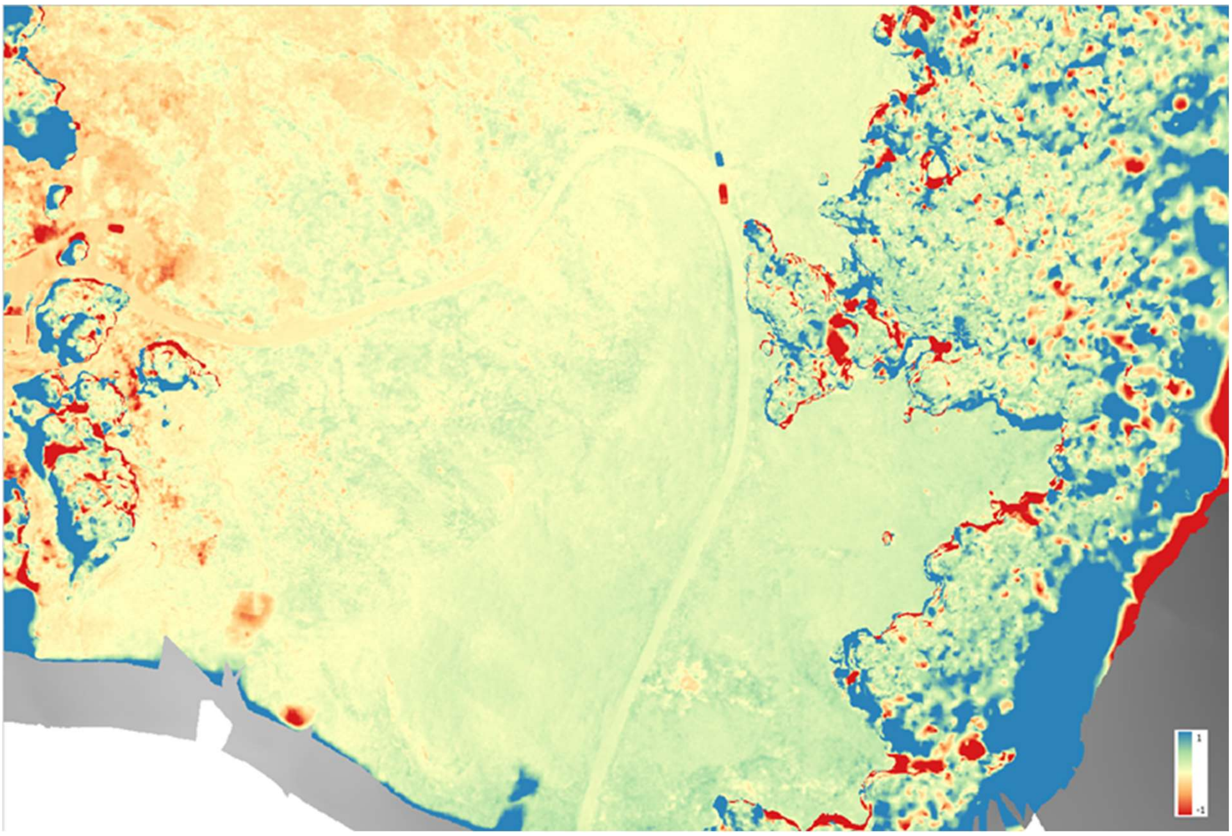
Despite these challenges, the approach remains a viable solution for monitoring trails in densely vegetated areas, though it is less efficient compared to surveys in open environments.

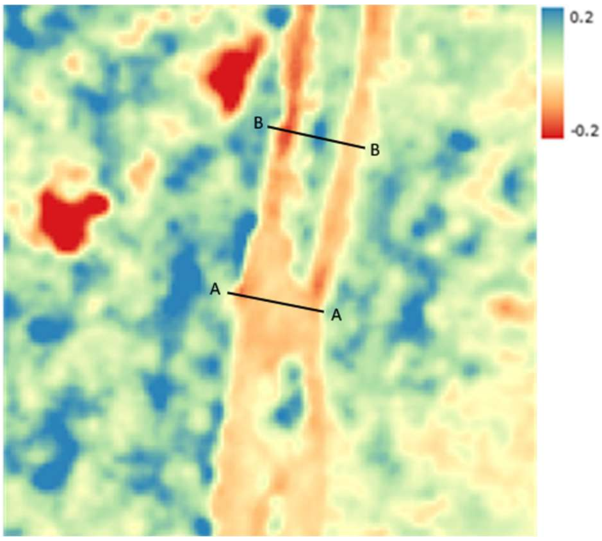
The comparison between photogrammetric surveys performed at different times, aimed at determining the erosion rate of the trails and potential trampling phenomena, is the main objective of these activities.

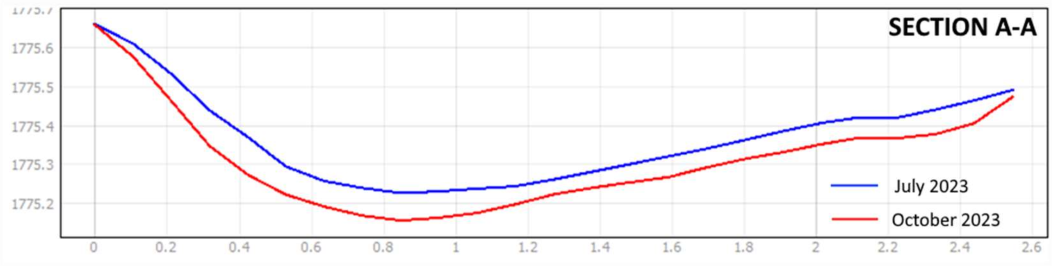


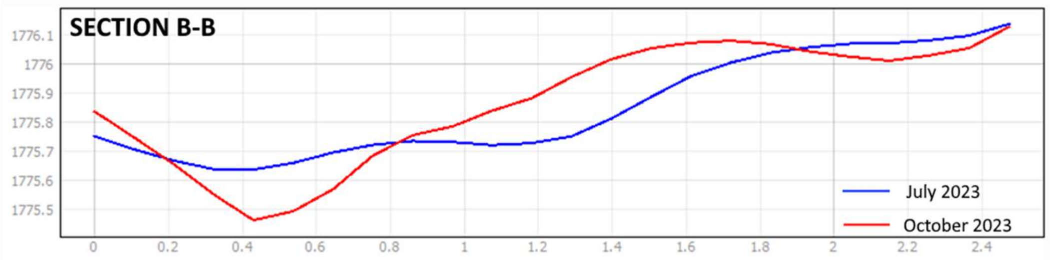
In the overall perspective, a clear distinction can be observed between the trail—characterized by moderate elevation variations—and the surrounding environment, where vegetation growth strongly influences altitude differences. At this broader scale, the analysis is particularly useful for detecting the formation of unofficial paths or trampling outside the main trail, as these disturbances are expected to generate noticeable variations in DSM comparisons.

When the observation scale is reduced, the method demonstrates its capacity to provide highly detailed insights into selected trail sections. In this configuration, the use of finer contour intervals allows a more accurate assessment of modifications affecting the trail profile. Additionally, it becomes possible to extract cross-sectional profiles along user-defined transects, further enhancing the analysis of localized changes.



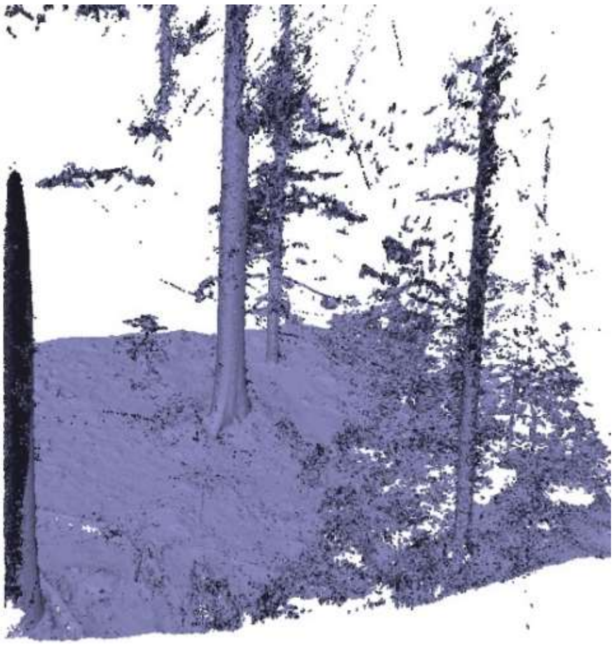




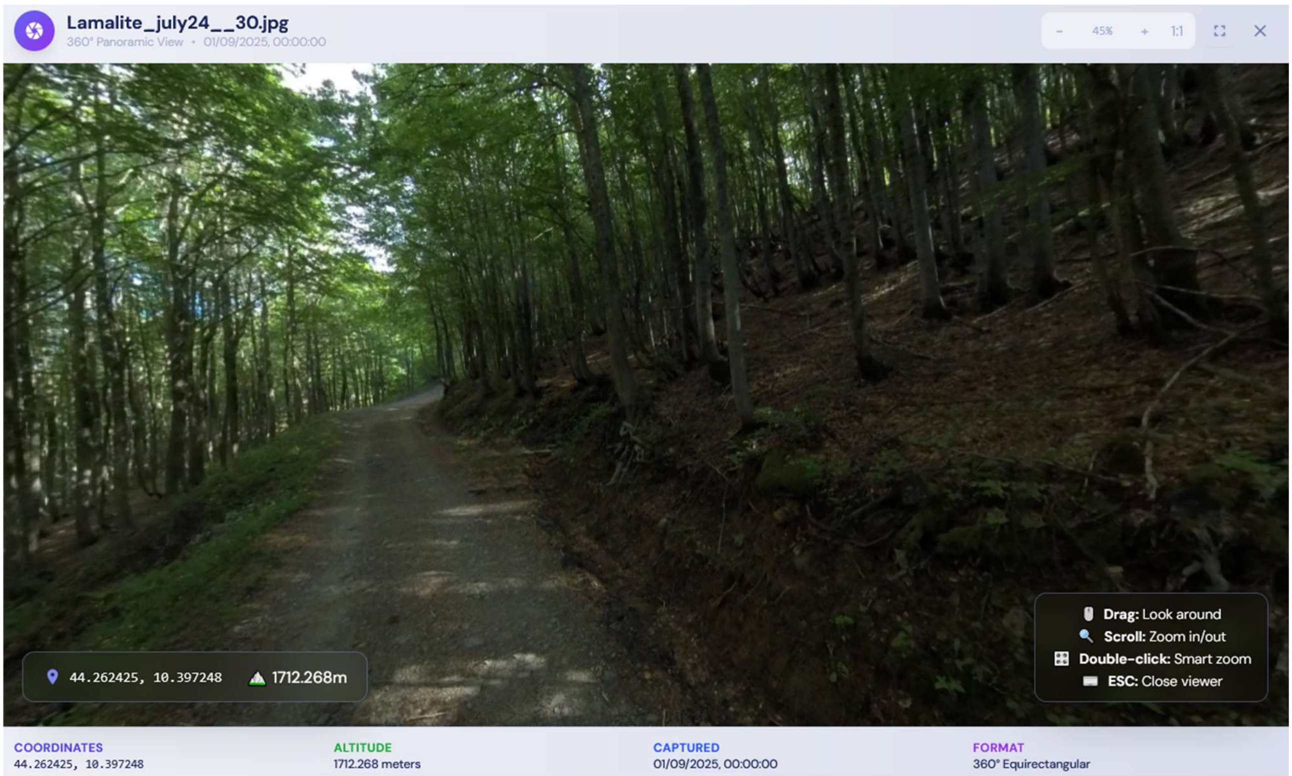


Ground-based photogrammetry with 360 camera

Backpack-mounted spherical imaging technologies were introduced specifically for surveys in densely vegetated areas, where the use of aerial sensors is less effective. Several preliminary acquisitions confirmed the practicality of this approach, demonstrating both the portability of the equipment and its reliability in field conditions. The selected acquisition mode, based on a 2-second time lapse, requires the operator to maintain a relatively slow walking pace to ensure adequate image density, making the process somewhat time consuming. Nonetheless, when compared with UAV-based surveys in similar contexts, this method offers advantages in terms of battery efficiency and operational simplicity. For these reasons, spherical imaging represents a valuable addition to the set of available technologies for trail monitoring.



Finally, a dedicated test site was prepared at the Mount Cusna pilot site with the objective of studying the sensor's behaviour over long portions of a trail in term of accuracy and drifting. Data are currently under elaboration; however preliminary outcomes of the analysis confirmed the effectiveness of this application in the studied context. This survey also evidenced the capability of this technique to provide accessible and easy-to-navigate information for a qualitative analysis of the trail conditions and the surrounding environment. For this purpose, a dedicated viewer was implemented in the web-based platform designed for the HUMANITA project, giving the user the possibility to navigate all images collected during the survey for a closer inspection.

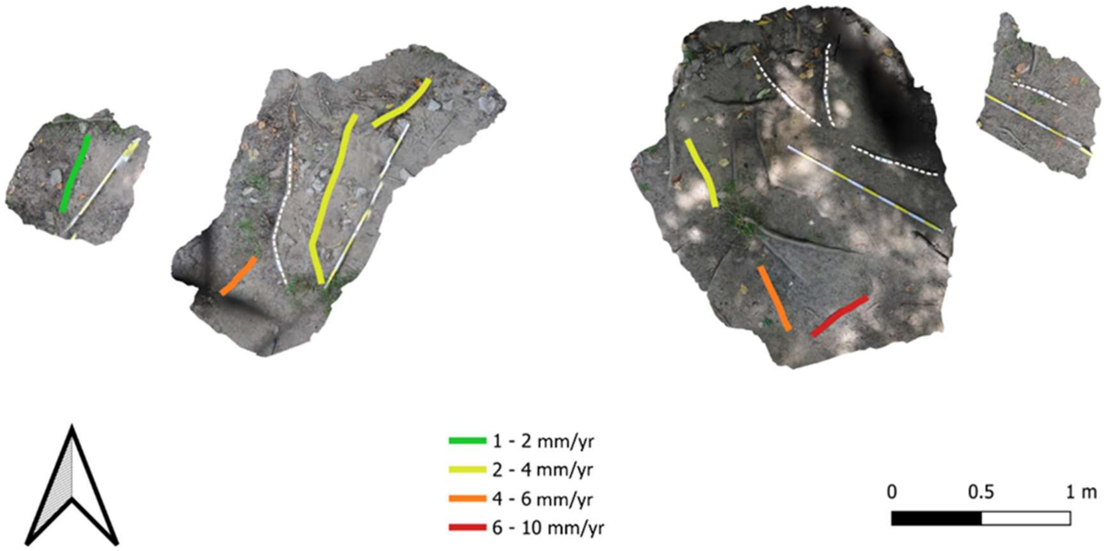


Dendrochornological analysis and close-range photogrammetry

The root sampling activities, which are essential to retrieve elements to analyse with appropriate laboratory tests, where perfomed at the beginning of the project (Summer 2023) in two pilot sites in the Tuscan-Emilian Apennine National Park:

- Pietra di Bismantova: here we sampled the exposed roots of some Field Maple trees (*Acer campestre* L.), and 15 trees from an undisturbed site in the vicinities for the construction of a reference chronology
- Val Parma: here we sampled the exposed roots of some Silver Fir trees (*Abies alba* Mill.) along a trail, and 15 trees from an undisturbed site in the vicinities.

The first estimates calculated for 7 roots at the lower site of Pietra di Bismantova, over the last 10 years indicate a mean soil erosion rate of Er = 4.55 mm/yr.



For what concerns the Val Parma pilot site, this activity was also supported by a series of photogrammetry surveys performed with a close-range approach, focusing specifically on the sampled roots to provide further information of the active erosion processes. While this approach does not represent a viable solution for continuous monitoring due to limited coverage and time-consuming operations, it is a useful complementary tool to gather extremely detailed information of specific locations, providing also an additional reference for results coming from other methodologies.

FUTURE DEVELOPMENTS

Building on the promising preliminary results, field surveys have been systematically continued at regular intervals in all pilot sites, allowing the creation of a consistent time series of observations. This long-term approach not only increases the dataset dimension but also improves its reliability by capturing seasonal variations and inter-annual changes in the monitored areas.

The current objective is to finalize the data processing workflow, with a focus on generating accurate three-dimensional models of each survey. These models represent a key advancement, as they enable precise comparisons across different time periods, making it possible to quantify surface changes with high spatial resolution. In particular, the analysis of multi-temporal 3D datasets will provide a robust basis for assessing the intensity, extent, and evolution of erosion dynamics, offering valuable insights into both localized trail degradation and broader landscape-scale processes.

In addition, the integration of these models with complementary monitoring outcomes—such as visitor counts or other environmental indicators—will enhance the capacity to interpret erosion phenomena in relation to human pressure and natural factors. This combined approach is expected to strengthen the overall understanding of trail sustainability and to support decision-making processes for conservation and management strategies.

WATER DEMAND MONITORING

STARTING DATE

The monitoring field activity and data collection has begun in June 2023.

METHODOLOGY DESCRIPTION

The main goal is to provide support to quantify the impact on groundwater resources caused by an excess of withdrawal of drinking water from an important group of springs during the peak due to seasonal tourism and along low recharge period of aquifer within the Appennino tosco-emiliano National Park and in a Natura 2000 network site (SAC/SPA IT4030004 „Val d'Ozola-Monte Cusna").
The case study selected to evaluate this possible impact is the Toano municipality's aqueduct system located in the Reggio Emilia province, Emilia-Romagna Region, which draws the water resource from a group of springs located along the north-east side of Mt. Cusna (2120 m a.s.l.) (Figure 39).

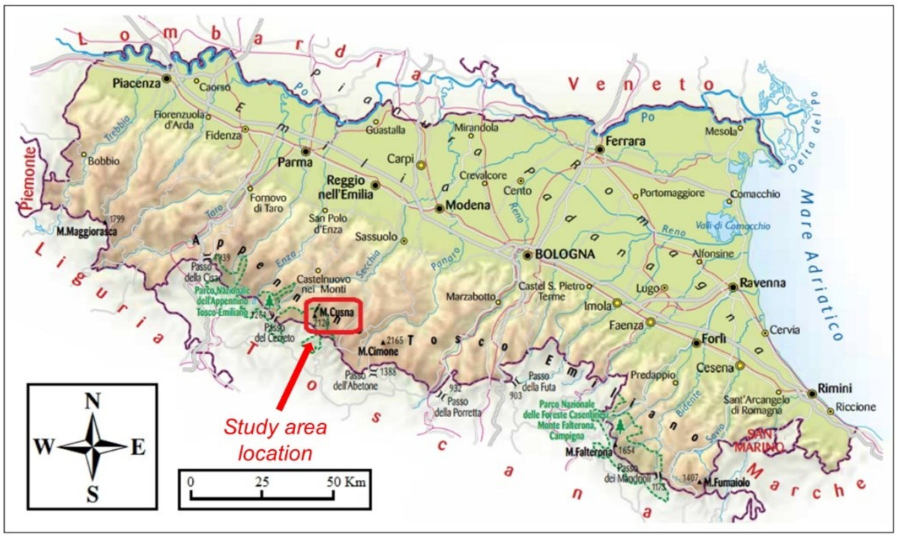


Fig. 39 – Study area location.

From a methodological point of view, this choice was made because the Toano aqueduct is the only way to obtain the data springs needed to evaluate the possible impact of the flow of tourists on the groundwater resource.

Toano is a village in the northern Apennines affected by an important tourist flow, especially during the summer period and on the north-eastern side of Mt. Cusna. There are important springs captured for drinking water use that feed the village of Toano.

We try to evaluate how the flow of tourists impacts on groundwater that is increasingly vulnerable due to the ongoing climate change that is manifested through a change in the water cycle (increase in the frequency and duration of drought periods and the intensification of extreme rainfall events).

This is also accentuated by the fact that, because of the last pandemic, there is a constant increase in the flow of tourists in the Apennines. This is prompting local communities' authorities to increasingly find new groundwater resources to capture for drinking water to satisfy this increasing tourist flow.

We will also try to understand how the springs are captured, the state of preservation of the spring box, whether there is an overflow and how this overflow is managed/released in the hydrographic reticulum, the modalities of its release.

Finally, Toano is a representative case study of a situation that is particularly widespread in the mountainous sector of the northern Apennines.

The collected data required for this type of analysis are:

1) Geological and geomorphological framework;
2) Hydrogeological setting;
3) Aqueduct framework;
4) Historical time series, from 2018 to 2022:
    a. hydrogeological and hydrochemical
        - Total flow discharge springs;
        - Water quality data analysis;
    b. Meteor and climatic setting (thermal and rainfall regime);
    c. Utility supply sources and different uses;
    d. How users vary throughout each year;
    e. Tourism water use based on readily available data;
    f. Municipality of Toano water supply information.

The aqueduct users and water supply information in the municipality of Toano data was given by the company that manages the aqueduct (A.S.T. Toano, https://www.acquatoano.it/).

In addition, a series of field surveys were carried out to:

1) Identify the type of spring capture methods (spring box), their characteristics, critical aspects, their state of conservation and in particular the presence of overflow to ditch, etc;
2) Survey census, through a citizen science project, the presence of springs still in natural conditions

Fig. 40 - A spring box.

Fig. 41 - Example of captured spring feeding the Toano aqueduct.

Fig. 42 – Examples of natural springs inventoried in the study area.

These two activities continued: for 2024, the data collection provide by the aqueduct ha been delivered, for the year 2025 the data are being collected and can be entered once validated in 2026; the Citizen science activities continued in 2024 and 2025, leading to an increase in reports, further information/training moments involving other people and a new appointment is expected by the end of the year.

All these data are available in digital and vector georeferenced format on Qgis software.

These data are the main components that allow the hydrogeologic reconstruction of the study area area and that permit to define the water capacity, the picture of vulnerability of the resources and the evolution of possible pollutions in relation to the tourist impact.

RESULTS AND OBSERVATIONS

Concerning the Toano aqueduct, through a degree thesis (University of Bologna, prof. Gargini Alessandro), an analysis was made of the geological and geomorphological data, hydrogeological and hydrochemical historical time series data (2018-2022) collected. This preliminary activity made it possible to:

1) Define the main characteristics of the aqueduct, in particular:

The Toano municipality's aqueduct system is fed by 26 perennial springs. All the springs are within the Natura 2000 network and 21 springs are inside the Tuscan-Apennine National Park (Figure 4). The total discharge withdrawn by **the aqueduct is measured continuously since 2018** at Volturimetro tank through an electromagnetic flowmeter installed on the discharge pipe (Figure 4). Only a part of the total discharge springs feeds the local aqueduct pipe. The total flow rate collected is not available, but only the flow rate fed into the Toano aqueduct. The remaining discharge overflows feed the local surface drainage system.

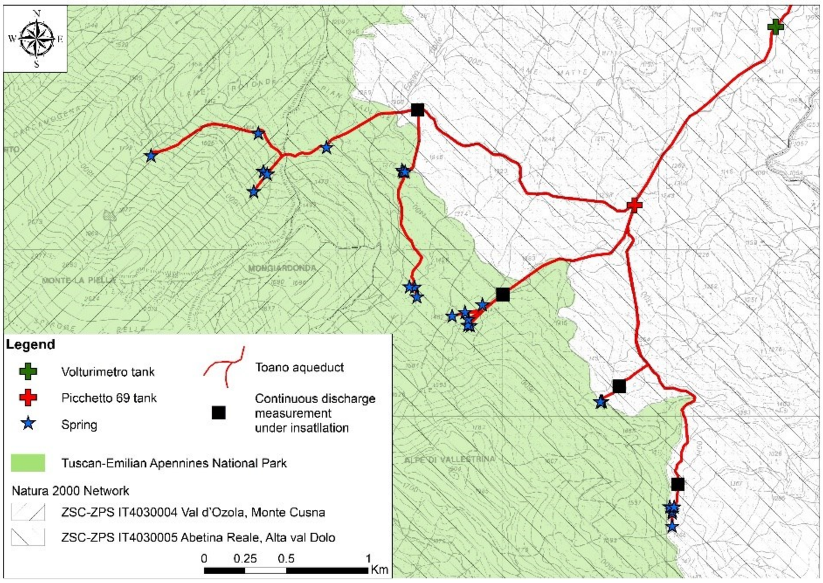


Fig. 43 - Springs location that feeds the Toano municipality's aqueduct system.

2) Made a hydrogeological balance that has allowed us to understand the main characteristics of the springs and criticalities of the Toano aqueduct.

The estimated total discharge rate of the system, defined on the basis of the recharge estimate, is around 50-70 liters per second per year. With a source recharge area of 2.63 km2, this corresponds to a specific productivity of quaternary deposits of 24.7 liters for second for km^2. The high average flow rate is ensured by the large amount of precipitation and the high permeability of the glacial deposits.

Obviously, seasonality has a significant impact on the water resource, dropping to a recent historical minimum of 18 liters per second, from a maximum of 150 liters per second in the recharge seasons of the years with the greatest inflows. It is precisely this significant variability that brings our system into a significant crisis: in fact, the lack of water, typical of August and September, combined with a large influx of tourists, causes the Toano aqueduct to request tens of thousands of m^3 of water from external company (Ireti S.p.A.), especially in drought years, to make up for the shortages of its own sources. During the summer of 2022, the aqueduct was forced, due to the stringent drought conditions present to supplement with 56,000 m^3 to meet the entire municipal demand; on the contrary, in 2020 (the year in which the lockdown was in force), the supplement needed was only 600 m^3 in total, proving that the system is, without any influx of tourists, self-sufficient.

It is precisely tourism that determines the need to demand water from an external company, as it alone leads to a net increase in demand of 25 %. If there were no 'fluctuating' inhabitants of any kind, even in the extremely dry seasons, as was the case in the year 2021-2022, the system would be able to stand on its own: the demand for water, both according to estimates at 200 liters per day and at 250, show a very low deficit during the two most critical months. Theoretically, with the amount of water supplied during the entire year, it would be possible to cope with all summer demands without any problems.

Toano aqueduct: how did we calculate the estimated consumption through historical data?
200 L/day and 250 L/day are estimated consumption values that derive from the law D.P.G.R. 28/R/03

Main user information on water consumption in the municipality of Toano (period 2018-2022)

- **Resident served: 4.380;**
- **Average fluctuating inhabitants (tourist components): 2.906;**
- **No domestic users: 58.856 m^3 for year;**
- **Agricolture, Zootechnical users: 251.358 m^3 for year**

(Average values from 2018 to 2022)	
User typology present in Toano municipality	*Each total user typology has been multiplied by 200 L/day* *Estimated daily consumption (m^3)*
Resident	876,0
Tourist components	581,2
No domestic	161,2
Agricolture, Zootechnical	895,2
Total	*2.513,6*

Table (1)

(Average values from 2018 to 2022)	
User typology present in Toano municipality	*Each total user typology has been multiplied by 250 L/day* *Estimated daily consumption (m^3)*
Resident	1.095,0
Tourist components	726,5
No domestic	161,2
Agricolture, Zootechnical	895,3
Total	*2.878,0*

Table (2)

Fig. 44 - Main user information on water consumption period 2018-2022.

This result is validated by comparison of two years: during the summer of 2020 (the year in which the lockdown was in force and not drought conditions), the aqueduct has been integrated with only 600 m^3 in total, showing that the system is, without any flux of tourists, is independent (resident habitants, no domestic-industry users and zootechnical use. Instead, during the summer of 2022 due to the hard drought conditions and the covid limit was not active, the aqueduct has been integrated with 56.000 m^3 (from Ireti S.p.A and this resource is paid) to supply the total municipal demand.

The minimum discharge springs is never below 18-20 L/sec, even in the summer 2022.

(Average values from 2018 to 2022)				
Difference in volumes m³ (including tourist component)	*August*		*September*	
	Estimate a 200 L/day	*Estimate a 250 L/day*	*Estimate a 200 L/day*	*Estimate a 250 L/day*
Estimated consumtion-Minimum Captured discharge	- 7.139 mc	- 18.435 mc	- 19.917 mc	- 30.849 mc
Estimated consumtion-Average Captured discharge	+ 9.153 mc	- 2.143 mc	- 6.457 mc	- 17.389 mc
Estimated consumtion-Maximum Captured discharge	+ 16.000 mc	+ 4.704 mc	+ 87 mc	- 10.845 mc

Table (1) ***Blue*** *indicates a positive balance and* ***red*** *a negative one.*

(Average values from 2018 to 2022)				
Difference in volumes m³ (not including tourist component)	*August*		*September*	
	Estimate a 200 L/day	*Estimate a 250 L/day*	*Estimate a 200 L/day*	*Estimate a 250 L/day*
Estimated consumtion-Minimum Captured discharge	+ 10.879 mc	+ 4.086 mc	- 2.481 mc	- 9.054 mc
Estimated consumtion-Average Captured discharge	+ 27.171 mc	+ 20.378 mc	+ 10.979 mc	+ 4.406 mc
Estimated consumtion-Maximum Captured discharge	+ 34.018 mc	+ 27.225 mc	+ 17.523 mc	+ 10.950 mc

Table (2) ***Blue*** *indicates a positive balance and* ***red*** *a negative one.*

Fig. 45 – Table 1: Difference between captured (minimum, average and maximum) and estimated consumption (in cubic meters) counting tourists. Blue indicates a positive balance and red a negative one.

Table 2: Difference between captured (minimum, average and maximum) and estimated consumption (in cubic meters) excluding tourists. Blue indicates a positive balance and red a negative one.

3) Identification of the aquifer that feeds the springs. These are important glacial deposits present in the study area (Figure 7). As the volume of the glacial cover is not excessive, this does not ensure a regulating effect that mitigates the negative effects of multi-year variations in the recharge, and as a result there is a high variability, with a wide gap between minimum and maximum flow discharge of the springs.

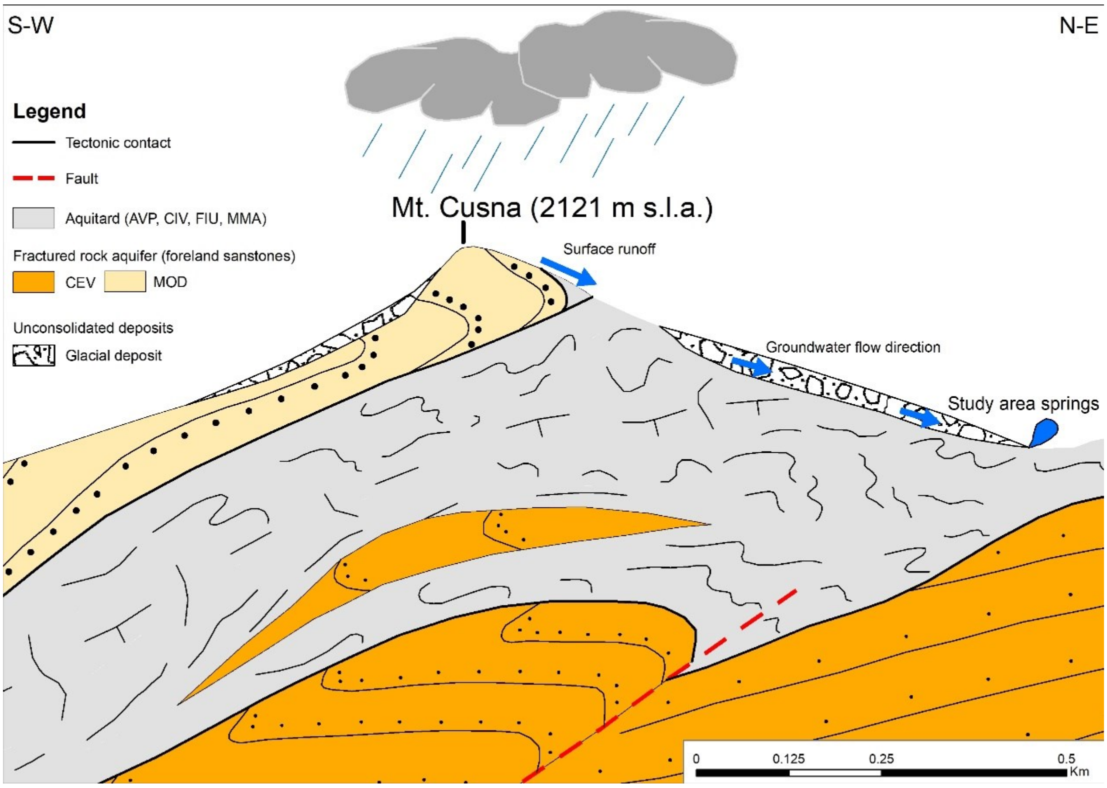


Fig. 46 - Important glacial deposits present in the study area feeds the springs.

4) The chemical data analysis made it possible to classify the type of spring water, namely very-low-alkalinity springs and therefore of high quality in a highly natural context. This is due to two main reasons: the aquifer is composed of non-soluble rock gravel and rapid groundwater circulation times within it.

5) The analysis of flow monitoring data for 2023 and 2024 and related hydrogeological balance (Figures 47 and 48) is congruent with the results of the historical data analysis.

Average values from 2023 to 2024				
Difference in volumes m³ ***(including tourist component)***	*August*		*September*	
	Estimate a 200 L/day	*Estimate a 250 L/day*	*Estimate a 200 L/day*	*Estimate a 250 L/day*
Estimated consumtion-Minimum Captured discharge	- 7.026 mc	- 18.035 mc	- 19.397 mc	- 29.484 mc
Estimated consumtion-Average Captured discharge	+ 9.043 mc	- 1.934 mc	- 4.847 mc	- 16.943 mc
Estimated consumtion-Maximum Captured discharge	+ 15.787 mc	+ 4.545 mc	+ 65 mc	- 9.871 mc

Fig. 47 - Blue indicates a positive balance and red a negative one.

Average values from 2023 to 2024				
Difference in volumes m³ ***(not including tourist component)***	*August*		*September*	
	Estimate a 200 L/day	*Estimate a 250 L/day*	*Estimate a 200 L/day*	*Estimate a 250 L/day*
Estimated consumtion-Minimum Captured discharge	+ 10.011 mc	+ 4.048 mc	- 2.001 mc	- 8.634 mc
Estimated consumtion-Average Captured discharge	+ 26.011 mc	+ 19.011 mc	+ 9.9611 mc	+ 3.689 mc
Estimated consumtion-Maximum Captured discharge	+ 33.131 mc	+ 26.501 mc	+ 16.003 mc	+ 9.850 mc

Fig. 48 - Blue indicates a positive balance and red a negative one.

For the years 2023, 2024 e il 2025 the main user information on water consumption in the municipality of Toano are the same of the 2018 to 2022 period.

Data relating to the year 2025 will be available next year due to internal validation at AST in Toano and Atersir (Emilia-Romagna regional agency for water and waste services).

FUTURE DEVELOPMENTS PLANNED FUTURE ACTIONS

1) Continuing the on-site monitoring and sampling activities in order to increase the dataset dimension provided by AST and to collect useful data to validate and consolidate what was preliminarily obtained from the analysis of historical data through the degree thesis and the data acquired during this project;

2) With the University of Bologna activation of a second-degree thesis to continue analyzing the hydrogeological balance of the study area to evaluate if there are conditions for better defining an index through which to determine the impact of tourist flow on groundwater resources.

3) By the end of 2025, the A.S.T. company, at strategic points, will install some devices for continuous monitoring of the total flow discharge from the springs, including the currently unmeasured overflows;

4) The presence of an aquifer composed of Wurmian moraine deposits (composed by gravels, blocks and silts - Upper Pleistocene) presents a high vulnerability with respect to springs fed by a rock aquifer. This topic will be the subject of discussion with the A.S.T. company to try to define appropriate measures to protect the aquifer, both from a qualitative and quantitative point of view;

5) In view of possible new capture springs to integrate the Toano aqueduct to satisfy excess demand during the peak due to seasonal tourism, an analysis will be carried out to identify the best springs capture methods (spring box, subterranean capture, Codeinse, surface water).
In the study area a spring box is the most widely adopted spring capture methods where a rock-blocks box surrounds a spring eye to protect it from contaminants such as surface runoff or rainwater. A representative installation is shown in Figure 49. Two key benefits of a spring box capture are that it is low cost and low maintenance. However, they are also subject to risks associated with poor construction and design vulnerabilities. These vulnerabilities include access points, the overflow pipe, and limitations from their assumption that water production is localized rather than dispersed;

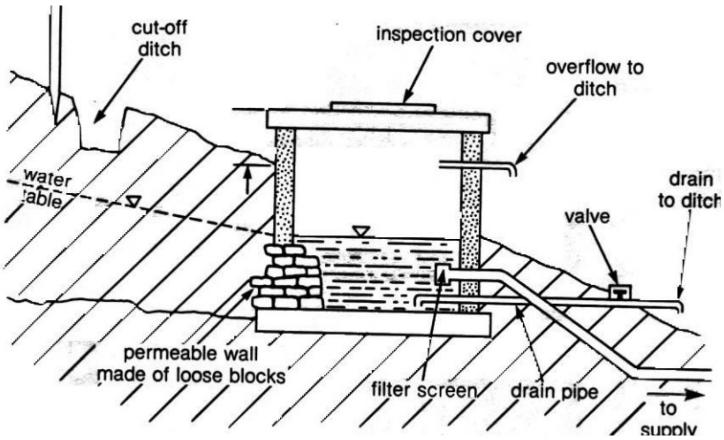


Fig. 49 – Schematic spring box scheme.

6) Improve the quality of data in relation to main user information on water consumption in the municipality of Toano, with particular attention to the agricultural and zootechnical components;

7) Trying to understand how to improve the release of the overflow to ditch in order to reduce the effects of erosion due to surface runoff and encourage the development of wetland environments that are currently absent;

8) An important action, consequently to the activity and information that emerged from the HUMANITA Project, has favored the preparation of a pilot project, by a Local Authority that will be carried out to promote, through forestry-type interventions and modes morphological changes, the recharge of the aquifer near some of the springs considered in the HUMANITA Project.