Agronomie Gembloux

DYNAMIC MANAGEMENT OF TEMPORARY NATURE IN QUARRIES

Maxime Séleck, Sylvain Boisson, Grégory Mahy

Presses Universitaires de Liège

Agronomie
Gembloux

DYNAMIC MANAGEMENT OF TEMPORARY NATURE IN QUARRIES

Presses Universitaires de Liège

Agronomie
Gembloux

DYNAMIC MANAGEMENT OF TEMPORARY NATURE IN QUARRIES

Maxime Séleck
Sylvain Boisson
Grégory Mahy

Scientific editors

Biodiversity and Landscape Unit,
Gembloux Agro-Bio Tech,
University of Liège

LES PRESSES UNIVERSITAIRES DE LIÈGE - AGRONOMIE - GEMBLOUX

Layout and graphic production

LOCO
ARCHITECTES PAYSAGISTES

2022

https://hdl.handle.net/2268/268136

2022, LES PRESSES AGRONOMIQUES DE GEMBLOUX, A.S.B.L
Passage des déportés 2 — b-5030 Gembloux (Belgium)
Tél. : +32 (0) 81 62 22 42
E-mail : pressesagro.gembloux@uliege.be URL : www.pressesagro.be
D/2022/1665/178
ISBN 978-2-87016-178-4

Suggested citation: Séleck Maxime, Boisson Sylvain, Mahy Grégory. Dynamic Management of Temporary Nature in Quarries. Gembloux, Belgium: Les Presses Universitaires de Liège - Agronomie - Gembloux, 2022. Available at https://hdl.handle.net/2268/268136

Published with the contribution of the LIFE Programme of the European Union.
Co-financed by the Walloon region and participating companies.

MS

ACKNOWLEDGMENTS

The scientific editors would like to thank here the LiFE in Quarries project (LIFE14 NAT/BE/000364) and in particular the contributions of the LIFE programme of the European Union, the Walloon region and the belgian Fédération des Industries Extractives et transformatrices de roches non combustibles (FEDIEX) and its affiliated quarries.

The editors would also like to thank the valued contributions from Julien Taymans (Natagora) and Benoît Gauquie (Scheldt Plain Nature Park).

Photographers helped completed this illustrated guide and are therefore thanked as well by the editors.
The editors are grateful to Atelier LOCO for their work allowing transposing our texts and pictures into a coherent document.

The editors would also like to thank the collaborators from the Presses agronomiques de Gembloux for their help in the finalization of the present document: Stéphanie Mathieu, Bernard Pochet and Jacques Mignon.

This document would not have been possible without the continued commitment from participating quarries, throughout the 6 years of the LiFE in Quarries project, to host and develop biodiversity on their sites.

Maxime Séleck
Sylvain Boisson
Grégory Mahy


Une action en faveur
de la biodiversité
est réalisée à cet endroit
CATERPILLAR
775B

AS

PREFACE

The importance of disused European quarries for biodiversity has been recognized for some years. There is a wealth of literature and guidance on how quarries can improve the biodiversity value of rehabilitated sites and many case studies to demonstrate the feasibility of implementation. In a western European context, this has led to the ecological restoration of a diversity of valuable open and humid habitats in exhausted quarries. Until recently however, the recognition of the role that quarries could play as developer of pioneer habitats was limited. While documenting the presence of rare species and habitats, the sector only acknowledged their presence in disused areas, away from the core of our exploitations.

An active collaboration between our industry and the regional public administration leads FEDIEX, the Belgian Federation of Extractive and Processing Industries for Non-Energetic Rocks, to commit to the development of biodiversity in its quarries. While a training program helped us to understand the biological role quarries could play, a lack of knowledge for implementation and legal uncertainties resulting from the presence of protected species at the core of our industrial sites limited realizations.

To answer both challenges, from 2015 to 2021, FEDIEX involved its members in an innovative project supported by the EU LIFE Programme: the LiFE in Quarries (LIFE14 NAT/BE/000364). Along with our partners (scientific (University of Liège), naturalist (Natagora and the Scheldt Plain Nature Park) and public (Public service of Wallonia)), we committed ourselves to find new ways to value and develop the biodiversity hosting capacity of our sites. In doing so, we enable all our members to master dynamic biodiversity management and to play their part in the conservation of regional biodiversity.

While delivering sound actions for targeted pioneer species, the project waived legal uncertainties associated to the Birds and Habitats Directives. Widening the eyes of quarry and environmental managers on the possibilities of coexistence between loaders and toads, it has exceeded its initial expectations by demonstrating that a private sector can contribute positively to its environment. Nature and its necessary biodiversity thank it for this.

This guide is a collection of dynamic management actions implemented through the LiFE in Quarries. By documenting the acquired knowledge, it should help broadening the geography of our action. In this regard, this practical guide completes the recent European sector commitment, through its Extractive Sector Species Protection Code of Conduct, providing the theoretical background to deal with and secure temporary nature habitats during operational phase.

Stephan Milis
President, FEDIEX

TABLE OF CONTENTS

MS

INTRODUCTION

A GUIDE FOR A DYNAMIC BIODIVERSITY IN QUARRIES

This guide aims to provide a methodological and technical sounded basis for the management of temporary nature in active quarries in temperate Europe. It is based on the experience of the LiFE in Quarries project (LIFE14 NAT/BE/000364).

The guide demonstrates how active quarries can contribute to biodiversity conservation based on the implementation of biodiversity management actions during the extractive phase and not only as part of rehabilitation, at the end of exploitation. This integration during the operational phase of a quarry requires the initiation of a new biodiversity development approach: **dynamic management of temporary nature.**

A wide diversity of habitats are generated throughout the life cycle of a quarry, ranging from pioneer habitats in the most active areas of the exploitation to more permanent habitats, in disused areas. Temporary nature management in actives quarries targets pioneer fugitive habitats, analogous to rare transitional natural habitats threatened in human-transformed landscapes. They include temporary ponds, vertical faces and pioneer grasslands. These environments are an important source of biodiversity in active quarries and benefit many rare or threatened species. Because they develop at the heart of the extractive activity, they represent a challenge and new opportunities to demonstrate that biodiversity conservation can be conciliated with exploitation.

This guide answers a need for technical and training tools identified during the LiFE in Quarries project, associated to the willingness of the extractive sector to be an active actor of biodiversity conservation. It aims to increase the independency of the sector for managing biodiversity through direct implication of quarries operators at all level of the organization. The methods described in this guide can be implemented with quarries human and machine resources, increasing the understanding and the link with biodiversity and bringing back nature into the daily lives of quarries staff.

The guide is organized in three main sections:

- A synthesis on the importance of quarries for biodiversity and a general methodology to implement the dynamic management of temporary nature.
- The description of temporary habitats in quarries with the methods and technical itinerary to create, restore and manage them in relation to species needs.
- The presentation of AMBREs platform: a digital interactive tool for managing and monitoring temporary nature management in quarries specifically developed for the project.

The guide is based on the experience gained during the LiFE in Quarries project. An EU LIFE Programme funded project. Running from 2015 to 2021, it demonstrated that operational biodiversity solutions can be proposed and implemented through controlled investments benefiting nature protection as well as the private sector. The general idea of the project was to define measures favorable to biodiversity acceptable to the private operator, legally and scientifically valid.

The partnership forged on this basis included the private sector, regional authorities, scientists and NGOs. The project was led by FEDIEX (Fédération des Entreprises Extractives) in partnership with the Walloon region (Department of Nature and Forests), University of Liège - Gembloux Agro-Bio Tech - Biodiversity and Landscape Unit, Natagora asbl and the Scheldt Plain Nature Park.

QUARRIES AND TEMPORARY NATURE

THE EXTRACTIVE INDUSTRY CONTRIBUTION TO EUROPEAN BIODIVERSITY

The extractive industry includes economic activities aimed at extracting aggregates from the ground and, sometimes, transforming them. The European aggregates industry represents approximately 15,000 companies producing 3 billion tons of aggregates per year. The large number of extraction sites across Europe combined with the specific characteristics of this industry – direct work on the earth's crust, extracting raw materials and providing a flow of goods to society – makes it a major player in the economy and of the European Union environmental challenges.

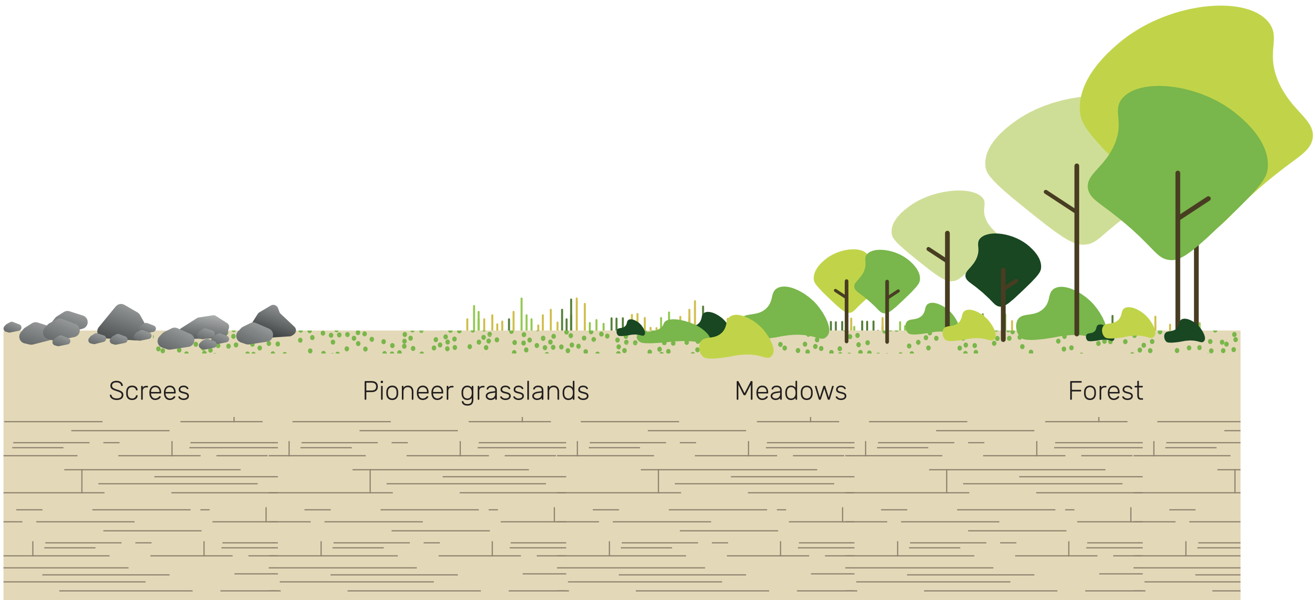
Biodiversity is at the heart of the EU environmental policy . The European Commission has adopted a new biodiversity strategy for 2030, associated to an ambitious long-term action plan to protect nature and reverse ecosystems degradation. The Habitats (92/43/EEC) and Birds (2009/147/EC) directives are two cornerstones of the European biodiversity policy. At their heart lies the creation of a network of sites designed to safeguard Europe's rarest and most threatened species and habitats - the Natura 2000 network. Today, the European extractive industry considers that biodiversity and its proactive management, is an intrinsic part of the productive process. There are a number of important synergies between the industry and nature conservation, as shown by the many case studies in which new ecosystems allowing the settlement of new species and an increase in environmental diversity have been generated. Extractive sites can thus be part of the EU Biodiversity and Green Infrastructure strategies with a significant potential for positive contributions to biodiversity conservation through passive restoration processes or sound rehabilitation but also by implementing biodiversity management measures during the extractive phase.

QUARRIES AND BIODIVERSITY

MS

The exploitation of a quarry inevitably causes a significant disturbance of the topography, land use and ecosystems in place. The development of open-air quarries leads to the modification of the present habitats (forests, meadows, ...) to the benefit of mineral environments. The daily exploitation generates recurring disturbances constantly rejuvenating the substrate. These conditions, impacting the biodiversity in place, may seem, a priori, unwelcoming to fauna and flora.

Quarries, however, offer a substantial potential for the development of biodiversity. Through its daily activity, extraction creates rare environmental conditions in landscapes strongly influenced by human activity: frequent disturbances generating dynamic processes of habitat succession, heterogeneity of substrates (mineral areas, rocky cliffs, spoil heaps with organic soil, ...) and oligotrophic soil and water conditions. Thanks to these conditions a great diversity of habitats is generated, ranging from pioneer habitats in the most active areas of the exploitation to more permanent ones, in the disused areas. These habitats can result from active ecosystem restoration activities or from the spontaneous development of nature. A growing number of studies and projects demonstrate that, with appropriate management, extraction sites can thus promote, throughout their life cycle, a diversity of habitats of biological interest supporting a diversity of species from numerous taxonomic groups (plants, birds, insects, amphibians, ...) and the development of populations of threatened and/or protected species.




AM


MS


MS

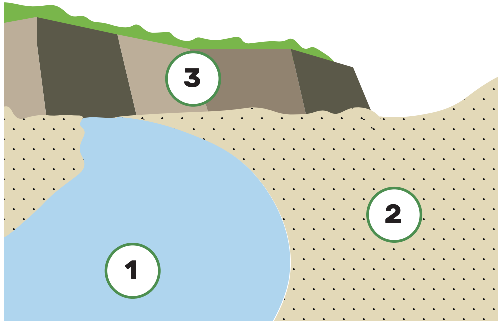

MS

BG

TEMPORARY NATURE IN QUARRIES

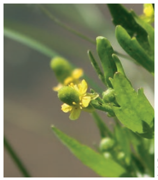
Among the great diversity of habitats in an active quarry, pioneer habitats are of high patrimonial value. These habitats, typical of extractive sites, include pioneer ponds (benefiting amphibians and dragonflies), bare grounds, pioneer grasslands (attracting insects and birds), vertical faces and sand banks (benefiting birds and solitary bees) and a variety of shelters (used by reptiles, amphibians and insects). These environments are of capital importance for biodiversity in active quarries and benefit to many rare or threatened species: Sand martins *(Riparia riparia)*, Natterjack toads *(Bufo calamita)*, Stoneworts *(Charas sp.)*, Common centauries *(Centaurium erythraea)*, solitary bees, Great crested newts *(Triturus cristatus)*, Smooth snakes *(Coronella austriaca)* or even Midwife toads (*Alytes obstetricans)*. They correspond to the European Commission's definition of 'TEMPORARY NATURE' meaning that, in a place where an extractive activity is set to develop, the establishment of nature can temporarily be authorized while allowing a future impact by extraction activities. These impacts are conditioned by the implementation of anticipated habitat replacement measures within a legal framework securing this activity.


MS



1 Pioneer ponds


AC

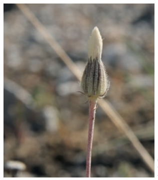

MS


MS


MS

2 Pioneer grasslands


JT

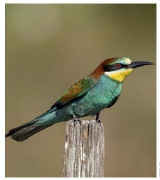

MS

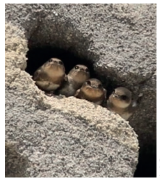

DD

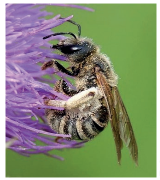

MS

3 Vertical faces and sand banks


JT


TC


MS

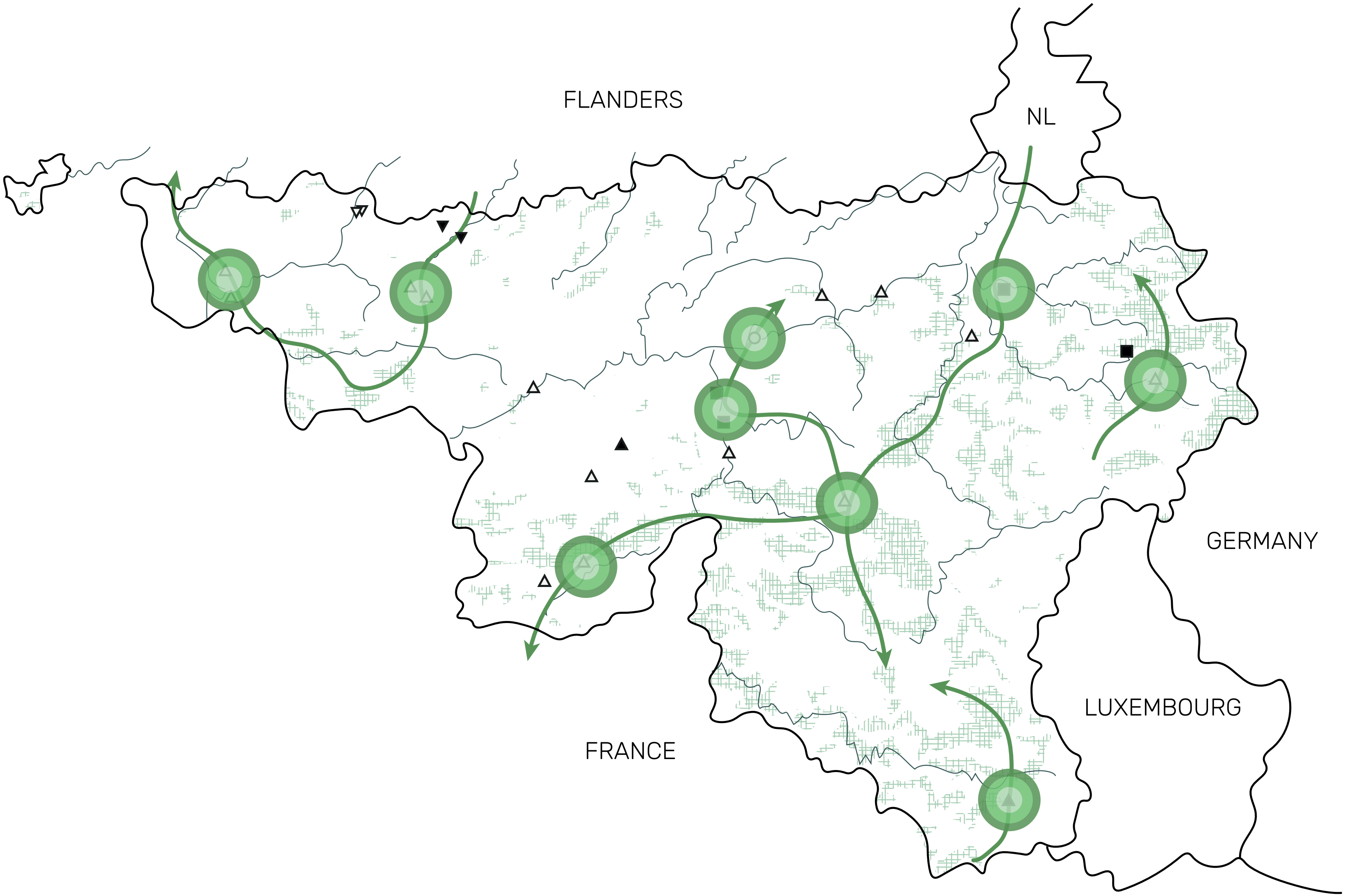

BG

JT

DH

CONTRIBUTION TO THE ECOLOGICAL NETWORK

These pioneer habitats are analogous to rare and threatened transitional natural habitats, impacted by the channeling of waterways, the control of river dynamics the stabilization of cliffs and the eutrophication of water bodies in Western European urbanized and agricultural landscapes. They can therefore contribute to the ecological network for adapted pioneer species as important connecting elements for the ones with a high dispersal capacity (e.g. dragonflies, pollinators, bats, birds) or even core habitats for those that are less mobile (e.g. amphibians, flora).


FLANDERS
NL
GERMANY
LUXEMBOURG
FRANCE

DYNAMIC MANAGEMENT OF TEMPORARY NATURE IN QUARRIES - Experience of the LiFE in Quarries project

JT

THE CONCEPT OF DYNAMIC MANAGEMENT

The promotion of temporary nature in active quarries requires the adoption of a dynamic management strategy during the extractive phase, as opposed to an approach limited to the rehabilitation phase. Dynamic management of biodiversity aims to create a network of temporary habitats managed dynamically in time and space across the quarry in parallel with extractive activity, ensuring the constant availability of habitats conductive to the development of pioneer species.

For example, a quarry can commit to maintaining a fixed number of pioneer ponds on its site throughout the exploitation project. When exploitation leads to the need to remove ponds, new pools will be dug anticipatively, outside of amphibians' breeding season, in a temporarily non-impacted area, making it possible to constantly maintain a number of ponds necessary to species viability in the quarry.

STEPS IN IMPLEMENTING DYNAMIC MANAGEMENT

The implementation of biodiversity dynamic management in a quarry requires the development of a management plan setting objectives and means of achieving these objectives. The management plan provides a strategy for the implementation of a set of actions. It describes the biological targets, the actions of creation, restoration or management of habitats to be implemented in a precise and operational way. It also provides a monitoring scheme of the results. This management plan follows three steps: **biodiversity diagnosis, action plan and actions implementation, monitoring of actions and biodiversity targets.**

The construction of a management plan results from a process of participatory exchanges between a quarry operator and experts in nature conservation. At the same time, the examination of the legislative framework relating to the protection of species and habitats is necessary to establish the derogations to nature laws ensuring legal certainty for the operator.

MS

Biodiversity diagnosis

The first stage of the process is to define the biodiversity reference state. This initial state aims to evaluate the state of the temporary nature at the start of the project in order to identify biodiversity targets, associated actions and to evaluate the results of implemented actions. The diagnosis includes: the mapping of habitats, data on the fauna and flora obtained by detailed naturalist inventories of the site and those extracted from existing databases beyond the site to assess the contribution to the network ecological. For the dynamic management of temporary nature, inventories and maps relate to pioneer habitats (pioneer ponds, vertical faces and sand banks, pioneer grasslands, shelters) and their associated flora and fauna (see the chapters describing the habitats). The existing habitats as well as the zones favorable to their creation are listed. Specialists with naturalist skills must carry out this step.

The purpose of this inventory is to identify:

- The presence of threatened/protected species associated to pioneer habitats;
- The location and potential areas for the development of temporary nature actions;
- The site's contribution to the ecological network for pioneer habitats and species.

On this basis, biodiversity targets are determined for the site. They consist in species and habitats for which habitat creation, restoration and management actions are implemented.

Action Plan

A multi-years action plan is designed to develop the quarry potential for the target species through the creation, restoration and management of habitats. This plan is built in an iterative approach of co-construction between experts and operators.

A first dialogue with the operator allows biodiversity experts to familiarize themselves with the quarry operation and management plan, its future development and major constraints for the implementation of biodiversity actions.

In a second step, experts define the potential for actions. In this proposal, proposed actions are broad because they maximize the potential identified during the biodiversity diagnosis. This approach allows the operator to access a complete information on the quarry's biodiversity potential.

The proposal synthetizes:

• The description of the biodiversity targets of the action plan: target habitats and species;
• A proposal of quantified objectives for the creation and management of target habitats ensuring the viability of the population of the target species on the site: number/areas of habitats;
• A mapping of target habitat creation, restoration and management areas;
• The technical actions to be implemented to create/restore/ manage the habitats according to the zones.

JT

This proposal for a potential action plan is then evaluated during an interactive session between operator and experts. The meeting aims to assess its feasibility and adapt the extent of actions to the operating constraints and available resources.

This step allows:

• Clarifying the actions proposed (a joint expert-operator site visit is useful in order to evaluate the areas proposed for actions);
• Selecting realistic actions in view of the constraints linked to operating permits, operating planning and the resources allocable to the creation, restoration or management of habitat;
• Exchanging proposals for the location of actions, with the operator providing his knowledge about the site and its future development.

After a period of reflection, validation is requested from the operator, allowing the final action plan to be drafted. Once the plan is validated, the field implementation of temporary nature actions is carried out according to technical specifications corresponding to the ecological characteristics of each habitat.

MS

The chapters of this guide devoted to temporary habitats describe the ecological characteristics that the different actions can meet to accommodate target species, as well as technical itineraries for creating and managing these habitats.

However, the implementation of actions requires adaptation to the specific situation of each site. It is therefore useful, when starting out, to be accompanied by an expert.

Monitoring and evaluating actions

In order to ensure regular monitoring of the action plan and its results, and to engage in dynamic management of actions supporting the temporary nature, two types of monitoring can be envisaged:

Annual monitoring is carried out by the operator based on simple indicators to assess the structure and functionality of created habitats, without the need for detailed biological inventories. For each type of action, the biological monitoring methods implemented in the LiFE in Quarries project with their indicators are listed in the chapters describing the temporary habitats. This annual monitoring is essential in a dynamic management strategy in order to anticipate the creation of habitats necessary to maintain the action plan's objectives (number/surfaces of habitat). Based on the monitoring reports, an operational planning of the actions to be implemented during the year is considered at the beginning. Ideally, this monitoring program is carried out using an interactive online monitoring and mapping tool. An example of such tools is provided in the chapter describing the AMBREs platform.

MS

MS

A specialized expert carries out a **five year monitoring** including a complete biological inventory. It aims to assess the biological response of target species and the effectiveness of the management plan.

This monitoring aims to assess the adequacy of the action plan based on the following elements:

• Biological response of the animal and plant populations targeted by the actions (population size, habitat occupancy, ...);
• Identification of new biodiversity targets, if present, and corresponding actions;
• Evolution of the perimeter of the site;
• Modification of the operating plan.

The action plan will then be adapted according to these elements.

MS

TEMPORARY NATURE IN PRACTICE

MS

MS

PIONEER PONDS

Accumulating on and along tracks, in technical ponds and depressions of silting ponds, water is key to life in mineral environments. Cold or warm, deep or shallow, large or small, the diversity of ponds' configurations promotes a variety of species.

TARGETS

The dynamic creation and management of water in quarries' active areas target the development of small or large scale pioneer ponds with little vegetation. These pioneer habitats host specific communities of rare and endangered amphibious annual plants, amphibians and dragonflies. Of particular interest, these *Oligo* and *Meso-trophic* ponds have become rare at the European level. Left to evolve naturally they lose these characteristic pioneer conditions over the course of a few years.

The endangered Natterjack, Midwife and Yellow-bellied toads spawn in these young ponds along with specialized dragonflies as the delicate Small bluetail or the larger Keeled and Southern skimmers. The developing Stoneworts and amphibious annuals are good indicators of the habitat's quality.


MS

Lesser centaury *(Centaurium pulchellum)*


MS

Small bluetail *(Ischnura pumilio)*


MS

Cursed buttercup *(Ranunculus sceleratus)*


MS

Natterjack toad *(Bufo calamita)*


MS

Midwife toad *(Alytes obstetricans)*


JT

Bristle club-rush *(Isolepis setacea)*


MS

Stoneworts *(Chara sp.)*


BG

Southern skimmer *(Orthetrum brunneum)*


MS

Yellow-bellied toad
(Bombina variegata)

MS

Accessibility to machine for recurrent creation and maintenance is essential and naturally favors locations at the core of exploitation.

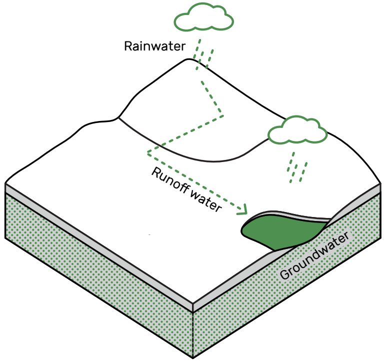
LiFE in Quarries' commitment - Site surface (in hectares) / 20

The LiFE in Quarries' management plans commit quarries to a number of pioneer ponds defined as a function of the quarry area and the presence of target amphibians.
Objective is set at one pond/20 ha of the site's area. For sites with presence of Natterjack or Yellow-bellied toads, this number is reviewed to one pond/10 ha. Resulting numbers are rounded to the nearest five.
Exceptions to these rules are allowed for sites with higher proportions of permanent nature areas.

CREATION

WHERE ?

Pioneer ponds can benefit from three different water sources: **rainwater**, **runoff water** and **groundwater**.



Adapted from Williams et al., 1997

Creating ponds from **rainwater** implies its collection on impermeable or compacted substrates. Quarries presenting clayey overburden materials can excavate pools in their extension or on recent spoil heaps. They can also be dug on impermeable coherent rocks such as sandstone or shales.
An easy mean of securing amphibians and dragonflies' habitat is to protect spontaneous depressions accumulating rainwater along tracks of exploited areas.

MS

MS

MS

MS


MS


MS


MS

Through the creation of permeable dikes and embankments, **runoff water** can be directed towards a succession of ponds. Sediments settle in the first pools facilitating their regular clearing and evacuation while allowing for clear water in the following ponds. Typical runoff zones can include areas below spoil heaps or rock faces, ditches beside tracks, seepages or springs.

When the **groundwater** table is reachable, the excavation of isolated depressions allows for an immersion during high waters. While this requires fractured rocks in hard rock quarries, excavation is facilitated in sandy substrates or in silting ponds. At the bottom of large pits, sumps are a favorite habitat for Midwife toads. To enhance their attractiveness, their design should maximize gentle slopes and pumps be maintained well above the bottom.


MS


MS

On sites hosting the species, technical bassins are often colonized by Midwife toads.


MS


MS


MS


MS

HOW ?

Creation goes through a diversity of means and machines and often needs to be adapted on a case by case basis. Bulldozers or loaders are ideal to create shallow pools on soft substrates but deeper ponds often require the intervention of an excavator.

Though a diversity of waterholes and shallow shores is a guarantee for rich ecosystems, the ideal pioneer pond encompasses the following characteristics:

1. Mineral grounds with little vegetation
2. Sunny conditions
3. Shallow profiles with depths of a few centimeters to 0.50 meter
4. Included in a network of small ponds
5. Presence of open water in spring and/or summer
6. Sizes ranging from a few to 1000 square meters.

1.

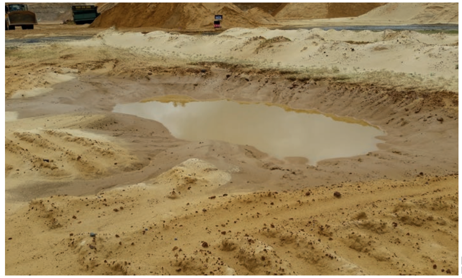
Mineral substrates, in and around ponds, allow for a slow vegetation dynamic and the maintenance of a pioneer stage favorable to target species. Stoneworts maintain lastingly in these environments.

MS

MS

2.

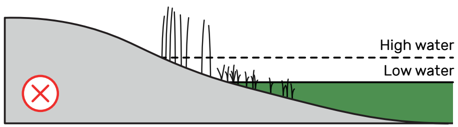
Bathed in sunlight, ponds warm faster and allow for a fast development of target amphibians and dragonflies.

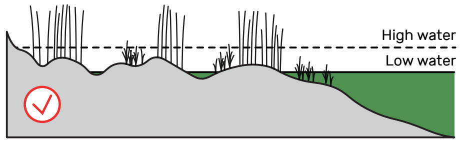


JT

3.

During high waters, depth should range between a few centimeters and 0.50 meter with at least part of the shorelines being shallow and favoring access to amphibians. Humid shores are home to annual amphibious plants as the Lesser centaury.



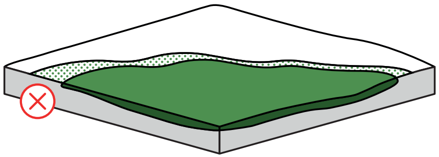


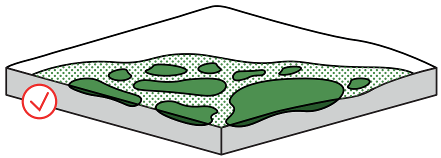
Adapted from Nicolet and Williams, 2008

4.

Rather than a large pond, a set of small size ponds allows for a broader diversity of species with a higher conservation value.

MS





Adapted from Nicolet and Williams, 2008

Ponds should be marked and protected with blocks or shelters securing the habitat even during dry periods.

MS

MS

5.

Ponds holding water for two to three months between April and August allow spawns of target amphibians and dragonflies to develop.

By maintaining pioneer conditions, an annual dry up can be favorable to a diversity of pioneer species sensitive to fishes and other predators.

MS

MS

6.

Larger waterbodies presenting structured shores allow for a broader diversity of microhabitats and species.

MS

VARIANTS IN THE « LiFE in Quarries »

Even though shallow and warm ponds are preferred, Midwife toads, Stoneworts and dragonflies benefit from cold waterbodies as sumps and silting ponds.

MS

MS

During a few years following their creation, larger permanent ponds present pioneer conditions hosting species linked to them.

Streaming runoff water can be guided through a succession of pools hosting Small bluetails, Keeled skimmers and Midwife toads.

MS

MS

Artificial alimentation can also be brought to dry areas taking advantage of onsite pumping infrastructure.

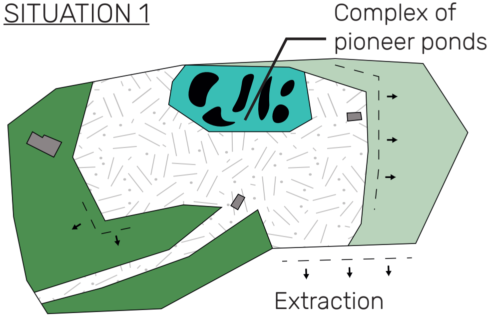
MANAGEMENT

The maintenance of a network of pioneer ponds requires regularly seizing new opportunities brought by the site's activity. Ponds meant to stay in place for longer periods demand periodic management through vegetation and sediments scraping to maintain pioneer conditions and prevent silting. A rotation in management ensures that not all ponds are impacted in the same year.

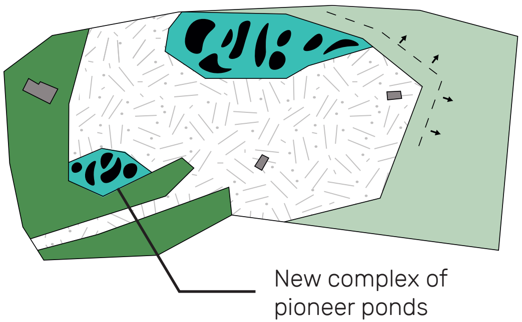
MS

To allow for colonization of new creations, locations within a few hundred meters from existing ponds are privileged. In case of impact on a group of ponds, a transfer of sediments hosting seeds and dragonflies larvae facilitates their migration. The dynamic management should take place outside of amphibians' activity in autumn/winter preferably in October.

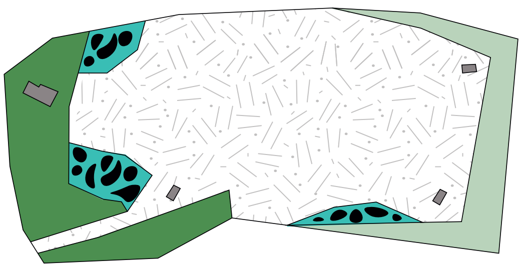
SITUATION 1



SITUATION 2 – *after 1-2 years*



SITUATION 3 – *after 1-2 years*



Adapted from Keller 1992

MONITORING

The LiFE in Quarries' monitoring scheme evaluates ponds through a minimum of two surveys taking place between May and August. Staff members determine whether ponds are still functional with the presence of water and vegetation cover limited to 25% with the exception of Stoneworts and green algae. The presence of tadpoles, egg strings of target amphibians or dragonflies further allows confirming ponds' biological interest.

IN PRACTICE

To learn more on benefiting species and implementation watch our video

PERMANENT PONDS

MS

In disused peripheral areas or in the finalization of slag heaps, the creation of large ponds reaching up to a few 100 m² promotes diversity. These permanent waterbodies are naturally colonized by an aquatic vegetation supporting long-lived amphibians as well as a broad diversity of aquatic birds and dragonflies. Searched characteristics are similar to those of pioneer ponds with greater depths allowing maintaining water throughout the season. Lining with clay may prove helpful to this effect.

ZB


MS

MS

MS

PIONEER GRASSLANDS

The exploitation of quarries and sandpits creates large open and pioneer grounds. Temporarily outside of daily activity, they evolve from bare substrates to first stages of pioneer grasslands. Within a few months or years, adapted pioneers progressively reclaim dry or humid benches in a diversity of new ecosystems reflecting the chemical and physical properties of the rock they form on.

TARGETS

Stripped from their vegetation and earth, benches and quarries' floors are important habitats for a diversity of specialized short-lived plant communities. Set aside for a few years, these barren grounds host species linked to dynamic environments. Depending on the level of humidity, they are colonized by thermophilous or amphibious sward vegetation. While the speed of encroachment by shrubs and trees highly depends on the compaction of the substrate, vegetation inevitably brings detrimental shade and competition to pioneers.


MS

Fern-grass (Catapodium rigidum)


AD

Little ringed plover's eggs
(Charadrius dubius)


RG

Woodlark (Lullula arborea)


MS

Carline thistle (Carlina vulgaris)


DD

Little ringed plover (Charadrius dubius)

Along with a large variety of specialized annuals, biennials and succulent plants, these areas serve as breeding and foraging grounds for birds as the Little ringed plover in barren areas and the Eurasian stone-curlew or Woodlark in sparsely vegetated ones. Natterjack toads and Blue-winged grasshoppers, tiger beetles and dragonflies use them to warm up, feed and reproduce.

The regular creation of refuge areas within active areas of the quarries aims at maintaining the availability of pioneer conditions where these highly patrimonial vegetal and animal species temporarily can thrive.


MS

White stonecrop (Sedum album)


MS

Blue-winged grasshoper
(Oedipoda caerulescens)

A diversity of rock chemistry favors different plant species

Small Cudweed is mainly found on acidic substrates - sandstone, porphyry or sands. It is often found in stocks and pits areas.

Calcareous substrates are home to a great variety of pioneers. In this quarry, the rare German gentian has developed a large population on previously stripped areas.

Within a few years, acid sands of sandpits are colonized by a Natura 2000 habitat: *"Inland dunes with open Corynephorus and Agrostis grasslands"* – Habitat 2330 of the EU Habitats Directive.


MS

Small cudweed *(Filago minima)*


JT

German gentian *(Gentianella germanica)*


MS

Grey Hair grass
(Corynephorus canescens)


JT


JT


JT

LiFE in Quarries' commitment - Site surface (in hectares) / 100

LiFE in Quarries' minimal commitment for pioneer grasslands is defined as a function of the quarry area. Objective is a surface set at one percent of site's area, rounded to the nearest 0.25 ha.

For sites with presence of Little ringed plovers, a minimal area of 0.25 ha is to be situated within the active pit areas, on benches or quarry's floor.
Exceptions to these rules are allowed for sites smaller than 25 ha or sites with a higher proportion of permanent nature areas.

CREATION

WHERE ?

Pioneer grasslands colonize benches, compacted tracks or large quarries' floors, stripped areas or loose mineral surfaces - below faces, surrounding tracks and stocks or slag heaps.

MS

Rocky substrates of **mineral benches, compacted tracks or large quarries' floors** naturally present oligotrophic and barren conditions slowing trees and shrubs colonization. These substrates are ideal grounds for annuals or succulents, thermophilous plant species as well as for ground nesting birds such as the Little ringed plover. On compact substrates, patches of sediments accumulating humidity favor a more vigorous vegetation and a diversification of habitats.

Following overburden removal, **stripped areas** temporarily give way to short-lived pioneer conditions with nutritious conditions between that of the overburden soils and rocky substrates. As a result of the diversity of subsoil depths, these surfaces evolve towards intricate fallow lands favoring a large diversity of microhabitats and species. These scarce vegetations represent nesting grounds for Woodlarks.

MS

The **loose mineral areas below faces, surrounding tracks and stocks or covering slag heaps** present filtering and oligotrophic conditions. Colonizing vegetation includes pioneer patrimonial annuals or specialized perennials. These substrates harbor warm diverse conditions allowing Midwife and Natterjack toads to dig burrows or Wall lizards to lay their eggs.

MS

JT

MS

Dwarf spurge *(Euphorbia exigua)*

MS

Pale poppy *(Papaver argemone)*

MS

Small alison *(Alyssum alyssoides)*

MS

MS

Common centaury
(Centaurium erythraea)

MS

Natterjack toad *(Bufo calamita)*

MS

Rough Marsh-mallow *(Althaea hirsuta)*

HOW ?

Temporarily set aside by blocks or stony shelters, these pioneer grounds evolve towards interesting habitats. Simple 'creation' implies protecting them for periods ranging from a few years to more than 10 years for compacted areas.

MS

MS

In compacted areas or on rocky substrates, a partial loosing up of the substrate favors a diversification of habitats and faster colonization. This is realized through the scratching of old circulation areas or the uneven addition of fine substrates as scalping materials, gravels or scrapings from tracks maintenance.

Conversely, on earthy substrates of spoil heaps, addition and compaction of mineral substrates slow vegetation dynamic down and favor pioneers.
While a diversity of methods are applicable, a typical sequence of creation goes through materials being transferred by dumpers, spreading done with a toothed bucket and compaction realized by driving on parts of the newly created grasslands.

1.

Mineral substrates slow down the development of trees and shrubs leaving ground for target pioneers.

MS

In creating or identifying new areas to set aside, a maximum of the following characteristics should be looked for:

1. Mineral substrates limiting vegetation dynamic
2. Minimum of 1000 m²
3. Sunny conditions
4. Maximizing the microrelief
5. Distributed within different areas of the quarry
6. Protected from traffic by blocs or shelters

MS

2.

While small areas can host a diversity of species, larger plots often lead to more diversity and fulfill vital needs of nesting birds.

3.

In temperate climates, sunbathed barren grounds allow cold-blooded species to warm up earlier in spring.

MS

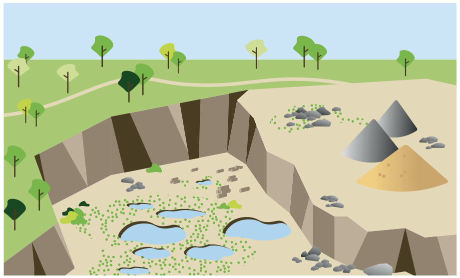
MS

4.

Grooves and depressions favor the accumulation of fine sediments trapping humidity facilitating seedlings installation.

5.

A patchwork of areas distributed in the quarry limits distances and facilitates colonization.



MS

6.

Effective protection allows for clear identification of 'NO-GO' areas by staff members while providing valuable hides for target species.

When spontaneous colonization is impeded by a lack of plant diversity, the sowing of common nectar or pollen providing species allows a diversification of food resources for birds and insects.

MS

Within the LiFE in Quarries, a diversity of 14 species from controlled provenances were sown in newly created or protected pioneer grasslands. Among these, the most successful in installing are Wild carrot, Autumn hawkbit, Bird's-foot trefoil, Oregano, Viper's-bugloss and Mullein. The sown areas serve as sources of seeds for newly created grasslands.

VARIANTS IN THE « LiFE in Quarries »

Vegetations developing on sunny slopes of loose gravels are typical habitats of French sorrels and Red hemp-nettles, both distinctive species of calcareous screes.


MS


MS


MS

On accumulated sediments of seepages, unique patchworks encompass vegetations ranging from amphibious swards to alkaline fens.


MS

New security standards developing protective berms from scalping materials represent an opportunity for the development of rich pioneer grasslands as they act as corridors between otherwise disconnected plots.

MANAGEMENT

As is true for pioneer ponds, the richer and deeper the substrate, the faster the vegetation closes and requires to be managed or dismissed of commitments.

New areas temporarily outside of activity should be partially reworked and protected to create new pioneer grasslands favoring target species. Substrates from interesting vegetations meant to be impacted can be scraped on 5-10 cm and spread on these areas allowing for the transfer of soil's seed banks.


MS

Areas meant to be maintained for longer periods can also be maintained pioneer.
The removal of trees and shrubs and/or the scraping of vegetation allow maintaining open conditions required by the target species while a rotation

in management ensures not all grasslands are impacted in the same year.

In case of presence of sensitive species, temporary protection should focus on areas meant to stay in place for longer periods and transfers be spread on a few years' time.

MS

Sand spurrey (Spergularia rubra)

MS

Basil thyme (Clinopodium acinos)

MONITORING

The LiFE in Quarries' monitoring scheme evaluates pioneer grasslands through a minimum of one annual survey between the months of May and August. Staff members determine whether grasslands are still presenting 25 to 95% of open ground and a maximum of 50% of woody vegetation including trees and shrubs. The monitoring also allows identifying areas protected within pits and specifically targeting the Little ringed plover. May to June is ideal for most species observation, but some target pioneer plants and the Blue-winged grasshopper require a second visit in August.

IN PRACTICE

To learn more on benefiting species and implementation watch our video

PERMANENT GRASSLANDS

MS

Through natural succession, pioneers areas evolve towards diverse grasslands hosting a wide variety. Orchid-rich calcareous or acidic grasslands reclaim these poor soils conditions. An adapted management is however necessary to maintain and enhance their interest. Partnerships with shepherds or farmers can promote extensive grazing or late mowing to insure their long-term maintenance while giving land back to local communities.

MS

JT


Une action en faveur
de la biodiversité
est réalisée à cet endroit

AS

BG

MS

VERTICAL FACES AND SAND BANKS

In spring, quarries are home to small-scale excavation activity. Originating from riparian habitats, Sand martins are busy boring galleries in sands and silts. Over spring and summer, they are flying back and forth: first excavating materials, then feeding their offspring. These loose materials also benefit solitary bees using sand embankments to dig their own nests.

TARGETS

In quarries, the maintenance or intentional creation of vertical faces and sand banks target the development of Sand martins and solitary bees' nesting grounds. European Bee-eaters and Common kingfishers regularly nest as well in quarries' vertical faces. A diversity of birds and insects benefits from these sandy habitats. In highly urbanized and stabilized landscapes, quarries play a role sustaining these pioneer species' populations. Aside from sand pits' faces, such habitats result from the stockpiling of sand or from vertical faces cut in overburden materials of gravel pits and hard rock quarries.

The conservation, intentional creation and maintenance of vertical faces and sand banks provide ideal habitat to these peculiar diggers. Without intervention, steep faces eventually collapse and vegetation invades barren sands rendering the habitat unsuitable.

MS

Sand martin *(Riparia riparia)*

BG

Great banded furrow fee *(Halictus scabiosae)*

RG

Blue-winged grasshoper *(Oedipoda caerulescens)*

TC

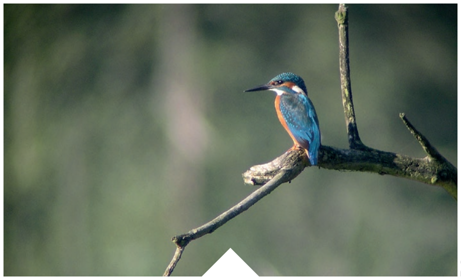
European bee-eater *(Merops apiaster)*

BG

Grey backed mining bee *(Andrena vaga)*

BG

Northern dune tiger beetle *(Cicindela hybrida)*



BG

European kingfisher *(Alcedo atthis)*

BG

Pantaloon bee *(Dasypoda hirtipes)*

BG

Common European sand wasp *(Bembix rostrata)*

Free flowing rivers are Sand martins primary nesting habitats with breeding pairs numbering the hundreds. Large winter flooding events erode riverbanks and create sandbars leading to availability of new vertical faces and pioneer sandy habitats.

DH

LiFE in Quarries' commitment - One vertical face or sand bank

LiFE in Quarries' minimal commitment is set to one vertical face long of 30 meters or one sandy bank either covering Sand martins or solitary bees' needs.
The commitment also implies a seasonal protection of spontaneously colonized faces in the event of Sand martins' installation in unintended areas.

CREATION

WHERE ?

As long as they present steep slopes, **vertical faces** can be located in most quarries' sectors. Previous experience has shown that Sand martins usually favor a situation at the core of exploitation. To allow for regular refreshment of verticality, locations easily accessible by excavators should however be privileged.
Colonies spontaneously occupy new sand heaps and exploitation faces and, wherever compatible with exploitation, vertical faces should be cut in these stocks or in the operating front.

AS

MS

Wild solitary bees benefit from sunbathed **sand banks** with dry and barren grounds. Situations within 100 to 300 m of flower-rich grasslands and early-blooming shrubs provide pollen and nectar for their life-cycle. Bordering areas, conciliating machines presence and biodiversity of reclaimed areas are thus optimal. As time leads towards larger nesting aggregations, creation is best set in areas maintained for longer periods. In sandy overburden, stripping topsoil a few meters beyond exploitation limits allows for swarming nesting grounds.

JT

HOW?

Both vertical faces and sand banks can either result from colonization by chance or favored by intentional creations.

MS

While in sand and gravel pits **vertical faces** result from extraction, the creation of artificial breeding sites in hard rock quarries goes through stockpiling and compacting sand heaps. Cutting off the desired face is realized by an excavator or a loader. By intentionally cutting off faces in temporarily set aside stockpiles, quarries allow for the rapid creation of habitat without impeding future economic use of products.
Planning and creation should take place in winter making sure new faces present sheer cliffs prior to the return of migrating Sand martins, in April or May.

To maximize chances of colonization, faces and sand heaps should present:

1. Fine sand materials

2. A minimum height of 2.5 m and length of several tens of meters

3. Vertical faces close to 90° with screes removed

4. Protection from dominant winds

5. An open runway

6. Association or proximity to large waterbodies

MS

1.

95% of substrate should consist in particles ranging between 0.20 and 2.38 mm in diameter. In quarries, this corresponds to unwashed 0-4 mm aggregates.

2.

Though small sand pockets are often colonized, large and high faces maximize installation chances and provide more room for additional breeding pairs.

3.

Sheer cliffs maintained with angles of 60° or more allow keeping most predators at bay and provide attractive nesting sites.

MS

4.

While orientation does not seem to import, easterly-oriented faces allow for protection from dominant winds. Crescent-shaped faces further present the advantage of limiting wind gusts.


MS

5.

Shrubs and trees, but also parked machines, prevent access to the faces and should thus be cleared.


MS

6.

Though not essential, water proximity provides favorable hunting grounds and further protection from predators when adjacent to the cliff.


MS


MS

Sand martin *(Riparia riparia)*

Ideal **sand banks** for solitary bees and other burrowing insects provide:

1. Loose substrates

2. A minimum depth of 50 cm

3. A diversity of slopes oriented to the south or SE/SW

4. Proximity to floral resources


MS

1.

Sandy to loamy substrates are preferred allowing for mining bees to bore upholding galleries.


MS


JT

2.

Terricolous species dig burrows reaching depth of 30 to 40 cm or more. Guaranteeing sufficient depths allows for a better protection.

3.

While most species colonize flat grounds or gentle slopes, small vertical faces favor some rarities species such as species of the *Anthophora, Colletes* and *Eucera* genus.


MS & DS


MS

4.

Diverse floral resources are essential to the diet of both generalist and specialist species. Multiplying biodiverse restorations in diverse sectors favors food diversity.

Sand banks can be created from processed sand, sandy and/or loamy overburden or silting ponds materials. In pre-existing sandy areas, substrates can be exposed by stripping off 10 to 20 cm of surface materials. New banks can also be created by stockpiling and compacting sands in areas expected to stay in places for a few years.


JT

In addition to the maintenance of pre-existing nesting aggregations in open and sandy berms, intentional creations of artificial sand banks favor solitary bees and a diversity of burrowing insects.


MS

VARIANTS IN THE "LIFE IN QUARRIES"


JT

Large swaths of overburden sands can be dedicated to the creation of diversified habitats for solitary bees.

Even if not directly successful at attracting new colonies of Sand martins, vertical faces are rapidly colonized by a diversity of solitary bees.


MS

While maximizing chances of colonization in specific areas temporarily outside of exploitation, quarry staff can also work on preventing installation in active stocks or faces. Softening of slopes in spring limits the risk of unforeseen birds installation while the vegetalization of banks allows progressively reducing attractiveness for solitary bees.


MS

MANAGEMENT

Two different cases are often distinguished in the creation of **vertical faces**: avoidance and intentional creation.
Stockpiles or sand pits faces expected to be excavated during the breeding season should be sloped to less than 60° during the critical period of April to June to avoid colonization.

MS

On the other hand, to favor colonization, faces should be maintained vertical by cutting them in the beginning of April. To favor habitat availability and continuity, previously occupied faces can be maintained every year.
Sand banks are partially rejuvenated in yearly rotations by gently scraping vegetation. As solitary bees overwinter at larval stage, limiting impacts to a maximum of 20 cm allows avoiding broods.

MONITORING

The LiFE in Quarries' monitoring scheme evaluates vertical faces and sand banks through a survey taking place between May and August. Quarries' staff determines if valid physical properties are still met. The presence of target birds, flying solitary bees or nesting aggregations allows confirming occupation.

IN PRACTICE

To learn more on benefiting species and implementation watch our video

PERMANENT NESTING WALLS

MS

The long-term securing of Sand martins can go through the creation of artificial nesting walls from L-shaped concrete blocks with holes and backfilled with sand or tubular structures accompanied by nesting chambers. These solutions present the advantage of providing installed colonies with controlled conditions and allowing continued presence in disused sites. Installation can however reveal costly and should be used as last resort in active sites.

MS

MS

MS

MS

SHELTERS

Carrying logs and stones and depositing them in piles along their courses, flooding rivers create a diversity of shelters used by a variety of reptiles, amphibians and micro-mammals. On large quarries' floors and spoil heaps smoothened by exploitation, the creation of analogous shelters provides similar hides benefiting micro-fauna.

MS

TARGETS

Stones, logs and sand piles are critical day or winter hides but also act as pantries or egg-laying sites. They provide sunny basking places for reptiles, moist burrowing grounds for amphibians and protection from predators to insects and small mammals. Created through a diversity of means, shelters providing holes and crevices or burrowing materials allow species to safely slip in during resting periods.

The creation of shelters allows to diversify the structure of habitats and favors the development of these species. In quarries and sandpits, their creation is both facilitated by the availability of rocks and sand and required in areas smoothened by exploitation. Following exploitation, stone piles are ideally associated to pioneer ponds or grasslands as day shelters. In rehabilitated areas, partially buried shelters - 'hibernacula' - provide overwintering refuges. Placed on loose substrates, shelters further allow micro-mammals to dig burrows that can then be used by species ill-fitted to dig.

CREATION

WHERE ?

The creation of shelters is meant to compensate for a lack of refuges linked to the homogenization of habitats.

MS

These structures should thus ideally be installed in areas that have been smoothened through exploitation as quarries' floors, large benches, spoil heaps, technical ponds, …

MS

In the morning freshness, reptiles look for warm basking sites to thermoregulate making areas presenting sunny conditions and protection from wind ideal to create new shelters.

As species require some time to encounter these new sites, stony shelters should be set in areas expected to stay in place for a minimum of 3 to 5 years with hibernacula, used yearlong, restricted to permanent sectors.

By setting shelters directly in ponds, protection from birds and other predators is provided to reproducing amphibians and tadpoles.
They also maintain humid conditions for insects' larvae in case ponds dry up prematurely.

MS

While they primarily target fauna, shelters' rocks and gravels can favor the installation of specialized plants species.

MS

LiFE in Quarries' commitment - Site surface (in hectares) / 10

The management plans commit quarries to a number of shelters defined as a function of the quarry area. Objective is set at one tenth of site's area rounded to the nearest five. Exceptions to these rules are allowed for sites with little availability of machines rendering transportation of materials difficult.

HOW ?

Shelters can take multiple shapes and be made in a diversity of materials, sizes and locations. Rocks maximizing interstices and loose sands or gravels favoring burrowing species are preferred to create:

Stony shelters, or **'day shelters'** made as rock piles of 1 m in height with a volume of 2 to 5 m³. To maximize interstices, rocks should mainly consist in diameters ranging between 20 and 40 cm. Shelters should be arranged in groups of 4 to 5 in areas temporarily outside of exploitation: quarries' floors, tracks or bordering other biodiversity actions.

PH

Hibernacula consist in frost-free hides that maintain buffered micro-climates favorable to hibernating reptiles and amphibians. They can result from the excavation of 80-100 cm depressions filled with gravel and 20-40 cm rocks, or from niches slot in slopes of spoil heaps adjusted with rocks and boulders.

1

MS

2

MS

3

MS

5

MS

4

MS

By maintaining buffered and humid conditions, loosened **sand piles** complement the interest of stony shelters and favor burrowing amphibians among which Natterjack toads. In hard rock quarries as well, Midwife toads readily settle in fine aggregates heaps deposited close to pioneer ponds.

JT

MS

Midwife toad *(Alytes obstetricans)*

While stones warm slowly and retain heat in the evening, wood heats up faster in the morning better answering basking reptiles' needs. Piles of **wood debris** can be stored in bordering areas of grasslands and regularly complemented to compensate for decomposition.

BP

Decomposing **hay piles and composting heaps** produce heat searched by egg-laying reptiles. Piles of a 2 to 5 m³ or larger are precious habitats for Grass snakes' reproduction if ideally located in sunny areas, close to large ponds. As with the piles of wood debris, they benefit from a regular supply of organic matter.

MS

MS

Smooth snake (Coronella austriaca)

JT

Sand lizard (Lacerta agilis)

MS

Grass snake (Natrix natrix)

To effectively develop shelters:

1.

Develop stony shelters directly from raw blasting materials.

2.

Protect ponds and grasslands with stony piles rather than with large boulders.

3.

Directly pile-up excavated stony materials aside from newly dug ponds.

4.

Store organic material resulting from habitats maintenance in areas known to be home to reptiles.

In cut stone exploitations, drystone walls bordering ponds allow creating display areas reconciling biodiversity and aesthetic values.

MANAGEMENT

Shelters are set up throughout the year with a preference for the winter season, outside of reptiles and amphibians activity. Ideally, they should stay in place for periods of minimum 3 to 5 years. Required management is limited and mainly consists in removing shrubs and trees that could install and overshadow them.

To allow for a continued availability of hides and an efficient use of resources, staff should take advantage of the presence of machines to create shelters. They should be installed prior to the completion of permanent areas but also temporarily, in the surrounding of pioneer grasslands and ponds.

JT

To avoid local extinction of species, a temporal continuity in the availability of shelters needs to be maintained. This is done through anticipated creations of substitute shelters in closeby sectors.
Impacts on shelters should only take place when no eggs, juveniles or immobile adults of target species are expected to be trapped. In temperate climate, this generally means autumn. They should be privileged during warm and sunny days allowing for individuals' movement.

MS

MONITORING

Life in Quarries' monitoring scheme evaluates shelters through a simple confirmation of continued presence between the months of May and August. As they mainly consist in hides, detectability of target species is limited even though basking reptiles or hiding amphibians are sometimes observed.

MS


AT

An objective of the LiFE in Quarries was to assess amphibians' use of shelters associated to pioneer ponds. 42 newly built shelters distributed in 5 quarries were monitored as part of a Master Thesis. Between April and June, stone piles were surrounded by drift-fences and moving amphibians captured in pitfall traps in 5 night sessions.
Individuals of Natterjack and Midwife toads allowed confirming the interest of the structures for the project's main pioneer target species.


AT


AT

IN PRACTICE

To learn more on benefiting species and implementation watch our video

PERMANENT SCREES


MS

By transferring rocky spoils and storing them in areas outside of future impacts, quarries can create an interesting combination of screes and edge habitat for reptiles. Raw rocky material set in lines bordering or connecting biodiverse habitats can act as dispersal corridors or hides for species such as the Wall lizard and the Smooth snake. They should ideally be created in sunny areas and maintained sunlit.


MS

Rather than isolating actions, associating them will provide foraging areas, shelters and reproduction grounds for pioneer species. In quarries' mineral areas, set aside pioneer ponds can be included in larger areas of humid and dry pioneer grasslands. These humid areas are ideal for the Little ringed plover to lay its eggs and search for food. The addition of stone piles further provides shelters for pioneer amphibians.


BG


JT

Midwife toads benefit from both pioneer and permanent waters close to rocky shelters.


PH

This combination of actions also makes sense outside of exploited areas with shelters substituted by linear screes, pioneer grasslands by blooming hay meadows or grazed calcareous grasslands and pioneer ponds replaced by permanent ones. The interface of habitats thus created will be searched for by Great crested newts – for permanent ponds and meadows – or by Smooth snakes – for screes and grasslands.


MS


MS

MS

SPECIES TRANSLO-CATIONS

Following the opening of a quarry, a diversity of pioneers progressively colonizes newly created habitats. While many species find their way naturally, fragmented landscapes impede some of the more emblematic species to reach these new opportunities. Providing a practical answer, the LiFE in Quarries project designed a program to develop populations of 10 pioneer plants and 3 amphibians: Natterjack and Yellow-bellied toads and Great crested newt.

TARGETS

A diversity of endangered pioneer species with large dispersal power use quarries as stepping-stones between sites. However, for less mobile species, colonization may be limited. This is particularly true for amphibians and a diversity of plant species with dispersal ranges typically limited to a few kilometers.

Even when biological requirements are met, this results in an under use of habitat resources. Assuming a guarantee of habitat availability for the years associated with the operation, the introduction of certain key species may allow for the development of new populations central to the surrounding landscape.

By seizing new translocations opportunities in dynamic or post exploitation areas, along with biologist partners, quarries can be active actors of species' populations conservation.

WORKING SEQUENCE

EVALUATION OF IUCN CRITERIA

Translocations should result from a precise evaluation process clearly identifying benefits and risks. The International Union on Conservation of Nature (IUCN) provides insightful *Guidelines for Reintroductions and Other Conservation Translocations* to be evaluated prior to any translocation project.

The main aspects imply securing the following sequence:
1. Meet the habitats requirements of the species within its geographical and climatic ranges
2. Identify source populations with mixed genetic provenances and assess potential negative effects of removing individuals
3. Guarantee animal welfare and prevent pathogens dispersal
4. Ensure social acceptance and stewardship
5. Comply with legal requirements
6. Ascribe adequate human resources

1. The LiFE in Quarries targeted species endangered and documented as establishing core populations in Walloon or foreign quarries. Species' requirements differ largely: the project secured adequate habitats through either the dynamic management of pioneer ponds, the conservation and development of large ponds or the identification of pioneer areas lacking them.

Natterjack toads require an association of pioneer grasslands to run and feed and warm pioneer ponds to breed. Such conditions are mainly found at the core of quarries' activity.

At the other end of the biological spectrum, **Great crested newts** reproduce in large ponds with important aquatic vegetation. These conditions are usually found in disused technical basins or old quarries' pits.

Yellow-bellied toads require a mix of both: small and muddy pools are used for reproduction while adults use larger, vegetated waterbodies.

Outside of these humid conditions, pioneer grasslands **flora** usually require poor soil conditions to grow without competition.


MS

Pioneer pond


JT

Vegetated permanent pond


MS

Pioneer area

2. For each species, viable populations were sourced close to the potential receptor sites, within the biogeographical region of translocation.

Natterjack toads' populations are well-known in the Walloon region. Within source sites situated within 20 km from reception sites, population statuses were further characterized allowing determining sites with a minimum of five spawns a year as potential sources. Quarries were preferred as sources of genetic material adapted to extractive environments.

Sizes of **Great crested newt** populations were evaluated by bottle trap surveys to identify the continuous presence of individuals on source sites within in a 20km radius from receptor quarries. The evaluations determined whether they hosted a minimum of 25 individuals estimated necessary to limit the impact of translocation on source populations.

For the **Yellow-bellied toad,** 10 individuals were captured from a previously reintroduced population and bred to produce offsprings used in reintroduction.

Seeds of targeted **annual and biannual flora** were sourced from wild populations in distinct biogeographical districts. Collection was restricted to large populations comprising a minimum of 50 individuals from which a maximum of 20% of seeds were collected.

MS

3. Prior to translocations, all **amphibians'** source populations were evaluated for the presence of the problematic amphibians' pathogens *Batrachochytrium dendrobatidis, B. salamandrivorans* and *Ranavirus.* Either using eggs or a captive breeding program for the transfers further limited the risks of contaminations while reducing induced stress on individuals.

PH

Only viable populations of **plants** not subject to illnesses were conserved in production. The use of seeds as translocation material further limited risks of contamination by pathogens.

4. For all translocated species, acceptance was ensured through dialogue with quarries and authorities. Exchanges helped secure commitments for the long-term maintenance and development of habitats from quarry managers.
While maximizing success chances by involving them in the development of species' habitats, specific attention was paid to avoid placing the burden of potential failures on the receptor sites.

5. Adequate derogations to the EU Habitats Directive and regional law were requested and documented to collect and transfer individuals of protected species.

6. Specific staff was ascribed to the design and implementation of translocations. Supervision of interns helped the project team's realizations and provided opportunities for students' training.

MS

Yellow-bellied toad *(Bombina variegata)*

MS

Deptford pink *(Dianthus armeria)*

MS

Natterjack toad *(Bufo calamita)*

MS

MS

Small flowered catchfly *(Silene gallica)*

JT

Great crested newt *(Triturus cristatus)*

MS

Sheep's-bit *(Jasione montana)*

RELEASE PROGRAM

The release of individuals should verify adequation between sites and the species' biological requirements necessary to the accomplishment of their life cycle stages. When these conditions are met, the strategy should consider most adequate life stages and numbers for released species as well as best timings for transfers.

For the **Natterjack toad**, the transfer of egg strings segments allowed translocating large number of individuals. The collection was limited to c. 20% of source spawns in order to avoid impacts on native populations.
For each receptor site, a maximum of 20 000 eggs - 100 fragments each representing c. 200 eggs and originating from 2 populations - was set as a target. Transfers from 8 sites were realized towards 5 new sites over the course of 3 years.


PH

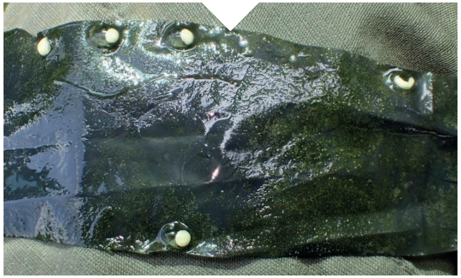
Following the evaluation of translocation relevance, LiFE in Quarries' sites were screened to determine their adequacy with each target species needs: sites missing the species were evaluated for their location within the known range, the likeliness of passive colonization from close by populations and the presence of the species' habitats. This resulted in a selection of most adequate sites and, within them, zones that would act as translocation and refuge areas.

Life stages for the releases were then defined in accordance with species biology:


JT


PH


JT


JT


JT

Great crested newts were transferred following an innovative egg collecting method: by encouraging females to lay spawns on plastic strips. An initial transfer objective for the 4 quarries was determined at 2000 eggs originating from 4 source sites. Final numbers ranged between c. 2500 and 13 000 over 2 to 3 years.

Some 1300 **Yellow-bellied** toadlets were released in temporary refuge areas of one quarry. While time consuming, the captive breeding method was best fitted to a limited number of adults available and resulted in a high number of well-developed offsprings with higher survival rates expected.


MS


AK


AK

Seed lots were developed in a nursery's optimal growing conditions and led to the production of large amounts of propagation material within one or two generations.
To limit genetic pollution, sowing of each lot was limited to sites pertaining to the biogeographical district of its source population.


MS

Common cudweed *(Filago vulgaris)*


MS

Calley pea *(Lathyrus hirsutus)*


MS


MS


MS


MS

MONITORING AND MANAGEMENT

Monitoring aims at evaluating the success of translocations but also at adjusting or cancelling the process in case of unsuccessful outcomes. To maintain the translocated populations over time, a long-term management of habitats may be required.

A specific monitoring scheme was designed for all translocations. It comprised levels of success based on the development and reproduction status.

For **Natterjack** and **Yellow-bellied toads**, an initial monitoring of translocated individuals allowed determining the presence of toadlets.

MS

The years following translocations, the presence of sub-adults on all sites confirmed an initial success of translocations.

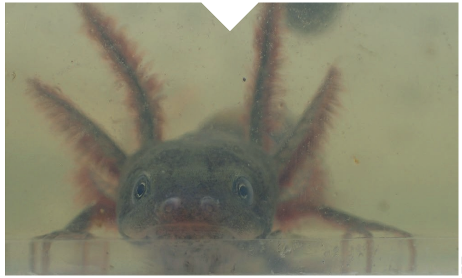
AK

A Capture-Marking-Recapture study led on 3 of the 5 sites estimated Natterjack's populations reaching between 50 and 80 individuals, with reproducing adults and spawns, within 2 years of translocations.

PH

MS

Great crested newt's bottle trap monitoring led to the capture of larvaes or sub-adults in all sites within two years following translocations.



JT

JT

A detailed study of sowing establishment allowed for the identification of new populations for 9 of the 10 sown **plant species**. All sown sites presented at least one new species' population.


MS

Childing pink *(Petrorhagia prolifera)*


MS

The monitoring is expected to be continued in the coming years to determine the development of introduced populations on the different sites. Outcomes will guide adjustments in dynamic and permanent nature management.


MS

COMMUNICATION

Communication is key to favor support from multiple stakeholders and transfer to other conservation projects by increasing awareness and sharing acquired knowledge.

In the LiFE in Quarries, continued involvement of quarries staff in translocations and monitoring has been a key to develop consciousness at site level. This awareness has been broadened outside of the sector through communication campaigns and involvement of students from the preparatory phase to the translocations and monitoring.


MS

MS

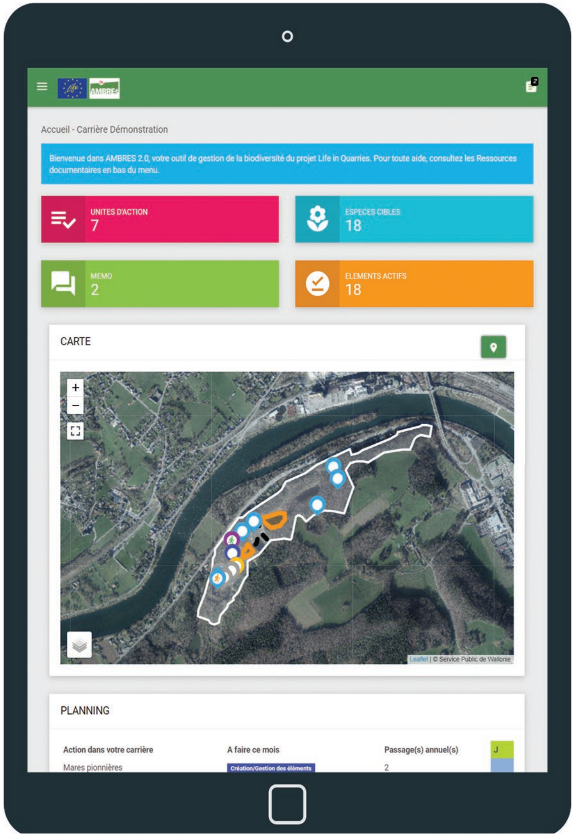
BIODIVERSITY PLATFORM

AMBRES, THE BIODIVERSITY MANAGEMENT TOOL FOR ACTIVE QUARRIES

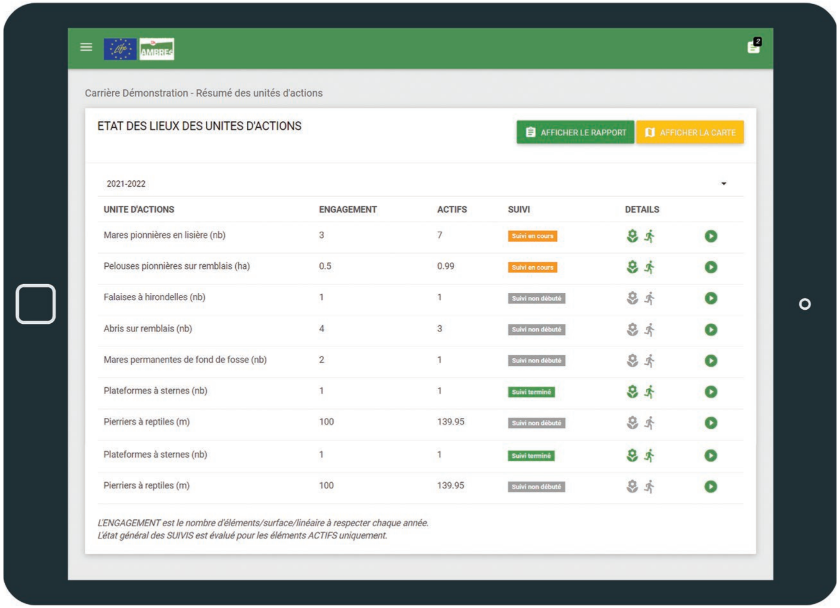
Why? The LiFE in Quarries project set ambitious short and long-term biodiversity goals. Through management plans, the active quarries are committed to maintain their biodiversity actions over 15 years. While these commitments have been reached, the dynamic management implementation of actions implies a continuous follow up of new realizations. To help and support operators and site managers in the monitoring of achievements, the AMBREs Webapp has been developed.

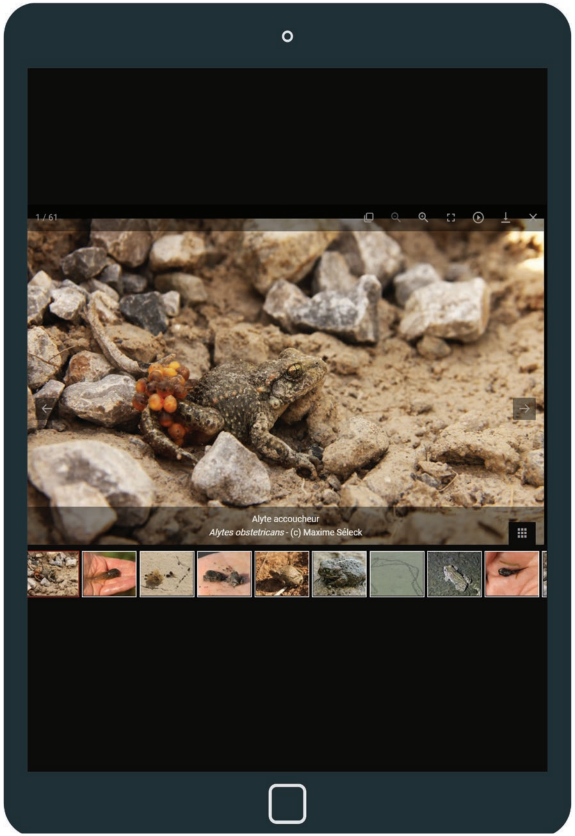
Missions On a daily basis, AMBREs allows non-biodiversity experts (non-naturalists) to manage biodiversity in their quarries. In practice, it acts as a companion in species recognition, in the care for biodiversity actions, to monitor their attractiveness for target species, in improving operators' day-to-day management and to report on actions and species statuses.
A two-faced tool. AMBREs allows following the progression of regional objectives in real time by merging each quarry's actions. At the quarry level, commitments are defined in accordance with the site characteristics: its size, the initial biodiversity surveys, the nature of exploitation and the extent of volunteer commitments.

Functionalities AMBREs is as much a library as an operational toolbox. On a unique platform, users are provided access to target species (fauna-flora) data and information, to real time progress of actions, to relevant actions promoting targeted species and to technical resources helping the on-site implementation and monitoring. AMBREs further provides a unique user-friendly experience to manage concrete biodiversity actions dynamically through both mapping and planning tools. Simple indicators, quantitative and qualitative, facilitate the monitoring of actions: while percentage vegetation cover is used as a criterion to determine the pioneer status of ponds targeting Natterjack or Midwife toads, butterflies colors are used as a surrogate indicator of meadows' biological value.



Constant reporting Annually the quarry personnel can edit a report on the status of actions and monitoring implementation. These automatic reports allow following the ad equation between realizations and commitments over the years. They allow reporting to competent authorities on the continuity of realizations.





And more Answering quarry operators' desire to further progress in biodiversity stewardship, AMBREs provides an additional function to report location of target species observations. This punctual reporting facilitates the identification of relevant locations for future actions benefiting targeted species.

AMBREs is an office and a field tool presenting responsive design. Compatible with all screen sizes from smartphones to large computer screens, it allows users to monitor realizations on the field and validate information at their desk. Designed to be fast and intuitive, it is adapted to help favor biodiversity in quarries.

MS

LITERATURE

LITERATURE

Bachmann, S., Haller, B., Lötscher, R., Rehsteiner, U., Spaar, R., & Voge, C. 2008. Guide de promotion de l'hirondelle de rivage en Suisse. Conseils pratiques pour la gestion des colonies dans les carrières et la construction de parois de nidification. Fondation Paysage et Gravier, Uttingen, Association Suisse de l'industrie des Graviers et du Béton, Berne, Association Suisse pour la Protection des Oiseaux ASPO/BirdLife Suisse, Cudrefin, Station orthinologique suisse, Sempach. https://www.landschaftundkies.ch/cvfs/4754366/VFS-DFA-1268597-leitfaden_uferschwalbe_fr.pdf

Davies, A.M. 2006. Nature After Minerals: how mineral site restoration can benefit people and wildlife. Sandy, UK. https://afterminerals.com/W

European Commission. 2021. Commission notice Guidance document on the strict protection of animal species of Community interest under the Habitats Directive C/2021/7301 final. 118. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=PI_COM:C(2021)7301

European Commission. 2010. EC Guidance on undertaking new non energy extractive activities in accordance with Natura 2000 requirements (European Commission - DG Environment, Ed.). European Commission, Luxembourg. https://doi.org/10.2779/98870

Flavenot, T. 2014. Évaluation de l'effet des carrières de granulats sur la connectivité du paysage . http://www.theses.fr/2014MNHN0001

Geigenbauer, K. (INULA), Hunger, H. (INULA), & Schiel, F.-J. (INULA). 2013. Birds in quarries and gravel pits - Flying gemstones and swift hunters (M. (HeidelbergCement) Rademacher, Ed.). Global Management Biodiversity and Natural Resources - HeidelbergCement, Freiburg i. Br., Germany.

Geigenbauer, K. (INULA), Hunger, H. (INULA), & Schiel, F.-J. (INULA). 2011. Dragonflies in quarries and gravel pits - The life of the quick and beautiful (M. (HeidelbergCement) Rademacher, Ed.). Global Management Biodiversity and Natural Resources - HeidelbergCement, Freiburg i. Br., Germany.

Geigenbauer, K. (INULA), Hunger, H. (INULA), & Schiel, F.-J. (INULA). 2012. Orchids in quarries and gravel pits - Colourful queens of the plant kingdom (M. (HeidelbergCement) Rademacher, Ed.). Global Management Biodiversity and Natural Resources - HeidelbergCement, Freiburg i. Br., Germany.

Geigenbauer, K. (INULA), Hunger, H. (INULA), Schiel, F.-J. (INULA), & Langley, N. 2014. Amphibians and reptiles in quarries and gravel pits - Wanderers between the elements (Rademacher, Michael (Biodiversity & Natural Resources, Ed.). Global Management Biodiversity and Natural Resources - HeidelbergCement, Freiburg i. Br., Germany.

Hunger, H. (INULA), Schiel, F.-J. (INULA), & Rademacher, M. (Fachhochschule B. 2015. Biodiversity management in quarries and gravel pits - Putting Nature back together (M. (Biodiversity & N. R. F. B. Rademacher, Ed.). Freiburg i. Br., Germany.

Karch. 2012. Notice pratique - Protéger et favoriser les reptiles indigènes. Neuchatel, Suisse.

Keller, V. 1992. Optimising measures for the protection of species during quarrying and recultivation. Anthos : Zeitschrift für Landschaftsarchitektur 3: 35–38. https://www.e-periodica.ch/digbib/view?pid=ant-001:1992:31::451#263

Mermod, M., Zumbach, S., Aebischer, A., Leu, T., Lippuner, M., & Schmidt, B. 2010. Notice pratique pour la conservation du crapaud calamite Bufo calamita. Neuchatel, Suisse.

Mermod, M., Zumbach, S., Borgula, A., Krummenacher, E., Lüscher, B., Pellet, J., & Schmidt, B. 2010. Notice pratique pour la conservation du sonneur à ventre jaune Bombina variegata. Neuchatel, Suisse.

Mermod, M., Zumbach, S., Borgula, A., Lüscher, B., Pellet, J., & Schmidt, B. 2010. Notice pratique pour la conservation du crapaud accoucheur Alytes obstetricans. Neuchatel, Suisse.

Mermod, M., Zumbach, S., Pellet, J., & Schmidt, B. 2010. Notice pratique pour la conservation du triton crêté Triturus cristatus & T. carnifex et du triton lobé Lissotriton vulgaris. Neuchatel, Suisse.

Meyer, A., Dušej, G., Bütler, M., Monney, J.-C., Billing, H., Mermod, M., Jucker, K., & Bovey, M. 2011. Notice pratique petites structures - Sites de ponte pour couleuvre à collier et autres serpents. Neuchatel, Suisse.

Meyer, A., Dušej, G., Monney, J.-C., Billing, H., Mermod, M., Jucker, K., & Bovey, M. 2011. Notice pratique petites structures - Tas et piles de bois. Neuchatel, Suisse.

Minterr, B. a, & Collins, J.P. 2010. Guidelines for Reintroductions and Other Conservation Translocations IUCN. IUCN Species Survival Commission, Gland, Switzerland. https://portals.iucn.org/library/node/10386

Nicolet, P., & Williams, P. 2008. Pond creation toolkit for the Aggregate exctraction industry. http://freshwaterhabitats.org.uk/projects/million-ponds/pond-creation-toolkit/#Case studies

Noiret, C., & Coppée, J.-L. 2004. Les Hirondelles de rivage – Répartition, habitats et mesures de sauvegarde en Wallonie. Réaménagement biologique des carrières après exploitation. Brochure Technique n°27 (J. Stein, Ed.). Jambes, Belgique.

Oertli, B., Joye, D.A., Castella, E., Juge, R., Cambin, D., & Lachavanne, J.-B. 2002. Does size matter? The relationship between pond area and biodiversity. Biological Conservation 104: 59–70. https://doi.org/10.1016/S0006-3207(01)00154-9

Pellet, J. 2013. Pro Natura : Réaliser des plans d'eau temporaires pour les amphibiens menacés. Bâle, Suisse.

Sparg, S., Nikokakos, N., Suffys, T., Jewell, C., & Somer, A. 2021. Extractive Sector Species Protection Code of Conduct: A manageable approach for planning and permitting procedures respecting EU legislation and fostering biodiversity. 17. https://www.birdlife.org/wp-content/uploads/2021/10/Code-of-conduct_With-signatures_Digital-low-res.pdf

The N2K Group EEIG, & Institute for European Environmental Policy. 2019. Non-Energy Mineral Extraction in Relation To Natura 2000 Case Studies (C. Olmeda & B. Barov, Eds.).

UNPG. 2011. Guide pratique d'aménagement paysager des carrières (A. Blouin & J.-P. Durand, Eds.). UNPG - École Nationale Supérieure du Paysage de Versailles-Marseille, Paris, France.

Voeltzel, D., & Février, Y. (Eds.). 2012. Gestion et aménagement écologiques des carrières de roches massives. Guide pratique à l'usage des exploitants de carrières. ENCEM et CNC - UNPG, SFIC et UPC, Paris, France. https://www.unicem.fr/wp-content/uploads/gestion-et-amenagement-ecologiques-des-carrieres.pdf

White, G.J., Gilbert, J.C., Benstead, P., Fasham, M., & José, P. 2003. Habitat creation handbook for the minerals industry (G. J. White & J. C. Gilbert, Eds.). The RSPB, Sandy, United Kingdom.

Williams, P., Biggs, J., Corfield, A., Fox, G., Walker, D., & Whitfield, M. 1997. Designing new ponds for wildlife. British Wildlife 8: 137–150. https://freshwaterhabitats.org.uk/wp-content/uploads/2013/09/Williams-et-al-1997-Design-new-ponds.pdf

INTERNET RESOURCES

http://www.lifeinquarries.eu

SUPPLEMENTARY RESOURCES

Hauteclair, P., Séleck, M., Taymans, J., Gauquie, B., Mathelart, C., & Mahy, G. 2021. Rapport synthétique de suivi de la biodiversité du projet LiFE in Quarries. Université de Liège, Gembloux Agro-Bio Tech, Gembloux, Belgique. http://hdl.handle.net/2268/266063

Maebe, L., Gillet, L., Mercken, K., Séleck, M., Dufrêne, M., Boeraeve, F., & Mahy, G. 2021. Ecosystem services assessment in the Extractive sector - Lessons from the LiFE in Quarries project. Université de Liège, Gembloux Agro-Bio Tech. http://hdl.handle.net/2268/266158

Mahy, G., Maebe, L., Dufrêne, M., Joassin, V., Mercken, K., de Wagter, A., Druez, C., & Séleck, M. 2021. Biodiversity perception in the Extractive sector - Lessons from the LiFE in Quarries project. Université de Liège, Gembloux Agro-Bio Tech. http://hdl.handle.net/2268/266146

Séleck, M., Mathelart, C., Gauquie, B., Taymans, J., Sneessens, Alexandre Calozet, M., & Mahy, G. 2019. Synthèse des inventaires biologiques des 24 carrières du LiFE in Quarries. Gembloux, Belgique. http://hdl.handle.net/2268/235590

PHOTOGRAPHS

Authors are referenced by the following initials

AD: Aurore Deflandre; AK: Domaine des Grottes de Han/Anthony Kohler; AT: Aurélie Tock; AS: Alexandre Sneessens; BG: Benoît Gauquie; DD: Dominique Duyck; DH: Damien Hubo; DS: Damien Sevrin ; JT: Julien Taymans; MS: Maxime Séleck ; OD: Olivier Defechereux; PH: Pascal Hauteclair; RB: Robin Gailly; ZB: Zoé Blanchet.

Agronomie Gembloux

LIÈGE université Gembloux Agro-Bio Tech

LIFE IN QUARRIES

9 782870 161784