After Life Plan

Conservation of the Montseny newt and its riparian habitat

LIFE TRITÓ MONTSENY - LIFE15 NAT/ES/000757

Coordinator: Diputació de Barcelona

Partners: Diputació de Girona, Zoo de Barcelona, Forestal Catalana and Generalitat de Catalunya

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INTRODUCTION

Calotriton arnoldi is an endemic amphibian inhabiting Montseny Natural Park and Biosphere Reserve (PNRBM). Due to its small distribution range and population size, it was listed as "Critically endangered (CR)" by IUCN. At the end of 2016, the Life Trito Montseny (LIFETM) project (LIFE15 NAT/ES/000757) was launched. This project's aim was to promote around fifty actions to ensure the conservation of C. arnoldi and its natural habitat with five strategic lines:

- ✓ Protection. To establish proper legal coverage and define long-term strategic planning.
- ✓ Conservation. To ensure its genetic conservation and expand its geographic distribution
- ✓ Habitat management. To eliminate or minimize threats that exist in the riparian habitat.
- ✓ Research.To increase scientific and technical knowledge with regard to C. arnoldi conservation status and its habitat management.
- ✓ Education & Divulgation. To Involve and engage stakeholders and local residents in the conservation of Montseny brook newt's riparian habitats.

The implementation of the LIFE Trito Montseny has been a success and most of the objectives have been achieved. In summary the results have been:

1. Protection

→ The distribution area of the newt takes up 3,039 ha, of which 63% corresponds to private properties. It has been possible **to apply protection measures to 23% of the surface area of private** estates through:

- The involvement of forest owners, with the signing of **three land stewardship agreements (65 ha)** to apply good environmental practices and protect the riparian habitat;
- **The purchase of two estates (90 ha)** of high ecological value for the protection of the Montseny newt;
- The establishment **of supervised management areas (65 ha)** along river courses and whose purpose is to preserve the riparian habitat.

→ Implementation of **biosecurity** measures to prevent the introduction and spread of infectious diseases throughout the Montseny Natural Park and Biosphere Reserve.

→ Elaboration of protocols to apply **good environmental** practices when visiting, working or managing the riparian forest.

→ The involvement of local people and institutions within the territory in the project.

→ Elaboration of the Montseny Newt Recovery plan, which must be approved by the **Generalitat de Catalunya.**

2. Conservation

- → Expansion and modernization of the **three breeding centres** : Torreferrussa, Pont de Suert and Barcelona Zoo.
- → Addition of **two new breeding centres** : Chester Zoo and the Calafell Centre for Environmental Research and Education (CREAC).
- → Expansion of personnel specialized in the management of captive breeding facilities.
- → **Elaboration of a Breeding protocol for the Montseny** newt to standardise its management.
- → An increase in the capacity of the five breeding centres, which can currently **have up to 1,723 specimens** for their potential release**.**
- → Maintaining a **viable genetic reserve**, as recommended by the IUCN for critically endangered species.
- → Addition of the Montseny newt in the European Endangered Species Program (EEP), once it became open to international participation in the captive breeding program.
- → Development of an agreed strategy, with technicians and scientists, for the release and creation of new newt populations in Montseny.
- → Elaboration and implementation of the Program for the creation of **new populations**.
- → **Selection of optimal streams** to accommodate new populations of captive-bred newts, with the involvement of a multidisciplinary team of experts.
- → S**anitary control and marking** of all animals before being released.
- → Creation and reinforcement of **five new** towns with Montseny newt.
- → **Release of more than 2,000** specimens of Montseny newt into optimal streams and annual monitoring of their evolution.

3. Habitat Management

- → Elimination of 7 water catchments from streams.
- → Installation of 1 water distribution box at the stream's bypass point, with the aim of **ensuring there is an ecological flow.**
- → Adaptation of 4 water accumulation tanks with **self-closing systems.**
- → Development of **rainwater collection and storage systems** in 3 farms.
- → Conversion of sprinkler irrigation to **drip irrigation** in a nursery.
- → Installation of a **lagoon system** for wastewater treatment.
- → **Reduction of erosion** and sediment contribution to streams with the construction of more than 1,000 m of palisades by implementing bioengineering techniques.
- → **Elimination of 9 exotic tree plantations** in order to increase water contribution to the streams.
- → Restoration of streams' **tree cover** with native species such as alder, ash or hazelnut.

- → Work to remove the river trout introduced into the streams where the newt lives.
- → Removal of drainage pipes to **restore the original channel** from streams and ecological connectivity.
- → **Elimination of 11 extraction tracks** to restore the natural watercourse.
- → **Construction** of 4types of bridges (5 made of filter stone, 3 made of vaulted stone, 6 platform bridges and 1 wood one).

4. Research

- → Study of the **newt's** diet by using the DNA in newt faeces.
- → New estimate of the newt's distribution area **by using environmental DNA techniques.**
- → Study of the newt's preferences and adaptation to temperature changes.
- → Analysis of fertility and development of animals in captivity.
- → Evaluation of the effect of emerging diseases.
- → Study of a newt population, demography and mobility of adults.
- → Spatial modelling to find suitable areas for reintroduction.
- → Geological study of streams.
- → Study of human impact on the newt's habitat throughout history.
- → Creation of **3 scientific** committees with regard to the newt's biology, breeding centres, new populations and the hydrological dynamics of the Montseny massif.
- → Hydrological monitoring network: installation of 9 stations to measure water flow and integration of 5 meteorological stations.
- → Analysis of the chemical composition of water in 30 streams in Montseny.
- → **Monitoring of newt populations in nature**, with more than 70 field campaigns and almost 700 observations.
- → Control of emerging diseases, with analysis of 426 samples from newts and other amphibians.
- → Integration of all the information in a **Geographic Information System** for it to be used.

5. Education & Divulgation

→ Elaboration of a communication strategy to agree on the informative content of the project.

→ Creation of a new educational facility at the Barcelona Zoo that has received almost 500,000 visitors since its inception. 13,800 schoolchildren have been able to participate in the educational activities related to the Montseny newt.

→ The exhibition "My name is *Calotriton* and I only live in Montseny" has been in 42 municipalities and has been visited by over 21,000 people since the beginning of the project.

→ The program "El Montseny a l'escola" has disseminated the Montseny newt to 2800 schoolchildren.

→ Dissemination of the project in 54 workshops that have reached a total of 5,446 attendees.

→ Creation and updating of the project website. Digital dissemination on social networks.

→ The 8 audiovisual capsules produced to disseminate the project's actions have received very good feedback and almost 30,000 views

→ Publication of the handbook "Infectious diseases in amphibians: Handbook of best practices in educational discovery activities"

→ Carrying out workshops and elaboration of various dissemination materials: the informative leaflet, a photographic exhibition, information panels, videos of the Montseny newt and a children's story, among others.

→ Carrying out workshops to make gypsum newts, where 613 people have taken part.

→ Exchange of experiences with 10 international projects that shared similar objectives.

→ Throughout the project, various articles of an informative, technical and scientific nature have been published

Despite the actions taken, the threats are still present in the upper basin of the river Tordera, which is the distribution area of *C. arnoldi.*

Surface water diversion is one of the most dramatic and immediate threats to this species since large amounts of water are being extracted from LIC Montseny for human consumption and livestock along all the river secondary basins. It is likely that water overexploitation is a severe threat because of the species' ecological requirements. In fact, the current environmental legislation is not being enforced efficiently about the maintenance of ecological flows and their monitoring and this constitutes a significant difficulty when dealing with this threat.

Wood plantations and, more specifically, those that consist of fast-growing allochthonous conifers, may be behind the waterflow reduction in the La Tordera basin. They require large amounts of water and take up 11.40 ha (12%) within the natural range of *C. arnoldi.*

Global warming and other severe climatic or weather events outside the natural range of variation are other threats currently affecting the species. For instance, the beech (*Fagus sylvatica*) forest, an excellent habitat for *C. arnoldi*, has shifted upwards by 70 m at the highest altitudes (1600–1700 m) since 1945, and it is being replaced by a holm oak (*Quercus ilex*) forest at lower altitudes (800–1400 m).

Infections disease. The recent appearance of an isolated focus of *B. salamandrivorans* very close to the *C. arnoldi* populations, forces us to be very strict with regard to preventive biosecurity measures.

THREATS

Threats to newt populations as described and as they already existed in the past decades, despite all the efforts made during the LIFE Trito Montseny, continue to exist at the end of the project, although, some of them eliminated or reduced in certain streams. All threats that *C.arnoldi* continues to suffer, are set out in the table below.

Threat Typology		Negative impacts	Medium&long-term consequences
Intrinsic threats to the specie or habitat			
	Inbreeding risk	Low genetic variability	Reduction of birth rates, reduction and loss of populations
	Emerging infectious diseases	Amphibian infection and population extinction	Extinction of the species
	Ecological specialisation	High vulnerability to environmental change	Low or no adaptation to habitat changes
	Specific torrent typology	Low availability of suitable habitat	Low possibility of increasing geographic distribution
Extrinsic global threat			
Climate chance			
	Increase in temperatures	Physical and chemical habitat changes	Change in ecological processes and loss of populations
	Reduction of the hydrological flow	Lack of water flow	Death due to lack of water
Extrinsic local threat			
Natural resources exploitation			
	Use of natural water	Reduction or removal of surface water flow	Death due to lack of water
	Release of wastewater	Water authorisation	Respiratory distress due to water pollution
	Forestry management	Destruction of the riparian habitat and the watershed	Trophic change disruption due geomorphological changes in the stream, loss of tree cover, increase sunstroke and temperature
	Fisheries management	Introduction of exotic predators (as *Salmo truta*)	Predation and competition on food resources
Communication routes			
	Timber activity roads	Fragmentation of the river course	Isolation of populations
	Roads network	Elimination of ecological connectivity	Isolation of populations
Human Frequency			
	Visitors	Amphibian manipulation. Disease introduction	Stress, reduction or disappearance of stocks
	Sports	Habitat degradation	Stress, lost of habitat and disappearance of stocks
	Education & divulgation	Amphibian manipulation. Disease introduction	Stress, reduction or disappearance of stocks
	Naturalist & photojournalist	Amphibian extraction. Disease introduction	Stress, reduction or disappearance of stocks

SWOT ANALYSIS

To evaluate the strengths, weaknesses, opportunities and threats at the end of the project we used de SWOT analysis method. This method will help to identify favourable or unfavourable factors to achieve our goals during the next years.

	Species	Habitat	Stakeholders	Management
Strengths	**Successful** creation of new populations.	**Good experiences in: Restoration** of riparian habitats.	**Multidisciplinary** of decisions made.	**Writing** a management and conservation plan.
	Successful ex-situ reproduction of the species.	**Removal** of barrier structures.	**Post**-Life commitment of the administrations to continue working	**Acquired** experience.
	Significant improvement in knowledge of the biology of the species.	Catchment improvement	Dozens of stakeholders involved in the project	Availability of management and conservation plan.
		Background knowledge of the environment restauration	**Good Experiences** in Land Stewardship Agreement	Creation of the areas of supervised management
			Knowledge and involvement of Montseny inhabitants	**Great experience** in the management of the territory and natural resources
			Good results in the purchase of private land.	
Weakness	**Not enough** information is available on the biology of the species.	**Short** duration of the project in relation to the time required to observe the evolution of actions.	**Few** similar experiences in LIC Montseny.	**Slowness** of administrative procedures to act in the territory.
	Very **difficult** species to track and mark	**Not enough** knowledge of ecological processes	Only 3 land owners signed agreement	Experienced but not stable or specific staff
	Critical status of conservation of the species.	Network monitoring hydrology difficult to implement and maintain	Not experience in land swap	Limited funding and human resources
		Previous experience on successful previous similar actions very scarce		
Opportunities	**Good** knowledge of the biology and ecology of *C.arnoldi*	**Improvement of** ecological information.	**Involvement** of many administrations or entities.	**Great successful** ex-situ reproduction and introduction of the species
	Implemented of biosecurity measures	**Involvement of** forest ecology research groups.	**Large number of entities** and landowners in favour of conservation	Established good practices
		Introduction of good forestry practices	Great involvement of herpetologist, hydrologist, ecologist	**Public** administration involvement. **Agreements** with landlords
		Monitoring information		
Threats	**Fragmented** population.	**Orography** complicated	**Involvement** of many administrations or entities	**Cost** of habitat management
	Low number of individuals.	**Some** private property	**Difficult** and time-consuming interlocution with private property	**Short** duration of the Life project to continue the habitat restoration
	Restricted distribution.	**Human** presence	**Ignorance** of the species and its threats	GIS needs **constant updating and** supervision
	Illegal capture or manipulation	**Traditional** resource exploitation	Significant increase in human presence	Private water and timber exploitation
	Infectious **diseases**	**Reduced** distribution area		Administrative slowness
		Poor forestry practices		**Land** ownership
		Overexploitation of hydric resources		
		Allochthonous riparian habitat		

AFTER LIFE PROPOSAL

Although, conservation of the riverside habitat, in some streams in the upper basin of the Tordera have improved, *C. arnoldi* is still an endemic amphibian in critically endangered status of conservation. It is still imperative to expand its distribution area, to continue reducing the threats it faces, to increase landowner involvement, and is highly recommended to eradicate the environmental malpractices, especially in forestry management and water abstraction from streams.

The manager team of LIC Montseny and the Wildlife managers of the government of Catalonia must continue to work to improve the state of conservation of the *C. arnoldi* and to protect and restore its riverside natural habitat.

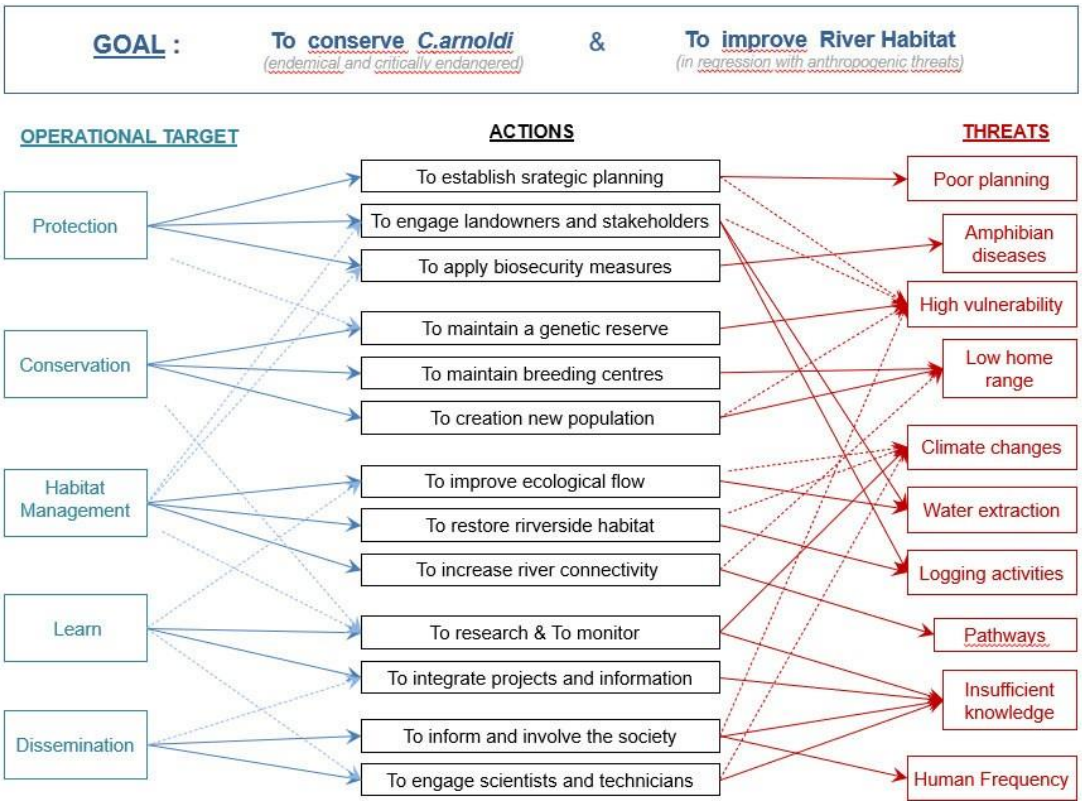
OBJECTIVE

The LIFE Trito Montseny project was never considered as a final project. From the beginning, in 2016, it was envisaged as the star of a new natural heritage management, based on *The European Biodiversity Strategy*:

- ✓ Putting natural "heritage" before natural "resource"
- ✓ Proposing new methods to make the exploitation of natural resources ecologically sustainable
- ✓ Promoting adaptation and resilience of natural habitats to climate change
- ✓ Involving society and residents, and seeking synergies to conserve natural heritage

This Strategy should continue to be the guideline to achieve the objectives during AFTER LIFE. Achieving our objectives will depend on how we act as project managers, while being aware of what it means to solve problems through action-oriented approaches.
We must therefore define actions that reduce or eliminate the threats, in order to achieve the established objectives.

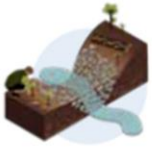
The two main objectives remain the same as in LIFE Trito Montseny: to protect and preserve *C. arnoldi* and to improve its River Habitat. The following diagram shows the operational targets to achieve, the actions required to reach them and the threats addressed by these actions. As observed in the diagram, this is not a linear pattern, but rather a much more complex one. Each operational objective requires several actions to achieve the expected results, while these actions also act on several objectives and threats at the same time.



Operational objectives

1. Protection:
To achieve greater legal coverage of the species. To develop a Recovery Plan. To involve owners in order to establish custody agreements.

2. Conservation:
To ensure the genetic conservation of the species and expand its distribution. To promote preventive management by increasing captive breeding and reintroduction so as to ensure the viability of Montseny newt populations in their natural habitat.



3. Habitat management:
To reduce the number of water catchments and encourage rainwater collection. To improve wastewater treatment, restore the riparian habitat and recover the streams' ecological connectivity.

4. Learn:
To increase the collaboration between natural environment scientists and managers in order to improve the understanding of the species' biology and disclose its ecological requirements and threats.

5. Dissemination
To raise awareness, get the involvement and commitment of agents within the area and society in general with regard to the conservation of the riparian habitat and its biodiversity.

METHODOLOGY

The results achieved in LIFE Trito Montseny have established a successful working dynamic. This dynamic is to be replicated at the LIC Montseny, with the aim of achieving the conservation objectives established in this protected area and with the will that good management practices ensure respectful exploitation of natural resources.

The administrations and institutions involved in the LIFE Trito Montseny are committed to continue working to improve the conservation status of C.arnoldi. The work plan for the next five years is based on the five operational objectives, subsequently commented. The five objectives are related, therefore the actions to be implemented are not single-target specific, many are transversal actions and in many cases serve a variety of purposes.

Finally, we must keep in mind the need to devote more financial and human resources to the actions that are of the highest priority and most urgent to improve the conservation status of C.arnoldi

The table below summarises the actions proposed in the After LIFE, linked to each of the 5 operational objectives. The programmes linked to each of these actions are described in the following chapter.

AFTER LIFE ACTIONS

Goal	Action Type	Num.of programes
PROTECTION		
	Recovery Plan	3
	Collaboration with landwners	5
	Biosegurety	2
	Coordination	3
CONSERVATION		
	Genetic reserve	3
	Breeding programe	5
	New population	3
HABITAT MANAGEMENT		
	Ecological flow	7
	Riverside habitat	5
	River connectivity	2
LEARN		
	GIS	1
	Monitoring	6
	Projects	2
DISSEMINATE		
	Divulgation	4
	Education	3

1. Protecció

1.1 Recovery Plan

The Recovery Plan and the Protection Plan for the LIC Montseny are two opportunities to ensure protection of *C.arnoldi*.

- ✓ The Montseny brown newt Recovery Plan is an essential planning tool for the future recovery of this endemisme
  - Action: Must first be approved by GenCat and later, competent administrations (GenCat, DiBa and DiGi) should implement it.
- ✓ The Montseny Natural Park Law ((Act. 127/2021) establishes:
  - Article 4.12. *C.arnoldi* and its habitat have strict protection, only research and conservation activities are allowed in their habitat and use which could have negative effects is prohibited.
  - Article 5.1. The Montseny Protection Plan must specify the zoning, the use of resources and the protected habitat ans species. This Plan is being drafted and results ans conclusions of LIFE TM are being included

ACTION
To define, in the Montseny Protection Plan, Natural Reserve Areas that include the riverside habitats where there are populations of the Montseny newt.
ACTION
The administration maneging The Montseny Natural Park (DIBA and DIGI) has to invest human and economic resources to comply with these legal articles. It should be obtained a financial commitment from the administrations

1.2. Collaboration with landowners

Establish agreements with private property and involve local agents for the conservation of the Montseny brow newt and its riverside habitat are a forward-looking strategy.
Water and timber are two historically exploited resources, but its extraction could spoil the riparian habitat. It's necessary to find a balance between individual interests, those of local communities and those of society as a whole (which the Administration defends). Finding a consensus will imporve the conservation of natural resources and thus conerve the natural heritage.

ACTION
To inform to the owner about the obligation to protect certain habitats and species, the sustainability in natural resource use or the application of good environmental practices, is an important job of LIC Montseny staff.
ACTION
The signature of stewardship agreements with commitments to implement good environmental practices, should continue to be promoted in the next years .
ACTION
The delimitation of supervised management areas in private land, which are outside nature reserve is necessary to protect riparian habitat.

ACTION
Private land purchase or exchange private land for public land with low conservation interest, should continue to be promoted in the next years .
ACTION
Provide subventions to landowners who agree to apply good environmental practices on their farm

1.3 Biosegurety

Application of biosecurity measures to all personnel who carry out activities in riverside habitats is essential to protecc the amphian comunity. Biosecurity measures and protocols have clearly proven their effectiveness. None of the three diseases surveyed (Bd, Bsal or Ranavirus) has been detected in any *C.arnoldi* wild or newly created populations. LIFE TM methodology with regard to biosecurity protocols has been effectiveis, abd it has been appropriate one to prevent the entry of pathogens into the species' wild habitat.

ACTION
Biosecurity measures and protocols must be implemented in all filed works to be carried out in Montseny streams and in lentic environments.
ACTION
Amphibian disease surveillance in all LIC Montseny, specially in Tordera basin

1.4 Coordination

The commitment and economic involvement of public institutions is essential to improve the conservation status of the Montseny newt. It is desirable to involve the different departments and public institutions who manage natural resources and study the natural heritage of the riverside habitat.
The EU's LIFE programme has been essential to achieving the project's objectives, thanks to its financial contribution and because it has established technical and administrative rigour.
Action: To establish a collaborating agreement between the 5 institutions that have led LIFETM.

ACTION
To incorporate the participation of the Catalan Water Agency, The Centre for Forest Ownership, Univerities and research groups, institutions liked to natural heritage and natural resources.
ACTION
To promote sectoral projects with external funding to take advantage of synergies. It would be advisable to consider a new LIFE project to achieve the restoration of the C.arnoldi's entire distribution area and to ensure the viability of their populations.

Summary of the actions to be carried out during the After LIFE

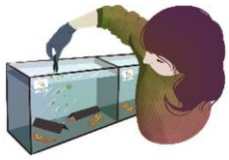
Goal	Accio Description	IMPACT value	Timescale	Responsible and committed
PROTECTION				
Recovery Plan				
	To be published, as a resolution, the Recupation Plan of C.arnoldi.	High	Short term	GenCat : To process the legal approval
	To invest human and economic resources To execute the Recuperation Plan	High	Long term	GenCat, DIBA, FC : To involve staff and allocate budget
	Establishing Natural Reserves linked to Protection Plan of Montseny Natural Park	High	Medium term	DIBA : Elaboration and approval of the protection plan
Collaboration with landwners				
	Inform to apply good environmental practices, to the landowners	Medium	Medium term	DIBA : To involve staff
	Sign Land Stewardship Agreement with landowners with natural or potential newt populations	Medium	Long term	DIBA : To involve staff
	To establish Supervised Management Areas in private land which are outside nature reserves	Medium	Long term	DIBA : To involve staff
	Purchase or exchange of a private property of high natural interest	Medium	Long term	DIBA : To involve staff and allocate budget
	Provide subsidies to landowners who agree to apply good environtmental practices on their farm	Medium	Long term	DIBA : To involve staff and allocate budget
Biosegurety				
	To implement biosecurity measures in all filed works to be carried out in aquatic environments	High	Long term	DIBA, GenCat : To involve staff
	Health monitoring of amphibians population	Medium	Long term	DIBA, GenCat, FC: Contract to external specialists.
Coordination				
	To establish a collaborating agreement between public administrations	Low	Short term	DIBA ,DiGi, GenCat, BCNZOO, FC : To involve staff
	To incorporate the implication of the sectorial adminstration and research groups	Low	Short term	DIBA ,DiGi, GenCat, BCNZOO, FC : To involve staff
	To promote sectoral projects with external funding considering a new LIFE project	High	Short term	DIBA ,DiGi, GenCat, BCNZOO, FC : To involve staff

Timescale: Short term (2023), Medium term (2024-2025), Long term (to 2027 minimum)

Responsible: DIBA (Diputacio de Barcelona, DIGI (Diputacio de Girona, GenCat (Generalitat de Catalunya, FC (Forestal Catalana) BCNZOO (Zoo of Barcelona), CREAC (Center for Research and Environmental Education of Calafell),

Site visit to establish an agreement with private owner. Implementation of the biosecurity protocol

2. Conservation



2.1 Genetic reserve

Breeding centres have managed to maintain a genetic variability of over 90% in the two populations (91% for Western and 97% for Eastern), which is the target for a genetic safeguard programme. Genetic diversity has increased year by year. As the analyses reveal, this current genetic diversity has potential for improvement in the coming years (94,9% for Western and 94% for Eastern), with the release of genetically over-represented specimens and pairing of new couples further improvements are expected. In addition, the upcoming recruitment of new founders will increase the genetic variability of the programme.
Genetic results indicate that there is an ancient isolation between the eastern and western subpopulations. For this reason, the LIFETM has treated both subpopulations as two distinct units both in terms of population management, breeding centres and the creation of new populations. However, if Global Change endangers the species in its natural area in the future, there would be the possibility of creating hybrid populations because what would really be endangered is the species itself. This is an objective not raised in the LIFETM, but should be discussed in an experts committee, in order to reach a consensus and it would require the GenCat's approval.

ACTION
Maintenance of a gene pool of *C. arnoldi* distributed among the breeding centres linked to the EPP programme
ACTION
To capture new specimens from natural populations that are genetically under-represented in the ex-situ population
ACTION
To reach a consensus, in an experts committee, about the possibility of creating hybrid populations

2.2 Breeding programe

To produce *C. arnoldi* specimens to release them in potential habitats in good condition is essential to expand its distribution area.
The European Association of Zoos and Aquaria (EAZA) approved, in 2020, the creation of the new EEP (European Endangered Species Program) for the *C. arnoldi.* LIFE TM has drafted the Captive breeding programme and It will be made public on the EAZA website and is destined to serve as a guide for the breeding of the Montseny brook newt, as well as a reference for breeding projects with other similar species that may require it in the future.
It is essential to keep the experts group of EEP-EAZA active in order to coordinating the implementation of the breeding programme and to agree on possible modifications or improvements to the programme. Should be good to publish, Montseny Brook Newt Breeding protocol adapted to the EAZA Best Practice Guideline format

ACTION
Coordination of European Endangered of C.arnoldi Program (EEP) link to European Association of Zoos and Aquaria (EAZA
ACTION
To maintain the three centres improved under LIFETM (Torreferrussa, Pont de Suert and ZOOBCN), ensure the medium and long-term operation of this breeding centres
ACTION
To consolidate the incorporation of new zoos or breeding centres, to the breeding programme, especially Chester ZOO (UK) and CREAC (Center for Research and Environmental Education of Calafell).
ACTION
The public administration must ensure the medium and long-term operation of breeding centres, establishing partnerships with other institutions involved in the conservation of endangered species
ACTION
Control of infectious diseases in the breeding centres and pre-release disease surveillance

2.3 New populations

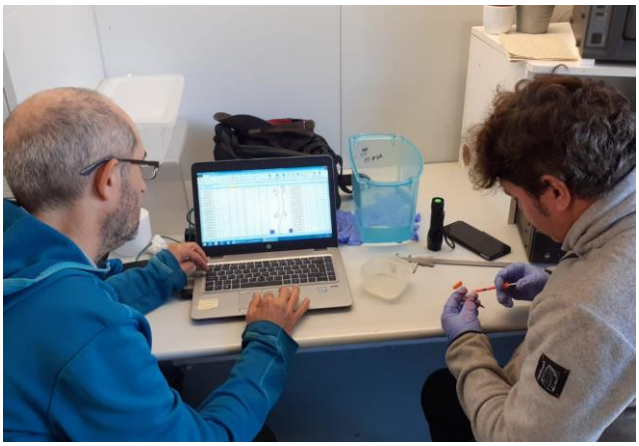
One of the goals of the breeding centres is essential to provide new individuals to create a new population and to widen the geographical distribution of Montseny brook newt.
A program for the creation of new populations of Montseny newt has been drafted and the Program sets out the potential streams where new settlements can be created from newts from the breeding centres, the minimum number of animals to be released, and the periodic reinforcements to be made to consolidate a new population. By following this planning five new localities opened and reinforced during LIFETM. But the distribution of *C. arnoldi* is still very small, and the localities opened still need to be reinforced an monitored to confirm its viability. It is necessary to continue to increase the number of streams with this endemic amphibian of the Montseny.

ACTION
To maintain the production of newts in the breeding centres for release, following the breeding programme.
ACTION
To extend the geographical distribution of *C. arnoldi*, increasing the number of streams with its presence, following the plan to create new populations.
ACTION
To continue searching for streams with good environmental conditions for the subsistence of the Montseny brook newt, in order to widen its distribution.

Summary of the actions to be carried out during the After LIFE

Goal	Accio Description	IMPACT value	Timescale	Responsible and committed
CONSERVATION				
Genetic reserve				
	Maintenance of a gene pool of C. arnoldi distributed among the breeding centres	High	Long term	GenCat, FC: To involve staff and allocate budget
	To add new specimens from natural populations that are genetically under-represented	Medium	Medium term	GenCat, DIBA, FC: To involve staff
	To reach a consensus about the possibility of creating hybrid populations	Low	Long term	GenCat, DIBA, FC: To involve staff
Breeding programe				
	Coordination of European Endangered of C.arnoldi Program (EEP)	High	Long term	FC, GenCat: To involve staff
	To maintain the three centres improved under LIFETM and ensuring its long-term operation	High	Long term	GenCat, FC, ZOOBCN: To involve staff and allocate budget
	To consolidate the incorporation of new zoos or breeding centres	Medium	Long term	FC, BCNZOO, ZOOChester, CREAC To involve staff and allocate budget
	To ensure the long-term operation of breeding centres.	High	Long term	GenCat, FC, BCNZOO: To involve staff and allocate budget
	Control of infectious diseases in the breeding centres and pre-release disease surveillance	High	Long term	GenCat, FC, BCNZOO: To involve staff and allocate budget
New population				
	Maintain the production of newts in the breeding centres for release,	High	Long term	GenCat, FC, BCNZOO: To involve staff and allocate budget
	To exten of the distribution area, establishing of new populations	High	Long term	GenCat, DIBA, FC: To involve staff
	To continue searching for streams with good environmental conditions	High	Long term	DIBA : To involve staff

Timescale: Short term (2023), Medium term (2024-2025), Long term (to 2027 minimum)
Responsible: DIBA (Diputacio de Barcelona, DIGI (Diputacio de Girona, GenCat (Generalitat de Catalunya, FC (Forestal Catalana) BCNZOO (Zoo of Barcelona), CREAC (Center for Research and Environmental Education of Calafell),



Implementation of the feeding protocol in the breeding centre. Individual identification of newts prior to release. Releases of newts bred in the breeding centres

3. Habitat Management

There are no ecological differences between the torrents where *C. arnoldi* lives and where it is not currently found. Therefore, the most plausible hypothesis is that human land use in the recent past have caused the rarefaction and disappearance of the species in many streams.
The Montseny brook newt depends entirely on the good state of conservation of the mountain streams. The riparian habitat must be restored and in particular, a minimum hydrological flow must be ensured throughout the year.

LIFE TM concluded that it is necessary to eliminate surface water abstractions or adapt them to respect an ecological flow; and use rainwater, helps the recovery of the hydrological flow in mountain streams. Innovative land- and water-management strategies, as well as forest management within the watershed scale, and water use and management should be applied.
Exploitation of natural resources in watersheds with actual and potential presence of *C.arnoldi* should be avoided.

3.1 Ecological flow

Ensuring the ecological integrity of watercourses is an obligation which establishes the Management Plan of river basin of Catalonia. ((MAH/2465/2006, DECRET 1/2017)
LIFETM designed a water distribution box, in the catchments of the torrents, which ensures the ecological flow.

LIFETM promoted rainwater harvesting and storage, to reduce water abstraction from streams and as a measure to adapt to the effects of climate change.
Tree plantations, which in the Montseny are usually exotic conifers, reduce the flow of water in the torrents

ACTION
Update the catalogue of water catchments
ACTION
To promote the installation of water distribution boxes following the model designed by LIFETM, to comply with current legislation
ACTION
To assess the elimination or legalisation of catchments without administrative concession
ACTION
Installation of accumulation tanks with locking systems in the accumulation tanks
ACTION
Promote projects to reclaim rainwater and reduce water abstraction in torrents
ACTION
To incentivise substitution Replacement of sprinkler irrigation with drip irrigation.
ACTION
To removal of exotic trees and forest plantations from the riparian forest area

3.2 Riverside habitat

The streams of the Montseny generally have a good quality of water that is oligotrophic and oxygenated; therefore, it is necessary to avoid its contamination with the discharge of wastewater.

Tree plantations, which in the Montseny are usually exotic conifers, , impoverish the soil and facilitate the processes of erosion. Therefore, these plantations have a negative effect on the conservation of the Montseny newt and in general are detrimental to biodiversity.

Traditional forest management should be replaced by a management that favours the natural evolution of the forest stand and to be more resilient to the effects of climate change.

ACTION
Promote the installation of wastewater treatment systems with lagoon systems.
ACTION
Preventing erosion with bioengineering techniques.
ACTION
Promote the elimination of tree plantations and replace them with native forests and open spaces in the whole river basin .
ACTION
Consensus on a manual of good forestry management practices, with forest owners and technicians.
ACTION
To empower autochthonous habitats resilient to climate change.

3.3 River connectivity

The forest tracks obstruct the streams and damage the ecological connectivity.
The traditional drainage pipes used installed in torrents to accumulate earth and allow vehicles to pass, are a real barrier to Montseny brook newt and aquatic fauna in general. These tubes should be removed to recover the natural course of the stream or build flyovers if necessary to keep vehicles passing through, without interfering with the natural stream flow.

ACTION
To avoid the construction of new forest tracks and remove existing road where possible.
ACTION
To promote the modification of existing tracks with flyovers to respect river connectivity.

Summary of the actions to be carried out during the After LIFE

Goal	Accio Description	IMPACT value	Timescale	Responsible and committed
HABITAT MANAGEMENT				
	Ecological flow			
	Update the catalogue of water catchments	Low	Medium term	DIBA : To involve staff
	Promote the installation of water distribution boxes, to comply with current legislation	High	Long term	DIBA : To involve staff and allocate budget
	To assess the elimination or legalisation of catchments without administrative concession	High	Long term	DIBA : To involve staff
	Installation of accumulation tanks with locking systems	High	Long term	DIBA : To involve staff and allocate budget
	Promote projects to reclaim stormwater and reduce water abstraction in torrents	Medium	Long term	DIBA : To involve staff and allocate budget
	To incentivise replacement of sprinkler irrigation with drip irrigation.	Low	Long term	DIBA : To involve staff and allocate budget
	To removal of exotic trees and forest plantations from the riparian forest area	Medium	Long term	DIBA : To involve staff and allocate budget
	Riverside habitat			
	Promote the installation of wastewater treatment systems with lagoon systems	Low	Long term	DIBA : To involve staff and allocate budget
	Preventing erosion with bioengineering techniques	Medium	Long term	DIBA : To involve staff and allocate budget
	Promote the elimination of tree plantations and replace them with native forests and open spaces. in the whole river basin	Medium	Long term	DIBA : To involve staff and allocate budget
	Consensus on a manual of good forestry management practices, with forest owners and technicians.	Medium	Medium term	DIBA - DIGI : To involve staff
	To empower autochthonous habitats resilient to climate change	Medium	Long term	DIBA - DIGI: To involve staff
	River connectivity			
	Avoid the construction of new forest tracks and to remove existing roads	High	Long term	DIBA : To involve staff and allocate budget
	Promote the modification of existing tracks with flyovers to respect river connectivity.	Medium	Long term	DIBA : To involve staff and allocate budget

Timescale: Short term (2023), Medium term (2024-2025), Long term (to 2027 minimum)

Responsible: DIBA (Diputacio de Barcelona, DIGI (Diputacio de Girona, GenCat (Generalitat de Catalunya, FC (Forestal Catalana) BCNZOO (Zoo of Barcelona), CREAC (Center for Research and Environmental Education of Calafell),

AFTER LIFE PLAN - HABITAT MANAGEMENT

Num. of actions to be executed in the streams with Natural, Entered or Potential newt population

Action Group	Natural	Entered	Potential	TOTAL
C4 - Remodeling of the water system of collection and distribution				
Improvement of water tank		1		**1**
Modification of water catchment	4	1	3	**8**
Remodeling or removal of catchment	15	6	17	**38**
Removal of water catchment	3			**3**
Tank shot-off valve	6	2	3	**11**
Water pipeline	2	3		**5**
C5 - Installation of the collection of rainwater				
Rainwater tank	8	1		**9**
Restoration of natural water drainage	1			**1**
C6 - Implemention of green filters of sewage in isolated houses				
Wastewater treatment	3			**3**
C7 - Ecological connectivity in streams across road				
Platform bridge	3		2	**5**
Road elimination, Riverbed recovery	6	2	2	**10**
Stone bridge.	1		2	**3**
Vault bridge.			3	**3**
C8 - Improve the riparian habitat				
Exotic Conifer felling	2		3	**5**
Planting native trees	3	2		**5**
Planting native trees & Bioengineering	3	1	2	**6**
Total Actions linked to habitat restoration	**60**	**18**	**37**	**115**

4. Learn

Should be continue the research and monitoring program to have truthful and objective information to apply to management. To implement an adaptative management allow the conservation objectives to be achieved

New population expert group and hydrological expert commissions are a very effective way to make a threat assessment like TRA (Threat Reduction Assessment). Furthermore, the long-term monitoring of this species is mandatory in order to provide managers with useful information to repeatedly evaluate the state of conservation and threats of *C. arnoldi* populations

LIFETM has promoted working groups to incorporate the expertise of more than dozens of experts, this has allowed to incorporate a lot of knowledge in habitat management and Montseny brook newt conservation. The involvement of researchers has facilitated the establishment of new hydrological monitoring networks, and the application of more robust scientific methodologies.

4.1 Geographic Information System (GIS)

A LIFETM Information System developed to integrate all the technical, scientific and promotional information linked to the project. This System contains more than 4.000 files distributed in 134 directories and include the information from the actions developed since the beginning of the project, in 2016. These files catalogued according to the type of information contained in each of them (documentary, cartographic, database). All the Montseny newt geolocations are being included in the current Montseny Biodiversity Database. An application (using the Arcgis software) to visualize, consult and analyse the project information efficiently developed, on an interactive map, dynamically updated as new information obtained. Actually, all project information developed includes 68.491 files (in 9.722 folders, 176 GB).

In the future, this information system should be updated with the monitoring and research programmes to be implemented during the After LIFE, in order to exploit the available information and to make management as adaptive, objective and efficient as possible.

ACTION
Updating the information system and its database

4.2 Research & Monitoring

The restoration of the riparian habitat is a job that does not yield immediate results. To determine how and where the interventions are working, threat reduction assessments should be performed to measure the conservation project's success. The monitoring carried out during the LIFETM and the elaboration of the works execution database (D1) should be kept active during the After LIFE, in order to assess the evolution of habitat restoration and also to incorporate new actions to be implemented in the next years.

Field sampling of the natural and introduced populations of the Montseny Brook newt done annually allows us to calculate indicators to objectively quantify the level of conservation of all populations of *C. arnoldi*. Information essential with species critically endangered, based on the criteria of the International Union for Nature Conservation (IUCN).
Monitoring campaigns should therefore be maintained to assess the evolution of the populations, and also to research programs to apply this knowledge to improve management and its protection.
The riparian habitat monitoring programmes established in the LIFETM, in particular the meteorological and hydrological monitoring network, are essential to assess the evolution of the habitat, in particular to link it to climate change and the extraction of natural resources.

ACTION
Researching about biology and ecology of Montseny brook newt
ACTION
Researching about river habitat and clime chance effects
ACTION
To monitor of habitat restoration actions and implementing improvements
ACTION
To maintain the monitoring programme for natural and introduced populations.
ACTION
To consolidate the network for the hydrological monitoring of streams and for the meteorology stations
ACTION
To monitor the ecological evolution of the riverside habitat

4.3 Projects

A Committee of experts has been created in the LIFETM with the aim of promoting a forum for discussion and exchange on technical and scientific aspects, advising and assisting in the design and implementation of the actions, guaranteeing their objectivity and rigour, proposing actions in the different fields of knowledge, as well as answering the questions raised by the project. The main contributions of these expert committees, in the different lines of work of the project have been:
a) To initiate a line of research and hydrological monitoring in newt basins.
b) To initiate original studies applying environmental DNA techniques.
c) To develop a rigorous methodology for the process of introduction of the species in its natural habitat.
d) To propose management methods for the riparian habitat, prioritizing its conservation.

As a conclusion, the debate between multidisciplinary specialists has created many new unanswered questions about the newt biology and the management of its habitat.
Maintaining and promoting the involvement of researchers and technicians in the conservation of *C. arnoldi* is necessary, if there is a willingness to improve knowledge and management applied to conservation.

ACTION
Coordination of scientists and technicians to develop multidisciplinary projects.
ACTION
To promote the involvement of experts through workshops and multidisciplinary projects

Summary of the actions to be carried out during the After LIFE

Goal	Accio Description	IMPACT value	Timescale	Responsible and committed
LEARN				
	GIS			
	Updating the information system and its database	Medium	Long term	DIBA : To involve staff + Contract to external technician
	Monitoring			
	Researching about biology and ecology of Montseny brook newt	Low	Long term	DIBA -GenCat - FC - BCN ZOO: To involve staff + Contract to external herpetology group
	Researching about river habitat and clime chance effects	Medium	Long term	DIBA : To involve staff + Contract to external research group
	Monitoring of habitat restoration actions and implementing improvements	Low	Long term	DIBA : To involve staff + Contract to external research group
	To maintain the monitoring programme for natural and introduced populations.	High	Long term	DIBA -GenCat - FC - BCN ZOO : To involve staff + Contract to external herpetology group
	To consolidate the network for the hydrological monitoring of streams and for the meteorologic stations	High	Long term	DIBA : To involve staff
	To monitor the ecological evolution of the riverside habitat	Low	Long term	DIBA : To involve staff + Contract to external research group
	Projects			
	Coordination of scientists and technicians to develop multidisciplinary projects.	Medium	Long term	DIBA - DIGI - BCN ZOO - FC - GenCat : To involve staff
	To promote the involvement of experts through workshops and multidisciplinary projects	Low	Long term	DIBA - DIGI - BCN ZOO - FC - GenCat : To involve staff

Timescale: Short term (2023), Medium term (2024-2025), Long term (to 2027 minimum)
Responsible: DIBA (Diputacio de Barcelona, DIGI (Diputacio de Girona, GenCat (Generalitat de Catalunya, FC (Forestal Catalana) BCNZOO (Zoo of Barcelona), CREAC (Center for Research and Environmental Education of Calafell),

Discussing and testing methods to obtain faecal samples. Collection of biometric measurements and survey of streams to observe newts

5. Disseminate

Disseminate the critical state of conservation of the Montseny brook newt and explaining the causes of their delicate state of survival, aims to raise awareness among the local population, society in general, and especially among the educational and university community, to become involved in the restoration of the riparian ecosystem and its ecological processes. It is therefore important to continue with the dissemination and education programmes promoted by LIFETM.

To disseminate the work being carried out to improve the conservation status of Montseny brook newt, increases the involvement of society and promotes public investment to conserve natural heritage.

The education programmes carried aot have been very well valued. They have been a very good investment to achieve the future involvement of society in the conservation of Montseny brook newt

ACTION
To offer reports, articles or interviewrs to media
ACTION
To keep the webside active, incorporating new developement that are generated, and keeping on the Youtube channel, the LIFETM documentary films
ACTION
To promote the mobility of the C.arnoldi exhibition between municipal libraries ans educational centres.
ACTION
Disseminate the Layman's Report dossier both digitally and on paper (especially to owners and LIFETM stakeholders).
ACTION
To maintain the educational programme in the ZOO BCN & LIC Montseny
ACTION
To present new results and conclusions at future congresses, symposia or conferences.
ACTION
Elaboration of scientific and informative articles.

Summary of the actions to be carried out during the After LIFE

Goal	Accio Description	IMPACT value	Timescale	Responsible and committed
DISSEMINATE				
	Divulgation			
	To offer reports, articles or interviewrs to media	Low	Long term	DIBA - DIGI - BCN ZOO - FC - GenCat : To involve staff
	To keep the webside active and youtube cannal	Medium	Long term	DIBA : To involve staff
	To promote the mobility of the C.arnoldi exhibition between municipal libraries and educational centres.	Low	Long term	DIBA : To involve staff
	Disseminate the Layman's Report dossier both digitally and on paper	Low	Short term	DIBA - DIGI - BCN ZOO - GenCat - FC : To involve staff
	Education			
	To maintain the educational programme in the ZOO BCN & LIC Montseny	Medium	Long term	BCNZOO - DIBA-DIGI I FC: To involve staff
	To present new results and conclusions at future congresses, symposia or conferences.	Low	Long term	DIBA - BCNZOO- GenCat- FC: To involve staff
	Elaboration of scientific and informative articles.	Low	Long term	DIBA - DIGI - BCN ZOO - FC - GenCat : To involve staff

Timescale: Short term (2023), Medium term (2024-2025), Long term (to 2027 minimum)

Responsible: DIBA (Diputacio de Barcelona, DIGI (Diputacio de Girona, GenCat (Generalitat de Catalunya, FC (Forestal Catalana) BCNZOO (Zoo of Barcelona), CREAC (Center for Research and Environmental Education of Calafell),

Presentation of the Montseny brook newt in the schools, by the park rangers.

CONCLUSIONS

As a conclusion, future work lines to improve the conservation status of *C. arnoldi*, should follow these basic recommendations and management proposals:

- ✓ Involvement of all stakeholders is essential for the conservation of the Montseny brow newt and its riverside habitat

- ✓ Research and monitoring should be promoted in order to manage the natural heritage and resources with technical and objective criteria. However, for effective conservation to be achieved, collaboration from all the participants is needed (researchers, managers, stakeholders).

- ✓ Changing water availability and demand and mitigation strategies to improve the management of water resources will need to continue being implemented. This requires the application of innovative land- and water-management strategies on the all-watershed scale.

- ✓ Open spaces such as pastures and grasslands should be recovered in the river basin, promoting a landscape with a diversity of habitats that respect the riparian and autochthonous forests on erodible and sloping soils.

- ✓ It is highly recommended to promote the rewilding of habitats in order to have an old and mature forest, between pastures and grassland, mainly because tree transpiration is sometimes much higher in younger than in older trees.

- ✓ Coniferous plantations, especially of fast-growing species (such as *Pseudotsuga menziesii, Pinus radiate, P. ponderosa, P. nigra or P. uncinate*), must be removed in the protected areas, in order to increase the streamflow where *C. arnoldi* is present, because the largest water yield increases appear after removal of conifer forest.

- ✓ Disseminate the work done to improve the conservation status of Montseny brook newt, increases the involvement of society and promotes public investment to conserve natural heritage.

To conclude, the **intensive human exploitation of natural resources in the Montseny is a threat to the survival of the *C. arnoldi***. Therefore, we should reduce water abstraction from the streams, and we should restore the diversity of natural habitats, especially by promoting meadows, respecting the natural evolution of the forest and encouraging the development of the autochthonous riparian forest.