



# The white-clawed crayfish

*Austropotamobius pallipes* an endangered species



**ERSAF**  
ENTE REGIONALE PER I SERVIZI  
ALL'AGRICOLTURA E ALLE FORESTE



Regione Lombardia





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an endangered species

**LIFE08 NAT/IT/000352**  
**Conservation and Recovery of**  
***Austropotamobius pallipes***  
**in Italian Natura2000 Sites - CRAINat**

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LIFE08 NAT/IT/000352

# CRAINat

## The project

The aims of the LIFE08 "Conservation and Recovery of *Austropotamobius pallipes* in Italian Natura2000 Sites" CRAINat NAT/IT/000352 (2010-2014) are to protect and boost populations of the native freshwater crayfish (*Austropotamobius pallipes*) by monitoring local habitats and carrying out conservation projects within the Natura 2000 network in Italy.

### How did the project come about?

The LIFE CRAINat project was conceived within the collaborative network established during the LIFE projects LIFE03 NAT/IT/000147 – "Requalification of the biological community in Valvestino Corno della Marogna 2" (to protect the autochthonous Freshwater Crayfish in Lombardy and central Italy) and LIFE03 NAT/IT/000137 – "*Austropotamobius pallipes*: protection and management in the SCIs of central Italy".

Because *A. pallipes* populations throughout Italy are critically depleted and under serious threat from numerous sources and because protective norms have not been uniformly applied by local administrative bodies, **this new project, CRAINat, is dedicated entirely to the protection and conservation of this species.**

The project partners selected over **60 actions** to carry out in **more than 40 sites of community importance (SCI)** in Lombardy, Abruzzo and Molise.

Project partners:



Protected areas in Lombardy participating in the project:



Scientific collaboration:



### Project partners

Provincia di Chieti, Ente Regionale per i Servizi all'Agricoltura e alle Foreste (ERSAF) - Regione Lombardia, Regione Abruzzo, Fondazione Mario Negri Sud, Parco Nazionale Gran Sasso e Monti della Laga, Provincia di Isernia.

### Financing

Programma CE - LIFE (49.84%)  
Project partners (33.96%)  
Regione Lombardia DG (16.20%).

## The Nature 2000 network and the Life Programme

Natura2000 is the European Union name for a network of areas - sites of community interest (SCI), Special Areas of conservation (SAC) and special protection areas (SPA) - set up to conserve local biodiversity, that taken together can be thought of as a European Union nature reserve. The Nature 2000 network was set up to protect the habitats and animal and plant species listed in Annexes I and II of the Habitats Directive 92/43/EEC and those listed in Annex I of the Birds Directive 79/409/EEC.

The EU financial programme LIFE was set up in 1992 to help develop and implement community legislation and policy on environmental issues. Funds are awarded and projects administered and monitored directly by the European Commission.



# What is *Austropotamobius pallipes*?

A freshwater crayfish species commonly known as the white-clawed crayfish and one of the largest freshwater invertebrates in Italy. *Austropotamobius pallipes* is its scientific name, and it is the only native genus of crayfish in Italy.



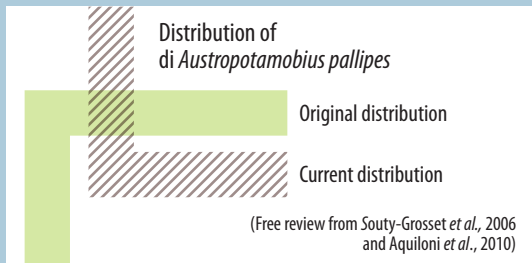
## WHITE-CLAWED CRAYFISH

### > BIOLOGICAL CLASSIFICATION

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Crustacea
Order:	Decapoda
Family:	Astacidae
Genus:	<i>Austropotamobius</i>
Species:	<i>A. pallipes</i>

### > NAMES IN EUROPE

Italy	Gambero di fiume
Spain	Cangrejo de río
France	Écrevisse à pattes blanches
Switzerland	Dohlenkrebs
Slovenia and Croatia	Bjelonogi rak, potočni rak
Great Britain and Ireland	White-clawed crayfish



*Austropotamobius pallipes* (Lereboullet, 1858) is found in the southern part of Western Europe: Spain, France, Switzerland, Italy and the Balkan Peninsula countries with Adriatic coastlines. It is also found in Ireland and the United Kingdom, but was introduced into these northern Atlantic islands in the Middle Ages by French monks for whom the white clawed crayfish was a delicacy.

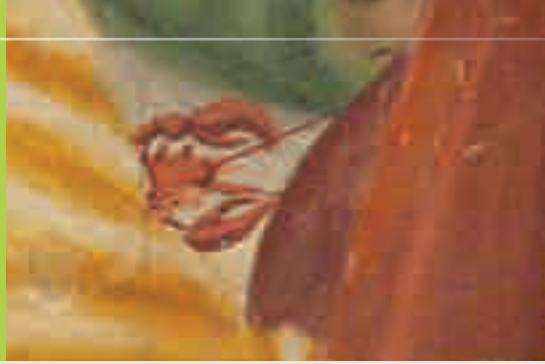
Data on the distribution of *Austropotamobius pallipes* in Italian rivers are fragmentary and limited to the provinces and regions where specific studies have been carried out. In the Lombardy region, the Laboratorio Acque Interne - Università degli Studi di Pavia has been censusing and monitoring indigenous crayfish populations since 2002 (see map p. 23).

## IDENTITY CARD

Its taxonomic status has not yet been clearly established and remains controversial. Genetic studies show that Italian populations of the freshwater crayfish *Austropotamobius* belong to two species: *A. pallipes* in the north west and *A. italicus* in the rest of continental and peninsular Italy.

European law protects *A. pallipes* which in fact corresponds locally to several threatened species not named in the legislation: all the protected areas involved in this project are inhabited by *A. italicus*. It is hoped that, in the future, laws will be integrated to rectify this shortcoming. Because no morphological differences between these two species have yet been found, they can only be distinguished by genetic analysis. The situation is even more complicated considering that *A. italicus* has four subspecies. Two of these are found in Lombardy: *carinthiacus* in the West and *carsicus* in the East. Differentiation between these species and subspecies is an essential starting point for any population management program involving breeding, reintroduction or repopulation. Genetic analyses will have to be conducted on each population.

Detail of a fresco of the Last Supper dating to the end of the '400s, in the church of Santo Stefano in Rovato (Brescia)



## Some history...

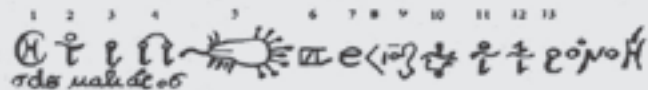
In the Middle Ages, the crayfish played an important role in diet and commerce. To Christians it was also a symbol of death and resurrection because of the periodic shedding and renewal of its carapace, or exoskeleton. For this reason, in alpine and prealpine areas, crayfish were often included in paintings of the Last Supper.

The alchemists, who studied transformations, used the crayfish as a symbol to represent the device that "makes things go back" (called *καρκινος* = gambero), used to convert mercury gas back to liquid mercury, in a chemical reaction that made copper look like silver.

Crayfish came to be considered heretical and were divested of their religious symbolism. Nevertheless, they were still widely consumed and intensively harvested, and remained a standard item in fish markets in major French and Italian cities.

The thriving trade led to the rapid spread throughout Europe of crayfish plague, a disease that originated in America, and that was first identified in 1859 in the Po Delta. Infected crayfish were probably brought to Europe accidentally in a con-

Crayfish alchemical formula (from Berthelot, 1938)



## CRAYFISH PLAGUE

This disease (aphanomycosis) is caused by the oomycete *Aphanomyces astaci*. Its spores penetrate the exoskeleton of the crayfish and encyst. Death is caused by the invasion of vital organs by fungal hyphae. Large numbers of spores are freed into the water from the body of the dying crayfish. These can survive for one to eight weeks, and can be transported by ex-

otic crayfish, by other animals and by objects that have been in contact with the infected water.

Crayfish plague is extremely contagious and can cause the extinction of whole populations.

signment of fish from North America. The disease decimated *A. pallipes* populations in Lombardy and spread rapidly throughout the rest of Europe.

The already critical status of crayfish populations deteriorated further in the course of the 20th century due to depletion of water sources and the progressive deterioration in water quality following industrial and urban development.

## IT'S PROTECTED!

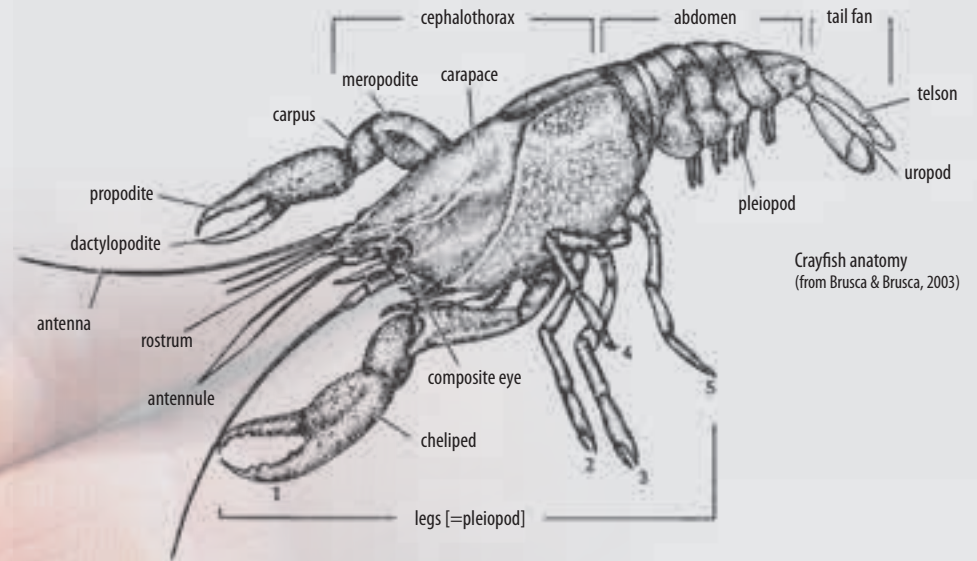
The freshwater crayfish *A. pallipes* is included in the International Union for Conservation of Nature and Natural Resources (IUCN) Red List, where it has been classified as endangered (the same level of risk of extinction as the Giant Panda!) since 2010.

European Community directive 92/43, which classifies it as "a species of community interest whose conservation requires the designation of special areas of conservation" (Annex II) and as a species "whose taking in the wild and exploitation may be subject to management measures" (Annex V), was implemented in Italian presidential decrees DPR 357/97 and DPR 120/2003. The species has been protected in Lombardy since 1977 by regional law L.R. n° 33 of 27/07/1977, which prohibits its capture, transport and sale; and since 2008, environmental regulations for the protection and conservation of small fauna, flora and spontaneous vegetation (L.R. n. 10, 2008) have been extended to include the *A. pallipes* complex species *A. pallipes* and *A. italicus*. The law also prohibits the alteration or destruction of their habitat. The fine for not complying with the regulations on the capture of freshwater crayfish is up to €500; and that for damaging crayfish habitat up to €4000, in addition to the obligation to restore damaged habitat.





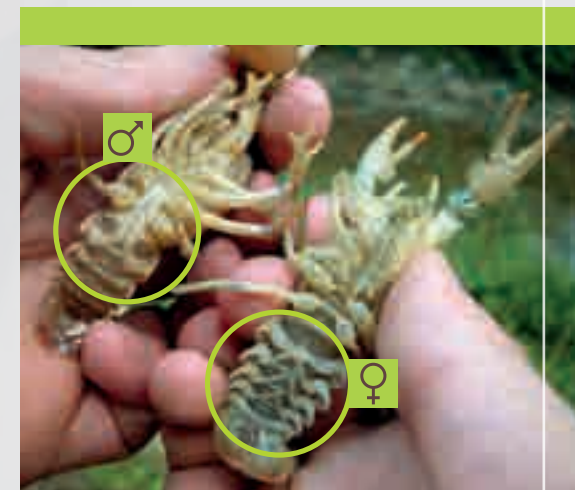
# What does it look like?



Like all crustaceans, it has a strong, hard external skeleton (exoskeleton). This is slightly rough and made of calcified chitin. Its body is divided into two easily distinguishable parts: the cephalothorax and the abdomen.

The **cephalothorax**, which terminates anteriorly in a triangular structure called the rostrum, bears two pairs of antennae, a complex mouth structure, a pair of claws (chelipeds: used in self-defence, predation and mating) and four pairs of legs (pereipods: used for walking forwards).

The **abdomen** is segmented and ends in a palette-shaped tail piece called the **telson**, that allows the animal to swim rapidly backwards away from danger. Females fold the telson over their eggs to protect them. Each segment of the abdomen bears a pair of appendices (pleopods). In the female crayfish these are all identical, whereas in the male the first two pairs, called gonopods, are modified for mating. This makes it easy to distinguish males from females even in the youngest crayfish.



The crayfish varies in colour from greyish-green to dark brown, to camouflage it with the bed of the stream it lives in. Some crayfish are completely blue!



## THE MOULT AND ITS ADVANTAGES

**Pre-moult:** lasts a few days with the carapace thinning out and calcium accumulating in the gastroliths.

**Moult:** lasts from a few minutes to some hours, with the crayfish emerging from the old exoskeleton through a dorsal split between the cephalothorax and the abdomen.

**Post-moult:** over the three-four days following the moult, the new exoskeleton hardens thanks to the reserves of calcium carbonate stored in the gastroliths.

**Intermoult:** in this phase the crayfish feeds and accumulates reserves of substances required for the next pre-moult. **Intermoult:** in this phase the crayfish feeds and accumulates reserves of substances required for the next pre-moult.

During the moult, the crayfish can repair any damage to its exoskeleton and **regenerate** legs and other appendages. This is why you sometimes see a crayfish with legs or claws of different sizes. In older animals, which moult less frequently, regenerated legs are smaller, although they function normally. The crayfish may even shed one of its own appendages (**autotomy**), such as a claw, in order to free itself from a predator or a crevice.



*A. pallipes* gastroliths

The rigid exoskeleton prevents gradual growth of the crayfish, so it must be shed and substituted periodically in a process known as **ecdysis** or **moulting**.



Phases of moulting

Split between cephalothorax and abdomen

The crayfish emerges from its shelter in this vulnerable phase to seek an open space where it will have more freedom of movement for the repeated contractions by which it sheds its old exoskeleton.

Once it has completed this laborious process, the crayfish has a short period in which to grow before the new exoskeleton hardens. At this point it is highly vulnerable to predation.

Crayfish just after moult next to its old exoskeleton



# The life of the white-clawed crayfish

## What is its ideal habitat?

The white-clawed crayfish favours clean, clear, flowing water which is cool and well-oxygenated (salmonid waters), and which runs over a bed of rock, gravel and sand. It also likes brooks, torrents and water courses in hilly and prealpine areas where there are mud, silt, plant debris (leaves and branches), submerged roots and aquatic vegetation it can use for shelter.

The crayfish was also once found in prealpine lakes, large rivers in the Po Plain and in resurgences and springs. These places have been completely colonized by exotic species of crayfish and are thus no longer suitable for *A. pallipes* (see Crayfish plague p. 10).





**Water** Water must be well oxygenated (>60 %) with a pH of 6 to 9 and calcium values of 200 to 350 ppm.

**Temperature** As crayfish are heterotherms (i.e. their body temperature varies with that of the environment), water temperature is an especially important factor in survival. They are resistant at optimal summer temperatures of 15 to 18°C. Physiological distress begins to set in at 22°C; and temperatures over 25°C can only be tolerated for a short period. In winter they survive in temperatures close to 0°C.

**Altitude** The altitudinal range of the freshwater crayfish is difficult to establish because other factors such as latitude also affect water temperature. Generally speaking, it is found at altitudes up to 800m asl; but it can live as high as 1200m as in central Southern Italy where temperatures are warm enough.

**Light** The freshwater crayfish prefers well-shaded water courses with abundant riparian vegetation that prevents direct sunlight falling on the water surface. Activity is mainly crepuscular and nocturnal, consistent with the passage from mosaic vision (like that of insects) to continuous vision (like that of man).

### What does it eat?

*A. pallipes*' diet varies according to the type of water course it lives in. Although it does feed on plant matter (algae and macrophytes) and fruit and seed debris, it is predominantly carnivorous, feeding on small insects and the carcasses of fish and other animals. It also preys on live aquatic invertebrates (insect, crustacean and mollusc larvae, etc.). Food is grasped with the chelae and brought to the mouthparts, which are densely lined with tactile and olfactory setae, where food is selected and then ground in the mandibles.



Freshwater crayfish feeding on a dead trout





Female *A. pallipes* with spermatophores

## How does it reproduce?

Sexual **maturity** is usually reached in the third or fourth summer of life, when males have reached a length of 60-70 mm (from the tip of the rostrum to the end of the telson) and females a length of 55-60 mm. **Coupling** takes place in Autumn, in October and November, generally when water temperature is around 10 °C.

After a sort of courtship, the male turns the female on her back and deposits spermatophores (white cylinders containing spermatozoa) on her sternal plate.

About a week later, eggs are excreted from her genital pores (small holes in the cephalothorax near the third pair of walking legs) and fertilized by the spermatozoa.

**The eggs** (about 50-100, depending on the size of the female) are attached to the abdominal appendages (pleopods) throughout the winter and until the end of Spring. The female, who now moves with difficulty, stays inside her shelter for most of this time, cleaning debris away from the eggs and keeping them well oxygenated. The eggs hatch after four to seven months, depending on water temperatures. The newly hatched **larvae** are less than a centimetre long, although they are similar in appearance to adults. Their first year of life is the riskiest, with the highest mortality rate.

*A. pallipes* adult female and first year juvenile



## Time to grow!

**Moulting**, which allows the body to grow, takes place at **varying intervals**, occurring more often in juveniles than in adults. It is limited to the summer when temperatures are favourable. White-clawed crayfish can reach lengths of over 120 mm, and weights of 70-80g. Females are always smaller than their male counterparts although they have a proportionately larger abdomen to hold and protect their eggs. They have smaller claws.



From left to right

*A. pallipes* females with maturing eggs in May

*A. pallipes* females with maturing eggs in June

Newly-hatched *A. pallipes* juveniles

Three month old *A. pallipes* juveniles



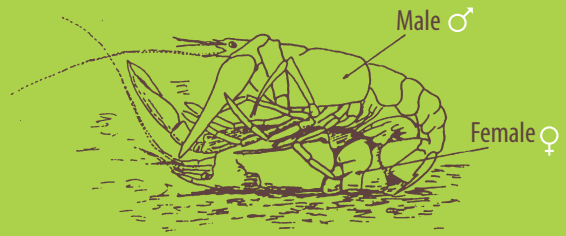
## THE FIRST DAYS OF LIFE

Hatchlings have a large cephalothorax which accommodates food reserves for the first three or four days of life, when they cling with miniscule claws to their mother's abdomen. The first moult occurs after about the first week of life, and the young become independent, feeding and moving about freely, although they do not go far from the mother who calls them back with alarm pheromones in case of danger.





# Life cycle of the white-clawed crayfish



SEPTEMBER/OCTOBER  
Mating



AT 3 YEARS  
Adults

OCTOBER /NOVEMBER  
Spermatophores

JUNE/JULY  
Larvae

JULY/SEPTEMBER  
Juveniles

NOVEMBER  
Eggs

# Enemies

The white-clawed crayfish has too many.

## 1. ALLOCHTHONOUS CRAYFISH

The most serious threat to our white-clawed crayfish comes from two introduced exotic species - *Procambarus clarkii* and *Orconectes limosus* - which are progressively replacing autochthonous populations and which pose a serious threat to their survival. These two American species bring with them fatal diseases like crayfish plague. They are also much more competitive than *Austropotamobius pallipes*, and have far more effective behavioural and reproductive strategies.

## KILLER CRAYFISH

Two exotic species threaten the survival of the Italian freshwater crayfish: *Procambarus clarkii* and *Orconectes limosus*.

The Louisiana crayfish, *Procambarus clarkii* (Girard, 1852), native to central and southern North America, is the most widespread allochthonous species in Italy, where it has naturalized throughout northern and central areas. It is a fast-growing, highly fertile species: individuals become sexually mature a few months after birth; an adult female can produce up to 600 eggs, sometimes twice a year; and embryos only take 2-3 weeks to develop at 22°C. This species favours warm water and can survive at temperatures of over 40°C, but can also adapt to low winter temperatures by sheltering in deep burrows (40-90 cm) which it digs on the bottom or in the banks of the water course. It can adapt to widely varying environments and **can live for several**



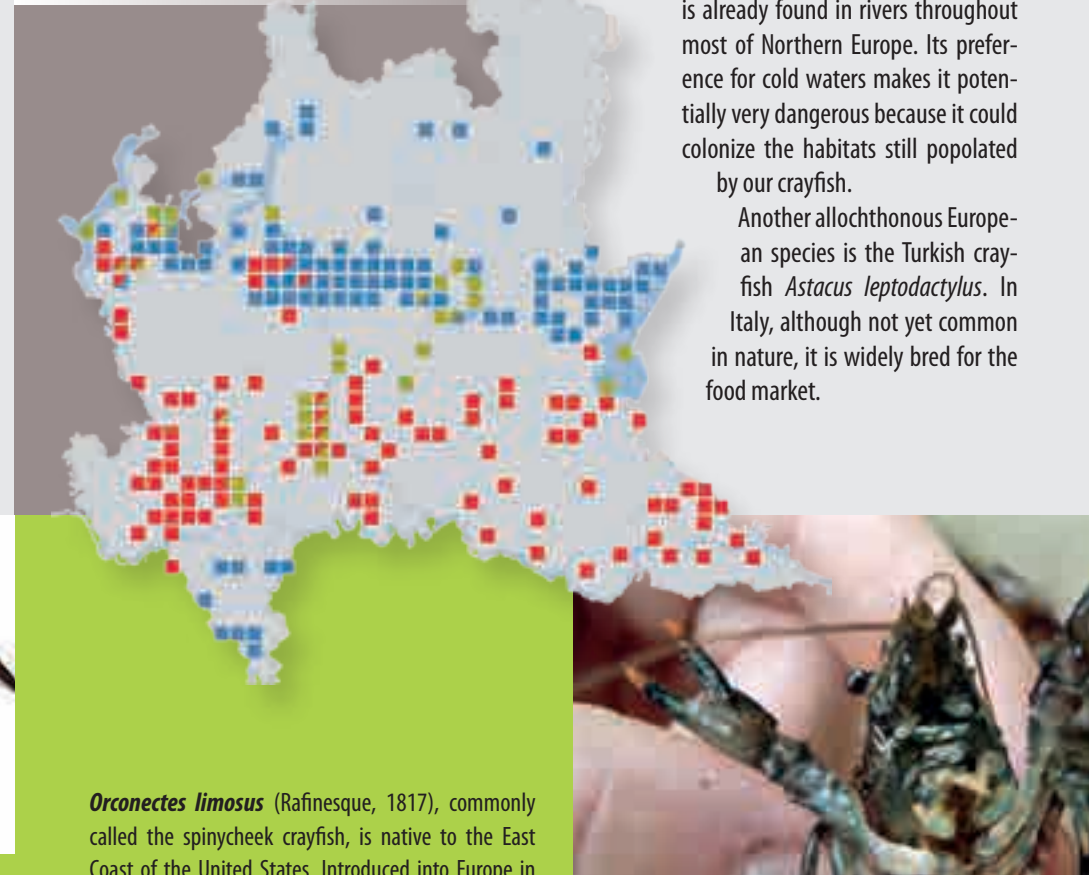
**days in oxygen-poor conditions by breathing with its gills out of the water.** This ability allows it to move from one water course to another. Because it is a healthy carrier of Crayfish Plague, it is the main vehicle for the spread of this disease.

Kingdom: Animal Phylum: Arthropod  
Class: Crustacean Ordine: Decapod  
Family: Cambaridae Genus: *Procambarus*  
Species: *P. clarkii*

## Distribution of freshwater crayfishes in Lombardy (Italy)

(by Laboratorio Acque Interne, Università degli Studi di Pavia)

- *Austropotamobius pallipes*
- *Procambarus clarkii*
- *Orconectes limosus*



Spotted in some parts of Italy, *Pacifastacus leniusculus* is another highly invasive species from North America already found in rivers throughout most of Northern Europe. Its preference for cold waters makes it potentially very dangerous because it could colonize the habitats still populated by our crayfish.

Another allochthonous European species is the Turkish crayfish *Astacus leptodactylus*. In Italy, although not yet common in nature, it is widely bred for the food market.

*Orconectes limosus* (Rafinesque, 1817), commonly called the spinycheek crayfish, is native to the East Coast of the United States. Introduced into Europe in the second half of the 1800s, it spread throughout most of the continent and is now found in many regions of Italy. It is **an extremely active and aggressive species** which when captured assumes a characteristic posture with its abdomen arched and its claws extended as far as the tip of the telson. It **tolerates poor water quality** and can colonize medium-slow flowing water courses, and lakes and ponds even where water is very polluted. Its ideal habitat, however, is in water

courses with a muddy or sandy substrate in which it can **dig burrows**. It is found in almost all the maggior and minor lakes in Northern Italy. It is a **healthy carrier** of crayfish plague.

Kingdom: Animal Phylum: Arthropod  
Class: Crustacean Ordine: Decapod  
Family: Cambaridae Genus: *Orconectes*  
Species: *O. limosus*



## GOOD PRACTICE

Prevention of the spread of Crayfish Plague spores is fundamental. Once in an aquatic environment they propagate uncontrollably and contact with native crayfish wipes out the entire population very quickly (a few weeks).

### TO PREVENT THE SPREAD OF SPORES IT IS ESSENTIAL:

- 1) not to move potentially infected live or dead crayfish or contaminated water or equipment to other environments;
- 2) not to release fish captured in waters inhabited by non-native crayfish;
- 3) not to release exotic crayfish into nature; and
- 4) to properly disinfect equipment (landing nets and traps, boots, boats and vehicles) when visiting different streams. It is enough to allow equipment to dry perfectly for three days.

## 2. DISEASES

Crayfish plague (see p. 10) is the most serious crayfish disease, and can kill off entire populations.

Another mycosis called **Burn Spot Disease**, which is caused by the fungus *Fusarium*, causes gill and muscle lesions. Externally, infected areas show as black-red spots, which give the disease its name; and which can degenerate into open lacerations. The disease has a long course and fairly low mortality rate, with death often being caused by secondary bacterial infections.

The microsporidian endoparasite *Thelohania contejeani* causes **Porcelain Disease**, which results in the degeneration of muscle tissue. It is easily diagnosed because the ventral part of the abdomen turns a porcelain white colour. The disease may take several months to run its course.

Where water quality is poor, leech-like exoparasites of the *Branchiobdella* genus (Hirudinea annelids) can weaken crayfish and make them more vulnerable to epidemics.



Above: small torrent with reduced water flow

Left below: Specimen of *A. pallipes* affected by porcelain disease (*Thelohania contejeani*)

Right below: Specimens of *Branchiobdella* on *A. pallipes* (photo by Ezio Galbusera)

## 3. CLIMATE CHANGE AND DROUGHT

The small, unpolluted hillside water courses which provide the ideal habitat for these crayfish are often particularly vulnerable to drying up, especially in summer, because of their limited capacity.

Reduction or drying up of tracts of the watercourse reduces the habitat available and exerts stress on crayfish populations.

## SOME GOOD ADVICE...

Regulation of the abstraction and diversion of water for irrigation and hydroelectrical production is a cornerstone of crayfish population management. Large reductions in the quantity of water lead to a higher pollutant concentration and eventually to stress and susceptibility to possibly epidemic diseases. Poor administration of water resources resulting in the drying up or contamination of water courses, has led to the extinction of many crayfish populations.





## THE FIRST MEETING WITH THE ERSAF

From 2004 to 2007, the Regional agency for the agricultural and forestry services (ERSAF) carried out an articulated project to conserve and boost biodiversity in the Western Garda Lombardy forest "FdL Gardesana Occ.le" - LIFE03NAT/IT/000147 - *Requalification of the biological community in Valvestino Corno della Marogna 2*.

Some actions were aimed at improving the ecosystem to favour consumers, and indirectly the stable resettlement or presence in the area of top predators: the Lynx, the Golden Eagle (*Aquila*

*chrysaetos*), the Bearded Vulture (*Gypaetu s barbatus*), the Eurasian Eagle owl (*Bubo bubo*); the Peregrine Falcon (*Falco peregrinus*); and the Short-toed Eagle (*Circaetus gallicus*).

Ecotone surface areas between grazing areas and forests were increased by cutting back grass and bushes and carrying out margin cuts. Controlled grazing was also carried out with sheep and donkeys in order to maintain and restore herbaceous habitats, to improve the reproductive success of the locally threatened tetraonids and rock partridges. The ultimate purpose of all these actions was to improve local biodiversity and

slow down the regrowth of forest in old grazing areas. In addition, filled-in wells were restored to attract deer, amphibians and other invertebrate fauna; and *Saxifraga tombeanensis*, a priority plant species emblematic of the Garda mountains, was supported by experimentally removing forest cover in some areas in order to eliminate competing rupicole herbaceous species.

The many project actions also included a population management experiment on the white-clawed crayfish. The ERSAF undertook a study of resident white-clawed crayfish populations and a breeding experiment with the aim of restocking the Corno della Marogna SCI.

### 4. ENVIRONMENTAL DEGRADATION

**Pollution:** our crayfish is particularly sensitive to heavy metal pollution and to pollutants in agricultural runoff, like **herbicides, pesticides and synthetic fertilizers**. The organic pollution from human settlements and animal breeding activities not only weakens the crayfish, making it more vulnerable to diseases, but also seriously damages its habitat by reducing the amount of oxygen in the water and altering the macroinvertebrate communities found in torrents. **Alteration** of the morphology of **water courses** is especially damaging to *Austropotamo-*

*bis pallipes* populations: channel deepening, excavations, rectifications – and the **denaturalization of the bank** and construction of weirs. In addition to a direct, mechanical impact, these operations cause considerable changes in section, depth, current speed and the composition of the substrate. These, in turn, cause a drastic **reduction in environmental diversity** and disappearance of some or all of the shelters that freshwater crayfish require.

### 5. POACHING

Frequent illegal fishing of the white-clawed crayfish is a threat to the survival of the remaining populations inside and outside of protected areas, in spite of European, national and regional conservation laws.

Above: water polluted by unregulated discharge

Below: rectification of river banks and cementification of the substrate destroy freshwater crayfish shelters

On the left: Lock in a water course reducing the flow downstream

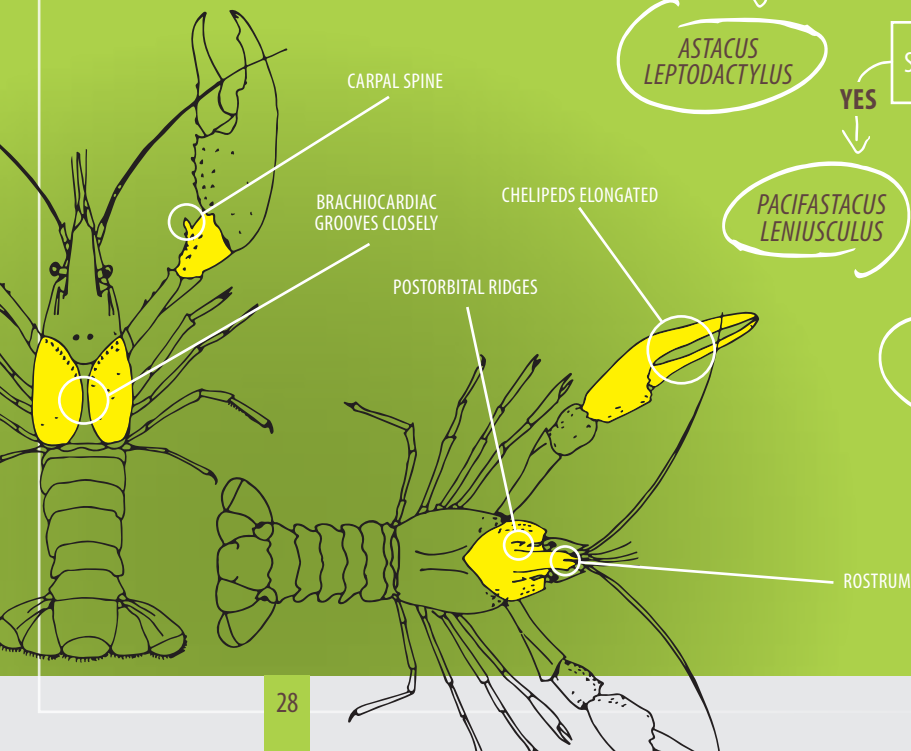
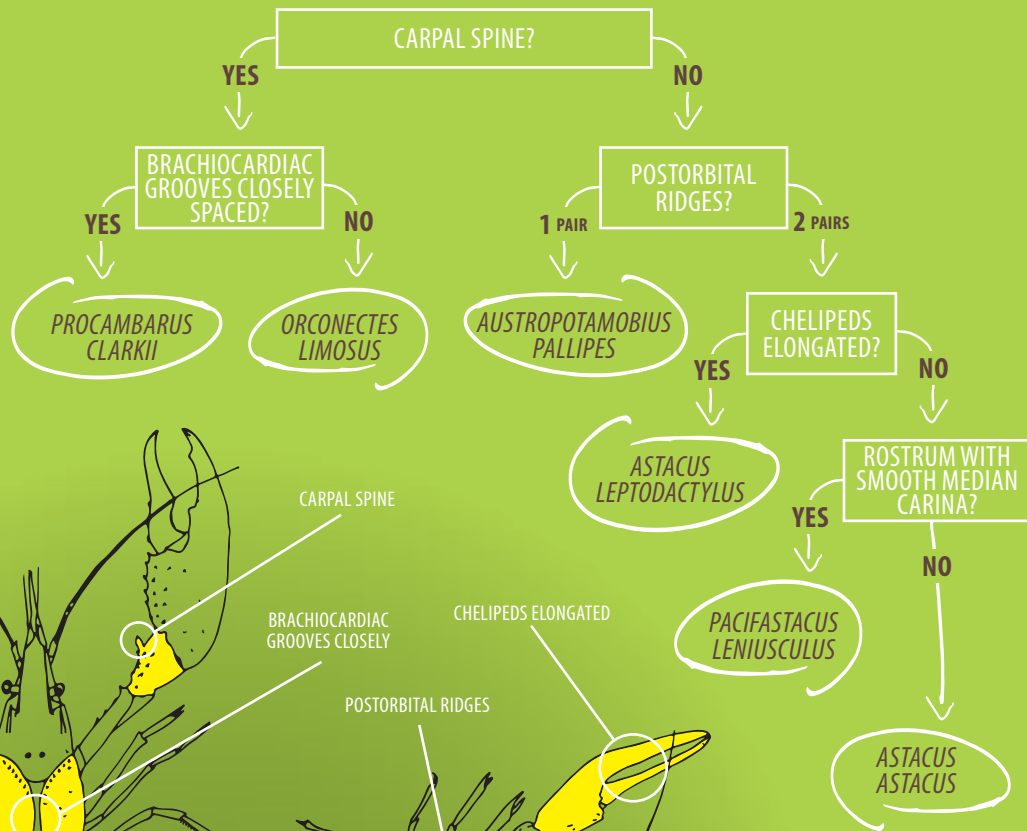
On the right: Illegally captured crayfish





The crayfish identification key is a flowchart of binary choices for morphological characteristics. The first step in the key for Italy discriminates between the presence or absence of the carpopodite spine. Progressing through the subsequent steps leads to the identification of the species.

# Identification key for the crayfish species found in Italy



# CRAINat in Lombardy

The activities, carried out in Lombardy and in the study area in Central Italy, were highly articulated and based on many direct and indirect aspects of conservation of the white-clawed crayfish.

They involved studying and monitoring present populations to learn about their size, state of health and conservation; conservation activities including reproduction and raising in specially built breeding facilities, repopulation of riverbeds suitable for the larvae, the recovery of damaged habitats, training of operators to work with white-clawed crayfish; and education of local residents on the species and the threats to its survival, including programs in schools.

The project was carried out in the SCLs of Parco Alto Garda Bresciano, Parco dei Colli di Bergamo, Parco di Montevecchia e Valle del Curone (Lecco province), Parco Campo dei Fiori (Varese province), Riserva Naturale Sorgente Funtani (Brescia province), Riserva Naturale Valpredina (Bergamo province) and Sasso Malascarpa (Como province).



Capture of crayfish for research purposes by hand



From left to right:

Capture of crayfish for research purposes by electrical fishing

Water course characteristics

Measuring water flow and pH

## What did the project involve?

Experts from the Laboratorio Acque Interne (internal waters laboratory) at the Università degli Studi di Pavia working in conjunction with ERSAF technical staff, investigated the distribution and size of white-clawed crayfish populations in all the SCIs. Genetic and habitat characteristics were then studied to see what risks and threats affect populations in different areas.

An **environmental study** was carried out to see what factors were responsible for population declines. Environmental conditions known to correspond to white-clawed crayfish needs were measured in order to identify suitable water courses in each territory for re-colonization; and those where requalification operations were required. In addition to chemical and physical water quality parameters and biological characteristics, the composition of the substrate, river morphology and features of the surrounding terrain were recorded.

To see what damage was caused by reduction in capacity, five water courses inhabited by the white-clawed crayfish were continuously monitored for water flow, while crayfish and water were periodically sampled. The **minimum water flow conducive to *A. pallipes* viability** has to be estimated at the end of the project. This information is key to the conservation of the species, enabling adequate control of water resources and planning in the management of SCI and protected areas.

The water courses in the Lombard SCIs involved in the study were found to host a total of **20 white-clawed crayfish populations**.

Water quality in the SCIs was excellent on the whole, both chemically and biologically, although some were found to be unsuitable for crayfish survival because of insufficient flow, or because of low temperatures in streams at high altitudes.

Genetic analyses were carried out on a total of over 150 individuals from all the white-clawed crayfish populations in the SCIs by the Università del Piemonte Orientale (Alessandria province). All populations were attributable to *A. italicus*, with two already known clades and over 40 haplotypes identified, showing **substantial genetic variation**.



## CONSTANT MONITORING

Water temperature, oxygen tension and flow rate are monitored constantly in both breeding facilities with high tech instrumentation. Other values – pH, conductivity, nitrite and nitrate, phosphate, sulphate, chloride, hardness and heavy metal levels – are measured periodically.



## Crayfish breeding facilities in Lombardy

### IN PRABIONE (TIGNALE -BS)

Built during the Life project “Requalification of the biological community in Valvestino Corno della Marogna 2” (2004-2007), the Prabione breeding facilities were expanded and developed with the addition of a **new incubator** and **another outdoor pond**. The outdoor facilities are intended to emulate the conditions in large pools in streams so that crayfish can reproduce in as natural a setting as possible. Here the *carsicus* clade of *Austropotamobius italicus* is bred to restock water courses in the SCIs of Eastern Lombardy. The water is from a spring near the Rio Acquasinega in the Western Garda forest, and flows continuously, guaranteeing the high levels of oxygen necessary to crayfish. Perforated bricks have been provided as shelters, with leaves and bundles of twigs to make the pools more natural and give additional shelter.

At the beginning of the breeding season, the facilities host about 200 adult crayfish (approximately 140 females and 60 males).

### AT PRIM’ALPE (CANZO - CO)

CRAINat established another breeding facility, for the *carinthiacus* clade of *Austropotamobius italicus* found in Western Lombardy, in Prim’Alpe in the Corni di Canzo forest (Foresta di Lombardia).

The two abandoned plant nursery ponds converted for breeding can now host about 90 breeding crayfish (60 females and 30 males).

Again, a semi-natural environment has been created using branches, bunches of twigs and leaves.

### HABITAT RESTORATION

Several interventions were carried out to prevent the isolation of white-clawed crayfish populations and to improve the state of their habitat in the SCIs: **consolidation of the banks** of small torrents, removal of debris from some pools, **restoration of flow** deviated by a small landslide, placement of low **fences** to keep bypassers away from tracts where juvenile crayfish had been released.

In other areas, shrubs were planted on the banks to increase shade. A wooden ramp was constructed to help crayfish get upstream past a weir. These simple but essential steps have made the water courses in the SCIs more habitable for our crayfish.

Semi-artificial crayfish breeding pond at Prabione

New incubator in the breeding facilities at Prabione and detail of the breeding tanks

Prim’Alpe Centro breeding facility: during construction (right) and at work (left)





### MULTIFUNCTIONAL POOLS

In the most suitable protected areas, **three semi-natural pools** were built to house small *A. pallipes* populations. These pools have a triple function: they **allow the crayfish lifecycle to be monitored and observed** for educational activities; they mimic the large natural pools found in water courses and can be used as a **temporary refuge** for crayfish recovered from dried up streams. Lastly, they are a **potential reserve of juveniles**, important to species conservation.

### CRAYFISH EMERGENCY RECOVERY TEAMS

In 2012 **six expert emergency teams** were set up to recover crayfish from drying water courses in summer and **during prolonged droughts**. These groups (G.Re.G. - Gruppi di Recupero Gamberi) consist of experts trained to save crayfish in emergency conditions by capturing them and moving them to wetter tracts of the same water course or to the multifunctional pools, or to one of the breeding facilities until water flow in their home water course returns to normal.

### NEW POPULATIONS

The environmental survey showed that **six small water courses** in the SCIs included in the study had suitable water quality and temperatures for crayfish survival. **A few hundred three month old juveniles**, raised in the breeding facilities

were released into each of these. At three months, juveniles are better able to adapt to their new habitat than smaller individuals and more likely to survive. Releases were repeated for at least three consecutive years. In another five water courses, **some tens of reproductive crayfish** were released to reinforce already existing populations. The crayfish were then monitored by experts from the University of Pavia and by ERSAF technicians for the next few years until reproductive activity was verified, indicating the release had been successful.



Release of *A. pallipes* juveniles



Wooden ramp to allow crayfish to move upstream



Fence to protect *A. pallipes* release site

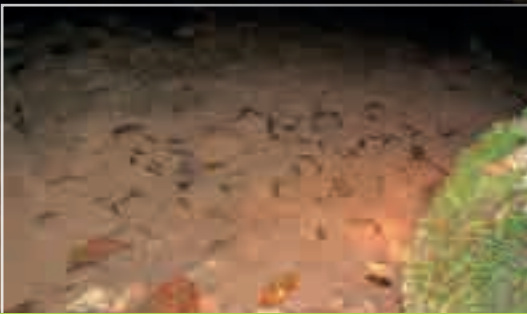


Multifunctional pool



Crayfish emergency recovery team training course (G.Re.G.)





Nocturnal monitoring of juvenile *A. pallipes*

### CONTAINMENT OF EXOTIC CRAYFISH

Our crayfish distribution study confirmed that the invasive species *Procambarus clarkii* was present in Lago di Ganna. In order to **limit the expansion of Louisiana crayfish populations** and the colonization of other water courses, **over 50 traps** are periodically placed.

Any exotic crayfish caught are removed for study. It was through trapping activity that another invasive species, *Orconectes limosus*, or spinycheek crayfish, was also discovered in the lake. **These two American species cause serious damage** because both are healthy carriers of the *Aphanomyces astaci* water mold, which is fatal to the white-clawed crayfish.

### TRAINING, AWARENESS AND ENVIRONMENTAL EDUCATION

The involvement of personnel from local institutions and associations in meetings and training seminars has been an important step in the project. Environmental education projects have been carried out in local schools to raise awareness and encourage the participation of local youngsters in protected areas. Classroom activities, field trips, night time excursions and laboratories have been conducted with **over 13500 children, teens and adults!** Illustrative panels showing the white-clawed crayfish life cycle, habitat restoration activities and other interventions have been installed in the protected areas involved in the CRAINat project.

Finally, the documentary "*Life CRAINat - A project for the freshwater crayfish*" (directed by F. Petretti; Italian/English versions) was produced to raise awareness about the white-clawed crayfish and the dangers it faces as well as the activities of the conservation programme conducted in Lombardy, Abruzzo and Molise.



Release of reproductive crayfish



Recovery of traps



*P. clarkii* individual captured in Lago di Ganna



Primary school field trip

# The protected areas in Lombardy that participated in the project

## PARCO REGIONALE CAMPO DEI FIORI

Via Trieste, 40 - 21030 Brinzio (Va) - Tel: 0332.435386 - Fax: 0332.435403 - [www.parcocampodeifiori.it](http://www.parcocampodeifiori.it)

**about the park:** it is situated a few km North of the city of Varese. Established in 1984 and expanded in 2009, the park covers about 6300 hectares distributed in 17 municipalities and 2 mountain communities in the province of Varese

**SCIs included:** Monte Martica IT2010005, Lago di Ganna IT2010001, Versante Nord del Campo dei Fiori IT20100003, Monte Legnone e Chiusarella IT 2010002 e Grotte del Campo dei Fiori IT 2010004

**crayfish census:** 6 (*A. pallipes*), 1 (*P. clarkii*), 1 (*O. limosus*)

**habitat interventions:** restoration of the Boscaccia torrent and of a rio in the Grotte di Ganna. Creation of a multifunctional pool

**releases:** 2 stocks of white-clawed crayfish juveniles, 1 stock of reproductive adults

**breeding facility:** Prim'Alpe di Canzo (CO)

**GReG:** it has been available in this area since 2012, in case of environmental problems (drought, pollution etc)

**environmental education:** more than 600 children and 250 adults have participated

**advice:** read the "Good Practise" paragraph on p. 24 and be careful to avoid harming native crayfish in the Lago di Ganna and the Lago di Varese in general!

## RISERVA NATURALE SASSO MALASCARPA

ERSAF - Direzione della Riserva - Corso Promessi Sposi, 132 - 23900 Lecco - Tel. 02.67404453 - Fax 02.67404469 - [www.parks.it/riserva.sasso.malascarpa](http://www.parks.it/riserva.sasso.malascarpa)

**about the reserve:** established in accordance with regional law (art. 37 della Lr. 86/83) as a partial nature reserve, of interest because of its geomorphological and landscape features. It covers 137 hectares situated in two municipalities, 57 of them owned by Regione Lombardia (Foresta di Lombardia Corni di Canzo)

**SCIs included:** Sasso Malascarpa IT2020002

**crayfish census:** 0

**habitat interventions:** restoration of the Ravella torrent along the geological trail

**releases:** 2 stocks of juveniles, 1 stock of reproductive adults

**breeding facility:** established since 2010 in Prim'Alpe di Canzo (CO)

**GReG:** it has been available in this area since 2012, in case of environmental problems (drought, pollution etc)

**advice:** read the "Good Practise" paragraph on p. 24 and be careful to avoid harming native crayfish in Lago di Annone and Lago di Pusiano!

## PARCO REGIONALE DI MONTEVECCHIA E VALLE DEL CURONE

Loc. Butto, 1 - 23874 Monteverchia (LC) - Tel.: 039.9930384 - Fax: 039.9930619 - [www.parcocurone.it](http://www.parcocurone.it)

**about the park:** established in accordance with regional law (*Legge Regionale n. 77 del 16/09/1983*). It covers about 2.745 hectares distributed in 11 municipalities

**SCIs included:** Valle Santa Croce e Valle del Curone IT2030006

**crayfish census:** 7

**habitat interventions:** restoration of flow in the Curone torrent. Creation of a multifunctional pool

**releases:** 2 stocks of juvenile crayfish, 1 stock of reproductive adults

**breeding facility:** Prim'Alpe di Canzo (CO)

**GReG:** it has been available in this area since 2012, in case of environmental problems (drought, pollution etc)

**environmental education:** more than 850 children and 220 adults have participated

**advice:** read the "Good Practise" paragraph on p. 24 and be careful to avoid harming native crayfish in the Mirasole resurgence!

## PARCO REGIONALE DEI COLLI DI BERGAMO

Via Valmarina, 25 - 24123 Bergamo (BG) - Tel.: 035.4530400 - Fax: 035.577530 - [www.parcocolliberghamo.it](http://www.parcocolliberghamo.it)

**about the park:** it covers an area of about 4700 hectares and is distributed in 10 municipalities in Bergamo province. It was established in 1977 to protect and enhance the existing balance between human activity and nature, in accordance with regional law (*L.R. n. 36 del 18 agosto 1977*)

**SCIs included:** Canto Alto e Valle del Giongo IT2060011, Boschì dell'Astino e dell'Allegrezza IT2060012

**crayfish census:** 2

**releases:** 3 stocks of juveniles

**breeding facility:** Prabione di Tignale (BS)

**GReG:** it has been available in this area since 2012, in case of environmental problems (drought, pollution etc)

**environmental education:** over 5800 children and 3500 adults have participated

**advice:** read the "Good Practise" paragraph on p. 24 and be careful to avoid harming native crayfish in the Bergamo area of the Po Valley!

## RISERVA NATURALE SICOASI WWF VALPREDINA

Via F. Lussana, 2 - 24069 Cenate Sopra (BG) - Tel.: 035.956140-956648 - [www.oasivalpredina.it](http://www.oasivalpredina.it)

**about the reserve:** this was the result of the 1983 donation by Bardoneschi consorts to WWF Italia ONG Onlus. It was established on 50 hectares, in accordance with regional law (L.R. n. 86/83), representing a partial nature reserve of interest because of its forest and landscape features. SIC presently covers 90 hectares and is situated entirely in the municipality of Cenate Sopra, Comunità Montana Val Cavallina, in the Bergamo province. A WWF wildlife recovery center (Centro Recupero Animali Selvatici) is housed here

**SCIs included:** Valpredina e Misma IT2060016

**crayfish census:** 1

**habitat interventions:** consolidation of river banks along the Predina trent. Creation of a multifunctional pool

**releases:** 1 stock of reproductive adults

**breeding facility:** Prim'Alpe di Canzo (CO)

**GReG:** it has been available in this area since 2012, in case of environmental problems (drought, pollution etc)

**environmental education:** over 1100 children and 550 adults have participated

**advice:** and be careful to avoid harming native crayfish in the Bergamo area of the Po Valley!

## RISERVA NATURALE SORGENTE FUNTANI

C/o Municipio - 25079 Vobarno (BS) - Tel.: 0365.596011 - Fax: 0365.596036 - [www.sorgentefuntani.eu](http://www.sorgentefuntani.eu)

**about the reserve:** situated in the municipality of Vobarno, it was established in 1985 following regional council resolution (*Deliberazione di Consiglio Regionale 5 febbraio 1985 n. III/1904*). It covers 66 hectares

**SCIs included:** Sorgente Funtani IT2070019

**crayfish census:** 1

**habitat interventions:** improvements along the short stream that runs from the resurgence to the Agna torrent

**releases:** 3 stocks of juveniles and 1 stock of reproductive adults

**breeding facility:** Prabione di Tignale (BS)

**GReG:** si fa riferimento alla task force del Parco Regionale Alto Garda Bresciano, attiva dal 2012

**environmental education:** over 650 children/teens and 150 adults have participated

**advice:** read the "Good Practise" paragraph on p. 24 and be careful to avoid harming native crayfish in the Po Valley!

## Networking with other Life projects

**Life Rarity LIFE10 NAT/IT/000239** - *Eradicazione del gambero rosso della Louisiana e protezione dei gamberi di fiume del Friuli Venezia Giulia* - [www.life-rarity.eu](http://www.life-rarity.eu)

**Life Rii LIFE11 ENV/IT/000243** - *Riqualificazione Integrata Idraulico-ambientale dei rii appartenenti alla fascia pedemontana dell'Emilia-Romagna* - <http://ambiente.regione.emilia-romagna.it/life-rii/temi/progetto-life-rii>

**LIFE03 NAT/IT/000147** - *Riqualificazione della biocenosi in Valvestino Corno della Marogna 2*

**LIFE03 NAT/IT/000137** - *Austropotamobius pallipes: tutela e gestione nei Sic d'Italia centrale*

**LIFE00 NAT/IT/007159** - *Conservazione di Austropotamobius pallipes in due Sic della Lombardia*

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## PARCO REGIONALE ALTO GARDA BRESCIANO E FORESTA DI LOMBARDIA GARDESANA OCCIDENTALE

Comunità Montana Parco Alto Garda Bresciano Via Oliva, 32 - 25084 Gargnano (BS) Tel.: 0365.71449 - 72108 Fax: 0365.72585 - [www.parcogardegarda.eu](http://www.parcogardegarda.eu)

ERSAF Via Oliva, 32 - 25084 Gargnano (BS) - Tel.: 0365.798470 Fax: 0365.798499

**about the park:** established in accordance with regional law (*legge regionale n. 58 del 15 settembre 1989*), it covers 38.000 hectares distributed in 9 municipalities

**SCIs included:** Valvestino IT2070021, Corno della Marogna IT2070022, Cima Comer IT2070016

**crayfish census:** 3

**habitat interventions:** installation of a wooden ramp to allow crayfish to move upstream across a weir in Valvestino

**releases:** 3 stocks of juveniles and 1 stock of reproductive adults

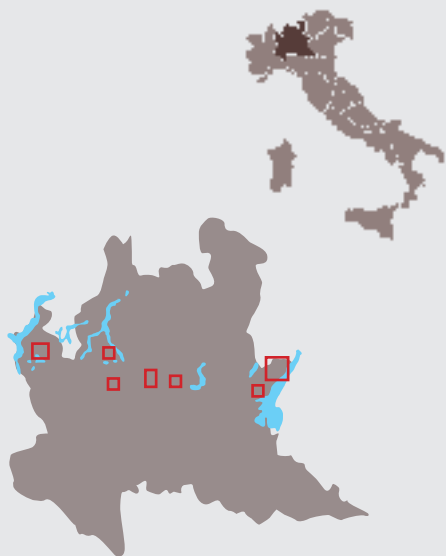
**breeding facility:** established since 2006 in Prabione di Tignale (BS). It consists on two big seminatural outdoor ponds and a hatchery with 12 tanks

**GReG:** it has been available in this area since 2012, in case of environmental problems (drought, pollution etc)

**environmental education:** over 300 children have participated. Production of the pamphlet "Senti come pizzica!" (It's nipped me!)

**advice:** read the "Good Practise" paragraph on p. 24 and be careful to avoid harming native crayfish in the Garda Lake!





To find out more:  
[www.lifecrainat.eu](http://www.lifecrainat.eu)

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