

# EFFECT OF INVASIVE ALIEN FISH CONTROL OVER THE POPULATION OF RED SWAMP CRAYFISH IN BANYOLES LAKE (Girona, Spain)

Carles Feo-Quer, Q. Pou-Rovira, I. Camós, R. Casadevall, G. Dalmau, A. Juscafresa, M. Campos.

Consorti de l'Estany. Plaça dels Estudis, 2. 17820. Banyoles, Girona, Spain. [cfeo@consorcidelestany.org](mailto:cfeo@consorcidelestany.org).



## ABSTRACT

The red swamp crayfish (*Procambarus clarkii*) was mentioned on Lake Banyoles for the first time in 1982. It is especially abundant in irrigation channels, streams and ponds of the lake surroundings. The presence of native crayfish in its waters is not known. Their presence and abundance in Banyoles lake is determined by the abundance of alien predatory fish, especially largemouth bass (*Micropterus salmoides*), in which the red swamp crayfish diet plays a major role.

In 2010 a LIFE project entitled "A Demonstration Project Improvement of habitats and species of the Natura 2000 network of Banyoles" (LIFE08 NAT/ES/000078) was started. Its main objective was to carry out a widespread intervention to fight, slow down and reverse the decline of species and habitats of community interest being caused by invasive species. Controlling alien fish species were necessary for the recovery of native species like mediterranean barbel and freshwater mussels. These actions have been conducted mainly by electric fishing from a boat, trammel nets, traps and even water management in the lagoons around. The evolution of the red swamp crayfish population has been used as an indicator of the evolution of these control tasks. An increase of crayfish in the main lake is expected, while the largemouth bass populations were declining. The elimination of red swamp crayfish is not the aim of this project, although it's one of the most damaging invasive species on the planet, because it is considered impossible to eradicate of the lake.

In 2014 a new project LIFE "Potamo Fauna" (LIFE12 NAT/ES/001091) reinforces the experimental control actions over alien predatory fish so it has continued the monitoring that began in 2010. We have used a standardized methodology for monitoring species at long term. Two campaigns a year, in summer and autumn, have been made, based on the sampling of 21 points on the lake and surroundings. At each point five traps have been placed during 24 hours baited with chicken liver.

Two LIFE project are involved in this results:  
LIFE08 NAT/ES/000078  
LIFE12 NAT/ES/001091



## LOCATION

Lake Banyoles is the second largest lake in the Iberian Peninsula. The lake is part of the karstic system of Banyoles-St. Miquel de Campmajor. Its origin is to be found in the dissolution of the underlying gypsum and eocenic marl layers by the underground currents, what causes downfalls of the ground in the form of a bucket or doline. It is formed by 6 sub-buckets and 13 points of water surges in the so-called polje, producing a complex bathymetry. Water has a high dissolved salts content, mainly sulphates and carbonates, which explains the high conductivity (0.8-1.9 mS/cm). It arrives at a constant temperature of 19°C and the length of residence in the lake is low (0.8 years). There is a complex stratification of the water column: the most superficial layer (mixolimnion) tends to separate in two during the summer (epilimnion and hipolimnion). Some of the buckets undergo meromixis processes. The lake is considered oligomesotrophic (chl a: 1-15 mg/l) Due to the bathymetric profile of the lake and the high stability of the water level, vegetal communities are configured in clearly defined concentric belts.

BANYOLES LAKE (Girona, Catalonia, Spain)



## OBJECTIVES

Monitoring the exotic crayfish population, to assess its evolution during an long program of culling (demographic control) of non native predator fish, under LIFE Project Estany and LIFE Potamo Fauna.

- Implementation of a standardized crayfish monitoring methodology in Lake Banyoles.
- Evaluation of tendencies on crayfish density, as a effect of the control of exotic predatory fish.
- Characterization of crayfish population structure.
- Elaboration and proposal of management tools of this exotic crayfish.



## METHODOLOGY

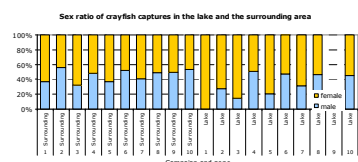
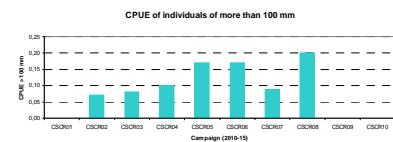
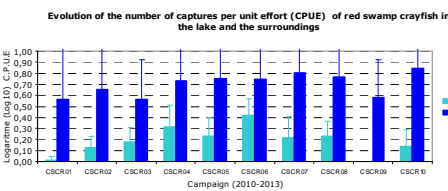
We have adapted the census methodology used in Sweden by Lennart Edsman of the Institute of Freshwater Research ("Swedish Standard Protocol for the Census Fishing for crayfish").

- Relative abundance has to be estimated, by means of CPUEs.
- The capture technique can be used in any kind of aquatic water body: lake, lagoons, ponds and small streams.
- It has been designed to obtain high quality information with low effort. It's useful for any kind of crayfish.
- Sampling should be performed during the season of crayfish activity, avoiding months with water temperature below 15 °C. Two annual campaigns finally programmed: mid July and early November.
- We use a tubular trap with small mesh size (5mm), provided with two funnel entrances, and baited with chicken liver.
- 5 traps are placed on each sampling point for a whole day (24 hours). In the lake, traps are hitched to a rope line, disposed perpendicularly to the shore.

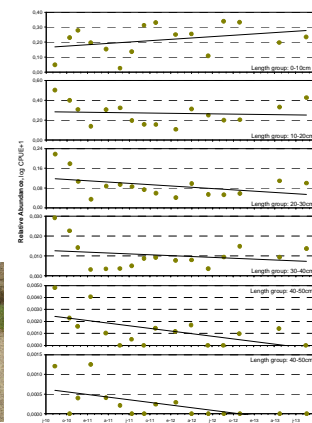


## RESULTS

- The population of *Procambarus clarkii* has increased in the lake between 2011 and 2013, when the reduction of *M. salmoides* has been significant.
- The population on the surroundings of the lake maintain its high density because the lack of control actions. There has been some actions against alien fish, as electrofishing in lake Vilar (VI), or decrease of water level in some ponds (MA: Margalit, AR: Ariga, AM: Amadorors), but the actions didn't have continuity all the years.
- The crayfish populations are less abundant in autumn (odd campaigns) than in summer (even campaigns) due to the natural dynamics of the species and the lower temperature of the water.
- The campaigns conducted in summer (even campaigns) have captures with a similar proportion of males and females, with a sex ratio close to 1. Instead, autumn campaigns (odd number) the ratio of males has low values between 0.2 and 0.6.



Evolution of the relative abundance of different age groups of largemouth bass (*M. salmoides*) in Banyoles lake in successive campaigns of electrofishing between 2010 and 2013



## CONTROL OF INVASIVE ALIEN FISH

Population culling campaigns are carried out against exotic fishes. A combination of catching techniques is planned (nets, traps and electrofishing). Most of the captures have been done at the littoral of the lake through electrofishing, where Largemouth Bass (*M. salmoides*) and Pumpkinseed (*L. gibbosus*) are clearly dominant. The results of these exotic control actions between 2010-2015 show a significant reduction of the adult fraction of *M. salmoides* population, especially of 5+ and older individuals. That explains the clear reduction of the average length of this species.



## CONCLUSIONS

1. We established a simple methodological basis for monitoring the crayfish populations
2. The red swamp crayfish population sampling has interest to know the evolution of this exotic specie considered one of the most invasive of the world. It presents a high abundance in aquatic habitats around the lake, especially in channels, streams and little ponds.
3. This monitoring has also served to assess the control actions of removing invasive exotic fish predators in Banyoles lake and Vilar lake. The crayfish is the main prey for Largemouth bass. The reduction of this predator fish has increased the population of crayfish in the Lake.
4. Crayfish populations in Lake Banyoles at the beginning of the project in 2010 and 2011 (1 to 3 campaigns) were very low. Catches have increased in 2012 and 2013 campaigns in spring and autumn clearly indicating a significant increase in the population of crayfish directly related to the decline in *M. salmoides* in the lake. In 2014 and 2015 the crayfish has decreased another time, by increasing the *M. salmoides* population. The electrofishing control campaigns have reduced its intensity during 2014 and 2015, and the *M. salmoides* population has been increased slowly.
5. The exotic control actions have been particularly effective, reducing older specimens of *M. salmoides*. This situation has generated a cascade effect leading to an increased of population density. Variations in crayfish populations can be used as an indicator of the state of predator exotic fish stocks.
6. There is an increase of captures in the lake of individuals of more than 100 mm which coincides with the general trend. Crayfish have been captured up to a depth of 17 meters.
7. It is not easy to determine management proposals for the specie in Banyoles Lake. Only in those water masses where we can regulate water levels, we can perform actions based on the flood control. The drying of ponds can help to control this specie, although it is known for its ability to resist burying more than half a meter on the ground.

