

## Recovering amphibians populations from four alpine lakes affected by introduced fish in Gran Paradiso National Park: early results from the LIFE+ BIOAQUAE eradication project

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**Abstract.** Alien fish species have been introduced into naturally fishless mountain lakes worldwide, with negative consequences for native amphibians. In the Gran Paradiso National Park (Western Italian Alps) the presence of introduced fish (brook trout, *Salvelinus fontinalis*) is a factor of ecological exclusion for common frog (*Rana temporaria*), compromising the suitability of alpine lakes as breeding sites. The negative impact depends on fish predation on tadpoles and adult frogs. An eradication program of introduced fish was started in 2013 to recover amphibian populations as well as other components of the alpine lakes ecosystems within the LIFE+ BIOAQUAE (Biodiversity Improvement of Aquatic Alpine Ecosystems). Eradication provides for the use of intensive gill netting as an effective and non-invasive eradication technique without lethal effects for non-target species. The breeding activity of *R. temporaria* and the development of tadpoles was monitored in four treated lakes since the beginning of the project. The eradication methods and the results at the second year of eradication campaign will be presented.

**Riassunto.** L'introduzione di pesci alloctoni nei laghi d'alta quota, naturalmente privi di fauna ittica, è un fenomeno globale. Nel Parco Nazionale Gran Paradiso (Alpi Graie) la presenza di pesci introdotti (salmerino di fonte, *Salvelinus fontinalis*) è un fattore di esclusione ecologica per *Rana temporaria*, impedendo la riproduzione nei laghi alpini. L'impatto negativo dipende dalla predazione su girini e esemplari adulti di *Rana temporaria*. Nel 2013 è stato avviato un programma di eradicazione dei pesci introdotti per ripristinare le popolazioni di anfibi e le altre componenti ecosistemiche, all'interno del progetto LIFE+ BIOAQUAE (Biodiversity Improvement of Aquatic Alpine Ecosystems). L'eradicazione prevede l'uso intensivo di reti da pesca come efficace tecnica di eradicazione non invasiva senza effetti letali per specie non-target. L'attività

riproduttiva e lo sviluppo dei girini in quattro laghi alpini trattati è stato monitorato. Saranno presentati i metodi di eradicazione e i risultati disponibili al secondo anno della campagna di eradicazione.

**Keywords.** *Rana temporaria*, *Salvelinus fontinalis*, gill-netting, non-invasive eradication technique.

Predation by nonnative species is one of the most serious threats to amphibian populations, since the absence of evolutionary adaptations to new predators makes amphibians particularly vulnerable (Gardner, 2001). Fish are the most common introduced predators of amphibians and they have been introduced even in the most remote aquatic habitats, such as high altitude lakes (Knapp et al., 2001; Tiberti et al., 2014). In the 1960s, Brook trout (*Salvelinus fontinalis*) was introduced in several naturally fishless lakes of GPNP, where the species established some reproductive populations. In the Gran Paradiso National Park (Western Italian Alps) the presence of introduced fish (brook trout, *Salvelinus fontinalis*) is a factor of ecological exclusion for common frog (*Rana temporaria*), compromising the suitability of alpine lakes as breeding sites (Tiberti and von Hardenberg, 2012). The negative impact depends on fish predation on tadpoles and adult frogs (large adult frog have been found in the gut content of brook trout).

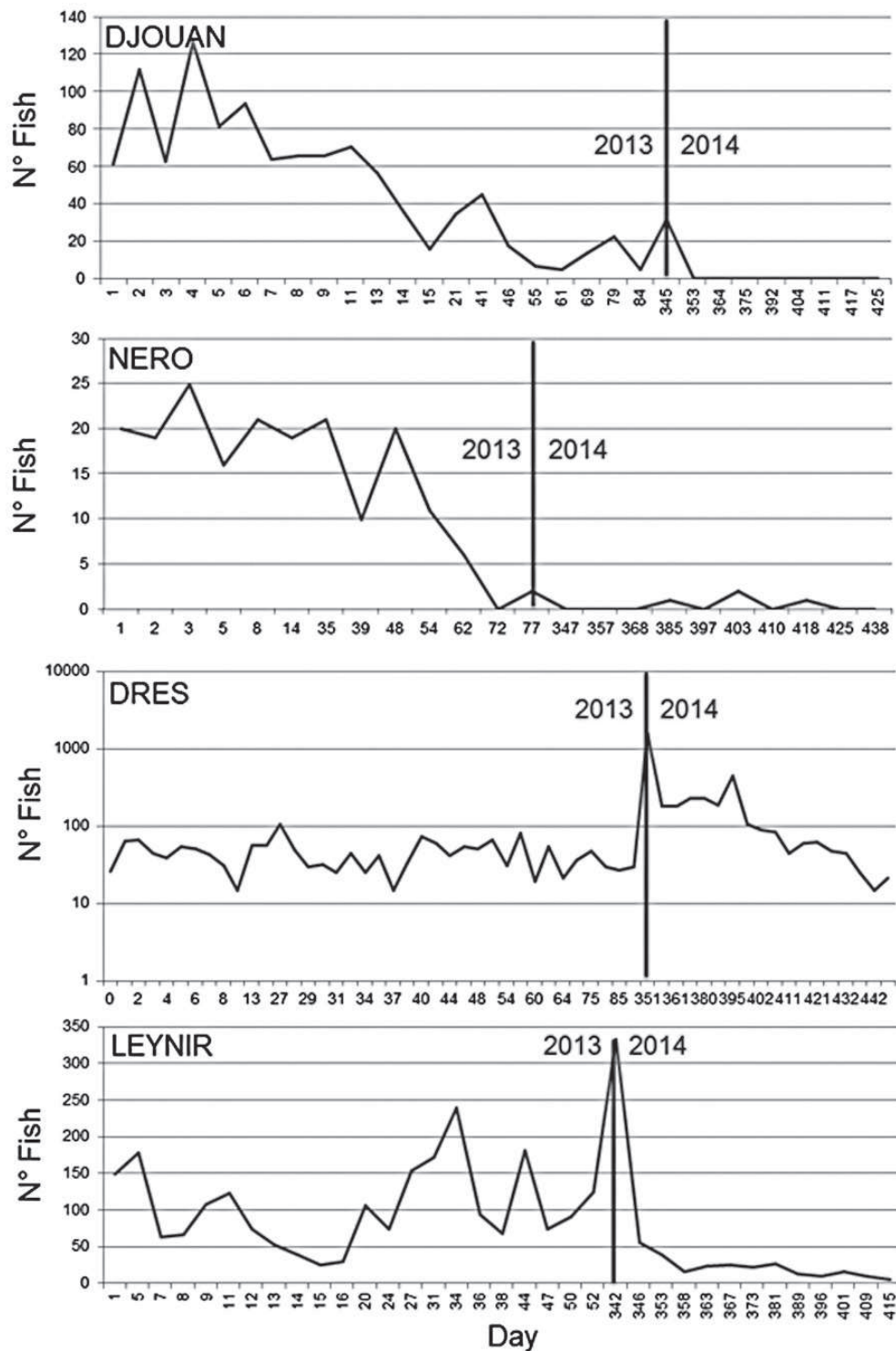
An eradication program of introduced fish was started in 2013 to recover amphibian populations -as well as other components of the alpine lakes ecosystems- within the LIFE+ project BIOAQUAE (Biodiversity Improvement of Aquatic Alpine Ecosystems). Eradication provides for the use of intensive gill netting as an effective and non-invasive eradication technique in four high altitude lakes. This technique was preferred to the use of pesticides, such as rotenone, because it has not lethal effects for non-target species, such as aquatic insect and planktonic crustaceans. This is an imperative characteristic in the choice of an eradication method for alpine lakes, which, thanks to their island-like nature, can promote genetic differentiation and even speciation in many taxa, such as zooplankton crustaceans (Bellati et al., 2014).

During the first two years of eradication campaign the fish density was drastically reduced (Fig. 1) and the eradication process was probably completed in the two smaller lakes (lakes Nero and Djouan) demonstrating that gill-netting is an effective, relatively fast, and non-invasive method for eradicating fish at least in small alpine lakes and, potentially, for recovering amphibians populations. In the next years the effectiveness of gill-netting will be tested also in deeper lakes.

The ecological resilience of *R. temporaria* was monitored by counting the egg-masses laid in the lakes -as a proxy of the effective population size- to check whether fish removal produces a population increase in *R. temporaria*.

During the first two years of eradication campaign *R. temporaria* bred in two studied lakes and in both the cases tadpoles completed the metamorphosis. In lake Djouan there was a moderate increase in the number of egg-masses (20 in 2013 and 44 in 2014), while in lake Dres a moderate decrease was observed (45 in 2013 and 37 in 2014). Probably, the recovery

of the populations of *R. temporaria* needs longer resilience time. The next few years will be important to check if *R. temporaria* will be able to colonize lakes Leynir and Nero and if the pop



**Fig. 1.** Fish captures under intensive gill-netting in four lakes (lakes Dres, Djouan, Nero and Leynir) in Gran Paradiso National Park. Preliminary data from the first two years (2013-2014) of the eradication project LIFE+ BIOAQUAE. Day: days from the start date of the project.

## References

- Bellati, A., Tiberti, R., Cocca, W., Galimberti, A., Casiraghi, M., Bogliani, G., Galeotti, P. (2014): A dark shell hiding large variability: a molecular insight into the evolution and conservation of melanic *Daphnia* populations in the Alps. *Zool. J. Linn. Soc.*, in press.
- Gardner, T. (2001): Declining amphibian populations: a global phenomenon in conservation biology. *Anim. Biodivers. Conserv.* 24: 25-44.
- Knapp, R.A., Matthews, K.R., Sarnelle, O. (2001): Resistance and resilience of alpine lake fauna to fish introductions. *Ecol. Monogr.* 71: 401-421.
- Tiberti, R., von Hardenberg, A. (2012): Impact of alien fish on Common frog (*Rana temporaria*) close to its altitudinal limit in alpine lakes. *Amphibia Reptilia* 33: 303-307
- Tiberti, R., von Hardenberg, A., Bogliani, G. (2014): Ecological impact of introduced fish in high altitude lakes: a case of study from the European Alps. *Hydrobiologia* 724:1-19.