

# Status of the marble trout (*Salmo marmoratus* Cuvier, 1829) populations in the freshwater environments of Friuli Venezia Giulia

## Introduction

In Friuli Venezia Giulia (Northeast Italy), *Salmo marmoratus* Cuvier 1829 (Fig. 1) is the only autochthonous trout (except for the Slizza Stream basin) and formerly showed a wide distribution area, including mountain and piedmont watercourses and several zones in the low plain.



Fig. 1. Marble trout *Salmo marmoratus* (Cuvier, 1829) captured in Friuli Venezia Giulia during the Water Protection Regional Plan monitoring activities (Picture by F. Bortolon).

The marble trout is one of the most endangered freshwater fish of the Adriatic Basin (Povž et al. 1996; Crivelli et al. 2000), listed in Annex II of the Directive 92/43/EEC and included as Critically Endangered in the IUCN Red List (Rondinini et al. 2013). A rehabilitation project has been led in Friuli Venezia Giulia since the late 1980s (Specchi et al., 2000). *S. marmoratus* is introduced both for restocking (fry and juveniles) and together with other salmonids for fisheries purpose (adults) (Fig 2).

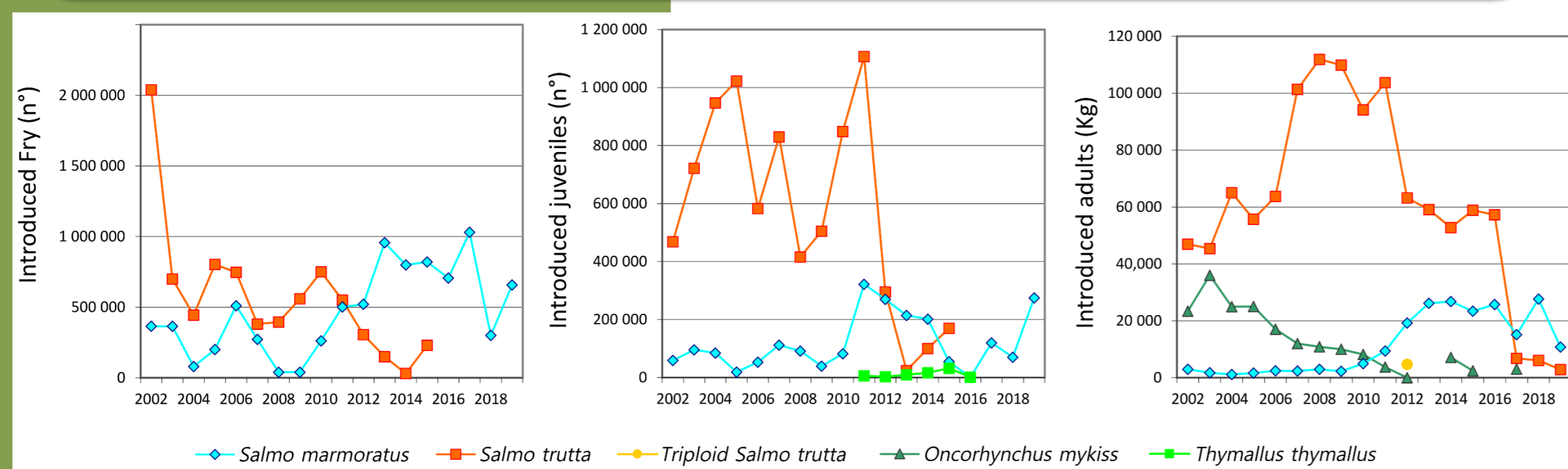


Fig. 2. Salmonids introductions performed in Friuli Venezia Giulia between 2002 and 2018 (data supplied by ETPI)

The present study reports partial results obtained in the context of a project regarding the Expected Fish Community Map of Friuli Venezia Giulia Region. Our work compares expected and observed distribution area of *S. marmoratus*, taking into account impacts for marble trout conservation.

## Data analysis

Data collected during monitoring activities of the past 10 years and related to the Regional Water Protection Plan project were considered (Fig. 4). Expected fish communities were built for 264 sites on the basis of literature (Tellini, 1895; Gridelli, 1936; Paradisi & Stoch, 1966; Flego, 1972; Buda Dancevich et al., 1982; Mojetta, 1984; Stoch., 1992; Pizzul et al., 2006) and interviews with local fishermen. Sites were clustered on the basis of the expected community composition and categorized by geographical position.

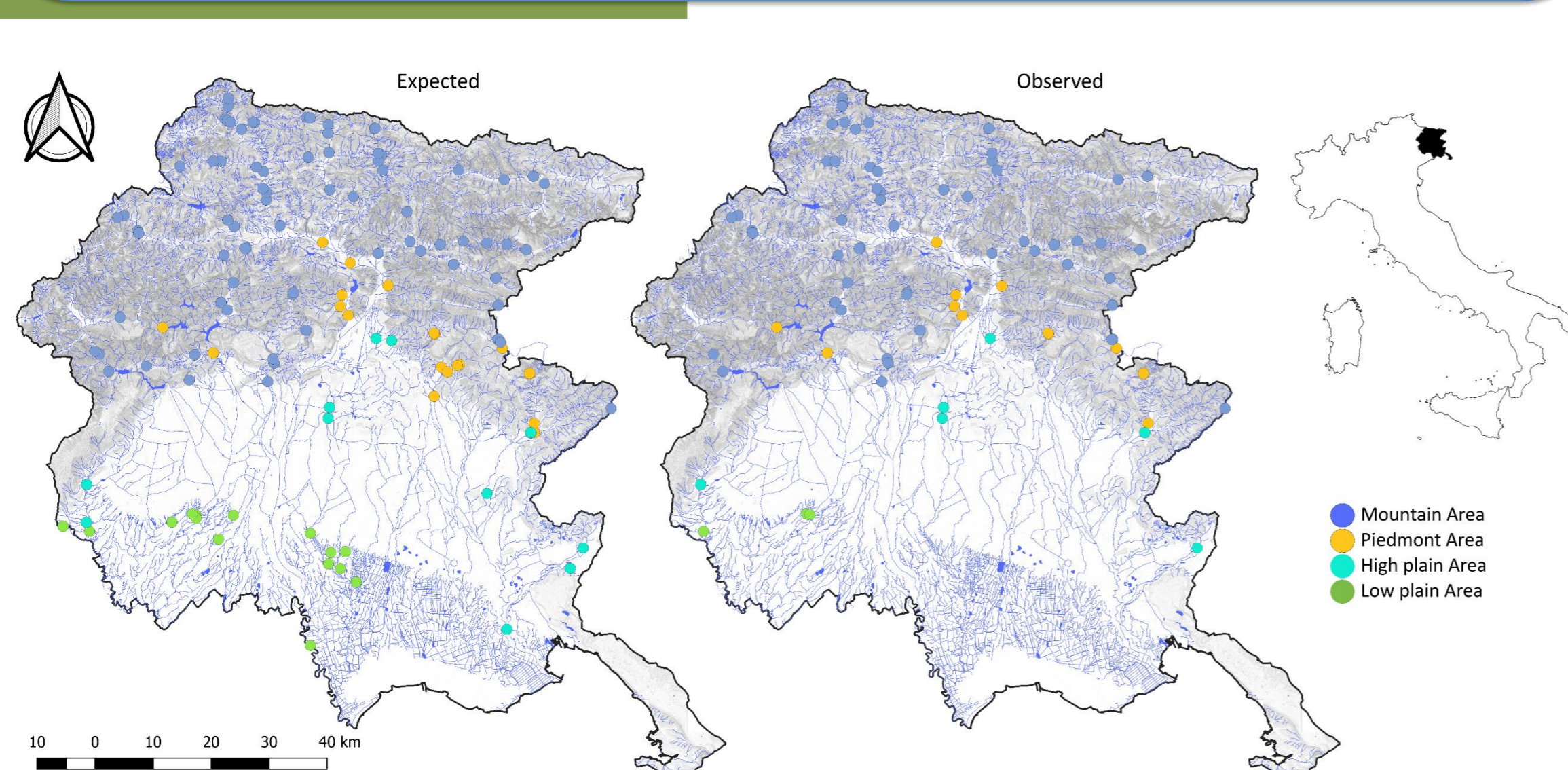


Fig 3. Sites where *S. marmoratus* was expected and where it was observed

The marble trout was expected in 161 sampling sites; it was found in 85 sites while hybrid between *S. marmoratus* and *S. trutta* were collected in 61 sites (Figure 3).

PERMANOVA was used to investigate significant differences among expected and observed communities, considering presence/absence data in each geographical zone and significant differences were detected ( $p < 0.001$ ). The contribution of the species to the observed dissimilarity was investigated with the SIMPER test, and contribution of the marble trout to the observed dissimilarities was highlighted (Tab. 1).

	Contribution to dissimilarity %	$p$ -value	Percentage of sites where <i>S. marmoratus</i> is present/absent	
			Expected	Observed
Mountain area (n=85)	<i>Salmo marmoratus</i> 35.56	0.001	100	16.5
	<i>S. marmoratus</i> x <i>S. trutta</i> 22.99	0.001	0	60
Piedmont area (n=32)	<i>Salmo marmoratus</i> 12.62	0.001	65.6	6.3
	<i>S. marmoratus</i> x <i>S. trutta</i> 9.1	0.013	0	43.8
Low plain Area (n=29)	<i>Salmo marmoratus</i> 4.53	0.001	58.6	0

Tab. 1. Contribution of *S. marmoratus* to the observed dissimilarities and percentage of sites where the species was present/absent, as highlighted by the SIMPER test.

## Conclusions

The highest contribution to dissimilarity was observed in the mountain area, where impacts for *S. marmoratus* are mainly represented by water diversions, weirs and dams (Fig. 4 a, b, c) while land use and habitat alteration are major threats in the plain areas, with particular regard to the disappearing of riparian vegetation (Fig. 4d). In particular, in the low plain of Friuli Venezia Giulia, the absence of riparian vegetation caused changes in the riverbed sediments and the consequent disappearing of suitable reproduction areas



Fig 4. Sources of impacts for *S. marmoratus* (Pictures: a, b, M. Bertoli; c, E. Pizzul; d, M. De Luca)

Hybridization with *Salmo trutta*, displacement by *Oncorhynchus mykiss* and habitat alteration are the main causes of concern for the survival of *S. marmoratus* (Zerunian, 2004; Turin et al., 2006; Marchi et al., 2017). However, within the *S. marmoratus* distribution area, the prohibition of adult brown trout and rainbow trout introduction led the management Authority to use adult marble trout for fisheries, with waste of resources due to high production costs and to unsatisfactory results regarding the restocking of native populations.

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