Deliverable D4.6

Version: FINAL
Date: 30/11/2013
Author: UB + IRD
Dissemination status: PU
Document reference: Deliverable_D4.6

Manuscript on the Comparative Biodiversity trend Analysis (M51)

STATUS: FINAL VERSION

Project acronym:	BIOFRESH
Project name:	Biodiversity of Freshwater Ecosystems: Status, Trends, Pressures, and Conservation Priorities
Call and Contract:	FP7-ENV-2008-1
Grant agreement no.:	226874
Project Duration:	01/11/2009 – 30.04.2014 (54 months)
Co-ordinator:	Leibniz-Institute of Freshwater Ecology and Inland Fisheries at Forschungsverbund Berlin e.V., Germany
Partners:	RBINS, Royal Belgian Institute of Natural Sciences, Belgium BOKU, Universität für Bodenkultur Wien, Austria ICLARM, International Center for Living Aquatic Resources Management, Malaysia IRD, Institut de Recherche pour le Développement, France UDE, Universität Duisburg-Essen, Germany IUCN, International Union for Conservation of Nature, Switzerland UOXF.AC, Oxford University, UK UB, Universitat de Barcelona, Spain UFZ, Helmholtz Zentrum für Umweltforschung, Germany UCL, University College of London, UK UCBL, Université Claude Bernard - Lyon 1, France UPS, Université Paul Sabatier- Toulouse 3, France ECOLOGIC, Ecologic GmbH Institut für Internationale und Europäische Umweltpolitik, Germany EC-ERC, Commission of the European Communities - Directorate General Joint Research Centre, Italy UD, University of Debrecin, Hungary NRM, Naturhistoriska riksmuseet, Sweden FIN, FishBase Information and Research Group, Inc.

BIOFRESH

Biodiversity of Freshwater Ecosystems: Status, Trends, Pressures, and Conservation Priorities

Project no. 226874

Large scale collaborative project

Deliverable number	D4.6
Deliverable name	Manuscript on the Comparative Biodiversity trend Analysis
WP no.	WP4
Lead Beneficiary (full name and Acronym)	Universidad de Barcelona – Institut de Recherche pour le Développement
Nature	Manuscript
delivery date from Annex I (proj. month)	**M51**
Delivered	yes
Actual forecast delivery date	2013-11-30
Comments	

Project funded by the European Commission within the Seventh Framework Programme Dissemination Level		
PU	Public	✓
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

This project has received funding from the European Union’s Seventh Programme for research, technological development and demonstration under grant agreement No 226874

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In case the report consists of the delivery of materials (guidelines, manuscripts, etc)

Delivery name	Delivery file name	From Partner	To Partner

Introduction

D4.6. Manuscript on the comparative biodiversity trend analysis for three European catchments including results from trend analyses from WP5+6 (Month 51)

Aim of the Deliverable

The aim of the Deliverable M51 is to produce a manuscript on the key component "Comparative Biodiversity Trend Analyses". This is a crosscutting key component that links WP4, 5, and 6, and has the main aim to assess current (WP4) and future distribution patterns of freshwater biodiversity under climate change (WP5) and other stressors (WP6) at the basin scale. There are three target basins in this key component that have been investigated extensively: the Ebro, the Elbe, and the Danube. In this Deliverable, we have applied climate envelope models and other statistical tools to forecast current and future distributions of the brown trout, *Salmo trutta*. We decided to focus on this emblematic species instead of other because (1) it is a native species widely distributed across Europe, (2) it has a high occurrence in the three target basins, (2) it is considered very sensitive to environmental variables related to climate or other stressors, (3) it has a high recreational and commercial value and thus its conservation and management is a priority, and (4) there is available and easily accessible data gathered with similar methods. In comparison to previous *Salmo trutta* forecasts that only focus on climatic variables, our manuscript examined the predictive role of multiple drivers, including climate, land uses and stream topography. The manuscript was published in the Diversity and Distributions journal in 2013 (http://onlinelibrary.wiley.com/doi/10.1111/ddi.12086/abstract), which has an Impact Factor of 6.122. It includes 8 authors from 5 different BioFresh partners (University of Barcelona, Leibniz- Institute of Freshwater Ecology and Inland Fisheries, University of Natural Resources and Life Sciences, Museum National d'Histoire Naturelle, Royal Belgian Institute of Natural Sciences).

Summary of the Manuscript

Species inhabiting fresh waters will be severely affected by climate change. Calls for effective management and conservation plans include improving the accuracy and reliability of species distribution forecasts. Here we aimed to build models of current *Salmo trutta* distributions and predictions for future scenarios using high-resolution presence-absence data and climatic and non-climatic environmental factors covering mediterranean (Ebro River Basin) and temperate-type streams (Danube and Elbe river basins) in Europe (Figure 1).

Data on climate and stream topography related with *Salmo trutta* ecological requirements for water temperature and flow regime along with land-use factors were built and assigned to stream reaches together with species occurrences. Consensus species distribution models and forecasts under the A1b scenario for 2020s, 2050s, and 2080s were built using four statistical techniques. We examined the influence of using data of distinct geographical extents in the performance and extrapolation ability of models.

The models obtained were excellent (area under the receiver operating curve >0.9) disregarding the geographical extent of data. However the models built with data from maximum geographical extent (i.e., all basins) provided species response curves more concordant with ecological requirements of species than the ones built with partial data. Climate variables had a predictive primacy above stream topography, while the incorporation of land-use did not significantly improve predictions. Extrapolations showed that the future distribution of *Salmo trutta* should be severely affected by climate change and increasingly restricted throughout time (Figure 2). In total, 64% of suitable stream reaches sampled will be unsuitable by 2080s, being the Elbe basin the most affected (95%), followed by Ebro (83%). Results showed that considering non-climatic environmental factors such as topography can improve the predictive ability of species distribution models in streams, and using a data of large extent where the species currently occurs (from mediterranean to temperate-type streams) avoid overestimations of future species distributional losses. This study provides advances to obtaining accurate forecasts for biota inhabiting streams.

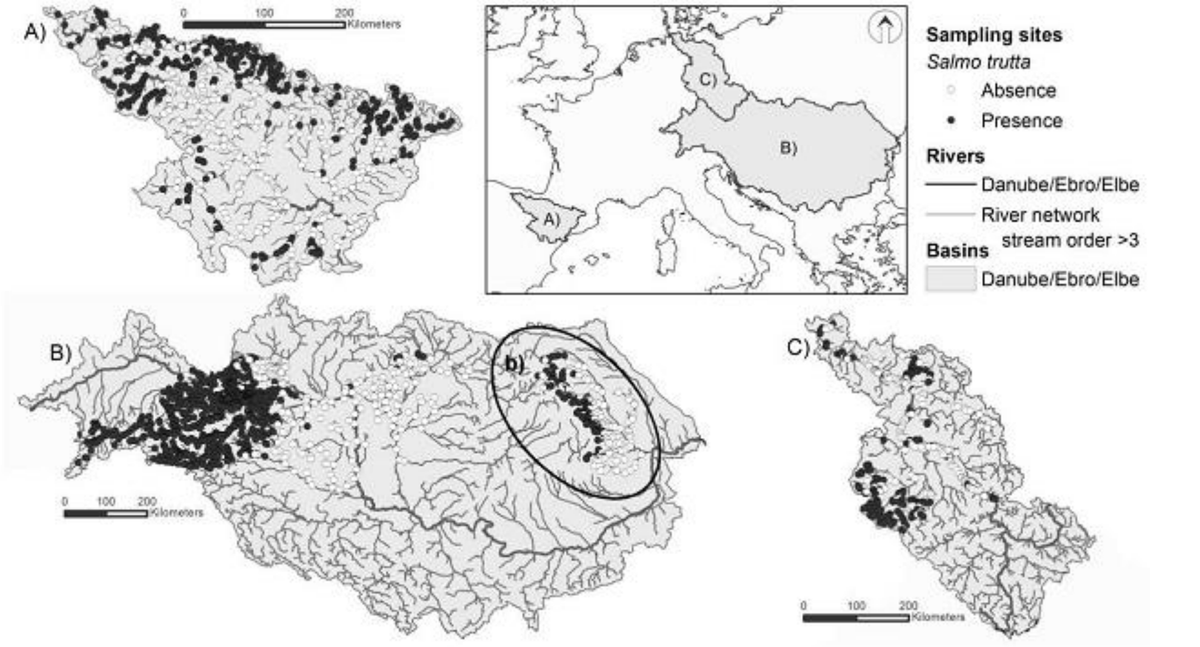

Fig. 1. Current distribution of *Salmo trutta* at sites sampled in the Ebro (A) and in the Danube and the Elbe (B) river basins.

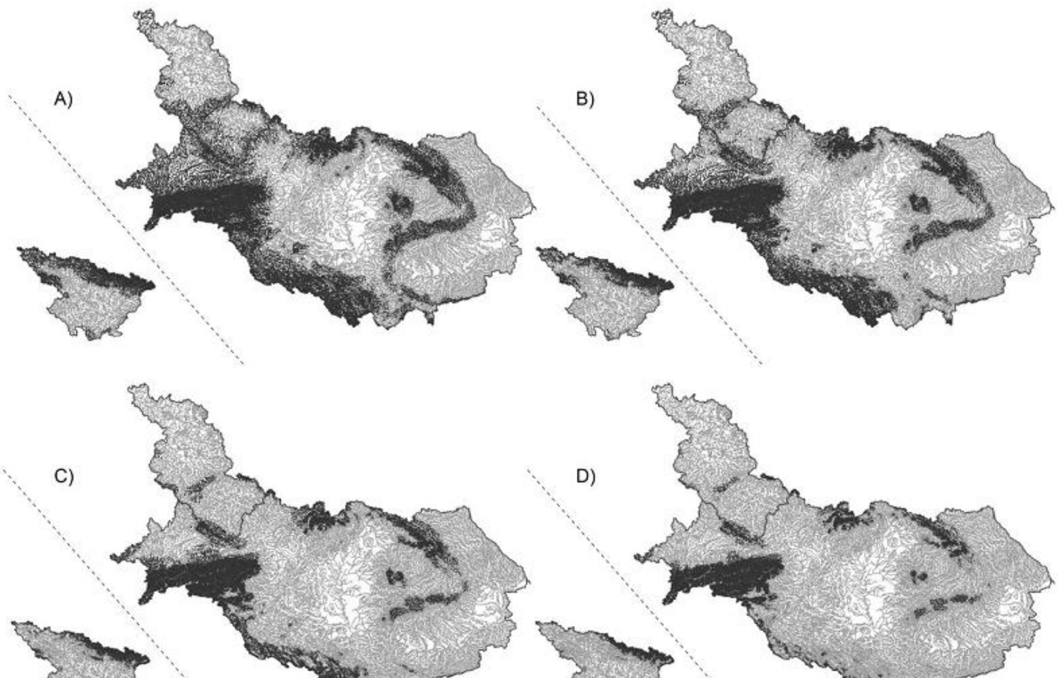

Fig. 2. Potential *Salmo trutta* presences (dark grey) and absences (light grey) across the river basins of the Ebro (left panels) and both the Elbe and the Danube (right panels). The predictions are shown for current environments (A) and future environments at distinct time frames: the 2020s (B), 2050s (C) and 2080s (D).

Diversity and Distributions, (Diversity Distrib.) (2013) **19**, 1059–1071

A Journal of Conservation Biogeography
Diversity and Distributions

BIODIVERSITY RESEARCH

Forecasting fish distribution along stream networks: brown trout (*Salmo trutta*) in Europe

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ABSTRACT

Aim Species inhabiting fresh waters are severely affected by climate change and other anthropogenic stressors. Effective management and conservation plans require advances in the accuracy and reliability of species distribution forecasts. Here, we forecast distribution shifts of *Salmo trutta* based on environmental predictors and examine the effect of using different statistical techniques and varying geographical extents on the performance and extrapolation of the models obtained.

Location Watercourses of Ebro, Elbe and Danube river basins (*c.* 1,041,000 km^2; Mediterranean and temperate climates, Europe).

Methods The occurrence of *S. trutta* and variables of climate, land cover and stream topography were assigned to stream reaches. Data obtained were used to build correlative species distribution models (SDMs) and forecasts for future decades (2020s, 2050s and 2080s) under the A1b emissions scenario, using four statistical techniques (generalised linear models, generalised additive models, random forest, and multivariate adaptive regression).

Results The SDMs showed an excellent performance. Climate was a better predictor than stream topography, while land cover characteristics were not necessary to improve performance. Forecasts predict the distribution of *S. trutta* to become increasingly restricted over time. The geographical extent of data had a weak impact on model performance and gain/loss values, but better species response curves were generated using data from all three basins collectively. By 2080, 64% of the stream reaches sampled will be unsuitable habitats for *S. trutta*, with Elbe basin being the most affected, and virtually no new habitats will be gained in any basin.

Main conclusions More reliable predictions are obtained when the geographical data used for modelling approximate the environmental range where the species is present. Future research incorporating both correlative and mechanistic approaches may increase robustness and accuracy of predictions.

Keywords
Climate change, distribution modelling, forecasts, land cover, stream fish, topography.

INTRODUCTION

In recent decades, climate change and other anthropogenic pressures have caused freshwater biodiversity to decline faster than terrestrial or marine biodiversity, and this trend is likely to continue in the future (Vörösmarty *et al.*, 2000; Alcamo *et al.*, 2003; Jenkins, 2003; Dudgeon *et al.*, 2006). Freshwater communities are particularly vulnerable to change, because fresh waters are already exposed to numerous anthropogenic stressors, are naturally fragmented in stream networks or

DOI: 10.1111/ddi.12086
http://wileyonlinelibrary.com/journal/ddi