

# CONSERVATION OF BIODIVERSITY IN FLOODPLAINS: IS MULTIFUNCTIONALITY THE SOLUTION?

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## Introduction.

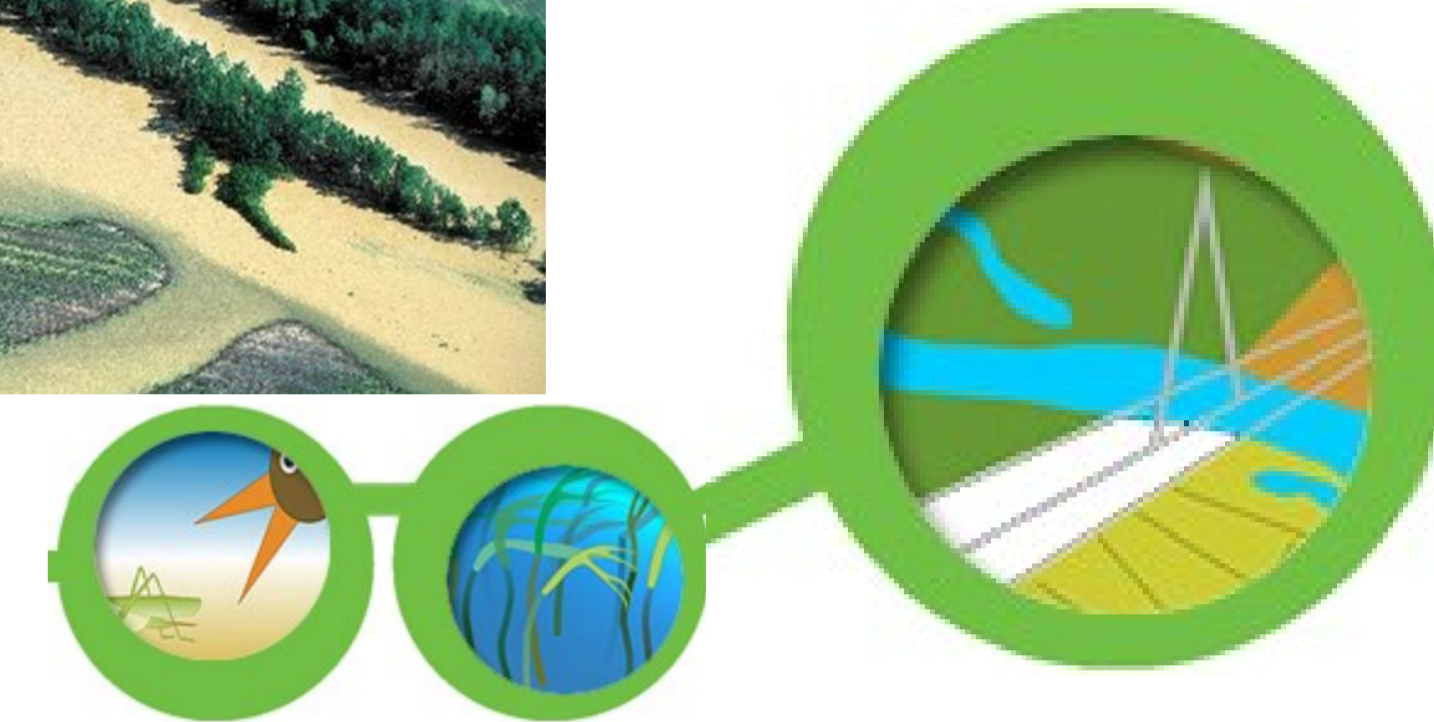
Green Infrastructure (GI) and multifunctional land-use are recently proposed as key concept to reconcile nature conservation with economical interests.

Floodplains are good examples for multifunctional landscapes and GI because their management requires close coordination among sectors and poses multi-dimensional challenges to policy-makers and project managers.

In the following study, we implemented a 'network of knowledge'-approach (Livoreil et al. 2012) in the frame of the EU FP7 Communication Action 'Biodiversity.Knowledge' to specify the effects of multifunctional floodplain management on biodiversity.



Biodiversity Knowledge



## Applied approaches. We conducted for European lowland floodplain and rivers:

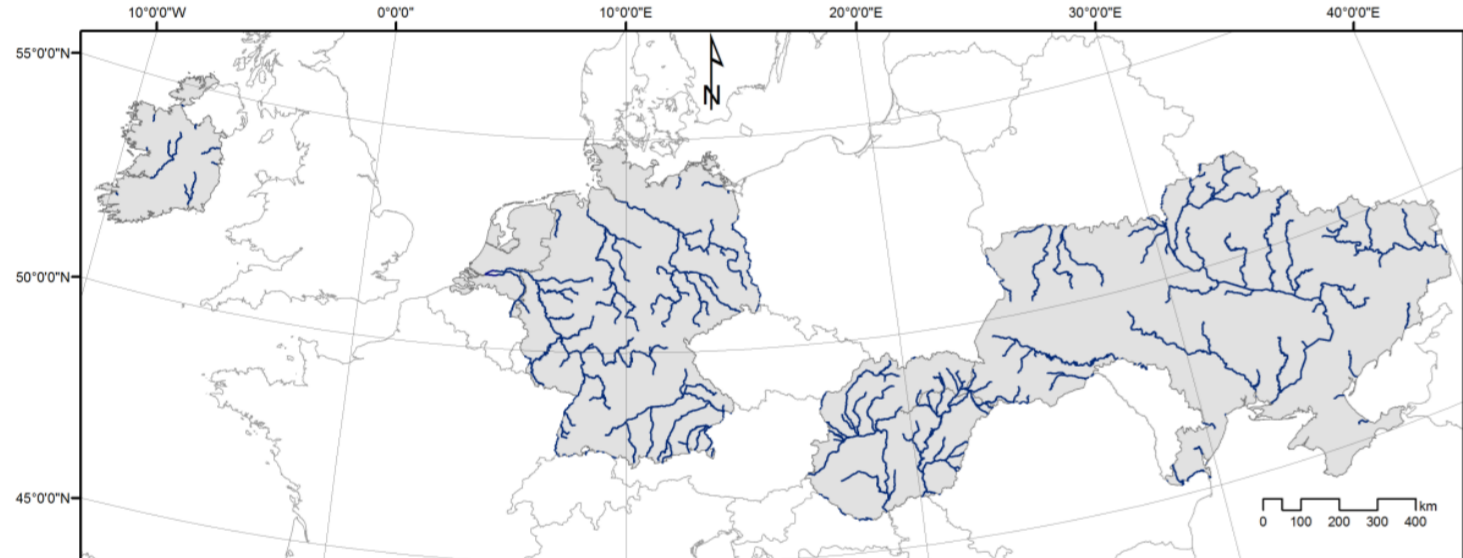
- (i) a country specific expert consultation covering IRE, NL, D, SLK, H and UKR to assess regulation history, multifunctional management projects and biodiversity effects (Schindler et al. 2013b, in prep.)
- (ii) An expert consultation that elaborated a matrix specifying the effects of 38 bundles of floodplain interventions to 21 ecosystem services (Schindler et al. 2013b, submitted)
- (iii) a systematic review protocol (Schindler et al. 2013a) and systematic map (Schindler et al. 2013b) dealing with the impact of floodplain management measures on biodiversity

## Results

- (i) Considered floodplains (fig. 1) and their management in 6 countries (Tab. 1);
- (ii) Matrix showing effects of interventions on ecosystem services (Tab. 2) and related spider web graphs (fig. 2);
- (iii) Systematically detected articles on biodiversity impact of floodplain management and considered taxa (fig. 3, 4).

**Table 2.** Expected effects of 38 floodplain interventions on the supply of 21 different ecosystem services. "0": no effect; "\": reducing effect; "+": supporting effect; "\\_": ambiguous effect.

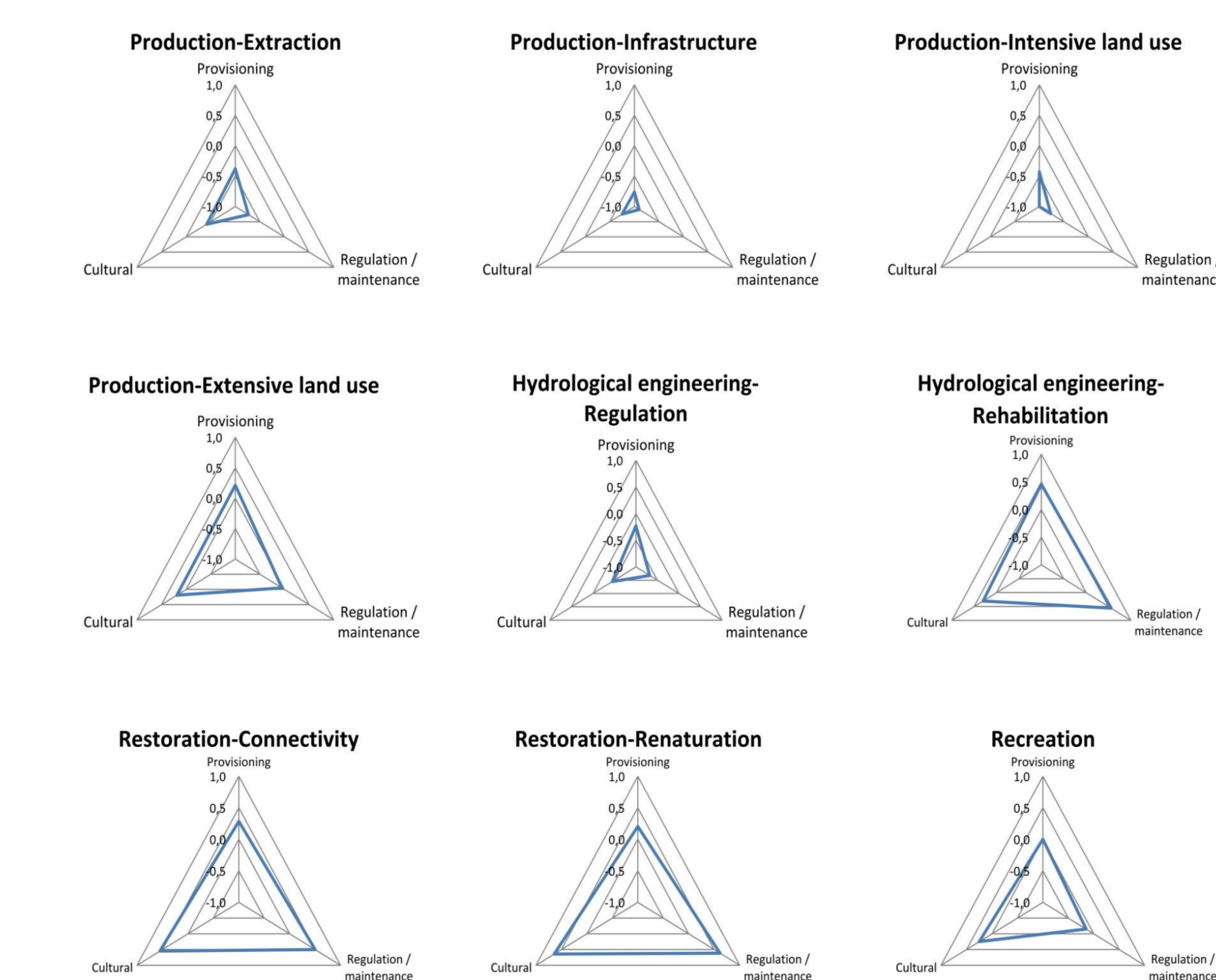
Intervention	Provisioning	Regulation / maintenance	Cultural	Provisioning	Regulation / maintenance	Cultural	Provisioning	Regulation / maintenance	Cultural
Surface water extraction	+	+	+	+	+	+	+	+	+
Groundwater extraction	+	+	+	+	+	+	+	+	+
Mineral resource extraction	+	+	+	+	+	+	+	+	+
Settlement and traffic infrastructure	+	+	+	+	+	+	+	+	+
Energy conversion	+	+	+	+	+	+	+	+	+
Navigational infrastructure	+	+	+	+	+	+	+	+	+
Forestry intensive	+	+	+	+	+	+	+	+	+
Agriculture intensive	+	+	+	+	+	+	+	+	+
Fishery intensive	+	+	+	+	+	+	+	+	+
Forestry extensive	+	+	+	+	+	+	+	+	+
Agriculture extensive	+	+	+	+	+	+	+	+	+
Fishery extensive	+	+	+	+	+	+	+	+	+
Hunting	+	+	+	+	+	+	+	+	+
Channel corrections	+	+	+	+	+	+	+	+	+
Dike construction	+	+	+	+	+	+	+	+	+
Bank/bed stabilization	+	+	+	+	+	+	+	+	+
Sediment removal/dredging	+	+	+	+	+	+	+	+	+
Detention basins	+	+	+	+	+	+	+	+	+
Controlled retention areas	+	+	+	+	+	+	+	+	+
Dike relocation	+	+	+	+	+	+	+	+	+
Ecologically improved groynes	+	+	+	+	+	+	+	+	+
Lowering floodplain/foreland	+	+	+	+	+	+	+	+	+
Sediment addition into river bed	+	+	+	+	+	+	+	+	+
Removing obstacles	+	+	+	+	+	+	+	+	+
Removal of bank fixations	+	+	+	+	+	+	+	+	+
Removal of dams and weirs	+	+	+	+	+	+	+	+	+
Lateral floodplain reconstruction	+	+	+	+	+	+	+	+	+
Channel, oxbow and pond creation	+	+	+	+	+	+	+	+	+
Construction of fish passages	+	+	+	+	+	+	+	+	+
Creating natural habitat from forest	+	+	+	+	+	+	+	+	+
Creating natural habitat from agro land	+	+	+	+	+	+	+	+	+
Creating nat. habitat from extraction sites	+	+	+	+	+	+	+	+	+
Control of invasive alien species	+	+	+	+	+	+	+	+	+
Creation of gravel banks	+	+	+	+	+	+	+	+	+
Elimination of top soil	+	+	+	+	+	+	+	+	+
Land use extensification	+	+	+	+	+	+	+	+	+
Recreational infrastructure	+	+	+	+	+	+	+	+	+
Recreational use of the floodplain	+	+	+	+	+	+	+	+	+



**Figure 1.** 6 countries and corresponding floodplains covered in the country specific expert assessment.

**Table 1.** Floodplains, floodplain management approaches, and evidence for biodiversity impact in the 6 investigated European countries.

Biophysical conditions	Main land uses in floodplain	Governance level responsible for floodplain management	Main strategic approaches / management aims	Multifunctional management approaches	Evidence for biodiversity impact
<ul style="list-style-type: none"> <li>IE Many small river systems and some large rivers with extensive floodplains</li> <li>NL "The Dutch live in a river delta"</li> <li>DE All kinds of rivers and floodplains from alpine to lowland, dominated by large river systems with formerly extensive floodplains</li> <li>SK Dense network of streams including mountain brooks, upland small rivers and mighty rivers in lowlands</li> <li>HU Meandering rivers in a flat landscape</li> <li>UA Most rivers are regulated and transformed into reservoir systems</li> </ul>	<ul style="list-style-type: none"> <li>IE Hydropower, agriculture, housing, tourism and leisure</li> <li>NL Mostly farmland, secondary functions are nature conservation, recreation</li> <li>DE Agriculture, forestry, settlements and industry</li> <li>SK Hydropower, settlements, agriculture nature protection, recreation</li> <li>HU Agriculture, forestry, nature conservation</li> <li>UA Hydropower, agriculture, settlements and industry, recreation</li> </ul>	<ul style="list-style-type: none"> <li>IE Combination of central (e.g. hydropower) and local/regional</li> <li>NL Centralized, decisions are taken at national and regional levels.</li> <li>DE Regional responsibilities but often depending on national framework</li> <li>SK Case dependent, mostly local, except for the big rivers</li> <li>HU Centralized, but involvement of regional and local stakeholders</li> <li>UA Central and regional, but not lower than the province level</li> </ul>	<ul style="list-style-type: none"> <li>IE Emphasis is currently on flood alleviation and drainage</li> <li>NL Flood protection is top priority</li> <li>DE Navigation along big rivers most important, flood protection also priority</li> <li>SK Decrease of water pollution, nature conservation, flood protection</li> <li>HU Flood protection is the top priority, forestry is the second</li> <li>UA Developed legislation of river conservation, but weak legal enforcement</li> </ul>	<ul style="list-style-type: none"> <li>IE Weir construction that allows both water flow control and passage of aquatic species; provision of habitat for species of conservation concern</li> <li>NL Management is multifunctional, with particular interest for flood protection</li> <li>DE Efforts to restrict and extensify agriculture, for restoring hydrological connectivity, for restoration and biodiversity conservation</li> <li>SK Creation of multimodal transport corridors respecting nature values</li> <li>HU Multifunctional projects for reintroduction of grazing, mitigation of invasive species and hydrological rehabilitation</li> <li>UA Drainages or irrigation are still primary aims</li> </ul>	<ul style="list-style-type: none"> <li>IE Particular projects had negative effects on Atlantic salmon, freshwater pearl mussel and conrcake due to habitat flooding and changes in land use</li> <li>NL Some projects show positive impacts regarding biodiversity, in particular due to increased natural dynamics and increased habitat diversity.</li> <li>DE Tendency towards positive impacts upon species as well as habitat</li> <li>SK Rich evidence of diverse effect mainly from Gubčovo and the Váh cascade</li> <li>HU Bird and fish diversity increased, plant diversity could be conserved</li> <li>UA Restoration of natural hydrological regimen resulted in biodiversity increase</li> </ul>



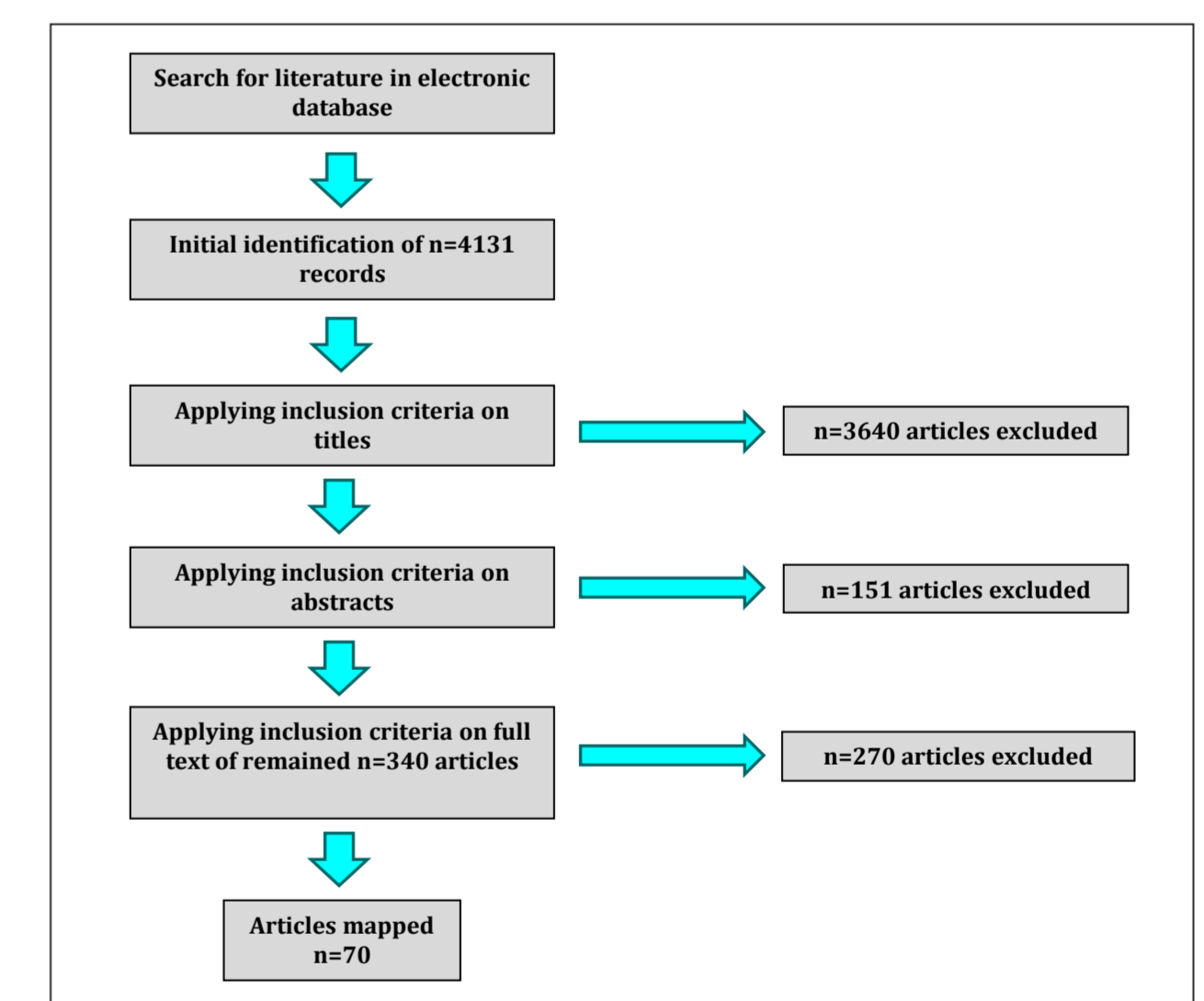
**Figure 2.** Impact of bundles of intervention on the supply of different ESS sections. Shown is the average net change of all interventions per bundle as multifunctionality index ranging between -1 (all ESS are negatively affected) and +1 (all ESS are positively affected).

## Systematic Review Protocol

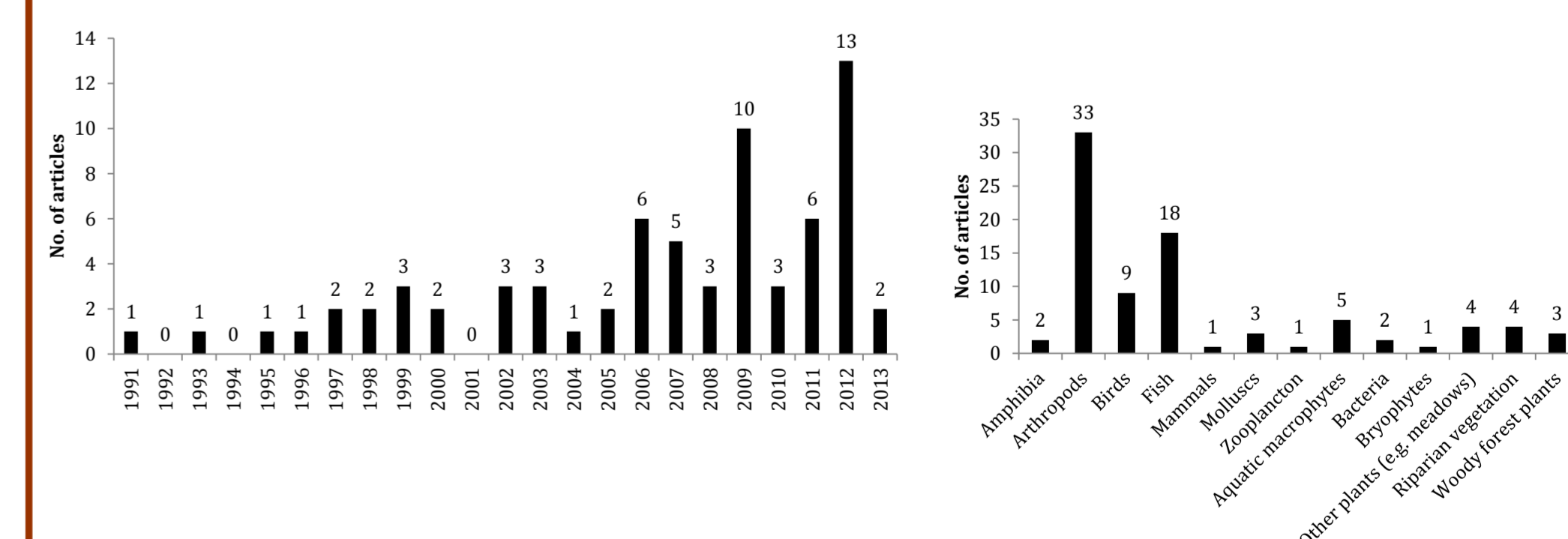
**Primary question:** What is the impact of floodplain management measures on biodiversity and how does the impact vary according to the level of multifunctionality of the measures?

- **Population:** floodplains and rivers.
- **Intervention:** floodplain management measures, commonly related to production and transport, water regulation and flood protection, conservation and restoration as well as recreation activities.
- **Outcome:** change in biodiversity indicators

## Systematic Map



**Figure 3.** Articles included and excluded at different stages of the review and mapping process.



**Figure 4.** Number of articles published each year and number of analyses per taxon encountered in the 70 papers.

## Conclusions and recommendations.

- (i) Multifunctional floodplain management has become an issue of growing attention in several European countries; however, it is still a complex and underresearched topic especially regarding its impact on biodiversity.
- (ii) Restoration and rehabilitation measures strongly improve the multifunctionality of the landscape and cause win-win situations for enhancing overall ecosystem supply from all three sections, i.e. provisioning, regulation/maintenance, and cultural services. Conventional regulation but also interventions related to extraction, infrastructure and intensive land use cause lose-lose situations.
- (iii) Evidence for biodiversity effects of floodplain management interventions is still scarce and scattered, focusing on few interventions, countries and taxa. Analytical research often fails to assess the large (spatial and temporal) scale effects on biodiversity.



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## References:

Livoreil B, Geijsendorffer I, Jongman R, Pullin A, Vandewalle M, Nešhöver C, Balian E (2012) Prototype NoK mechanism. Deliverable 2.1 of the EU-FP7 project KNEU. <http://www.biodiversityknowledge.eu/documents>

Schindler S, Kropik M, Euller K, Bunting SW, Schulz-Zunkel C, Hermann A, Hainz-Renetzedler C, Kanka R, Mauerhofer V, Gasso V, Krug A, Lauwaars SG, Zulka K-P, Henle K, Hoffmann M, Biró M, Essl F, Jaquier S, Balázs L, Borics G, Hudin S, Damm C, Pusch M, van der Sluis T, Sebesvari Z, Wrбка T (2013a) Floodplain management in temperate regions: is multifunctionality enhancing biodiversity? *Environmental Evidence* 2:10. <http://www.environmentalevidencejournal.org/content/2/1/10>

Schindler S, Livoreil B, Sousa Pinto I, Araújo R, Zulka K-P, Santamaría L, Euller K, Kropik M, Wrбка T (2013b) Final knowledge assessment reports of the 3 case studies and lessons learned. Deliverable 3.1 of the EU-FP7-project KNEU (in press).

Schindler et al. (submitted) Multifunctionality of floodplain landscapes: relating management options to ecosystem services. *Landscape Ecology*.

Schindler et al. (in prep.) Multifunctional floodplain management in temperate Europe and evidence for biodiversity effects: an expert consultation.