# *BIODIVERSITY FRIENDLY MANAGEMENT OF FISH PONDS*

How to manage ponds to produce fish and conserve biodiversity in fish pond systems?

biodiversa

Agence Nationale de la Recherche
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# HOW FISH POND MANAGEMENT INFLUENCES BIODIVERSITY?

## FISH PRODUCTION AND BIODIVERSITY CONSERVATION

Conservation and management of biodiversity is an important global issue today as more and more species are threatened or are disappearing in different types of agricultural landscapes.

Therefore, a major question is how agricultural commodities can be produced but not at the detriment of species and habitats, and which management options exist for this. We provide here management options for fish pond systems.

## INTRODUCTION

The management of biodiversity in aquatic ecosystems requires knowing the state of water quality to evaluate them in relation to species richness. High levels of nutrients in water bodies due to anthropogenic activities such as fish farming may cause significant eutrophication leading to loss in species diversity and a shift from high coverage of aquatic plants to phytoplankton dominance.

This shift can be represented by a tipping point where an important change in the state of the ecosystem is observed, e.g. a change from high to low aquatic plants species richness and cover. We examined such tipping points by studying the fish ponds in the Dombes and Forez regions, France. These waterbodies are characterized by a high diversity of species.

## STUDY AREAS AND RESEARCH METHODS

More than 100 fish ponds were studied during five years in the Dombes and Forez region, France, to determine important changes (tipping points) in aquatic plant richness and cover, and in richness of phytoplankton, dragonflies and macroinvertebrate along a chlorophyll α (CHL) gradient with two statistical methods. CHL reflects well nutrient status of ponds. In addition, fish farmers were interviewed about their fish production practices and pond management to evaluate impact on biodiversity in the system. Only results about aquatic plants in the Dombes region will be presented in this brochure, and only results over five years, but not for single years.

### Publications


Robin J., Wezel A., Bornette G., Oertli B., Arthaud F., Pobel D., Rosset V., Angélibert S., Vallod D. (2014). Biodiversity in eutrophicated shallow lakes: determination of tipping points and tools for monitoring. Hydrobiologia 723: 63-75.

Vanacker, M., Wezel, A., Payet, V., Robin, J. (2015). Determining tipping points in aquatic ecosystems: the case of biodiversity and chlorophyll α relations in fish pond systems. Ecological Indicators 52: 184–193.

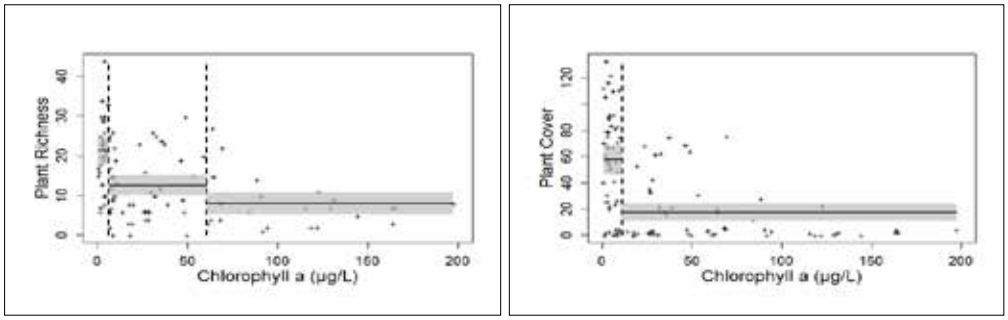
Wezel, A., Oertli, B., Rosset, B., Arthaud, F., Leroy, B. Smith, R., Angélibert, S., Bornette, G., Vallod, D., Robin, J. (2014). Biodiversity patterns of nutrient-rich fish ponds and implications for conservation. Limnology 15 (3): 213-223.


The research group Agroecology and Environment at ISARA-Lyon, France works since several years on fish pond systems, their best management, and more specifically about the question of biodiversity in these systems.

# MAIN RESULTS

## Important changes of species richness and cover at certain levels of chlorophyll a concentrations

Important changes (tipping points) for aquatic plant richness were observed at 6 µg/l and 60 µg/l of Chlorophyll a (CHL) (left figure). Below 6 µg/l, the average of aquatic plant richness was higher than to 20 species, decreased to 12 species when CHL was between 6 and 60 µg/L, and diminished to 9 species when CHL was above to 60 µg/l. In plant cover, only one tipping point was observed at 11 µg/l (right figure) with a mean plant cover near to 60 % for a concentration of CHL inferior to 11 µg/L, and which decreased to 20 % for a concentration of CHL superior to 11 µg/l. With the second statistical method, quite similar tipping points were found: plant richness at 12 µg/l of CHL, plant cover at 15 µg/l of CHL. Tipping points were observed in all parameters of water quality. However, tipping points can vary between years, sometimes strongly influenced by weather conditions.




Tipping points for plant richness and cover along a chlorophyll a concentration

## Management practices for fish production and biodiversity conservation

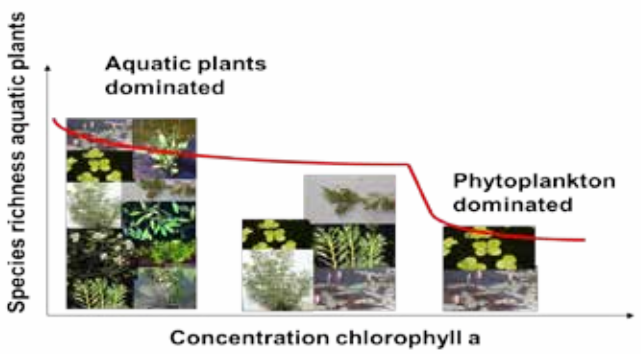
Different practices in pond management can support aquatic plant species conservation. The objective is to get a good equilibrium between aquatic plants and phytoplankton in cover and diversity to allow good fish production and conserve species at the same time. Too much phytoplankton reduces aquatic plant species richness and cover significantly.

The different management options are:

- Prolonged "dry period" after fish harvest of 2-5 weeks: better mineralisation of organic matter in sediments and decrease of high nutrient concentrations in water afterwards.
- Integration of a dry year after 3-5 years of fish production: increase of species due to perturbation.
- Liming: better mineralisation of organic matter in sediments.
- Development of structural heterogeneity of fish ponds: creating different shoreline habitats, winding shoreline, and shallow zones <0.5 m.
- Corrective fertilisation: unbalanced state of the pond is often due to extreme N:P ratio with a shortage of phosphate (sometimes) or nitrate (often). Small inputs of nitrate can balance this ratio.

Fish pond with too much phytoplankton

Fish pond with good aquatic vegetation cover



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## *Conclusions*

- Tipping points with important changes in aquatic plant species richness and cover were observed in different water quality parameters.
- A good equilibrium between aquatic plants and phytoplankton in cover and diversity permits good fish production and species conservation at the same time. Phytoplankton density should be not too high to allow the development of aquatic vegetation.
- Management practices such as prolonged dry periods after fish harvest, dry years after 3-5 years of fish production, liming, corrective fertilisation and development of heterogeneous ponds allow production of fish and persistence of a high number of aquatic plant species.

## ACKNOWLEDGMENTS

*This research was funded by the ERA-Net BiodivERsA, with the national funder Agence National de la Recherche (ANR), France, part of the 2012 BiodivERsA call for research proposals.*
*We acknowledge also the support of Région Rhone-Alpes, Conseil Général de l'Ain, and Conseil Général de la Loire.*



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