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# Integrated Multitrophic Aquaculture: Ecological intensification of freshwater ponds

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**IMTA  
EFFECT**

Integrated Multi Trophic  
Aquaculture for Efficiency and  
Environmental Conservation

Cooperation in  
Fisheries,  
Aquaculture and  
Seafood Processing

# Context

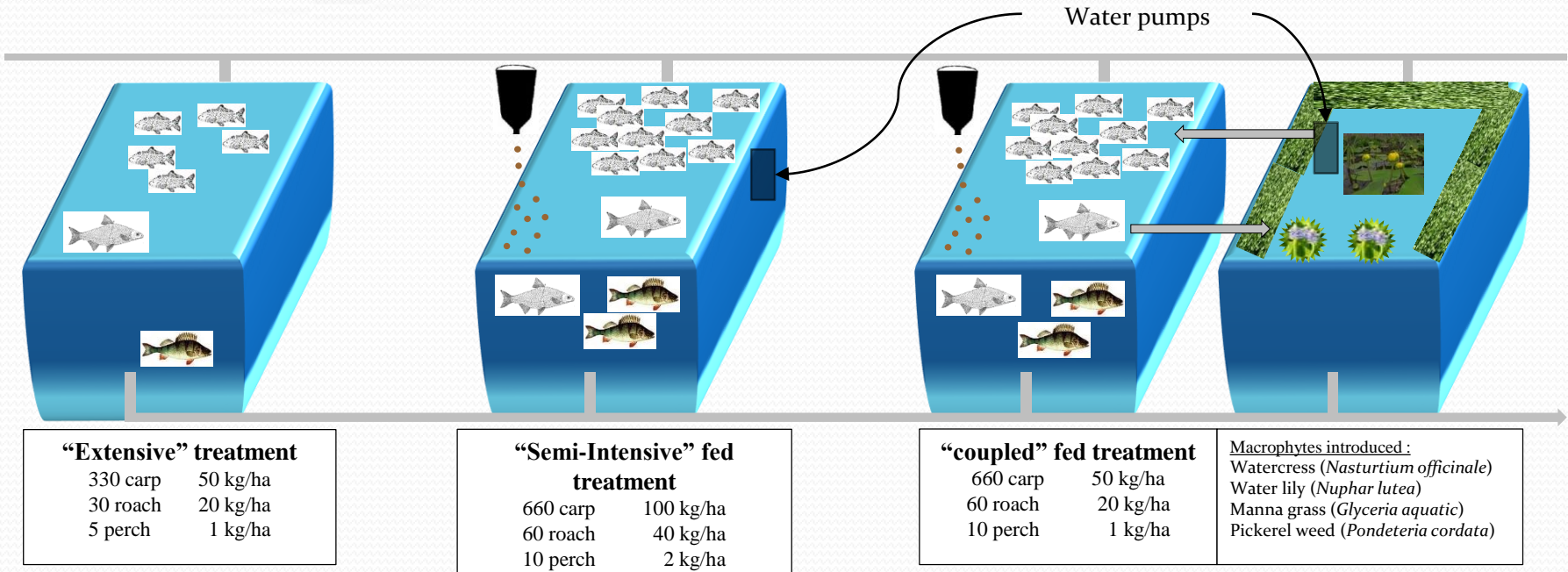
**Multi goals for aquaculture :**

- **Aquaculture products more and more required**
- **To Produce in systems environmentally friendly**
- **Sustainable systems and less dependent in exogenous resources**

**How answer to fish production increase and limit impacts on environment at the same time?**

**That's the work scope of the IMTA effect project and of this work**

# Experimental design



## Polyculture :

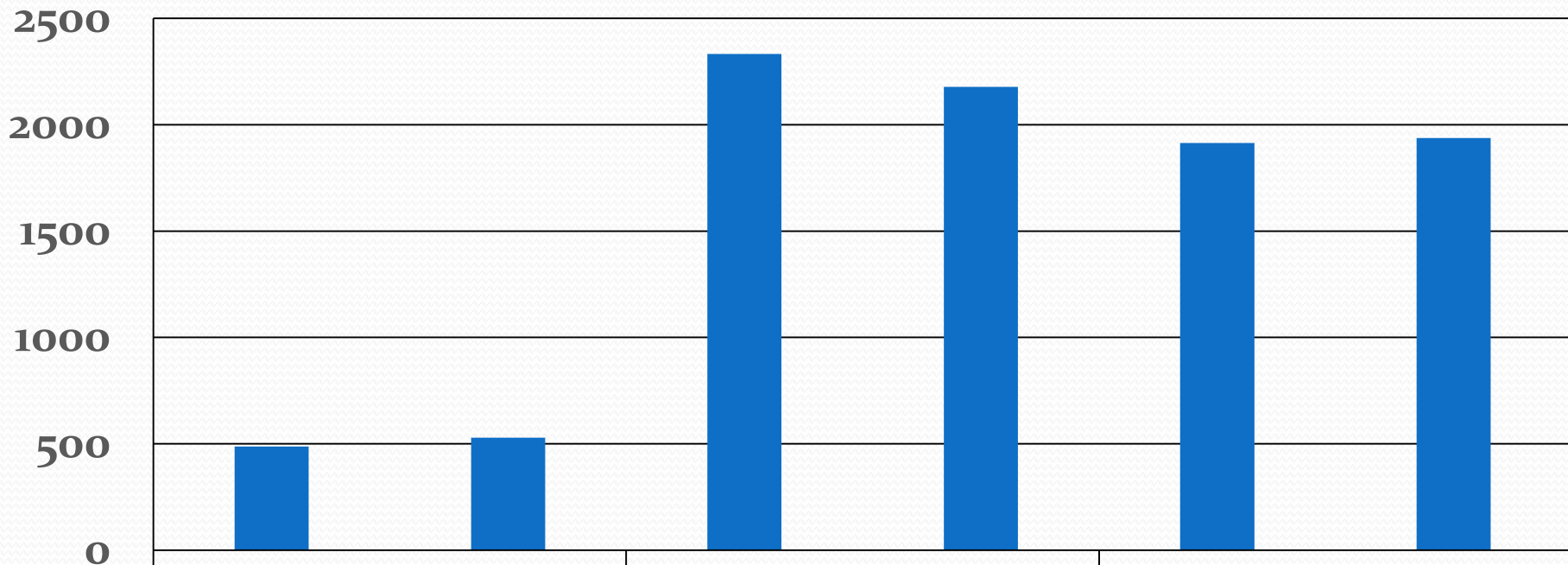
- Fingerlings of common Carp, target species, wide diet, burrowing behavior and ability to keep nutrients available for phytoplankton and macrophyte
- Adults of Roach, wide diet, use entire water column
- Only male of Perch, carnivorous diet, to limit fry, crayfish and tadepole

# Experimental design

- Experimentation lasted from March to December
- Ponds were filled with water from the nearby watershed river, 3 weeks before the beginning and during the experiment to counteract evaporation
- At stocking and harvesting fish were weighed and counted
- Quantity of pellets was daily recorded and supplied on the basis of 2.8% live weight
- Water quality :
  - Weekly, recorded for  $t^{\circ}$ , pH,  $[O_2]$ ,  $\%O_2$ , water transparency, conductivity,
  - Monthly, analyzed for Nitrogen and Phosphorus compounds,
- Chlorophyll : fluorometer analyzer (Phyto-PAM<sup>®</sup>),
- Nutrient budget for N and P

# Fish weight gain in fishponds

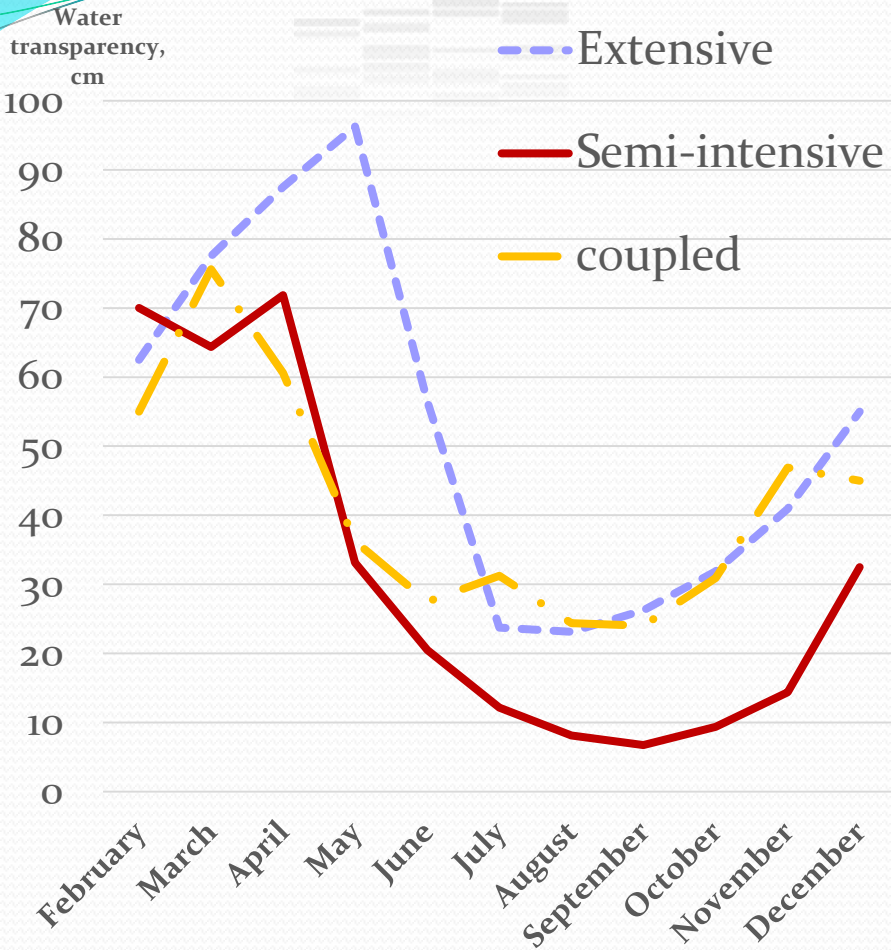
Yield  
(kg.ha<sup>-1</sup>)



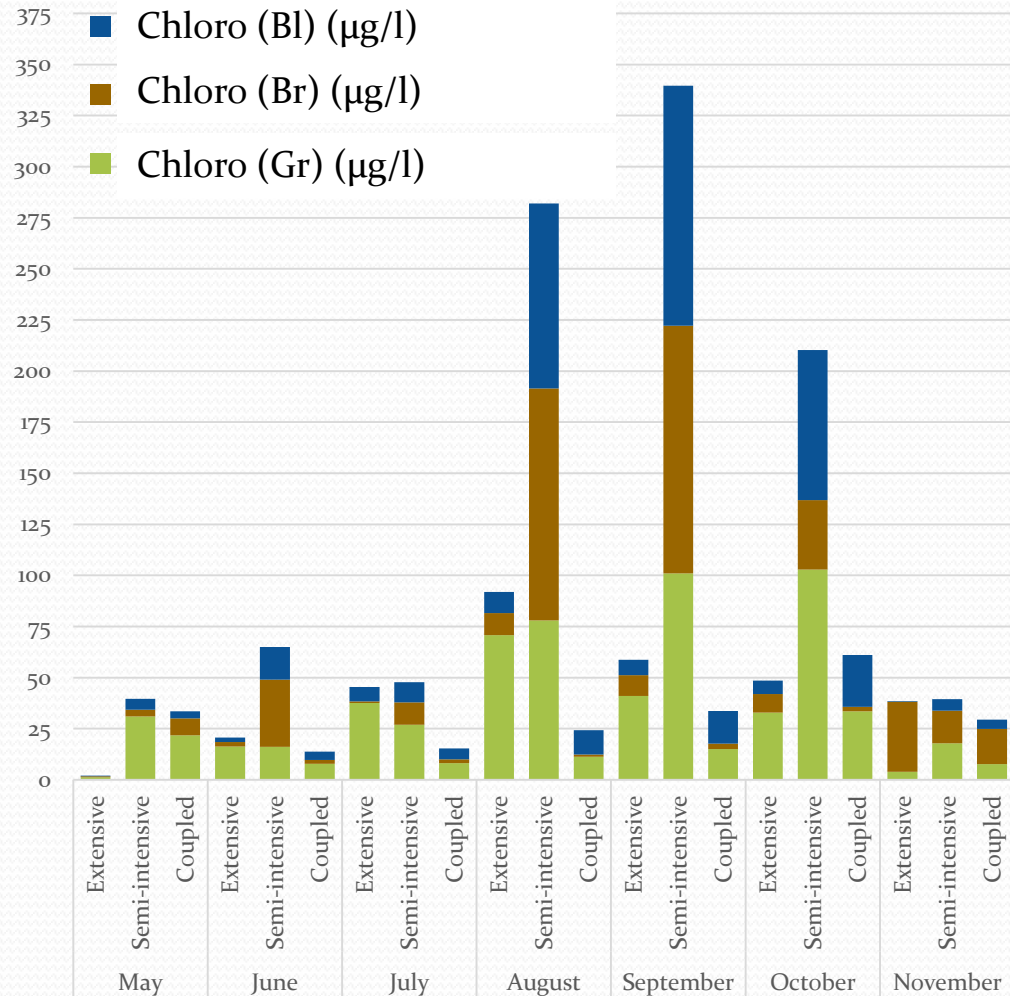
• Survival rate : survival rate similar between treatments, within each fish species

• Feed Conversion Ratio value 16% lower for semi-intensive Coupled treatment than for coupled treatment

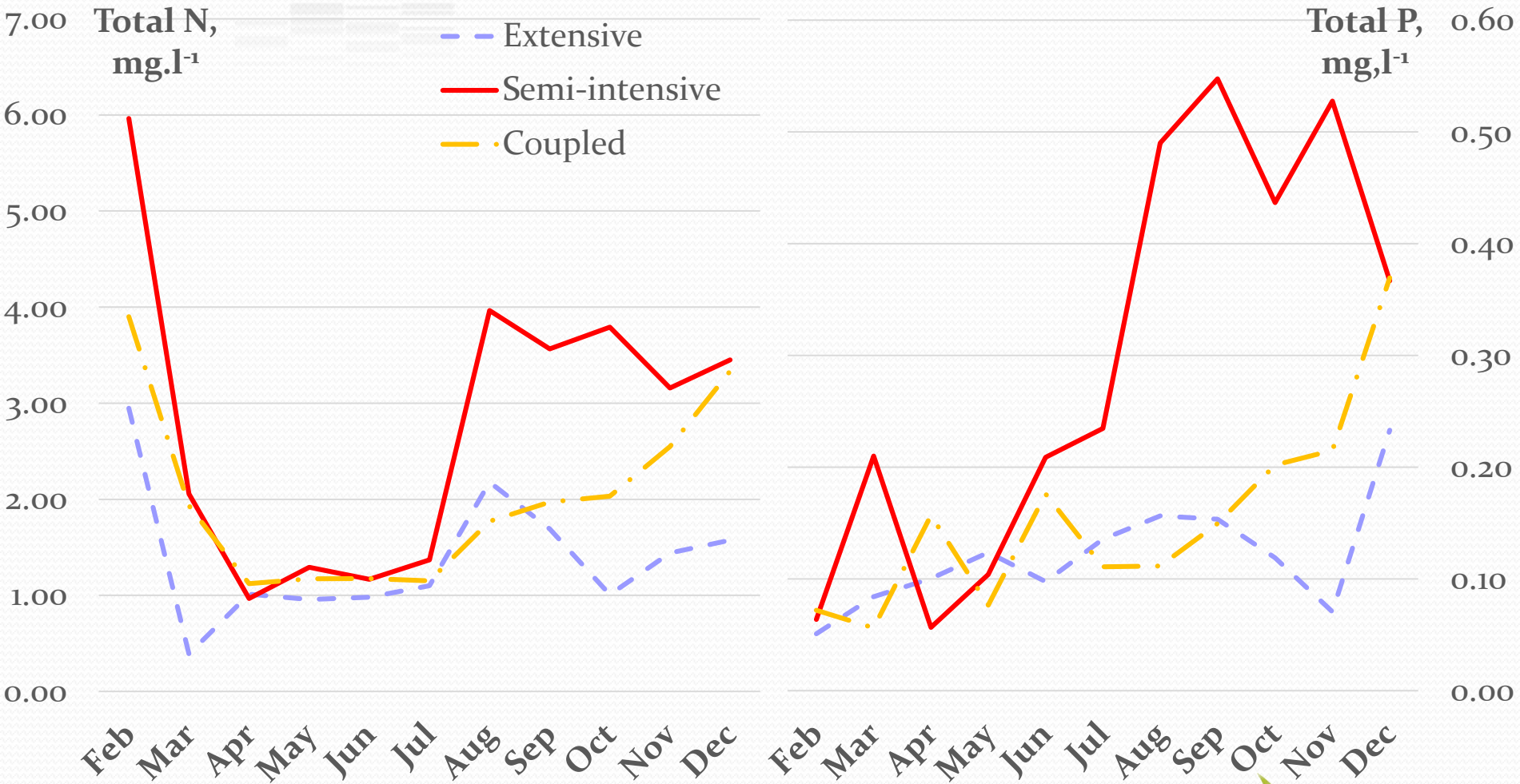
# Water transparency



# Chlorophyll concentrations



# Evolution of N and P in water





## Mass balance for N

	Extensive 1	Extensive 2	Semi-intensive 1	Semi-intensive 2	Coupled 1 fish	Coupled 1 plants	Coupled 2 fish	Coupled 2 plants
<b>N Inputs, g</b>								
fish	108	82	164	165	161	0	160	0
feed	0	0	608	608	608	0	608	0
water	2104	2497	2527	2426	1155	1781	1930	2480
<b>N Outputs, g</b>								
fish	642	648	2628	2451	2173	8	2168	53
Proportion of N input recovered in fish biomass gain	25%	23%	79%	75%	57%		41%	
Water	490	605	1118	1034	1369	1192	544	798
<b>Unaccounted for</b>	1079	1325	-448	-287	-1036	1615		

- No treatment well balanced
- But, in every treatments, N quantity in outlet water < inlet water,
- N input (from feed and water) was used more efficiently for fish biomass production in semi-intensive treatment

⇒ Feed seemed improving trophic web production but in a less extent in coupled treatment



# Mass balance for P

	Extensive 1	Extensive 2	Semi- intensive 1	Semi- intensive 2	Coupled 1 fish	Coupled 1 plants	Coupled 2 fish	Coupled 2 plants
<b>P inputs, g</b>								
fish	27	19	38	39	38	0	38	0
feed	0	0	151	151	151	0	151	0
water	50	68	30	33	31	84	28	92
<b>P outputs, g</b>								
fish	147	145	578	535	477	2	477	14
Proportion of P input recovered in fish biomass gain	241%	184%	297%	270%	166%		167%	
water	66	98	135	91	136	137	24	119
<b>Unaccounted for</b>	-137	-155	-493	-403	-447		-325	

- P outputs > P inputs in every treatments
- P quantity in outlet water > inlet water, in every treatments ⇒ role of senescence of plants?
- Proportion of P input recovered in fish biomass gain >100% ⇒ a large part of phosphorus came from environment ... sediments

## Conclusion

- Feed clearly improved fish production
  - In coupled treatment:
    - Phytoplankton development was limited to the benefit of Macrophytes
    - As a possible consequence, fish growth was limited too
    - Water concentration in N and P was buffered during the period observed
- ⇒ coupled treatment improved fish production compared to extensive treatment and improved water quality compared to semi-intensive treatment

## Perspectives

- **Further investigations need to be carried out to :**
  - **well balance nutrient budget: sediments dynamic, macrophytes yield, gas emission**
  - **Evaluate potential of coupled ponds to support biodiversity and to produce plants of market value**



# Thank you