

OPTIMISATION OF STOCKING DENSITY AND FEED FORMULATION IN SEMI-INTENSIVE PRODUCTION SYSTEMS: HOW IT CAN MINIMISE THE ENVIRONMENTAL IMPACTS OF EARTH POND AQUACULTURE

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INTRODUCTION

The environmental risks associated to intensive aquaculture together with the increasing demand of consumers on food safety and on cultivated species welfare, have brought semi-intensive aquaculture products back into the front scene. Nevertheless, the economic viability of semi-intensive production systems is often compromised by its low productivity and the increased competitiveness for space allocation and market competition. One way to ensure the competitiveness of this type of aquaculture is by optimising production systems, while maintaining sound environmental conditions in the adjacent water bodies. With this purpose, and within the scope of the SEACASE Project, a case study was designed to test different improved production protocols in polyculture ponds of gilthead seabream (*Sparus aurata*) and sole (*Solea senegalensis*). Some of the goals of this study were to: i) evaluate the effects of different stocking densities and feed formulations (a commercial feed and an ecofeed with low-phosphorus content) on effluent water quality and to ii) define acceptable ranges for water quality parameters in order to prepare an Environmental-Friendly-Allowing-Maximum-Production Protocol.

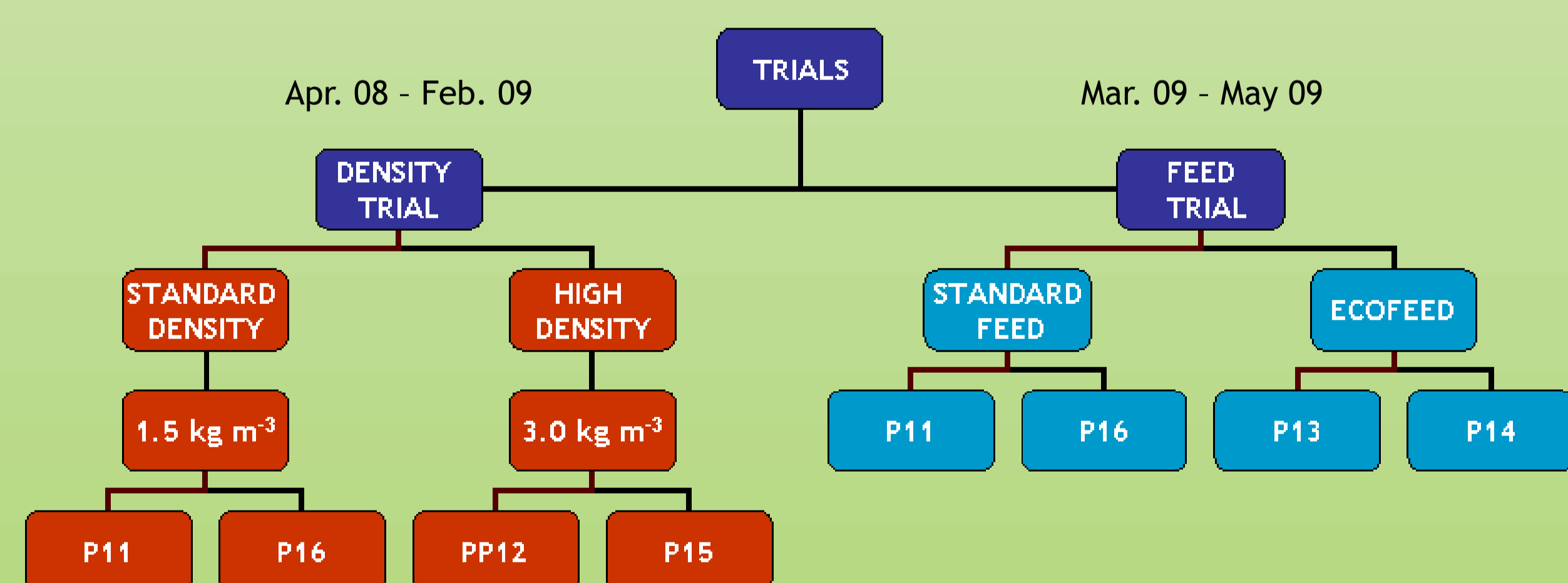
METHODOLOGY

Study site



Figure 1. IPIMAR Aquaculture Research Station.

Experimental design



Field and laboratory work

The impact of farming protocols on effluent water quality was evaluated by determining several physical, chemical and biological parameters in water samples collected at regular intervals, with special incidence in warmer periods.



RESULTS and DISCUSSION

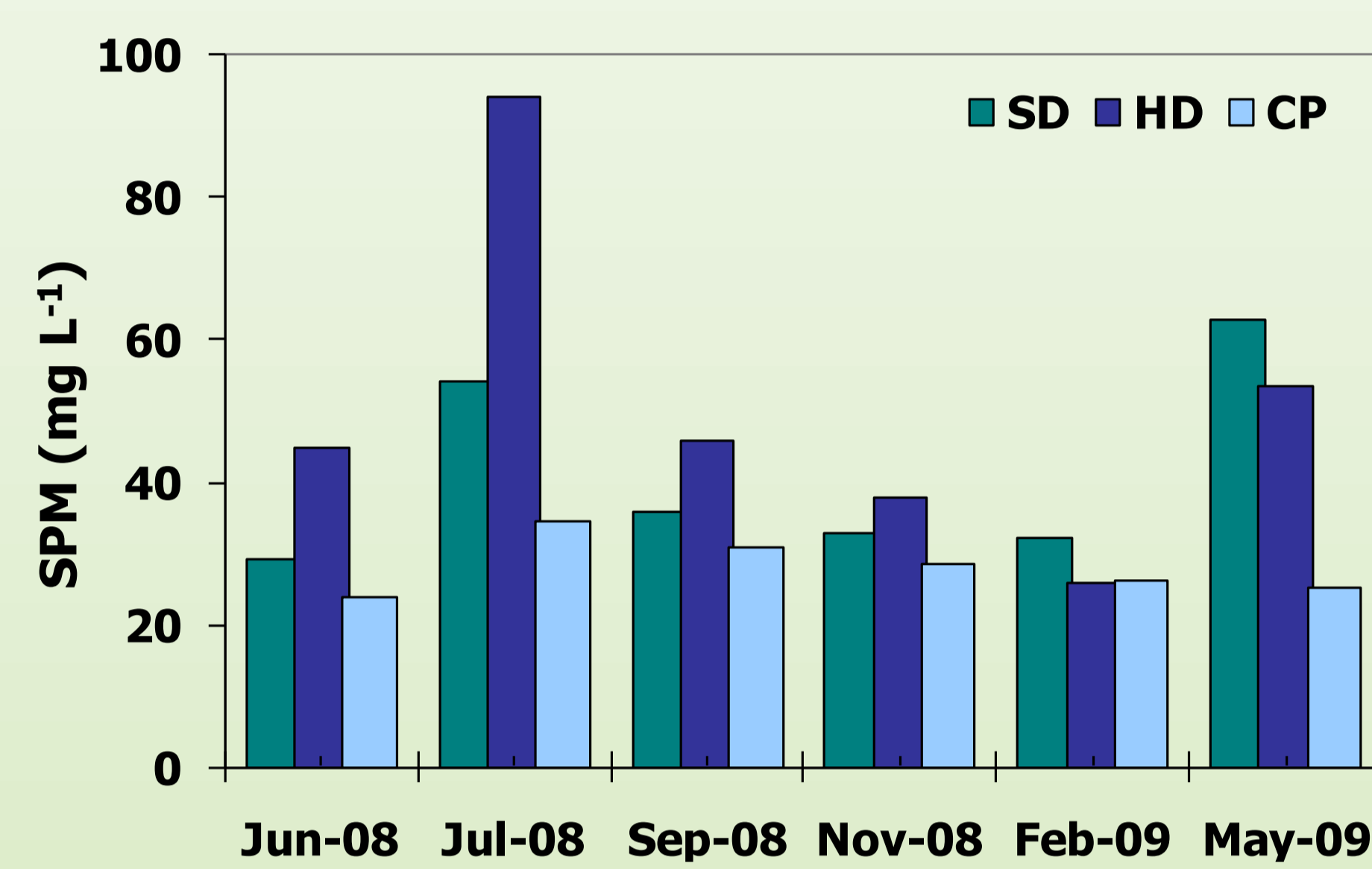


Figure 2. Suspended particulate matter (SPM) in the effluent waters of standard (SD) and high (HD) density ponds, and in the control pond (CP), without fish.

SPM values were higher in the effluent waters of high density ponds, probably as a result of fish activity (faeces, uneaten feed and sediment bioturbation).

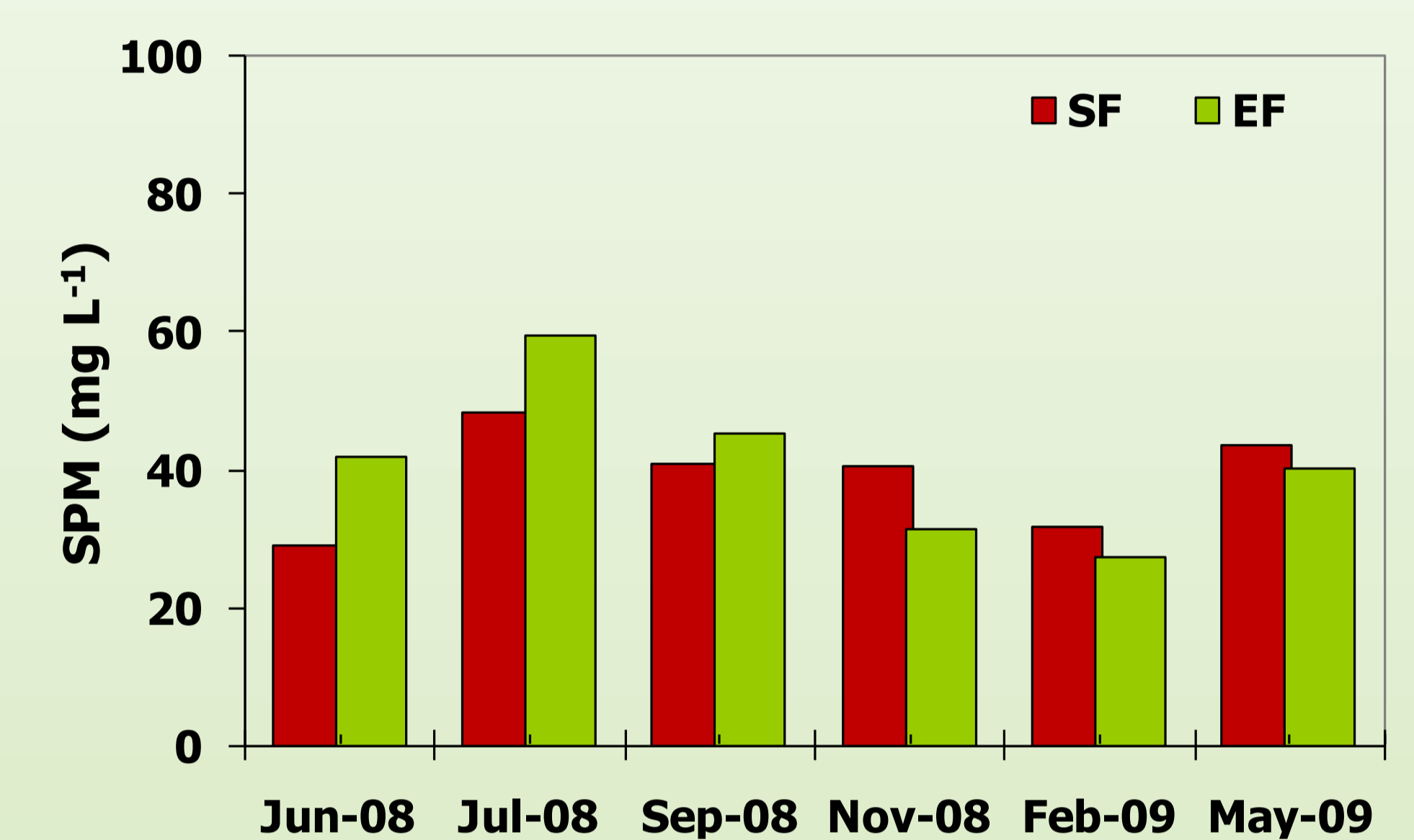


Figure 3. Suspended particulate matter (SPM) in the effluent waters of the ponds supplied with standard (SF) and ecofeed (EF).

In the feed trial, no significant differences ($p < 0.05$) were found for SPM in ponds with standard and ecofeed most likely due to the similar fish biomass in these ponds.

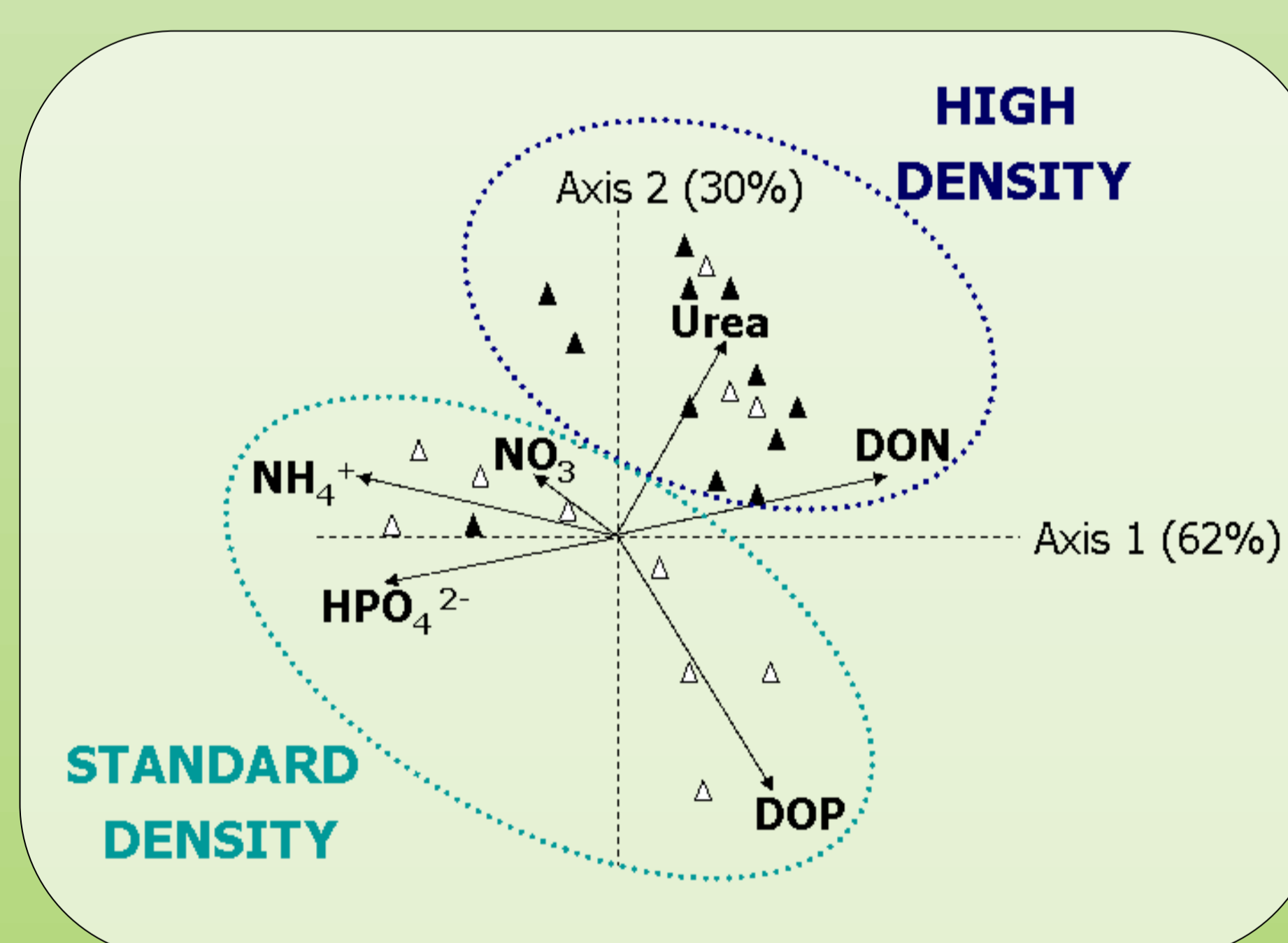


Figure 4. Correspondence analysis (CA) ordination plot for the chemical parameters of effluent waters from standard (Δ) and high (\blacktriangle) density ponds.

Inorganic compounds (NH_4^+ , NO_3^- and HPO_4^{2-}) were highly correlated to standard density ponds, whereas organic nitrogen compounds presented strong affinity with the high density ponds, probably as a result of fish excretion.

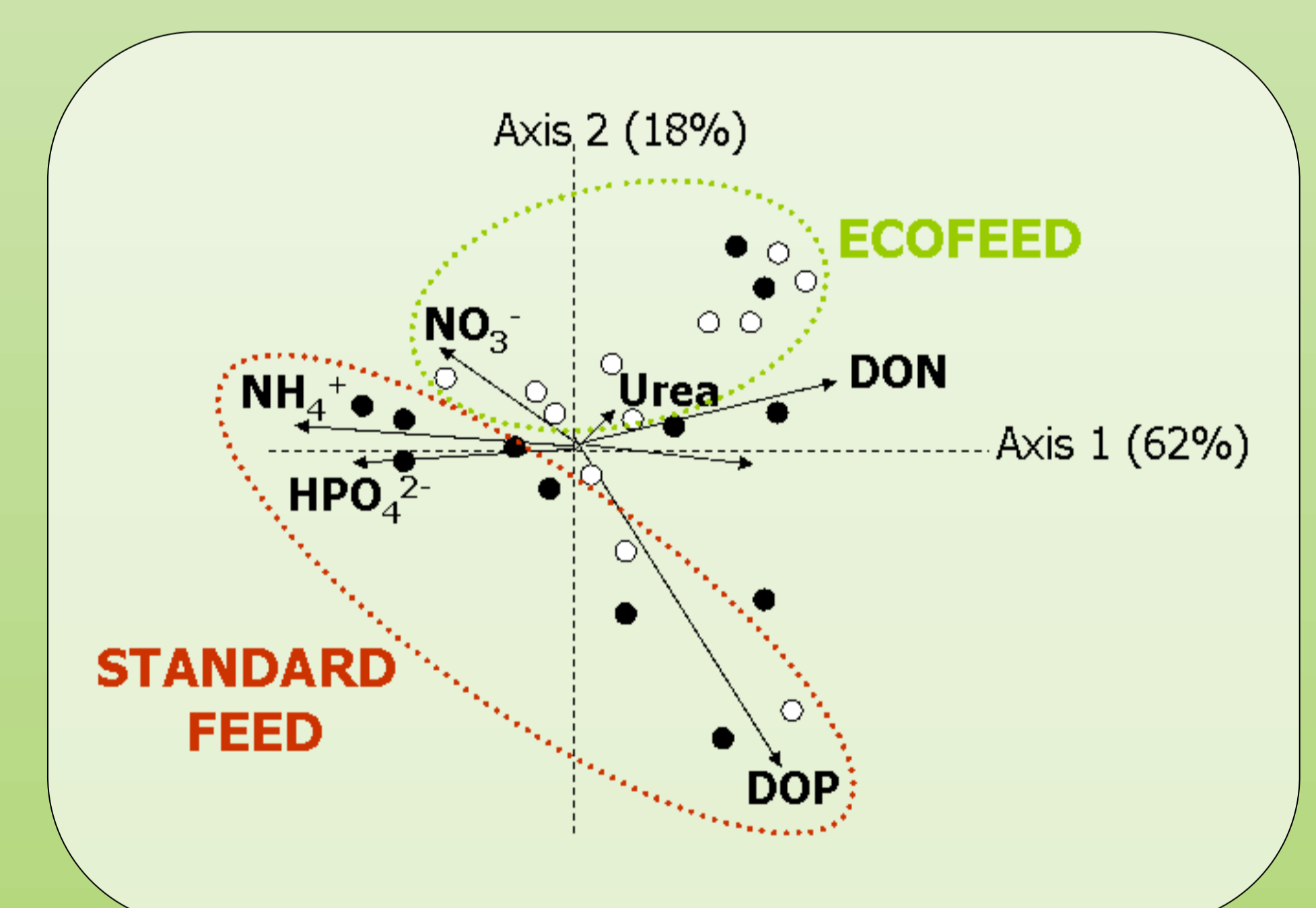


Figure 5. Correspondence analysis (CA) ordination plot for the chemical parameters of effluent waters from ponds supplied with standard (\bullet) and ecofeed (\circ).

Phosphorus compounds (HPO_4^{2-} and DOP) were lower in the effluent of ecofeed ponds, most likely due to the lower content of soluble phosphorus in this feed.

CONCLUSIONS

- Higher fish densities (3 kg m^{-3}) tended to increase the amount of suspended particulate matter and organic nitrogen compounds in the effluent waters of fish production ponds.
- The use of ecofeeds may reduce the amount of organic phosphorus released into the environment, minimising the impact of semi-intensive aquaculture.
- The water parameters determined in the effluents of experimental ponds were within the normal ranges found in the Ria Formosa lagoon, suggesting that the farming protocols were environmentally sustainable.

Table 1. Ranges for water parameters in the effluents of experimental ponds and in the Ria Formosa lagoon.

| WATER PARAMETER | POND EFFLUENT (mg L ⁻¹) | RIA FORMOSA (mg L ⁻¹) |
|---------------------|-------------------------------------|-----------------------------------|
| NH_4^+ | 0.001 – 0.66 | 0.03 – 0.37 |
| NO_3^- | 0.001 – 0.05 | 0.002 – 0.04 |
| DON | 0.03 – 0.42 | 0.2 – 1 |
| HPO_4^{2-} | 0.001 – 0.07 | 0.003 – 0.05 |
| SPM | 26 – 94 | 27 – 55 |

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