The integrated multitrophic aquaculture of Veta la Palma (Doñana Natural Park, SW Spain): a successful coupling of ecological and socio-economic values.

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Veta la Palma is a 11300 ha private estate owned by “Pesquerías Isla Mayor, S.A.”, adjacent to the Doñana National Park. 3200 ha are available for fish farming although only half of this area is in production at once because of the farming cycle strategy. This farm is an example of multitrophic aquaculture.

It comprises about 40 extensive polyculture pans, 70 ha each, with a controlled flooding regime and shallow depth (0.5 m). In 2009-2010, mullet and shrimp yielded ~116 and 82 t/yr, respectively.

Additionally, these pans depurate the water from adjacent smaller semi-intensive ponds used for sea bass grow-out, and provide them with natural food. Sea bass production (~605 t/yr) is supported by a combination of naturally occurring food, and specifically formulated fish-feed.

**Farming cycle:** pans and ponds are dried & dredged every 3-4 year.

**CONCLUSIONS**

- Veta la Palma is a successful example of sustainable local economy which directly supports ~100 local jobs. It achieved 4.6 % of total sea bass production in Spain in 2010, marketed at premium prices due to high nutritional quality fish.
- Ecological added value: Water recirculation and farm active management increased water quality, and exported high quality microalgae to an heterotrophic estuary.
- Integrated multitrophic aquaculture provides a sustainable future for this restored marshland as it contributes to both the conservation of the environment and the development of a local economy.
- High quality and environmentally friendly seafood should be encouraged through consumer choice to support sustainable aquaculture across Spain and the rest of Europe.

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Some published results from 2009-2010 survey*: 

- Phytoplankton blooms (>10³ cell/ml): alternation of Haptophyta vs. Chlorophyta.
- Biomass of phytoplankton was 10 times the biomass of phytoplankton.
- Extensive beds of submerged macrophyte (*Ruppia maritima*) up to 700 g d.w./m²
- Primary producers strongly regulated by low phosphate concentration (<2 μM).
- Extensive pans retained 91% of the incoming DIN from the semi-intensive ponds.
- Lower turbidity and total suspended matter at farm outlet than inlet.
- Extensive polyculture pans exported chlorophyll a and high quality microalgae that recirculates through the semi-intensive units across the farm.

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Farmed species in extensive and semi-intensive units (all natives):

<table>
<thead>
<tr>
<th>%</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>75%</td>
<td>Sea bass (<em>Dicentrarchus labrax</em>)</td>
</tr>
<tr>
<td>14%</td>
<td>Mullet (<em>Mugil cephalus, Liza ramada</em>)</td>
</tr>
<tr>
<td>10%</td>
<td>Shrimp (<em>Penaeus monodon</em>, <em>Penaeus vannamei</em>)</td>
</tr>
<tr>
<td>&lt;1%</td>
<td>Sea bream (<em>Sparus aurata</em>)</td>
</tr>
<tr>
<td>&lt;1%</td>
<td>Sole (<em>Solea senegalensis</em>)</td>
</tr>
<tr>
<td>&lt;1%</td>
<td>Eel (<em>Anguilla anguilla</em>)</td>
</tr>
<tr>
<td>&lt;1%</td>
<td>Meagre (<em>Argyrosomus regius</em>)</td>
</tr>
</tbody>
</table>

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Veta la Palma is part of the Doñana Reserve of the Biosphere and is included within the Natura 2000 Network. It is an Important Bird Area, providing food and shelter for large populations (~60% of produced biomass is lost to birds).

Monthly total bird population in Veta la Palma can surpass 10⁶ individuals, with a total richness of more than 250 species.

A marine protected area has also been declared in the Guadalquivir estuary to protect sensitive fish spawning and nursery grounds.

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*Fuentes et al. (2010) Food Chemistry 119:1514-1518