



# The Costa Brava approach to the Dutch concept of Waterharmonica

Lluís Sala · Consorci Costa Brava (Girona, Spain) · [lsala@ccbgi.org](mailto:lsala@ccbgi.org)  
Ruud Kampf · Waternet (Amsterdam, NL) · [ruud.kampf@waternet.nl](mailto:ruud.kampf@waternet.nl)

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# What is Waterharmonica? (I)

- Conceptual idea developed by Kampf & Claassen in order to use constructed wetland systems for polishing treated wastewater and provide a simultaneous nature enhancement
- Double goal:
  - Water treatment / effluent polishing – EU WFD compliance
  - Ecosystem recreation and restoration / biodiversity enhancement
- Website - <http://www.waterharmonica.nl>
- Reference paper – R. Kampf & T. H. L. Claassen (2005) “*The Use of Treated Wastewater for Nature: The Waterharmonica, a Sustainable Solution as an Alternative for Separate Drainage and Treatment*” - Water Intelligence Online



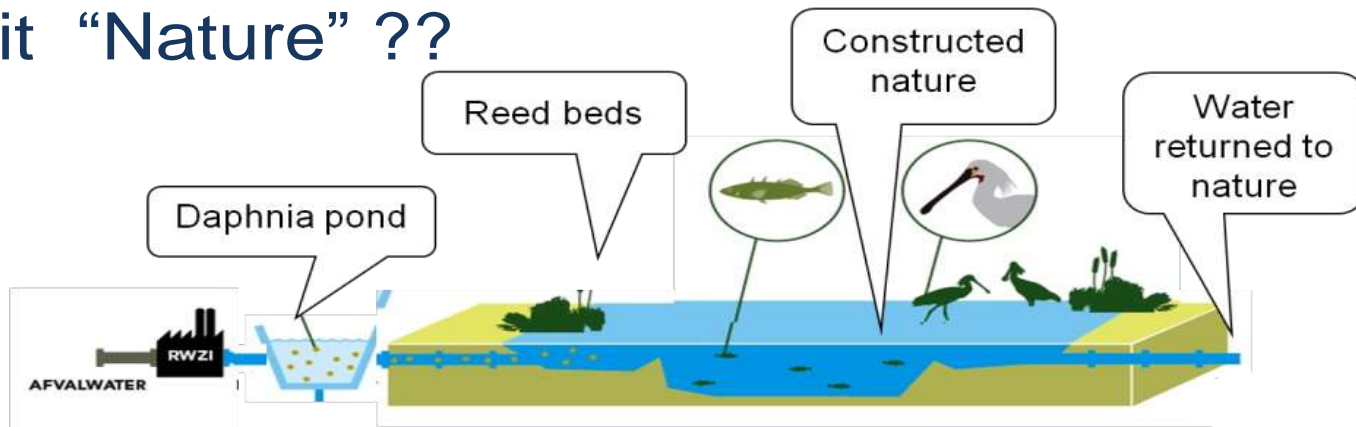
Waterharmonica Grou, NL



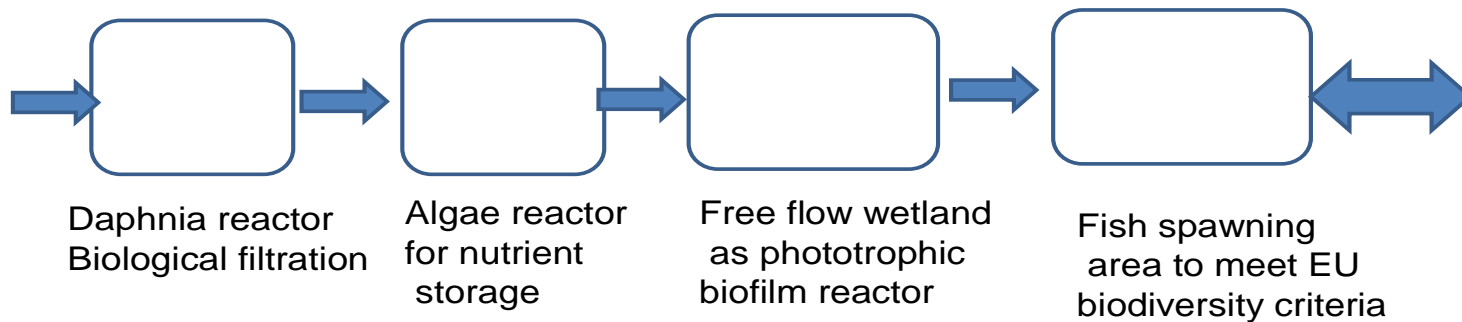
Waterharmonica Soerendonk, NL

# What is Waterharmonica? (II)

Is it “Nature” ??



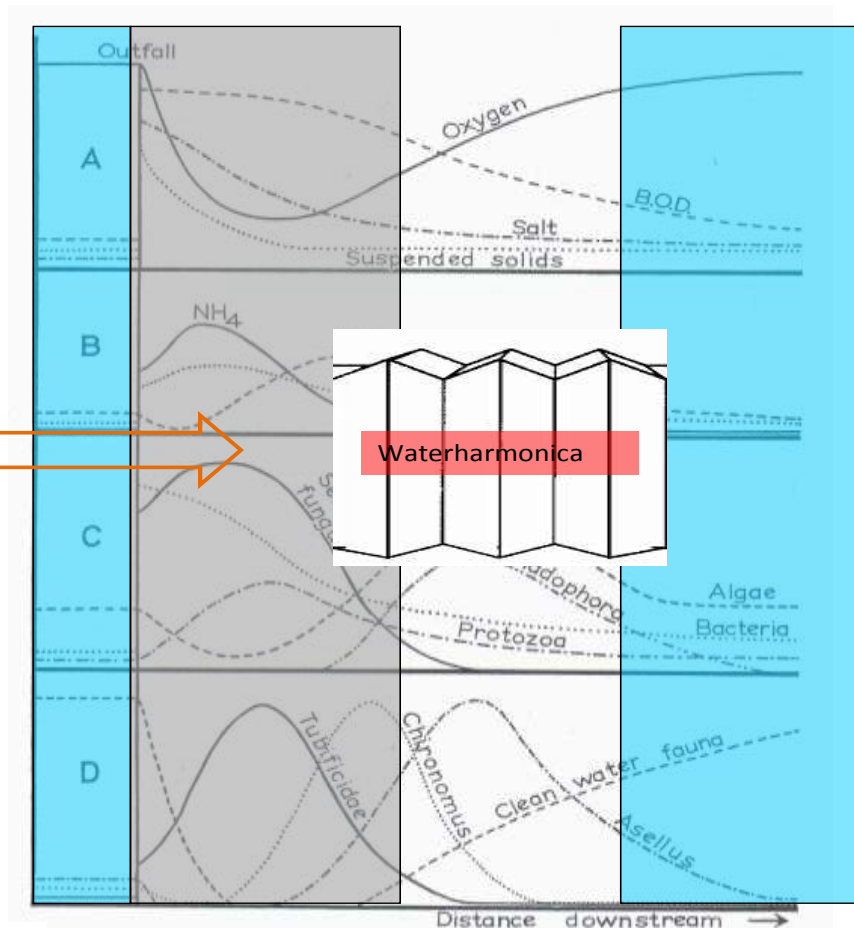
Or a process??



# What is Waterharmonica? (III)

The  
Waterharmonica:

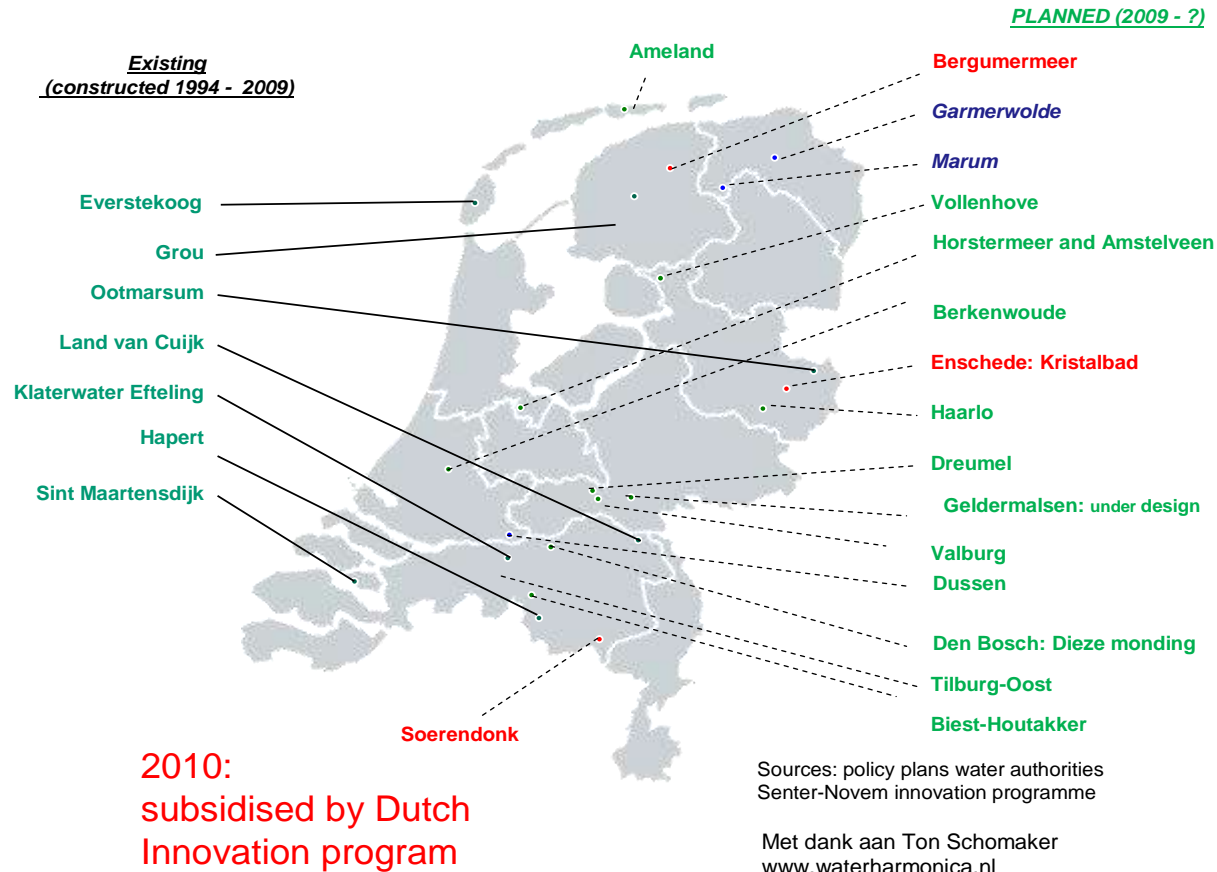
Bridge between  
sewage treatment  
and  
surface water



Based on Hynes, 1960 The biology of polluted waters

# Waterharmonica systems in NL

## WATERHARMONICA SYSTEMS





## Main idea



- To develop food webs from the nutrients dissolved in treated water to produce high-value biomass from the ecological point of view
- To give water back to nature in a good ecological status

# The Dutch vs the Catalan experiences

- Same ideas, different approaches, similar results



Texel



Grôu



Empuriabrava

Two of the Dutch experiences

Catalan experience

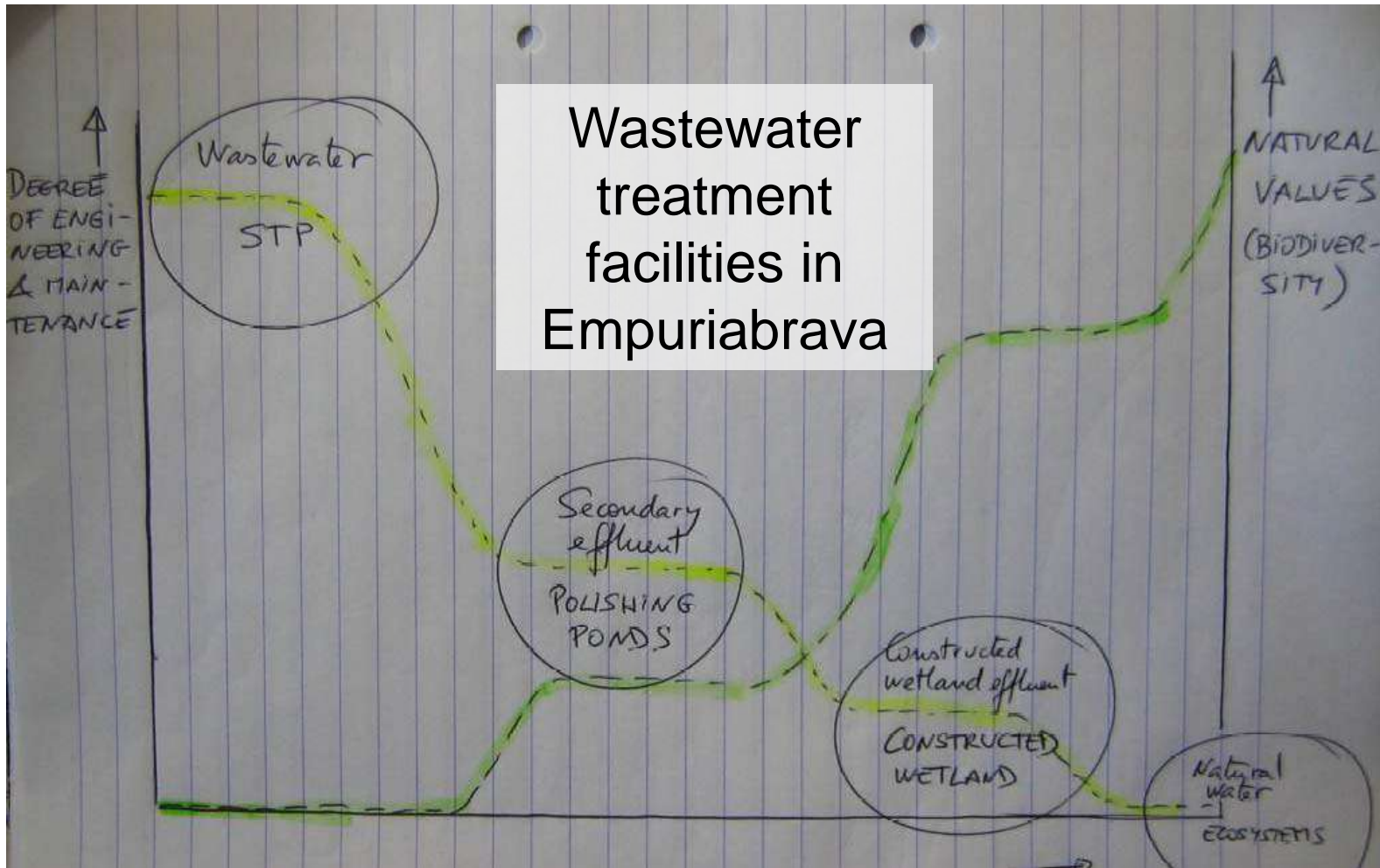
# It's about food chains

It's about providing time and space for the dissipation of chemical energy into biomass = to allow **LIFE** to develop

➔ Sense of events in the Empuriabrava wetland system



# Some brainstorming...



# Choices to make

Reclaimed water produces biomass – which one to grow?



Golf course turf, Sta. Cristina d'Aro, June 2005



Corn, Sta. Cristina d'Aro, June 2005

Or



Constructed wetlands, Texel (NL), July 2004



Constructed wetlands, Empuriabrava, March 2009



Reclaimed water in the Tossa Creek, June 2005

## Result: building nature



# Reclaimed water potential for aquatic ecosystem restoration or recreation

- Urban supply is a non-consumptive activity: availability of water is limited, but the volumes are predictable and relatively constant over time.
- If there are no toxic discharges, original quality can be restored to a great extent.
- It can be used for restoration of ecosystems affected either by drought and/or pollution and for recreation of vanishing habitats (i.e., wetlands)
- Can play an important role in Mediterranean areas

Secondary effluent from the Empuriabrava WWTP after biological filtration in *Daphnia* ponds, 10 July 2007



# Reclaimed water potential for aquatic ecosystem restoration or recreation



Water produced by the Blanes reclamation plant (N/DN + Title-22) and used for the recharge of the lower river Tordera aquifer by percolation, 7 July 2005

## Summary of quality in 2010

(Percentile 90 of the annual set of data):

**SS = 4.0 mg/L (235 samples)**  
**Turbidity = 2.5 UNT (235 samples)**  
**Total nitrogen = 10.8 mg N/L (141 samples)**  
**Total phosphorus = 1.8 mg P/L (140 samples)**  
**E. coli = 2 cfu/100 mL (123 samples)**



Effluent from the Empuriabrava WWTP (N/DN, P removal) and constructed wetland system, 23 August 2007

## Summary of quality in 2010

(Percentile 90 of the annual set of data):

**SS = 6.2 mg/L (27 samples)**  
**Turbidity = 3.7 UNT (27 samples)**  
**Total inorganic nitrogen = 1.6 mg N/L (16 samples)**  
**Total phosphorus = 4.7 mg P/L (15 samples)**  
**E. coli = 190 cfu/100 mL (27 samples)**

# Additional opportunities for biodiversity enhancement

- Create diversity of environments (ponds with different depths, bushes with berries, wet meadows)
- Control of water levels
- Design of specific areas for the protection and/or breeding of species threatened by habitat loss -fartet (*Lebias iberica*), European pond turtle (*Emys orbicularis*), etc.



# Empuriabrava environmental reuse project

- Mid 90's - Need of a new source of water for the Aiguamolls de l'Empordà Nature Reserve
- New WWTP in Empuriabrava (1995) in the south side of Muga river, where Nature Reserve is located
- Secondary effluent is proposed as alternative source
- Nutrient –specially N- removal is needed. Reclamation through a constructed wetland system is proposed.



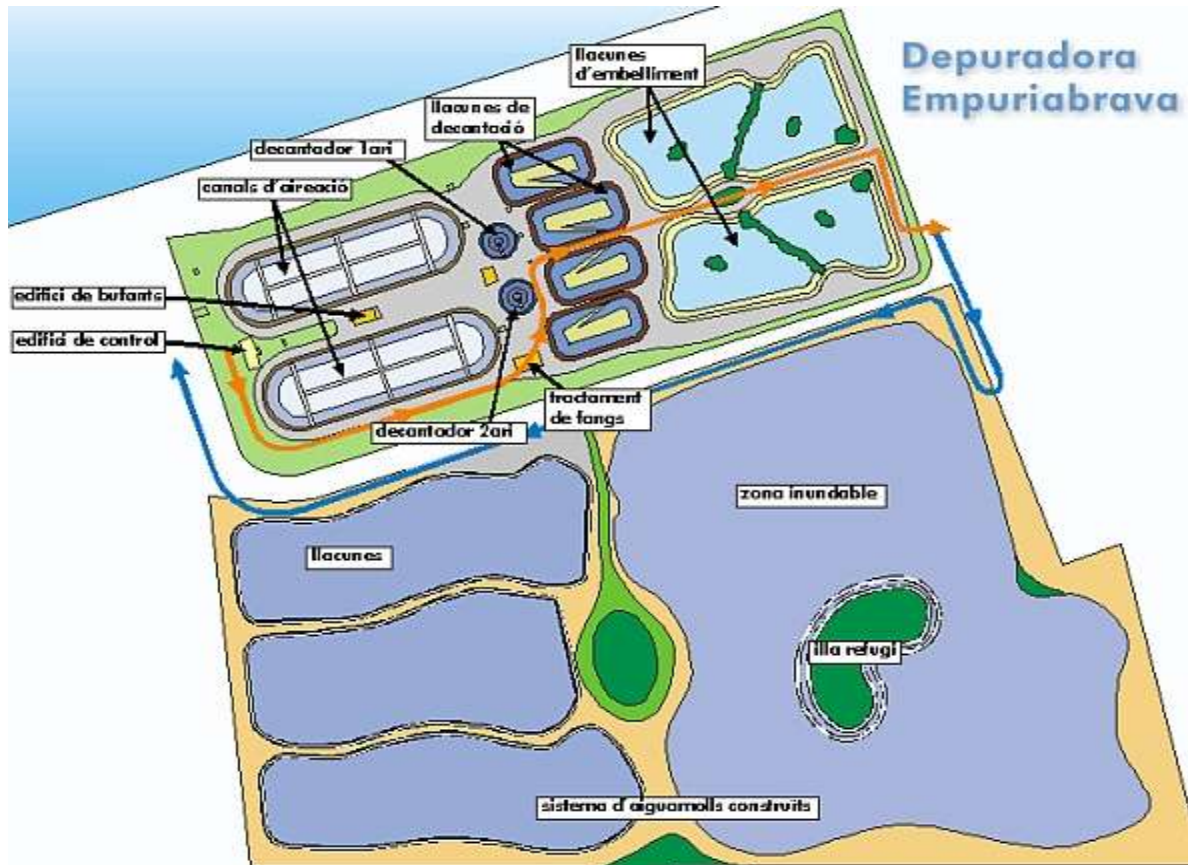
# Empuriabrava WWTP & CWS

- In operation since 1995, it services the touristic community of Empuriabrava (Castelló d'Empúries)
- Range of treated flows (m<sup>3</sup>/day):
  - winter, low season: 1,500
  - summer, peak season: 7,500
- Originally, two independent treatment lines. Extended aeration (N/DN). Recent improvements: third biological reactor and chemical P removal
- Constructed wetland system in operation since 1998
- Project funded by EU Cohesion Funds (80%) and CCB (20%)
- Constructed wetland: 3 treatment cells of 0,8 ha each + shallow lagoon of 4,5 ha (total, approx. 7 ha)
- Pumping station and 2 km pipeline to deliver reclaimed water to the Parc Natural dels Aiguamolls de l'Empordà (PNAE).



Location: 42°14'35.89"N, 3° 6'7.62"E

# Diagram of the facilities



Empuriabrava

Empuriabrava, Castelló d'Empúries

WWTP and  
Wetland  
System

Visitor  
Center  
(Cortalet)

1701 m

© 2009 Tele Atlas  
Image © 2009 Institut Cartogràfic de Catalunya  
Image © 2009 TerraMetrics  
Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
breedte 42.226980° lengte 3.109336°

Datum van beeldmateriaal: 12 Jun. 2008

©2009 GO  
Oogho

# Reuse sites of reclaimed water



Wet  
Meadows

Visitor  
Center

Cortalet  
Lagoon

# Goals of the project


- To supply water to the 18-ha manmade Cortalet lagoon and/or to restore wet meadows in the surrounding area.
- To reduce discharges in the nearby Muga river
- To avoid the eutrophication that reclaimed water could cause if nutrients were not removed.
- To help with the preservation of the local habitats and their specific flora and fauna

# Operation of the system

- 2000-2010: Average of 82 % of the secondary effluent treated in the wetland system and recycled for environmental purposes (808.000 m<sup>3</sup>/year out of 985.000 m<sup>3</sup>/year ⇒ not discharged to the Muga river).
- Since 2007, reuse > 90% thanks to the quality in the secondary effluent achieved with the third biological reactor.
- Performance:
  - Evaluated according to the removal of total inorganic nitrogen (TIN)
  - Nutrient loads (concentration x flow) calculated for both system inlet and outlet
  - Consistent removal of 80-90% of TIN over the years. In 2010, 82% (approx. 9,000 kg N)
  - P removal show greater annual variability; in 2010, 25% of total phosphorus (approx. 2,700 kg P).

# Conclusions

- Waterharmonica concept can be defined as an effluent polishing technique that is achieved through the development of trophic webs
- Double goal:
  - Water quality improvement
  - Nature enhancement
- Reclaimed water produced by these systems can also be reused for nature enhancement purposes
- Increasing number of facilities and experience in the Netherlands
- Since 2000, Empuriabrava constructed wetland in Costa Brava, Spain, has treated 82% of the secondary effluent produced by the nearby WWTP
- Empuriabrava constructed wetland effluent has been used for nature enhancement purposes at the Aiguamolls de l'Empordà Nature Reserve

A photograph showing a vast field of white water crowfoot flowers (Ranunculus aquatilis L.) growing in shallow water. The flowers are small, white, and numerous, creating a dense carpet of white against the green stems and the blue-grey water. The stems are tall and thin, reaching up from the water. The overall scene is a lush, natural wetland environment.

**Photo: White water crowfoot (*Ranunculus aquatilis* L.)  
grown on reclaimed water produced by the Empuriabrava  
constructed wetland facility which is used to restore wet  
meadows in the Parc Natural dels Aiguamolls de  
l'Empordà, April 2007**

**Thank you for your attention!**