Macroinvertebrate diversity of man-made ponds: Integrated Constructed Wetlands (ICWs)

Gustavo Becerra-Jurado, Rory Harrington & Mary Kelly-Quinn

University College Dublin, Ireland
Waterford County Council
Objectives

- Outline main findings on ICW ponds, including a comparison with natural ponds
- Present the full macroinvertebrate diversity potential, with particular reference to Coleoptera
Background Information
Wetlands

- **Definitions:**
  1. Mitsch and Gosselink, 2000:
     - Variable hydrology
     - Hydric soils
     - Hydrophytes
     *High biodiversity*
  2. Different types...Ponds: “a waterbody between 25 m² and 2 ha in area, which may be permanent or seasonal”
Integrated Constructed Wetlands

- Series of interconnected ponds that treat wastewater from farms
- Uses wetland’s natural ability to cleanse water
- Potential hotspots for landscape biodiversity
- A number of them have been built in Ireland
Wastewater in

Clean water out to river
Study Area
Materials and Methods
Pond Action
Biggs *et al.* 1998

- 1 mm mesh pond net
- Three, 3-min multihabitat samples
- Two seasons: spring and summer
Mesohabitats
Mesohabitat
Study on sampling methods
(Becerra-Jurado et al. Hydrobiologia 2008)

• Most taxa are common to both methods
• A number of taxa are exclusive to traps
• Fewer exclusive taxa are caught by netting in ponds with high percentage of emergent vegetation

\[ P < 0.01 \] (Becerra-Jurado et al. Hydrobiologia 2008)
Sampling protocol

- 3x3 min multihabitat net sampling (Biggs et al., 1998)
- Setting 10 activity traps per mesohabitat for 48h
- Spring and summer 2006
- Samples preserved in alcohol 70%
- Samples sorted in the lab on adjusted tray when necessary
- Identification level: Species except from Diptera
Results on biodiversity: ICW ponds
ICW systems: (Two-way nested ANOVA, F4,30 = 4.32, P < 0.05)
Ponds within systems: (Two-way nested ANOVA, F10,30 = 10.99, P < 0.01)

Becerra-Jurado et al. Wetlands 2010
Macroinvertebrate groups

- Coleoptera: 49%
- Hemiptera: 15%
- Diptera: 8%
- Gastropoda: 8%
- Trichoptera: 7%
- Hirudinea: 4%
- Other: 9%
ICW systems: (PERMANOVA, $F_{4,30} = 13.00, P < 0.01$)

Ponds within systems: (PERMANOVA, $F_{10,30} = 9.08, P < 0.01$)
Results on biodiversity: ICW vs natural ponds
**ICWs vs. Natural ponds**

Two-way ANOVA testing for differences in taxon richness due to nature of the pond (natural or artificial), season (spring or summer) and the interaction between the two factors.

<table>
<thead>
<tr>
<th>Factor</th>
<th>df.</th>
<th>MS</th>
<th>F-ratio</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature</td>
<td>1</td>
<td>76.1</td>
<td>1.25</td>
<td>0.280</td>
</tr>
<tr>
<td>Season</td>
<td>1</td>
<td>151.3</td>
<td>2.49</td>
<td>0.134</td>
</tr>
<tr>
<td>Interaction</td>
<td>1</td>
<td>61.3</td>
<td>1.00</td>
<td>0.330</td>
</tr>
<tr>
<td>Residual</td>
<td>16</td>
<td>60.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Becerra-Jurado *et al.* *Wetlands* 2010
Nature, i.e. natural vs. constructed: (PERMANOVA, $F_{4,30} = 13.00$, $P < 0.01$)
Season, i.e. spring vs. summer: (PERMANOVA, $F_{10,30} = 9.08$, $P < 0.01$)
Becerra-Jurado et al. Wetlands 2010
Main findings

- Significant differences along ICW ponds
  1. Taxon richness
  2. Community structure

- Significant differences between ICW (last ponds in the system) and natural ponds
  - Community structure
ICW full macroinvertebrate diversity potential: Coleoptera
Coleoptera diversity
Species composition

- 68 water beetle species
  (21% of all species present in Ireland)

- A number of species of interest (Foster et al., 2009):
  Helophorus strigifrons Thomson VU
  Enochrus melanocephalus (Olivier) NT

pH = 6.5-8

Optimize pond habitat
Coleoptera diversity

- 88 water beetle species
  (27% of all species present in Ireland)

- A number of additional species of interest (Foster et al., 2009):
  - Agabus conspersus (Marsham) EN
  - Berosus signaticollis (Charpentier) EN
  - Helophorus nanus Sturm VU
  - Ilybius subaeneus Erichson VU
  - Hydraena testacea Curtis VU

pH = 6.5-8

Factors driving diversity?
Factors driving diversity

1. **Area**: In general biodiversity increases with area but depends on the macroinvertebrate group

2. **Habitat heterogeneity**: diverse water depth profile increases biodiversity

3. **Water quality**: In general biodiversity increases with water quality
Conclusions
ICWs

- ICWs have the capacity to host a high number of macroinvertebrate species in farmland areas (pH 6.5-8)

- ICWs can play a *significant role in the conservation* of aquatic macroinvertebrates, especially *Coleoptera*
As recipients of future efforts to enhance *aquatic biodiversity* the *last ponds* of the ICW systems have the highest potential due to the improved water quality
ICWs

- Future management efforts should also consider the presence of potential rare species.

- This could be achieved by creating a number of shallower clean ponds at selected sites and varied mosaic designs.
The total ICW area may be increased to ensure *excellent water quality* at the end of the system, comparable to natural ponds.

Depending on the intended use the last ponds should be designed *targeting specific biota*. 

**ICWs**
References


References


Acknowledgments

We would like to thank everyone involved!!!

In particular, Prof. Garth Foster, Dr. Brian Nelson, Dr. Jim Johnson, Dr. Hugh Feeley, Mr. Mark Masterson and Waterford County Council.
Macroinvertebrate diversity of man-made ponds: Integrated Constructed Wetlands (ICWs)

Gustavo Becerra-Jurado, Rory Harrington & Mary Kelly-Quinn

University College Dublin, Ireland
Waterford County Council