Determination of nutrient threshold values relevant to groundwater-dependent terrestrial ecosystems (GWDTEs) in Ireland: Progress and challenges

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Presentation outline

- Groundwater (GW) body chemical status assessment, GWDTEs and threshold values (TVs)
- GWDTE types occurring in Ireland
- UK WFD Technical Advisory Group (TAG) method for determining chemical TVs
- Application of UK TAG method to Irish GWDTEs
- Progress to date
- Conclusions
GWB chemical status assessment: GWDTE Test

Assessment of ecological damage within GWDTE

Assessment of chemical inputs from groundwater bodies into GWDTEs.
• TVs are used in the assessment of nutrient inputs from groundwater bodies into GWDTEs.

• To date, no specific TVs have been determined for Irish GWDTEs.
<table>
<thead>
<tr>
<th>GWDTE Type/Annex I Habitat Type</th>
<th>EU Habitats Directive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkaline fen</td>
<td></td>
</tr>
<tr>
<td>*Calcareous fen with <em>Cladium mariscus</em> and <em>Carex davalliana</em></td>
<td></td>
</tr>
<tr>
<td><em>Petrifying springs with tufa formation (Cratoneurion)</em></td>
<td></td>
</tr>
<tr>
<td>Transition mire (quaking bogs)</td>
<td></td>
</tr>
<tr>
<td>*Active Raised bog</td>
<td></td>
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<tr>
<td>*Turloughs</td>
<td></td>
</tr>
<tr>
<td>Blanket bog (* if active) (FLUSHES ONLY)</td>
<td></td>
</tr>
<tr>
<td>Northern Atlantic wet heaths with <em>Erica tetralix</em> (FLUSHES ONLY)</td>
<td></td>
</tr>
<tr>
<td>*Alluvial forests with <em>Alnus glutinosa</em> and <em>Fraxinus excelsior</em></td>
<td></td>
</tr>
<tr>
<td>Machair (<em>in Ireland</em>)</td>
<td></td>
</tr>
<tr>
<td>Humid dune slacks</td>
<td></td>
</tr>
</tbody>
</table>
**UK TAG methodology for determining TVs**

- Compare GW nitrate and phosphate concentrations among good and poor ecological condition groupings
  - Identify protected groundwater-dependent wetlands with hydrogeologically linked GW monitoring boreholes.
  - Calculate 6 or 3 yearly mean GW N and P concs. for each site.
  - Assign sites to either good or poor ecological condition groups.
UK WFD TAG methodology for determining TVs

**Ideal**
- Good
- Poor

Schematic distributions of GW nutrient concs. for good and poor condition GWDTEs

**Actual**
- Good
- Poor

TVs
- 25th percentile
- 75th percentile

Final UK TVs
- Means or percentiles of ecological groupings
- Data from site investigations
- Expert judgement
- Validated where possible using logistic regression
Application of TV methodology to Irish GWDTEs

Availability of groundwater quality data

1. Monitoring points for the EU Drinking Water Directive (1998) (DW MP) include groundwater used for public water supply – dataset includes nitrate data but not phosphate data.

## Application of TV methodology to Irish GWDTEs

<table>
<thead>
<tr>
<th>GWDTE Type</th>
<th>No. of sites</th>
<th>No. of sites within 5km of DW MP (Ground or Spring)</th>
<th>No. of sites within 5km of GWQ MP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkaline fen</td>
<td>110</td>
<td>71</td>
<td>21</td>
</tr>
<tr>
<td>*Calcareous fen with <em>Cladium mariscus</em> and <em>Carex davalliana</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Petrifying springs with tufa formation (Cratoneurion)</em></td>
<td>14</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Transition mire (quaking bogs)</td>
<td>50</td>
<td>18</td>
<td>0</td>
</tr>
<tr>
<td>*Active Raised bog</td>
<td>136</td>
<td>101</td>
<td>29</td>
</tr>
<tr>
<td>*Turloughs</td>
<td>256</td>
<td>206</td>
<td>108</td>
</tr>
<tr>
<td>Blanket bog (* if active) (FLUSHES ONLY)</td>
<td>441</td>
<td>152</td>
<td>54</td>
</tr>
<tr>
<td>Northern Atlantic wet heaths with <em>Erica tetrailix</em> (FLUSHES ONLY)</td>
<td>48</td>
<td>24</td>
<td>5</td>
</tr>
<tr>
<td>*Alluvial forests with <em>Alnus glutinosa</em> and <em>Fraxinus excelsior</em></td>
<td>191</td>
<td>100</td>
<td>52</td>
</tr>
<tr>
<td>Machair (<em>in Ireland)</em></td>
<td>61</td>
<td>19</td>
<td>6</td>
</tr>
<tr>
<td>Humid dune slacks</td>
<td>311</td>
<td>99</td>
<td>24</td>
</tr>
</tbody>
</table>
Annex I Calcareous fens

Distribution of Annex I Calcareous fens in Ireland (Kilroy et al., 2008)

Species-rich *Cladium* fen (7210)
Selecting suitable DW and/or GWQ MPs

Issues to consider:

- in same groundwater body as fen?
- up hydraulic gradient from fen?
- distance from fen?
Selecting suitable DW and/or GWQ MPs

- Initial screening: 71 sites within 5 km of a GW monitoring point
- Further screening: 44 sites have a hydrogeologically linked GW monitoring point

<table>
<thead>
<tr>
<th>Ecological Condition (confidence level)</th>
<th>Number of calcareous fen sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good (High and Moderate Confidence)</td>
<td>13</td>
</tr>
<tr>
<td>Good (Low confidence)</td>
<td>29</td>
</tr>
<tr>
<td>Sites with disputed ecological condition</td>
<td>2</td>
</tr>
</tbody>
</table>

NB no sites with agreed poor ecological condition based on existing ecological data
Conclusion: Defer setting a TV until further site investigations are carried out.
Further Site Investigations

- Basic surveys of 44 calcareous fens with hydrogeologically linked GW monitoring points

- Fen types (e.g. Basin fen, Open-water transition fen etc.)
- Dominant habitat types (Guide to Habitats in Ireland (Fossitt, 2000))
- Within-site management
- Surrounding land-use intensity
- Assessments of nutrient impact using nutrient indicators
Positive Nutrient Indicators

Annex I Calcareous fen habitat types
Negative Nutrient Indicators

Wet grassland dominated by *Juncus* spp. and/or *Glyceria* spp.
Extensive, dense *Reed* and *large sedge swamps FS1* dominated by Common Reed (*Phragmites australis*) and/or Bulrush (*Typha latifolia*)
Negative Nutrient Indicators

Extensive, dense Scrub WS1
Of the 44 sites surveyed:
- 3 were not accessed
- 2 not calcareous fens
- 2 under significant quantitative pressures

<table>
<thead>
<tr>
<th>Ecological Condition</th>
<th>Criteria</th>
<th>No. of sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>Sites with only positive indicators</td>
<td>11</td>
</tr>
<tr>
<td>Poor</td>
<td>Sites with negative indicators</td>
<td>26</td>
</tr>
</tbody>
</table>
Results: Following UK TAG method directly

Option 1: Mean of Good and Poor medians = 8 mg L$^{-1}$

Option 2: Mean of Good 75th percentile and Poor 25th percentile = 7 mg L$^{-1}$
Results: Binary logistic regression

Ecological Condition
- Red: Poor
- Green: Good
- Black line: Fit line for Total

Equal probability of a fen being in good or poor condition

Nitrate Conc. mg l⁻¹

Predicted probability

R Sq Cubic = 0.992
Results: Data screening followed by UK TAG approach

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<tr>
<td>Poor*</td>
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<td>15</td>
</tr>
</tbody>
</table>

*Poor condition sites with GW nitrate concs. less than the Irish NBL (9.2 mg L\(^{-1}\)) excluded on the basis that the poor condition is unlikely to be attributable to GW nitrate inputs at these sites.
Results: Data screening

Option 1: Mean of Good and Poor medians = 15 mg L\(^{-1}\)

Option 2: Mean of Good 75\(^{th}\) percentile and Poor 25\(^{th}\) percentile = 11 mg L\(^{-1}\)
Phosphate Threshold Values

• P could be the key limiting nutrient in some fens

• Irish dataset is inadequate to determine a TV for P (groundwater P only available for 4 MPs hydrogeologically linked to fens)

• Future monitoring of groundwater P in the vicinity of fens is necessary
Conclusions

• TVs trigger site investigations which should focus on sites with HD habitat types and evidence of a nutrient impact from GW.
• There is a need for data screening, which deviates from the UK TAG approach.
• TV should lie between the 75\textsuperscript{th} percentile for good condition sites and the 25\textsuperscript{th} percentile for poor condition sites.
• Basic habitat surveys of GWDTEs are a minimum requirement for inclusion within the GWB classification process.
• Groundwater monitoring appropriate for karst situations should be conducted within a range of calcareous fen sites.
• Research is needed into the nature of nutrient limitation within Alkaline fens (7230) and species-rich Cladium fens (7210).
Acknowledgements

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Aine O`Connor, NPWS

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