Natterjack toad monitoring project, 2011 - 2012

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Natterjack toad monitoring project,

2011 - 2012

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Cover photo: Natterjack toads (*Epidalea calamita*) in amplexus by Pascal Sweeney © NPWS

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Executive Summary

The purpose of the present project, undertaken by Sweeney Consultancy, was to monitor the natterjack toad (*Epidalea calamita*) in County Kerry, during the 2011 and 2012 breeding seasons, to examine and analyse factors affecting breeding success and population trends and recommend actions that could be taken to favourably enhance conditions for this species. From April to June inclusive of both years, traditional breeding sites and ponds constructed as part of the NPWS Natterjack Toad Scheme were visited on an 8 to 10 day interval to record data on spawn, tadpoles and toadlets, as well as environmental parameters.

The main findings of the study were:

- The weather in both 2011 and 2012 was unfavourable for natterjack toad breeding, due to early dry conditions.
- Spawn production was similar in both years, with a slight increase in spawn strings recorded in 2012.
- A few of the smaller traditional breeding sites were not used by natterjack toads in 2011 or 2012.
- While traditional breeding sites accounted for most of the spawning activity, there was a statistically significant increase in usage of constructed ponds by breeding natterjack toads in 2012, in terms of spawn laid. The numbers of new ponds used for spawning also increased in 2012. While these increases are modest, they show that the NPWS Natterjack Toad Scheme is beginning to show positive results.
- Comparing spawn string production in 2011 and 2012 with that recorded by a previous study in 2004, when conditions were somewhat drier, indicates that a decline in the natterjack toad population has taken place in the intervening period.
- Dune habitats were shown to be statistically significantly correlated with natterjack toad breeding.
- Threats to the natterjack toad population include desiccation of traditional breeding sites. This is particularly noticeable in the Magharees, where the number of ponds available for breeding has declined over the years. Changes in the water table level and a high bovine stocking rate are thought likely to be causes of this change.
- Of the environmental factors examined, sward height in the areas surrounding the breeding sites is seen to be a factor affecting site usage by breeding natterjack toads.

Actions recommended for increasing natterjack toad breeding success are:

- New pond construction in five identified areas where breeding success is most likely and to enhance pond connectivity.
- Revision of the Commonage Framework Plans for the Magharees to favour natterjack toads, rather than focusing solely on vegetation.

- Sward management by additional grazing or cutting/strimming, where vegetation surrounding ponds is tall and rank.
- Creation of small areas of calm water by placement of boulders in Lough Yganavan, where strong winds and waves cause problems for breeding.
- In the event of another dry spring, translocation of spawn from ponds in the Magharees to suitable constructed ponds that are not being used for breeding at that time.

1 INTRODUCTION

1.1 Natterjack toad ecology, distribution and legal status

The natterjack toad (*Epidalea calamita*) is widely distributed along the western fringe of Europe, from Iberia to the Baltic, with populations in the more northern parts of its range being of more localised distribution (Gasc *et al.,* 1997). According to Buckley and Beebee (2004), the natterjack toad is recognised as being under substantial threat not only in Ireland and Britain, but also in parts of northern France, Belgium, Sweden and Estonia. The populations farther south in Iberia are larger.

In Ireland, the populations are restricted to coastal sites in County Kerry on the Dingle and Iveragh Peninsulas, mostly concentrated around Castlemaine Harbour and in the vicinity of the Magharees. There is a small population in southeast Wexford, introduced from Kerry in the 1990s. The species' range is estimated to have contracted by over 50% between 1900 and the 1970s (Beebee, 2002). As a result, the species is classified as being "Endangered" in Ireland in the most recent Red List for Amphibians, Reptiles & Freshwater Fish (King *et al*., 2011).

The natterjack toad is listed on Annex IV of the EU Habitats Directive (92/43/EEC). Article 11 of this Directive obliges Ireland to undertake surveillance of such a listed species and to report regularly on its conservation status, in accordance with Article 17 of the Directive. In Ireland, the natterjack toad is protected under the Wildlife Act, 1976 and the Wildlife Amendment Act, 2000. Internationally, the IUCN have listed the natterjack toad on the *Red List of Threatened Species* as a species of Least Concern but with a declining population (Beja *et al.*, 2009).

Natterjack toad spawning usually begins in April, with each breeding female laying a single string of spawn, although some double-clutching can occur (Denton and Beebee, 1996). Eggs usually hatch within ten days and tadpoles metamorphose into toadlets usually in six to eight weeks (Beebee, 2002). This gives a typical development time, from spawning to emergence as toadlets, of about 60 days. The rate of development is temperature dependant and is accelerated by warmer weather conditions. As toads are terrestrial for the remainder of the year, mainly nocturnal, sheltering in burrows and under logs and stones during day and hibernating from October to March, the spring/early summer breeding period is the most suitable for population monitoring.

1.2 NPWS natterjack toad scheme

Beebee *et al.* (1996) found that, in a study in Britain, adult toad density correlated positively with toadlet production, which, in turn, correlated to the density of breeding ponds. In 2008, the National Parks and Wildlife Service (NPWS) launched a new scheme to increase the number of breeding ponds around Castlemaine Harbour and along the coastal strip west of Castlegregory. This involves landowners entering a five year agreement and receiving annual payments for digging and maintaining ponds. To date, 94 constructed ponds have been entered into the scheme.

1.3 Rationale and objectives of project

The primary objectives of this project are to provide data on breeding success and trends in population growth to inform the next report required under Article 17 of the EU Habitats Directive. Sweeney Consultancy was contracted by NPWS to carry out monitoring fieldwork during the breeding season from April to June inclusive in 2011 and 2012.

2 STUDY AREA

2.1 Geographic spread of sites

All of the traditional natterjack toad breeding areas monitored in 2004, 2005 and 2006 by Bécart *et al.* (2007) in County Kerry were monitored in this study. These sites are:

- Castlegregory Golf Club (referred to as Stradbally Golf Course by Bécart *et al*. (2007)
- Lough Gill
- Magharees
- Tullaree
- Roscullen Island
- Lough Yganavan
- Lough Nambrackdarrig
- Dooks
- Glenbeigh Quarry
- Glenbeigh Field
- Glenbeigh Marsh
- Caherdaniel

These traditional breeding site areas are indicated in Figure 1 and the exact locations of sites monitored both in 2004 – 2006 and in the present survey are shown as red dots in Figures 2 to 12.

Within these twelve areas, data from 53 separate sites (separate ponds, or sections of lake shoreline) were recorded. Some of these, located in the Magharees, were dry from the beginning of the field-work season. In 2011 this amounted to 10 Magharees sites, while in 2012, nine of these sites were dry from the beginning of April. The relevant sites for surveying on the Magharees were indicated by Tim O'Donoghue, the local NPWS Conservation Ranger, at the start of the project.

The traditional breeding sites monitored do not include a known breeding area at the back of the Inch Spit, which was excluded from both surveys due to sensitivities regarding access. Neither is the translocated County Wexford population included in this study.

At Lough Yganavan the five areas of shoreline included in the 2004-2006 survey were included in the current survey. The five locations shown in Figure 10 indicate the start of the shoreline monitoring areas, which run clockwise around the northern half of the lake. At Lough Nambrackdarrig, where most of the perimeter of the lake is lined with floating scraw over deep water, a 100m section of shoreline was surveyed, where it is safe to approach the water's edge. At Lough Gill, one area on the

north-east shore, where conditions are suitable for reliable monitoring, was included in the current survey.

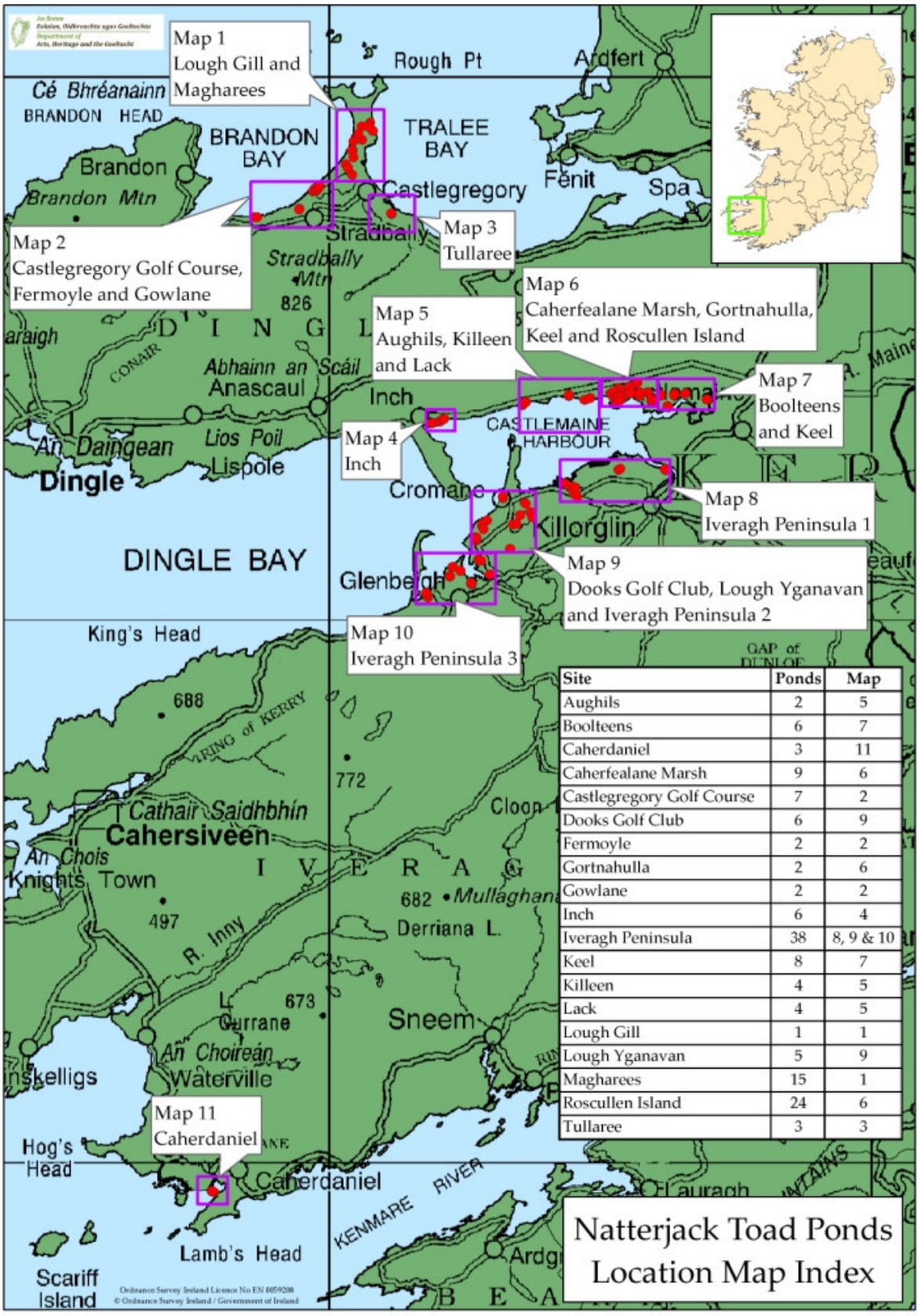
Of the three constructed ponds at Fermoyle that were monitored in 2004-2006, one was excluded from the present monitoring, as it is too overgrown. The other two are included in the NPWS Natterjack Toad Scheme. In addition to the two ponds in NPWS property at Caherdaniel that were part of the 2004-2006 survey, a more recently created small pond is also included for monitoring.

All 94 constructed ponds included in the NPWS Natterjack Toad Scheme are in the present monitoring programme. 90 of the NPWS Natterjack Toad Scheme ponds are concentrated in the Castlemaine Harbour area.

The locations of new sites, monitored in the present survey, but not in 2004 – 2006, are shown as blue dots in Figures 2 to 12. These are mainly ponds constructed for the NPWS Natterjack Toad Scheme, but also include the new pond at Caherdaniel (Map 11). Ponds newly constructed for the NPWS Natterjack Toad Scheme which are within wider areas surveyed at Roscullen Island in 2004 – 2006 are also shown in blue.

The site naming and numbering system for traditional breeding sites in this survey follows that of the 2004-2006 survey. For the ponds included in the NPWS Natterjack Toad Scheme, code numbers supplied by NPWS are used.

All monitoring site locations shown on maps in this report were mapped onto Ordinance Survey Ireland ortho-photography with a nominal date of acquisition of 2005 by Geographic Information Systems Unit, NPWS. Ordinance Survey Licence No. EN0059208 © Ordinance Survey Ireland/Government of Ireland.



Site	Ponds	Map
Aughils	2	5
Boolteens	6	7
Caherdaniel	3	11
Caherfealane Marsh	9	6
Castlegregory Golf Course	7	2
Dooks Golf Club	6	9
Fermoyle	2	2
Gortnahulla	2	6
Gowlane	2	2
Inch	6	4
Iveragh Peninsula	38	8, 9 & 10
Keel	8	7
Killeen	4	5
Lack	4	5
Lough Gill	1	1
Lough Yganavan	5	9
Magharees	15	1
Roscullen Island	24	6
Tullaree	3	3

Figure 1. Location map

Figure 2. Map 1.

Figure 3. Map 2.

Figure 4. Map 3.

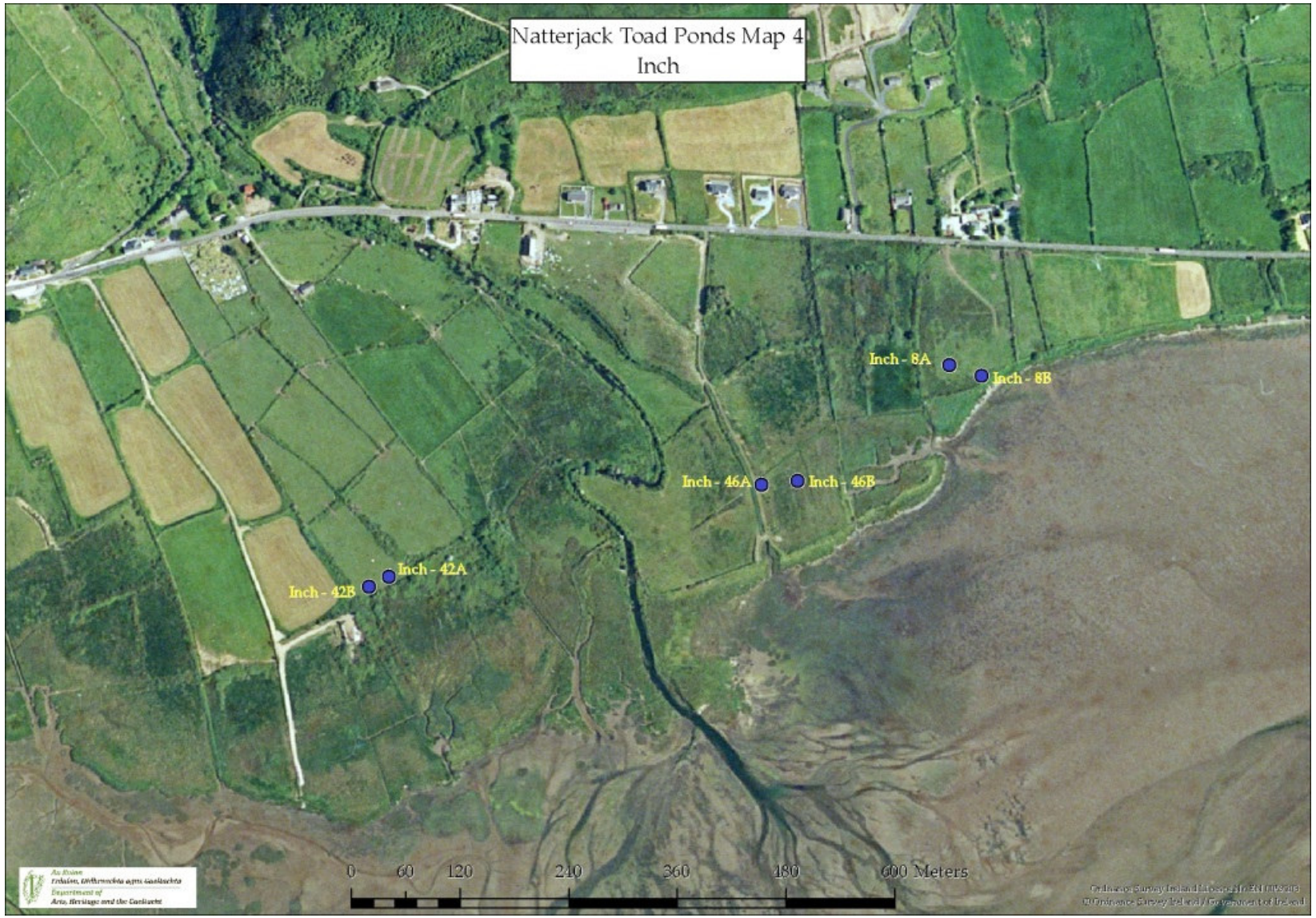


Figure 5. Map 4.

Figure 6. Map 5.

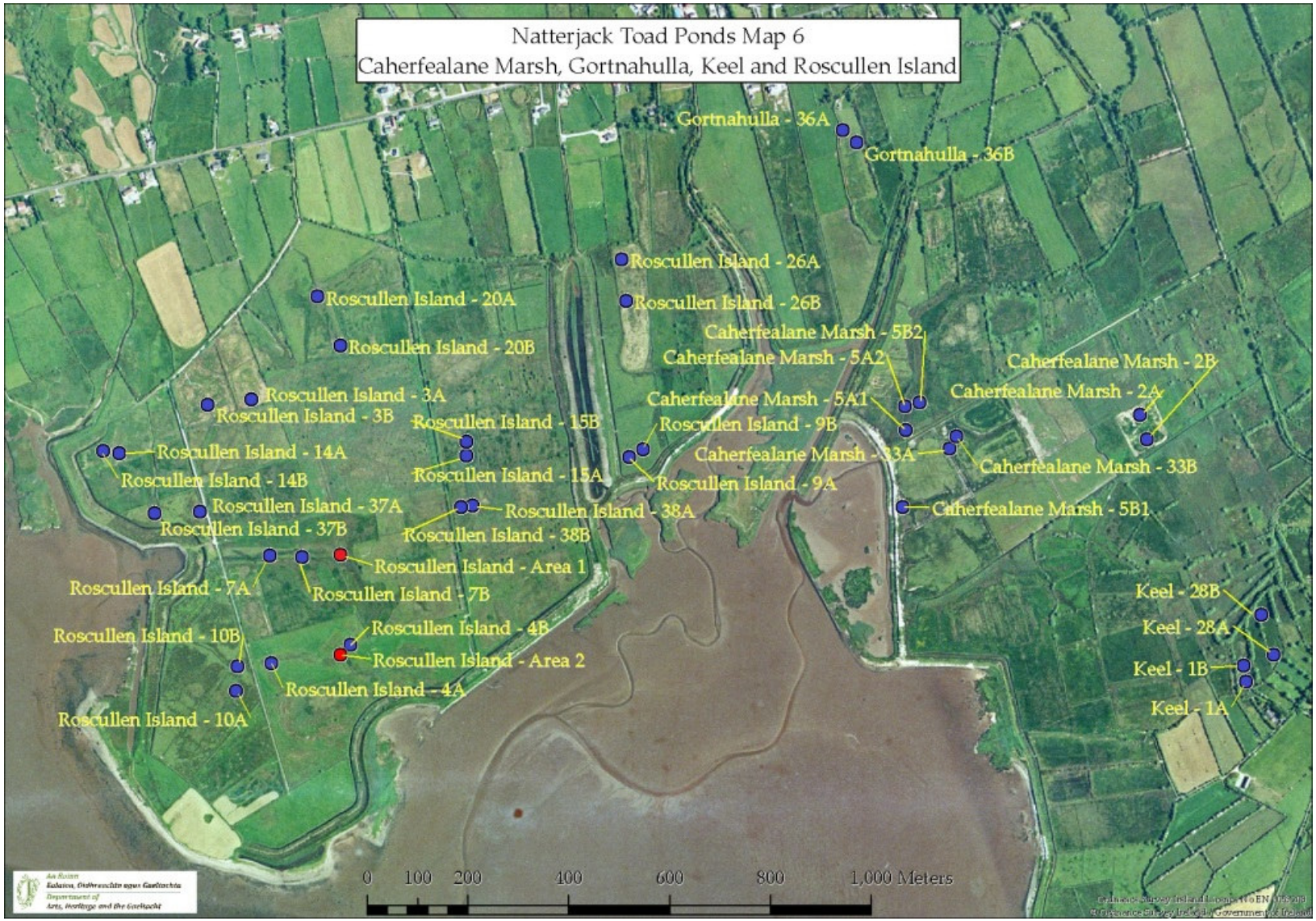


Figure 7. Map 6.

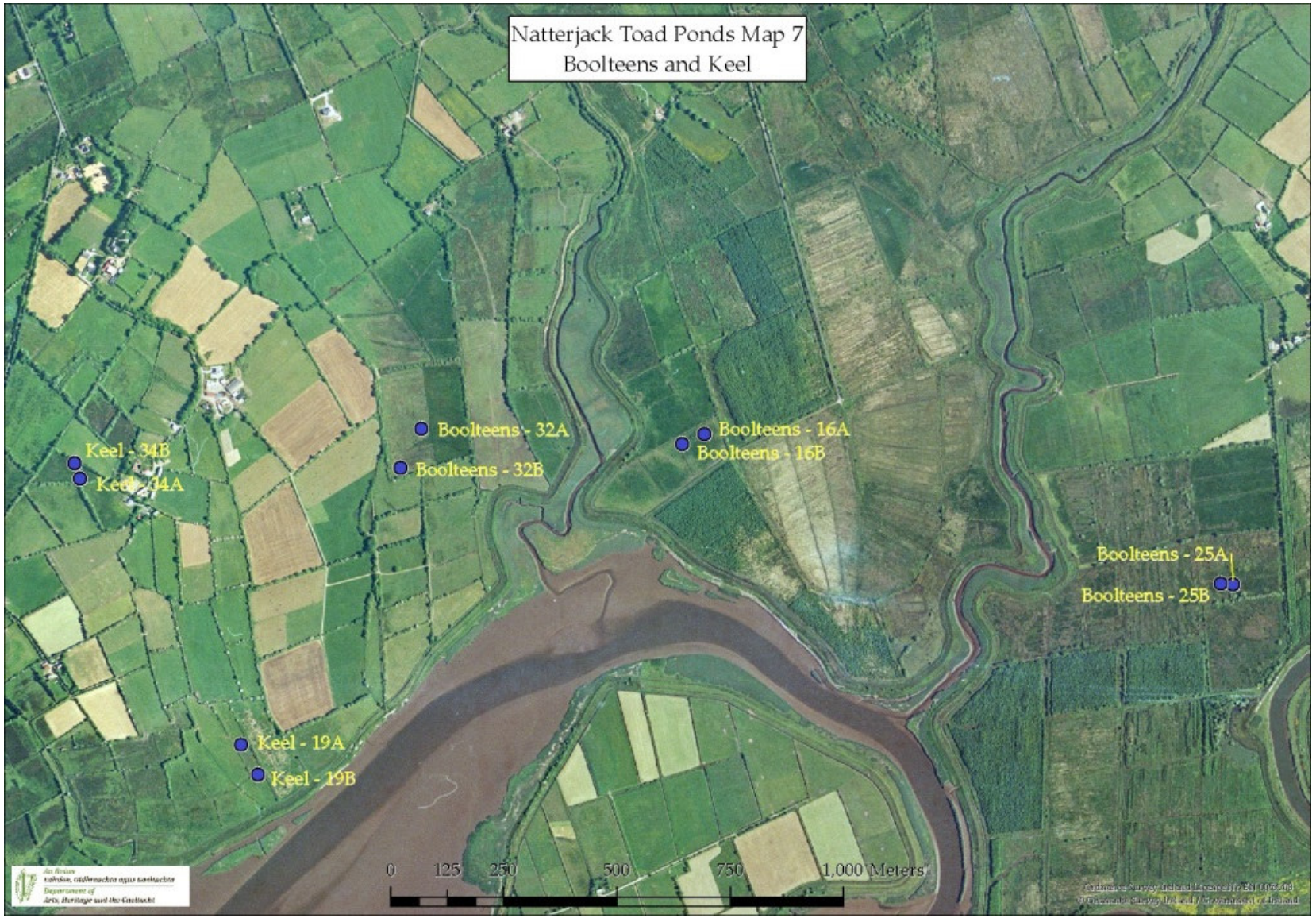


Figure 8. Map 7.

Figure 9. Map 8.

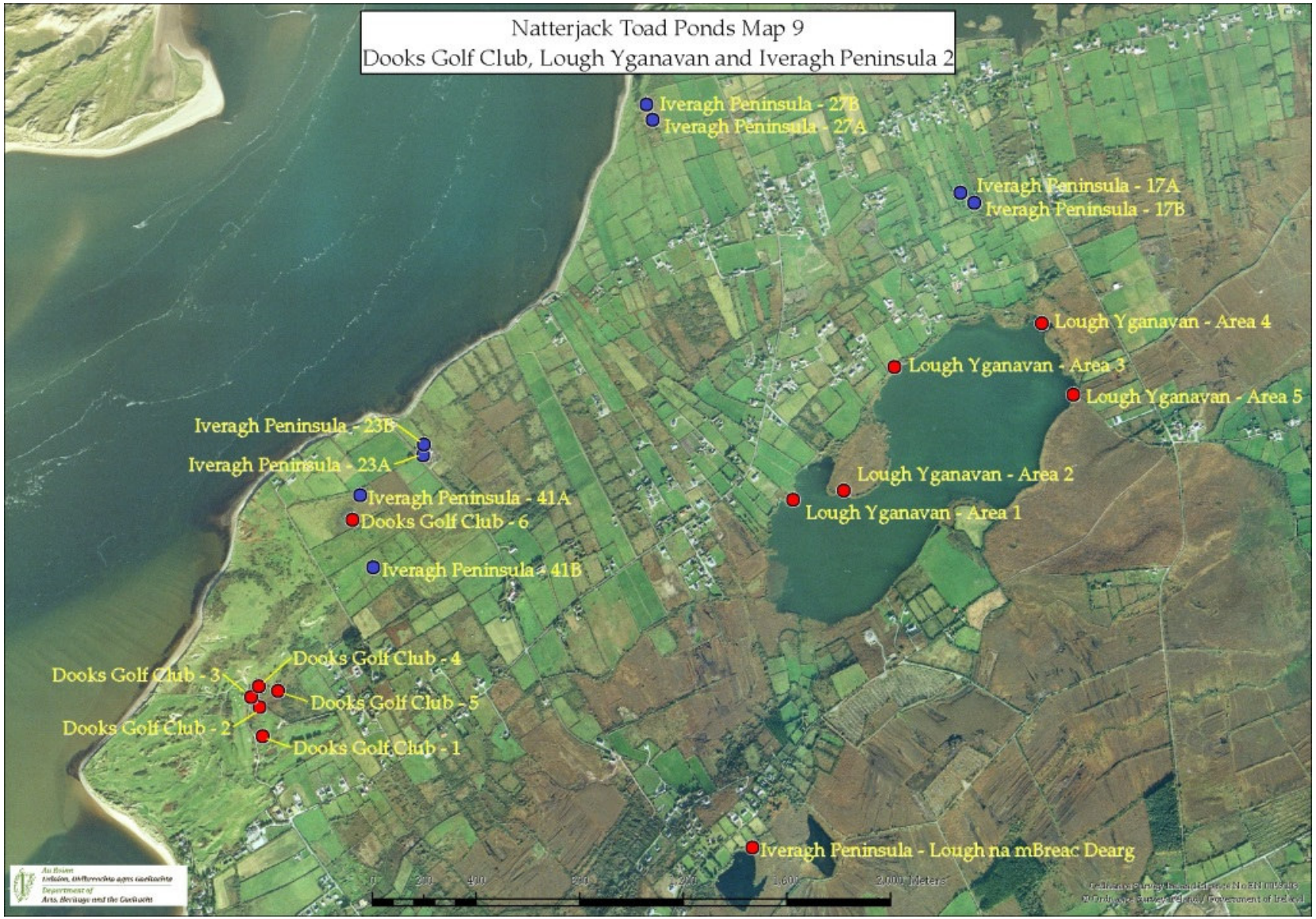


Figure 10. Map 9.

Figure 11. Map 10.

Figure 12. Map 11

2.2 Site types

The constructed ponds are small (mostly 40m² to 60m² in surface area), are less than 1m deep and are generally round or oval in shape (Plate 1). The traditional breeding sites vary in type and size from lakes (Plate 2) to ephemeral pools (Plate 3).

Plate 1. Constructed pond, Iveragh Peninsula 11B (*Niamh Sweeney*)

Plate 2. Lough Yganavan (*Niamh Sweeney*)

Plate 3. Ephemeral pool, Magharees Pond 6 (*Caroline Hurley*)

3 METHODOLOGY

3.1 Survey team

The fieldwork was mainly carried out by Caroline Hurley and Niamh Sweeney, with sites monitored on the Dingle Peninsula by the former and on the Iveragh Peninsula by the latter. When either of these ecologists was unable to carry out fieldwork at the pre-organised dates, surveying was conducted either by the other, or by Pascal Sweeney. The fieldworkers were assisted by 3rd Year Wildlife Biology students at Tralee Institute of Technology on work placement: Seán Dundon assisted in 2011 and Thomas Sheehan assisted in 2012.

3.2 Survey time

Sweeney Consultancy was contracted to conduct fieldwork between 1st April and 30th June in both 2011 and 2012. However, in both years, observations of toad spawn were reported to Sweeney Consultancy in late March. Consequently, to avoid missing counts of these early spawn strings at these sites, the survey work was commenced on March 29 2011 and March 28 2012. The two local NPWS Conservation Rangers, Pascal Dower and Tim O'Donoghue, met with all the surveyors in 2011 in order to show them the locations of the monitoring sites. Surveying of sites commenced following these meetings. Sites were visited at an eight to ten day interval throughout the field study periods. A total of 936 site visits were carried out in 2011 while in 2012 a total of 1092 visits were made.

3.3 Spawn

At all the constructed ponds and most of the traditional breeding sites, the perimeter was walked and the number of egg strings recorded. For some of the traditional breeding sites, where it was not possible to count egg strings accurately from the water's edge, transects were carried out by wading in a regular zigzag pattern, where possible. Care was taken not to double count egg strings when revisiting the pond after 8-10 days during cold periods by marking the locations of strings on a sketch map and by noting the state of egg development. In ponds where the water was very dark and it was difficult to see beneath the surface, net sweeps were carefully conducted in order to determine if strings were present.

3.4 Tadpoles

At sites where tadpoles were easily visible (typically shallow sites with a sandy bottom), estimates of toad tadpole numbers were made visually. Where tadpoles were not visible or where distinguishing between toad and frog tadpoles was difficult (typically deeper, darker ponds), a sweep sample was taken with a pond net and any tadpoles found were examined against a pale background, before returning to the pond. In these ponds, the number of tadpoles was estimated by counting the number in the net and taking account of the area of the sweep sample. Natterjack toad tadpoles were distinguished from common frog tadpoles by differences in colouration and size.

3.5 Toadlets

Only sites where toad spawn and/or tadpoles were recorded in the earlier part of the season and where the ponds did not dry up were surveyed for toadlets in June. At all breeding sites, the land surrounding the pond from the water's edge to a distance of up to 5m was surveyed. Random quadrats (area 0.25m²) were used. The number of quadrat throws per site varied, depending on the length of the adjacent water's edge and the variability of the terrestrial vegetation. Toadlet numbers in each quadrat were counted.

The number of traditional sites surveyed for toadlets in 2011 was 23 and 21 were surveyed in 2012. These are listed in Table 1.

Table 1. Traditional sites surveyed for toadlets in 2011 and 2012.

2011	2012
Magharees Pond 1, 23	Magharees Pond 1, 9.
Castlegregory Golf Club Pond 1, 2, 4, 6, 8	Castlegregory Golf Club Pond 1, 2, 4, 6, 8
Lough Gill	Lough Gill
Tullaree Pond 1, 2, 3	Tullaree Pond 2
Roscullen Area 1	Roscullen Area 1, 2
Lough Yganavan Area 1, 3, 4, 5	Lough Yganavan Area 1, 3, 4, 5
Dooks Golf Club Pond 3, 6	Dooks Golf Club Pond 6
Quarry A and B	Quarry A, B
Caherdaniel Pond 1, 2, 3	Caherdaniel Pond 1, 2, 3

The number of constructed ponds surveyed for toadlets in 2011 was 14 and in 2012, 16 were surveyed. This corresponds to a total of 20 constructed ponds that were surveyed for toadlets over the 2011-2012 survey period. These are listed in Table 2.

Table 2. Constructed sites surveyed for toadlets in 2011 and 2012.

2011	2012

4 A and B	4A and B
6A	6A
7A and B	7A and B
9A	9B
10A and B	10A
14B	14A and B
21A	21A
23 A and B	37 A and B
37A	38A and B
38B	43A and B

3.6 Habitat

Habitat data pertaining to the aquatic sites and the surrounding area were recorded. A visual record of each pond habitat was taken using digital cameras. A minimum of one photograph was taken of each site per year. Where conditions changed noticeably in the course of the field survey period, additional photographs were taken.

3.6.1 Aquatic habitat

3.6.1.1 Physical/Chemical

At each site, the following physical and chemical data was recorded:

- Estimated wetted/pond area.
- Estimated degree of summer shade of pond.
- Water temperature, using a Eutech PD650 meter (more accurate than thermometer).
- Conductivity, using a Eutech Multi-Parameter PCTestr 35.
- pH, using a Eutech Multi-Parameter PCTestr 35.
- Dissolved Oxygen (as mg/l and % saturation), using a Eutech PD650 meter.

3.6.1.2 Biological

At each site, the following biological data was recorded:

- Estimated percentage aquatic plant cover of the substratum.
- Estimated percentage aquatic plant cover of water surface.
- Estimated percentage plant litter cover of the substratum.
- Estimated percentage cover of the substratum by filamentous algae.

3.6.2 Terrestrial habitat

At each site, the following information was recorded:

- The percentage cover of each of the surrounding habitat types, as defined by Fossitt (2000), within 100m radius of the site.
- Estimated percentage of bare ground and percentage of sward height which was divided into three height categories of <5cm, 5-20cm and >20cm, within 100m or the nearest physical barrier of the aquatic habitat.
- Distance to and type of potential physical barrier to adult toad movement.
- Site management practices.

3.6.3 Damage/Potential threats

At each site, the following information was recorded:

- Evidence of damage.
- Observed predators.
- Other observed or suspected potential threats to toad populations.

3.6.4 Other amphibians

Observations of common frog (*Rana temporaria*) and of smooth newt (*Lissotriton vulgaris*) were recorded. It should be noted, however, that these two species were not specifically surveyed for in the present project.

In 2012, Sweeney Consultancy was approached by the Herpetological Society of Ireland and asked to take part in their 2012 Irish Amphibian Chytrid Survey. Caroline Hurley agreed to assist and where possible, collected swab samples from adult natterjack toads (except when observed in amplexus). These samples were sent to the Herpetological Society of Ireland to be analysed for the Chytrid fungus. At the time of writing, the results from these swab samples were not available.

3.6.5 General Information

At each site, the following general information was recorded:

- Date and time of site visit.
- Grid Reference, using a Garmin GPS handset.
- Air temperature, using an alcohol thermometer.

3.7 Data processing and analysis

The processing and analysis of the collected field data was managed using software packages Microsoft Excel and Statistical Package for the Social Sciences (SPSS) version 18.0. Non-parametric tests were used during analysis as data were not normally distributed. Spearman's rank order correlation was used to investigate associations among the abundance of spawn strings, tadpoles, toadlets, and physicochemical and vegetative data. Mann-Whitney U test was conducted to test for differences between the abundance of spawn strings, tadpoles and toadlets in the survey years 2011 and 2012. Spearman's rank order correlation was used to explore relationships between percentage Fossitt habitat data and breeding success. Habitats that were not recorded at a site and given a zero percentage were coded as missing values in the analysis.

4 RESULTS

All results of the 2011 and 2012 survey period were recorded in Microsoft Excel format. The main findings are summarised below.

In this report, the term "constructed ponds" is used to signify those ponds which are included for payment in the NPWS Natterjack Toad Scheme. The term "traditional breeding sites" is used for all other sites monitored, even though some of these were artificially created.

The term "northern sites" is used for sites to the north of Castlemaine Harbour, i.e. on the Dingle Peninsula (mostly monitored by Caroline Hurley) and "southern sites" is used for sites to the south of Castlemaine Harbour, i.e. on the Iveragh Peninsula (mostly monitored by Niamh Sweeney).

4.1 Spawn

In 2011, the earliest date on which spawn was recorded was March 29, at Caherdaniel. This spawn had been reported two days earlier, when it was already a few days old. The earliest spawning in 2011 was therefore probably about March 22. The latest date on which spawn was recorded in 2011 was June 30, in the Magharees.

In 2012, the earliest date on which spawn was recorded was March 28, at Caherdaniel. Seven spawn strings were recorded, all of which were only one or two days old. The earliest spawning in 2012 was therefore approximately March 26. The latest spawning in 2012 was recorded on July 3, in Castlegregory Golf Club Pond 8.

In 2011, a gap in spawning occurred beginning in May. No new spawn was recorded in successive visits to the southern sites over a five week period (mid-May to mid-June). The corresponding gap in spawning recorded in the northern sites was of three weeks duration (mid-May to early June). In 2012 there was no evidence of such a gap in spawning.

The total number of spawn strings counted at all sites over the 2011 breeding period was 1067. In 2012, 1107 strings were recorded. The mean depth of water in which these spawn strings were found in 2011 was 17.9cm (max=51cm, min=6.3cm). In 2012, the mean depth of water where spawn strings were recorded was 19.75cm (max=55cm, min=4cm).

4.1.1 Traditional breeding sites

Over the 2011 and 2012 survey period, toad spawn was recorded at 27 of the traditional breeding sites. This represents 50.9% of these sites. Spawn was also present within one additional pond in 2011 (Magharees Pond 6) during the preliminary site visit with the local Conservation Ranger before the survey proper commenced. This pond subsequently dried up.

In 2011, 97.2% of the total number of spawn strings counted were located in the traditional breeding sites. This represented 1037 spawn strings. In 2012, this proportion was smaller at 84.0% which corresponded to 930 spawn strings.

The largest decline in spawning at a single traditional site from 2011 to 2012 was at Magharees Pond 9, where spawn string production dropped from 112 strings in 2011 to four strings in 2012. This was due to the pond drying up in 2012. A large decline in spawn string production was also recorded at Magharees Pond 1, where the drop over the two years was from 149 to 81. At traditional breeding sites where no natterjack toad breeding occurred in 2011, there was no spawning in 2012. At five of the traditional breeding sites which were positive for spawn in 2011, there was no spawning in 2012. Three of the traditional ponds where no natterjack toad breeding occurred in 2011 were positive for spawn in 2012.

An increase in spawn string production was recorded at a few of the traditional breeding sites, most notably at Lough Yganavan Area 1, where the number of spawn strings doubled, from 13 in 2011 to 26 in 2012.

The maximum number of spawn strings recorded on a single visit to a site was 149 at Castlegregory Golf Club Pond 1 on April 12 2011. In 2012, the same site had the largest number of strings recorded on a single visit, in this case 116 strings, on April 30 2012.

Traditional breeding sites at which spawn was recorded are listed in Table 3.

Table 3. Traditional sites at which spawn was observed in 2011 and 2012.

2011	2012
Magharees Pond 1, 6, 7, 8, 9, 23	Magharees Pond 1, 9, 23.
Castlegregory Golf Club Pond 1, 2, 4, 6, 8	Castlegregory Golf Club Pond 1, 2, 4, 6, 8
Tullaree Pond 1, 2, 3	Tullaree Pond 2
Roscullen Area 1	Roscullen Area 1, 2
Lough Yganavan Area 1, 3, 4, 5	Lough Yganavan Area 1, 3, 4, 5
Dooks Golf Club Pond 3	Dooks Golf Club Pond 6
Quarry A and B	Quarry A, B
Caherdaniel Pond 1, 2, 3	Caherdaniel Pond 1, 2, 3
	Lough Gill (Area 3)

4.1.2 Constructed ponds

Toad spawn was recorded at 20 of the constructed ponds over the 2011-2012 survey period. This represents 21.3% of these sites.

The total number of spawn strings counted at all constructed ponds over the 2011 breeding period was 30 (or 2.8% of the total recorded), while in 2012 this was greater, at a total of 177 spawn strings, which represented 16.0% of all the spawn strings recorded in 2012. Seven of the constructed ponds where no natterjack toad breeding occurred in 2011 were positive for spawn in 2012. At three of the constructed ponds which were positive for spawn in 2011, there was no spawning in 2012.

The largest increase in spawn string production from 2011 to 2012 was at Roscullen Pond 7B, where a total of five strings were recorded in 2011, compared with 89 strings in 2012.

The maximum number of spawn strings recorded on a single visit to a constructed pond in 2011 was five. This occurrence was at Pond 21A on the Iveragh Peninsula on April 14 2011. In 2012, the maximum number of spawn strings recorded on a single visit to a pond was on the Dingle Peninsula at Roscullen Pond 7B, where 33 spawn strings were recorded on April 19 2012.

The Mann-Whitney U test revealed that among constructed ponds there was a significant difference ($p< 0.05$) in the abundance of spawn strings between the survey periods of 2011 (Mr=626, n=579) and 2012 (Mr=640, n=687). There was an increase of spawn strings from 2011 to 2012. There was no significant difference ($p> 0.05$) in the abundance of spawn strings in traditional sites, and in tadpoles or toadlets between the two survey periods in either the constructed ponds or traditional sites.

Constructed ponds at which spawn was recorded are listed in Table 4.

Table 4. Constructed ponds at which spawn was observed in 2011 and 2012.

2011	2012
4 A and B	4A and B
6A	6A
7A* and B	7A and B
9A*	9B
10A* and B*	10A
14B*	14A and B
21A	21A
23 A and B	37A and B
37A*	38A and B
38B*	43A and B

*Indicates that spawn was not observed at these ponds but that subsequent observations of tadpoles confirmed that spawn was present but went undetected.

4.2 Tadpoles

The earliest date on which tadpoles were recorded in 2011 was April 5 at Caherdaniel, while in 2012 the earliest record of toad tadpoles was on April 3 at Roscullen Island Area 1. Of the 31 sites where tadpoles were recorded in 2011, 20 still had tadpoles present at the end of June (the end of the contracted fieldwork period). In 2012, 13 ponds still had tadpoles present at the last survey visit (end of June/early July).

4.2.1 Traditional Breeding Sites

Tadpoles were found at 24 of the traditional breeding sites over the 2011-2012 survey period. This represents 45.3% of these sites. In 2011 there were 52 occasions where over 500 tadpoles were estimated to be present at a traditional breeding site. On 34 occasions, over 1000 tadpoles were estimated to be present.

In 2012 there were 73 occasions where more than 500 tadpoles were estimated to be present at a traditional breeding site. On 53 occasions, over 1000 tadpoles were estimated to be present.

Traditional breeding sites at which tadpoles were recorded are given in Table 5.

Table 5. Traditional sites at which tadpoles were observed in 2011 and 2012.

2011	2012
Magharees Pond 1, 7, 23	Magharees Pond 1, 23.
Castlegregory Golf Club Pond 1, 2, 4, 6, 8	Castlegregory Golf Club Pond 1, 2, 4, 6, 8
Lough Gill	Lough Gill
Tullaree Pond 1, 2	Tullaree Pond 2
Roscullen Area 1	Roscullen Area 1, 2
Lough Yganavan Area 1, 3, 4, 5	Lough Yganavan Area 1, 3, 4, 5
Dooks Golf Club Pond 3, 6	Dooks Golf Club Pond 6
Quarry A and B	Quarry A, B
Caherdaniel Pond 1, 2, 3	Caherdaniel Pond 1, 2, 3

4.2.2 Constructed Ponds

Tadpoles were found at 13 of the constructed ponds. This represents 13.8% of these sites.

On 3 occasions in 2011, over 500 tadpoles were estimated to be present at a constructed pond. The estimated presence of over 1000 tadpoles was never found at a constructed pond in 2011.

In 2012, there were 7 occasions where over 500 tadpoles were estimated to be present at a constructed pond. In contrast to 2011, the presence of greater than 1000 tadpoles was estimated to be present on 3 occasions at constructed ponds in 2012.

Constructed ponds at which tadpoles were recorded are given in Table 6.

Table 6. Constructed ponds at which tadpoles were observed in 2011 and 2012.

2011	2012
4 A and B	4B
7A and B	6A
9A	7A and B
10A and B	14A and B
14B	21A
21A	37A
23 A and B	38A and B
37A	43A and B
38B	

4.3 Toadlets

The earliest date on which toadlets were recorded in 2011 was June 4 at Magharees Pond 23. In 2012, toadlets were first recorded on June 3 at Lough Yganavan Area 1.

4.3.1 Traditional Breeding Sites

Toadlets were found at 9 of the traditional breeding sites in 2011 and in 8 of the traditional sites in 2012. This corresponds to a total of 12 sites or 22.64% of traditional sites where toadlets were recorded.

The highest mean density of toadlets at any site in 2011 was 14.1/m^2, recorded at Magharees Pond 23. In 2012, the highest mean density of toadlets was recorded at Lough Yganavan where a density of 33.6/m^2 was recorded.

The overall mean density at all the traditional sites surveyed in 2011 was 3.58/m^2 while in 2012 this was 8.4/m^2.

Traditional breeding sites at which toadlets were recorded are given in Table 7.

Table 7. Traditional sites at which toadlets were observed in 2011 and 2012.

2011	2012
Magharees Pond 23	-
Castlegregory Golf Club Pond 1 and 6	Castlegregory Golf Club Pond 2, 4
Lough Gill	Lough Gill
Roscullen Area 1	-
Lough Yganavan Area 1, 3, 4	Lough Yganavan Area 1, 3, 4
Caherdaniel Pond 2	Caherdaniel Pond 2, 3

4.3.2 Constructed Ponds

Within the quadrat survey toadlets were found at 2 of the constructed ponds in 2011 and at 1 pond in 2012. This corresponds to a total of 2 sites and represents 2.2% of these sites. The highest mean density of toadlets was 0.5/m². The overall mean density at all the constructed sites surveyed was 0.44/m².

It is noteworthy that in 2011 there were an additional 2 ponds where toadlets were observed outside of the quadrat survey. While no density information is available for these sites, this is still important information in relation to the successful breeding at the constructed ponds. Hence, survival to toadlet stage was observed in 4 constructed ponds, representing 4.3% of the constructed ponds.

Traditional breeding sites at which toadlets were recorded are given in Table 8.

Table 8. Constructed sites at which toadlets were observed in 2011 and 2012.

	2011	2012
Sites with toadlets observed within quadrats	21A	21A
	23B	
Sites with toadlets observed outside of quadrats	14B	
	37A	

Table 9. Summary for all ponds where toads were observed in 2011 and / or 2012

Site	2011			2012		
	Total Spawn	Max. Tadpoles	Max Toadlets/m²	Total Spawn	Max. Tadpoles	Max Toadlets/m²
10A	0	150	0	3	0	0
10B	0	100	0	0	0	0
14A	0	0	0	6	2	0
14B	0	25	0	1	80	0
21A	6	200	0.5	2	200	0.33
23A	3	100	0	0	0	0
23B	2	50	0.5	0	0	0
37A	0	700	0	1	100	0
37B	0	0	0	1	0	0
38A	0	0	0	1	300	0
38B	0	75	0	5	800	0
43A	0	0	0	3	100	0
43B	0	0	0	1	10	0
4A	2	200	0	8	0	0
4B	5	350	0	21	100	0
6A	7	0	0	23	800	0
7A	0	750	0	18	1000	0
7B	5	1000	0	89	2000	0
9A	0	100	0	0	0	0
9B	0	0	0	1	0	0
Caherdaniel 1	42	4000	0	43	1000	0
Caherdaniel 2	36	6000	0.27	28	500	0.29
Caherdaniel 3	24	2000	0	21	1500	0.67
CGC Pond 1	220	5000	1.69	181	7250	0
CGC Pond 2	150	10000	0	121	10050	4.13
CGC Pond 4	85	5000	0	81	6050	0.22
CGC Pond 6	13	5000	0.44	20	1850	0
CGC Pond 8	4	350	0	18	550	0
Dooks Pond 3	5	500	0	0	0	0
Dooks Pond 6	0	100	0	2	50	0
Lough Gill	0	2000	1.24	4	7150	0.06
LYG Area 1	13	1000	12.36	26	4000	33.6
LYG Area 3	15	6000	5.17	19	2000	4.53
LYG Area 4	11	6000	12	38	5000	24
LYG Area 5	27	2000	0	18	2500	0

	Total Spawn	Max. Tadpoles	Max Toadlets/m²	Total Spawn	Max. Tadpoles	Max Toadlets/m²
Magh Pond 1	149	750	0	81	17000	0
Magh Pond 23	112	100000	14.08	135	50	0
Magh Pond 6	1	0	0	0	0	0
Magh Pond 7	4	100	0	0	0	0
Magh Pond 8	3	0	0	0	0	0
Magh Pond 9	112	0	0	4	0	0
Quarry A	3	1000	0	9	100	0
Quarry B	2	2000	0	8	500	0
Ros.Is. Area 1	5	500	0	62	1000	0
Ros.Is. Area 2	0	0	0	3	20	0
Tullaree Pond 1	1	30	0	0	0	0
Tullaree Pond 2	18	60	0	1	350	0
Tullaree Pond 3	4	0	0	0	0	0

Table 9 contd.

4.4 Developmental stages recorded at all sites

The occurrence of spawn and tadpoles recorded at all monitoring locations in 2011 and 2012 is shown on maps in Appendix 1. Toadlet occurrence is not mapped, as this development stage had not been reached at all ponds by the end of the of the survey period.

4.5 Additional toad records during habitat survey

Tadpoles and toadlets were noted at the sites shown in Appendix 2 during the habitat survey undertaken during July and August 2011. This resulted in an extra four sites where toadlets were found.

4.6 Habitat data

4.6.1 Air and water temperature

The maximum air temperature recorded each week during the 2011 and 2012 fieldwork periods are shown in Figure 13. During 2012 the final set of pond visits extended into week 27 of the year. The median air temperatures for the survey periods of 2011 and 2012 were 14ºC (min=7.5ºC, max=25ºC) and 12ºC (min=3ºC, max=22ºC), respectively. The minimum temperature of 3ºC was recorded in April 2012, during which morning temperatures remained below 6ºC with a mean monthly temperature of 10ºC (±2.64).

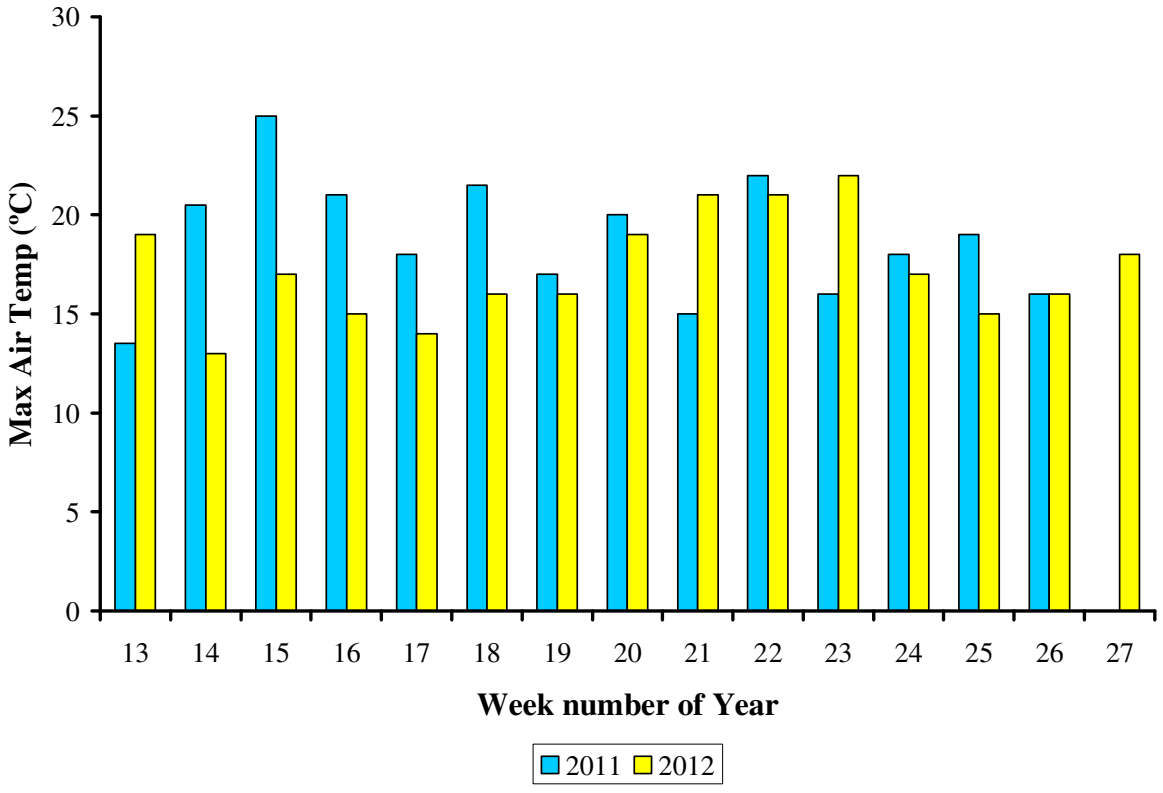


Figure 13. Maximum weekly air temperatures from April – June, 2011 and 2012.

The maximum weekly water temperatures recorded during the fieldwork periods are shown in Figure 14. Note that in Week 21 in 2011, no water temperatures were recorded. Also, the final set of pond visits during the 2012 survey period extended into week 27. The survey periods of 2011 and 2012 had median water temperatures of 16.9ºC (min=6.4ºC, max=29.2ºC) and 14.2ºC (min=6ºC, max=26.7ºC) respectively.

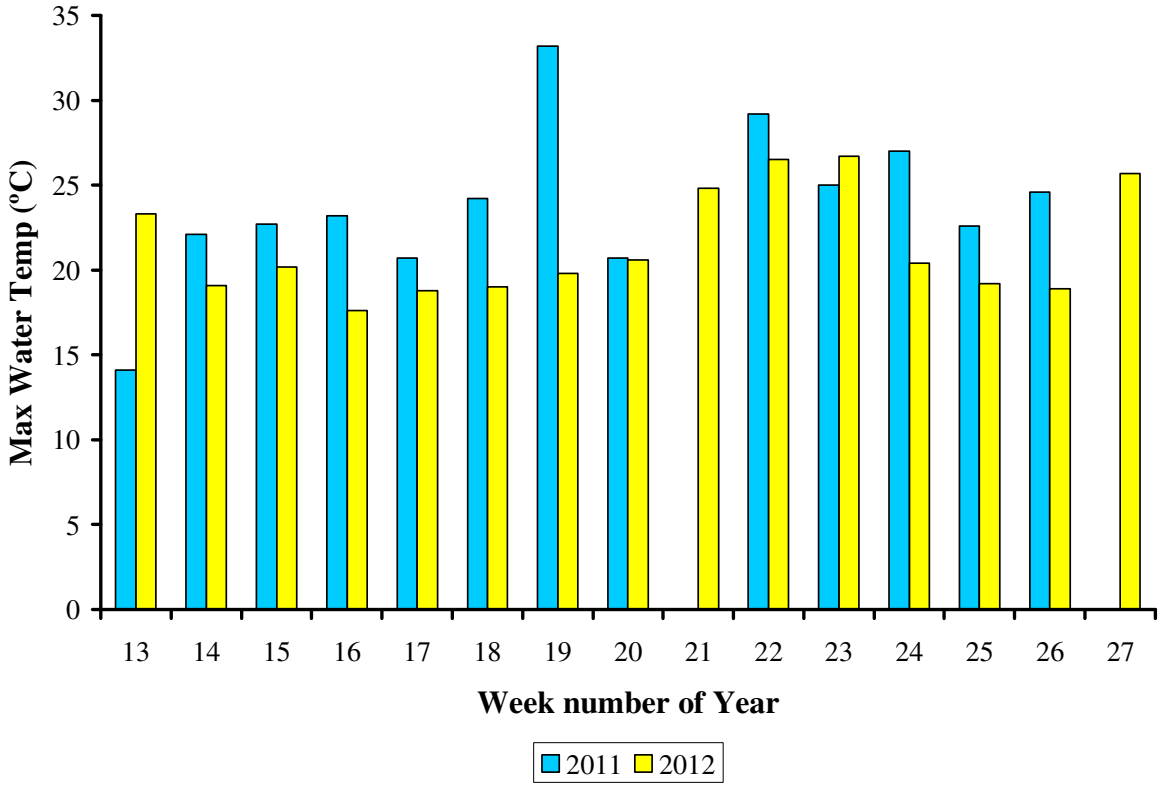


Figure 14. Maximum weekly water temperature from April – June, 2011 and 2012.

Weekly natterjack toad spawn string production for 2011 and 2012 and the corresponding maxima air and water temperatures are illustrated in Figures 15 and 16, respectively.

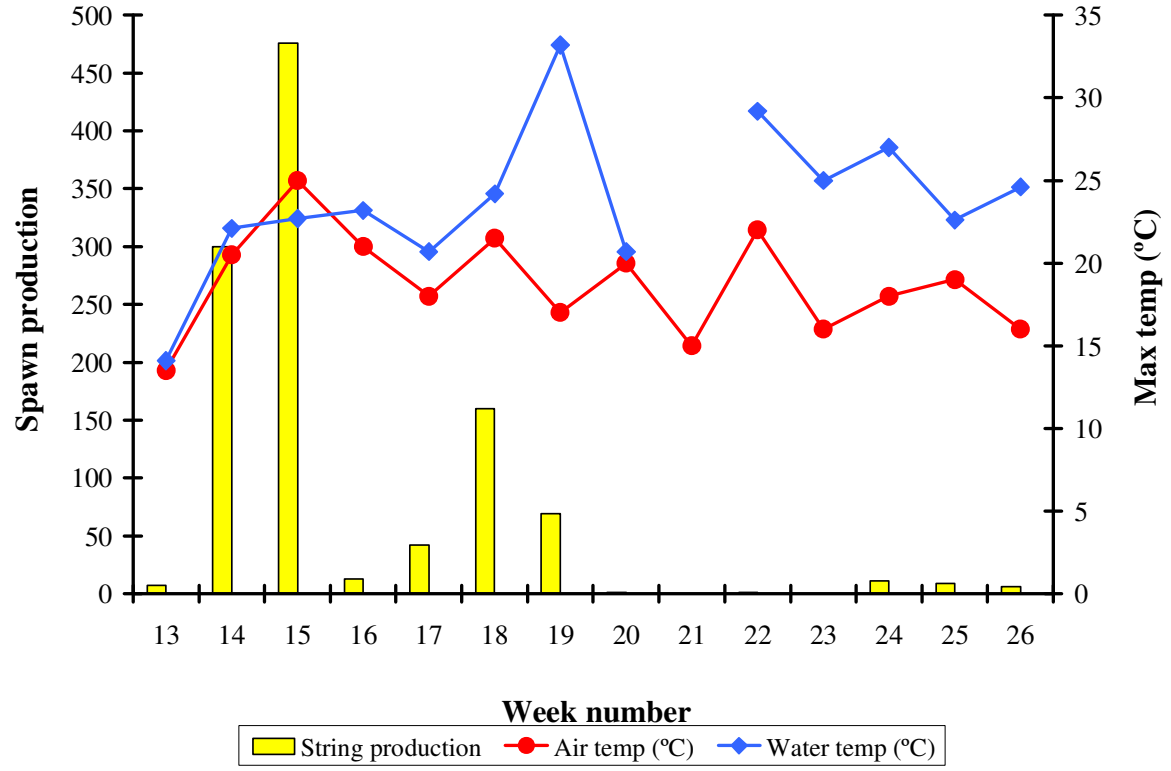


Figure 15. Spawn string production with weekly maximum air and water temperatures for 2011.

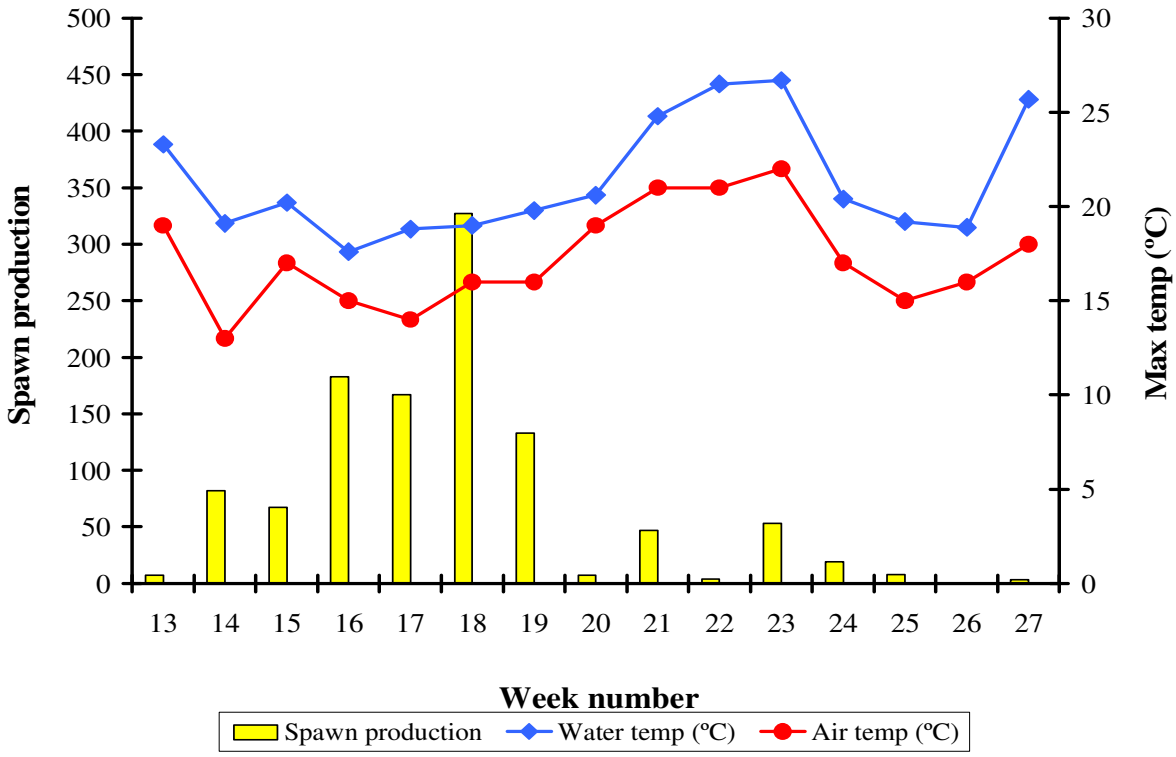


Figure 16. Spawn string production with weekly maximum air and water temperatures for 2012.

4.6.2 Conductivity, pH and Dissolved Oxygen

The median, minimum and maximum values of conductivity, pH and dissolved oxygen (D.O.) obtained during 2011 and 2012 fieldwork are detailed in Table 10.

Table 10. Conductivity, pH and D.O. values for 2011 and 2012.

Parameter	2011			2012		
	Median	Minimum	Maximum	Median	Minimum	Maximum
Conductivity (µS/cm)	248	58	18640	215	63	19120
pH	7.75	3.8	10.7	7.4	5.3	12.8
D.O. (mg/l)	9.25	0.68	19.87	4.91	2.04	11.16

The minimum conductivity values in 2011 and 2012 were both recorded at constructed ponds on the Dingle Peninsula, Ponds 26A and 32A. The maximum conductivity values were recorded at Pond 27B in 2011 at Cromane, Iveragh Peninsula, and at Pond 46A near Inch Strand, Dingle Peninsula. Both ponds are situated in a coastal setting. On 7 occasions in 2011 and on 4 occasions in 2012, the conductivity meter reported an error reading, as the conductivity was above the scale of the meter. This was due to the influence of saline water.

The minimum pH in both 2011 and 2012 were recorded on the Dingle Peninsula, Ponds 5B and 7A respectively. Maximum pH values were also recorded at sites on the Dingle Peninsula, Pond 8B in 2011 and 45B in 2012.

The minimum D.O. concentration in 2011 was noted at Pond 44B. The site visit to this pond took place at 9.40 a.m. and the pond area had reduced to 2m². In 2012 the minimum D.O. value was recorded at Pond 20B, Dingle Peninsula. The maximum D.O. values were recorded at Magharees Pond 1 in 2011 and at Caherdaniel Pond 3.

4.6.3 Substratum and aquatic vegetation

The percentage of the substratum covered by vegetation was estimated for each pond. For some ponds, the water was too dark to see the bottom, but it can be assumed that the vegetation cover in these ponds was nil to low due to the low light levels reaching the bottom. The estimated vegetation cover of the substratum ranged from 0% to 100%. Typical species that were recorded include *Callitriche* spp. and charophytes. Many of the traditional areas, such as Roscullen Island Areas 1 and 2, the Field on the Iveragh Peninsula and Ponds 4 and 5 of Dooks Golf Club, had 100% substrate cover as these sites include a mix of natural vegetated wet habitats, such as wet heath, wet grassland, and reed/sedge swamps. In 2011, 3 constructed ponds on the Iveragh Peninsula, Ponds 18B, 30B and 31B, also recorded 100% substrate cover. This cover was due to the encroachment of grass species, such as *Agrostis stolonifera*, covering the substrate of these shallow ponds as the survey season progressed. In 2012, Pond 18B was dredged and the rushes surrounding Pond 30B were cut.

Surface aquatic vegetation cover was also estimated at each pond. Measurements ranged from 0% to 98% at different ponds. Typical species recorded include *Glyceria* spp. and *Potamogeton* spp. Surface vegetation cover greater than 80% occurred during late April and May of both survey periods.

One non-native species notable for its high invasiveness was recorded at Castlegregory Golf Club Pond 1. This is *Crassula helmsii* (the New Zealand pygmyweed).

4.6.4 Surrounding sward

In 2011 at 39 (41.49%) of the constructed ponds ≥80% of their surrounding sward fell into the category 'greater than 20cm' high. At 17 (18.09%) of the constructed ponds ≥90% of the ponds' surrounding sward was greater than 20cm high. In 2012 the number of constructed ponds that had ≥80% of their sward in the 'greater than 20cm' category was 32 (34.04%). Seventeen of these ponds had ≥90% of their surrounding sward greater than 20cm in height. The site numbers of these ponds are given in Appendix 3.

4.6.5 Surrounding habitats

Thirty nine Fossitt level 3 habitat classes were identified within a 100m radius of the monitoring sites. Four habitat types occurred at greater than 50% of sites; wet grassland (GS4), improved agricultural grassland (GA1), scrub (WS1) and drainage ditches (FW4). Six habitat types were recorded at 30-50% of sites; artificial ponds (FL8), reed/sedge swamps (FS1), hedgerows (WL1), earth banks (BL2), marram dunes (CD2) and fixed dunes (CD3).

Four Fossitt habitat types were found to be significantly correlated to the successful breeding of natterjack toads (n=143). Table 11 details the habitat types and corresponding r values.

Table 11. Significant correlations between habitat types and breeding

Habitat Type	Spearman's rho	Significance Level
FL8 (other artificial lakes and ponds)	0.401	0.01
CD3 (fixed dunes)	0.676	0.01
ED2 (bare ground)	0.794	0.05
LS5 (mixed sediment shores)	0.862	0.01

4.6.6 Potential barriers

Approximately 30% of the sites surveyed have a potential barrier between the next nearest set of ponds. Distance between ponds was recorded as the main barrier between some of the ponds.

4.6.7 Site management

The management of the habitats surrounding the sites varies considerably. Some of the sites are located within agricultural land and are grazed by cattle, sheep or horses. For the sites on agricultural land that are in the NPWS Natterjack Toad Scheme, sward height is managed by grazing and/or cutting.

The sites on the Magharees are on commonage land that is grazed by the livestock of a number of commonage shareholders. Commonage Framework Plans (CFPs), available on http://www.commonage.agriculture.gov.ie, prescribe the management conditions for these areas. The CFPs relevant to the Magharees are those for Management Units KE23C, KE23D and KE23E.

The ponds that are located within golf courses at Castlegregory and Dooks are surrounded by habitats that are managed for golf. This includes areas where the sward is mown very short and others where the sward is untouched.

In most of the agricultural land and the golf courses, the ponds are surrounded by habitats with short sward. This type of management is beneficial to the natterjack toads which need areas of short sward for foraging (Beebee, 2002). However, there are a number of sites where grazing or mowing either did not take place or was insufficient to maintain a short sward during the survey season and vegetation was very rank and dense. This type of vegetation structure is generally believed to be disadvantageous to the natterjack toad. However, at some of these sites, natterjack toads did breed, most notably at Tullaree, although it is possible that breeding would have been more successful if more management of the sward was carried out.

4.6.8 Natterjack toad developmental stages and physicochemical associations

In 2011 five parameters were significantly correlated with the abundance of spawn strings, eight with tadpole abundance and one with toadlet abundance. In 2012 seven parameters were significantly correlated with spawn strings, nine with tadpoles and five with toadlets. The parameters and associated r values are given in Tables 12A and 12B below. R values were small with the greatest value being 0.291.

Table 12A. Significant correlations (r values) between physicochemical parameters and breeding, 2011

Parameter	Spawn strings	Tadpoles	Toadlets
Air Temp (ºC)	---	---	0.0708*
Water Temp (ºC)	---	0.135**	---
Conductivity (µS/cm)	0.100**	0.084*	---
pH	0.219**	0.221**	---
Substrate cover	0.139**	0.291**	---
Surface cover	---	0.107**	---
Bare sward	0.091*	0.095**	---
<5cm sward	0.121**	0.175**	---
>20cm sward	---	-0.152**	---

Table 12B. Significant correlations (r values) between physicochemical parameters and breeding, 2012

Parameter	Spawn strings	Tadpoles	Toadlets
Air Temp (ºC)	-0.136**	0.127**	0.121**
Water Temp (ºC)	-0.144**	---	0.098**
Conductivity (µS/cm)	0.150**	0.093**	---
pH	0.211**	0.132**	---
Substrate cover	0.154**	---	---
Surface cover	---	-0.180**	-0.090*
Algae cover	---	-0.111*	-0.074*
Bare sward	---	-0.113**	---
<5cm sward	0.162**	0.146**	---
5cm-20cm sward	---	0.082	-0.131**
>20cm sward	-0.110**	-0.063**	---

*Correlation is significant at the 0.05 level.

**Correlation is significant at the 0.01 level.

4.7 Threats

4.7.1 Ponds drying

In 2011, 18 traditional sites dried out during the survey period. Five of these, all on the Magharees, had spawn and/or tadpoles present at the time when they dried. 228 strings of spawn were recorded in these ponds. Seven constructed ponds dried during the survey period. None of these had spawn or tadpoles present. In 2012 20 traditional sites dried out at some point during the survey period. Seventeen of these refilled for a time, but became dry again and remained so until the end of June. Only one of these traditional sites had spawn present, which amounted to 4 strings. Eight constructed ponds dried in 2012, but no spawn or tadpoles were recorded at these ponds. The site names or codes, along with the date of drying and the presence of spawn or tadpoles are given in Appendix 5.

4.7.2 Predators

Beebee (1979) states that the great diving beetle (*Dytiscus marginalis*) is a major predator of natterjack tadpoles and that, in captive conditions, can kill up to 20 tadpoles per day. Other natterjack tadpole predators of significance reported by Banks and Beebee (1988) are backswimmers (*Notonecta* spp.), Odonata nymphs and the crested newt (*Triturus cristatus*). Great diving beetles, backswimmers, dragonfly and damselfly nymphs are widespread at the sites surveyed. The crested newt does not occur in Ireland, but the smooth or common newt (*Lissotriton vulgaris*), which is known to eat frog tadpoles (personal observation) and could therefore possibly eat natterjack tadpoles, was found at 17 sites (Appendix 6). The horse leech (*Haemopis sanguisuga*), which is widespread at the sites, also eats tadpoles (Elliott and Mann, 1979).

Beebee (2002) states that *Bufo* tadpoles are distasteful to most fish species. However, available literature mostly refers to the common toad (*Bufo bufo*). No information could be found on whether brown trout (*Salmo trutta*), which are plentiful in both Lough Gill and Lough Yganavan, will eat natterjack tadpoles.

A heron (*Ardea cinerea*), was regularly seen at the Quarry ponds at Glenbeigh. On May 30 2011 approximately 100 tadpoles were present at Pond B, a tenfold drop from the 1000 or so tadpoles recorded in the previous visit. Numerous heron imprints were seen on the mud throughout the pond, No obvious potential prey for herons, other than the natterjack tadpoles, had been present.

4.7.3 Other risks

Inundation with saline water occurred at Pond 18A in 2011. This pond is adjacent to the Keal river estuary. A drain running the length of the field in which Pond 18A is situated backed-up with sea water and flooded both the field and pond. An error reading for conductivity was recorded at the time of the flooding and during the subsequent visit to the pond, by which time the flooding had receded.

Overgrown surrounding vegetation, getting to a state where movements of toad would be difficult, could be causing problems at some ponds.

Banks and Beebee (1987) found that growth rates of natterjack tadpoles were grossly inhibited when large numbers of common frog tadpoles were present. Common frogs are widespread at the toad sites and are present in high numbers at some sites.

Trampling by the cattle at some traditional breeding sites, particularly in the Magharees and Lough Yganavan, contributes to increased mortality of eggs and tadpoles.

4.8 Other amphibians

4.8.1 Common frog (Rana temporaria)

The presence of frogs was noted at 10 traditional sites and 36 constructed ponds in 2011. Both these numbers increased in 2012 with 12 traditional sites and 40 constructed ponds having positive record for frogs. These sites are listed in Appendix 6.

4.8.2 Smooth newt (Lissotriton vulgaris)

During the pond survey from April to June 2011, the presence of newts was noted at 6 traditional sites and 5 constructed ponds. They were also recorded at 3 ponds during the habitat survey in July and August 2011, two of which had not been previously recorded for the presence of newts. In 2012 only three traditional sites and 4 constructed ponds had newts present. These sites are listed in Appendix 6.

5 CONCLUSIONS & DISCUSSION

A total of 1067 spawn strings were counted during the 2011 field survey period of the present study. There were 9 sites where no spawn was recorded, but where tadpoles subsequently were. It is probable that in most of these cases, particularly at 7 constructed ponds, the numbers of spawn strings at the sites were low, possibly only single strings. This corresponds to relatively low numbers of tadpoles recorded at these constructed pond sites. However, in Lough Gill, where surveying the shoreline is difficult, c. 15000 tadpoles were subsequently encountered. Based on the proportion of spawn strings to tadpoles recorded in Lough Yganavan, the presence of c. 15000 tadpoles in Lough Gill would indicate that about 16 spawn strings had been present at the site. During the preliminary site visits with the local Conservation Ranger, some additional spawn was also seen.

In 2012, the total number of spawn strings counted was 1107, an increase of 40 on the 2011 figure. However, an examination of the figures for spawn strings and tadpole numbers recorded points to fewer strings missed in 2012. The total estimate for these sites, using the methods described above is 1120 spawn strings, a 1.8% increase on 2011.

The small increase in spawning recorded is mostly due to breeding in the constructed ponds. In 2012, spawning occurred in seven of these ponds where there had been no breeding recorded in 2011, while only three of the ponds used in 2011 had no spawn in 2012. Statistical analysis also shows a significant increase in the number of spawn strings in constructed ponds in 2012. By contrast, many of the traditional breeding sites performed poorly in 2012, with no spawn recorded at five that were used in 2011. The numbers of spawn strings at the traditional breeding sites mostly declined also, particularly in the Magharees and Castlegregory Golf Club.

A smaller survey in June 2011 of natterjack toads breeding on the northern side of the Dingle Peninsula (Korky, 2011) found similar results to those of the present survey, with the exception of Lough Gill and Lough Naparka (Magharees Pond 1 of the present survey), where no spawn or tadpoles were recorded. An ongoing decline in natterjack toad breeding in the Magharees is noted.

Weather conditions in 2011 and 2012 were bad for natterjack toad breeding, particularly in the Magharees. Weather data given on the Met Éireann website [http://www.met.ie/climate/monthly_summarys] show that before the breeding season began in 2011, the weather had been very dry, with only 48% of the monthly average precipitation for March (based on 1961-1990 data). This resulted in low water levels at many sites. Most of the rainfall in April 2011 was in the first week. Then conditions became mostly dry and warm, with Valentia Observatory recording the warmest April in over a century of records. The rainfall in early April, combined with the warm conditions, probably stimulated the peak in breeding activity at this time (see Figure 15).

The period April 15 to 30 2011 was dominated by high pressure close to Ireland. Rainfall recorded at Valentia Observatory for April was 88% of the monthly average. May and June were generally unsettled, with higher than the average rainfall amounts for those months. The early dry conditions were undoubtedly responsible for pools drying up. The warm, dry conditions in the second half on April 2011 might have stimulated the interruption in spawning recorded (see Figure 15). As spawning levels were so low, it appears unlikely that much of the later spawning recorded in 2011 was double clutching, but rather a recommencement of first spawning. Spring 2012 was also dry, with the Met Éireann spring summary reporting rainfall at the Valentia station at only 68% of the average for the March to May period. Although in April 2012, the rainfall was 123% of the average for that month,

March and May were very dry, with corresponding figures of 34% and 57%, respectively. Thus, in the 2012 breeding season, insufficient rainfall was again largely responsible for the desiccation of ponds.

Bécart *et al*. (2007) estimated the adult toad population for 2004 to 2006 by first dividing the number of spawn strings by 0.65 to get the number of breeding females, based on a European study by Aubry & Emmerson (2004) which showed that, on average, 65% of the adult female population breeds each year. An assumption of a 1:1 male to female ratio is made, and the number of females is multiplied by 2 to get the total adult toad population.

The total Irish population of natterjack toads, estimated for the years 2004, 2005 and 2006 by Bécart *et al*. (2007), was 4089, 11283 and 12612, respectively. These figures do not take the population at the back of the Inch Spit or the Wexford population into account. There could also be some breeding in other small pools or drains within the study area, but it would appear unlikely that these would add significantly to the total numbers. The results of the 2004-2006 survey indicate that the proportion of breeding females in Kerry varies considerably from the European yearly average of 65% of the adult female population reported by Aubry & Emmerson (2004). For 2005, Bécart *et al*. (2007) reported the number of spawn strings to be 2.8 times that of 2004. It is therefore obvious that, in a dry season, a higher proportion of adult female toad do not breed. Consequently, the results of a single breeding season should not be looked at in isolation.

Using figures of 1100 and 1120 for the numbers of spawn strings laid in 2011 and 2012 respectively, and presuming no double clutching, the formula gives a figure of 3385 for the total adult population in 2011 and 3446 for the total adult population in 2012, at the sites assessed.

While the population figures for 2011 and 2012, calculated by the above formula, are less than one third of those obtained by Bécart *et al*. (2007) for 2005 and 2006, a population decline of this magnitude should not be presumed, as the effects of weather conditions on water levels in ponds must be taken into account. This is particularly seen in the pattern of ponds drying in the Magharees. The 2004-2006 survey recorded water present from the beginning of the season until metamorphosis had occurred in Pond 1 in 2004, in Ponds 1 and 23 in 2005 and in Ponds 1, 4 and 23 in 2006. In 2004, there were only three other ponds that had water at the beginning of the season that subsequently dried, while the corresponding figures for 2005 and 2006 are ten and eight, respectively (Bécart *et al*., 2007). In the present survey, water was present from the beginning of the season until metamorphosis had occurred in Magharees Ponds 1 and 23 in both 2011 and 2012, while six other Magharees ponds that had water at the beginning of the 2011 season subsequently dried. Five other Magharees ponds that had water at the beginning of the 2012 season subsequently dried. Thus, conditions in 2011 and 2012 were less favourable for natterjack toad spawning than in 2005 and 2006. If the natterjack toad population remained at the calculated 2006 level, the number of spawn string produced in 2011 and 2012 would indicate that approximately 27% of the adult female population bred in each year, rather than the European average figure of 65%.

The population figures calculated for 2011 and 2012 are still, however, less than 85% of the population figure calculated for 2004, a year with less favourable breeding conditions. It is likely that some reduction in the natterjack toad population has occurred in the intervening period. Further evidence of a population decline is seen in the fact that several of the traditional breeding sites, such as Lough Nambrackdarrig, Fermoyle, Iveragh Peninsula Field and Marsh and most of the Dooks Golf Club ponds are no longer used by natterjack toads for breeding.

While the results of the present survey suggest a decline in the overall population of natterjack toad in Kerry, it is interesting to compare the relative importance of individual sites, based on numbers of

toad spawn recorded, to the results of the 2004-2006 survey. Bécart *et al*. (2007) found that Castlegregory Golf Club contributed the highest proportion (43.1%) of egg strings to the population in 2004, while the Magharees contributed the highest proportion in 2005 (26%) and 2006 (27.5%). The current survey found that the population in Castlegregory Golf Club contributed the highest proportion of egg strings in both 2011 (43%) and 2012 (38%), while the Magharees contributed the second highest proportion, with 34.6% in 2001 and 19.6% in 2012 (see Appendix 7). In 2012 the total number of egg strings recorded at Roscullen Island (both in traditional and constructed ponds) also accounted for 19.6% of the total population. This suggests that the habitat conditions at these sites, in particular, need to be maintained in a favourable status for the natterjack toad. It also suggests that these areas may be the most suitable areas for population expansion and more pond construction.

As tadpoles were still present in most breeding ponds and some spawn was also present at the end of the field survey season, the Kiritani-Nakasuji-Manly method (KNM method) used by Bécart *et al*. (2007) could not be used for estimating survival rates using this data.

There are a number of factors that could affect a decline in the Irish population of the natterjack toad. Korky (2011) suggests that the severe Irish winters of 2009/2010 and 2010/2011 likely increased toad mortality. Indeed, the Met Éireann website reports that December 2010 was the coldest month on record across Ireland since January 1963. However, it must be remembered that natterjack toads survive the winter weather on the Baltic coast of Estonia, where low temperatures are the norm.

Ponds in the dune slacks of the Magharees dried out in both 2011 and 2012. This reduced the number of available breeding ponds and lead to breeding dead ends for spawn laid in ponds that subsequently dried out before metamorphosis to toadlet stage occurred. This problem was also highlighted by Bécart *et al.* (2007) and by Korky (2011). In 2011, 228 spawn strings were counted in ponds in the Magharees that dried before metamorphosis took place. In 2012, only four spawn strings encountered the same fate. The corresponding figures for 2004, 2005 and 2006 were, 23, 541 and 602, respectively (Bécart *et al*., 2007). As this represents a considerable proportion of the adult female natterjack toads in this area that spawned, but for whom procreation was not successful, it could have serious implications for the population. While Beebee (2002) reported that up to 25 ponds could form in the dune system and Bécart *et al*. (2007) reported that in 2004-2006, nine ponds formed and were used for breeding, in 2011 and 2012 the number of ponds holding water for any period was eight and seven, respectively. Bécart *et al*. (2007) suspect a drop in the water table, due to possible changes in water resource, as a cause, combined with an increase in the number of cattle and other animals on the dunes. Interestingly, two ponds that held water at the beginning of the 2004 survey were dry throughout the present survey, while three ponds that were dry in 2004 held water at the beginning of both the 2011 and 2012 survey seasons. This suggests that a drop in the water table is not uniform throughout the area and might point to differences in water resource utilisation.

In addition to the list of ponds that dried completely during the survey period, presented in Appendix 5, the volume of water in other ponds diminished to the extent that spawn strings were no longer in water or tadpoles were crowded into small shallow pools, making them vulnerable to predators (Plates 4 and 5).

Plate 4. Magharees Pond 7, April 10 2011 (*Caroline Hurley*)

Plate 5. Magharees Pond 7, April 18 2011 (*Caroline Hurley*)

Natterjack toad breeding success at Lough Yganavan was affected by wind, particularly in 2012. Throughout much of April 2012, the wind was strong and predominantly from a south-westerly direction, with gale gusts recorded at the Valentia station by Met Éireann on 11 days. This resulted in strong wave action hitting the shoreline at Lough Yganavan Areas 4 and 5 for the main part of the spawning season. Consequently, natterjack toads were found to spawn in small temporary pools up

from the shoreline. None of this spawn developed to tadpole stage and much appears to have been eaten by predators.

Analysis of habitat types surrounding the breeding ponds is important; habitat loss has been identified as the main cause of decline in some natterjack toad populations (Rannap *et al.,* 2007). Statistical analysis of the correlation between natterjack toad breeding and occurrence of different habitat types around the monitoring sites of the present survey showed four habitats to have a statistically significant correlation with breeding. The correlation values must be taken into account here. Correlation values range from -1.00 to 1.00 and indicates the strength of the relationship between variables. Correlation values are small when ranging from 0.1 to 0.29, medium from 0.3 to 0.49 and large from 0.5 to 1.0 (Cohen, 1988). Furthermore, the significance of some of these correlation values could have been influenced by the large sample sizes in this study, as small correlations may reach statistical significance in large samples greater than 100 (Pallant, 2010).

The four habitats showing significance, other artificial lakes and ponds (FL8), fixed dunes (CD3), bare ground (ED2) and mixed sediment shores (LS5) were positively correlated with breeding, the first with a medium strength correlation and the other three with strong correlations. Dune habitats are undoubtedly important, as these are the traditional strongholds of the natterjack toad. The correlation is strong and highly significant, with 14 breeding sites in the Magharees, Castlegregory Golf Club and Caherdaniel, having a high proportion of this habitat type surrounding the ponds. The positive correlation with other artificial lakes and ponds is due to 17 breeding sites, mostly in the NPWS Natterjack Toad Scheme, being within 100m of another constructed pond. The statistically significance of bare ground is due to its high occurrence at the Quarry sites and the correlation with mixed sediment shores is due to the location of sites 43A and 43B close to the sea wall.

Among the physicochemical parameters showing statistical significance with natterjack toad breeding, there are some obvious reasons for the correlations found. Toadlets are positively correlated with air temperature because they develop later in the survey period, when air temperatures have increased. The situation is similar for the correlation between tadpoles and water temperature. The reason for the positive correlations with pH and conductivity is because average values for these two parameters are naturally higher in sand dune areas.

The positive correlation with the coverage of the substratum by plant material is probably due to the natural high coverage at traditional breeding sites in the Magharees, Castlegregory Golf Club and Caherdaniel.

The significant correlations with sward height, although not shown to be strong, are still worth considering, as it is logical that, for toads to access the breeding sites, easy passage through short vegetation is an advantage. Stevens *et al.* (2006) also demonstrated that dispersing toadlets also prefer low vegetation. The strongest correlations found between sward height and breeding in the present study were with sward height of less than 5cm. 61.5% of breeding sites were found to have more than 20% of the surrounding area with a sward height of less than 5cm, while the corresponding figure for sites where no breeding occurred is 51.2%. This second figure includes many constructed ponds where factors other than sward height are likely to have been the reason for lack of breeding activity. For this reason, and from field observations, it is felt that sward height influences natterjack toad breeding to a greater extent than indicated by the results of the statistical analysis carried out here.

Connectivity between the new constructed ponds and the traditional breeding areas is obviously important if the new ponds are to be colonised by natterjack toads. Identifying and assessing barriers to natterjack toad movement across the landscape is difficult given the scale of the current survey and the lack of information available on actual physical barriers to toad movement. It is known that natterjack toads can occasionally move up to 1km or more from their breeding site (Beebee, 2002;

Miaud *et al.*, 2000). They have been known to cross streams, roads, embankments, ditches and, rarely, mudflats at low-tide. Hence, in this study, potential barriers were recorded, and these may vary in terms of permeability for the toads. For instance, a potential barrier of a muddy estuary was recorded between Glenbeigh Quarry and Ponds 12A and B. However, some toads may cross this barrier at low tide. Similarly, rivers have been recorded as potential barriers, but again, the variation in speed of flow and width of these rivers may present a variation in the permeability of the barriers to the toads. Distance between ponds appears to be the main barrier between some of the ponds. For example, a distance of 4.5km lies between Ponds 44A&B and the next nearest ponds to the west (8A&B), a distance that might be too great for natterjack toads to complete. Construction of additional new ponds between those that are currently far from any other would increase their likelihood of being used by natterjack toads.

Predators undoubtedly ate a considerable proportion of the natterjack toad tadpoles produced in the study area. This predation is natural and probably no greater than in other natterjack toad populations. Where tadpole densities are high in shallow pools, they would be more susceptible to predation by large predators, such as herons. Increasing the spread of spawning into a higher number of sites might diminish such predation somewhat.

Enhancement of existing habitats, where possible, would be beneficial to the natterjack toad populations in Kerry. The most obvious improvement would be control of vegetation surrounding the breeding ponds. Such vegetation control by cutting and/or grazing is a condition for inclusion in the NPWS Natterjack Toad Scheme. At traditional breeding sites, particularly the three ponds at Tullaree, some clearance of high vegetation with a strimmer before breeding commences would be advantageous for toads.

Korky (2011) advocates the widening and deepening of the traditional breeding sites in the Magharees. This, however, would be problematical, as the Magharees are within the Tralee Bay and Magharees Peninsula, West to Cloghane Special Area of Conservation (SAC 002070). One of the Qualifying Interests for this SAC is "Humid Dune Slacks" (Code 2190). Physically changing this habitat could be considered contrary to the Conservation Objectives of the SAC.

Given that, in Ireland, a cow can drink up to 110 litres of water on a very hot day (Ryan, 2009), it appears possible that cattle are contributing to the desiccation of ponds in the Magharees, due to the substantial intake of water by these animals, particularly in good weather when water is already being lost through transpiration and evaporation. The livestock numbers and grazing regime on the commonage areas of the Magharees are prescribed in the Commonage Framework Plans for Management Units KE23C, KE23D and KE23E. However, the grazing prescriptions in these plans are based primarily on vegetation coverage and condition. Revision of these plans to take the requirements of natterjack toad into consideration could be of significant benefit in terms of reduction in both desiccation and damage by trampling.

When another dry spring is encountered and ponds with spawn in the Magharees are drying up, it might be worth considering the translocation of this spawn to suitable constructed ponds that are not being used for breeding.

In summer 2011, a short causeway was constructed across a small bay in Lough Yganavan Area 1. This resulted in a small body of water being cut off from the main lake (Plate 6). In 2012, increased breeding here resulted in a doubling of spawn production at this site, from 13 strings in 2011 to 26 in 2012.

Plate 6. New causeway at Lough Yganavan Area 1, cutting off bay to left (*Pascal Sweeney*)

The creation of this causeway, which inadvertently improved natterjack toad breeding habitat, demonstrates the benefits of creating a small sheltered area of water. The main section of Lough Yganavan that is subject to wind and wave disturbance is Area 5, where toad spawning is often unsuccessful, due to spawn being laid in temporary pools beside the lake, when conditions are rough. Lines of locally sourced sandstone boulders placed parallel to the shore along sections of this area could create areas of calmer water and enhance breeding success. While this area is within the Lough Yganavan and Lough Nambrackdarrig Special Area of Conservation (SAC 000370) for which "Oligotrophic Waters Containing Very Few Minerals of Sandy Plains (Littorelletalia uniflorae)" (Code 3110) is a Qualifying Interest, it is considered that such introduction of boulders could be done without having any negative impacts on the Conservation Objectives of this Natura 2000 site.

Construction of some more new ponds in the NPWS Natterjack Toad Scheme could be of benefit. Any such pond creation should be targeted for areas where there is greatest likelihood of utilisation of these ponds. Five locations are suggested, which would be subject to landowner co-operation. The first is between Gowlane Ponds 47A&B, which are currently unused and the Castlegregory Golf Club ponds, one of the main breeding areas. This location is also close to sand dunes, a habitat shown to have a significant, strong correlation with breeding. The second suggested location is between Lough Gill and Tullaree. Wet habitats occur between these two sites and it is likely that the natterjack toad currently breeds in some of this area. However, the creation of some new ponds would aid survivorship of toadlet stage in dry summers. On the southern side of the Dingle Peninsula, natterjack toad breeding at the traditional sites at Roscullen Island has expanded westwards to Killeen 6A (see Appendix 1, Map 5). Further westward expansion seems possible. To aid this, creation of new ponds would be desirable, to link up existing constructed ponds, where distances between ponds might currently be an obstacle. Two locations are suggested here, one between Lack 45A&B and Aughils 39A&B and another between Aughils 44A&B and Inch 8A&B. The final suggested location for

additional constructed ponds is in the vicinity of Iveragh Peninsula Ponds 43A&B, where breeding occurred for the first time in 2012, having spread from the nearby Iveragh Peninsula Pond 21A.

Overall, while some decline in the Irish population of natterjack toads appears to have occurred between the 2004-2006 survey and the 2011-2012 survey, the 2012 results from the newly constructed ponds, both in terms of numbers of spawn strings and sites utilised, are encouraging. It indicates that the creation of new constructed ponds for the NPWS Natterjack Toad Scheme is beginning to show positive results and has potential for greater success.

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APPENDIX 1: Toad breeding activity at all sites – spawn and tadpoles

MAP LEGEND:

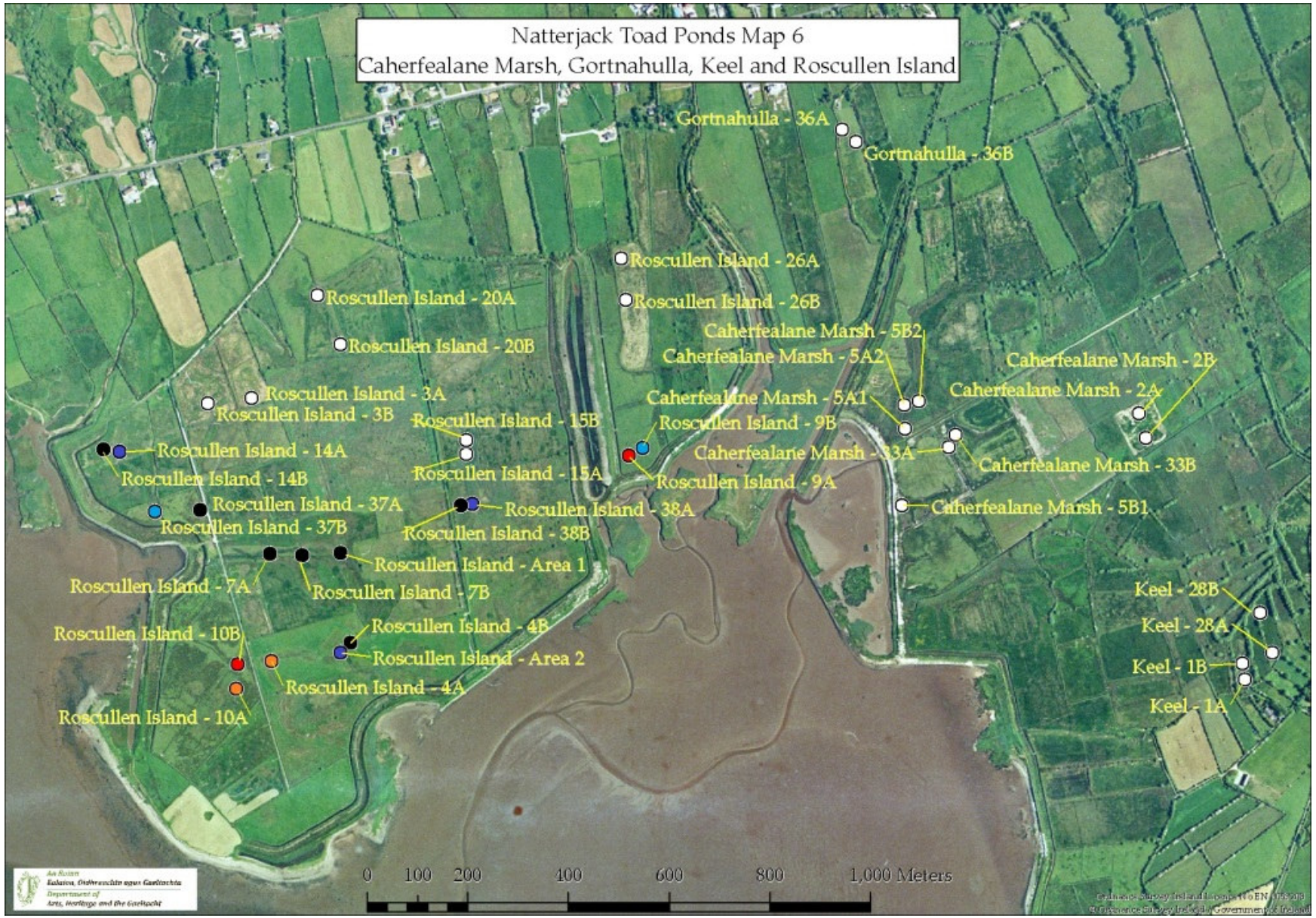

Natterjack Toad Ponds Map 1
Lough Gill and Magharees
Magharees - 4 complex
Magharees - 7
Magharees - 6
Magharees - 8
Magharees - 1
Magharees - 9A
Magharees - 9
Magharees - 12
Magharees - 15
Magharees - 16
Magharees - 17
Magharees - 18
Magharees - 19
Magharees - 22
Magharees - 23
Lough Gill - Sluice
0 100 200 400 600 800 1,000 Meters

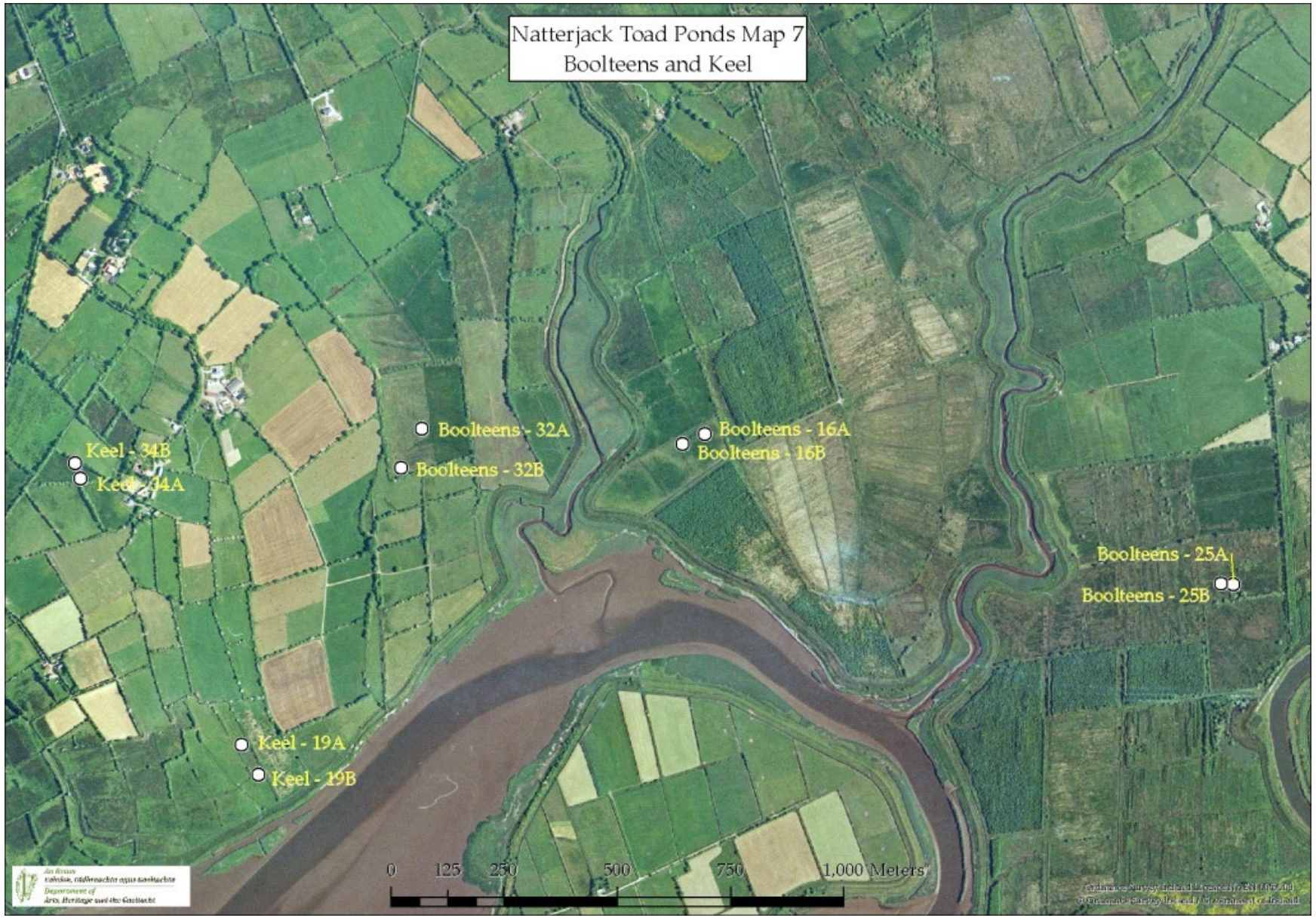

Natterjack Toad Ponds Map 2
Castlegregory Golf Course, Fermoyle and Gowlane
Castlegregory - 5
Castlegregory - 4
Castlegregory - 2
Castlegregory - 1
Castlegregory - 3
Castlegregory - 6
Gowlane - 47A
Gowlane - 47B
Fermoyle - 3
Fermoyle - 1
0 150 300 600 900 1,200 Meters


Natterjack Toad Ponds Map 3
Tullaree
Tullaree - 3
Tullaree - 2
Tullaree - 1
0 25 50 100 150 200 250 Meters

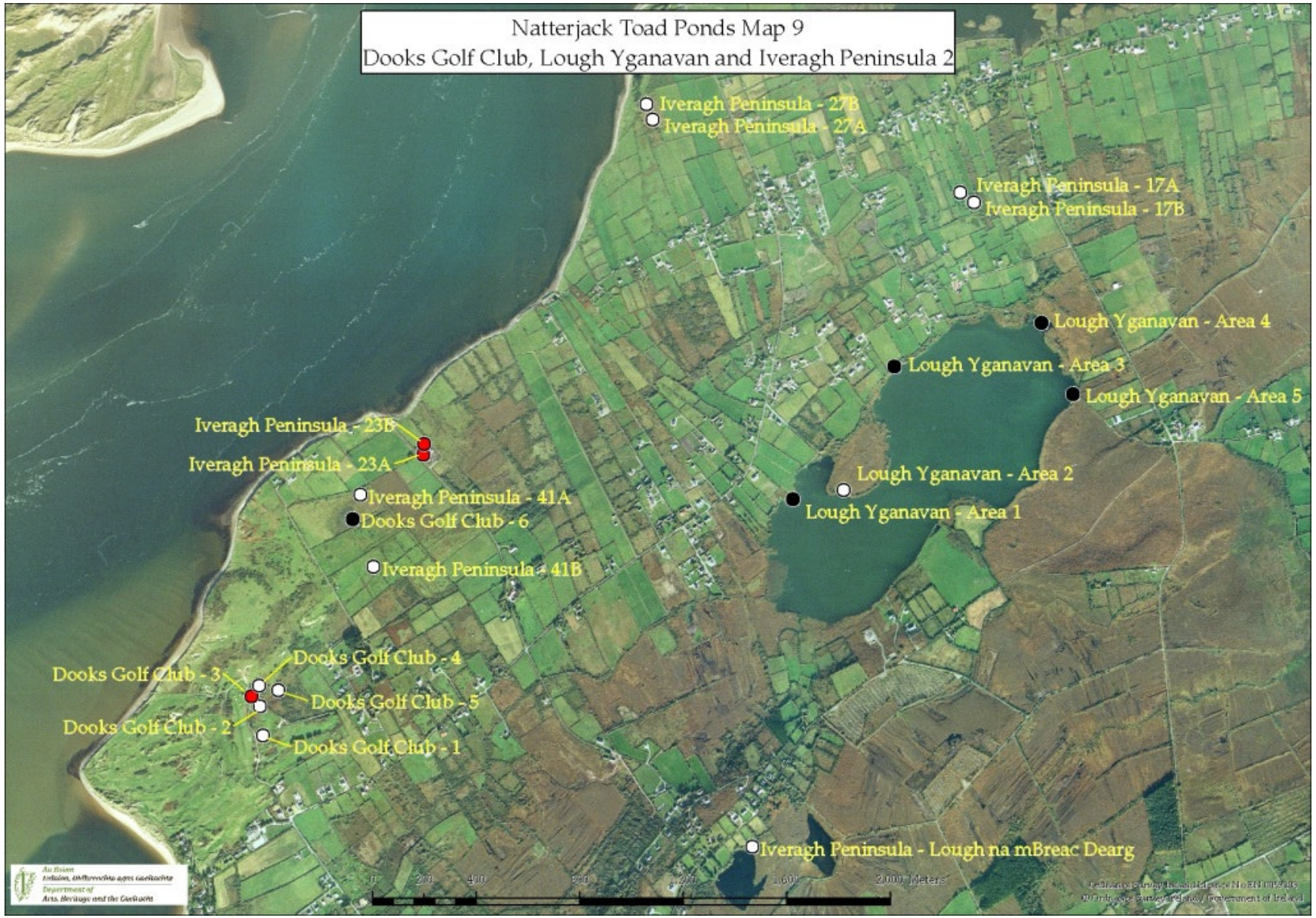

Natterjack Toad Ponds Map 4
Inch
Inch - 8A
Inch - 8B
Inch - 46A
Inch - 46B
Inch - 42A
Inch - 42B
0
60
120
240
360
480
600 Meters


Natterjack Toad Ponds Map 5
Aughils, Killeen and Lack
Aughils - 39B
Aughils - 39A
Killeen - 6A
Killeen - 24A
Killeen - 6B
Killeen - 24B
Lack - 45B
Lack - 45A
Lack - 44B
Lack - 44A
0 150 300 600 900 1,200 1,500 Meters


Natterjack Toad Ponds Map 6
Caherfealane Marsh, Gortnahulla, Keel and Roscullen Island
Gortnahulla - 36A
Gortnahulla - 36B
Roscullen Island - 26A
Roscullen Island - 26B
Roscullen Island - 20A
Roscullen Island - 20B
Caherfealane Marsh - 5B2
Caherfealane Marsh - 5A2
Caherfealane Marsh - 2B
Caherfealane Marsh - 2A
Caherfealane Marsh - 5A1
Roscullen Island - 3A
Roscullen Island - 3B
Roscullen Island - 15B
Roscullen Island - 9B
Roscullen Island - 14A
Roscullen Island - 14B
Roscullen Island - 15A
Caherfealane Marsh - 33A
Caherfealane Marsh - 33B
Roscullen Island - 9A
Roscullen Island - 37A
Roscullen Island - 37B
Roscullen Island - 38A
Roscullen Island - 38B
Caherfealane Marsh - 5B1
Roscullen Island - Area 1
Roscullen Island - 7A
Roscullen Island - 7B
Keel - 28B
Keel - 28A
Roscullen Island - 4B
Roscullen Island - 10B
Roscullen Island - Area 2
Keel - 1B
Roscullen Island - 4A
Keel - 1A
Roscullen Island - 10A
0 100 200 400 600 800 1,000 Meters


Natterjack Toad Ponds Map 7
Boolteens and Keel
Boolteens - 32A
Boolteens - 32B
Boolteens - 16A
Boolteens - 16B
Keel - 34B
Keel - 34A
Boolteens - 25A
Boolteens - 25B
Keel - 19A
Keel - 19B
0
125
250
500
750
1,000 Meters


Natterjack Toad Ponds Map 8
Iveragh Peninsula 1
Iveragh Peninsula - 29B
Iveragh Peninsula - 29A
Iveragh Peninsula - 35B
Iveragh Peninsula - 35A
Iveragh Peninsula - 31B
Iveragh Peninsula - 30A
Iveragh Peninsula - 30B
Iveragh Peninsula - 18A
Iveragh Peninsula - 18B
Iveragh Peninsula - 31A
0 250 500 1,000 1,500 2,000 Meters


Natterjack Toad Ponds Map 9
Dooks Golf Club, Lough Yganavan and Iveragh Peninsula 2
Iveragh Peninsula - 27B
Iveragh Peninsula - 27A
Iveragh Peninsula - 17A
Iveragh Peninsula - 17B
Lough Yganavan - Area 4
Lough Yganavan - Area 3
Lough Yganavan - Area 5
Iveragh Peninsula - 23B
Iveragh Peninsula - 23A
Lough Yganavan - Area 2
Lough Yganavan - Area 1
Iveragh Peninsula - 41A
Dooks Golf Club - 6
Iveragh Peninsula - 41B
Dooks Golf Club - 4
Dooks Golf Club - 3
Dooks Golf Club - 5
Dooks Golf Club - 2
Dooks Golf Club - 1
Iveragh Peninsula - Lough na mBreac Dearg
Department of Arts, Heritage and the Gaeltacht
0
200
400
800
1,600
2,000 Meters


Natterjack Toad Ponds Map 10
Iveragh Peninsula 3
Iveragh Peninsula - 11B
Iveragh Peninsula - 13A
Iveragh Peninsula - 11A
Iveragh Peninsula - 13B
Iveragh Peninsula - Marsh 2
Iveragh Peninsula - Marsh 1
Iveragh Peninsula - Field
Iveragh Peninsula - 12A
Iveragh Peninsula - 12B
Iveragh Peninsula - 40A
Iveragh Peninsula - 40B
Iveragh Peninsula - Quarry D
Iveragh Peninsula - Quarry A
Iveragh Peninsula - Quarry C
Iveragh Peninsula - Quarry B
Iveragh Peninsula - 43B
Iveragh Peninsula - 43A
Iveragh Peninsula - 21A
Iveragh Peninsula - 21B
Department of
Arts, Heritage and the Gaeltacht
0
150
300
600
900
1,200
1,500 Meters


Natterjack Toad Ponds Map 11
Caherdaniel
Caherdaniel - 1
Caherdaniel - 3
Caherdaniel - 2
0
62.5
125
250
375
500 Meters

APPENDIX 2: Additional toad breeding activity

Spawn Strings	Tadpoles	Toadlets
---	14B	14B
---	---	Castlegregory Golf Club Pond 4
---	Caherdaniel Pond 1	Caherdaniel Pond 1
---	Caherdaniel Pond 3	Caherdaniel Pond 3
---	Quarry A	---
---	Quarry B	---
---	Lough Yganavan Area 1	---
---	Lough Yganavan Area 3	---

Locations at which Natterjack toad spawn strings, tadpoles and toadlets were recorded during the habitat assessment of July and August 2011.

APPENDIX 3: Sward height – constructed ponds

Constructed ponds with ≥90% surrounding vegetation >20cm in height

2011	**2012**
1 A and B	5 A2 and B2
5 A1 and B1	7 A and B
7 A and B	15 A and B
12 A and B	26 A and B
45 A and B	28 A and B
47 A and B	32 A and B
38 A and B	34 A and B
3 B	38 A and B
24 B	31B
31 B	

APPENDIX 4: Percentage of sward <5cm high surrounding sites

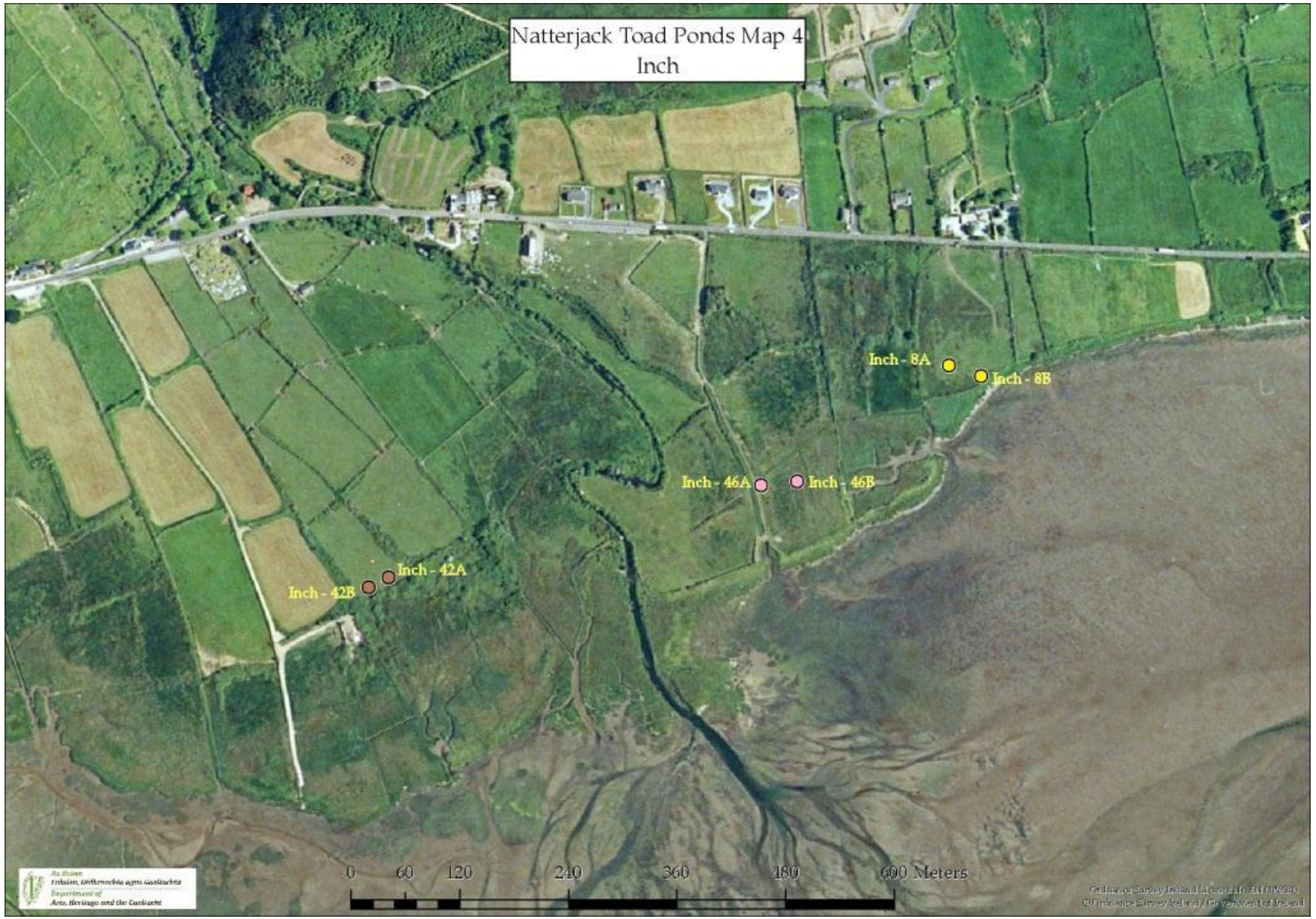
MAP LEGEND:

These colours indicate the highest percentage of sward less than 5cm in height recorded at a site on any field visit.

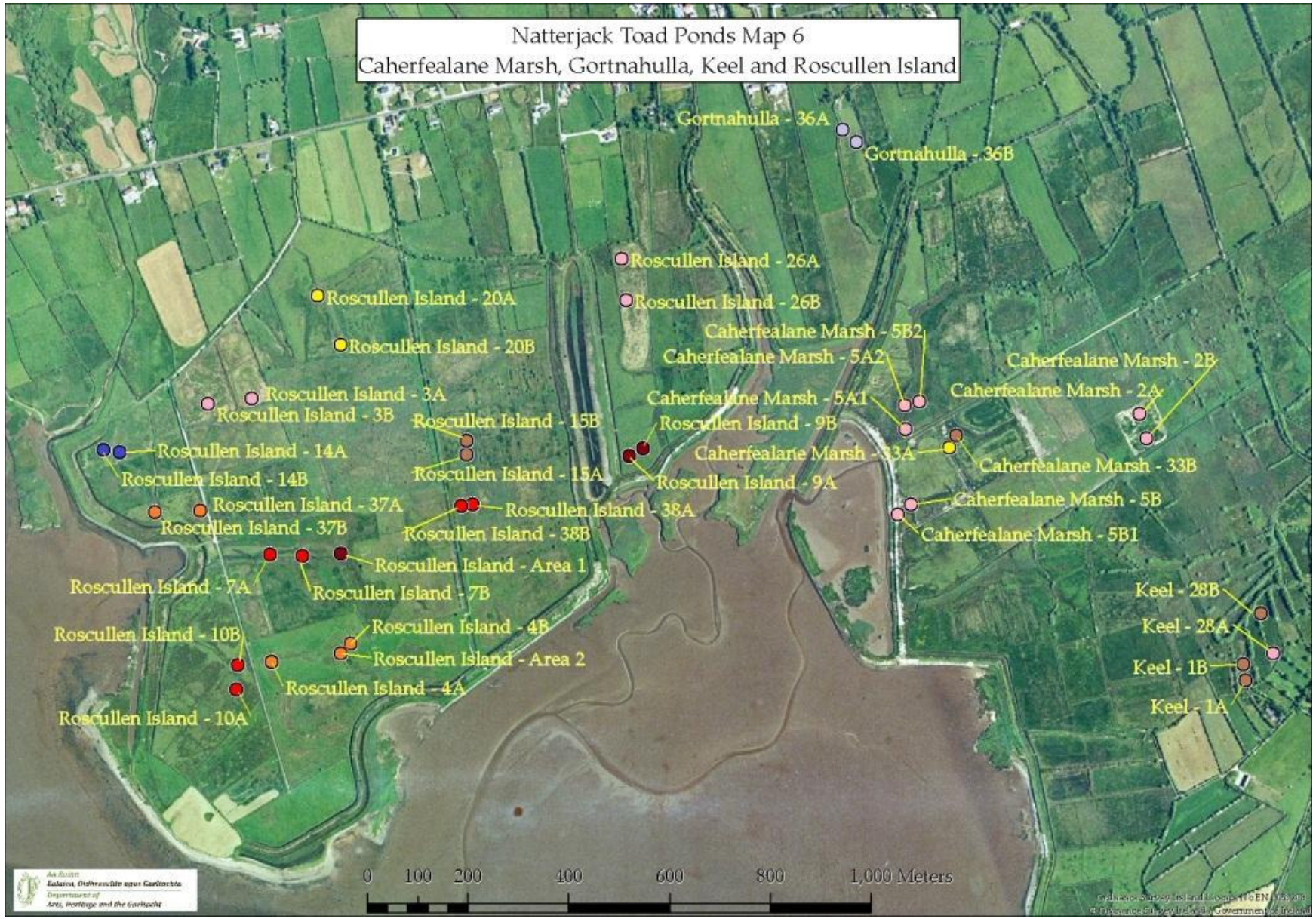

Natterjack Toad Ponds Map 1
Lough Gill and Magharees
Magharees - 4 complex
Magharees - 7
Magharees - 6
Magharees - 8
Magharees - 1
Magharees - 9A
Magharees - 9
Magharees - 12
Magharees - 15
Magharees - 16
Magharees - 17
Magharees - 18
Magharees - 19
Magharees - 22
Magharees - 23
Lough Gill - Sluice
0 100 200 400 600 800 1,000 Meters

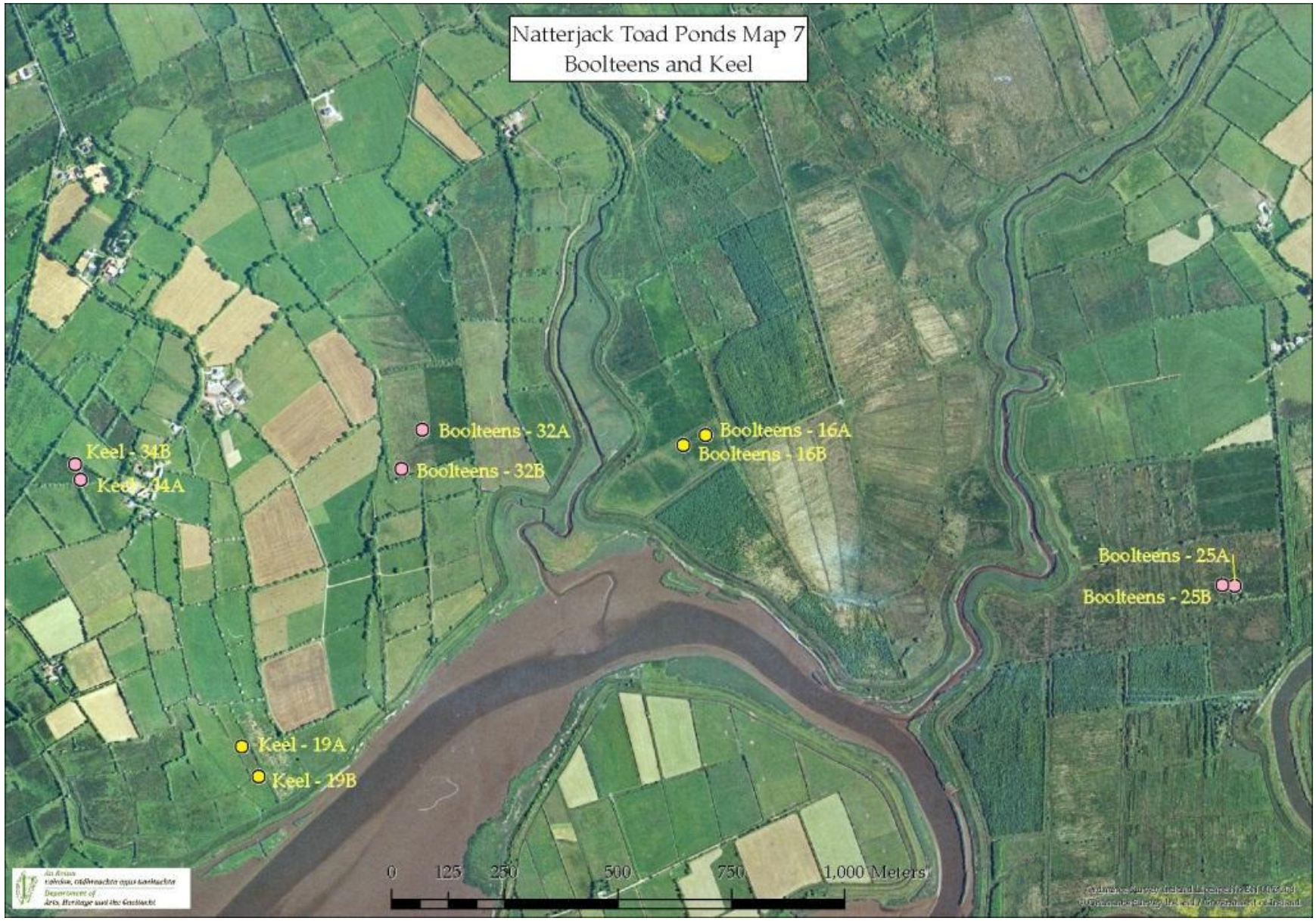

Natterjack Toad Ponds Map 2
Castlegregory Golf Course, Fermoyle and Gowlane
Castlegregory - 8
Castlegregory - 5
Castlegregory - 4
Castlegregory - 2
Castlegregory - 1
Castlegregory - 3
Castlegregory - 6
Gowlane - 47A
Gowlane - 47B
Fermoyle - 3
Fermoyle - 1
0 150 300 600 900 1,200 Meters


Natterjack Toad Ponds Map 3
Tullaree
Tullaree - 3
Tullaree - 2
Tullaree - 1
0 25 50 100 150 200 250 Meters

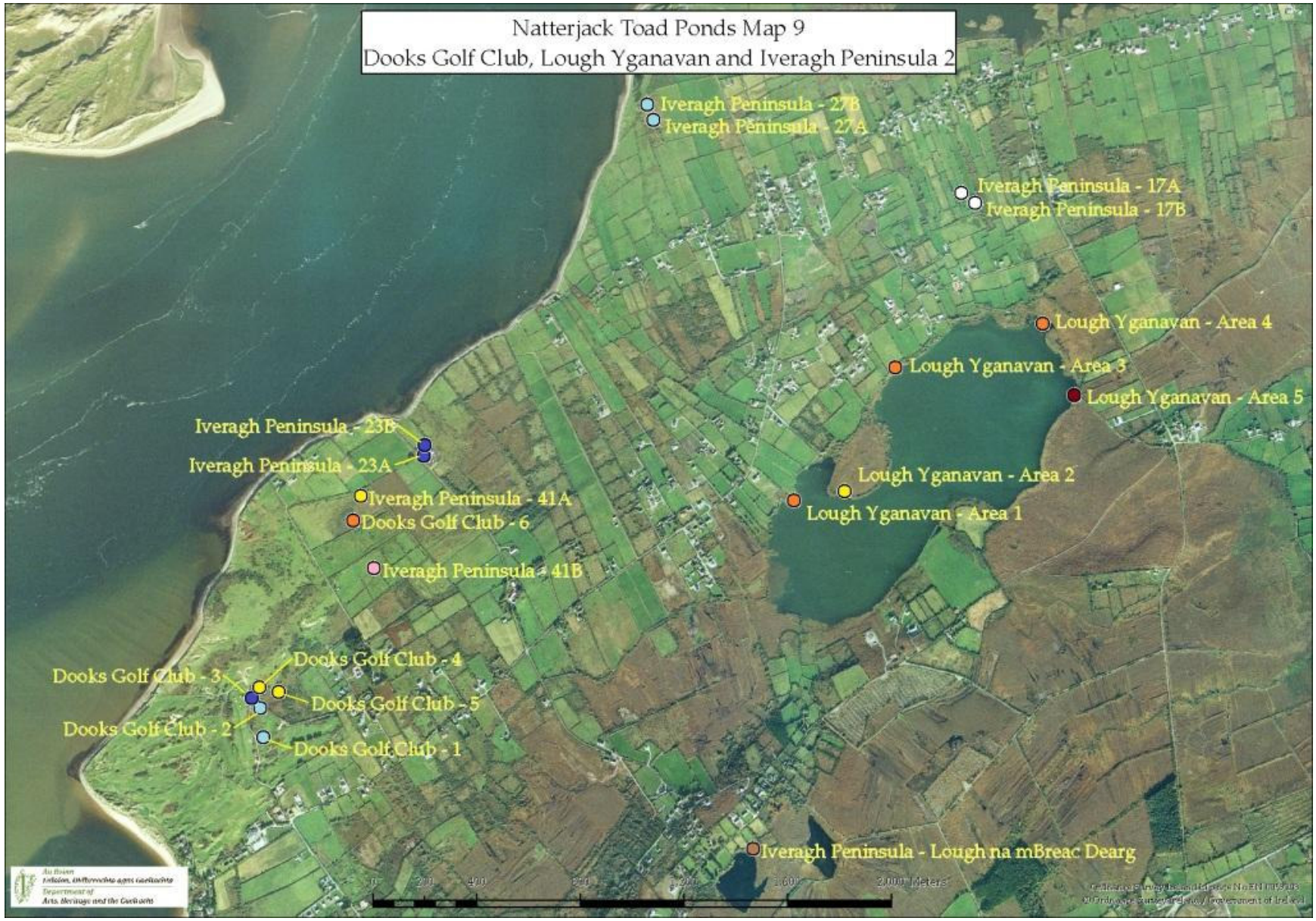

Natterjack Toad Ponds Map 4
Inch
Inch - 8A
Inch - 8B
Inch - 46A
Inch - 46B
Inch - 42A
Inch - 42B
0
60
120
240
360
480
600 Meters


Natterjack Toad Ponds Map 5
Aughils, Killeen and Lack
Aughils - 39B
Aughils - 39A
Killeen - 6A
Killeen - 24A
Killeen - 6B
Killeen - 24B
Lack - 45B
Lack - 45A
Lack - 44B
Lack - 44A
0 150 300 600 900 1,200 1,500 Meters


Natterjack Toad Ponds Map 6
Caherfealane Marsh, Gortnahulla, Keel and Roscullen Island
Gortnahulla - 36A
Gortnahulla - 36B
Roscullen Island - 26A
Roscullen Island - 20A
Roscullen Island - 26B
Caherfealane Marsh - 5B2
Roscullen Island - 20B
Caherfealane Marsh - 5A2
Caherfealane Marsh - 2B
Roscullen Island - 3A
Caherfealane Marsh - 5A1
Caherfealane Marsh - 2A
Roscullen Island - 3B
Roscullen Island - 15B
Roscullen Island - 9B
Roscullen Island - 14A
Caherfealane Marsh - 33A
Caherfealane Marsh - 33B
Roscullen Island - 14B
Roscullen Island - 15A
Roscullen Island - 9A
Roscullen Island - 37A
Roscullen Island - 38A
Caherfealane Marsh - 5B
Roscullen Island - 37B
Roscullen Island - 38B
Caherfealane Marsh - 5B1
Roscullen Island - Area 1
Roscullen Island - 7A
Roscullen Island - 7B
Keel - 28B
Roscullen Island - 4B
Keel - 28A
Roscullen Island - 10B
Roscullen Island - Area 2
Keel - 1B
Roscullen Island - 4A
Keel - 1A
Roscullen Island - 10A
0 100 200 400 600 800 1,000 Meters


Natterjack Toad Ponds Map 7
Boolteens and Keel
Boolteens - 32A
Boolteens - 32B
Boolteens - 16A
Boolteens - 16B
Keel - 34B
Keel - 34A
Boolteens - 25A
Boolteens - 25B
Keel - 19A
Keel - 19B
0
125
250
500
750
1,000 Meters


Natterjack Toad Ponds Map 8
Iveragh Peninsula 1
Iveragh Peninsula - 29B
Iveragh Peninsula - 29A
Iveragh Peninsula - 35B
Iveragh Peninsula - 35A
Iveragh Peninsula - 31B
Iveragh Peninsula - 30A
Iveragh Peninsula - 30B
Iveragh Peninsula - 18A
Iveragh Peninsula - 18B
Iveragh Peninsula - 31A
0 250 500 1,000 1,500 2,000 Meters


Natterjack Toad Ponds Map 9
Dooks Golf Club, Lough Yganavan and Iveragh Peninsula 2
Iveragh Peninsula - 27B
Iveragh Peninsula - 27A
Iveragh Peninsula - 17A
Iveragh Peninsula - 17B
Lough Yganavan - Area 4
Lough Yganavan - Area 3
Lough Yganavan - Area 5
Iveragh Peninsula - 23B
Iveragh Peninsula - 23A
Lough Yganavan - Area 2
Iveragh Peninsula - 41A
Lough Yganavan - Area 1
Dooks Golf Club - 6
Iveragh Peninsula - 41B
Dooks Golf Club - 4
Dooks Golf Club - 3
Dooks Golf Club - 5
Dooks Golf Club - 2
Dooks Golf Club - 1
Iveragh Peninsula - Lough na mBreac Dearg


Natterjack Toad Ponds Map 10
Iveragh Peninsula 3
Iveragh Peninsula - 11B
Iveragh Peninsula - 13A
Iveragh Peninsula - 11A
Iveragh Peninsula - 13B
Iveragh Peninsula - Marsh 2
Iveragh Peninsula - Marsh 1
Iveragh Peninsula - Field
Iveragh Peninsula - 12A
Iveragh Peninsula - 12B
Iveragh Peninsula - 40A
Iveragh Peninsula - 40B
Iveragh Peninsula - Quarry D
Iveragh Peninsula - Quarry A
Iveragh Peninsula - Quarry C
Iveragh Peninsula - Quarry B
Iveragh Peninsula - 43B
Iveragh Peninsula - 43A
Iveragh Peninsula - 21A
Iveragh Peninsula - 21B


Natterjack Toad Ponds Map 11
Caherdaniel
Caherdaniel - 1
Caherdaniel - 3
Caherdaniel - 2
0
62.5
125
250
375
500 Meters

APPENDIX 5: Sites that dried during the survey period

5a: Traditional Breeding Sites that dried over the 2011-2012 survey period.

Site Name	Date recorded as dry		Spawn strings		Tadpoles	
	2011	2012	2011	2012	2011	2012
Magharees Pond 4	08/04/2011	04/04/2012	Absent	Absent	Absent	Absent
Magharees Pond 6	18/04/2011	04/04/2012	Present	Absent	Absent	Absent
Magharees Pond 7	06/05/2011	19/04/2012	Present	Absent	Present	Absent
Magharees Pond 8	26/04/2011	29/04/2012	Present	Absent	Absent	Absent
Magharees Pond 9	06/05/2011	16/06/2012*	Present	Present	Absent	Absent
Magharees Pond 9A	08/04/2011	29/04/2012	Absent	Absent	Absent	Absent
Magharees Pond 10	08/04/2011	-	Absent	-	Absent	-
Magharees Pond 11	08/04/2011	-	Absent	-	Absent	-
Magharees Pond 12	08/04/2011	04/04/2012	Absent	Absent	Absent	Absent
Magharees Pond 15	08/04/2011	03/04/2012	Absent	Absent	Absent	Absent
Magharees Pond 16	08/04/2011	03/04/2012	Absent	Absent	Absent	Absent
Magharees Pond 17	08/04/2011	03/04/2012	Absent	Absent	Absent	Absent
Magharees Pond 18	08/04/2011	03/04/2012	Absent	Absent	Absent	Absent
Magharees Pond 19	08/04/2011	03/04/2012	Absent	Absent	Absent	Absent
Magharees Pond 22	18/04/2011	03/04/2012	Absent	Absent	Absent	Absent
Magharees Pond 23	22/06/2011	29/05/2012	Present		Present	
Dooks Golf Club Pond 4	WP	27/05/2012*	n/a	Absent	n/a	Absent
Dooks Golf Club Pond 5	WP	27/05/2012	n/a	Absent	n/a	Absent
Quarry A	WP	13-20/06/2012**	n/a	Present	n/a	Present
Quarry B	WP	13-20/06/2012**	n/a	Present	n/a	Present
Quarry C	02/05/2011	26/05/2012*	Absentn/a	Absent	Absentn/a	Absent
Quarry D	22/04/2011	INF	Absent	-	Absent	-
Roscullen Area 1	WP	29/05/2012**		Present		Present

* indicates pond was dry for a period earlier in the season, refilled and then became dry again. The date in the table is the earliest date after which no further water was observed in the pond.

** indicates that the pond dried out on or between the given date/s but water was subsequently observed in the pond during the field season.

WP indicates that water was present throughout the field season

- Indicates not surveyed.

INF indicates infilled.

5b: Constructed Ponds that dried over the 2011-2012 survey period.

Pond Code	Date recorded as dry		Spawn strings		Tadpoles	
	2011	2012	2011	2012	2011	2012
6B	09/04/2011	18/05/2012*	Absent	Absent	Absent	Absent
29B	14/04/2011	04/04/2012	Absent	Absent	Absent	Absent
17A	15/04/2011	04/04/2012	Absent	Absent	Absent	Absent
8A	17/04/2011	28/04/2012*	Absent	Absent	Absent	Absent
24A	17/04/2011	28/05/2012*	Absent	Absent	Absent	Absent
44B	17/04/2011	WP	Absent	Absent	Absent	Absent
17B	20/05/2011	04/04/2012	Absent	Absent	Absent	Absent
45B	WP	28/05/2012*	n/a	Absent	n/a	Absent
31A	WP	05/04/2012	n/a	Absent	n/a	Absent

* indicates pond was dry for a period earlier in the season, refilled and then became dry again. The date in the table is the earliest date on which no further water was observed in the pond.

** indicates that the pond dried out between the given dates but water was subsequently observed in the pond during the field season.

WP indicates that water was present throughout the field season.

APPENDIX 6: Other amphibians

Newts, Traditional Sites 2011:

Magharees 1 and 23

Castlegregory Golf Club Pond 4, 5 and 8

Roscullen Area 1

Newts, Constructed Ponds 2011:

2A

4B

7B

34A

38B

Newts, Habitat Surveys July and August 2011:

4A

20A

34A

Frogs, Traditional Sites 2011:

Castlegregory Golf Club Pond 1, 2, 5 and 6

Magharees Pond 1, 7, 8, 9 and 23

Lough Gill

Tullaree Pond 1

Roscullen Area 1 and 2

Quarry A, B and C

Caherdaniel Pond 1, 2 and 3

Frogs, Constructed Ponds 2011:

1 A and B

2 A and B

4 A and B

7A

9B

10 A and B

14 A and B

16A

18B

20B

21B

23A

26B

28 A and B

30A

31 A and B

33B

36 A and B

37A

38B

39B

40A

44A

47 A and B

Fermoyle Pond 1 and 3

Newts, Traditional Sites 2012:

Dooks Golf Club Pond 2

Magharees Pond 1, 23

Newts, Constructed Ponds 2012:

4B

7A

10A

38A

Frogs, Traditional Sites 2012:

Magharees Pond 7, 9, 17 and 23

Caherdaniel Ponds 1, 2 and 3

Roscullen Areas 1 and 2

Lough Gill Sluice

Frogs, Constructed Sites 2012:

Fermoyle Pond 1

1B

2 A and B

4 A and B

6A

7A

8B

9 A and B

10A

11 A and B

13 A and B

14 A and B

15 A and B

16 A and B

19A

23 A and B

Frogs, Constructed Sites 2012 continued

27B

28 A and B

30 A and B

31B

33 A and B

34A

36 A and B

37 A and B

38B

39 A and B

44A

APPENDIX 7: Number of egg strings recorded at each site in 2011 & 2012 and the contribution made to the total number of egg strings recorded

	2011		2012	
Site	**Number of egg strings counted**	**% of all egg strings counted**	**Number of egg strings counted**	**% of all egg strings counted**
Castlegregory Golf Club	472	43	421	38
Magharees	381	34.6	220	19.6
Roscullen Island	17	1.5	220	19.6
Caherdaniel	108	9.8	92	8.2
Lough Yganavan	66	6	101	9
6A	7	0.6	23	2.1
Tullaree	23	2.09	1	0.089
Quarry	5	0.45	17	1.5
21A	6	0.55	2	0.18
Dooks Golf Club	5	0.45	2	0.18
Lough Gill	0	0	4	0.36
43A	0	0	3	0.27
23A	3	0.27	0	0
23B	2	0.18	0	0
43B	0	0	1	0.09