

Risk Assessment of *Bufo bufo*

Name of Organism:	<i>Bufo bufo</i> Linnaeus, 1758 – Common Toad
Objective:	Assess the risks associated with this species in Ireland
Version:	Final 15/09/2014
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Expert reviewer:	John Wilkinson

Stage 1 - Organism Information

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About the risk assessment

This risk assessment is based on the Non-native species APplication based Risk Analysis (NAPRA) tool (version 2.66). NAPRA is a computer based tool for undertaking risk assessment of any non-native species. It was developed by the European and Mediterranean Plant Protection Organisation (EPPO) and adapted for Ireland and Northern Ireland by Invasive Species Ireland. It is based on the Computer Aided Pest Risk Analysis (CAPRA) software package which is a similar tool used by EPPO for risk assessment.

Notes: Confidence is rated as low, medium, high or very high.
Likelihood is rated as very unlikely, unlikely, moderately likely, likely or very likely.
The percentage categories are 0% - 10%, 11% - 33%, 34% - 67%, 68% - 90% or 91% - 100%.
N/A = not applicable.

This is a joint project by Inland Fisheries Ireland and the National Biodiversity Data Centre to inform risk assessments of non-native species for the European Communities (Birds and Natural Habitats) Regulations 2011. It is supported by the National Parks and Wildlife Service.

DOCUMENT CONTROL SHEET

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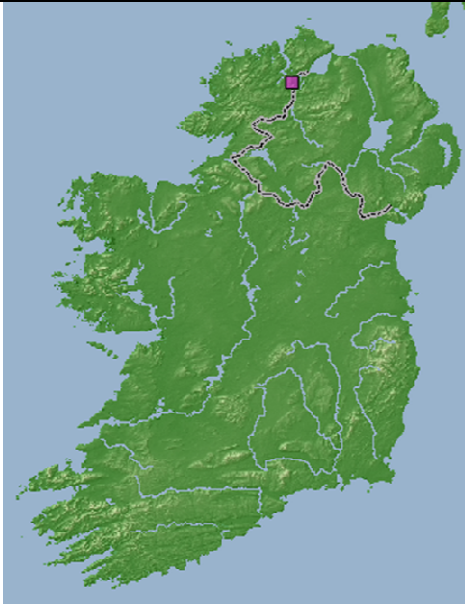
Stage 1 - Organism Information

The aim of this section is to gather basic information about the organism.

N	QUESTION	RESPONSE	COMMENT
1	What is the reason for performing the risk assessment?	-	A risk assessment is required as this species is listed as a "Non-native species subject to restrictions under Regulations 49 and 50" in the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011, SI 477/2011.
2	Identify the organism. Is it clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?	YES	<p><i>Bufo bufo</i> Linnaeus, 1758 – Common toad</p> <p>Taxonomy: Phylum: Chordata (mammals, birds, amphibians, reptiles, birds) Class: Amphibia Order: Anura Family: Bufonidae Genus: Bufo Species: bufo</p> <p>Synonyms:</p> <p>Common name (English): European common toad (Agasyan <i>et al.</i>, 2009).</p> <p>It is assumed that the common toads present in Ireland are <i>Bufo bufo sensu stricto</i> as occurs naturally in the UK. Toads of the <i>B. bufo</i> species group are superficially very similar and may also contain subspecies which can be difficult to distinguish visually. For further comments on taxonomic entity refer to Stage 1: Questions 5 and 6, also see Stage 2: Question 6.04.</p>
3	If not a single taxonomic entity, can it be redefined? (if necessary use the response box to re-define the organism and carry on)	-	
4	Describe the organism.	-	The adult dorsum (upper side) and flanks are brown, olive-brown or greyish-brown in colour, sometimes partly blotched or banded with a darker shade (Arnold, 2002). The ventral side is dirty white, speckled with grey and black patches (Kuzmin and Cavagnaro, 1999). Males have a typical snout-vent length of 50-60 mm, while females are typically 80-90 mm in length (Naish, 2009), sometimes much larger. Its body is broad, with a head that joins the body with no distinctive neck. The skin, which is permeable, has a rough appearance, with small wart-like lumps. Behind the eyes, positioned at an angle, are two distinct bulging parotoid glands which contain noxious bufotoxin, used to deter potential predators (Winchester, 2008). Males have dark nuptial pads during the breeding season on 1st, 2nd and sometimes 3rd fingers (Kuzmin and Cavagnaro, 1999).

Stage 1 - Organism Information <i>The aim of this section is to gather basic information about the organism.</i>			
N	QUESTION	RESPONSE	COMMENT
5	Does a relevant earlier risk assessment exist? (give details of any previous risk assessment)	NO	
6	If there is an earlier Risk Assessment is it still entirely valid, or only partly valid?	N/A	
7	Where is the organism native?	-	Taxonomy of the <i>B. bufo</i> species group was recently elaborated by Recuero <i>et al.</i> (2012), <i>Bufo bufo sensu stricto</i> is native to Albania, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Kazakhstan, Latvia, Liechtenstein, Lithuania, Luxembourg, Macedonia, the Former Yugoslav Republic of, Moldova, Republic of, Montenegro, Netherlands, Norway, Poland, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Sweden, Switzerland, Turkey, Ukraine, United Kingdom.
8	What is the current global distribution of the organism (excluding Ireland)? (map optional)	-	Albania, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Kazakhstan, Latvia, Liechtenstein, Lithuania, Luxembourg, Macedonia, the Former Yugoslav Republic of, Moldova, Republic of, Montenegro, Netherlands, Norway, Poland, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Sweden, Switzerland, Turkey, Ukraine, United Kingdom (Figure 1; Recuero <i>et al.</i> , 2012). Populations in SW France, Iberia and North Africa are now assigned to the distinct species <i>Bufo spinosus</i> (<i>ibid.</i>).

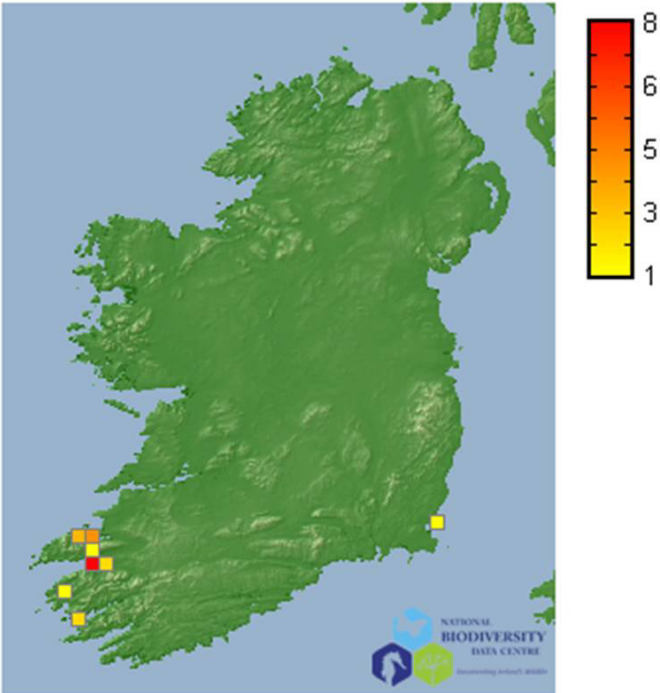
Stage 1 - Organism Information <i>The aim of this section is to gather basic information about the organism.</i>			
N	QUESTION	RESPONSE	COMMENT
			 <p>Figure 1. The global distribution of <i>B. bufo</i> and <i>B. spinosus</i> (Modified after Recuero <i>et al.</i>, 2012)</p>
9	What is the current distribution of the organism in Ireland? (map optional)	-	<p><i>Bufo bufo</i> was first recorded at Long Lough, Rathmullan, Co. Donegal in spring 2011 (David McNamara, per. comm., 28th Jan 2014). The species is believed to have been introduced by an enthusiastic breeder (unproven despite investigation) and at the time of this first verified recording long strings of spawn were noted as evidence of breeding (David McNamara, per. comm., 28th Jan 2014). An abundant breeding population of the species is, however, expected to have been present in the area near Rathmullan prior to 2008 and have so far apparently been restricted to breeding at Long Lough (Rob Gandola, per. comm. 3rd February 2014). Locals have also said to have counted a good number of dead animals along the road but whether this is an indication of outward spread or just crossing to the breeding site is unknown. (Rob Gandola, per. comm. 3rd February 2014). As of yet no eradication measures have been undertaken (David McNamara, per. comm., 28th Jan 2014). There has also been an unverified sighting in Glenveagh National Park, Letterkenny, Co. Donegal (Rob Gandola, per. comm. 3rd February 2014). This unverified sighting is ~35km away from the known population in Rathmullan and warrants investigating.</p>

Stage 1 - Organism Information <i>The aim of this section is to gather basic information about the organism.</i>			
N	QUESTION	RESPONSE	COMMENT
			 <p>Figure 2. Map showing the verified recording of <i>B. bufo</i> in Ireland (National Biodiversity Data Centre – draft map).</p>
10	Is the organism known to be invasive anywhere in the world?	NO	<p><i>Bufo bufo</i> is not usually considered to be an invasive species. In Ireland there are three native amphibian species; the common frog (<i>Rana temporaria</i>), the natterjack toad (<i>Epidalea calamita</i>) and the smooth newt (<i>Lissotriton vulgaris</i>) (King <i>et al.</i>, 2011). The common frog and natterjack toad are legally protected under the EU Habitats Directive [92/43/EEC], while all three species are protected under the Wildlife Act 1976 and the Wildlife Amendment Act 2000 (King <i>et al.</i>, 2011). In Ireland the natterjack toad is listed as an endangered species and has declined substantially in its range (Beebee, 2002; King <i>et al.</i>, 2011). The primary threat to the decline of the natterjack toad both in Ireland and elsewhere is alteration to its habitat (Banks <i>et al</i> 1994; Beebee, 1977, 2002; Beebee <i>et al</i>, 1990). Throughout its range the species is associated with relatively open, unforested habitats and shallow ponds; with sand and gravel pits, coastal sand dunes</p>

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N	QUESTION	RESPONSE	COMMENT
			<p>and marshes, and lowland heaths all constituting potential natterjack habitat in northern Europe (Beebee, 2002). In Ireland, natterjack toads occur in coastal dunes, lowland heath-bog systems and in wet fields near the sea. It is found on the Dingle peninsula and at Derrynane in Co Kerry and also at Raven Point in Co. Wexford, where it was introduced to a dune site (Figure 2) (Beebee, 2002). As adults, <i>B. bufo</i> and <i>E. calamita</i> are known to have marked spatial niche separations; <i>B. bufo</i> has a relatively wide niche associated with complex, dense vegetation structures, while <i>E. calamita</i> has a narrower niche, occurring mostly on open and poorly vegetated ground (Denton and Beebee, 1994). However, land use change over the natterjack toads' geographical range in Ireland, most notably, cessation of grazing or increased forestry would permit widespread encroachment by tall vegetation, which creates shade, and would result in undesirable habitat for the natterjack toad (Beebee, 1977). This alteration in habitat structure would, however, favour the common toad, and may allow the species to enter and displace, reduce or eliminate the natterjack population (Beebee, 1977, 1979). Displacement, reduction and elimination has been shown to be exerted via <i>B. bufo</i>'s competitive superiority during spawn and larval development, with both species often overlapping in their breeding season (Banks and Beebee, 1987; Heusser, 1972). As adults, natterjack toads subjected to such alteration in their habitat have been found to lose mass and become hyperactive in densely-vegetated conditions because their hunting efficiency was selectively reduced relative to that of <i>B. bufo</i> (Denton and Beebee, 1994). Although <i>B. bufo</i> is not considered to be an invasive species, its presence in Ireland has the potential to negatively impact upon the native <i>E. calamita</i> population, a species which Ireland is legally obligated to protect.</p>

Stage 1 - Organism Information

The aim of this section is to gather basic information about the organism.

N	QUESTION	RESPONSE	COMMENT
			 <p>Figure 3. Map showing all the known verified records for <i>Epidalea calamita</i> (natterjack toad) per 10km² in Ireland. Colour scale bar shows density of records per 10km² (National Biodiversity Data Centre, 2014).</p>

Stage 2 - Detailed assessment: Section A - Entry <i>This section evaluates the probability of entry of an organism into Ireland. For organisms which are already present, only complete the entry section for currently active pathways of entry and potential future pathways. The entry section need not be completed for pathways which have allowed an organism to enter in the past but are no longer active.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
1.01	How many active/future pathways are relevant to the potential entry of this organism (n/a, very few, few, moderate number, many or very many)?	VERY FEW	MEDIUM	There are very few active/future pathways relevant to the entry of <i>B. bufo</i> .
1.02	List significant pathways through which the organism could enter. Where possible give detail about the specific origins and end points of the pathways.	1. pet and/or aquarium/aquatic pond plant trade	HIGH	Origin: Potential for the species to be sourced through the pet/aquarium trade (is sometimes available from international traders, e.g. from Eastern Europe). Accidental importation of tadpoles with e.g. aquarium plants is also considered possible but has low likelihood. End point: This may result in release or escape from captive amphibian collections or possibly garden centres.

Pathway 1 – Pet and/or aquarium/aquatic pond plant trade				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
1.03	Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (e.g. the organism is a contaminant of imported goods)?	INTENTIONAL AND ACCIDENTAL	MEDIUM	It is known to be traded as a pet and/or aquarium species (Agasyan <i>et al</i> , 2013). The recording of the species in Rathmullen, Co. Donegal is thought to be as a result of introduction by an enthusiastic breeder (unproven despite investigation) (David McNamara, per. comm., 28 th Jan 2014)
1.04	How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over the course of one year?	UNLIKELY	MEDIUM	The number of common toads potentially entering Ireland via this pathway is expected to be low and infrequent. Movement of <i>B. bufo</i> along this pathway would be dependent on the demand for the species by amphibian enthusiasts and gardeners, plus unlikely and infrequent accidental imports.
1.05	How likely is the organism to enter Ireland undetected or without the knowledge of relevant competent authorities?	LIKELY	MEDIUM	It is likely that the species could enter Ireland undetected and without the knowledge of the relevant authority.

Pathway 1 – Pet and/or aquarium/aquatic pond plant trade				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
1.06	How likely is the organism to survive during passage along the pathway?	LIKELY	MEDIUM	Likely for the species nutritional and housing requirements to be catered for by the pet trader and subsequent pet owner.
1.07	How likely is the organism to arrive during the months of the year appropriate for establishment?	MODERATELY LIKELY	MEDIUM	The breeding season occurs from March to June (Beebee and Griffiths, 2000). Establishment success would be initially dependent on the release or escape of one sexually mature toad of each sex to a suitable breeding pond during the breeding season or inadvertent release of tadpoles.
1.08	How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	VERY LIKELY	HIGH	This terrestrial species favours forested habitat with coniferous, deciduous and mixed woodland, especially in wet locations, and requires a pond, lake or any suitable waterbody for breeding (Beebee 2002; Kazmin and Cavagnaro, 1999). The species is very likely to encounter such suitable habitat within the Irish landscape (Fossitt, 2000).
1.09	Estimate the overall likelihood of entry into Ireland based on this pathway?	MODERATELY LIKELY	MEDIUM	Entry is moderately likely via pet/aquarium trade as the species may occasionally be kept in captivity and escapes/accidental releases are possible.
1.10	Do other pathways need to be considered?	NO	HIGH	No other pathways require consideration.

Overall likelihood				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
1.11	Estimate the overall likelihood of entry into Ireland based on all pathways (comment on the key issues that lead to this conclusion).	MODERATELY LIKELY	MEDIUM	Refer to Question 1.09

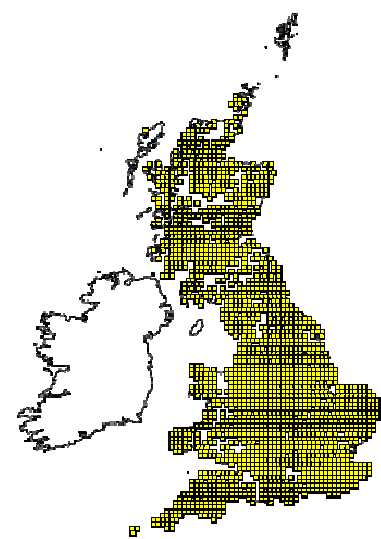
Stage 2 - Detailed assessment: Section B - Establishment

This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
2.01	Is the organism well established in Ireland (if there is any uncertainty answer 'unsure')	NO	MEDIUM	The species could not be described as well established. There is a population recorded in Ratmullen Co. Donegal, where breeding it restricted to Long Lough (refer to Question 9)
2.02	How likely is it that the organism will be able to establish in Ireland based on the similarity between local <u>climatic conditions</u> and the organism's current global distribution?	VERY LIKELY	MEDIUM	The majority of <i>B. bufo</i> 's geographical range falls within the temperate climatic zone, although the species is cold tolerant (Naish, 2009), with populations extending into the polar zone i.e. Norway, Sweden and Finland. The species range, therefore, includes climatic conditions comparable with Ireland; a temperate oceanic climate which is mild, moist and changeable, with abundant rainfall and lack of temperature extremes (Keane and Collins, 2004). The species is widespread across the United Kingdom (Figure 3.) (NBN Gateway, 2013), Ireland's nearest and climatically similar neighbour. Rago <i>et al.</i> (2012) showed that variation in establishment success of non-native frogs and toads is primarily explained by variation in introduction pathways and climatic similarity between the native range and introduction locality, with minor contributions from phylogeny, species ecology, and life history.

Stage 2 - Detailed assessment: Section B - Establishment

This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
				 <p>Figure 4. Distribution of <i>Bufo bufo</i> in the United Kingdom (2012 record of <i>B. bufo</i> in Ireland not shown) (NBN Gateway, 2013)</p>

Stage 2 - Detailed assessment: Section B - Establishment <i>This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
2.03	How likely is it that the organism will be able to establish in Ireland based on the similarity between other local <u>abiotic conditions</u> and the organism's current global distribution?	VERY LIKELY	HIGH	Air temperature and air moisture are abiotic conditions known to influence patterns of terrestrial movement in <i>B. bufo</i> (Daverson <i>et al.</i> , 2012). The species requires low temperature and moisture for efficient respiration through its permeable skin (Hartel <i>et al.</i> , 2008). It is likely that the abiotic conditions in Ireland will be favourable to the establishment of <i>B. bufo</i> , especially given that the species is well established and widespread in the United Kingdom (Figure 3) where climatic conditions and habitat availability are comparable.
2.04	How likely is the organism to encounter habitats necessary for the survival, development and multiplication of the organism in Ireland?	LIKELY	MEDIUM	<i>Bufo bufo</i> is mostly terrestrial (Sinsch, 1988). It has a wide habitat niche, most commonly associated with complex, dense vegetation structures such as coniferous, deciduous and mixed woodland (Denton and Beebee, 1994), especially in wet locations, as they do require ponds for breeding each spring (Daverson <i>et al.</i> , 2012). The species is likely to encounter such suitable habitat, necessary for its survival, development and multiplication, within the Irish landscape (CORINE, 2006; Fossitt, 2000).
2.05	How likely is it that establishment will occur despite competition from existing species in Ireland?	LIKELY	MEDIUM	It is likely that establishment will occur despite competition. In its larval stage <i>Bufo bufo</i> is competitively superior to the endangered Irish anuran <i>E. calamita</i> - natterjack toad (Banks and Beebee, 1987; Bardsley and Beebee, 2001; Heusser, 1972; Romero and Real, 1996). Common toads breed generally later in the year than common frogs, reducing interspecific competition, and they generally prefer larger, deeper ponds (or parts of them) than frogs (Beebee and Griffiths, 2000). It is unlikely that any competition from common frogs would hinder establishment.
2.06	How likely is it that establishment will occur despite predators, parasites or pathogens already present in Ireland?	LIKELY	HIGH	Predation of the species in Ireland is unlikely to impact on establishment. Adults are preyed upon by a variety of birds (e.g. herons, corvids and raptors) and mammals (e.g. otter, mink, hedgehog and brown rats) and tadpoles are also preyed upon by newts and predatory insects (Winchester, 2008). A foul tasting toxin (bufagin) produced by both adults and tadpoles helps to deter predators (Winchester, 2008).

Stage 2 - Detailed assessment: Section B - Establishment <i>This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
2.07	How likely is it that establishment will occur despite existing management practices?	LIKELY	MEDIUM	Deforestation and agricultural land improvements (e.g. drainage of wetlands) causing a reduction in the amount of suitable habitat, may limit the establishment of <i>B. bufo</i> (Kuzmin and Cavagnaro, 1999).
2.08	How likely is it that management practices in Ireland will facilitate the establishment of the organism?	LIKELY	MEDIUM	Management practices that permit the widespread encroachment of tall vegetation and create shade, such as cessation of grazing and increases in forestry plantation, will facilitate the establishment of <i>B. bufo</i> (Beebee, 1977).
2.09	How likely is it that the biological characteristics of the organism would allow it to survive eradication campaigns in Ireland?	MODERATELY LIKELY	HIGH	Though adults are generally obvious during the breeding season, they are highly fecund (several thousand eggs per spawn string), so numbers could easily increase rapidly if any eradication campaign missed just one mature pair, one spawn string or cohort of tadpoles.
2.10	How likely is it that the biological characteristics of the organism will facilitate its establishment?	LIKELY	MEDIUM	The species would be expected to establish well locally given that adults use the same location year after year to reproduce and over 80% of males marked as juveniles have been found to return to the pond at which they were spawned (Reading <i>et al.</i> , 1991)
2.11	How likely is it that the organism's capacity to spread will facilitate its establishment?	MODERATELY LIKELY	MEDIUM	The species is vagile, with movements of between 1 km to 3.6 km after the breeding season, via slow walking or short shuffling jumps of all four legs (Sztatecsny and Schabetsberger, 2005). However, <i>B. bufo</i> have high breeding pond fidelity, with Reading <i>et al.</i> (1991) reporting between 79% and 96% of adults that survived to breed the following year returned to the original pond. Breeding pond fidelity is likely to be a limiting factor in the species capacity to spread and establish elsewhere. Reading <i>et al.</i> (1991) note the following factors, not strictly related to the species' direct capacity to spread, but which are likely to aid spread: (1) a toad while on its spring migration to a known breeding pond, may encounter a new pond by chance; (2) if the conditions in a breeding pond deteriorate, some toads may actively leave and search for a new pond; and (3) some males pair with females on land before reaching the breeding pond and will be passively taken to the female's pond. It is, however, additionally possible that spread could occur more rapidly given the absence of conspecifics at other nearby ponds.

Stage 2 - Detailed assessment: Section B - Establishment <i>This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
2.12	How likely is it that the organism's adaptability will facilitate its establishment?	MODERATELY LIKELY	MEDIUM	Romero and Real (1996) state that " <i>B. bufo</i> lacks the ability to adapt to unpredictable conditions", with the species more likely to be found in areas where the climate is stable. Denton and Beebee (1994) also discuss the species inability to adapt to inhospitable conditions; unlike <i>E. calamita</i> that survives desiccation in open habitat by burrowing into substrate. However, <i>B. bufo</i> has a relatively wide habitat niche (Denton and Beebee, 1994), with Martinez-Solano and Gonzalez (2012) noting that the species is tolerant of a wide range of ecological conditions.
2.13	How likely is it that the organism could establish despite low genetic diversity in the founder population?	LIKELY	MEDIUM	It is likely that <i>B. bufo</i> could establish despite low genetic diversity in the founder population (Reading <i>et al.</i> , 1991). Genetic diversity can be increased if only one individual per sub-population per generation interacts with another sub-population (Reading <i>et al.</i> , 1991).
2.14	Based on the history of invasion by this organism elsewhere in the world, how likely is it to establish in Ireland? If possible, specify the instances of invasion elsewhere in the justification box	N/A	-	<i>Bufo bufo</i> is not documented as being an invasive species. It is considered a possible invasive species in Ireland because of its potential to negatively impact upon the native <i>E. calamita</i> population (refer to Question 10).
2.15	If the organism does not establish, then how likely is it that transient populations will continue to occur?	MODERATELY LIKELY	MEDIUM	The Irish climate and availability of suitable habitat within the landscape would allow for transient populations to occur.
2.16	Estimate the overall likelihood of establishment. Mention any key issues in the comments box	LIKELY	MEDIUM	The Irish climate and the availability of breeding, summering and wintering habitat would be considered as favourable to the establishment of the species, with a breeding population recorded at a site in Ratmullen Co. Donegal. Any increases in afforestation are likely to favour this competitively superior anuran. Low vigilance towards the presence of <i>B. bufo</i> will aid establishment.

Stage 2 - Detailed assessment: Section C - Spread

This section evaluates the probability of spread of an organism within Ireland. Spread is defined as the expansion of the geographical distribution of an organism within the risk assessment area.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
3.01	What area (given in % or 10km squares) in Ireland could the organism establish (0% - 10%, 11% - 33%, 34% - 67%, 68% - 90% or 91% - 100%)?	0%-10%	MEDIUM	Only ~4% of Ireland is covered with the species favoured terrestrial habitat of coniferous (3.23%), deciduous (0.41%) and mixed woodland (0.42%), with an additional 5.89% of transitional woodland (CORINE, 2006). Water bodies, which the species requires as breeding habitat, constitute 1.78% of land cover (stream courses – 0.11% and water bodies (lakes and ponds) – 1.67%, (CORINE, 2006). It is of note that CORINE land cover data does not account for gardens, which represent important terrestrial habitat for the species, or linear features, e.g. streams, <100m in width, which represent potential breeding habitat for the species. It is suspected that even if these habitat features were accounted for, the area in Ireland that the species has the potential to establish would still amount to 0%-10%.
3.02	How important is the expected spread of this organism in Ireland by <u>natural</u> means (minimal, minor, moderate, major or massive)?	MODERATE	MEDIUM	<i>Bufo bufo</i> migrate long distances, but most individuals return year on year to their original spawning pond (Sztatecsny and Schabetsberger, 2005) which would be considered as a limiting factor in the natural spread of the species.
3.03	How important is the expected spread of this organism in Ireland by <u>human assistance</u> (minimal, minor, moderate, major or massive)?	MODERATE	MEDIUM	May be subject to collection and subsequent release by members of the public. This is the suspected caused of the species establishment in Rathmullen, Co. Donegal and its range is presently considered to be limited to this area (refer to Question 9).
3.04	Within Ireland, how difficult would it be to contain the organism (minimal, minor, moderate, major or massive)?	MINOR	MEDIUM	Efforts to contain the species, during its adult stage, may only present minor difficulties, given that locomotion is slow and most individuals utilise the same location to breed year on year (Davessa <i>et al.</i> , 2012). Additionally, where present the species is not very abundant, with highs of 70 specimens per 100 m of pond shore or, on land, 200 individuals per hectare (Kuzmin and Cavagnaro, 1999). Efforts to contain the species during its spawn and larval stages may present greater difficulties.
3.05	What proportion (%) of the area in Ireland suitable for establishment, if any, has already been colonised by the organism?	0%-10%	MEDIUM	To-date the species is only known to be present in the area of Rathmullen, Co. Donegal (refer to Question 9).

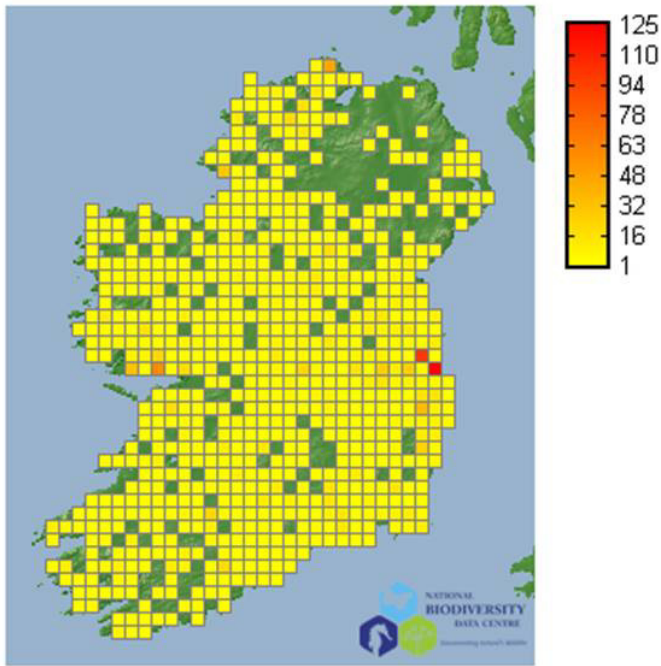
Stage 2 - Detailed assessment: Section C - Spread

This section evaluates the probability of spread of an organism within Ireland. Spread is defined as the expansion of the geographical distribution of an organism within the risk assessment area.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
3.06	What proportion of the area in Ireland suitable for establishment, if any, do you expect to have been invaded by the organism five years from now (including any current presence)?	0-10%	MEDIUM	It may be established in 0-10% of the landscape in five years, time.
3.07	What other timeframe would be appropriate to estimate any significant further spread of the organism (10, 20, 40, 80 or 160 years)? Please comment on why this timeframe is chosen.	10	MEDIUM	The generation time of common toads approximates to 3 years (Beebee and Griffiths, 2000). After 10 years or 3 generations it may be apparent whether or not common toads are likely to be spreading from their current known single site.
3.08	In this timeframe, what proportion of the area (including any currently occupied areas) is likely to have been invaded by this organism?	0-10%	MEDIUM	Spread within this timeframe is still likely to be very modest unless assisted by human agents.
3.09	Based on the answers to questions on the potential for establishment and spread in Ireland, define the area endangered by the organism. Be as specific as possible. If available, provide a map showing the area most likely to be endangered.	-	HIGH	Coniferous, deciduous and mixed woodland, as well as gardens, where suitable water bodies exist in close proximity are most susceptible to the potential invasion of <i>B. bufo</i> . In the United Kingdom the species is said to be syntopic with the common frog (<i>Rana temporaria</i>) (Bardsley and Beebee, 2001). If, in Ireland, the establishment and spread of the species was syntopic with the endemic common frog the area endangered is potentially extensive (as reflected in Figure 4) and not limited to forestry.

Stage 2 - Detailed assessment: Section C - Spread

This section evaluates the probability of spread of an organism within Ireland. Spread is defined as the expansion of the geographical distribution of an organism within the risk assessment area.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
				 <p>Figure 5. Map showing all the known verified records for <i>Rana temporaria</i> (common frog) per 10km² in Ireland. Colour scale bar shows density of records per 10km².</p>
3.10	Estimate the overall potential for future spread for this organism in (very slowly, slowly, moderately, rapidly or very rapidly). Use the justification box to indicate any key issues.	SLOWLY	MEDIUM	<p>The spread of <i>B. bufo</i> may be limited naturally by its high fidelity to original breeding ponds. The expected infrequency of escape or release by human assistance would also be a limiting factor to the spread of the species; success of which would be additionally dependent on the release or escape of one toad of each sex, or tadpoles, and the availability of suitable aquatic habitat nearby.</p>

Stage 2 - Detailed assessment: Section D - Impact <i>This section evaluates the probability of impact of an organism within Ireland.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.01	How great is the economic loss caused by the organism within its global distribution (excluding Ireland), including the cost of any current management?	N/A	N/A	As it is not considered as an invasive or potentially invasive species there are no known economic impacts.
4.02	How great has the economic cost of the organism been in Ireland from the <u>time of introduction to the present</u> ? Exclude any costs associated with managing the organism from your answer.	N/A	N/A	To-date there are no known economic costs incurred.
4.03	How great is the economic cost of the organism likely to be in the <u>future</u> in Ireland? Exclude any costs associated with managing the organism from your answer.	N/A	N/A	It would be expected that the costs incurred would only be in relation to management (monitoring and eradication) of the species.
4.04	How great have the economic costs of managing this organism been in Ireland from the <u>time of introduction to the present</u> ?	MINIMAL	MEDIUM	Preliminary monitoring of the population at the site in Ratmullen, Co. Dongel has been carried out (David McNamara, per. comm., 28 th Jan 2014), for which there are no reported costs.
4.05	How great is the economic cost of managing this organism likely to be in the <u>future</u> in Ireland?	MODERATE	MEDIUM	Costs would accrue from monitoring and management practices.
4.06	How important is environmental harm caused by the organism within its global distribution?	N/A	N/A	No known or documented environmental harm.
4.07	How important has the impact of the organism on biodiversity* been in Ireland from the time of introduction to the present? *e.g. decline in native species, changes in community structure, hybridisation	N/A	N/A	To-date there is no known documented impact of the species on biodiversity.
4.08	How important is the impact of the organism on biodiversity likely to be in the <u>future</u> in Ireland?	MAJOR	HIGH	Establishment and spread of the common toad in Ireland may result in displacement, reduction, or elimination of the native natterjack toad. Land use change over the, native and endangered, natterjack toads' geographical range in Ireland, most notably, cessation of grazing or increased forestry would permit widespread encroachment by tall

Stage 2 - Detailed assessment: Section D - Impact <i>This section evaluates the probability of impact of an organism within Ireland.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
				vegetation, which creates shade, and would result in undesirable habitat for the natterjack toad (Beebee, 1977). This alteration in habitat structure would however, favour the common toad, and may allow the species to enter and displace, reduce or eliminate the natterjack population (Beebee, 1977, 1979). Refer to Question 10 for a detailed description of the potential effect to natterjack toad diversity. If any individuals of the species establish which are infected with the chytrid fungus, further and potentially catastrophic threats are posed to all native amphibians (Fisher & Garner 2007; Hanselmann <i>et al.</i> , 2004)
4.09	How important has alteration of ecosystem function* caused by the organism been in Ireland from the time of introduction to the present? *e.g. habitat change, nutrient cycling, trophic interactions	N/A	N/A	To-date there is no known or documented alteration of ecosystem function caused by the presence of <i>B. bufo</i> in Ireland.
4.10	How important is alteration of ecosystem function caused by the organism likely to be in Ireland in the <u>future</u> ?	MODERATE	MEDIUM	If the species encroaches on the habitat of the natterjack, in particular the breeding ponds of this native species, trophic competition is likely, where <i>B. bufo</i> is the competitive superior.
4.11	How important has decline in conservation status* caused by the organism been in Ireland from the time of introduction to the present? *e.g. sites of nature conservation value, WFD classification, etc.	N/A	N/A	To-date there is no known or documented decline in conservation status caused by the presence of <i>B. bufo</i> in Ireland.
4.12	How important is decline in conservation status caused by the organism likely to be in the <u>future</u> in Ireland?	MAJOR	MEDIUM	Possible decline in conservation status would be as a result of a displacement, reduction, or elimination of endemic amphibians, in particular the endangered <i>E. calamita</i> .
4.13	How important is social or human health harm (not directly included in economic and environmental categories) caused by the organism within its global distribution?	MINIMAL	MEDIUM	Not documented as having negative social or human health harm

Stage 2 - Detailed assessment: Section D - Impact <i>This section evaluates the probability of impact of an organism within Ireland.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.14	How important is social or human health harm (not directly included in economic and environmental categories) caused by the organism within Ireland?	MINOR	MEDIUM	The sight of the animal may cause repulsion or be symbolic of ill omen.
4.15	How important is it that genetic traits of the organism could be carried to other organisms / species, modifying their genetic nature and making their economic, environmental or social effects more serious?	MINIMAL	HIGH	Hybridisation between common toads and natterjacks has been reported by Arnold and Burton (1978) but there is no recent evidence for this. Recent taxonomy places the natterjack in a distinct genus (<i>Epidalea</i>) and the two species have distinct reproductive ecologies. Though Irish natterjack populations have not previously encountered common toads and a tiny possibility of hybridisation remains, this is considered exceptionally unlikely.
4.16	How important is the impact of the organism as food, a host, a symbiont or a vector for other damaging organisms (e.g. diseases)?	MODERATE	MEDIUM	A potential threat is posed to all native amphibians if one or any individuals of <i>B. bufo</i> that have established in Ireland are infected with chytridiomycosis (chytrid fungus), a potentially catastrophic fungal disease of amphibians (Fisher & Garner 2007; Hanselmann <i>et al.</i> , 2004).
4.17	How important might other impacts not already covered by previous questions be resulting from introduction of the organism? Specify in the justification box.	N/A	MEDIUM	Presently, there are no other impacts to consider.
4.18	How important are the expected impacts of the organism despite any natural control by other organisms, such as predators, parasites or pathogens that may already be present in Ireland?	MINIMAL	MEDIUM	Predation on common toads in Ireland area is likely to be of minimal significance. Refer to Question 2.06.
4.19	Indicate any parts for where economic, environmental and social impacts are particularly likely to occur. Provide as much detail as possible, where possible include a map showing vulnerable areas.	-	MEDIUM	Potential impact relate primarily to the threat to native biodiversity and perhaps secondarily to alterations in ecosystem functioning. Costs would accrue from monitoring and management practices. The sight of the animal may cause repulsion or be symbolic of ill omen, but perhaps not so much so as to result in persecution.

Stage 2 - Detailed assessment: Section D - Impact <i>This section evaluates the probability of impact of an organism within Ireland.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.20	Estimate the overall potential impact of this organism in Ireland. Use the justification box to indicate any key issues.	MODERATE	HIGH	The most significant potential impact of <i>B. bufo</i> relates to biodiversity. Presence of the species in Ireland may result in displacement, reduction, or elimination of the native natterjack toad. If any individuals of the species establish which are infected with the chytrid fungus, further and potentially catastrophic threats are posed to all native amphibians (Fisher & Garner 2007; Hanselmann <i>et al.</i> , 2004)

Stage 2 - Detailed assessment: Section E - Conclusion <i>This section requires the assessor to provide a score for the overall risk posed by an organism, taking into account previous answers to entry, establishment, spread and impact questions.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
5.01	Estimate the overall risk of this organism in Ireland. Noting answers given in 1.11, 2.16, 3.10 & 4.20	MODERATE	HIGH	<p>Although <i>B. bufo</i> is not considered to be an invasive species, its presence in Ireland has the potential to negatively impact the native <i>E. calamita</i> population, a species which Ireland is legally obligated to protect. Land use change over the, native and endangered, natterjack toads' geographical range in Ireland, most notably, cessation of grazing or increased forestry would permit widespread encroachment by tall vegetation, which creates shade, and would result in undesirable habitat for the natterjack toad (Beebee, 1977). This alteration in habitat structure would however, favour the common toad, and may allow the species to enter and displace, reduce or eliminate the natterjack population (Beebee, 1977, 1979). Displacement, reduction and elimination has been shown to be exerted via <i>B. bufo</i>'s competitive superiority during spawn and larval development, with both species overlapping in their breeding season (Banks and Beebee, 1987; Heusser, 1972). As adults, natterjack toads subjected to such alteration in their habitat have been found to lose mass and become hyperactive in densely-vegetated conditions because their hunting efficiency was selectively reduced relative to that of <i>B. bufo</i> (Denton and Beebee, 1994).</p> <p>Entry is moderately likely via pet/aquarium/aquatic plant trade; the species may occasionally be kept in captivity and escapes are possible.</p> <p>The Irish climate and the availability of breeding, summering and wintering habitat would be considered as favourable to the establishment</p>

				<p>of the species, with a breeding population recorded at a site in Ratmullen Co. Donegal. Any increases in afforestation are likely to favour this competitively superior anuran. Low vigilance towards the presence of <i>B. bufo</i> will aid establishment.</p> <p>Establishment is likely if the species arrives with at least one toad of each sex in founder stock, or as tadpoles; with suitable breeding habitat present nearby; and low vigilance toward invasive amphibians in the local area.</p> <p>The spread of <i>B. bufo</i> may be limited naturally by its high fidelity to original breeding ponds. The expected infrequency of escape or release by human assistance would also be a limiting factor to the spread of the species; success of which would be additionally dependent on the release or escape of one toad of each sex, or tadpoles, and the availability of suitable aquatic habitat nearby.</p>
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Stage 2 - Detailed assessment: Section F – Additional questions <i>This section is used to gather information about the potential effects of climate change on the risk posed by an organism. It is also an opportunity for the risk assessor to highlight high priority research that could help improve the risk assessment.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
6.01	What aspects of climate change, if any, are most likely to affect the risk assessment for this organism?	-	MEDIUM	The species requires low temperatures and moisture for efficient respiration through its permeable skin (Hartel <i>et al.</i> , 2008, Winchester, 2008). Increases in temperature as a result of climate warming would be likely to impact on the physiological functioning of the species. Increases in temperature may cause pond desiccation thereby potentially impacting upon the species' breeding success.
6.02	What is the likely timeframe for such changes (5, 10, 15, 20, 50 or 100 years)?	20-50	MEDIUM	In a climate modelling study by Araujo <i>et al.</i> (2006), Bufonidae are projected to lose suitable climate space by 2050.
6.03	What aspects of the risk assessment are most likely to change as a result of climate change	-	LOW	The risk of establishment and spread would require reanalysis under altered or new climatic factors.
6.04	If there is any research that would significantly strengthen confidence in the risk assessment, please note this here. If more than one research area is provided, please list in order of priority.	-	-	Research on <i>B. bufo</i> 's recently recorded presence in Ireland, including the source population and its origin/taxonomic status, is urgently required. Detailed knowledge relating to the species' population density and dynamics at its established location are necessary, in addition to research on how to effectively remove the species. This research will likely lead to more effective remedial action if carried out soonest.

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