

Crocidura russula (greater white-toothed shrew)

- A large bi-coloured shrew, with prominent ears, distinctive white teeth and long tail with white hairs.
- Native to northern Europe but not the UK or Ireland.
- Detected for the first time in GB in 2022 but probably present since at least 2005.
- Invasive in Ireland, where it displaces the native pygmy shrew. It is not yet clear whether similar impacts could occur in GB.



History in GB

First detected in September 2022 following DNA tests and photographic evidence from two sites in County Durham, northeast England. Subsequent surveillance identified further individuals at both sites. Photographic evidence suggests it has been present in this area since at least 2005. A separate population was discovered in Nottinghamshire following photographs sent to biological recording schemes.

Native Distribution



Native to parts of continental Europe and North Africa.

GB Distribution

Recorded from County Durham and Nottinghamshire



Impacts

Environmental (major, low confidence)

- Associated with the rapid decline of the native pygmy shrew in Ireland and some declines of *C. leucodon* and *Neomys fodiens* in parts of Europe.
- It is not yet clear whether similar impacts will occur in GB as this species coexists with pygmy shrews and other species in much of its native range.
- There is potential for some impact on the wider ecosystem through competition for food and predation on invertebrates and possibly reptiles and amphibians.

Economic (minimal, v high confidence)

- None reported.

Social (minor, v high confidence)

- May enter people's homes causing problems similar to a mouse invasion.

Introduction pathway

Unknown but a likely stowaway among goods or equipment imported from northern Europe, including Ireland.

Spread pathway

Natural (rapid, medium confidence) – spreading rapidly in Ireland at an estimated 5km per year

Human-aided (rapid, medium confidence) – range jumps in Ireland suggest movement by people is an important part of this species spread.

Summary

	Response	Confidence
Entry	V LIKELY	V HIGH
Establishment	V LIKELY	V HIGH
Spread	RAPID	MEDIUM
Impact	MAJOR	LOW
Overall risk	HIGH	LOW

GB Non-native Species Rapid Risk Assessment (NRRA)

Rapid risk assessment of: *Crocidura russula* (Greater white-toothed shrew)

Risk assessment area: Great Britain (England, Scotland and Wales)

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Placed on NNS website: TBC

Introduction:

The rapid risk assessment is used to assess invasive non-native species more rapidly than the larger GB Non-native Risk Assessment. The principles remain the same, relying on scientific knowledge of the species, expert judgement and peer review. For some species the rapid assessment alone will be sufficient, others may go on to be assessed under the larger scheme if requested by the Non-native Species Programme Board.

Section A – Organism information

1 - What is the principal reason for performing the risk assessment? (Include any other reasons as comments)

Response:

To rapidly assess the risk associated with this species in Great Britain (England, Scotland and Wales).

The greater white-toothed is native to northern Europe, including the Channel Isles, but is not native to the UK or Ireland. It was introduced to Ireland sometime before 2007, when it was first detected in the pellets of barn owls and kestrels. Subsequent live-trapping surveys revealed that it was rapidly spreading and is negatively impacting populations of pygmy shrews.

In September 2022 this species was detected for the first time in Great Britain from DNA (from a dead specimen and shrew faecal samples) and subsequent photographic evidence from two sites near Houghton-le-Spring, Sunderland. From this photographic evidence of a *Crocidura* species, it is highly likely that the species has been present in this area since 2015 (Bond et al. 2022). Subsequent investigation has identified two further populations of this species, one in County Durham and another in Nottinghamshire (see Fig. 1).

The reason for this risk assessment is to better understand the potential risk from this species establishing in GB, including potential impacts on native shrew species.

2 - What is the name of the organism (scientific and accepted common; include common synonyms and notes on taxonomic complexity if relevant)?

Response:

Scientific name: *Crocidura russula*

Common name: Greater white-toothed shrew

3 – Briefly describe the organism

Response: Adult greater white-toothed shrews can weigh between 8 and 14g (pregnant females can weigh greater than 20g). Greater white-toothed shrews are bicoloured, with greyish or reddish brown dorsal (upper) surface and whitish or yellowish grey ventral (lower) surface. They have distinctive white teeth in comparison to the red-tipped teeth of native British shrews (water, common and pygmy shrews). The species has prominent ears for a shrew and their tail has long, white hairs. Males have large scent glands on their flanks during breeding season, which gives off an unpleasant musky odour. The species is found in a wide range of habitats with sufficient ground vegetation and includes agricultural fields, hedgerows, forest/woodland edges, urban areas, farms and gardens. The species will also live in close proximity to houses in more northern latitudes and take up residence in said houses.

4 – Where is the organism native?

Response: Greater white-toothed shrews are listed as ‘Least Concern’ in its native range (IUCN, 2021). It is native in Spain, Portugal, France, Belgium, Netherlands, Luxembourg, Germany, Switzerland, Lichtenstein, Italy and Austria within Europe. The species recently reached the Czech Republic seemingly naturally (De Bellocq et al. 2023). It is present on several of the Channel Islands off the coast of France, which are British Crown dependencies but are not part of the United Kingdom. Outside of the European continent, its range extends to North Africa, being present in Morocco and Algeria. The large degree of genetic divergence at multiple regions of the genome between greater white-toothed shrews in these regions and those in Tunisia and Sardinia (Italy) has led to the latter populations now being considered as a separate species (*C. pachyura*, formerly known as *C. ichnusae*; Brändli et al. 2005).

5 - What is the global distribution of the organism (excluding the risk assessment area)?

Response: The greater white-toothed shrew is distributed in Spain, Portugal, France, Belgium, Netherlands, Luxembourg, Germany, Switzerland, Austria, the Channel Islands, Morocco and Algeria and has been recently introduced to Great Britain, Republic of Ireland and Norway.

6 - What is the current distribution of the organism in the risk assessment area?

Response: Confirmed records from two locations in northeast England, Easington Lane and Houghton le Spring (Bond et al. 2022) and a further location in Nottinghamshire. The north-east records are more than 3km apart. The Houghton le Spring record came from faecal samples found near a stone wall in August 2022 and were later DNA tested to find they 100% matched *Crocidura russula*. The Easington Lane records were from one individual caught by a cat in September 2021 and DNA confirmed the species as *C. russula*. The person whose cat had caught the specimen then produced photos ranging from July 2015 until July 2022 that clearly resemble *Crocidura* shrews as opposed to *Sorex* shrews (Bond et al. 2022). In Nottinghamshire, greater white-toothed shrews have been trapped from three locations near Bilsthorpe, which are approximately 2km apart.

7 - Is the organism known to be invasive anywhere in the world?

Response: This species is invasive in the Republic of Ireland where it is known to replace the pygmy shrew (*Sorex minutus*) in as little as 1 year after they come into contact with each other (Montgomery et al. 2012, 2015; McDevitt et al. 2014; Browett et al. 2023). Species first recorded in Norway in 2012 (van der Kooij & Nyfors 2023) in the southwestern part of the country. Although most records from the citizen science-based

study were of the greater white-toothed shrew in the area, it is too early to tell if the species is outcompeting other shrew species as the results may be biased by the nature of the media call and commensal nature of the invasive species in comparison to other shrew species (van der Kooij & Nyfors 2023).

Section B – Risk assessment

Entry

Estimate the overall likelihood of entry into the risk assessment area for this organism (comment on key issues that lead to this conclusion).

Response: *very likely*
Confidence: *very high*

Comments (include list of entry pathways in your comments):

The species is already present in Great Britain (Bond et al. 2022). Given the large volume of trade/goods/freight moving between Great Britain, Ireland and mainland Europe via ports, it was considered inevitable that the species would reach mainland Great Britain eventually (McDevitt 2019). It is probable that the species was initially brought to Ireland with horticultural/arboricultural produce, given its initial discovery close to tree nurseries in the south of the island (Tosh et al. 2008; Gargan et al. 2016). This could have occurred via large, hessian wrapped root balls of trees where soil would have harboured the insect prey and water necessary to sustain the shrews during transportation (Gargan et al. 2016). A similar mechanism could have facilitated the introduction of the species to Britain. At present it is unknown if the species arrived in Britain from Ireland but specimens will now have their DNA sequenced to compare them to Irish, mainland Europe and African populations (Gargan et al. 2016) to infer the likely source of the British introduction.

Establishment

Estimate the overall likelihood of establishment (comment on key issues that lead to this conclusion).

Response: *very likely*
Confidence: *very high*

Comments (state where in GB this species could establish in your comments, include map if possible):

This species present in two areas (approximately 3km apart) in northeastern Britain and also in Nottinghamshire so it is very likely that the species has become established (Fig 1). Likely present in Easington Lane since 2015 based on photographic evidence of a *Crocidura* species (Bond et al. 2022). *Crocidura* shrews are a more social species than native *Sorex* and *Neomys* shrews (which are solitary and territorial) and live in communal nests. Therefore, the species tends to occur in high densities where it is present (McDevitt et al. 2014). In Ireland, species established and spread rapidly after introduction. However, Ireland has fewer small mammals, with only the pygmy shrew and two species of non-commensal rodents present (wood mouse and non-native bank vole). Britain has three shrew species (water, common and pygmy shrew) and a larger number of small rodent species present. Although competition for resources would be greater in the invaded environment in Britain than Ireland, there is currently no evidence that this will delay/inhibit establishment. In its native range, the species shows no phenotypic evidence of inbreeding depression despite evidence of mating among relatives (Duarte et al. 2007), suggesting that initial small population sizes won't be a hinderance to establishment.



Figure 1. Location of sites where the greater white-toothed shrew has been detected in Britain.

Spread

Estimate overall potential for spread (comment on key issues that lead to this conclusion).

Overall response: *rapid*

Confidence: *medium*

Sub scores:

Natural spread only:

Response: *rapid*

Confidence: *medium*

Human facilitated spread only:

Response: *rapid*

Confidence: *medium*

Comments (in your comments list the spread pathways and discuss how much of the total habitat that the species could occupy has already been occupied):

Initially the species was found in a relatively small area but photographic records indicate its presence in one of the locations since 2015 (Bond et al. 2022). However, further records from live-trapping in 2023 have identified the species in Durham and Nottinghamshire (Fig. 1). In Ireland, species is spreading very rapidly, with estimates of the invasive range expanding at 5km/year (McDevitt et al. 2014) and backed up by more recent data (S. Browett & A. McDevitt, unpublished data). In addition, the species' range has 'jumped' in several parts of Ireland with significant gaps between the main invasive range and these smaller range pockets further north and west (A. McDevitt, unpublished data), showing likely evidence of human-mediated dispersal throughout the island (McDevitt et al. 2014; Granger et al. 2016). The species is present in a 60 × 20 km area in Norway after the first record in 2012 up to 2021 (van der Kooij & Nyfors 2023) but in an area with one of the mildest climates in the country. Species generally limited to altitudes below 2000m and not adapted to the colder climates of the northern latitudes in the same way *Sorex* shrews are (Oliveira et al. 2022). Greater white-toothed shrews are found in hedgerows, grasslands, woodlands and around human dwellings (again, more so than native British shrews) in their native range in Europe and invasive range in Ireland so there is ample habitat available to spread through on the majority of the island. Indirect estimates of dispersal for the species in their native habitat is

800m on average per generation (Jaquierey et al. 2008) with direct estimates of a maximum dispersal distances of 660m for females and 710m for males (Dussex et al. 2016). Given the original underestimation of the invasive range in Ireland, a similar scenario may be occurring in Great Britain. Therefore, extensive live-trapping surveys, birds of prey pellet studies (McDevitt et al. 2014) and small mammal camera trapping (Littlewood et al. 2021) would be warranted in Great Britain also. The Mammal Society have recently started a campaign to raise awareness of the species and to report records.

Impact

Estimate overall severity of impact (comment on key issues that lead to this conclusion)

Overall response: *major*

Confidence: *low*

Sub-scores

Environmental impacts:

Response: *major*

Confidence: *low*

Economic impacts:

Response: *minimal*

Confidence: *very high*

Social impacts:

Response: *minor*

Confidence: *very high*

Comments (include list of impacts in your comments):

The presence and spread of the greater white-toothed shrew is associated with the rapid decline and replacement of the pygmy shrew in invaded regions in Ireland (Montgomery et al. 2012, 2015; McDevitt et al. 2014; Browett et al. 2023). The pygmy shrew was previously the only shrew species present on the island of Ireland. The two species can coexist in other parts of their range in western Europe, but within larger shrew and small mammal communities (and the pygmy shrew tends to be rare within these communities). Current evidence suggests that the primary mechanism by which the greater white-toothed shrew is causing the decline of the pygmy shrew in Ireland is due to direct dietary competition, with the greater white-toothed shrew shifting its diet from bigger invertebrate prey when it first enters an area to the smaller invertebrate prey that is more important to the pygmy shrew after it becomes established and more abundant (Browett et al. 2023). This replacement can happen in as little as one year (McDevitt et al. 2014) and in all the sites where the species co-existed in 2012-2013 in Ireland that were re-visited in 2017-2018, the pygmy shrew was no longer present (Browett et al. 2023). The greater white-toothed shrew is known to displace other shrew species, with evidence of displacement of *C. leucodon* in Switzerland (Vogel et al. 2002) and on French islands (Cornette et al. 2015). The greater white-toothed shrew has also been associated with the water shrew (*Neomys fodiens*) appearing less frequently in barn owl diet in the Netherlands (Witte 2016).

Britain has three shrew species present so the same replacement process may not occur to the same extent. The Irish pygmy shrew has not had a direct competitor in Ireland so is likely unable to adapt to a new species for the same resources in such a short timeframe. Pygmy shrews in Britain have co-existed with common and water shrews for millennia so it is not known at present if similar negative impacts will occur. Differential resource use and niche separation among these insectivorous small mammals is known to be integral for facilitating multi-shrew communities (Rey et al. 2019) and this has been proposed to facilitate the sympatric existence of pygmy shrews (albeit in low abundance) with larger species of shrews in mainland Europe (Churchfield & Rychlik 2006). Therefore, competition between the greater white-toothed shrew and the larger common shrew (Guelat et al. 2008) could act as a buffer to reduce the impacts on the pygmy shrew in Britain.

Browett et al. (2023) also highlighted the potential that the invasive greater white-toothed shrew was exhausting invertebrate prey resources based on the evidence of its diet changing after it has become established. A recent study by Montgomery et al. (2023) has now provided direct evidence of this, with the greater white-toothed shrew associated with a decrease of 33% in invertebrate taxon richness, 46% decrease in invertebrate abundance, 35% decrease in arthropod body length and a huge 89% decrease in arthropod biomass. Therefore, the species is clearly having impacts on the wider ecosystem beyond competition with other shrew species.

There is also the potential for adverse impacts on the terrestrial vertebrate (e.g. amphibians and reptiles) which the greater white-toothed shrew has been known to prey on in other regions of its native range (Brahmi et al. 2012). However, no evidence of these species has been found in Ireland in their diet thus far (Browett et al. 2023). A wide range of invertebrates are taken, with earthworms, centipedes, flies, millipedes, beetles, woodlice and snails/slugs eaten (Browett et al. 2023). Known predators include barn owls and kestrels amongst birds of prey (Tosh et al. 2008), and red foxes, stoats and pine martens amongst mammalian predators (e.g. O'Meara et al. 2014).

The greater white-toothed shrew was found to carry a novel pathogenic strain of *Leptospira* in Ireland from samples collected in 2013 (Nally et al. 2016). Approximately 12% of *C. russula* in Germany carried *Leptospira* (Haring et al. 2023) but ongoing investigations in Ireland have not found further cases in Irish shrews (Jahns & McDevitt, *unpublished data*). In terms of ectoparasites, Irish pygmy shrews have a prevalence of ticks and fleas that is similar before and after they come into contact with the greater white-toothed shrew (Cooper, McDevitt & Bown, *unpublished data*). Additionally, the prevalence of pathogenic bacteria spread by these invertebrate vectors (e.g. *Bartonella*) was similar also. Ongoing work investigating gut helminth and microbiome communities (using DNA metabarcoding) between the two species in Ireland is ongoing (McDevitt et al. *unpublished data*). Although there are currently no thorough investigations underway on the potential of disease-mediated interactions leading to the demise of the pygmy shrew in Ireland, it can not be ruled as a potential cause (or indeed, a cumulative factor along with dietary competition). *Crocidura* shrews are known to harbour a range of viruses (e.g. Borna virus, Niller et al. 2020; and Evre virus, Chastel et al. 1989) and other pathogens so investigations into the full range of pathogens carried by the invasive greater white-toothed shrew would be warranted to understand the potential spillover into other mammalian species.

Economic impacts are expected to be minimal but there could be minor societal issues with the species coming into contact with humans and entering homes (something that native shrews do infrequently). The adult males have large scent glands along their flanks which have a distinct and unpleasant smell. Given that the species is social and lives in communal nests, several to many individuals may be present in a dwelling (Guelat et al. 2008) and this issue has been reported in Ireland on several occasions (McDevitt et al. 2014). This can lead to problems similar to a mouse infestation (in terms of noise/scratching, sightings and unpleasant odour but not the consumption of food items in the home) that could potentially be more difficult to control (i.e. not a species pest companies would be used to dealing with for example given the protected status of native shrews).

Climate Change

What is the likelihood that the risk posed by this species will increase as a result of climate change?

Response: *high*

Confidence: *medium*

Comments (include aspects of species biology likely to be effected by climate change (e.g. ability to establish, key impacts that might change and timescale over which significant change may occur):

Greater white-toothed shrews are more associated with warmer Mediterranean climates and *Sorex* shrews are more associated with Palearctic (more temperate and colder) climates (Oliveira et al. 2022). *Sorex* shrews in particular show unique adaptations (e.g. Dehnel's phenomenon; Lazaro & Dechmann 2021) to surviving cold winter periods. *Sorex* shrews tend to be more sparsely populated in Iberia for example. Vogel et al. (2002) highlighted that the species would continue to spread in continental Europe with ongoing climate change and this may make Britain more suitable for greater white-toothed shrews and give the species a competitive

advantage over native British shrews.

Conclusion

Estimate the overall risk (comment on the key issues that lead to this conclusion).

Response: *high*
Confidence: *low*

Comments:

The greater white-toothed shrew has already arrived in Great Britain (Bond et al. 2022) and become established in two regions (Fig. 1). It is very likely that the species is spreading but is under-recorded. This may be similar to what has happened in Ireland and Norway where sparse initial records eventually led to substantial invasive ranges being identified with extensive live-trapping and records from birds of prey (McDevitt et al. 2014) or records from citizen science-based projects (van der Kooij & Nyfors 2023). Given the significant negative impact that the invasive greater white-toothed shrew has had on the pygmy shrew in Ireland, there are genuine concerns it may have similar impacts in Britain. However, it is also important to note that the pygmy shrew was the sole shrew species present in Ireland prior to the greater white-toothed shrew's invasion and the species co-exist in continental Europe. Browett et al. (2023) has proposed through a thorough investigation of dietary overlap between the two species in Ireland that this previous absence of competitors for the pygmy shrew is the reason the species has been rapidly out-competed and replaced. However, disease-mediated interactions can not be ruled out either until the necessary investigations are undertaken. In Britain, there are other species of shrew present so the pygmy shrew has been living amongst competitors for millennia. The pygmy shrew and the greater white-toothed shrew co-exist in mainland Europe along with the species that are present in Britain so resource/niche partitioning may occur in Britain. It is clear that the initial invasive range and potential impacts on the native shrews (not just pygmy shrews) in terms of dietary competition and disease-mediated interactions needs to be established quickly because eradicating an invasive shrew species over such large areas is very unlikely to be feasible (Seymour et al. 2005).

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Provide here a list of the references cited in the course of completing assessment

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